Developing an Urban Resilience Index for Ajman City

تطوير مؤشر المرونة الحضرية لمدينة عجمان

by

ALYA OBAID MEJLAD ALSHAMSI

A thesis submitted in partial fulfilment

of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN ARCHITECTURE

AND SUSTAINABLE BUILT ENVIRONMENT

at

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ABSTRACT

Land-use change and worldwide environmental degradation are both accelerated by urbanisation. With global urbanisation accelerating, new regulations are needed to protect urban ecosystems, species, and the services they offer, ensuring more viable, adaptable, and liveable cities. The increase in the research of sustainable development has enhanced the awareness and attention of various global sectors such as developers and policymakers regarding advanced sustainable cities, along with the associated impact of sustainability in terms of the urban transformation.

Ajman, one of the seven emirates that make up the UAE, has begun to establish plans, policies, and initiatives for this aim in collaboration with the other governmental agencies. Ajman has faced more obstacles as a result of the Emirate's growing population, improved social conditions, way of life, and industrial revolution. These difficulties line up with the national and international aims and strategies that focus on pressing environmental, social, and economic problems. As a result, Ajman Municipality has made it a priority to integrate sustainability into all facets of daily life, and considers it to be essential to both its vision and goals.

This research is intended to develop an urban resilience index (URI) for Ajman city to support future planning. The primary objective was to develop a tool for measuring and quantifying the resilience of an area, in order to assist policymakers and urban planners in determining whether a development project will be instrumental in enhancing city-level resilience. The proposed URI is based on data collected from a range of indicators spanning a number of key URI component indices. The dimensions over which the indices are distributed were identified through a critical literature review, while keeping Ajman's local context in mind. The methodology for the current research was the primary qualitative approach, which was collected by conducting interviews.

Ajman's URI, according to the stakeholder feedback, should include institutional, infrastructural, social, and economic factors. The stakeholders also pointed out that the primary urban indicators that should be included in Ajman's URI are the ecological environment's quality, environmental policies, land use, public service amenities, disaster response and reduction framework, and critical city infrastructure. One of the issues raised was that the population of urban areas has grown significantly in recent years, and is expected to grow even further. Therefore, planners cannot find a balance between measures that can be better implemented to make urban systems, cities, and their people more resilient to problems.

A 17-item universal resilience indicator composite was developed and found to be effective in assisting policymakers with the planning and assessment of a resilient future Ajman. The proposed URI can provide comprehensive information on urban resilience to climate change for municipal planners in cities. It allows for comprehensive city comparisons, which aids in the qualitative evaluation of areas of strength and weakness. It also allows one to look into the relationships between the total URI and other aspects of urban climate change resistance. Thus, the URI can be used to assess individual components of urban resilience and their associated indicators, as well as broad indicators of urban climate change resilience.

الملخص

تزداد سرعة تغير استخدامات الأرض والتدهور البيئي العالمي جرّاء التحضر. مع تسارع التحضر العالمي، أصبح إلزاماً توفير لوائح جديدة لحماية النظم البيئية الحضرية والفصائل والخدمات التي تقدمها، مما يضمن مدنًا أكثر قابلية للحياة والتكيف والصلاحية للعيش، حيث أثمرت حالة المباحثات في مجال البيئة المستدامة إلى تعزيز وعي واهتمام مختلف القطاعات العالمية مثل المطورين وصانعي السياسات فيما يتعلق بالمدن المستدامة المتقدمة جنبًا إلى جنب مع تأثير الاستدامة المرتبط بالتحول الحضري.

عجمان، إحدى الإمارات السبع التي تشكل دولة الإمارات العربية المتحدة، بدأت في وضع خطط وسياسات ومبادرات لهذا الهدف بالتعاون مع الجهات الحكومية الأخرى. كما واجهت عجمان المزيد من العقبات جرّاء النمو السكاني للإمارة وتحسن الظروف الاجتماعية وأسلوب الحياة والثورة الصناعية. وقد أُدرجت هذه الصعوبات في الأهداف والاستراتيجيات الوطنية والدولية التي تركز على المشكلات البيئية والاجتماعية والاقتصادية الملحة. ونتيجة لذلك، وضعتها بلدية عجمان في أولوياتها لدمج الاستدامة في جميع جوانب الحياة اليومية واعتبرتها ضرورة في رؤيتها وهدفها.

يهدف هذا البحث إلى تطوير مؤشر للمرونة الحضرية لمدينة عجمان للتخطيط المستقبلي. كان الهدف الأساسي هو تطوير أداة لقياس مرونة منطقة ما لمساعدة صانعي السياسات والمخططين الحضريين في تحديد ما إذا كان مشروع التنمية مفيدًا في تعزيز مستوى مرونة المدينة. يعتمد مؤشر المرونة الحضرية المقترح على البيانات المجمعة من مجموعة من المؤشرات التي تغطي عددًا من المكونات الرئيسية لمؤشر المرونة الحضرية. وتحددت الأبعاد التي يتم توزيع المؤشرات عليها من خلال الاستعراض المرجعي للدراسات العلمية السابقة مع مراعاة الوضع المحلي في عجمان. كانت منهجية البحث للدراسة الحالية هيو المنهج الكيفي الأساسي الذي تم جمعه من خلال إجراء المقابلات.

حيث تعيّن أن يتضمن عنوان مؤشر المرونة الحضرية لعجمان، وفقًا لتعليقات المعنيين، على العوامل المؤسسية والبنية التحتية والاجتماعية والاقتصادية. وأشار المعنيين أيضًا إلى أن المؤشرات الحضرية الأساسية التي يجب تضمينها في مؤشر المرونة الحضرية لعجمان هي جودة البيئة البيئية، والسياسات البيئية، واستخدام الأراضي، ومرافق الخدمة العامة، والاستجابة للكوارث وإطار الحد من الكوارث، والبنية التحتية الحيوية للمدينة. حيث كانت إحدى القضايا التي أثيرت هي نمو سكان المناطق الحضرية بشكل ملحوظ في السنوات الأخيرة ومن المتوقع أن ينمو أكثر. لا يمكن للمخططين إيجاد توازن بين تدابير يمكن اتخاذها بشكل أفضل لجعل النظم الحضرية والمدن وسكانها أكثر مرونة في مواجهة المشاكل.

تم تطوير مؤشر مرونة عالمي مركب مكون من 17 عنصرًا ووجِد أنه فعال في مساعدة صانعي السياسات في تخطيط وتقييم مستقبل عجمان المرن. يمكن أن يوفر مؤشر المرونة الحضرية المقترح معلومات شاملة عن المرونة الحضرية لتغير المناخ لمخططي البلديات في المدن. يسمح بإجراء مقارنات شاملة بين المدن، مما يساعد في التقييم النوعي لمناطق القوة والضعف. كما أنه يسمح للفرد بالنظر في العلاقات بين مؤشر المرونة الحضرية الكلي والجوانب الأخرى لمقاومة تغير المناخ الحضري. وبالتالي، يمكن استخدام مؤشر المرونة الحضرية لتقييم المكونات الفردية للمرونة الحضرية والمؤشرات المرتبطة بها، وكذلك المؤشرات العامة لمرونة تغير المناخ الحضري.

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I owe a debt of gratitude to my esteemed professor, Dr. Bassam, whose wisdom, mentorship, and dedication to my academic growth have been instrumental in shaping this thesis. His expertise and guidance have been invaluable, and I am profoundly thankful for the opportunity to learn under his tutelage.

I would also like to express my appreciation to my friends and colleagues. Their camaraderie, encouragement, and willingness to help have been a constant source of motivation. Together, we have faced the challenges of academia and celebrated its triumphs.

Lastly, I want to acknowledge the countless individuals and resources that have contributed to my academic journey in various ways. Your collective support has played a vital role in my success, and I am deeply grateful for your assistance.

This thesis represents not only my own dedication and hard work but also the support and contributions of these remarkable individuals and entities. Thank you for being a part of this academic adventure.

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LIST OF ABBREVIATIONS

3Rs	Reduce, Reuse, and Recycle
AMPD	Ajman Municipality and Planning Department
GIS	Geographic Information System
IBM	International Business Machines
KPI	Key Performance Indicator
MCE	Multiple Criteria Evaluation
NGO	Non-Governmental Organisation
NKPI	National Key Performance Indicator
OECD	Organization for Economic Co-operation and Development
SB-URPSS	Scenario-Based Urban Resilience Planning Support System
SDG	Sustainable Development Goal
SPSS	Statistical Package for the Social Sciences
UAE	United Arab Emirates
UCCR	Urban Climate Change Resilience
UN	United Nations
UNDP	The United Nations Development Programme
URI	Urban Resilience Index
URCI	Urban Resilience Capacity Index
UST	Urban Sustainability Transformation

CHAPTER 1: INTRODUCTION TO THE RESEARCH STUDY

This chapter presents the problem statement of the current thesis, along with the aims and objectives, expected outcomes, and their benefits. It also includes the motivation to undertake this research and make this the topic of the present doctoral thesis.

1.1 Background

The complexity of cities weaves together social, economic, environmental, and institutional threads with substantial effects on individual and social well-being. The population in urban centres has increased significantly in recent years, and is even expected to increase further. According to a report published by the Organization of Economic Cooperation and Development (OECD), the urban population in the world is projected to reach 6 billion by 2050 (Figueiredo et al. 2018). The growth of urban communities and urban areas will increase the scale and impact of shocks and stresses. Crises that are related to environmental degradation, climate change, and volatile weather have already become frequent occurrences in recent years.

As such, a conceptual understanding of the vulnerabilities, risks, and aptitudes of urban resilience systems is necessary. It is essential in the design and development of approaches to focus heavily on disaster risk reduction. In turn, the concept of urban resilience, in tandem with smart cities and urban sustainability, has gained substantial momentum in recent years and has been a focal topic under consideration by the governments and stakeholders of cities around the world (Nop & Thompton 2019). Resilience has become a priority among local, national, and international planners, and in this context, there has been an increased emphasis on the different approaches to climate change adaptation (Suárez et al. 2016).

The ability to prepare, react, and then recover from various threats and hazards is referred to as the resilience of a particular region. Resilience is an essential idea that evaluates economic, environmental, and social circumstances for planning cities and provides a route towards the achievement of strategic goals (Folke et al. 2016). The notion of flexibility or resilience is the active aspect of sustainability that gives surety to the achievement of the sustainable aim and forms mechanisms to identify future changes in the urban structure (Childers et al. 2014). The attention of researchers, planners, and other stakeholders towards urban resilience is a welcome step and is identified as an essential aspect in the process of city development. The positive news is that this trend is increasing in cities and is growing more popular among the authorities that govern the city as they come to terms with reality – sooner or later. In the development of resilient cities, researchers have suggested that planners consider a myriad of factors, including climate change, economic crises, managerial mistakes, disaster risk and reduction, response systems, population growth, migration, employment, sustainable development goals (SDGs), recreation, and terrorism, among others.

These cities should have resilience to a multitude of challenges and threats, ranging from environmental disasters to socio-economic disruptions. Since the urban centers are in an ever-continuing population growth, they have susceptibility to shocks and stresses related to environmental degradation, climate change, and volatile weather patterns. Thus, resilience is a great aspect for preparing such cities to be able to withstand, and also recover from the impacts of these environmental crises. Besides, urban resilience should further encompass the ability to adapt to economic downturns, financial crises, and managerial mistakes that may occur. Notably, a resilient city must have the capacity to respond effectively to the shifting economic conditions, and hence offer robust systems that are geared towards ensuring the maintenance of critical services and determining support for its inhabitants during challenging times.

Notably, the notion of resilience can be looked at as an umbrella term that covers various procedures through which a society, institution, or country responds to changes and stresses from various internal and external sources. The existing literature contains a good number of cases that are based on studies in the domain of resilience and have addressed issues related to different topics that are of interest to us in urban planning and resilience. An inclusive strategic plan is the directorial idea that leads to the land use, and long-term resource development within a certain place. Reviewing this plan frequently in the case of Ajman city can help in checking the compliance of the city's schedules and strategies related to infrastructure development with the Emirate's standards and rules. Similarly, the development management of land resources must comply with the policies identified in the plan for resilience. This research outlines the approaches that have been proposed for planning and presents an overview of the processes considered in Ajman's updated plan. Guidance for decision-making about the city's future will be provided by a resilience plan that will focus on three aspects: (a) the implications of the plan by 2040, (b) future urban policies, and (c) strategies to achieve the proposed plans.

Developing a resilience index assessment and an adaptation plan is important to make a resilient city (Hall 2017). Urban resilience needs to be integrated with the Ajman, UAE, planning policy in order to understand the interdependences of their system and address the urban challenges. This study addresses this gap to highlight the ability of Ajman city to adapt to the future and to better mitigate the impact of climate change.

1.2 Research Questions, Aim, and Objectives

1.2.1 Research Questions

The research questions of the current research will be:

- In the context of urban resilience, how might climate-sensitive knowledge be translated into enhancing strategies?
- What is the current state of knowledge on resilience indices?
- What are the urban regulatory tactics that should be explored as part of the search for more long-term solutions?
- Which urban indicators are the most appropriate for generating the city's finest urban resilience index?

1.2.2 Research Aim

This study aims to develop an urban resilience index (URI) appropriate for the city of Ajman, UAE. The development of such an index will support policymakers with the planning and assessment of a resilient future city.

1.2.3 Research Objectives

The research aim will be addressed through the following objectives:

- To investigate how climate-responsive knowledge can be translated for the enhancement of strategies in Ajman city within the context of urban resilience.

- To find out how adapting to climate change affects the quality of life, leading to a resilient Ajman city urban design.
- To develop urban regulation strategies that Ajman city planners need to consider when taking more sustainable measures for the future.
- To identify what measures and climate adaptation policies need to be acknowledged in Ajman city.
- To establish the most adequate urban indicators that should be included in Ajman city's urban resilience index.

To realise the study, aim to develop a URI applicable in policymaking for climate change in Ajman city's future plan. The research should include a clear introduction that outlines the problem statement and research questions corresponding with their objectives that will draw the proposed research outline. This will be further divided into some sub-topics throughout the study, with the following section defining the problem statement that the study aims to address.

1.3 Problem Statement

The smart and sustainable city concept has been getting much attention and is considered the most critical and crucial topic in public policies worldwide. It has been found that there is a combined link between sustainable cities and smart technologies; however, smart technologies can be used without considering sustainable developments. To approach building energy sustainability, it is important to consider the sustainable energy resources available. Across the globe, smart grids, the Internet of Things, and artificial intelligence are enhancing the development of the smart city. Hence, the government of the UAE has put forward the concept of ensuring sustainable development, along with preserving the environment and eventually achieving an adequate balance between social and economic development. Additionally, following the trend nationally and globally, the Ajman Government is also experiencing urbanisation. Hence, this research will be helpful for the Ajman Municipality and Planning Department (AMPD) and its workers to help in understanding the challenges and opportunities that will be required. Furthermore, it will help provide a clear understanding of all the relevant and related factors that need to be considered during the evaluation, planning, and implementation of policies and regulations to achieve the development of a URI within Ajman city.

UAE and Ajman should have resilience due to the increasing complexity and interconnectivity of urban environments, along with the growing challenges they face. Significant population growth is continuously being observed contemporarily, and there is also projected further increase in urban populations. This makes these two cities become more susceptible to shocks and stresses related to environmental degradation, and the shifts in climate. Hence, resilience is necessary for ensuring that the two cities have effectiveness in preparing for and responding to such challenges. Through fostering of resilience, Both UAE and Ajman can enhance their capacity to adapt, recover, and thrive in the face of a wide range of threats and uncertainties. This further ensures their long-term sustainability and the resilience of their communities.

This research study aims to develop an urban resilience index (URI) specific to Ajman, UAE, in order to support policymakers in planning and assessing a resilient future city. The complexity and interconnectivity of urban environments, coupled with the challenges posed by population growth and environmental degradation, highlight the need for resilience in both UAE and Ajman. By fostering resilience, the given cities can enhance their capacity to prepare for, and respond to various shocks and stresses. This would guarantee their long-term sustainability, besides illustrating their communities' wellbeing. In this research, investigations about the translation of climate-sensitive knowledge into enhancement strategies, are explored, besides exploring the impact of climate change adaptation on quality of life and urban design. Urban regulatory tactics for sustainable measures and determine the most appropriate urban indicators for Ajman's urban resilience index, are further identified. Significantly, valuable insights for policymakers are availed, divulging how they contribute to the development of a resilient and sustainable future for Ajman.

1.4 Novelty of the Research

This research study contributes both theoretically and practically to the field of urban resilience and sustainable city development in several novel ways:

1.4.1 Theoretical Contributions

1.4.1.1 Integrated Approach

This research takes an integrated approach by considering the translation of climate-sensitive knowledge into urban resilience strategies, the impact of climate change adaptation on urban design and quality of life, and the development of urban regulatory tactics and indicators. This holistic perspective offers a comprehensive framework for understanding and enhancing urban resilience.

1.4.1.2 Localized Urban Resilience Index

The development of an Urban Resilience Index (URI) specific to Ajman, UAE, is a novel contribution. While there are existing urban resilience indices, tailoring one to the unique context of Ajman provides a valuable tool for policymakers to assess and plan for the city's specific challenges and opportunities.

1.4.1.3 Resilience and Sustainability Nexus

This research explores the intersection of urban resilience and sustainability, shedding light on how the two concepts are interconnected. It addresses the need to balance social, economic, and environmental aspects within the context of urban development.

1.4.2 Practical Contributions

1.4.2.1 Policy Guidance

The findings of this research will offer practical guidance to policymakers, particularly the Ajman Municipality and Planning Department (AMPD). It will assist in understanding the challenges and opportunities specific to Ajman's urban development, facilitating evidence-based policy decisions.

1.4.2.2 Community Well-Being

By focusing on the impact of climate change adaptation on quality of life and urban design, this research directly addresses the well-being of Ajman's residents. The insights gained can inform strategies to enhance the overall living conditions in the city.

1.4.2.3 Long-Term Sustainability

The development of a localized URI will aid in the long-term sustainability planning for Ajman. It will enable the city to prepare for and respond effectively to various challenges, ensuring the resilience of the community and the continuity of essential services.

1.4.3 Flow of Thesis and the Interlink Between Chapters

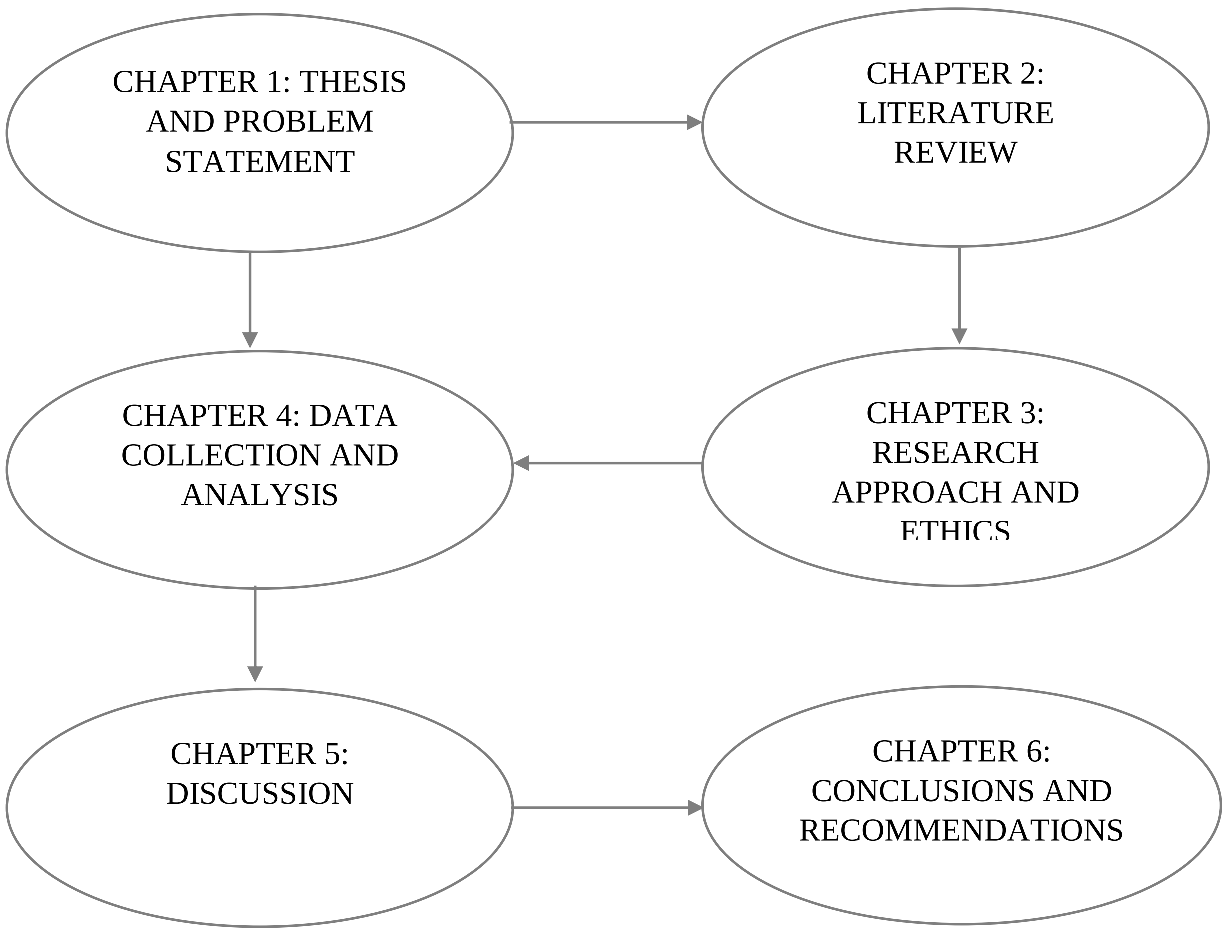

Figure 1.1: Flow of Thesis

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In order to give a description, summary, and critical evaluation of these works in relation to the research subject under investigation, a literature review examines books, scholarly papers, and any other materials pertinent to a specific issue, field of research, or theory.

Climate change has introduced new difficulties, such as climatic uncertainties and different implications for daily living. Furthermore, planning and designing have become important and difficult, for which several policies have been adopted. In the sciences of sustainability, resilience has become the key concept, frequently translating "sustainable" into everyday discussions. In the past four decades, the word resilience has been used in so many different forms and industries that some authors question if it has lost its meaning or whether it is a bridge idea across disciplines. Resilience is even a priority at the municipal, national, and international levels, having been identified as a key objective in local climate adaption strategies or the Sustainable Development Agenda 2030 of the UAE’s Development Programme (Sturiale 2020).

Different researchers have focused on different dimensions of resilience and presented a wide variety of guiding frameworks to tackle issues and enhance resiliency. The current thesis addresses urban development and city planning with the inclusion of resilience measures as a necessary parameter in the required procedures to establish cities with high resilience (Almoghathawi et al. 2019). It is also centred on building an urban resilience index (URI) for the city of Ajman in the UAE. Ajman city has been taken as an example in this study since it is a small-sized city that tends to have significant pressure on the land resources. Considering these factors, the study found it to be a relevant case for this thesis both in terms of analysis and the development of a related index (Almoghathawi & Barker 2019).

The practice of considering resilient theory as an essential aspect in the field of sustainability research has prevailed recently. Huge attention has been given to developing a framework that can aid planners and other stakeholders in establishing cities of high resilience in the era of increasing climatic fluctuations. However, the existing literature does not acknowledge the usability of planning scenarios and preservations methods, while suggesting development plans for the establishment of resilient urban centres (Almarzouqi 2017). Hence, there is a need to consider both aspects while suggesting development frameworks and investigating the URI as a guiding tool to assist planners in the process of development and environmental protection integration in urban project planning that will enable resilience improvement in the underlying project plans. To ensure enhancement in the resiliency of a city, it is vital to understand the determinants of resilience, and the procedure to measure it. The current research will focus on formulating a URI that is based on the integration of protection mechanisms for vacant areas and the efficient use of land structure (Al-Maamary et al. 2017).

The evolving design of growing urban centres is associated with long-term consequences as once built, urban centres have been found to be problematic to adjust. Integrating an understanding of the challenges associated with climate and other threads with urban development decisions is an important constituent in city planning and for the establishment of more resilient cities. In this respect, the development of tools and frameworks for evaluating the influences of land use, urban designs, population, and various human activities, and the resultant impacts on the atmosphere and environment is necessary. Understanding the influence of individual cities on the global climate and planning consistent with the need for a timely solution is vital. In fact, various research has been undertaken to suggest and provide the framework for planning, yet the evidence of their use in the formation of spatial decision-making is lacking. Various causes have led to the failure of knowledge circulation (Allam & Jones 2019). One of the reasons is the incompatibility of the concerns of development planners and knowledge regarding the climate of the locality, which leads to a lack of inclusive strategic planning.

The approaches that have been undertaken depend on the evaluation of climatic conditions with the help of strategic plans to enable statistical calculations and to gain insights for producing the best procedures, practices, and policies to enable the establishment of an urban structure within a city that is functional, resilient, sustainable, and also responsive to the climatic fluctuations faced. Most of the world's population lives in urban ecosystems, which are defined as systems in which people dwell in high densities and which cover most of the city land. Given that people are primarily responsible for environmental change, new urban planning paradigms need to be implemented to not only build more sustainable, liveable, and resilient towns, but also to reduce their environmental and social consequences globally. There is, however, no consensus as to what resilience means to cities and how to integrate such definitions into urban planning (Staddon et al. 2018).

The research has influenced the way ecologists think about the structure of ecosystems and their ability to absorb disturbances while maintaining stability. It distinguished between two types of resilience: technological and environmental resilience. The former concerns the capacity of a system to return to equilibrium after a disruption, whereas ecological resilience acknowledges that there are many equilibrium states and that after a disruption a new state may emerge (Smith & Mayer 2018). Although the first and the second are on the rebound, they both are founded on the concept that every system may strike a stable balance.

Urban resilience is a complex concept that contributes to the good development of this arduous process to solve the ecological, social, and economic problems of contemporary cities. However, resilience is inherently vague, like other broad concepts such as sustainability. Therefore, it may be difficult to determine what this means for local options and plans (Sitas et al. 2021). Specific processes and conducts that enhance resilience in a city and that contribute to policies and practices are known as principles of resilience. They may focus on the system or its management. Buffering, variety, omnivorousness, network flatness, balance, and enhanced resource flow are only a few examples. Resilience may be eased via the use of resilience principles. They help to clarify and apply the concept of "urban resilience". They may be used to generate new ideas, evaluate proposed options and methods, and explore the views of stakeholders. These ideas may be used in a wider evaluation process that considers the context, urban systems, and components, as well as envisioned scenarios of the past, the present, and the future. Scenario planning, vulnerability analysis, and integrated urban planning are some of the kinds of evaluations to be carried out (Lin et al. 2018). These assessments include choices and trade-offs, and should be explored and addressed openly (Sheikhi et al. 2021).

Resilience principles are a useful tool for explaining how urban areas may enhance their resilience: helping urban storms and evaluating urban resilience choices and strategies in a meaningful and complete manner. In the past decade, the emphasis on urban resilience has increased significantly. The idea of resilience is employed from its ecological and systemic foundations, notably in catastrophe management, governance research, economics, adaptation to the effects of climate change, space planning, urban social studies, and many other disciplines

(Shanks 2018). The task of building the concept of resilience into fabrics of societies as essential to the realisation of their objectives has also been taken up in international agreements, for example, and so forth the EU Urban Agenda and United Nations (UN)-Habitat III SDGs, the UN Framework Convention on Climate Change (UNFCCC) Paris Agreements, and the Sendai Disaster Risk Reduction Framework. As a fundamental idea in their policies and operations, many cities and organisations included resilience. For example, regional and global city networks promote urban resilience among their members. The 100 Resilient Cities Foundation also actively supports cities to establish a resilience bureau and build urban resilience plans: individuals throughout the globe enable cities to become more capable of meeting the rising physical, social, and economic problems faced by the 21st century (Shanableh et al. 2018).

There are undoubtedly many challenges to ensuring resilience in urban settings. Cities now house more than half of the world's population, and these numbers are continuing to rise. Urban administrations must fulfil the housing, jobs, water, food, and energy demands of their growing populations, while also controlling the stresses that follow. In today’s linked world, coping with a slew of additional stressors and shocks arising from local and global trends, all while dealing with a high level of complexity and unpredictability, is essential. In constructing a decent urban future, it will be important to be resilient to these various difficulties (Shamsuddin 2020). Urban resilience involves “the capacities, regardless of the kind of chronic stresses or acute shocks that they experience, of individuals, communities, institutions, companies, and systems in a city to survive, adapt and grow” as well as the ability for a system to survive in the face of unrestful change and uncertainty. Resilience is a large, wide, good notion. That's useful. A combined multi-topic and multi-level strategy, adapted to regional and local demands, may be implemented in a broad range of circumstances (Shamout et al. 2021, p.285–298). Its malleability implies that resilience may operate as a “border object” concept, that links the numerous areas that participate in the street network, industries, users, and the problems and objectives. Urban resilience is also an explicitly constructive method to address urban concerns such as disaster management, resource management, climate change, economic and population issues, and other urban policy objectives. Positive framing may motivate individuals and help them build solutions rather than negative structures. This contributes to the development of constructive solutions by a wide variety of players (Serre & Heinzlef 2018).

Research indicates that the phrase “urban resilience” is frequently associated with other broad, positive concepts such as ‘sustainability’ and ‘integrated urban planning’. The long-term survival of sustainability clearly means more than resilience: it also involves resistance, such as traditional dikes, withdrawal from sensitive areas, and addressing the causes of the change, such as the decrease of greenhouse gas emissions or the use of resources. Discussions on urban sustainability often concentrate on the latter (mitigation of climate change) rather than the former (urban climate resistance stress adaptation). Integrated urban planning is a technique for tackling many urban problems, instead of working in a sector-based or department-based silo (Seddighi & Baharmand 2020). Non-integrated methods and integrated approaches may help improve sustainability and resilience, while integrated planning helps to prevent adverse side effects and enhances synergy. On the other hand, since resilience is such a broad word, it may be a little confusing (Alabdulqader et al. 2017). Politicians and stakeholders may "feel", but they may not really grasp what urban resilience means. Worse yet, they may feel that they understand it intuitively and develop and execute remedies that they think will enhance it. This may lead to political dangers. To begin, the intuitive knowledge and framework of stakeholders on what resilience means in practice may be different. Resilience methods can only address the problems in part, and only in specific groups of individuals or places because of this diversity (Schmude et al. 2018).

When stakeholders utilise a range of frames, a "dialogue of the deaf" may occur (and have enough authority to contribute to the discussion). Actors may seem to agree that a comprehensive strategy has to be developed to make the city more resilient, but have very different, uncertain points of view on what to do, by whom, when, why, and how. This may lead to a stalemate. Because of its vagueness, resilience may eventually be confined to a metaphorical ad hoc meaning that remains a blank word. Several writers highlighted that the practice of resilience is often employed as an all-encompassing approach for future-proofing without explaining what it implies or how the solutions will assist to accomplish this goal. As a consequence, apparent solutions may not really solve the issue (Schlör et al. 2018). In addition, a study shows that the social-ecological perspective on resilience – also known as adaptive resilience – has more recently increased consciousness about the continuing flow of complex systems without a permanent equilibrium in which they are able, after a disturbance, to return or advance. Resilience refers in this context to the capacity of the complex social-ecological system to change, adjust and, most crucially, transform stress and strain. In the literature, the continued use of engineering and ecological resilience in urban planning and policymaking, especially in the field of risk management, has been criticised. After a disruption, attempts are made to return as soon as possible to a previous condition, to believe it was a good state, and to ignore social injustice and environmental problems (Sayigh 2021).

Another criticism is that the urban literature often addresses resilience in terms of certain kinds of disruption, particularly natural disasters. The increasing unpredictability resulting from global warming, however, has required the development of resistance to a wider range of interference. Environmental extremes, such as hurricanes and heatwaves, constitute a danger to cities, but they are also a broad variety of unexpected shocks, including technological failures, water scarcity, or the loss of fisheries, forests, oil, or other important urban resources (Santos et al. 2020). In addition to the endurance of the system, the paradigm of social-ecological resilience utilised for urban settlements emphasises its capacity to learn, innovate, and adjust. It is presumably true that human beings may deliberately intervene, reduce, maintain, or improve resilience in the process (Mohamed et al. 2019). It is a permanent process leading to the ideal state in response to constant urban and external stressors, which enable it to better adapt to the characteristics of mobility settings. Complex systems have a characteristic termed social-ecological resilience, which cannot be produced directly (Sallam 2020).

Social-ecological resilience, however, may be helped by characteristics that are shown to increase resilience, such as diversity, modularity, tight feedback, social cohesion, and creativity. The resilience of the system can be determined if indicators can be developed to evaluate these characteristics. Because the complexity of any organisation is compressed into a compact and understandable amount of information, these indicators may be used for studies, judgments, and public discussions. By enhancing their urban resilience capacity, authorities and communities can make informed choices on how to make cities more resilient. The literature encompasses indicators and indices used to measure the sustainability of towns, countries, and regions; the literature on risk assessments is considered to be the foundation for resilience by many authors; and the literature on resilience and risk reduction provides knowledge and insights for addressing various natural hazards, such as earthquakes, floods, and heatwaves. Most of these are social, institutional, economic, and physical markers (Chen et al. 2019).

The economic and social components are determined by the socio-demographic elements, including family income, medical coverage, jobs, education, or age. For example, individuals with health insurance or education should be more robust than others. The physical and infrastructural aspects of the building, infrastructure, and urban green infrastructures such as electricity, water, and communications systems, play a critical role in shapimg urban environments and supporting human activites (Cheer & Lew 2017). There are metrics that need social and environmental resilience such as social cohesiveness or ecosystem services, but no extra resilience conditions are taken into consideration from a non-equilibrium point of view. Few indicators were identified to measure urban resilience to non-specific risks and concentrate on specific elements of the urban system such as power, water supply, and drainage. These methods evaluate the continuity and future accessibility of the service for the urban community and incorporate characteristics linked to resilience, including diversity, redundancy, and self-organisation. Despite considerable progress in recent years, current urban resilience measurement methods look mainly at it from an engineering or environmental viewpoint for disturbances or urban-specific services (Chapman & Bell 2018).

The methodology employed in this research primarily involved a comprehensive literature review to examine the existing body of knowledge related to urban resilience and its integration into urban planning and development. The literature review process began with the formulation of a specific search string, which included keywords such as "urban resilience," "sustainability," "climate change," "urban planning," and "resilience principles." Relevant academic databases and scholarly sources were systematically searched, and inclusion criteria were established to select studies and papers that were directly related to the research subject. The selected literature was critically analysed, and key themes, concepts, and frameworks were identified. Additionally, the research involved a qualitative analysis of various urban resilience indices and indicators proposed in the literature. The methodology also considered survey data and empirical research findings where applicable to gain insights into practical applications of urban resilience principles in different urban contexts. Overall, the research methodology employed a comprehensive literature review and analysis approach to synthesize and critically evaluate the existing knowledge in the field of urban resilience and its relevance to urban planning and development.

The methodology presented in the literature review primarily focuses on identifying and discussing various indicators related to urban resilience without providing a clear framework or process for developing an index. To create an index for urban resilience, it is essential to establish a structured approach that assigns weights to these indicators, considers their interrelationships, and quantifies the overall resilience of a city. This process would involve data collection, normalization, and aggregation techniques to generate a comprehensive Urban Resilience Index (URI) that provides a quantifiable measure of a city's resilience capacity.

2.2 Resilience, Definitions, and Scope

There are different definitions and properties of resilience, which vary according to the source consulted. They can also vary due to the context of the programme. The properties of resilience as defined by the Resilience Alliance include three main elements (Agrawal et al. 2020). Firstly, the extent of the change that the system can go through and still not lose control of its previous structure; secondly, the system's ability to organise itself independently; and lastly, the extent to which the system can adapt and teach itself.

The need for resilience and planning related to it is only pronounced in today's time and there is an urgent need for urban planning and demand from urban developers and planners to make their contribution to the design of emerging cities. Moreover, there is a need to reform the design of the cities that have been previously built and are growing at such a rapid pace that their resilience capacities have been dramatically reduced, and due to poor and antique planning, they will not be able to absorb stress and tackle any shocks that given the circumstances, are imminent (Adamec et al. 2021). The need for resilience was explained earlier by the realities, or rather the impending dooms of population growth and climate change, so now it is important to shed some light on the further reasons for the need for resilience planning.

These changes have factored in a great deal of uncertainty in the system, which also makes it very difficult to plan ahead (Goldbeck et al. 2019). Moreover, due to the urban–rural divide and the changing needs of the population, there has been intense and unprecedented growth in urbanisation and the emergence of a great number of urban areas. They have been done in haste and just to meet the short-term and immediate needs of the people rather than with proper planning and concern for the future. This puts a greater strain on resources, results in poorly planned and structured cities that will face immense destruction in the wake of a hazard or disaster, and will also invoke the need for retrospective planning that is a difficult, cumbersome, and laborious field of study and practice on its own (Abu Qdais, Abdulla, & Kurbatova 2019).

Different researchers have focused on various dimensions of resilience and presented a wide variety of guiding frameworks to tackle issues and enhance resiliency (Ye et al. 2021). The UN University has researchers that came up with the idea of the Megacity Resilience Framework that was supported by previous research work and says that megacities are resilient if the people living there, and the cities' agencies, operate properly, meaning that they can handle shocks and changes when needed. There must be a balanced approach to the use of services for social and economic improvements. And so, it is once again seen that resilience is closely related to achieving sustainability in development and planning (Abdrabo 2020).

The Rockefeller Foundation formed the Asian Cities Climate Change Resilience Network, and they were operating to predict the exact magnitude of climate change and the effects that could fall upon the cities. They also focused on constructing better systems that could pinpoint and subsequently take action on the challenges that have been posed by climate change in cities. It is also pertinent and important to add that when development experts started measuring vulnerability, they began by only measuring poverty, but soon realised that it was certainly not enough and began to add other measures such as climate change to determine the real level of poverty. Therefore, it is important to remember that in the effort to measure urban resilience through an index, they will need to make sure that it is multidimensional (Broto 2017).

It is of significance to look at some important concepts that will serve as a constant theme throughout my thesis, and therefore it is prudent and logical to define them here, at the start. A brief discussion on these areas will help the reader with the complexities of the whole study and clarify a lot of concepts related to the field of urban planning and development, resilience-building, and the scope of this study. The relationship between the heightening risk of climate change and the need for future adaptation and resilience measures highlights the urgent need for action to adsress this critical issue (Bozza et al. 2017). Humans are risk-takers, because if they were not then the changes in societies that they have seen over time would not have occurred. The daily routine of a human being is encountered by risks, and they deal with it and reach the next day. This forms the crux of one's life.

Examples of risk include driving on the motorway, crossing the street, or playing a demanding sport. It is impossible for any human being in their daily lives to eliminate risk completely, but what they can do is mitigate these risks very well. For example, the prospect of a person dying from a plane crash is something that cannot be eliminated completely, but there are ways in which he can mitigate this risk. The person can mitigate that risk by choosing an airline that has a great reputation and safety, by following the safety precautions to the best of his ability, or by avoiding travelling altogether when the weather does not favour such a risk or increases the chance of death by a plane crash. Humankind has sufficient knowledge of different weather trends and the risks attached to them (Borsekova et al. 2018).

With the developments and advancements in medicine, doctors now also know how to deal with illnesses of different kinds that affect groups of patients, such as malaria after downpours. The general population will agree that the purpose of the researcher is to advance science for the betterment of humanity, and therefore researchers have spent years working on the occurrence of disasters in any area. Now, with their hard work and advancement in knowledge, they are also able to predict such events in the future and then devise methods and strategies that could prevent or reduce these disasters and other risks associated with them (Boudiaf 2020).

In this context, it is pertinent to revert back to the topic of climate change that is a big risk as the weather dwindles into uncertainty, further defeating even the most meticulous of planning. There are times when there are intense and heavy rainfalls, while there are also times when there are absolutely no rainfalls at all, to the extent that there is the occurrence of drought. This phenomenon and the perils of climate change are not unique to Ajman city or the UAE, but are being experienced in different places all around the world.

The historical data on climate that researchers possess has drastically changed with the new developments that they are facing today, and with an increasing pace of climate change and no slowdown in the man-made actions that contribute to it (Borie et al. 2019). It is now getting more difficult for researchers and climate scientists to forecast potential dangers and disasters. Due to this very reason, the policymakers do not have access to the correct data that they can make use of in decision-making. Furthermore, even if the data are there and are not delivered to them at the right time, the data will be rendered completely useless for the policymakers as they are unable to make current decisions based on untimely data for the betterment of the environment and the people in urban settings. Another thing is the uncontrolled growth in the world population and the world resources that are being consumed in an unsystematic and unjust way (Beunen et al. 2017).

Resource issues such as falls in the level of groundwater; soil degradation; the unplanned cutting down of forests; the disappearance of greenery; dangerous rises in the level of seawater, smog, water, and noise pollution; the discovery of diseases; and the spread of new kind of epidemics and pandemics are risks to all humans. Keeping in view these factors, urban planning becomes more important as all these factors and variables are not distant from urban planning, but affect it and city life equally. Therefore, bad planning and mismanagement in urbanisation programmes also make matters worse (Berger & Marinacci 2020). In the future, mankind will be up against new risks that will develop from very difficult scenarios that will be the result of climate change. A high level of the shift of people from rural to urban cities and declining environmental conditions further affect urban resilience, and therefore will also be factored into the planning and implementation of sustainable development strategies in urban areas. The risk will be majorly influenced by migration from settings to urban cities, extreme poverty, and the inability of the current system to tackle these risks (Ben-Romdhane et al. 2020).

In addition to this, it can be discussed that urban planners including designers and engineers are the ones that are deeply involved in the process of designing, along with focusing on the potential solutions that can respond to the local climate as part of the results that are sustainable to be achieved. The sustainable processes being considered majorly involve energy conservation, followed by building a more adaptive urban environment, design, and planning in consideration of energy conservation (Casini 2020). In the section conducting a literature review, the focus of researchers will be on the principles, pathways, and urban resilience that are associated with urban planning. In this section, the researchers will be considering the theories and frameworks that can be used to understand the topic in detail. The explanation of variables will also be studied in the research, of which the insights will be provided in the current section.

Urbanisation results in significant changes to land, meaning the process is logically linked to environmental decline as well. As towns develop, planning results in the reconfiguration of the natural environment, with original features paving the way for new human-made structures.

Natural land denudation is the result of years of adaptation to climatic and environmental features; hence, replacing the natural space with one that is built is likely to force conventional environmental patterns to conform to the new shape of a region. The question that city planners have faced regards whether a city has the capacity to withstand different tests. In the constant push and pull between nature and the built environment of a city, natural forces usually prevail, meaning that the degree to which a city can withstand these processes is a factor of the length to which planners go to accommodate nature. For this matter, researchers advocate for an approach that merges the city with the environment, as opposed to replacing the natural space with a concrete jungle.

Climate change has affected the environment and will continue to impact local and regional environments for years to come. Various indicators depict that those changes are already happening, such as unstable vegetation varieties and frequent events of extreme weather conditions (Sever, Tok, & D'Alessandro 2019). In consequence, climate change affects the way people and decision-makers in organisations plan and apply management strategies for land use, and infrastructure development. It was in April 2007 when the Security Council of the UN established climate change as a security issue for the first time. The Department of Defense of the UN described that a changing climate could multiply instability threats in various regions in the world that are more volatile. This concept is intensely applicable in the Arab region, due to the high temperature, desert landscape, and other management issues (Ajaj et al. 2019). Due to the countries being susceptible to disasters, it is suggested that Arab regions take action to build resilience at the local level in order to mitigate disaster risk. Resilience enhancement will then assist the countries to cope with the economic, social, and environmental risks created by the change in the climate.

Decision-makers and other stakeholders must start preparing today for the effects of the changing climate and appropriately adopt strategies to cope with the ecological and economic impacts, along with the utilisation of possible opportunities. These are the concepts that are underlined in the adaptation and mitigation strategies related to climate change. The significant components for adequate adaptation planning for climate change are standardised procedures, the strategic integration of planning, stakeholder participation, and consistent monitoring and evaluation.

At the same time, urban ecosystems, which Suárez et al. (2016) describe as high-density systems, house the majority of the world's population. Since humans account for the largest share of environmental changes, a need arises for the introduction of resilient and sustainable cities. The problem that arises, however, is the lack of consensus regarding the more resilient and sustainable approach. This is especially the case across cities in the UAE, since the country has a unique environment characterised by desert features, which present both opportunities and challenges. For this matter, the current study aims to develop a set of features that can be compartmentalised into a resilience index for policy applications in Ajman city.

Areas in the UAE are particularly susceptible to a changing climate. Most of these areas are among the water-scarce regions, and a large share of their population and main economic events are centred in coastal zones susceptible to a rise in sea levels (Sever, Tok, & D'Alessandro 2019). Ajman also has a coastal area and is vulnerable to various challenges posed by changing climate and varying sea levels. The authorities in the region plan to improve the resilience of the area and enhance the quality of life. Despite early success, the Emirate still faces numerous challenges because of the increasing population and changing climate (Ajaj et al. 2019). Most of the population is comprised of migrants from other regions of the world who choose to live there because of various economic and environmental incentives. For instance, the people who work in Sharjah or any nearby region of Ajman choose to have residency in the city due to the comparatively low wages in the city.

Ajman city is also an urban area that is now fully developed, houses many people and businesses, hosts competitive architecture, has a budding and widespread network of infrastructure, provides for the livelihoods of many people, and is the image of a typical metropolitan. Therefore, in its quick development and construction, it is very much possible that it has missed out on the inclusion of proper urban development and resilience measures (Abiad & Meho 2018). Consequently, in the light of these facts and my deduced conclusion from them, my idea of making a URI and the index itself take centre stage for Ajman city, UAE, and any urban dwelling in the world concerned with resilience and sustainability.

Variations in precipitation and temperature patterns may harm strategic economic segments like tourism and agriculture (Saleh et al. 2019). Ajman city is planning to focus on the establishment of a resilient urban structure that can ensure the sustainability and well-being of the population.

Climate change causes various impacts on the environment and quality of life in terms of the economic and social effects. Hence, the city is keen to develop a built environment that is inclusive and can provide resilience against the risks posed by changing climate. To manage and monitor such plans and development projects, a systematic way is needed for evaluating the performance and compliance of the projects. A measurement tool that is developed based on specific indicators can assist in measuring the resilience of a region at present, and in the future.

Resilience has been a focus of urban planning in recent years, introducing new paradigms of climate change adaptation (Alawadi et al. 2018). Environmental movements have arisen in nearly all sectors of industrialised countries, notably business, industry, transport, farming, and architecture, because of the real or prospective environmental concerns to people's quality of life. Researchers are creating and improving techniques of analysis to retrofit communities with mitigating climate change strategies (Abunnasr 2013).

Resilience has become a critical concept that studies have shown to support the science of sustainability, and has replaced the term sustainability in everyday speeches. Over the past four decades, resilience has been used in so many diverse ways and industries that some authors question whether it is lost its meaning or if it is just a bridge principle between disciplines. Resilience has even become a municipal, national, and international priority in urban planning as a major target for local climate change adaptation programmes or the UN Development Program 2030 Sustainable Development Agenda (Gaziulusoy & Ryan 2017). According to research, a significant part of the world's population is home to urban ecosystems that are described as systems in which people live in dense concentrations and built structures and infrastructure. Because humans are the main driver of environmental change, new urban planning paradigms are essential to not only build more sustainable and more resilient cities, but also to reduce their social and environmental implications throughout the world. However, there is no consensus on what resilience for cities implies and how urban design may be included (Gargiulo et al. 2017).

According to research, the majority of the world's inhabitants live in urban ecosystems, which are described as systems in which people live in dense concentrations and built structures and infrastructure. Given the fact that humans are the main cause of environmental change, new urban planning paradigms need to be implemented to not only build more sustainable and resilient towns, but also to reduce their social and environmental impacts globally. There is, however, no consensus on how to integrate resilience into the urban design of cities (Galal Ahmed 2021). Studies have shown that a social-ecological perspective of resilience, which is also known as evolutionary resilience, raises the awareness that complex systems are always changing, and that the system cannot return or go forward after disturbances. Resilience in this sense refers to the capacity of a complex social-ecological system to change, adapt, and transform under stress and strain. The continued employment of engineering and ecological resilience in urban planning and policymaking has been a subject of criticism in the literature, especially in the field of risk management. After a disorder, effort is made to restore as soon as possible to a precondition, to believe it was a good state, and to ignore the realities of social injustice and environmental problems (Gai et al. 2018).

Another criticism is that the urban literature often addresses resilience in relation to certain kinds of disruptions, such as natural disasters. However, the increasing unpredictability caused by climate change has required resistance to a wider range of disorders. Environmental extremes such as storms or waves of heat constitute a threat to towns, but a wider variety of unexpected shocks is also involved, for example, technological failures, water shortages, or the depletions of fisheries, forests, oil, and other important city supply resources (Fuenfschilling et al. 2019). According to research, the idea of social and environmental resilience applied to urban systems focuses not only on the system's sustainability, but also on its learning capacity, creativity, and adaptability. It is presumably true that people may deliberately intervene, reduce, maintain, or improve resilience in this process. This is an ongoing process leading to the desired state in response to persistent urban and external stressors that enable it to adapt better to the characteristics of urban systems. People can observe empirically whether the system is robust after disruption, but how can they know whether a town is resilient to stressors and disturbances?

Complex systems have a characteristic termed social-ecological resilience, which cannot be measured directly. However, it may be helped by characteristics that are shown to increase resilience, such as diversity, modularity, tight feedback, social cohesion, and creativity. The resilience of the system can be determined if indicators can be developed to evaluate these characteristics (Miller et al. 2020). As the complexity of any system is compressed into a compact and understandable amount of information, these indicators may be used, not only for research but also for decision-making and public communication (Mfarrej 2019). According to research, if people increase their capacity to assess urban resilience, politicians and society may decide to enhance urban resilience more informally. Jha et al.’s (2019) study is based on a number of sources in the areas of the science of sustainability, resilience, and vulnerability. Literature about the indicators and indices is used to measure the sustainability of cities, countries, and regions; and resilience and risk-reduction literature about known threats such as earthquakes, floods, and heatwaves, and a broader range of natural hazards (Javadi et al. 2020).

Most of these indicators are social, economic, institutional, and physical. The social and economic components are compiled using a variety of socio-demographic data, such as household income, employment, health coverage, age, or education (Meyer et al. 2020). For example, residents with health insurance or those with a higher education level are regarded as more resilient than those without. The physical dimension or infrastructure refers to the resilience of buildings and infrastructure, such as electricity, water, communication systems, and the operation of cities’ green infrastructure (Jahangiri et al. 2019).

According to research, the institutional component takes into consideration both government risk policies and their financial resources. Some indicators contain social-ecological resilience variables such as social cohesion or ecosystem services, whereas other words linked to resilience from a non-balanced point of view are not included (Mees et al. 2019). Few indicators were developed for evaluating urban resilience against non-specific threats and focused mainly on discrete elements of the urban system like power, water supplies, and drainage systems (Meerow et al. 2019). These methods seek to evaluate the continuity and future accessibility of the service to the urban population including variety, redundancy, and self-sustainability.

It is critical to first grasp the idea of resilience in order to successfully handle the resilience-building challenges, particularly those linked to urban disaster and climate risk resilience. The concept's development from Roman antiquity to current times is traced in a study. The initial scientific definition of the term was based on a study that focused on the general persistence of ecological systems that are constantly changing (Mallick et al. 2021). It was then broadened to include the topic of human adaptation in nature.

According to a study, the concept's most recent refinement addresses the more pressing issue of social transformation in the face of global change, with the latter implying that environmental issues cannot be addressed in isolation from the social context, and that when a system is exposed to specific shocks it can transform from one state to another, resulting in the creation of a new system (Malit & Tsourapas 2021). Simply said, according to the UN International Strategy for Disaster Reduction resilience is a system's long-term ability to deal with change and shocks while continuing to evolve:

> The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, adapt to, transform, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. (Makate et al. 2019, p.860)

Hazards and the capacity to withstand and recover rapidly are highlighted in this definition. The Intergovernmental Panel on Climate Change (2014) defines resilience similarly to the United Nations Office for Disaster Risk Reduction (UNISDR), with the exception that it emphasises the ability to anticipate hazards as a key component of resilience-building, as well as the ability to maintain "the capacity for adaptation, learning, and transformation". Scholars from the Resilience Alliance (2010) brought attention to other resilience features while focusing on social-ecological systems (i.e., the capacity of a system for learning, adaptation, and self-organisation).

According to its Strategic Plan 2014–2017: Changing with the World, The United Nations Development Programme (UNDP) defines resilience as

> an inherent as well as acquired condition achieved by managing risks over time at an individual, household, community, and societal levels in ways that minimize costs, build capacity to manage and sustain development momentum and maximize transformative potential.

Importantly, the UNDP places risk at the heart of resilience-building, connecting it to long-term development goals. Change (particularly in the form of shocks) and its accompanying risks, typically (but not always) a change that might possibly have a negative influence on a system, are at the heart of the concept of resilience (e.g., disaster, crisis, stress, or disturbance).

Resilience has emerged as a major issue in urban development, according to studies, and is seen as both a feature of sustainable urban development and a driver of growth. The UN Task Team on Habitat III presented the Urban System Model Approach as a concept for urban resilience in the run-up to the Habitat III Conference in October 2016. The model identifies a number of threats and, more significantly, the urban systems whose resilience is critical to the construction and maintenance of cities' successful functioning.

The model considers four important and interconnected aspects of urban resilience that are universal to all human settlements: organisational, spatial, physical, and functional resilience. At various scales, organisational resilience refers to the resilience of any human relationship, whether official or informal, corporate, or political (Mahanta & Rajput 2019). The variation in the geographical distribution of human settlements from the smallest plot up to urban segments, peri-urban, district, national, and international contexts is highlighted by spatial resilience. Physical resilience refers to the ability of infrastructure, ranging from tiny homes to the complex-built environment of megacities, to withstand natural disasters (Lyu et al. 2019). Finally, functional resilience indicates the relevance of activities and flows ranging from a small-town market and transportation hub to large-city economic, governmental, and social operations. When it comes to addressing urban resilience to natural hazards, it is critical to comprehend the catastrophe and climate risk scenarios that might jeopardise the well-being of the urban population and the city's ability to function properly (Lu et al. 2018). The risks to urban systems are caused by a complex interaction of hazards, exposure, and vulnerabilities in the urban environment, as well as the efficiency of the existing resilience capacity.

Before delving into an examination of Arab cities' urban resilience, it is necessary to consider the following factors, which assist in understanding the magnitude of the issue and guide resilience assessments.

2.3 Pathways and Principles Associated with Urban Resilience

Multiple studies have tried to develop specific criteria and understand the principles associated with resilient cities. According to Figueiredo et al. (2018), the attention depicts the constant shift from equilibrium resilience to evolutionary resilience. On this note, Meerow et al. (2016) identified three pathways to achieving resilience: persistence, transition, and transformation. Figueiredo et al. (2018) conflate the pathways based on the analysis of other studies to suggest that resilient systems characterise absorptive coping, adaptivity, and transformative capacity.

Similarly, Folke et al. (2016) emphasise adaptability and transformability as the main factors in a resilient system. The development of resilience frameworks has expanded to include specific principles of a resilient city.

The frameworks that have emerged in the past five years illustrate a significant shift from short-term responses to broad processes associated with preventing, responding, consulting, and monitoring events in a continuous loop. Sharifi and Yamagata (2016) characterised resilient systems as redundant, diverse, independent, interdependent, resourceful, robust, creative, collaborative, efficient, and adaptable. The City Resilience Framework, developed by the Rockefeller Foundation, depicts the overarching principles that should guide city planning (Leitner et al. 2018). According to the framework, resilient cities should be reflective, robust, resourceful, flexible, redundant, inclusive, and integrated.

Based on different dimensions, several scholars have tried to place the principles contextually. For example, Suarez et al. (2016) studied 50 cities in Spain and characterised the elements into modularity, diversity, innovation, social cohesion, and tightness of feedback. According to the authors, the principles interact with each other in a continuous loop to create urban resilience. Figure 2.1 indicates the multiple interactions. The illustration emphasises the social-ecological perspective of understanding urban resilience. While it provides substantial insights, it requires additional support to fit in the context of resilience to environmental risks.

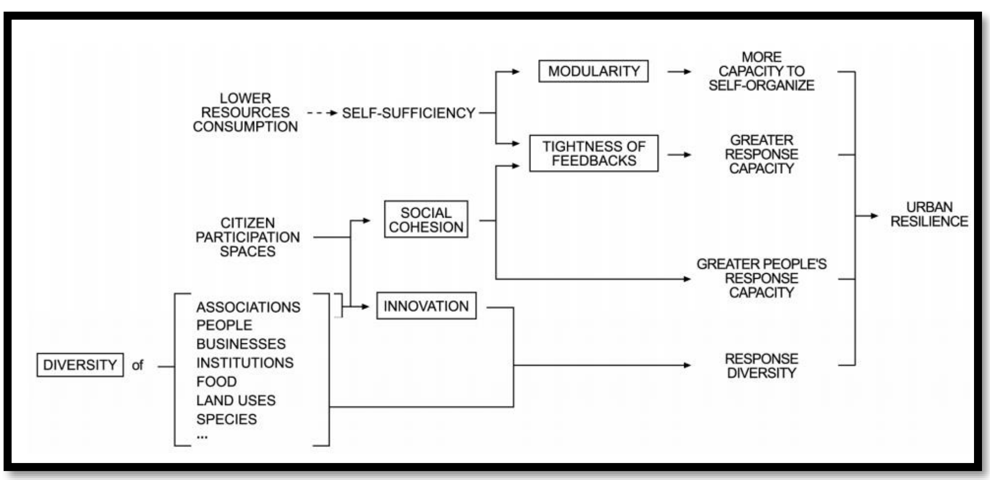

Figure 2.1: Elements of URI: Social-Ecological Perspective (Suarez et al. 2016, p. 780)

The study is hinged on the theoretical construct of social-ecological systems, because it focuses on the intertwined nature of society and the environment. Folke et al. (2016) argue that the lack of biosphere stewardship increases the risk of crossing potential tipping points and thresholds, triggering the emergence of pervasive implications. The framework of the resilience plan for Ajman city shall be in line with Folke et al.'s (2018) argument that incentives and transformations are required to redirect human actions and enhance sustainability. Stewardship, which is the careful management of resources for the sake of future and current generations, is embedded in stewardship theory.

Stewardship theory denotes a relationship-centred partnership that encourages trustworthiness. Eco-system stewardship is an action-oriented approach that can promote social-ecological resilience and sustainability under the conditions of uncertainty (Collier & Cox 2021). Therefore, the greatest challenge for human beings is to understand their new and difficult role in the operation of the biosphere and its impacts on the entire Earth system, which requires the adoption of technologies, developments, and actions to adapt to the transformed Anthropocene. Social-ecological systems theory is appropriate in the current study because it provides a holistic perspective of the numerous decisions, power structures, and incentives that function in the economic, social, political, and institutional spheres (Cohen et al. 2019).

Other works have focused on socio-environmental dimensions. For example, Sharifi and Yamagata (2016) developed a framework that focused on the built environment and infrastructure. Notably, the framework and matrix resonate with previous works that emphasise planning for, recovering from, absorbing, and adapting to disruptive events (Coaffee et al. 2018). Besides, the matrix includes additional elements, including foresight capacity, flexibility, equity, agility, and efficiency. While this framework purports to focus on the environment, it provides crucial insights into the interrelatedness of the elements that influence urban resilience. For example, when combined with the other two frameworks, it would imply that the spatial disparities in environmental threats create conditions for rising inequality. In turn, this inequality could endanger social cohesion, weaken social resilience, and hinder economic resilience (Cities 2021).

Based on the review, it emerged that the development of URI requires the consideration of a range of factors and dimensions. The response to the challenges cities face today requires the integration of economic, social, institutional, and environmental dimensions. Current efforts in the country reveal a focus on several of the dimensions. However, additional efforts are required to bring them together into a single framework that illustrates the aspects of resilience developed in previous research concisely (Ciplet & Roberts 2017). The existing methodologies and frameworks can enable the development of a URI that addresses the contextual factors of individual countries.

This section elaborated on the resilient plan that will be consisting of two major components: the identification of the vision relating to the future, along with having an articulation of policies for achieving the desired vision. In addition to this, the all-inclusive plan provides insights into the structure for achieving the community vision by the identification of strategies, objectives, goals, and topics that are linked with the effects on the built environment (Chokhachian et al. 2017). In addition to this, the current research provides insight regarding the best practice by the attributes, processes, and content linked with the urban resilience plan, which was considered majorly throughout the city's development.

In line with the discussion above, it can be added that the indicators and resilience management should help in ensuring that the plan will contain consistency regarding the goals, visions, policies, actions, and objectives, which are based on the evidence regarding the impacts, major issues, and conditions of the community being discussed in the current research (Chester et al. 2020). In addition to this, the research provides consideration towards the responsibilities for carrying out the plan, which have been stated previously. This will be carried out by considering the evaluation of progress and flexibility in achieving the outcomes that are required. Following the discussion above, the consideration should be towards the urban morphology of cities that creates a climate that is unique and affects the environment to be built. Building the environment involves land use, energy, infrastructure, and transportation, which work together to provide sustainable and green places for living (Cheng & Kim 2019). It also involves recreating, working, and ensuring that the community is prepared for acting with uncertain and certain changes.

The expansion of populations and assets in harm's way, especially in metropolitan areas, will be the primary driver of damage and losses caused by related catastrophes in the next decades. As a result, urban resilience is becoming increasingly popular. Climate change-related strategies may be used by cities, municipalities, and counties to achieve goals like sustainable and efficient energy usage and renewable energy generation, as well as to create an environment in which relevant behavioural and technological breakthroughs can emerge and spread. Cities are hubs for innovation, which is an important aspect of resilience (Chen et al. 2019).

Cities with concentrated assets and people are often located near the coast, in flood plains, or in seismic rifts, putting them in danger of catastrophe. They must be modified to the past and future consequences of climate change, notwithstanding related uncertainties, unknown risks, and local repercussions. The city management and risk communication systems, early warning systems, emergency contingencies, evacuation plans, and recovery plans must all be upgraded on a regular basis (Fraser et al. 2017). Long-term loss patterns have yet to be caused by natural or human disasters, but climate change adds a layer of risk and unpredictability to urban planning and administration. Numerous climatic scenarios examined in the literature indicate that both urban sustainability and urban resilience need a holistic approach (Lassa 2018).

Appropriate responses to the impacts of climate change, while keeping limited resources in mind and maintaining a stable balance of natural ecosystems, will ensure people's security and help push the nation towards sustainable development. Enacting or amending relevant legislation, collecting, and analysing big data from all types of disasters, effectively controlling the urban density of the population, attempting to manage growth in the city, improving the capacity to incorporate and assign tragedy-preventative health and rescue resources, constructing a more efficient emergency alert system, and reviewing the current policing system are all examples of these responses (Fekete & Fiedrich 2018). In addition to top-down solutions, bottom-up community empowerment may reflect local characteristics and needs, reducing the transaction costs of implementing climate change policies and helping in the transition to a more resilient society.

The capacity of a system, group, or society that is exposed to hazards need to rapidly and effectively resist, absorb, accommodate, and recover from the impacts by maintaining and restoring key basic structures and functions as reported by UN International Strategy for Disaster Reduction. Resilience is defined as:

> the capacity of social, economic, and environmental systems to cope with a hazardous event, trend, or disturbance, responding or reorganizing in ways that maintain their

> essential function, identity, and structure while also maintaining their capacity for adaptation, learning, and transformation. (Lagos et al. 2019)

As well as “The capacity of people, organizations, and systems to survive, adapt, and thrive in the face of stress and shocks, and even to change when circumstances demand it" (Laeni et al. 2019). Because being highly resistant to one kind of stress or shock may increase vulnerability in general, general and specific resilience must be blended. Resilience is developing as a new paradigm for urbanisation in the context of cities, affecting how people understand and deal with urban hazards, as well as how they construct cities in general. A resilient community may adjust to stress or shock while maintaining its basic structures and providing services (Feagan et al. 2019).

Any civilisation and any kind of disruption, whether natural, man-made, or a mix of both, may benefit from resilience. Examining disaster risk in the context of resilience enables urban planners to better comprehend the various impacts of catastrophes and determine a community's long-term ability to adapt to and deal with unforeseen dangers (Kundzewicz et al. 2018). Essentially, resilience may be regarded as a catch-all term for contemporary risk and sustainability concepts. Every level of government (national, regional, and municipal) is responsible for the protection of its citizens (Fastenrath et al. 2019). Local governments, on the other hand, have a unique duty to reduce risk and build community resilience since they are the first to react to disasters conforming to UN International Strategy for Disaster Reduction. Risk management and communication are the responsibility of governments. It may be difficult to construct and enforce city and municipal governments’ obligations to effectively manage and communicate risk, in part because it requires a long-term perspective (Farahmand et al. 2020).

2.4 Environmentally Friendly Cities and Sustainability

Governments have taken up the task of addressing the challenges of cities becoming green in response to climate change by providing resources, partnerships, and a platform for climate action (Davies & Lafortezza 2017). As a first step towards sustainability, green cities have been created for ecologically favourable features supported by public awareness methods to approach eco-friendly towns and communities with satisfied lifestyle needs. Therefore, the targeted cities should be designed with the current populations’ social, economic, environmental, and resilient habitats in mind, without jeopardising future generations' ability to do so (Darwish & Fadel 2017). Green, social, and economic sustainability are the main pillars of environmentally friendly cities.

Design choices that concentrate on these pillars will help the development of these cities. Water, energy, and food inputs must all be minimised in these systems, as well as waste and associated pollution such as air annoyance (Darkwah et al. 2018). In this regard, the following are the main characteristics of these cities: resources and services in the city are accessible to all, and supported by renewables; public transportation is seen as a viable alternative to environmentally friendly cars; walking and cycling are safe and common, with little use of private cars; and open space areas are safe, accessible, healthy, and enjoyable. Some of the advantages of sustainable buildings include lower life-cycle costs, cheaper insurance fees, higher property value, increased productivity, improved image, fewer risks, healthier tenants and visitors, fewer infrastructure impacts, and better for the environment and local economy.

2.5 Social Resilience

Social resilience is the ability of a social system to recover and respond to disasters or unfavourable conditions. It includes those conditions that are inherent in allowing the system to absorb the consequences, alongside coping with the event as well as the post-event. To guarantee that gains in resilience are accomplished throughout whole cities or municipalities, rather than in one community at the cost of another, all city or municipality districts must incorporate resilience in their policies, planning, and construction (Kumar et al. 2021). Resilience encompasses not just risk management and reduction, but also the capacity to adapt to and recover rapidly from disasters. Resilience is required for urban growth; short-, medium-, and long-term investment and planning; hazard management; and urban governance (Kruse et al. 2017). Community-based development initiatives that improve local people's and communities' capacity to adapt to climate change, as well as community-based solutions that create social capital, may be an essential component of creating urban resilience. Civil society may be helped to prepare for climate change through local non-governmental organisations (NGOs) and communities that combine adaptive governance methods with participatory planning tools (Fang & Zio 2019).

According to research, definitions of urban resilience only offer a few clues. In the research on social-ecological resilience, more specific characteristics are identified such as the ability to absorb shocks, to self-organise and self-reorganise, and to generate learning and adaptive capacity (Kontokosta & Malik 2018). The capacity to absorb and deal with shocks in a dynamic and flexible way is described as resilience (Climate 2014). This distinguishes resilience-based methods from conventional "predict-and-prevent" approaches, which concentrate on completely preventing disturbances from entering the system, such as by raising levees (Fang & Sansavini 2017). Many recent studies on urban resilience have looked at how cities adapt to stress and whether they are resilient. Therefore, lists of traits, characteristics, actions, and behaviours that underpin resilience have been developed (some ad hoc, others more systematic). These so-called "resilience principles" describe the processes that make a system resilient or help policies and practices to enhance it. They may focus on both the governing and governance systems (e.g., system structure and dynamics). System-oriented ideas include redundancy, omnivorousness, buffering, flatness, homeostasis, and high flux (Etinay et al. 2018).

Effctive disaster management involves a multifaceted approach, where some strategies are designed to deal with absorbing disturbances, while the others address quick responses, recovery, self-(re)organisation, and learning. Some examples of governance-oriented sets include using a systems view, looking beyond design events; building according to the "remain functioning" principle; enhancing recovery capability through social and financial capital; and being resilient into the future (Koliou et al. 2020). Several ideas have been suggested in the literature, many of which are similar but have different phrasing or emphases. Resilience principles, whether they are focused on the system, governance, practices, or all of these, may assist in grounding the otherwise ethereal concept of urban resilience (Eltinay 2019). By making things more concrete, they provide policymakers with guidance on how to create alternatives that may enhance urban resilience, as well to assess whether/how proposed solutions contribute to this goal.

2.6 Conceptualisation of Urban Resilience

The existing body of academic literature provides a myriad of interpretations. Despite the dynamism of the concept, Meerow et al. (2016) developed a working definition applicable to different fields and stakeholders. Broadly, the term refers to the ability of a city's system to return to its desired functions after disturbance, to adapt to change, and to transform the capacities of the system to adapt and respond to consequences. Based on the definition, cities must have strategic plans that include appropriate dimensions of a URI (Cariolet et al. 2019).

Urban development has brought a myriad of challenges. Several cross-sectional issues pose a challenge to planners and policymakers: environmental degradation, the insufficient provision of services, insecure land tenure, and vulnerability to shock (Nop & Thornton 2019). As such, many cities have started incorporating concepts of resilience within their sustainable development initiatives. Since the publicisation of the UN SDGs in 2015, urban resilience has become a common term among planners and policymakers. Based on this understanding, Meerow et al. (2016) recommend conceptualising urban resilience by understanding the "5Ws" of its definition, as seen in Figure 2.2.

Questions to Consider		
Who?		Who determines what is desirable for an urban system?
		Whose resilience is prioritized?
		Who is included (and excluded) from the urban system?
What?	T	What perturbations should the urban system be resilient to?
	R	What networks and sectors are included in the urban system?
	A	Is the focus on generic or specific resilience?
When?	D	Is the focus on rapid-onset disturbances or slow-onset changes?
	E	Is the focus on short-term resilience or long-term resilience?
	O	Is the focus on the resilience of present or future generations?
Where?	F	Where are the spatial boundaries of the urban system?
	F	Is the resilience of some areas prioritized over others?
	S	Does building resilience in some areas affect resilience elsewhere?
Why?	?	What is the goal of building urban resilience?
		What are the underlying motivations for building urban resilience?
		Is the focus on process or outcome?

Figure 2.2: 5Ws of Urban Resilience (Meerow et al. 2016, p. 46)

According to the authors, answering the questions requires an inclusive approach to planning. On the same note, Figueiredo et al. (2018) highlighted three aspects that planners could use in approaching the development of urban resilience: disaster risk reduction, sustainable livelihoods, and social-ecological. Oriangi et al. (2019) included the concept of sustainability from a socio-environmental perspective to illustrate the importance of creating, testing, and maintaining adaptability. Additionally, Zheng et al. (2018) argued for the need to move from traditional disaster risk reduction to the adoption of broad approaches to resilience. As such, the authors identified four interrelated dimensions that should guide the development of a URI: economic resilience, social resilience, ecological resilience, and infrastructural resilience (Cariolet et al. 2019).

Based on these studies, it is evident that developing resilience requires an adaptive approach that considers urban systems as dynamic entities that undergo frequent changes. In this case, Sharifi and Yamagata (2016) identified self-organisation capacity, system integrity, and learning as the components that depict adaptive urban resilience. While the systems may not achieve their initial equilibrium after a disturbance, they must show the capacity to bounce forward. In other words, cities should show their capacity for adaptive change to multiple threats, including climate change. Lang's (2011) study came to conclude that there is a new view on the urban resilience concept, which revolves around the minds of institutions that take into account social science as well as when planning for changes in cities. Since urban planning is a very wide concept with many factors that need to be taken into consideration, and it should be kept the same way when studying for resilience, this will allow the decision-makers to look at very different aspects as well, such as the indication of vulnerability, danger, and change. This point of view will be ideal when conducting research for governance so that governance research is not filled with rational perceptions of how the government should be. He argues that systems are not controllable, instead they are adaptive and evolvable. One way to reduce the gap in institutions' concepts is by jointly studying the resilience concept along with knowledge of theory that will enable understanding of the evolving systems that are complex and interdependent. With the suggestion of analytics, institutions could be able to pinpoint characteristics that will help bring resilience to urban systems.

Martin and Sunley (2015) argues that the treatment of resilience should be constructive, so that the mistake of a conceptual gap does not create a problem, and to understand the concept as a set of large processes that needs explanation. A major problem is how people understand and quantify resilience. The definition of resilience that is put forward shows long-term growth and development, along with employment, output, welfare, and income trends. Further, people need to stop simply accepting resilience as something that originates internally. It is extremely important to understand that local employees and organisations do not have sufficient resources recover if there is a disruption, and they require support from the government and other sources as well (Cariolet et al. 2019).

Recoverability depends on the economic system, and in such circumstances, the local's power is very limited. It is also fundamental to think that resilience is an evolving process and that it has a relationship with the process of the irregular development of regions. He has also suggested that resilience should be seen as a combination of four elements: vulnerability, resistance, robustness, and recoverability. These elements are formed by the region's economic development. The past development of regions influences their resilience, and the shocks will change their development. The shock might change a region's results from presenting, while stopping new opportunities to take advantage of shocks can bring blessings as well as doom. Shocks can change behaviour, which could in turn affect business strategies. Creative destruction is something that shows a new path for the most pressing matters in institutions, regulations, and infrastructure. Trends of long-term irregular growth also tell people how different regions adapt to shocks, or people could say that resilience should be analysed in such a way (Cai et al. 2018).

2.7 Resilience as the Key to Disaster Risk Reduction

According to studies, urban resilience is the "measurable ability of any urban system, including its people, to preserve continuity despite all shocks and stressors, while constructively adapting and evolving toward sustainability" (Cities 2021). As a result, a resilient city is one that evaluates, prepares, and acts to prepare for and respond to risks, both natural and man-made, foreseen, and unexpected (Kershaw 2017). Cities that are more resilient are better able to safeguard and improve people's lives, secure development benefits, promote an investible environment, and drive good change (Du et al. 2020).

Coping with stress and in the process not obstructing developments in the systems is required for a coherent risk-reduction strategy. When adapting there are certain adjustments that need to be carried out in a proper manner, but the existence of measures of resilience dives deep into the system and identifies what needs to be made stronger to tackle the upcoming threats. Resilience may be a theory, but it has great potential for practical applications (Béné et al. 2018).

A city's resilience is contributed by the people living there, and therefore it is also important to identify as to what are the strengths of the people and the elements that can be used in urban resilience planning. It is also noteworthy how people participate and deal with institutions and among themselves. Cities today are an assimilation of different religions, cultures, races, genders, ethnicities, social statuses, and other such groupings. They host a very diverse range of inhabitants who all come from different backgrounds thanks to rural-to-urban migration and globalisation (Bellinson & Chu 2019). This also means that there is great diversity in the culture, lifestyle, personality, identity, and norms of the city. So, a range of contributions can be made from different methods and ways of life to a city's resilience-building.

It is resilience that builds a connection amongst the people in a spectacular manner. This connection is different in every city, and that is why some urban settlements have a greater degree of resilience embedded in them, their operations, and their structure as compared to other settlements (Ahmed et al. 2021). Major cities now constantly face the dangers that are erupting from climate change. It is essential to acknowledge that a certain degree of resilience is present in the cities that have been built, and it is not that these cities are entirely devoid of any form or plan of resilience (Becker et al. 2018). This resilience is complemented by help from external sources and internal welfare organisations, stakeholders' designed plans for safety in the case of untoward incidents, and the provision of funding to tackle the gaps that are evolving in resilience. But these measures of resilience alone cannot help in reducing the risks of disasters and responding to them. The more prepared cities have strengths emerging from resilience measures that must be identified and improved to tackle the risk posed by climate change in an even better way. Resilience may be new when linked to climate change, but it has been addressed in the natural sciences and its research for a considerable period of time (Battamo et al. 2021).

The level of resilience, whether it is low or high in an existing system, also needs to be understood by urban planners. The case of Surat city in India where a devastating flood occurred can be used as a pertinent example, which in this case shines a light on how tragedies can be controlled and managed in an efficient way in the case of a disaster where there is proper management and planning for resilience and urban safety. The people of the city did not ask for help from outside sources and charity organisations; in fact, they were rather determined to manage this disastrous situation themselves. This also shows us the role of other factors apart from hardcore urban development methods, such as national unity and the attitude of people, which are also influential in the build-up of resilience in any city or country (Barbosa & Azar 2018).

It should be kept in mind that Surat is a very wealthy city in India where diamonds are cut, polished, and also sold. Many people who originally belonged to Surat but live abroad supported the city in its desperate times by aiding it financially. This act helps us in understanding that community bonds can also help in recovering from shocks and disasters, and therefore add to the level of resilience of a city (Bankoff 2019). The local authorities were also active on duty, and even after the flooding had passed they had a positive approach to the rehabilitation of the people. This is one of the success stories in the recovery from disaster, and could be imitated in other cities.

While Surat has served as a success story due to some level of urban planning and the innate resilience of the people of the city, a failed disaster recovery story comes from the hegemony of the world and the world's most powerful country, the United States of America (Baldwin & King 2018), where a hurricane that brought devastation to the city of New Orleans was not properly managed by local, state, and federal authorities. As a result, the hurricane cost billions of dollars to the state, even though a strong government and strong local bodies were present. It is evident that the need for understanding local people and their engagement in all processes is an important element to consider in the decision-making processes related to urban planning and development to strengthen resilience (Bande et al. 2019).

Sadly, the consequences of poor planning went on even after the hurricane, as it was found out that the people in New Orleans, as well as other communities, had been severely neglected by the government. The decision-makers in this regard and most of the people of New Orleans did not have a relationship that was based on mutual trust, as policies that were made did not coincide with the people and their financial conditions at the time. The evacuation process was inefficient and slow as well. It did not result in a good number of successful evacuations in terms of the number at the start, which resulted in a major and rising death toll that many thought was preventable. After the hurricane had passed causing significant devastation, the recovery phase started, but even that was not done in a satisfactory manner and even in the recovery stage, people still had deep distrust and decided that now they would not go to New Orleans (Balaei et al. 2020). The juxtaposition of the two cases presented in front of the reader forms a perfect example that shows that sure finances and resources are helpful in the fight against disasters and natural calamities, but their presence does not mean the existence of resilience. In addition, it is also important for institutions to build trust with the people of the cities and involve them along with their understanding to strengthen the process and measures of resilience (Balachandran et al. 2020).

2.8 Incorporating Urban Risk through the View of Urban Resilience

The system of governance and the operations, handling, and actions performed in the system are directly related to the resilience of the city. Institutions have a very large role to play and exert a strong influence over the planning of cities. They are foremost involved in the planning of the cities, and so their decisions can have a very heavy outcome on how the cities will become in the future. The institutions of a country on any level that concern themselves with the habitation, settlement, planning, and design of the city have the authority being discussed in the present study, and therefore their role must be discussed as well (Asadzadeh et al. 2017). Institutions have supreme decision-making power in this regard, and their decisions impact the long-term development and determine the prospects of any city that is being designed.

The person in the main seat of the concerned institution tasked with city development also assumes a great degree of power and importance, and therefore should be a qualified individual who is visionary in terms of urban development and factors in the concept of resilience in his decisions (Arneson et al. 2017). Similarly, institutions should be trained in resilience and building it in the system. The case of Ajman city is the same, as it is a small city that has been developed rapidly without extensive planning, and therefore has a lot of pressure on it now. City management can sometimes be very complex, and it is understood that if there are many public organisations in such management it will not be as effective to implement changes and achieve prosperity because it becomes difficult to coordinate. It is often found in big cities that there are agencies that have common tasks for development, and they all report to a central authority; however, this arrangement is seen to be very ineffective (Appelgren & Jönsson 2021).

The responsibility of managing the cities is usually from the local and municipal bodies as they provide actual insights into urban planning. It is extremely necessary for a resilient city to have a framework that ensures swift actions during events that would potentially be disastrous, and to simultaneously work towards ensuring these have no effect in the future. For adaptation to be successful, it is critical that the collaboration of other jurisdictions and neighbouring boundaries must be done. There are also numerous cases where it is observed from various parts of the world that participatory management takes place. Once the idea of involving people in planning and decision-making was on the rise, but the idea was only kept and not exercised. And so, plans are only made by central authorities, which may be because people are not aware or may be because people hesitate in involving themselves (Alzaabi et al. 2019). This could also bring the notion of the formation of an informal city within the actual city. The actual city comprises informal and formal cities, but it fails in responding to resilience when climate change and disasters occur. Coastal cities are more threatened if such is the case, as they have sea disasters to tackle as well.

2.9 The Economic Context

Urbanisation starts with how land is used and the jobs of the people. The land is changed by construction activities because more office buildings, housing, factories, and warehouses are required when business activity grows. The jobs created then call for more immigration as people come to the cities to earn a living (Alteneiji et al. 2020). Interdependent sectors originate due to this system in informal and formal areas, giving opportunities for jobs. These jobs vary in nature, and some require specific skills that only a few people can execute. When this happens, there is a difference among people that creates boundaries due to the type of jobs people have. This separation due to jobs could also hinder the strengthening of resilience in the cities.

2.10 Good Governance or Bad Politics?

Governance and politics play a significant role in cities as they have a direct relation to what will happen when changes for good are being made in the city. The local authorities are usually not given the proper resources to tackle complex situations in the fast-paced changing environment of a city. The municipalities are often under the umbrella of political influence (Zuniga-Teran et al. 2020). The population keeps on increasing, which is directly related to housing, and so people require more housing in the cities and to govern and maintain these developments, the size of the local authorities has to increase, as well as their reach. Failure starts to occur when the growing housing needs and the population are not properly managed by the local bodies, who fail to provide necessary solutions as they themselves are not able to handle it (Zobel et al. 2018).

2.11 Resilience from the Regional Perspective

Staple foods are grown in villages and come to the cities to feed the population. If the production of these staple food is affected in any way, then people living in large cities will also be ultimately affected by that. Cities bring in millions of people as they provide employment opportunities and entertainment. Many people use intercity transportation to travel, which could be for travelling, for entertainment, or just going to their homes in the village (Zampieri et al. 2019). The transportation links connecting the city and going in and out of the city are very important, and if they were to be disturbed by any disaster then there would be major setbacks to the city. The setbacks could be food supplies not reaching the markets for people to eat, or the stoppage of oil tankers that will cause the vehicles in the city to not operate (Feldmeyer et al. 2019). So, it is very important that cities should plan to tackle times of crisis, but also take the initiative to join with others in their regions so that there is a clearer understanding of the risks involved; this will also enable regions to help each other and achieve regional resilience (Zaidan et al. 2019).

2.12 Resilience within Sectors of Emerging Urbanisation

Resilience within sectors of emerging urbanisation is a topic of growing importance in the urban development discourse. According to the UN, by 2050 two-thirds of the world's population is expected to live in cities, with much of this growth occurring in developing countries. This rapid urbanisation presents many challenges, including increasing vulnerability to natural disasters, economic downturns, and social unrest. Building resilience is essential for sustainable development, as it enables cities to continue functioning and serving their residents, even in the face of challenges. To foster resilience within sectors of emerging urbanisation, several strategies can be employed, including:

1. **Developing robust infrastructure**: Investing in high-quality infrastructure such as roads, bridges, public transport systems, and utilities such as water and sanitation, that can withstand natural disasters, extreme weather events, and other shocks.
2. **Promoting local economic development**: Encouraging the growth of small businesses and promoting entrepreneurship can help to diversify the local economy, making it more resilient to economic downturns and other shocks.
3. **Strengthening social cohesion**: Creating inclusive communities with strong social networks and a sense of belonging can help to build resilience to social unrest, promote cooperation during times of crisis, and foster a shared sense of responsibility for community resilience.
4. **Building capacity for disaster preparedness and response**: Developing emergency response plans and providing training and resources for community members can help to minimise the impact of disasters and reduce the time needed for recovery.
5. **Encouraging sustainable development**: Implementing sustainable development practices such as green infrastructure, energy-efficient buildings, and waste reduction can help to reduce the environmental impact of urbanisation, increase resource efficiency, and reduce the vulnerability of cities to environmental shocks.

By implementing these strategies, communities and systems in emerging urban areas can build resilience and ensure a sustainable and prosperous future for their residents (UN 2020).

In conclusion, resilience within sectors of emerging urbanisation is critical for the sustainable development of cities in developing countries. By investing in infrastructure, promoting local economic development, strengthening social cohesion, building capacity for disaster preparedness and response, and encouraging sustainable development practices, cities can build resilience and ensure a brighter future for their residents.

2.13 Building Densities, Bylaws, and Populations of Emerging Urbanisation

Observation of past data is needed to understand the growth of urban areas, which will also give insights into how the population was able to grow more intensely in particular areas of the city. When the network of transport is well established and makes people have greater convenience then most people are willing to stay in those areas, which is one reason for the population to become more concentrated in different sections of the city (Fratini et al. 2019). The buildings may have the potential to house twenty times as many people as compared to a single house on the very same piece of land, and when more people live in buildings and there are many buildings in one area, then it creates a burden on the network system as more people will require the availability of everything including food, transport, healthcare, and entertainment (Ye et al. 2021). These population-intense locations in cities where there are high temperatures will have also increased demand for cooling facilities and equipment in hot seasons, which ultimately requires more energy from the grid, hence creating an imbalance in the energy supply (Xie et al. 2019).

Regulations and plans are made so that once implemented they will have long-lasting effects. The division of spatial planning to be done in zones is very useful and makes it easier to administer. Since the cities are very large, this approach allows for a comparison of how the land is being utilised and how the functions are being implemented amongst the different zones of the city. When there is weak resilience due to rough functions this will result in disaster if a crisis occurs, so it is important to have the distribution of functions at different levels to ensure good resilience (Xu et al. 2021). The World Bank highlights the importance that intelligent cities have thick, close-packed structures and housing that result in central extension in cities, and putting a stop to urban stretch-outs will help in the reduction of higher energy consumption and will ensure lower carbon emissions. This happens when fewer cars need to travel or less area needs to be travelled by cars and instead of individual heating solutions, people use centralised heating that saves energy (Xie et al. 2018).

Buildings are a huge factor that shapes the cities. The buildings provide greater housing to people on one piece of land and through that process, they require more energy as well. The bylaws constitute and take into consideration the climate of the city, the financial standards of the people that will occupy certain buildings, and the raw material and practices used for construction (Wu et al. 2020). These bylaws make sure that safety is provided to the occupants, and when these laws are applied and followed then harm from disaster will have less or no damage since people will be able to evacuate quickly, but could be fatal if the bylaws are not followed. Many cities in the world have a greater percentage of buildings that do not follow such laws (Wu et al. 2020).

There are three reasons why this is the case in major cities around the world. First, the labour that is involved in the construction of the buildings is untrained, since they belong to those areas of the city that are not formal. Secondly, those bodies of the city that have the responsibility and duties to make sure the bylaws are being implemented are fully occupied since they do not have enough resources and the number of projects being constructed is considerably more than they could monitor. Lastly, the people of the city and the occupants that will live in these buildings are unaware of the bylaws and they do not protest to get them right, so in the end buildings are constructed and they become a nuisance at times of crisis (Wittmayer & Bartels 2018).

2.14 Development Authority Functions in Urbanisation

The responsibility for the development of land and buildings in cities mostly lies in the hands of government authorities. There is the involvement of private builders, but at a very small scale and most usually they are engaged in providing maintenance and construction. Since there is a lot of fast-paced construction happening all around the world, the development authorities have insufficient resources to monitor all these construction activities. This results in more faults in the system as buildings are then constructed on lands where they were not meant to be constructed according to the city plans. When these activities continue, then in the long run they prove to be more challenging for the development authorities as they get more pressure and the development in the city doesn’t follow the city plan for creating gaps in the process (Wilkin et al. 2019).

2.15 Municipal Functions in Urbanisation

Municipalities have the duty of maintaining the infrastructure of the city. Mostly, the municipalities of cities around the world lack the resources and the manpower to conduct their functions properly. Infrastructure that is not properly looked at and serviced will break down more frequently when natural disasters strike the city (Webber et al. 2020). As the world is developing, so is the infrastructure and the system of infrastructure is becoming complicated, which in turn raises the need to improve the current resources at hand. In terms of municipalities' focus on tackling the dangers posed by climate change, this is very limited or non-existing; therefore, in the future, the municipal bodies need to start making a plan of action for the dangers that climate change could bring (Watanabe 2019).

2.16 Incompatible and Hazardous Land Uses in Emerging Urbanisation

The city structure is such that the type of buildings and their purpose usually complement each other. In reality, it can be observed that this is not the case and there are buildings that instead of complimenting have a high variance to each other that creates more catastrophe. If land use is properly planned and implemented, then huge losses can be avoided. These examples show how the misuse of land creates negative outcomes (Wardekker et al. 2020). Waste being dumped that created huge hills once resulted in a huge landslide in the Manila metro network that killed many people. In the area of Bhopal, a tragedy happened where a deadly gas accident happened and today people consume crops that grow from the soil that the gas affected and still has effects. Small-scale industries operating in residential areas where the use of chemicals was common also have affected the air and proved dangerous for those living in that area.

2.17 Transportation and Housing Aspects in Emerging Urbanisation

Transportation is a blessing, and can prove to be a threat to city life. When cities have abnormal growth, so the need for transport also rises. The authorities are not successful in encouraging the use of public transport. So, people are not conditioned to use environmentally friendly means of transportation, while other factors that contribute to this are no pavements for people to walk on, inclement weather that does not facilitate people to walk, and the use of cars that brings people status (Fu 2018). The use of cars and motorbikes has led to an increase in fuel consumption resulting in pollution, and people have become dependent on fuel as a necessity (Wang et al. 2018). Another effect of the increasing use of cars is that the number of people dying from car accidents is on the rise, despite how the use of cars helps businesses to increase efficiency. The rise in the use of cars has resulted in more frequent traffic jams and has made the roads busy. The mismanagement and bad execution of the construction of road networks can be dangerous when weather conditions such as rain block the roads for days and in the case of rainwater, floods will fill the cities. Hence, working to make the transportation system better in the city holds great significance to achieve resilience (Wahid et al. 2021).

From the very beginning of time, shelter has been one of the necessities that everyone should have by right. Cavemen also used caves as shelter to protect themselves during bad weather. Housing is believed to be aiding in the making of cities that emit less carbon. People usually spend most of their lives paying for better housing and avoid living in low-standard accommodation that is not suitable to leading a good life. Housing designs and architecture that people want are linked with having low-cost and energy-friendly houses that, in turn, aid in the creation of resilient cities (Vu et al. 2021).

2.18 Resiliency and Spatial Planning

Resiliency in cities is hence filled with many complications, but if it is achieved then climate change can be tackled in a smooth manner. It is essential to plan for the future and build strong resilience, and in order to do that, it is necessary to initiate the planning process (Sun et al. 2019).

Spatial planning is slowly becoming irrelevant, since the planning process is learning from past trends and data, which are then used to predict the scenarios, and they are constant. To make sure there is a sustainable future for cities, it is important for decision-makers to take into account the issues of extreme weather conditions that can have disastrous outcomes (Sun et al. 2019).

2.18.1 New Interpretation of ‘Risk’ And ‘Hazards’ in the Spatial Resilience Paradigm

Currently, the focus of urban resilience research is on catastrophe preparation and susceptibility to catastrophic occurrences, rather than on smaller, gradual, and incremental improvements. Adopting a more inclusive approach necessitates:

> acknowledging many layers of a connotation for ecological and social words and responding to the necessity to pick an acceptable degree of a connotation for

> conversation among ecology, social science, design, and planning. (Roelich & Giesekam 2019)

As a result, some ontological concerns are required for translating the resilience notion from the natural to social science.

Social work scholars have critiqued the natural hazard approach for focusing solely on natural catastrophes based on this viewpoint. Social vulnerability, according to these experts, builds up over time and is not confined to physical or demographic damage (Rodriguez et al. 2018). As a result, this view rejects the idea of resilience thinking as a reactive strategy to prevent, prepare for, respond to, and recover from crisis circumstances because of "emergency preparedness" and "shock treatment". The vulnerability stems from social processes and reasons that may be unrelated to the disruption. It is critical to acknowledge this problem to comprehend and explain the disturbance's sources (Ribeiro & Gonçalves 2019).

Change cannot be considered a discrete, singular occurrence in this way, since it is impacted by the actions and processes that produce it. As a result, a place's resilience should not be restricted to fast reactions to big bad occurrences, but should also consider long-term planning and coping techniques to deal with numerous social issues. Risk and hazards can be redefined in this sense as follows: not only does the new approach to risk and hazards change the conventional hierarchy of variables, but it also separates itself from the physical aspects (Rezaie et al. 2020). Contextual variables are used to describe the sources of risks in the new paradigm. Risks occur when they grow in an urban setting, eventually leading to a catastrophe. Also, because of many underlying social, economic, and physical variables, risks and their impacts may vary.

2.18.2 The Concept of Spatial Resilience

The ability of a territorial system to bounce back to its intended functions after unanticipated shocks and disruptions to increase its adaptive capacity and evolve all its material and non-material elements towards a large territorial system's organisation is referred to as spatial resilience (Reynolds et al. 2020). People require resilience because it provides them the strength to absorb and overcome adversity. Those who lack resilience are more likely to become overwhelmed and resort to harmful coping strategies. The capacity of the body to adapt to difficulties and recover rapidly is referred to as physical resilience. In the context of urban research and development, urban resilience is described as a complex social-ecological system's capacity to endure, adapt, and evolve in response to a variety of stresses.

Some studies have been determined to stress the spatial and location elements of resilience, and to offer a good grasp of the approach in the areas in which the articles were published. Several publications exist in the areas of ecology, social studies, and urban studies. These studies were sufficient to capture all the characteristics of resilience and content needed for qualitative evaluation, given their coverage of problems connected to perception, function, morphology, and political dimensions (Rehman et al. 2019).

Content analysis was used to extract keywords linked to place, and the position of "place" in relation to "spatial resilience" was characterised and interpreted. Most likely years after the notion of resilience was established by studies on spatial resiliency and coral reefs, the idea of spatial resilience was created. The dynamic ability to cope with perturbation and limits on geographical dimensions greater than particular ecosystems is known as spatial resilience. Early studies of 'spatial resilience' focused on coral reefs and underlined people's growing effect on the maritime ecosystem.

Spatial resilience in environmental terms implies a greater degree of resilience that crosses local habitat limits. This indicates that spatial resilience takes into consideration various interactions (bi-directional) across scales. The term spatial resilience refers to 'ecological legacy' studies as well as the connection between neighbouring systems to withstand shocks and avoid changes in the schemes of particular focal systems that are strengthened by geographical scope, heterogeneity, and landscape variety (Reguero et al. 2020). The spatial resilience method is rooted in the developmental process of literature on social-ecological systems theory: from an evolutionary perspective, spatial resilience is a 'continuously changing process' leading to the conception of 'non-equilibrium dynamics'.

This idea emphasises the need for considering subjective as well as objective elements in spatial resilience. In this context, the research on spatial resilience's sense of place demonstrates how the environmental context may strengthen a territory-based system's resilience potential (Ratter & Leyshon 2021). Place definition is significantly influenced by the concept of territory, and spatial resilience aims to reflect and maintain local identity, history, and legacy in the face of change on various scales. As a result, it appears that identity, system memory, place, human perception, learning, and subsequent behaviours, as addressed by research, are at the heart of resilience consideration.

2.18.3 Resilience is an Achievable Task

The city contributes a lot to emissions, and it must be understood that change is happening in the communities present in the cities. Rural people have less awareness and fewer resources as compared to their urban counterparts (Fu et al. 2021). This is something that can be exploited to be used to spread awareness of a resilient city. Awareness must be used to compel the urban population to act as well. The problems faced by people in cities can be used to provide solutions. If the public and private sectors do their jobs with collaboration, and different communities in the cities are also persuaded to take action, then there is great potential for achieving resilience in cities to tackle climate change as well (Taleb & Kayed 2021).

2.19 Indicators of Urban Resilience

Updated projections regarding climate are being utilised to develop tools so that planners get assistance in planning urban design with resilience against climatic changes (Fu 2018). Therefore, the management of indicators for urban resilience is the main concern from a global perspective for designing sustainable and environmentally friendly urban structures (Eltinay & Harvey 2019).

Although there have been various studies regarding the hot arid region's urban climatology, the research has not been able to create inclusive guidelines for climate-resilient city design and examine the urban microclimates in the all-inclusive dimension for the UAE (Elshimy & El-Aasar 2020). To measure the expected impacts of these changes in climate, practical studies and simulations will be needed. To help designers and engineers in developing cities with a high resilience towards a changing climate in the future, there is a need to frame a user-friendly and simple planning guideline (Klöck & Nunn 2019).

This perspective is supported by social-ecological resilience theory, which emphasises the need for harmony between social life and elements in the biosphere. According to Folke et al. (2016), the biosphere is an ecological system that incorporates all living things and their interactions with people. The research further establishes that components in the biosphere and species diversity enable it to adapt to accommodate emerging conditions, thus increasing the resilience of the Earth system (El-Kholei 2019). Adaptability includes human activities that innovate, develop, and improve development on current pathways. Since people are inhabitants of the biosphere, they shape its resilience, either consciously or unconsciously (Kim et al. 2021).

Therefore, a broader viewpoint to detect urban space adaptation can be made possible by building and implementing user-friendly tools for city design. Zheng et al. (2018), with the aim of developing an analytical framework for measuring urban resilience, focus on the megacity of Beijing. The authors explore important factors, for instance, population and social wealth, because they are under threat from climatic risks. Zheng et al. (2018) argue that climatic risks are long term and system-based; thus, they are likely to inflict more negative impacts than traditional natural disaster risks. Following a rainstorm disaster that occurred in 2012, Beijing administrators discovered the need to build risk-proof infrastructure to prevent further losses (El Bilali 2019).

While Beijing is exposed to different climatic conditions to Ajman, it has formulated a five-year plan to address disasters and climatic problems, such as rainstorms. Ajman lacks a comprehensive resilience index assessment and an adaptation plan; thus, the city is unable to comply with international standards and meet the SDGs (Kim et al. 2017). A resilience index assessment tool is pivotal and should be integrated into the UAE’s planning to understand the challenges facing its cities and make the appropriate adjustments. City designing is complicated due to the clashes of different climate needs to meet resiliency, and it is also found that previous research lacks local and focused studies on clime regions that lie in the hot arid region. Therefore, this study will focus on the type of climate in the UAE, which previous studies did not cover (El Gayar & Hamed 2017).

The stabilising trends of urbanisation will fundamentally impact every aspect of human life, including social, health, economic, and environmental spheres in the future (Kilbane 2020). In alignment with the theory of social-ecological systems, people, communities, cultures, economies, and societies evolve together with the biosphere because they are embedded parts. As complex adaptive systems, the theoretical construct of the social-ecological perspective seeks to address multiple factors, including population dynamics (Kijak 2020). To define and apply suitable policies and activities to react to the global urban challenges, it is crucial to figure out and project the population density that is in the urban centres (Ehnert et al. 2018).

The proposed land-use simulation process by Fu (2018) includes a phased approach, following land-use changes that follow the historical trend, the research technique highlights the outline for guiding research, and various stages in the project. Steps in the research include creating a simulation model, calibration, and a validation process to conduct scenario planning as the tool used in the study to analyse the data. The course framework completes with outcomes that provide suggestions for eventual urban resilience based on the scenario and practical inferences (Dvorakova et al. 2020). Engaging stakeholders and promoting leadership development in communities that lack advantages was necessary to get participation from diverse people throughout the planning process (Khazai et al. 2018). Alternate scenarios are developed for the future to enable the provision of understandable and ongoing information for all contributors. Various channels of communication are utilised for informing communities and to involve them while assuring the participants' engagement continues after the adoption of the comprehensive plan (DuHadway & Hazen 2019).

According to studies, urban resilience is the "measurable ability of any urban system, including its people, to preserve continuity despite all shocks and stressors, while constructively adapting and evolving toward sustainability" (Cities 2021). As a result, a resilient city is one that evaluates, prepares, and acts to prepare for and respond to risks, both natural and man-made, foreseen and unexpected (Kershaw 2017). Cities that are more resilient are better able to safeguard and improve people's lives, secure development benefits, promote an investible environment, and drive good change (Du et al. 2020).

Climate change, natural catastrophes, and terrorism have all been discussed in academic circles as risks to urban resilience (Kendra et al. 2018). The non-physical, as well as the physical components of urban planning and design have been explored in relation to resilience to these dangers. As a result, resilience measures have tended to be framed in terms of counterterrorism, other catastrophes (earthquakes, wildfires, tsunamis, coastal floods, solar flares, and so on), and the adoption of sustainable energy infrastructure (Kazemi et al. 2020). More lately, genealogies of urban resilience and the ability of urban systems to adapt to shifting situations have received more attention.

The concept of cities as extremely complex adaptive systems underpins this area of resilience theory (Karakoc et al. 2019). This discovery has the potential to shift urban planning away from traditional techniques focused on geometric designs towards a network science-based strategy that includes less involvement in the operation of cities. Network science establishes a relationship between the size of a city and the types of networks that are likely to enable cities to function in various ways. It can also reveal information about the success of various municipal strategies (Kakderi & Tasopoulou 2017). This necessitates a deeper grasp of the many behaviours and instruments that contribute to urban resilience. Genealogical methods look at how these practices have changed through time, as well as the values and power dynamics that drive them (Driessen et al. 2018).

Building city resilience, according to studies, relies on investment decisions that prioritise spending on activities that provide alternatives and function well in a variety of circumstances. Future risks and uncertainties must be considered while making such judgments. Emergency and catastrophe preparedness are essential since risk can never be completely avoided (Kaied et al. 2021). Frameworks for disaster risk management, for example, provide real options for improving resilience. Since 2007, more than half of the world's population has lived in cities, with urbanisation expected to reach 80% by 2050 (Hosseinioon 2018).

This means that cities will decide whether the era's main resilience problems, such as poverty reduction, natural disasters, climate change, environmental sustainability, and social inclusion, are won or lost. Because of their high population density, they are particularly vulnerable to both acute disasters and the gradual, creeping consequences of climate change, necessitating the development of resilience plans (Hölscher et al. 2019). At the same time, increasing urbanisation has been linked to a significant increase in urban sprawl during the last century. Individuals, communities, and businesses may use resilience to not just deal with numerous shocks and pressures, but also to seize chances for transformative change (Hodson et al. 2017).

National and municipal governments, with the help of international financing organisations, participate in relocation as one means of mitigating catastrophe risk in metropolitan areas (Jumah 2020). This might be done before or after a tragedy. While this minimises people's exposure to dangers, it also has the potential to cause additional issues, making them more susceptible or worse off than before. Resettlement must be viewed as an integral component of long-term development, not merely as a way of reducing catastrophe risk (Hittini & Shibeika 2019).

The choice of assigning equal weight to all proposed indicators for developing an urban resilience index is based on the recognition that in the context of urban resilience, each of these indicators plays a crucial role in evaluating a city's ability to withstand various shocks and stressors, adapt, and move towards sustainability. Given the complex and interconnected nature of urban systems, it is difficult to prioritize one indicator over another without comprehensive data and analysis. Moreover, urban resilience requires a holistic approach that encompasses both physical and non-physical components, as well as social, economic, and environmental aspects. By assigning equal weight to these indicators, the aim is to capture the multifaceted nature of urban resilience and ensure that planners and policymakers consider all relevant factors when designing sustainable and climate-resilient cities. Weighted indicators could introduce subjectivity and potential biases, making it challenging to create a comprehensive and universally applicable urban resilience index.

2.20 Resilience-Building Indicators and Targets

According to studies, the globe is getting more urbanised, and cities are constantly battling the 21st century's complex environmental, social, economic, and political issues. Cities, according to several international organisations, will need to become more robust to mitigate these issues (Liu & Song 2020). However, it is unclear what this entails. Regulations frequently utilise the term "resilience" as a catchphrase. Resilience principles, which define the processes that make a city resilient, might assist in explaining the idea and its relevance in this respect (Lin et al. 2018). Several case studies show how such concepts may be utilised as brainstorming tools, to evaluate suggested policy choices and overall urban resilience plans, and to compare stakeholders’ preferences for national policy initiatives. Resilience principles are a strong tool for moving urban resilience thinking from a symbolic discussion to meaningful solutions when implemented in a systematic fashion.

According to research, recognising resilience in action is difficult (Liew & Eidem 2021). Some say that resilience cannot be quantified but can only be expressed in terms of comparison, such as being more resilient than before or more resilient than others (Lew et al. 2017). Furthermore, there is a general agreement that measuring resilience offers a potentially powerful approach to evaluate both deliberate changes, such as those caused by programmes or policies, and accidental changes caused by unanticipated system dynamics. Indicators of resilience are frequently created to target the objective of positive livelihood results rather than resilience itself (León-Mateos et al. 2021).

As a result, development indicators may be used to assess resilience in this context. Process, output, and proxy effect indicators are among the levels and types of indicators defined by the OECD (2013). Meanwhile, according to the results of the Overseas Development Institute (2015), a robust system possesses specific characteristics that constitute the main set of resilience indicators: learning, choices, and adaptability. Learning entails gaining a better understanding of hazards and vulnerabilities, being aware of risks, and being able to apply what people have learned to resilience methods and programmes (Leitner et al. 2018).

The choices, or diversity criteria, indicate having access to several methods for dealing with risks and avoiding vulnerability causes. The term "flexibility" refers to a system's ability to operate and supply services in a variety of situations, including disasters (Lavorel et al. 2019). While numerous attempts have been made to conceptualise resilience assessment and related indicators, there is a practical need to evaluate resilience using uniform procedures to increase accountability, drive public investment, and create an improvement roadmap.

At the World Urban Forum in 2014, a new coalition of nine of the world's major UN and non-UN organisations called the “Medellin Collaboration for Urban Resilience” was formed to address some of the disparities in the tools and methods for developing urban resilience. Its goal is to promote the harmonisation of techniques and instruments for assessing the strengths and vulnerabilities to natural disasters that are utilised in various situations. Another issue of resilience assessment to be aware of is the impossibility of quantifying resilience mathematically. Because of the various dangers that individuals face and the various talents they may rely on to handle those risks, resilience cannot be assessed as a single thing.

The absence of customized targets for specific indicators in the context of Ajman's urban resilience may be attributed to the complex and context-dependent nature of resilience building. As highlighted in the provided content, resilience is a multifaceted concept influenced by a range of factors, including environmental, social, economic, and political dynamics. Customizing targets for each indicator would require a deep understanding of Ajman's unique challenges and vulnerabilities, which can vary significantly from other cities. Moreover, the lack of targets for some indicators might stem from the difficulty in quantifying resilience directly, as resilience is often assessed in relative terms (e.g., more resilient than before or than other cities). Therefore, it may not always be feasible or meaningful to set specific numerical targets for every resilience indicator in Ajman's urban context, and instead, a holistic and adaptive approach to resilience planning and assessment may be more appropriate.

2.21 Resilient Cities and City Resilience Index

Urban resilience is defined as "the ability of individuals, communities, institutions, companies, and systems within a city to survive, adapt, and flourish regardless of the types of chronic stressors and acute shocks they face", according to the 100 Resilient Cities study by the Rockefeller Foundation, which is a key component of achieving SDG 11 (Herslund et al. 2018). The Rockefeller Foundation launched the 100 Resilient Cities initiative in December 2013, with the goal of promoting urban resilience, which is defined as the ability of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow regardless of what kinds of chronic stresses and acute shocks they experience.

The design of modern cities requires a resilient system, as is the case with planet Earth. One of the Earth's inherent qualities is the ability to couple sustainable energy with material recycling (Lenton 2016). Abdullah (2017) reports that the AMPD privatised waste management and pest control services in an effort to develop a green and sustainable economy. The problem is that private firms usually prioritise profitability and efficiency, meaning that a robust and resilient plan may be foregone as companies strive to achieve higher returns. Apart from recycling, resilient systems also need to be self-regulated.

Naturally, the Earth maintains stable and habitable conditions through a system of negative feedback mechanisms, such as silicate weathering, which stabilises temperature over time (Lenton 2016). Self-regulation, as is the case with resilience, incorporates a variety of constructs, including problem-solving, critical thinking, and self-management, among others (Artuch-Garde et al. 2017). More importantly, with regard to Ajman city, for the city to achieve sustainability, urban planners need to develop a model in which Ajman can activate, adapt, monitor, inhibit, and preserve external resources. To achieve this capability, city officials need to focus on three areas: planning, performance monitoring, and reflection. The resulting resilience framework is multifaceted, encompassing four main dimensions: strategy and leadership, society and economy, well-being and health, and environment and infrastructure (Joy et al. 2020). The index is meant to be used as a planning and decision-making tool to assist in direct urban investments towards outcomes that promote long-term urban growth and citizen well-being (Chamie 2020). The goal is for city authorities to use the tool to discover areas for improvement, systemic flaws, and risk mitigation possibilities. Its generalisable style also allows cities to share information and learn from one another (Heinimann & Hatfield 2017). The index is a comprehensive assessment of urban resilience that influences city resilience. The relative relevance of these factors varies. The factors are divided into four categories that make up the urban resilience framework:

Leadership and Strategy: Effective leadership and management, empowered stakeholders, and integrated development planning are all part of leadership and strategy (Hecht et al. 2019).

Health and Well-Being: Minimal human vulnerability, a broad range of livelihoods and job opportunities, and adequate safeguards for human health and life are all part of health and well-being (Hayes et al. 2019).

Economy and Society: This category includes a healthy economy, complete security, and the rule of law, as well as collective identity and communal support (Haworth et al. 2018).

Infrastructure and Environment: Reduced exposure and fragility, effective provision of vital services, and dependable mobility and communications are all part of the infrastructure and environment.

The Rockefeller Center's urban resilience challenge has attracted a total of 100 communities from six continents (Home 2021). With technical assistance from a Chief Resilience Officer, each of the 100 cities has established its own City Resilience Strategy (CRO). The CRO should report directly to the city's chief executive and assist in coordinating all the city's resilience initiatives (Haruna et al. 2018).

Besides the above four categories that make the resilience framework, there are other diverse tools that provide different perspectives and insights into urban resilience, and can be used in combination to provide a comprehensive assessment of Ajman's resilience challenges and opportunities. For instance, City Resilience Index (CRI), is a comprehensive tool that assesses a city's ability to withstand and recover from various shocks and stresses. Such tool covers multiple dimensions such as infrastructure, health, economy, environment, and governance. The CRI can help Ajman identify its resilience strengths and weaknesses across different sectors and guide targeted interventions. The other one that can be used entail the Urban Resilience Assessment (URA): The Urban Resilience Assessment, focuses on evaluating a city's resilience to various risks. It examines factors like governance, risk assessment and planning, infrastructure, social capacity, and economic resilience. The URA can provide insights into Ajman's preparedness, adaptive capacity, and areas requiring attention to enhance resilience.

Another profound tool that can ideally work in the case of Ajman comprise the Urban Vulnerability Assessment (UVA). The tool specifically evaluates a city's vulnerability to hazards and stresses. It assesses factors such as exposure, sensitivity, and adaptive capacity of urban systems and populations. Conducting a UVA in Ajman can help identify the city's vulnerabilities and guide the development of targeted strategies for resilience enhancement. Lastly, SDGs provide a comprehensive framework for sustainable development, and specific indicators related to urban resilience can be used to assess Ajman's progress, and thus can be applied in Ajamn. Relevant indicators may include those related to climate action, sustainable cities and communities, affordable and clean energy, and infrastructure development. Aligning Ajman's resilience efforts with the SDGs can help ensure a holistic and integrated approach to building resilience.

2.22 Concepts for the Development of a Conceptual Urban Resilience Assessment Framework

The definition and understanding of urban resilience against risks associated with climate change are important to develop a conceptual assessment outline (Noy & Yonson 2018). People who live and work in cities are adversely affected due to the poor resilience of the area. The instantaneous response to an emergency tends to be seeking to get better information through the measurement of occurrences, employing more parameters for regulation, and the adoption of an appropriate planning structure. The introduction of novel guidelines is a comprehensible first response (Smith et al. 2018). Nevertheless, management in the urban area requires an understanding of the locality and response targets in the form of various initiatives by organisations and society to cope with the emergency.

The requirement to involve stakeholders in the role of urban governance is evident from the impact they can have on the enhancement of resilience (Almutairi et al. 2020). An adaptive structure of governance has been recommended rather than a top-down approach to obtain benefits from challenging situations. Examples of adaptive governance are given in various research. The reactions of an urban area after a pandemic or other catastrophe are the need for more resilient economies, organisations, institutions, and communities. The diverse stages and intensities of resilience are interlinked (Saja et al. 2021). Resilience is regarded as the capacity of economic, environmental, and social systems to manage situations during hazardous events or disruptions, and to respond or restructure in ways that preserve their critical function, structure, and identity along with the maintenance of the ability for learning, adaptation, and revolution. The important constituents of urban resilience stated in most of the literature are economic, social, ecological environment, infrastructure, and institutions, and every dimension is evaluated by numerous indicators. Different authors have given differing explanations for these economic, social, and other components (Guo et al. 2020). For instance, the literature contemplates economic resilience as an individual's or organisation's adaptive response to hazardous situations, while other research studies the economic resilience as a community's economic strength (Kakderi & Tasopoulou 2017). Likewise, the literature also proposes that environmental resilience is associated with the intensity and frequency of catastrophes, whereas ecological resilience is connected to land utilisation and biodiversity according to another research (Torabi, Dedekorkut-Howes, & Howes 2018). The differences in the interpretation are due to the scale of the considered area and the aims of the diverse studies. Based on the interpretations of various works, a conceptual framework of an urban resilience assessment is suggested in this research in the context of climate change.

These urban arrangements are intertwined and are the main systems influencing the abilities of cities to repel, adapt, and absorb fluctuations resulting from disasters and alteration (Al-Sarihi

& Luomi 2019). Every component is divided into numerous sub-dimensions that can be measured by several indicators. These dimensions and components are obtained by analysing various project objectives, SGDs, and engaging stakeholders from the Ajman city resilience planning to obtain relevant indicators (Graveline & Gremont 2017).

2.23 International Framework

An updated version of the Dashboards and SDG Index was presented by the "Sustainable Development Report 2019", which contains a distinguished assessment of the distance of regions to the targets of each SDG. The weaknesses and strengths of each country are highlighted in the 17 SDGs (Figure 2.3). The Middle East and countries in North Africa show varied performances (Figure 2.4). The goals of the UAE that are on track are highlighted below: progress in water and sanitation (SDG 6), and progress in work and economic growth, industry, innovation, and infrastructure (SDG 8 and SDG 9). Below are the decreasing goals:

- Trends in climate (SDG 13) are alarming.
- There is stagnating data available for the trend in sustainable cities and communities (SDG 11).

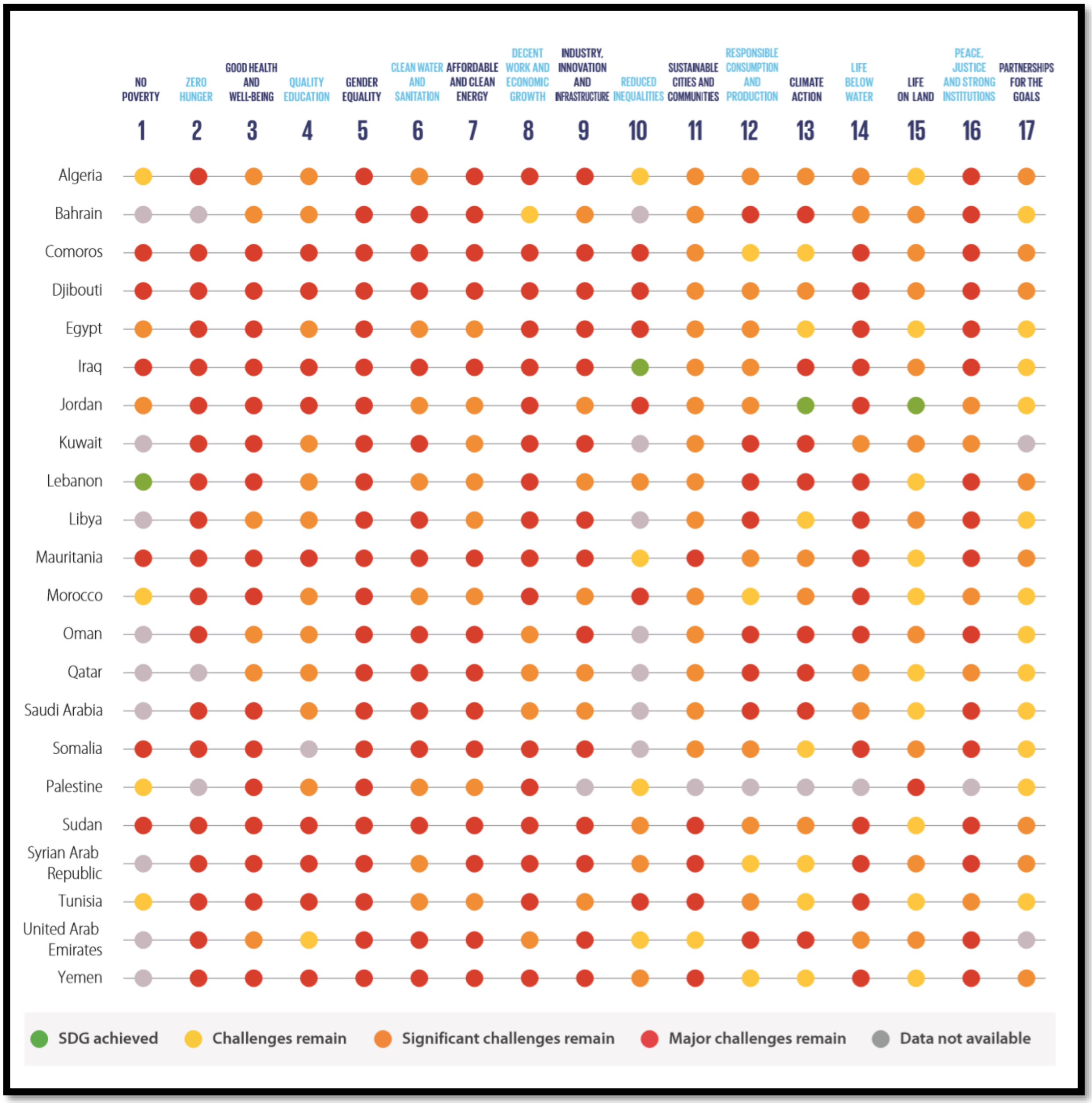

Figure 2.3: SDG Dashboard for the Arab Region (Luomi et al. 2019, p. 12)

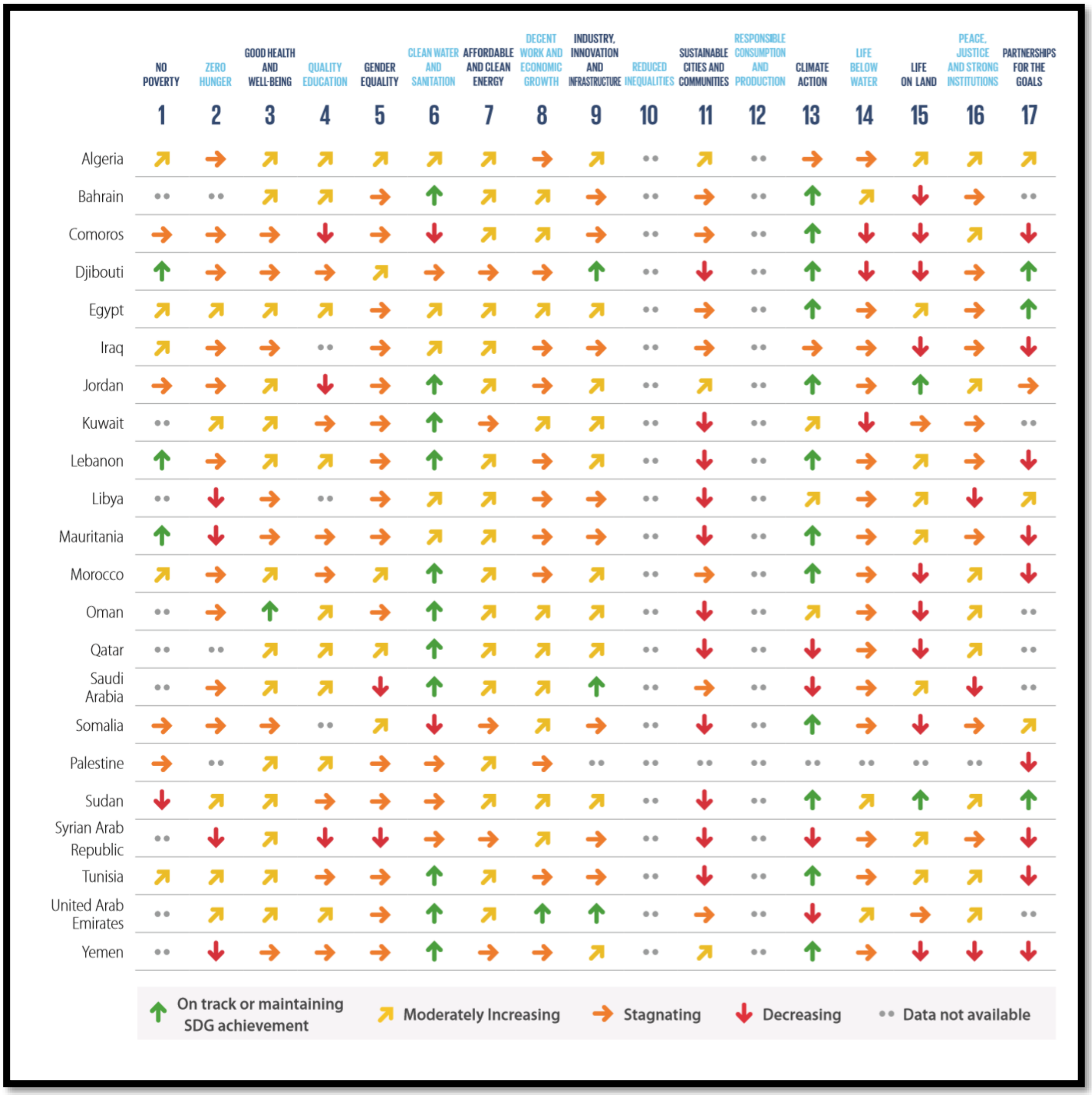

Figure 2.4: SDG Trend Dashboard for the Arab Region (Luomi et al. 2019, p. 13)

In 2018, the UN provided an overview report about SDG 11 – sustainable cities and communities – focusing on urban areas and the role of cities in tackling global challenges such as climate change, road safety, resilience, and environmental degradation. This goal includes 10 targets, 15 indicators, and has been interlinked with other SDGs. Resilience in SDGs has been explored by Bahadur et al. (2015) to provide an operational framework for reducing present and future risks by assessing climatic elements and social, environmental, and economic uncertainty. The paper acknowledged that resilience is a core element of target 13.1 for the adaptive climate. While it is a support feature for the targets of 9.1 to develop a resilient infrastructure, 2.4 to achieve resilient agriculture usage, 11.5 for vulnerability to economic losses, and finally 11.b that focuses on applying an inclusive policy to mitigate and adapt to climate change. Furthermore, climate action is among the most significant environmental issues at the global and regional levels, due to the social, environmental, and economical effects that are mentioned in SDG 13.

This problem has attained early and considerable attention in the UAE, and the government has employed several efforts to tackle climate change to adjust to the impacts it can have on the economic and ecological sphere. The UAE has embraced various policies in line with the need to adjust and adapt to climatic fluctuations. These policies include economic diversification, the diversification of energy sources and achieving a green economy, enhancing efficiency and a renewable share in energy, and policies regarding sustainable infrastructure development. The Climate Change and Environment Ministry has collaborated with various parties in the private and public domain to work and support the efforts for managing climate change through adaptation and mitigation techniques (Gim et al. 2019).

The ministry, with the help of the National Climate Change Plan 2050 and the National Climate Change Adaptation Program, which the Cabinet adopted in June 2017 and September 2017, respectively, as well as other relevant programmes, seek to support the efforts. The UAE's National Climate Change Plan develops a climate risk assessment for good health and well-being (Gaziulusoy & Ryan 2017). It defines climate change as one of its pillars, along with green diversification by the private sector and greenhouse gas accounting. The risk framework covers the health, energy, infrastructure, and environment sectors, and identifies ten priority climate risks fostering resilience, as shown below in Figure 2.5.

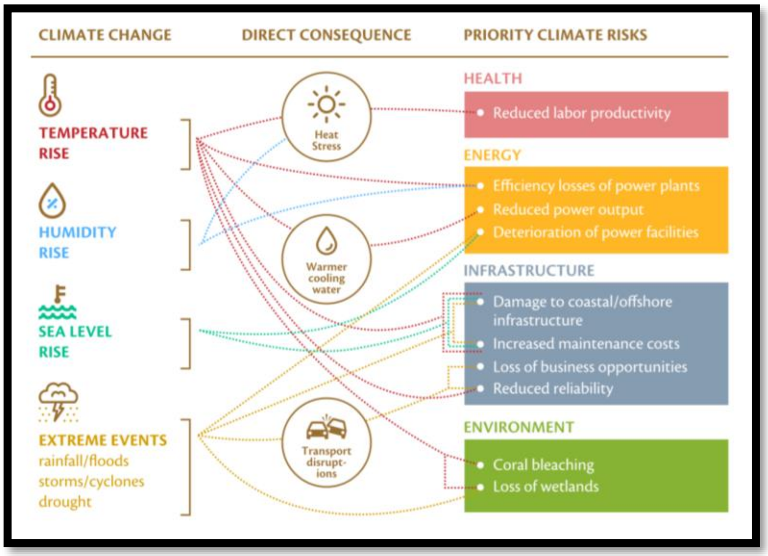

Figure 2.5: Ten Priority Climate Risks for the UAE's National Climate Change Plan 2017–2050 (Luomi et al. 2019, p. 31)

2.24 UAE National Framework

Federal and local government authorities govern the UAE, which includes seven emirates. Different responsibilities, power, and sectors are distributed among the government bodies to run the country effectively (McEwen et al. 2018). The central policy and portfolios of service delivery are handled by the federal government, which includes defence, interior and foreign policies, services, education (secondary and higher), health, environmental policy, and macroeconomic policy. The delivery of municipal services like the management of waste, sanitation, local urban planning, usage of land resources, sewerage, public transportation, local roads, economic licensing, and other tasks consistent with the national strategies and standards are included in the responsibilities of local government (McEachern, Warnaby, & Moraes 2021). Nevertheless, each emirate has substantial autonomy to plan and design the trajectories of their development of the national vision of the UAE (2021–2030 vision), as an outline for future planning (Hutchins et al. 2021).

According to the the Sustainable Development Agenda 2030 of the UAE, national key performance indicators (NKPIs) are used to monitor and track the outcomes in national areas and to achieve the National Agenda targets. With a vision to ensure that the NKPIs are implemented, each indicator has been assigned to the specialised entities according to their authorisation and then incorporated into the governments' framework for performance management (Hughes et al. 2020). Therefore, the NKPIs and national initiatives that are associated with them and their strategies are merged into the performance management framework of government and allied to the five year operational and strategic plans of federal ministries to sustain the implementation of the National Agenda of the UAE effectively. Strategic objectives and key performance indicators (KPIs) are included in the plan that is employed through an operative plan that involves initiatives and KPIs related to service delivery. These are further supported by government enabler's KPIs. The pyramid of KPIs is presented in Figure 2.6.

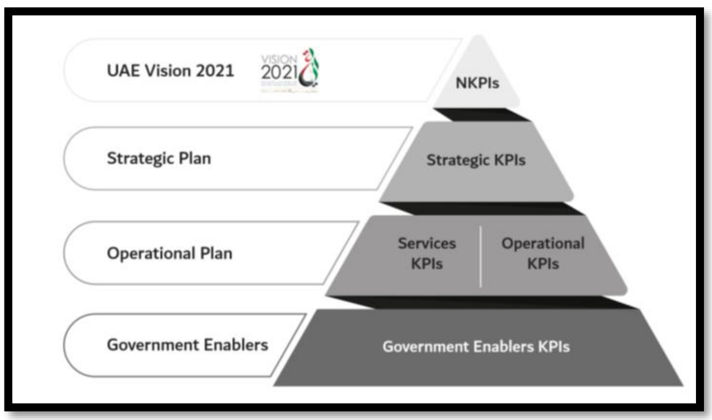

Figure 2.6: UAE National Agenda: Performance Management Framework 2018 (Goals 2018, p. 13)

The NKPIs were cascaded to local governments to ensure alignment between the plans of local and federal bodies (Mawed et al. 2020). This includes the "National Agenda" as one of the key contributors to the strategic plans of local governments. The UAE's National Agenda consists of six priorities that are aligned with the 17 SDGs, and those goals can be planned consistent with the National Agenda, as represented in Figure 2.7.

Figure 2.7: Mapping of SDGs to UAE's National Agenda (Goals 2018, p. 17)

Measurement of the green economy is a puzzling task due to its multi-dimensional and complex nature, and no approved set of indicators are available to date, irrespective of the efforts made by enormous organisations internationally like the UN Environment Programme, the OECD, and the Global Green Growth Institute. The Ministry of Climate Change and Environment (MOCCAE) in the UAE has taken the first effort to tackle this challenge and has succeeded by framing a green economy indicators framework that serves the objectives related to the Green Agenda (Matsler et al. 2021). This framework is called the UAE Green KPIs. Each indicator's performance is compiled by the MOCCAE based on the available data and has been reported annually to the public since 2015 through the State of Green Economy Report of the UAE (Masselink & Lazarus 2019). This practice resulted in the selection of 41 Green KPIs that are classified as per the three dimensions (social, economic, and environmental) of sustainable development. The framework of the UAE's Green Agenda is given in Figure 2.8.

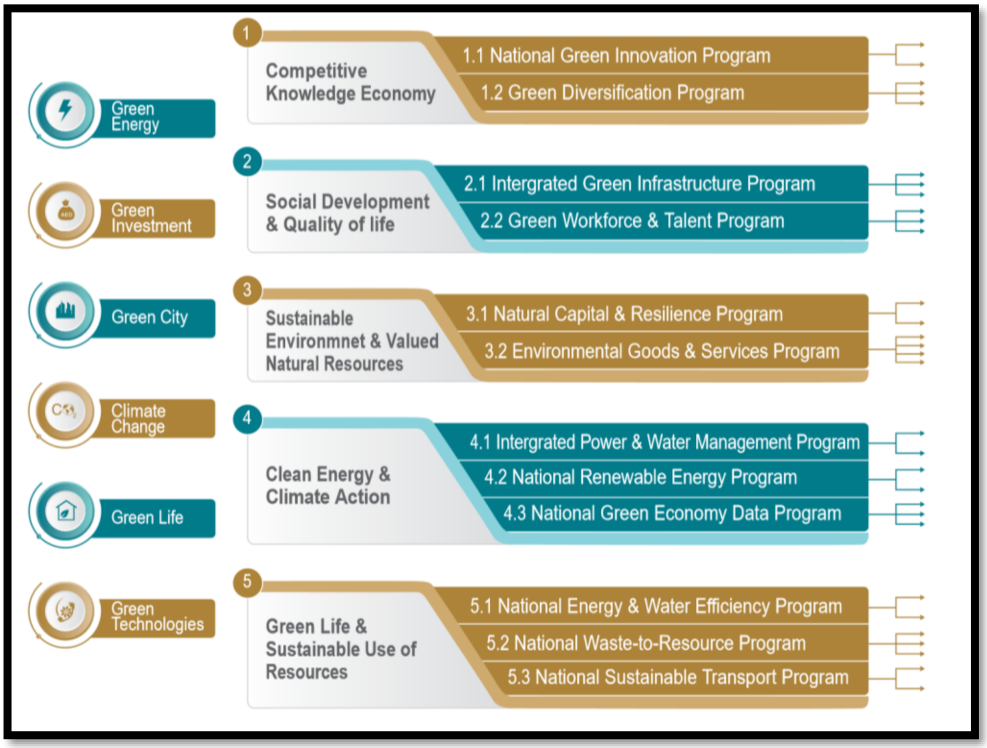

Figure 2.8: Structure of the UAE Green Agenda 2015–2030 (Environment 2016, p. 45)

As the Emirate of Ajman transitions into a sustainable environment and green economy, its development plans, objectives, and priorities have been mapped to the SDG targets for ensuring alignment with the standards at the world level, and the capability to serve the requirements of citizens, as given in Figure 2.9. Although sufficient efforts have been taken to apply the vital foundations of a planning outline in Ajman's Urban Strategic Plan 2015–2030 and Urban Strategic Plan 2019–2040, to assist in the efforts towards the accomplishment of Vision 2021 of Ajman city, recently it has been realised that there is a need to take a more substantial review and policy innovation that includes a planning scheme review, to create a framework that can direct sustainable growth in the future and enable economic development (Huck et al. 2020).

Pillars of Ajman Plan 2021	SDG
A Distinguished Government	8, 9, 17
A Green Economy	8, 9, 11
A Vibrant Community	3, 4
Best Place to Live	6, 7, 11, 16

Figure 2.9: Outcomes of the Target Mapping Exercise (Goals 2018, p. 18)

Therefore, a complete understanding can be established to attain an extensive strategy, followed by development actions that could reinforce the process of planning. To thrive in an environment where uncertainty is becoming the norm, organizations need to be able to adjust quickly and effectively, and this requires them to adopt a proactive approach to risk management, foster a culture of innovation and experimentation, and build resilience into their systems and processes (Huck 2020).

2.25 Current UAE Resilience

The UAE has been rapidly developing its cities, particularly Dubai and Abu Dhabi, over the past few decades. With increasing urbanisation and the challenges, it brings, there has been a growing focus on urban resilience in the country. Below are some studies regarding the current state of urban resilience in the UAE:

"Building urban resilience in the UAE: A review of progress, challenges, and opportunities" (2018) by Marwa Dabaieh and Alaa Al-Masry. This paper provides an overview of the urban resilience initiatives that have been undertaken in the UAE, including the Dubai Plan 2021 and the Abu Dhabi Vision 2030. It also discusses the challenges that the country faces in building resilience, such as climate change, rapid urbanisation, and a high dependence on imported resources.

"A review of urban resilience in Dubai, UAE" (2020) by Manal Alsharif and Muhammad Adeel. This paper explores the concept of urban resilience and its application in the context of Dubai. It examines the city's vulnerability to natural and man-made disasters, as well as its efforts to build resilience through policies and initiatives such as the Dubai Resilience Strategy.

"Abu Dhabi's urban resilience: Assessing the built environment's role in the context of extreme heat and water scarcity" (2019) by Marwa Dabaieh and Mohammad Qatu. This paper focuses on the challenges of extreme heat and water scarcity in Abu Dhabi and how the built environment can contribute to urban resilience. It discusses the role of sustainable design and infrastructure, green spaces, and community engagement in building resilience.

"Urban resilience in the UAE: A review of research and practice" (2020) by Sari Hanafi and Lamis Alsharif. This paper provides a comprehensive review of the research and practice on urban resilience in the UAE. It examines the various factors that contribute to resilience, such as governance, infrastructure, and social cohesion, and highlights the need for an integrated and holistic approach to building resilience.

Overall, these references demonstrate that the UAE is taking urban resilience seriously and is making efforts to build resilience in its cities. However, there are still significant challenges to overcome, and ongoing research and practice are necessary to ensure that the country's cities are prepared for the future.

2.26 Ajman Local Framework

An Ajman local framework would be different from the national framework, as each emirate is allowed to maintain its own respective judicial authority and legislative body.

2.26.1 The Emirate of Ajman

The Ajman Emirate has shown rapid growth recently to become a vigorous modern community internationally, and has been able to attract both investors and visitors (Alhosani, Kaied, & Darwish 2021). A vibrant society has come into existence due to the efforts and support from the Government of Ajman city in terms of developing exceptional resources in the city that in consequence have provided opportunities for economic and industrial development. The Ajman

Emirate's strategic location in the UAE's northern region offers numerous opportunities for investors from different parts of the world (Wahid et al. 2019). The city of Ajman has been able to expand trade and commerce in the region, contributing to the enhancement of the local economy. The improvement has been brought about with the help of enhanced industrial facilities, mobility, and transport infrastructure such as ports and roads.

The economic potential of Ajman city has been further enhanced with the establishment of the Ajman Free Zone. It is regarded as one of the UAE's first free zones established in 1988, and it has an independent status that was approved by the Ruler of Ajman and Supreme Council Member, H.H. Sheikh Humaid bin Rashid Al Nuaimi (Mogielnicki 2021). Since then, the free zone has progressed steadily and has become the main contributor to the economy of the city. The Ajman Free Zone remains the heart of progress in Ajman and plays an important role in merging the business of the community with the help of the Emirate's highly competitive model, attracting companies from different backgrounds locally and internationally that plan to enhance their business with sustainability (Ghazaleh & Ahmad 2018). The zone is characterised by regulations that are investor-friendly and business operations, various support services, modern technology, and innovative options and processes for licensing. The free zone provides a favourable environment for businesses and investors to operate in an efficient and fast manner.

The sustainable development in the Emirate in the local context is driven by the Ajman Department of Economic Development (DED) through the creation of an attractive landscape for businesses, and those eager to invest in the Emirate and take benefit from the opportunities for expansion available in Ajman (Usrof 2020). The department provides all the significant information, the latest data, and actions, along with investment opportunities in Ajman. The DED has formed a partnership with the free zone to offer various business aid programs, such as consumer rights protection and granting operational permission to organizations licensed by Ajman DED and leased from the Ajman Free Zone.

The Department of Tourism Development in Ajman is an important organisation that preserves and brings to the fore the unique features of the Emirate as a tourist destination (Mogielnicki 2021). The agency promotes the potential of Ajman and the strategic advantage for holding conferences at the local and international level, and exhibitions. The department further works to develop tourism facilities and services within the Emirate and allow businesses to invest and operate in Ajman and support economic growth in the locality. The Ajman Free Zone (AFZ) partners with the tourism department and has enabled organisations to obtain an advantage from fast and efficient business transaction approval under a single platform.

Housing in the UAE has been boosted by the migrant influx from various parts of the world like workers from East Asian countries, according to studies (Wahid et al. 2019). The UAE also became a safe refuge for Arabian citizens that experienced the chaos of war and dislocation in neighbouring regions. The traditional hospitality, along with open policies in the UAE region, has established an association in the business and world trade that creates opportunities for expatriates. Population migration plays a significant part in the process of urbanisation in the UAE. Experts argue that the fast increase in the population in the UAE has resulted from the huge influx of labour from various countries (Young 2021). Ajman's population was just 14,351 in 1975, and in 2003 it had reached 225,000. The population growth rate per year cannot be figured out specifically, because of the unexpected increase in the urban population. The growth rate was 5.3% in 1975 and shifted to 5.69% in 1983, whereas during the period from 2001 to 2002 it dropped to 3.48%; nevertheless, the annual growth rate increased to 6.28%.

The main reason behind the huge influx of migrant laborers is believed to be the attractive wages and ready job opportunities in Dubai. As per the Labor Ministry, migrant workers contribute to 85% of the total population, which is a relatively larger value than other countries in the region (Valenta et al. 2020). In 2005 there were 4.5 million migrants, compared with just 800,000 Emirati citizens. The UAE’s population exceeded 9 million by 2016, of which around 1 million were Emirati citizens. Ajman, which is the smallest among the seven emirates, has an area of 259 square kilometres. It covers around 0.32% of the UAE’s total area, and spreads over a space of 10 miles between the Umm Al Quwain and Sharjah emirates. The Ajman Emirate is comprised of three main cities: Ajman, Manama, and Masfout. Ajman city is the commercial area of the Emirate.

With the economy of the petrodollar in 1980, urbanisation in Ajman started to increase. The increase in the world economy led Ajman’s government to take several initiatives to modernise the rural population in the Emirate to enable their full participation in the modern economy by inviting expatriates from various countries. The basic driving force behind the increasing urbanisation in the UAE is the country’s infrastructure (Young 2021). The UAE has the most progressive infrastructure in the Arab region. The land, sea, and air that aid the country are finely interlinked with key destination and activity centres for the economic well-being of the country.

The location of Ajman Emirate between Sharjah and Dubai city in the south, and Umm Al Quwain and Ras Al Khaimah in the north, aids the region to receive infrastructure expansion from all angles. The Municipality of Ajman has the responsibility for several socio-economic projects that range from projects of basic needs to investments in education and industrial growth (Alhosani, Kaied, & Darwish 2021). Ajman has become an attractive option to live in due to the close boundary with Dubai and comparatively low residential rents. Housing demand in Ajman is not driven by internal rural–urban settlement, but it is instead caused by the huge influx of foreign workers. The territorial boundary of the Emirate experienced expansion due to the transformation of the economy from oil-based industries to more varied commercial and industrial sectors (Young 2021). The location of Ajman close to the Arab Gulf and the Gulf Cooperation Council (GCC) encourages industrial sectors along with other practices such as fisheries, trading, agriculture, and tourism (Palazzo 2019). Thus, the strategic value of the essential activities started by the locals is encouraged for Ajman to be the gateway to various neighbouring regions.

Migration and urbanisation can be thought of as responses to globalisation (Valenta et al. 2020). Modernisation is supported in Ajman through housing. Nevertheless, since the 1970s the scenario of development in Ajman has changed (Ozkaya & Erdin 2020). A long-term commitment is shown by these housing schemes through the investment in the state for new communities' development that can aid future projects in the Emirate (Al-Dabbagh 2021). Major cities such as Dubai, Abu Dhabi, and Sharjah were among the earliest destination for foreign workers. The three big cities also experienced an increase in total population from 70% to 75% during the period from 2010 to 2015.

2.26.2 Ajman Demographics and Development

The proportion of expatriate residents in Ajman is about 89%, according to the 2017 census (Research and Statistics Department, 2017). Figure 2.10 shows a substantially greater percentage than in 2005. The trend in the expatriate population rate is obviously rising, according to the research.

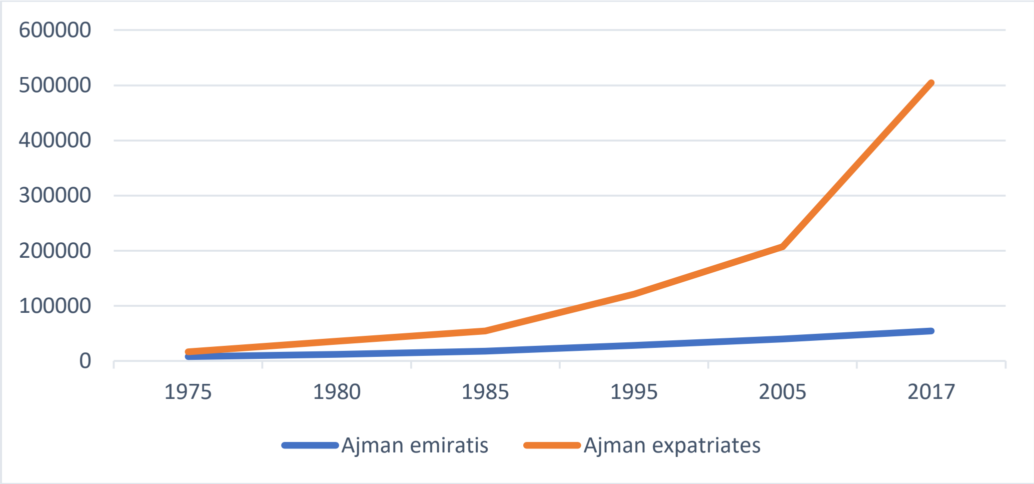

Figure 2.10: Proportion of the Total Population in the Ajman Emirate (Research and Statistics Department *2017*)

Wherever possible, the Ajman development strategy uses an infill method to rehabilitate deteriorated regions while limiting sprawl (Patel et al. 2021). The entire residential area (including built and planned development) is 39,031,182 m2, or around 27.25 percent of the total land area. Due to inexpensive rents and a strong connection to key transportation routes in and out of the city, Ajman acts as a residential centre for both Sharjah and Dubai, resulting in considerable demand for homes (Panno et al. 2017). More than 55% of Ajman city's total plot area is already occupied, making the land availability for the long-term vision one of the most significant constraints. Ajman city's future land use has been designed to maintain existing land use patterns while strengthening its function and interdependence, according to the 2040 Strategic Plan. It will result in a highly liveable and sustainable city for both inhabitants and tourists, to serve the people by providing defined character regions and hubs that offer a distinct purpose, character, and function. While the Emirate's population grew at a 2% yearly pace between 2005 and 2017, the expatriate population grew at an 8.7% annual rate over the same period.

It is critical for municipal authorities and other key sectors to offer the required services, facilities, and the legal and regulatory frameworks in advance of development to forecast the direction of growth and act as proactive planning.

SDGs: Ajman's 2021, Sustainable Development Guidelines highlight that Ajman is one of the smaller emirates in terms of land area (260 km2). The city is called Ajman, the capital of the

Emirate of Ajman. The city of Ajman, which is part of the Dubai–Sharjah–Ajman metropolitan region, is home to about 95% of the Emirate's inhabitants. Manufacturing, construction, wholesale, and retail; real estate and business services; and transportation, storage, and communications make up most of the economy (Huang et al. 2021). Ajman, which is located on the Arabian Gulf's shore, also has sovereignty over two inland exclaves – Manama and Masfout – both of which are largely agricultural territories (Figure 2.11).

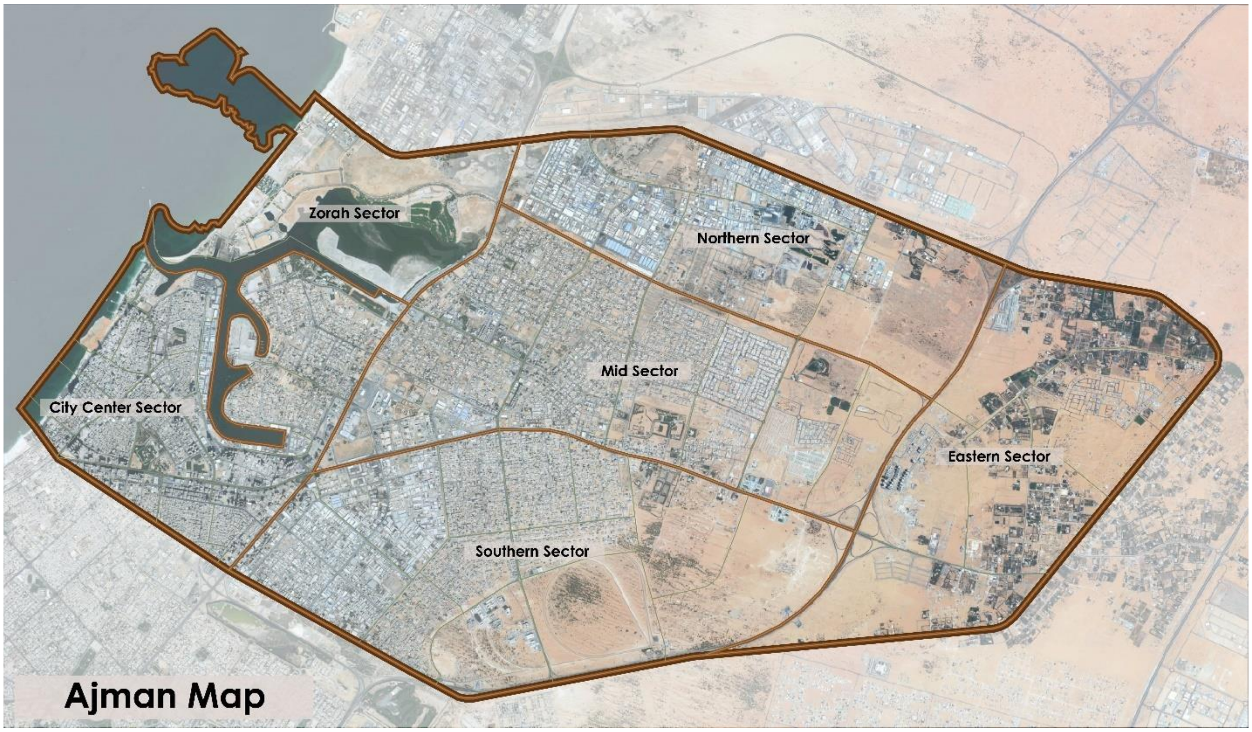

Figure 2.11: UAE Map, Emirate of Ajman City Map (MPDA-ArcGIS *2022*)

Through conferences, seminars, training courses, and workshops, the AMPD have organised a number of initiatives to increase public awareness and transfer technology. In order to advance current and future research on environmentally friendly practices, environmentally sound technologies, managing carbon footprints, and supporting the expansion of sustainable and environmentally friendly initiatives, these activities aim to promote the exchange of ideas and valuable experience. Activity sessions included presentations and discussions of practices used by experts and specialists from many countries in the fields of business and technology. These initiatives resulted in the publication of scientific publications that covered a variety of themes, including development strategies, laws to protect natural resources, diversification of energy sources, and sustainability. Examples include the Annual Ajman Environmental Seminar and the biennial Ajman International Environment Conference. The Ajman Government oversees and encourages these initiatives.

Sustainable development is a collection of trends and alternatives aimed at enhancing human living circumstances while maintaining a balance between social, economic, and environmental preservation (Masnavi et al. 2019). The government of Ajman has accepted this idea, with the development aiming to consider the preservation of natural resources and societal values, as well as contributing to the establishment of a green economy that interacts favourably with the environment. It contributes to the Emirate's residents' human development through a highly efficient and effective governance structure that adheres to the national values. (Abubakar & Alshammari, 2023) states the ambition of the Ajman Government is to develop a sustainable urban environment to achieve the Ajman 2021 Sustainable Development Guidelines as follows:

- To offer social well-being based on equality and fairness, to increase social well-being and personal production, and to establish an essential services level control to quality of life.
- Supporting business competitiveness, advancing the Emirate's economy to new heights by implementing green economy applications based on knowledge and innovation, and developing the required infrastructure, processes, and regulations to promote an active and sustainable economic movement.
- Investing in the development of competent and appropriate national skills, as well as assisting people in their integration into the business sector and other essential and central sectors.
- The protection and enhancement of biological variety, as well as the development of natural resources and the promotion of the use of alternative and renewable energy sources.
- To improve government functions, ensuring the protection of rights, gains, balanced planning, and the compatibility and integration of national efforts towards high-quality outputs commensurate with future aspirations.
- Superior government performance and differentiated and intelligent services to promote consumer satisfaction.

The proposed new Ajman Urban Strategic Plan for the year 2040 will provide the standard and strategy for planning, development control, and suitable laws and enforcement. The proposed new order to design an effective city will also have to lay out the underlying concepts and techniques for dealing with land-use management and the social, environmental, and economic sustainability aspects, as well as ensuring successful implementation. The KPIs are used to relate objectives to indicators in order to track and analyse progress towards the goals outlined in the Urban Strategic Plan. The recommended KPIs must be measurable and allow for updates from geographic information systems (GISs) and demographic measurements. The Inter-Agency and the Expert Group on the SDG indicators have created a battery of global indicator frameworks. Following a comprehensive assessment, the KPI was chosen in these SDGs, which are directly linked to Ajman's Urban Strategic Plan, with some of the goals listed below:

- Ensure universal access to water and sanitation, as well as long-term management.
- Encourage long-term, inclusive, and sustainable economic growth, as well as full and productive employment and decent labour for all people.
- Improve infrastructure, promote inclusive and sustainable industrialisation, and encourage innovation.
- Create inclusive, safe, resilient, and sustainable cities and human settlements.
- Take immediate action to address climate change and its consequences.

2.27 Sustainability and Resiliency in Ajman

The SDGs were established by the UN to rehabilitate the environment and ensure peace and prosperity for future generations. The UAE is one of the countries that has backed these aims. In this regard, Ajman has proposed measures to demonstrate its commitment to sustainability by analysing the SDGs and mapping materials and initiatives to them (Bush & Doyon 2019).

The municipal Comprehensive Plan 2015–2019, and the future of 2030 to 2040 established the data-collection dimension primarily. The data will reflect and evaluate land usage in various regions, as well as sustainable features that have been examined or implemented to address municipal concerns, with a systematic strategy following. Although the findings frequently rely on statistical analysis and traversing through the purposefully intended treatments in an experiment to generate valid and trustworthy data, research techniques differ along a quantitative/qualitative axis. An overall urban vision and plan to govern the overarching development and expansion of the city has been developed by the Ajman Comprehensive Plan. In view of the strong population expansion and development throughout the interim period, including new industrial and trade clusters and population hubs in high density, several challenges emerged for the local government. Combined, these strategies provide the city with a sound basis for sustainable development and progress now and for the future.

A workshop was attended by the Executive Director of the "Infrastructure Development Sector", the Project Manager, a planning specialised preparation consultant, representatives from government agencies of the strategic partners in the Emirate, stakeholders from the private sector, community leaders, and officials of Masfout and Manama. The workshop began by presenting the purpose of the gathering. It was highlighted that the aim was to bring all government departments concerned with the development and achievement of the anticipated prosperity in the region.

Since the Ajman Emirate is keen to succeed in establishing inclusive urban development in the Emirate, the gathering was called to expand the prospects of inspirational thinking. It was mentioned that this would enable inspirational ideas to come together that could lead to a tangible reality, which will then contribute to a better future for the overall Emirate (Center and News 2021). It was explained by the Executive Director that the inclusive project of Urban Planning 2030 is one of the most significant projects that the sector will accomplish soon, and the department plans to place a development frame for the sustainability and expansion of the urban growth in rural areas (Alhosani, Kaied, & Darwish 2021). It was briefed that the project provides the finest design alternatives for the current urban areas and will help manage the current challenges by connecting all resolution alternatives to cohesive plans that contain the road network plan, transportation means, infrastructure plan, project plan related to real estate, and developmental projects. Plans for communal facilities and integrated mechanisms for current and future urban centres were also discussed to ensure efficient distribution and sustainability.

It was explained by the Executive Director that Manama and Masfout contain various archaeologic sites, as well as "beautiful nature and tranquillity"; therefore, preservation of the current features along with the development of the areas can improve the dynamics of both areas

(Center and News 2021). He indicated that vibrant hotels and commercial centres will be established in the areas to enhance the economy and well-being of the areas. The Executive Director reviewed the work stages of the project. As per his presentation, the first task in the proposed project was to collect and analyse the required data for evaluating the present situation of the areas and the located buildings. He demonstrated that stage one of the projects had been completed, and that the department would now schedule meetings with government agencies in the Ajman Emirate, Manama, and Masfout (Center and News 2021). The Executive Director mentioned that population needs and demands are considered with the purpose of developing a comprehensive and clear plan to attain the aims of Ajman 2040. The main objective is to establish a happy society that enables the development of a green economy motivated by a distinctive government that agrees with the “spirit of the Union”.

The most noticeable challenges including the low water issue and resolutions were reviewed by the female consultant, noticing that wastage and misuse play a vital role in exacerbating the issue. Effective mechanisms that contribute to overcoming the challenges were presented by her. She added that great attention is given to the transportation network under the plan (Center and News 2021). The consultant said that the plan aims to find a modern and efficient transportation arrangement consistent with the most contemporary safety and security principles. She mentioned that the project is focused on utilising the most efficient technologies and their effective applications in the field of transportation to enable the connection between areas in the cities to those in their vicinity and the overall Emirate (Alhosani, Kaied, & Darwish 2021). In this way, transportation will be promoted. She specified that the plan will provide routes for bicycles and pedestrians that will help people to stay healthy and will encourage sports that will provide a refreshing experience to the citizens. She also emphasised that the plan will establish an ideal vision to assist decision-makers in the Water and Federal Electricity Authority in developing a transparent and inclusive plan to source lines in both cities.

The participants agreed at the workshop’s end that holding these meetings is necessary throughout the phases of the project. The collaborative workshop infused extraordinary participation from all stakeholders who totally agreed that if the urban plan productivities are applied on the ground, Ajman could be an attraction point for the world and attract tourists and investors from different places, which in turn will provide benefits to everyone.

The Comprehensive Plan laid the groundwork for future urban development, planning control, and regulation throughout the city, addressing population growth, commercial activity, housing provision, infrastructure, community facilities, and transportation, all with the goal of positively guiding the city's future growth. It will also be critical to maximising Ajman's potential, ensuring that its limited land allocations, especially those along the coastline, are developed in a way that balances the demands of industry, urban growth, tourism, and environmental preservation.

The detailed plan established an overarching foundation for the design of the property and land over a certain region, based on input from relevant parties and data gathering, to identify the underlying challenges and development objectives for the medium to long term. The result is an inclusive, progressive, and integrative planning model that provides wide development plans and regulations that cover a variety of important urban planning components. These procedures and policies must be transposed into particular plans, and eventually provide a mechanism for regulating and controlling municipalities at a high level and ensuring that public and private developers understand each other regarding the city's overarching vision and long-term objectives.

Comprehensive plans are generally evaluated and modified on a regular basis, usually every five to ten years. Each three to five years, a reassessment may be undertaken. This is a crucial part of sustaining the plan's relevance since it ensures that the objectives are aligned and consider the ever-changing market needs, socioeconomic developments, government priorities, and market circumstances. It is critical to evaluate the plan after it has been implemented, recognising its strengths and shortcomings, and making the required modifications to ensure that the plan stays relevant to the state's and people's requirements. Because the city is under a lot of growth pressure, and because so much of it is already constructed, rigorous urban planning legislation and guidance are required to guarantee that the greatest possible use of land may be accomplished. To build adaptable economic, social, and environmental longevity and prosperity, not just sustainability but also resilience must be addressed in all facets of Ajman's future, thus building a city that can thrive in the face of climate change by fostering industry, urbanisation, and general expansion in a resilient manner that allows it to adapt effectively to unpredictability.

Sustainability and resilience are closely related but distinct concepts. Sustainability focuses on the long-term viability of a system, emphasizing the responsible use of resources, environmental preservation, and social well-being to ensure that current and future generations can thrive. On the other hand, resilience is the capacity of a system to withstand shocks, adapt to change, and recover quickly from disruptions. While sustainability aims to create stable and enduring systems, resilience ensures that these systems can endure and adapt in the face of unexpected challenges. In the context of Ajman's urban planning, sustainability involves planning for environmentally friendly development and social well-being, while resilience ensures that the city can withstand and recover from potential disruptions, such as climate change impacts or economic fluctuations, while continuing its sustainable growth.

2.28 SDG Implementation by the AMPD

As shown in Figure 2.12, SDGs related to the quality of air are highly recognised by the AMPD. Air quality has been emphasised in this research as it largely impacts the damage to health and the ecosystems. Air pollution is linked in the idea with most SDGs in terms of sources (transport, energy, and industry), air pollution monitoring, and the implications for ecosystems and health, in a broad perspective. Air pollution is mentioned under the Health Objectives (SDG 3, Good Health and Well-Being) and the Cities (SDG 11, Sustainable Communities and Cities), but also may be associated with other objectives such as Water Quality and Restoration (SDG 6, Sustainable Cities and Communities), and Affordable Clean Energy and Water-related Ecosystems (SDG 11, Sustainable Cities and Communities) (Brunetta et al. 2021).

Figure 2.12: SDGs Related to Air Quality (Alhosani et al. 2021, p. 3)

The AMPD has employed a variety of techniques to monitor air quality. By disseminating awareness about the potential of good air quality, plans are being undertaken to ensure healthy air quality for future generations. To ensure the Emirate's long-term development, the AMPD has made preserving healthy air quality a strategic priority. In order to accomplish this objective, the Municipality has built Continuous Ambient Air Quality Monitoring Stations (CAAQMS) in various air quality-sensitive locations across the Emirate of Ajman (Brunetta & Salata 2019). These stations measure sulphur oxide, nitrogen oxide, carbon dioxide, ozone, and other air pollutants in Ajman. The goal for the next several years is to increase the number of monitoring stations in Ajman to cover more ground and ensure that the Emirate's air quality is under control, as well as to improve air quality standards. The AMPD's commitment in this respect is to "deliver the required solutions & consultancies, in the right way, on time, and in a cost-effective manner", to assist the municipality in improving environmental laws (Brunetta et al. 2018).

2.29 The AMPD and Achievements Towards Energy Efficiency and Climate Change

According to the research, the AMPD seeks to contribute to national efforts to reduce the effect of climate change factors on reducing emissions via innovative methods and actions. Furthermore, waste reduction with a goal of zero landfills requires a concerted effort from individuals and governments, as well as the use of cutting-edge technology to guarantee clean air and environmental compliance with Ajman's laws and the UAE's federal regulations and guidelines. Sustainable energy provides affordable, accessible, and reliable energy services that meet the economic, environmental, and social needs of the society for which they are intended, while also ensuring equitable distribution.

Some of the objectives suggested include reducing the cost of energy production, enhancing energy transit security, and promoting the usage of green technologies (van der Jagt et al. 2017). One of the AMPD's main objectives was to maintain energy efficiency in both the household and industrial sectors. This was done to ensure that all applications and performances follow the industry standards. It was able to save a significant amount of energy by improving performance and maintaining a high level of efficiency in all areas (UNESCO-UNEVOC 2021).

To contribute to the national efforts, the AMPD plans to reduce the emissions that impact on climate change with the help of innovative initiatives and measures, while additionally reducing waste with a goal of eliminating landfills and utilising cutting-edge technologies to maintain clean air and environmental compliance with federal UAE legislation and Ajman-level legislation, regulations, and directives. In order to meet the economic, social, and environmental demands of the society for which the services are meant, sustainable energy delivers inexpensive, accessible, and dependable energy services that also take into account fair distribution while addressing those needs. The goals set forth include low or zero carbon dioxide emissions, no necessary negative ecological effects, increasing the use of green technology, lowering the cost of energy generation, and improving the security of energy transportation. Maintaining energy efficiency in all residential and commercial sectors was one of the AMPD's major concerns. This has been planned to guarantee that all applications and performances adhere to the highest standards of best practices. It has achieved significant energy savings by enhancing functionality and maintaining high standards of efficiency in all areas.

2.30 The AMPD and Eco-Friendly Hybrid Vehicles

The Department of Agriculture and Public Parks, which is part of the AMPD's environment and public health sector, has launched environmentally friendly hybrid vehicles to guide, regulate, and educate visitors to Ajman's tourist sites and public facilities about alternative energy and how it can help protect the environment (Hall 2017). This is with the aim of providing public facilities with clean, renewable energy in order to support long-term development. To ensure future person mobility (individual mobility with the choice of one's own mode of transportation, as well as the use of all public transportation options) and goods transportation, a basic requirement that humans will take for granted in the future, it will be necessary to overcome future road transportation challenges (Umar et al. 2017).

Battery-electric power, according to research, will be a feasible alternative for motorised transport in metropolitan areas with short travel and transit distances. Longer journeys will need the use of other powertrains. According to current understanding, internal combustion engines (ICE) will play a major role in this. In the next decades, the development of compensation will be important in fulfilling mobility demands in the European road transport system. Sustainable or "green mobility" will be needed in the future, with "green vehicles" and associated infrastructure guaranteeing individual and environmentally friendly mobility independence, as well as commodity transportation (Umar et al. 2020). In the future, securing mobility and commodity distribution in cities and conurbations will be a significant challenge to solve.

According to a study, a sustainable transportation system, also known as sustainable mobility, may enable individuals, businesses, and society to react safely and consistently to their basic access and development needs while also promoting justice across generations and people. It is cost-effective, operates fairly and efficiently, provides a diverse variety of transportation options, and promotes a moderate economy and steady regional development (Uddin et al. 2020). It also minimises the effect of land usage and noise generation by utilising renewable energy sources at or below their rates of production, as well as conventional sources at or below alternative replacements' rates of growth.

In the context of sustainable mobility, with its individual mobility, public, and commodities' transportation, appropriate infrastructure technology plays a major role in addressing the problems of environmental impact, air quality, and sustainable mobility. Green vehicles and the infrastructure that supports them must work together to address future challenges (Uddin et al. 2021). The green vehicle industry, like the infrastructure that supports it, is still in its infancy. Green cars are described in this roadmap as cars with "new" technologies that are deemed "green".

Vehicles that run on "gas, bio-fuels, or dedicated new Internal Combustion Engines (ICE)" and have a low environmental impact, include:

> fuel cell electric vehicles (FCEV) or hydrogen-powered vehicles, hybrid electric vehicles (HEV) or full electric vehicles (EV) with or without plug-in devices, vehicles that run on gas, bio-fuels, or dedicated new Internal Combustion Engines (ICE).

The "green vehicles" need their own infrastructure. This European roadmap's goal is to determine which new infrastructure is required for "sustainable mobility", which existing infrastructure should be upgraded, and which research is required (Turnheim et al. 2020).

Many infrastructure technologies and processes are well known; others have been developed, where fresh and interesting ideas have arisen, and research projects have been carried out (Mochizuki et al. 2018). Smart power grids, multi-story parking garage charging stations, hydrogen, gas, renewable fuel filling stations, logistics and services, user information systems, and traffic management are just a few of the infrastructure needs for new research, development, and implementation. The development and introduction of "green" vehicles, as well as the provision of supporting infrastructure, must all take place at the same time (Tselios & Tompkins 2017).

2.31 Efforts Towards Green Sustainable Buildings in Ajman

The certification level and grading system must be carefully considered when determining how green or sustainable a building is. It has been proposed that a measure for evaluating environmental performance be created (D'Auria et al. 2018). The UAE, and particularly the Emirate of Ajman, is looking for innovative ideas, city-wide projects, public involvement, and education programmes to promote climate action and resilience.

The objectives of Ajman city, including improving living standards and providing economically viable employment, assist to reduce environmental harm. Pure renewable energy sources include solar thermal, photovoltaic, and wind. Other energy sources, such as geothermal and hydrogen, were later accepted as viable alternatives.

Residential buildings use 40% of energy, while industrial buildings consume 22%, commercial buildings 18%, and other structures 20%, as seen in Figure 2.13. As part of its attempts to convert Ajman into a sustainable smart city, the government of Ajman announced a policy on 31st May 2018, mandating all projects to be green, starting on the 1st of June, beginning with villas and moving on to all other kinds of structures at a later date (Contestabile & Vicinanza 2020). "The department is focused on implementing sustainability standards in all of the Emirate's key sectors in order to prepare for building the future of Ajman", said Sheikh Rashid bin Humaid, the Chairman of the AMPD.

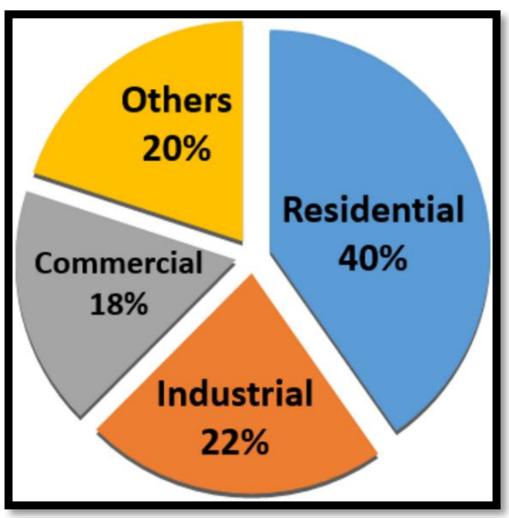

Figure 2.13: Energy Consumption Sectors (Alhosani et al. 2021, p. 7)

The Central Laboratory building was the world's first green building, built to worldwide green building standards. According to the chairman of the AMPD, it also fits with the municipality's goal, which seeks to create modern, long-term solutions to enhance infrastructure and define Ajman's future (Connolly 2018). Solar-reflecting glass for insulation and energy savings, thermal bricks for energy efficiency, ecologically friendly materials, and green concrete were all used in the construction.

The AMPD has established Continuous Ambient Air Quality Monitoring Stations in different, air quality-sensitive areas throughout the Emirate of Ajman, as part of the air quality-related SDGs. Furthermore, a smart mobile vehicle is equipped with the most up-to-date artificial intelligence measurement systems. The municipality has strategies in place to adapt to climate change and implement programmes and practices for achieving sustainable energy performance and behaviours. Examples include eco-friendly hybrid vehicles, which have been shown to save energy and reduce carbon dioxide (CO2) emissions. In the next years, the number of these vehicles is expected to rise, especially in the case of pure electric vehicles.

Waste management is another highly successful method. The AMPD has implemented sustainable waste management plans to accomplish sustainable waste management, which have been demonstrated to be effective via several successful actions aimed at achieving the objective of no landfill. The "Day Without Plastic Bags", for example, was observed for several years. It can be summarised by stating that Ajman is striving to establish an ecologically friendly smart city by focusing on green sustainable structures that have a minimal carbon footprint during construction, and thereafter with waste minimised to as-close-to-zero as feasible. Through conferences, seminars, training courses, and workshops, the AMPD has made great progress in raising public awareness and transferring technology. The current research will evaluate and report accordingly on the attainment of the key strategic indicators in this regard. The goal of the study is to compile a list of all the effective elements to consider when developing, implementing, and assessing legislation and policies to accomplish the UN-SDGs.

2.32 Ajman Urban Strategic Plan

The population of Ajman has continued to expand, as has the city's variety. The redevelopment of high-quality and appropriate infill, as well as enhancing the attractiveness of commercial corridors, remain priority goals. Make the greatest use of current facilities and land functions to strike a balance between development and environmental protection requires a careful evaluation of the impacts of any new development and a commitment to sustainable practices (Heaphy 2014). The resilience plan will likely focus on identifying more possibilities and methods for implementing the city's sector plans, as well as further defining character, design, and infill concepts for transitional regions and special districts. One of the biggest obstacles to a long-term vision in Ajman is the land available for expansion.

A high-level study of the existing situation in Ajman Emirate was required in order to develop an adaptable strategy approach for the Emirate. The available GIS data were combined with current drone pictures to better understand the existing land-use model. To begin, a distinction was made between constructed and unbuilt regions in order to determine which parts of the land had already been physically occupied by structures and which parts were still undeveloped. After that, four strategic groupings were selected based on the type of activity shown in each region. This categorisation is based on functional characteristics that divide the general activity into some key categories including inhabitants’ daily life (residential areas, mixed areas, and primary services offered to residents: health, administration, education, and religion), economic activities and job centres (productive zones, commercial zones, and hotels), and environmental protection and open-air recreational–sporting regions. It also includes land that is used for agriculture and land that is not urbanised.

According to studies, the world's urban population is at an all-time high, and by 2050, the urban population will account for two-thirds of the global population (Osman & Sevinc 2019). In the last three decades, increasing urbanisation has raised the percentage of the world's urban population from 10% to over 50% (Opach et al. 2020). Cities are facing problems as they develop due to a variety of causes such as climate change and socio-economic shifts (Oliva & Lazzeretti 2018). Urban resilience has become a popular and extensively utilised term in the face of such problems. The term "resilience" is becoming more popular in academic and policy circles (Normandin et al. 2019).

Depending on the research and the requirements and priorities of the interested groups, it has been framed in many ways. Although resilience theories have been around since the 1960s and early 1970s, their use in urban planning and architecture is relatively new (Olazabal et al. 2018). There is currently no agreement on what constitutes urban resilience. This variety of definitions might be the result of various disciplines’ views of the notion of resilience; it could also be the result of ecological approaches to social systems being applied incorrectly (Odeh et al. 2021).

According to a study, resilience has been utilised as a guiding concept across multiple urban multi-scales to create planning, recovery, and adaptation skills to deal with a wide variety of changes in social, economic, environmental, and physical systems, especially at the urban design scale (Noy & Yonson 2018). The idea of resilience is used in urban planning to establish ways and methods for improving a place's, a community's, or a city's ability to adapt to future changes that may influence the urban system's operation.

It has been used by some scholars to critique the inefficiencies of sustainable urban development plans and their inability to improve the quality of places and generate resilient places in recent decades (Nowell et al. 2018). Despite the growing usage of the term "resilient urban design" in the urban design field, knowledge of the idea of resilient places remains limited and fragmented. This necessitates more investigation to better comprehend the features of location and space that may enable cities to react to continuously changing demands and dynamics.

Although each group incorporates some elements of the others, they are not mutually exclusive (health centres, for example, host services for the population preferably linked to residential areas but are also working places). This generalisation allows for a high-level segmentation of the Emirate’s area and makes it easier to comprehend the land and functional demands of the activities that make up the cities (Newman et al. 2017). Understand the connections between climate change, the urban economy, land use, transportation, and the built environment, enables us to create more resilient and adaptive cities that can better withstand the impacts of climate change. As a result, current land uses are divided into two primary categories and four strategic groups:

Living City: The term “Living City” refers to the land used for residential areas, as well as the current facilities that provide services to the public. It will have to expand in accordance with the population prediction, while also establishing criteria for habitat occupancy, residential typology, and density (Neisser & Müller-Mahn 2018).

Working City: The categories linked to major job sectors and economic activity make up Working City. They provide guidance for improved circumstances in industrial regions, the tourist sector, and new sectors that might result in greater levels of creativity and productivity, enhancing new business models and a robust global model for competing both locally and worldwide.

Green Space & Sport: This category includes both open space and recreational amenities.

Not Occupied: A Not Occupied group is defined as the brown- and green-field areas that contain vacant lots, land reclamation, vacant industrial land, and agricultural land.

These categories may also be used to assess growth prospects, allowing planners and decision-makers to make decisions about the city's future development and function. To meet the community's requirements, the city has committed to reinvesting in public amenities and infrastructure. Creating a balance between transportation systems that promote long-term development and expansion by ensuring that everyone has safe, efficient, dependable, and convenient access (Negev et al. 2020) requires careful planning and collaboration among various stakeholders. Creating a transit corridor that may influence future development by providing a transportation strategy that considers all types of transportation (Mwafy 2019) involves analyzing current transportation patterns and identifying opportunities for improvement. Examining the potential for new modes of transportation to deliver high levels of employment accessibility and to meet the strategic plan's goals entails evaluating the feasibility and effectiveness of various transportation options. Identifying possibilities for economic revival and strategic investments to strengthen the notion of resiliency involves conducting a thorough analysis of economic trends and identifying opportunities for growth and investment.

People have begun to migrate to cities all around the world in increasing numbers. For many visitors and investors, the UAE is one of the most appealing countries. This has put pressure on all the emirates, and particularly the Emirate of Ajman, to preserve a safe, long-lasting, and sustainable way of life that provides well-being and a high level of living. The AMPD is the authority that has played a key role in establishing plans to address the linked environmental issues. This literature study provided and examined the concepts and success factors of an ecologically friendly metropolis. It emphasised how these standards are attained and practised for the Emirate of Ajman's benefit. The UN-SDGs need to be incorporated into the AMPD, and each SDG has to be assigned to one or more specific activities. The SDGs related to the AMPD's plans and goals, infrastructure and roads, waste management, community health and welfare, and climate change are included in these activities.

2.33 Chapter Summary

This Chapter provides a comprehensive literature review on the concept of resilience in urban planning and development, particularly in the context of climate change and environmental challenges. It highlights the growing importance of resilience as a key objective in local and international agendas, such as the Sustainable Development Agenda 2030. The chapter emphasizes the need to integrate resilience into urban development and planning processes, using the example of Ajman city in the UAE. It also discusses the various dimensions of resilience and the development of frameworks and indices to assess and enhance urban resilience. The chapter notes the challenges and complexities associated with defining and measuring resilience, including its multidimensional nature.

Furthermore, the chapter underscores the urgent need for resilience planning due to the increasing uncertainties and risks associated with climate change, rapid urbanization, and poor planning in many cities. It highlights the role of researchers and organizations in developing frameworks and tools to predict and address challenges posed by climate change in urban areas. The chapter also discusses the concept of risk and how individuals and societies deal with and mitigate risks in their daily lives. It connects this understanding of risk to the broader context of climate change and resilience, emphasizing the importance of proactive measures to mitigate risks associated with climate-related disasters. Overall, the chapter provides a comprehensive foundation for understanding the key concepts and challenges related to urban resilience and its integration into urban planning and development processes.

2.33.1 Key Issues Identified from the Reviewed Literature

1. Lack of Comprehensive Integration

The literature suggests that while resilience has gained significant attention in urban planning and development, there is a notable lack of comprehensive integration of resilience principles into urban planning frameworks (Almarzouqi 2017). Many existing studies focus on defining resilience but do not provide practical guidance for incorporating it into urban development plans and strategies.

2. Inadequate Use of Planning Scenarios

The literature highlights a gap in the utilization of planning scenarios and preservation methods in the development of resilient urban centers (Almoghathawi et al. 2019). The research often emphasizes the importance of resilience without addressing how specific development plans and scenarios can be designed to enhance it.

3. Limited Application of Resilience Concepts

While resilience is considered a priority at various levels of government and within international agendas, there appears to be a limited understanding of how resilience concepts can be practically applied in urban planning and decision-making (Staddon et al. 2018).

4. Diversity in Resilience Understanding

There is a lack of consensus on what resilience means in the context of cities and urban planning. Stakeholders and policymakers may have differing interpretations of resilience, leading to potential confusion and challenges in implementing resilience strategies (Sitas et al. 2021).

5. Overemphasis on Disaster Resilience

The literature suggests that much of the focus on urban resilience has been on disaster resilience, particularly in response to natural disasters. However, there is a need to broaden the scope of resilience planning to address various stressors, including those related to climate change and resource management (Santos et al. 2020).

6. Limited Frameworks for Assessment

While the literature mentions the importance of assessing urban resilience, there is a lack of standardized frameworks and indicators for measuring resilience comprehensively. Existing methods often focus on specific aspects, such as infrastructure or environmental factors, but do not provide a holistic assessment of urban resilience (Chen et al. 2019).

2.33.2 Justification for the Research Problem

The identified gaps in the literature justify the research problem of this study. The literature review highlights the pressing need for a more comprehensive and practical approach to integrating resilience principles into urban planning and development. There is a gap between theoretical discussions of resilience and the practical implementation of resilience strategies in real-world urban projects. This disconnect hinders the ability of cities to effectively address the complex challenges posed by climate change, population growth, and other stressors.

Furthermore, the lack of consensus on the definition and scope of urban resilience underscores the need for research that clarifies and operationalizes resilience concepts for urban planning. Resilience is a critical concept for building sustainable and adaptable cities and bridging the gap between theory and practice is essential for achieving this goal.

CHAPTER 3: RESEARCH APPROACH AND ETHICS

3.1 Introduction

There is no approved method for measuring the resiliency of a region to climate change. Various researchers have approached the task to develop a systematic way to measure urban resilience for cases. In this section, some of the previous research in the domain of "URI" development has been analysed in order to figure out the best method for the current study. Analysis of the methodologies of a few relevant research articles is presented in this section that provides insights about reliable methods that can help in the identification of the most suitable method for this study. Moreover, the evaluation will assist in identifying improvement in the methods being used, and thus overall benefit can be gained.

3.1.1 Methodology of the Resilience Index of Spanish Cities

Suárez et al.'s (2016) study of the URI of 50 Spanish cities will provide the primary framework for the upcoming study's research design. The researchers adopted the objectives of their study to the resilience index based on five major steps. In the first three phases, the researchers focused on the selection of a relevant spatial scale of analysis, the identification of primary factors that sustain resilience, and the selection of indicators. The process ended with the last two steps, which included data normalisation, and data weighting and aggregation.

Regarding the spatial scale and sample, the study started with the selection of municipalities to provide a minimum spatial scale of centralised statistical data. By the localisation of the scale to municipalities, the researcher was assured of generating data from the most basic level of the city. To put it differently, the 50 Spanish cities formed the primary sample units in this study. Concerning the study's primary factors for sustaining resilience, the researcher sought to develop a new conceptual framework, which was necessary since existing indicators of resilience approach the phenomenon from either an engineering or ecological point of view. The study began by identifying key factors that impact resilience in a city as the core indicators in the index. These factors were generated after extensive reading of the literature and further reference to existing case studies. Among the factors that were selected by Suárez et al.'s (2016) study were diversity, modularity, tightness of feedback, innovation, and social cohesion. To arrive at these factors, the study began by listing all factors that appeared in the literature, before proceeding to sort them according to the number of times they were mentioned in the research.

3.1.2 Water Squares Case Study of Mexico City and Rotterdam

To investigate how resilience-related policies could be transferred from one city to another, researchers conducted an empirical in-situ analysis using an explanatory case study. An empirical in-situ exploration, as opposed to a conceptual principle-based framework, requires a model that is process-based (Ilgen et al. 2019). The research design was termed explanatory since the study did not merely explore in-situ learning but came up with a theory to provide insight into the primary processes involved during the transfer (Ilgen et al. 2019). The two cities that were selected for the study, Mexico and Rotterdam, as the researchers reported, had instituted the concept of water squares. Regarding the exploration of issues relevant to the study, the researchers performed two interviews with the architectural companies involved in the design and construction of the water squares and an international firm specialising in city-to-city knowledge transfer (Ilgen et al. 2019). The first set of interviews was focused, and they explored the specific aspects of collaboration (Ilgen et al. 2019). The second set of interviews, on the other hand, was open-ended, and they were held with different actors involved with knowledge exchange in the two cities (Ilgen et al. 2019). The researchers collected further data through site visits and the observation of subjects. Overall, the researchers employed an exploratory explanatory study to explain knowledge transfer regarding urban resilience in cities.

The authors of this research presented an analysis of the way knowledge relevant to policy on the view of "Water Squares" was exchanged between Mexico and Rotterdam. The authors mobilised an outline that was composed of four separate stages: exploration and marketing, pipeline building, translation and adoption, and internalisation and reflection. They showed that a reflective analysis of a city's own arrangements, assets, and weaknesses was performed in the first stage, rather than a search that was outward-looking. In the second stage, the cities restructured their own descriptions to relate to those of their equivalents as a means of generating a common understanding of each other's histories and struggles. The procedure helped the cities to exchange knowledge and assist policymaking based on trust. During the third stage, Reliance leaders were employed in the process from the locality to present information to the public and to decrease the jeopardies of losing “institutional memory” in hierarchical and centralised establishments. The authors mentioned that the fourth phase should be focused on the internalisation of such programmes, to strengthen the city’s own resilience along with enhancing knowledge exchanges in the future with other urban areas (Ilgen et al. 2019).

3.1.3 A Case Study of Phnom Penh City, Cambodia

Elsewhere, researchers employed a mixed-methods research design that combined qualitative and quantitative methods. The study focused on Sangkats or communes of the Cambodian capital, which included Kouk Roka, in Khan Praek, and Khmuonh, in Khan Saen Sokh (Nop & Thornton 2019). The localities were deemed appropriate since they fell within the urban outskirts of the city where city upgrading activities are concentrated. At the same time, the chosen areas were also preferred because the communities living in the spaces are classified as vulnerable, and they have very limited access to resources. Regarding sampling and data collection, the researchers acquired their secondary data on urban resilience from several journal databases, government websites, and NGOs (Nop & Thornton 2019). The primary data, on the other hand, were generated from a sample of 428 households, from which one member was selected to provide feedback. While 207 respondents were from Khmuonh, Kouk Roka provided 221 subjects. The researchers followed the systematic sampling technique, in which every fifth household of the chosen villages was included in the study. The quantitative data generated from the survey were analysed using IBM’s SPSS v.24. Among the risks that residents identified included strong winds, floods, storms, landslides, thunder, vector-borne diseases, and heatwaves.

In Nop and Thornton’s (2019) research, the findings revealed partial attention of the local government in the improvement of infrastructure and negligible commitment to supporting susceptible poor communities in urban areas to form resilience to natural hazards. The authors recommended that the local authorities should support livelihood development agendas, address insecurity related to land tenure, and refine basic infrastructure in informal residential areas (Nop & Thornton 2019). The authors explored rigidities related to the search of reforming cities in emerging countries for both urban resilience construction and economic growth. They found that urban advancement as a method to renovate has not upgraded the livelihoods of the poor population of the urban centre.

3.1.4 Developing an Integrated Scenario-Based Urban Resilience Planning Support System

In this study, the researcher evaluated the application of eco-aesthetics in planning urban resilience as a theoretical basis. Eco-aesthetics is concerned with the modification of aesthetic sensory capability by implanting better ecological knowledge and highlights the integration of development and environmental protection to enhance the experience of humans. Fundamentally, a resilient urban structure relying on eco-aesthetics gives active ecological utilities along with the provision of valid social and economic abilities, and therefore increases the capacity of absorption, adaptation, and the mitigation of an urban centre due to diverse turbulences.

Fu (2018) utilised the "urban resilience capacity" calculation and scenario generation and modelling in his research to apply an eco-aesthetics outline for resilience planning for the case of Hamilton County, Ohio. The outcome of the research was a Scenario-Based Urban Resilience Planning Support System (SB-URPSS) that aimed to serve as a tool for decision-making for planners, public leaders, and other stakeholders. The features of ecological, social, and economic system meanings were combined to make the SB-URPSS for evaluating land-use variations under diverse scenarios (Fu 2018). The resulting scenarios were compared with the help of a merged URCI.

The author utilised seven scenarios that were set over 20 years, to assess the SB-URPSS application. The historic trend of the land-use scenario was maintained as a baseline to function as a control. Two other scenarios were developed for the purpose of comparison, of which one scenario was focused on economic development, and the other was focused on environmental development. Four other forms of eco-aesthetics' scenarios were produced with the help of the principle of integration. The same amount of "undeveloped land" was kept in all cases to address ecological protection. Four scenarios resulted through the combination of the amount of infill development and developed land to address social and valid economic capabilities (Fu 2018). The amount of developed land embraced a moderate amount of the Chicago framework and the

high intensity of the model of Philadelphia. Vacant lots had two versions of policies regarding infill development: one transformed them into developed land, while the other converted them to open space.
The researcher as part of a Multiple Criteria Evaluation (MCE) utilised quantitative and objective approaches that were aimed to improve the selection, scoring, and weighting process for finding factors that were suitable for the simulation model, named the Cellular Automata-Markov Land-Use Model. The approaches were adopted to enable the derivation of suitability factors from data on local historic land use and to create a relation between the actual historical land-use trends in the locality and the MCE process.

Fu (2018), with a compound URCI, assessed scenarios that replicated the city resilience's multiple-dimensionality, physical form, discourse urban system, and the urban resilience plans' spatial structure. The URCI was created to aid planners and other stakeholders in the identification process of planning for scenarios that can ensure the achievement of overall and high economic, social, and ecological quality. The SB-URPSS and URCI that were produced by the researcher based on a dynamic scenario and engaging the public were aimed to enable decision-makers to approach planning for urban resilience as integration, which consists of economic advantages, ecological integrity, or social fulfilment.

3.1.5 Climate Change Adaptation: A Green Infrastructure Planning Framework

Abunnasr (2013) explored multiple aspects of planning a green infrastructure as an adaptation mechanism for climatic fluctuations in urban centres. The author organised his research into three distinct but connected fragments. An adaptation employment model was developed by the researcher in the first part of his thesis that was based on generating conditions rather than time. The model was based on the literature in the domain of planning and adaptation, and was applied to two different case studies. Abunnasr (2013) argued that uncertainty during deployment might be mitigated by flexible and incremental policy, needs-based investment expansion, monitoring conditions, and adaptation procedures by the organisation with no hesitation to implement innovative measures.

The author developed a green infrastructure in the second part of his project as a framework for organisations to mainstream policies regarding adaptation arrangements. For the vertical and horizontal assimilation of policy, the framework adds multi-dimension and situational features of green infrastructure. Literature from landscape and city planning was integrated into the framework and tested in Boston. The author stated that adaptation measures are prioritised based on location. The results of the research suggest that green infrastructure policies of adaptation should be consistent with the structure of zones.

To develop a percent-responsive metric, the author utilised Boston's spatial data, enabling the categorisation of the study area into six zones with different perviousness. The research assessed opportunities across land use and then defined space opportunities based on intensification, conservation, expansion, and transformation. The outcomes of the research highlighted that transformation opportunities of impervious surfaces to green surfaces were highest in the city area and its vicinity. The growth of vegetation on porous lands adjacent to all types of land uses is increasing significantly. The exact significance or implications of this phenomenon are unclear. It was also concluded that existing land conversion into forest was important for climate-proofing in the future. The research, in conclusion, argued that planning based on conditions for green infrastructure rather than time-based is beneficial and effective for adapting to climatic changes.

3.1.6 Measuring Urban Resilience to Climate Change in Three Chinese Cities

This research is relevant to the current thesis since this paper is also about developing a URI. The researchers' main aim was to build a measuring tool for measuring and quantifying the resilience of an area and to help policymakers and urban design planners to recognise whether a development project is prominent in enhancing resilience at the city level. The URI suggested by Zhang et al. (2020) utilised data on 24 indicators that were distributed over six URI constituent indices. The researchers stated that these six dimensions were identified by critically analysing previous literature and keeping the local framework of the case study cities in mind. Although perfection in the measurement of complex phenomena like urban resiliency is difficult, the authors claimed that the URI they developed proved to be useful, effective, and robust. A connection between urban resilience against changing climate and policy significance could be created by a URI. The findings of the research also showed that integrated information access on urban resilience to climate change was ensured by the URI.

As per the authors of this research, the URI enabled the comparison of urban centres in a quantitative and systematic way, along with the identification of strong and weak areas related to urban resilience. It is mentioned in the article that the URI enables a noticeable measure of the overall degree of urban resilience to change climate, along with the measurement of components and related pointers of urban resilience. Hence, the researchers claimed that a wide range of policy and research requirements could be met by the URI. It is a helpful measurement framework for urban planners and decision-makers at the city level to perform tangible measurements of goals, quantify progress, standardise performance, and recognise urgencies to establish urban centres with high resiliency against changing climate (Zhang et al. 2020).

The authors concluded that urban resilience to turbulences like climate change is complex, yet can be measured. As per the authors, cautious selection, and scientific tests, can enable the effective measurement of resiliency at the city level by a URI. The URI that was developed in this research used 24 indicators spread over six URI constituent indices and was proven to be useful, vigorous, and effective. Particularly, the URI was claimed to ensure integrated information access to decision-makers and planners at the city level on urban resilience against turbulences, specifically changing climate (Zhang et al. 2020). It is mentioned in the article that comparison between cities could be enabled by the URI in a systematic manner, and that this would help in quantifying the resilience and figuring out the areas of success or failure, and therefore to identify opportunities and priorities. Moreover, the URI was claimed to enable exploration into the connections between the overall URI and different features related to urban resilience against changing climate.

3.1.7 Summary

The above works of the literature are relevant to the current study, and the authors of the research utilised various methods to develop measurement tools to obtain the tangible value of resiliency of an urban area. Table 3-1 presents the summary of the studies considered in this section. As the table highlights, the methods used by the authors share some commonalities, while major differences can be seen in the approach adopted. Based on the analysis of the above works, and consistent with the aims of the current study method, this research will be identified to develop a “URI” for the city of Ajman.

Table 3-1: Climate Resilience Analysis Methods

No.	Author	Research Title	Methodology
1	Abunnasr 2013	Climate change adaptation: A green infrastructure planning framework for resilient urban regions	• The dissertation employs a mixed-method approach that utilises literature reviews, case study analysis, policy analysis, and GIS mapping to address the propositions.
2	Fu 2018	Developing an integrated scenario-based urban resilience planning support system	• This research uses quantitative and objective methods as part of an MCE that could improve selecting, scoring, and weighting suitability factors for the Cellular Automata-Markov Land-Use Simulation Model. • The methodology, including scenario generation, scenario modelling, and resilience capacity assessment, is embedded into a Planning Support System, which is designed as a platform for the eco-aesthetics planning process and decision-making tool for community leaders, as well as the public.
3	Ilgen et al. 2019	City-to-city learning for urban resilience: The case of water squares in Rotterdam and Mexico City	• The study conducted an empirical, in-situ analysis. They examine the process of city-to-city learning through semi-structured interviews, site visits, and participant observation. This process is assessed using a preliminary analytical framework.
4	Nop & Thornton 2019	Urban resilience-building in modern development	• Adopted a mixed-methods approach, which combined both quantitative and qualitative techniques for a case study design, sampling, data collection, and data analysis.

5	Suárez et al. 2016	Towards an urban resilience index: A case study in 50 Spanish cities	• Offers the URI as a theoretical framework for measuring resilience in urban social-ecological systems. • The methodology was adapted to the resilience index, along with the following steps: (i) selecting an appropriate spatial scale of analysis, (ii) identifying key factors for sustaining resilience, (iii) selecting indicators, (iv) normalising data, and (v) weighting and aggregating data.
6	Zhang et al. 2020	Measuring urban resilience to climate change in three Chinese cities	• This study analysed and integrated findings from previous literature to develop a URI for three cities in China.

3.2 Research Approach

The research approach utilized in this study was a qualitative method, combining a literature review and interviews to gather data. The literature review examined previous studies on resilience and climate change in urban planning, providing insights into relevant issues. Interviews were conducted to understand the current situation, potential challenges, and opportunities that could inform the development of effective policies for climate change resilience in Ajman. The literature review data helped identify key performance indicators (KPIs) used in previous case studies, while the interview data identified relevant and context-specific indicators for Ajman. By combining these two methodologies, a proposed urban resilience index (URI) plan for Ajman was formulated and validated.

To address these concerns, interviews were primarily conducted to gain insights into the origins, vision, longevity considerations, and implementation of the study's action plan. The interviews aimed to understand the intended beneficiaries of the policy and the issues it aimed to address. These data were then utilized to support the selection of urban vulnerability indicators.

Given the research's focus on policy, environmental, and geographical aspects of Ajman city, as well as the sustainability outcomes resulting from these dimensions, it was crucial to consider the underlying policies that shaped the current plan. Additionally, an analysis of how policies are managed post-implementation was conducted since policymaking extends beyond the creation of a plan. The implementation of planning regulations has both physical and temporal impacts on the utilization of the plan. These factors, among others, influence the overall resilience of a city.

Examining policy frameworks is vital as policies significantly influence strategic planning and its outcomes. Policies manifest themselves tangibly and impact land use and activities within each location (Fu 2018). Therefore, policies can be seen as instruments of authority that shape planning decisions and outcomes. Flexibility and durability are intertwined concepts in planning theory and practice, emphasizing the importance of planning at various levels. Planning must be evaluated across different scales, from broad political considerations to interconnected causes of change, to effectively contribute to urban resilience.

3.3 Rationale Development

Both natural and artificial phenomena had a determined point at which they functioned optimally. Traditionally, resilience was derived from two types: ecological and engineering (Suárez et al., 2016). The former type, as defined by Folke (2016), was a form in which a system could return to equilibrium after a perturbation, while the latter, according to Suárez et al. (2016), acknowledged the existence of multiple states of equilibrium, meaning the system could assume any of these states after a disturbance. Despite the two types of resilience denoting distinct states in which, in one form, a system bounced backward, while in the other, it bounced forwards, both were identified with the fact that a system had a known stable equilibrium (Suárez et al., 2016).

However, although these two models shed significant light on the operations of a city, they failed to recognize its ability to evolve; hence the need for the current research, which specifically focused on the city of Ajman. The notion of evolutionary resilience, as described by Suárez et al. (2016), recognized that complex systems of cities constantly changed, meaning that in the wake of a disturbance, cities did not return to a specific equilibrium state. Based on this rationale, a need arose to understand how the complex social-ecological system of Ajman city could not only change but also adapt and transform in response to stresses and strains.

The goal of this work was to examine and expand upon past plans and data as a starting point for developing a strong vision, objectives, and general direction for the city's detailed Urban Strategic Plan 2040. Data collection and involvement were started, and meetings with experienced employees from several government agencies, as well as other stakeholders, were conducted to obtain further information and expertise into the current development challenges and concerns. The data collecting and interview exercise allowed for the identification and analysis of the existing circumstances in the city. The study looked at land use and development, as well as ecology and stability. The results were compiled into the stages of present status and prognosis, which emphasized major findings, identified opportunities and limits across all industries, highlighted critical concerns that would impact future planning possibilities, and offered current results.

In order to develop the city's urban resilience, a comprehensive understanding of the city's physical, economic, social, environmental, and cultural elements and attributes was required, as well as a deeper understanding of the key elements and drivers, and a shift towards a more adaptive plan to monitor climate change projections for future vision and planning. The formulation and assessment of conceptual spatial development alternatives for Ajman involved using a variety of qualitative criteria, creating a framework for future growth, addressing major concerns, and adhering to the city's desired development choice, such as plans, projections, and policies.

In this context, the research strategy depicted in Figure 3.1 explains the steps of the data analysis in order to build a thorough understanding of Ajman and its current conditions, as well as to summarise the results of the first data collecting and stakeholder engagement activity, identifying any data "gaps" as well as the difficulties in reaching out to important stakeholders. The study is based on the information currently available for Ajman; hence, it contains an overview of the existing data as well as a list of omissions that will have to be filled in as the investigation continues.

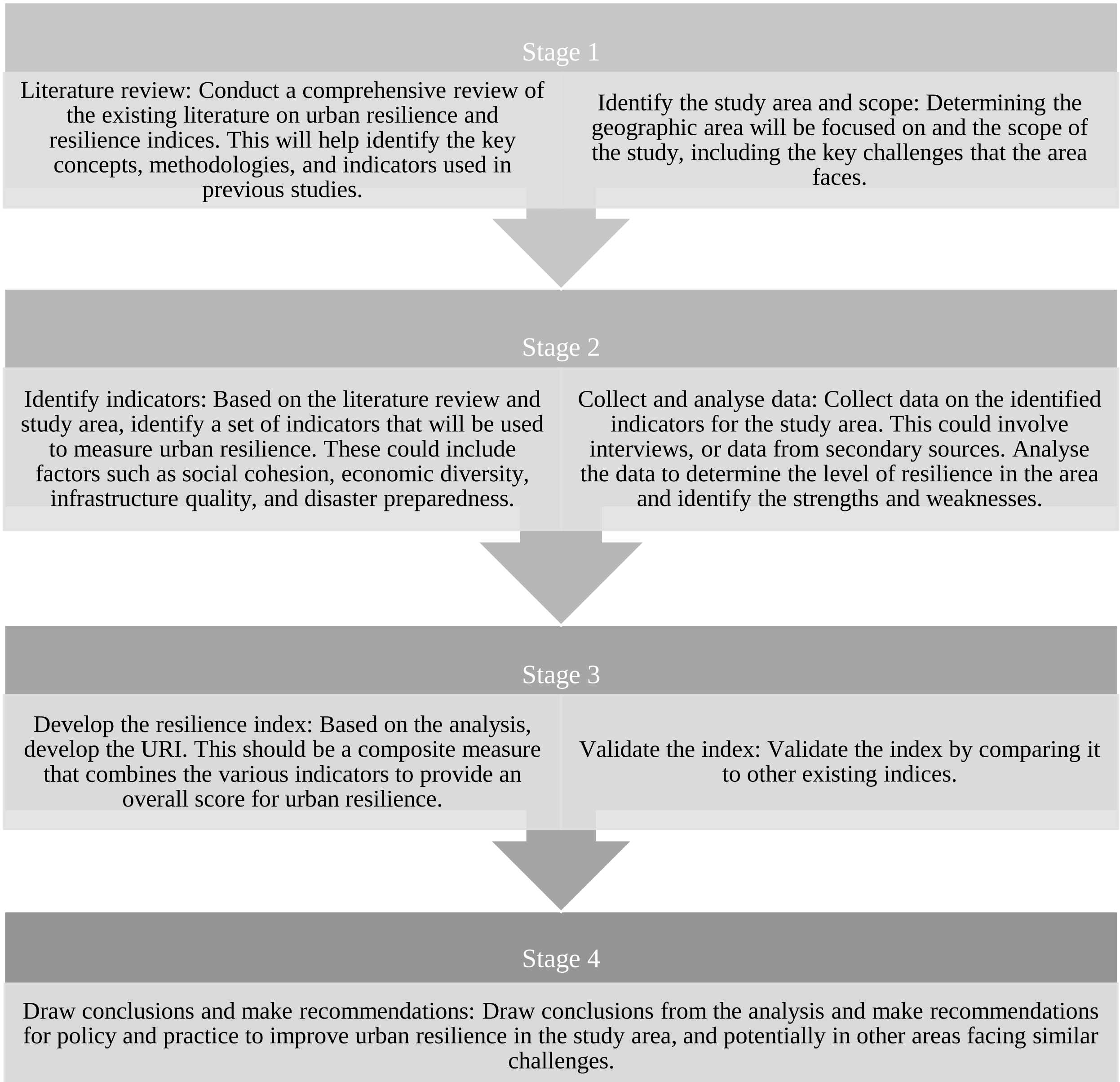

Figure 3.1: Study Approach Stages

The developing urban structures and designs are linked with long-term impacts as once the urban infrastructure is built it becomes very challenging to alter and adjust. Integrating an understanding of the challenges associated with climate and other threads with urban development decisions is an important constituent in city planning, and for the establishment of more resilient cities. In this respect, it is compulsory to develop frameworks and tools to evaluate the influences of land use, urban designs, population, and various human activities, and the resultant impacts on the atmosphere and environment. It is vital to understand the influence of individual cities on global climate and make plans consistent. Hence, this research is designed to develop a systematic tool for evaluating the resiliency of Ajman and will provide assistance for planning and help leaders to monitor projects for their resiliency and compliance with the nation's standards.

The development of a URI for a particular area requires complete knowledge of the features of the region like the topographical, cultural, and environmental elements, along with a comprehensive understanding of the main drivers, enablers, and change to achieve an adaptive plan for monitoring and projecting climate change in the future and planning accordingly. The evaluation and formulation of rigorous development options for Ajman need the utilisation of various qualitative and quantitative standards. Establishing a framework for future development, tackling the main concerns, and respecting the city's anticipated expansion choices, projections, policies, and plans is the objective. This study is dependent on the existing available information regarding Ajman city; therefore, it comprises an overview of the current data, along with a list of omissions that will have to be filled in as the study continues.

The data about Ajman was collected through primary sources such as the interviews of stakeholders and reports available on the municipality regarding the city's development plans. The literature review techniques examined significant theories that describe resilience and define the most operational factors when measuring the effects of climate change, to suggest policies and develop methods and planning objectives. This research focuses on the findings and evaluation after mining the available data and comparing the outcomes with the literature review. It will provide insights regarding future research and ideas for better planning for resilience development.

This research relies on the data from existing studies, along with primary data sources, to develop and assess a specific resilience plan for Ajman. Engaging stakeholders is important to enhance synergy and welfare, and to assess the efficacy of the proposed plan. Therefore, selecting appropriate methods was crucial to engage stakeholders in the planning process with the help of interviews. The current research scheduled interviews with stakeholders and their contribution has been utilised in the development process of the URI. The stakeholders involved are mainly the ones that are directly involved in the preparation of the plan for Ajman city. The reason to involve them was to obtain reliable and updated information about the status of the projects and the goals associated with them.

3.4 Ethical Considerations

Ethical norms are vital for every research work. There are numerous reasons behind the importance of following ethical norms in undertaking research. The most important role of ethical consideration is that these norms enable the promotion of research aims like truth, knowledge, and the prevention of harm (Reid et al. 2018). For instance, preventions against misrepresenting, faking, or fabricating data in the study reduce error and promote the truth. Secondly, essential values to enable collaborative work are achieved by following ethical norms in the process of research. It is vital because usually research projects require coordination and collaboration among various stakeholders in diverse institutions and disciplines, and these requirements can be met by adopting values like mutual respect, truth, and fairness (Bracken-Roche et al. 2017). For example, to protect knowledgeable, property, interests and encourage coordination many ethical standards like copyright, policies for data sharing, confidentiality rules, and authorship guidelines are considered.

In addition, most of the ethical rules assist in ensuring the accountability of researchers to the public (Reid et al. 2018). For example, interest conflicts, policies regarding misconduct in research, policies regarding animal use, and the protections of people are compulsory to ensure the accountability of those researchers who utilise funds from the public to the people. Moreover, ethical considerations in the study also assist in building support from the public for the research project. The public tend to support and provide funds to a researcher whose project has high quality and integrity.

Lastly, ethical norms in the study also encourage various other social and moral standards like human rights, social responsibility, agreement with the law, animal welfare, safety, and public well-being. Humans and other living subjects, and the public will be harmed significantly if ethical lapses occur in the research process (Bracken-Roche et al. 2017). For instance, when a researcher misinterprets guidelines related to biological safety in research, then the researcher can potentially harm his/her safety and health along with others. These aspects depict the importance of ethical norms in performing research. Considering the importance of ethics, the following values have been considered in the process of the current research.

To protect the interests of the participants and their future well-being, the identity of the subjects will not be shared. Particularly, the study will obey the two principles of anonymity and confidentiality (Bhattacherjee 2012). The latter, on the other hand, will mainly affect the face-to-face interviews, in which anonymity may not be possible, and thus although the identity of the respondents are known to the researcher, such information will not be divulged to third parties.

The researcher also makes necessary disclosures concerning the study. This enables the respondents to decide whether they are willing to participate in the process or not. The participants were notified that they have a right to withdraw their participation at any time. The principle of informed consent requires researchers to provide sufficient information regarding the study and advise participants about the implications of their participation (Creswell & Creswell 2017). Moreover, the researcher will avoid causing any harm to participants by avoiding questions that may compel them to engage in unlawful activities. Lastly, concerning the analysis and reporting, all unexpected or negative findings will be disclosed, even if they cast an element of doubt on the study's design. Ethical documents will also be filled to ensure confidentiality regarding research with human subjects, and will be included in the appendix of the research after being reviewed and approved by the University's Ethics Committee. The researcher will not use offensive, discriminatory, or offensive language during the formulation of the interview questions. Finally, the researcher will maintain the highest level of objectivity to avoid asking unnecessary questions. This also entails focusing on appropriate analyses and presentations throughout the study.

3.5 Strengths and Limitations

3.5.1 Strength

The major strengths of this study are that it will overcome the limitation faced by Suarez et al. (2016) regarding the selection of a scale and sample of the resilience index. In the previous study, the researchers faced this obstacle since they sought to develop a generalised sample that fitted all the Spanish cities, which was hard because some cities lacked data. However, since the current study focuses on one city, this limitation will not be experienced. Moreover, since the study will collect data using interviews in addition to publicly available records, the researcher will not lack relevant information to feed into the indicators. Therefore, as future directions this research will result in building a database of resilience indices, identifying for example a pattern of social, environmental, and economic indicators in Ajman according to its climatic conditions and plans.

The significance of this research is that only a small portion of planners are beginning to exclusively focus on the need to investigate urban resilience strategies and indicators beyond sustainability. The research is perhaps the first to propose and develop a URI for Ajman and in the UAE for comprehensive planning. The resilience framework and strategies that shape the city hold the potential to provide feedback for decision-making based on analysis, and more importantly towards facilitating the rebuilding, recovering, and bouncing back to respond to various effects of climate change.

3.5.2 Limitation

The major limiting factor of this study regards the selection of variables for the resilience index. Furthermore, as the results of the current research were made specifically for Ajman and revolve around Ajman city, hence was unusable for any of the other cities or emirates. To make sure sufficient consideration of the environment and comprehensive viable development takes place, the resilience concept required examination in the developing stages of the Comprehensive Plan 2040. Advised activities, specifications, and steps for the execution of development such as screening, scoping, reviewing, and monitoring provide the ability to embed a complete view. The evaluation techniques allowed policymakers to create perceptive policies, and by using the available data sets they would execute strategies for tackling climate change. The only research common was limitations inconsistency and the unavailability of information. Even though these were seemingly challenging, the findings were still reliable and valid despite those limitations. There are a few critical areas where the reliability of results would be directly influenced by the accuracy of available information and assumption. Gaps in the available information are unavoidable, so efforts are made to locate and utilise data through multiple sources, for instance, missing data were incorporated based on conditions, historical trends, similar data, and possible future tendencies.

3.5.3 Reliability

Despite the limitation of finding adequate data and information regarding some aspects of Ajman city, particularly on environmental resilience, the researcher will use available government documents and adopt a qualitative method to collect reliable information from key participants. The reliability of the findings is enhanced by the fact that the research focuses on only one city. Therefore, the limitations that Suarez et al.2016 experienced in their work can be avoided. Additionally, the researcher will borrow substantial information from local sources, international studies, and historical data to enhance the reliability of the study.

3.5.4 Validity

To increase the validity of this study, the researcher utilises articles that are not older than 10 years. This approach is important because it improves the accuracy of the data and information collected. In addition, the approach enables the researcher to avoid including unnecessary information. Moreover, the researcher conducted a literature review of urban resilience plans that are reviewed on a regular basis to improve validity. For instance, Zheng et al. (2018) describe an urban resilience plan for Beijing city that is evaluated every five years to determine its ability to respond to emerging climatic conditions. Finally, the researcher adopted peer-reviewed, government publications, scholarly sources, and international reports to enhance the validity of the research.

The data collection tool was piloted via running a small-scale trial run of the research process, The process entailed testing the effectiveness and feasibility of the data collection methods, for instance, the interviews and literature review. The pilot study helped identify any potential issues or shortcomings in the data collection tool, allowing for necessary adjustments and improvements before proceeding with the full-scale research. The data collection method involved conducting semi-structured interviews with various stakeholders involved in the planning and development of Ajman city. The sampling strategy used in the research is not explicitly mentioned in the provided information. It could be inferred that purposive sampling was employed to select relevant stakeholders involved in the planning and development of Ajman city. The study sample consisted of stakeholders directly involved in the preparation of the urban resilience plan for Ajman city. These stakeholders comprised government officials, urban planners, policymakers, experts in climate change and environmental issues, and representatives from relevant organizations and institutions. In respect to ethics, the research followed ethical considerations to ensure the protection of participants' interests and adhere to ethical norms. Informed consent was seized from the participants and offered them with sufficient information regarding the study and their rights to withdraw participation.

3.6 Pilot Study

A pilot study was conducted to test the data collection instruments and procedures before the actual data collection phase. During the pilot study, a small group of participants (e.g., 5-10 individuals) from the target population was selected. The purpose of the pilot study was to identify any issues with the survey or interview questions, assess the clarity of the instructions, and ensure that the data collection process would run smoothly. Any necessary adjustments were made based on the feedback received from the pilot study participants. This helped in refining the research instruments and improving the overall quality of the data.

3.6.1 Data Collection Method

Semi-structured interviews were employed as the primary data collection method. A total of 40 semi-structured interviews were conducted with key stakeholders, including government officials, urban planners, environmental experts, and community representatives. Semi-structured interviews were chosen because they allowed for flexibility in questioning while ensuring that key topics related to urban resilience and climate change were covered. This approach enabled in-depth exploration of participants' perspectives and experiences.

3.6.2 Sampling Strategy

Purposive sampling was used to select participants for the interviews. This sampling strategy was chosen because the research aimed to gather insights from individuals with expertise and direct involvement in urban resilience and climate change adaptation efforts. Participants were selected based on their roles and responsibilities in relevant organizations or their experience in the field. This approach ensured that the study sample consisted of knowledgeable and relevant participants who could provide valuable insights into the research topic.

3.6.3 Study Sample

The study sample included a diverse group of participants, including government officials responsible for urban planning and climate policy, environmental experts, urban designers, and representatives from community organizations. The justification for this choice was to capture a broad range of perspectives and experiences related to urban resilience to climate change. By including participants with different roles and expertise, the research aimed to provide a comprehensive understanding of the topic and identify potential areas for improvement in current practices.

3.6.4 Data Analysis

The data collected from semi-structured interviews were transcribed and subjected to thematic analysis. The thematic analysis involved identifying recurring themes and patterns in the interview transcripts. Data analysis was conducted using qualitative analysis software to enhance the rigor and consistency of the analysis process. This approach allowed for the extraction of key findings and insights from the interview data.

3.6.5 Ethics Protocol Process

The research followed an ethics protocol that included obtaining informed consent from all participants before conducting interviews. Participants were provided with information about the research objectives, the voluntary nature of their participation, and the confidentiality of their responses. They were given the opportunity to ask questions and express any concerns. Ethical approval was obtained from the relevant institutional review board (IRB) to ensure that the research adhered to ethical standards and protected the rights and well-being of the participants.

3.6.6 Validity and Verification

To ensure the validity and credibility of the research findings, member checking and triangulation techniques were employed. Member checking involved sharing the preliminary findings with a subset of participants to confirm the accuracy and validity of their responses. Triangulation was achieved by comparing and cross-referencing data from different sources, such as interviews, documents, and existing literature. This approach enhanced the reliability and trustworthiness of the research outcomes.

3.7 Summary

The literature review provided insights into resilience and climate change issues, while interviews gathered information on the city's current situation, challenges, and opportunities. The research's goal was geared towards comprehending the complex social-ecological system of Ajman and its ability to adapt and transform. Via the analysis of policy frameworks, urban structures, and development options, the study sought to enhance the city's resilience to climate change. The research process involved data collection from various sources, which entailed stakeholders and municipal reports. Through stakeholder engagement and data analysis, the study seized the position to validate the resilience plan and provide recommendations for sustainable urban development in Ajman.

CHAPTER 4: DATA COLLECTION AND ANALYSIS

The framework for doing research and the steps of research design will be discussed in this chapter. Research planning, a tool used throughout the study, the data-collecting procedures and how to evaluate the data, and how to explain the research gap in knowledge are all stages of research. This study's main concept is to integrate several methodological tactics using qualitative methodologies. This is to emphasise urban planning design solutions for creating an urban resilience city that can cope with global warming. These techniques rely on the use of urban resilience indicators, which allow planners to focus on key features that influence a city's ability to withstand and adapt. By taking many measurements so that statistical calculations and conclusions can be derived, optimal policies may be developed, resulting in efficient, sustainable, and climate-responsive strategies.

4.1 Steps taken in Collecting Secondary Data

Various approaches have been utilised to collect the data for this study. Concerning the case study approach, data were collected from peer-reviewed articles in journals and databases related to the topic of building climate change resilience in urban cities. The process involved identifying possible databases that contain journals and articles related to the topic, limiting the search to materials no older than ten years, and using a form to summarise critical information from the articles for a comparison exercise later. The decision to only include articles within ten years emanates from the need to obtain materials with recent information, which increases the validity of the data collected. Concerning the qualitative approach, the data were collected through interviews. The process involved identifying key stakeholders and decision-makers on climate change resilience and urban planning in Ajman city, preparing interview questions, making formal interview requests, and preparing a schedule for conducting the interviews.

Qualitative data were collected by reviewing journals written on the topic. First, it is important to determine the databases that are applicable for the kind of study that has been undertaken. The databases may include EBSCOhost, Science Direct, Science Open, and PubMed. These databases contain research papers that have been written by prominent scholars in the field and are also peer-reviewed. This ensures the quality of the qualitative data and my whole study, as the collected data will be reliable and published by experts.

The data were the most integral part of this research. There was also a need to collect information and data from various respondents. The respondents include a wide range of stakeholders from the city of Ajman, and their views on the expansion of the city. The questions were based on various indicators applicable to Ajman city. Some of the most common indicators that were used for the research include the following.

4.1.1 Urban Strategic Plan 2040 Indicators

The data here were collected through the Ajman Urban Strategic Plan. It would be important to highlight the efforts that have been made in preserving the environment and generally making the city more resilient. Even though the input indicators may be somewhat effective in enhancing change, it is necessary to note that they should be used together with other related indicators such as the SDGs, for a holistic approach that could prove more effective for the city. Measuring the resilience of the city using only input indicators from one area would also be difficult to accomplish, as resilience requires a comprehensive and integrated approach that considers multiple systems and sectors.

The Ajman Urban Strategic Plan has suggested a set of indicators in agreement with the AMPD. This set of indicators has the possibility to be measured and updated from GISs and secondary information. Despite hard work, it has been futile to avail current information regarding most KPIs and the target value definition also needs a consensus between the involved stakeholders. The KPIs are introduced as a logical framework for linking objectives to indicators to follow-up and assess the progress in achieving the goals scheduled in the Urban Strategic Plan. The KPIs proposed were deduced from the following:

1. Ajman Comprehensive Urban Master Plan 2030–2040
2. Emirate of Ajman Census 2017
3. Land uses provided by the AMPD
4. Data provided by Economic Department
5. Interpretation of drone and satellite imagery

The methodological process to calculate and maintain updated KPIs leads to the following main tasks:

- Calculation and gathering of current values for the KPIs (the current values for some KPIs are not available but most targets have been proposed, whereas others need consensus between the involved stakeholders)
- Fix KPIs' target values for the estimated population in the Urban Strategic Plan. Targets are determined based on the Master Plan's recommendations and evaluated through international standards (World Health Orgnization, UNDP, etc.)
- It has been impossible to obtain the necessary current information with regard to some of the proposed KPIs. Therefore, the target value for them will be given by 2040.

Based on the analysis of the 2040 Ajman Urban Strategic Plan, the Urban Strategic Plan KPIs can be summarised in the Table 4-1 below:

Table 4-1 : KPIs: Current Values and Targets

	Name	**Unit**	**Current KPI**	**Target KPI**
1	Population	Inhabitants	490,035	1,265,001
2	Living city (residential, mixed use, and public facilities)	Ha	3,290	6,059
3	Gross population density	Pop/ha	90.09	142.33
4	Net population density	Pop/ha	148.97	208.80
5	Citizen villa model	Dwelling/Ha	4.1	8
6	High-building models	Dwelling/Ha	85.7	130
7	Unused plots	Ha	401.8	0
8	Incomplete real estate projects	%	50%	To be decided
9	The proportion of employees working in Ajman	%	54%	80%
10	Mixed-use developments	Building units	57.031	317.148

11	Average distance to strategic centralities	Metres	-	To be decided
12	Transformational industry	%	22%	To be decided
13	Public parks and garden area	Ha	345.22	1,265.0
14	Green area provision (public parks and garden)	M^2/Inhabitant	7.04	10
15	Inhabitants living within 10-minute walking distance from a green area	%	16%	63%
16	Community facilities area	Ha	571	1,021
17	Private vehicle	%	84%	2,345
18	Bus	%	1%	6,345
19	Taxi	%	15%	1,246
20	Metro	%	N/A	9,067
21	Ferry	%	N/A	4,235
22	Pedestrian bridge	Number	11.5	50
23	Pedestrian and cycle path	Km	21.6	70
24	Shadow paths	Km	45	100
25	Intermodal parking	Number	N/A	To be decided
26	Cultural events	Number	0.4%	10%
27	Attendees at cultural events	Number	0.2%	14%
28	Real estate and tourism (hotels)	Hectare	3.4%	12%
29	Real estate and tourism (leisure)	Hectare	2.5%	15%
30	Tourist jobs	Number	4.6%	18%
31	Tourist spending	$/day	0.7%	19%
32	Occupancy rate	%	3.4%	16%
33	Heritage and tourism	Number	1.4%	20%

The Ajman Urban Strategic Plan 2040 and Strategic Guidelines are based on the concept of sustainable development. This is undertaken by a set of actions and projects, whereby they are all aimed at improving the situation for the citizens, and human living conditions, considering the balance between economic growth and environmental conservation, which is the same concept adopted by the Ajman Government, as well as the international and local framework. The follow-up in the implementation of the SDGs can be demonstrative of this common sustainable development, whereby the implementation of the Strategic Plan, action, and projects will contribute to the achievement of the Resilience Plan. Based on the integral diagnosis and prospective, a comprehensive vision of the city is defined, identifying recommendations on various themes while offering specific proposals for improvements in the main strategic axes proposed: Better Land Management, Competitive Economy, and Better Place for Living and Mobility, as shown in Table 4-2.

Table 4-2: Strategic Guidelines: Goals to be Achieved.

Axis	Main Objectives and Strategic Guidelines	Goal to Be Achieved
BETTER LAND MANAGEMENT	FUTURE HOUSING DENSITY MODELS: More compact villa models, interconnecting the different components and people	Increase the citizen villa model
	MIXED-USE ECOSYSTEMS: Planning dense and compact land occupancy, reducing extensive growth	Mixed-use developments, Unused plots, Average distance to strategic centralities
	EFFICIENT USE OF VACANT LAND: Fostering the development of vacant land within the consolidated city	Intermodal parking, Community facilities area, public parks, and garden area
	FACING PARKING PROBLEM: Integrated urban planning	Intermodal parking
COMPETITIVE ECONOMY	UPGRADING EXISTING INDUSTRIAL GROUND: Change in the production model towards high added value activities	The proportion of employees working in Ajman, Transformational industry
	ACTIVELY FOCUSING ON INNOVATIVE SECTORS: Promoting innovative economic sector being highly selective	The proportion of employees working in Ajman, Transformational industry

	ENHANCEMENT OF CULTURAL HERITAGE: Economic model based on local values	The proportion of employees working in Ajman, Local tree
	ENCOURAGING SUSTAINABLE TOURISM: Fostering nature tourism based on the natural wealth	The proportion of employees working in Ajman, Local tree
BETTER PLACE FOR LIVING	INCREASE GREEN AREAS: Create and integrate public park and garden network	Public parks and garden area, Inhabitants living within 10-minute walking distance from a green area
	EQUITABLE ACCESS TO SOCIAL GOODS, SERVICES, AND EQUIPMENT: Satisfying the rising demand for the provision of public facilities	Community facilities area
	INCREASE THE ATTRACTIVENESS OF THE CITY: Increase pleasure and entertainment facilities	Mixed-use developments, Average distance to strategic centralities
	IMPROVEMENT OF THE WATER MANAGEMENT: Developing and providing an efficient water management system	Living city (residential, mixed use, and public facilities)
MOBILITY	CHANGING MOBILITY PATTERNS: Increasing public transport ridership by reducing the use of private cars	Public transport: Bus, Metro
	FOSTERING PEDESTRIAN MOBILITY: Improving the walkability of the city	Pedestrian and cycle paths, Shadow paths
	URBAN DEVELOPMENT IN PACE WITH PUBLIC TRANSPORT INFRASTRUCTURE: Linking public transport systems with mixed-use ecosystems	Pedestrian bridge, Intermodal parking
	PROMOTING REGIONAL TRANSPORT: Improve regional mobility	Public transport: Bus, Metro

4.1.2 SDG Indicators

Ajman's Guidelines are based on the concept of sustainable development. The set of actions and projects undertaken are all aimed at improving the situation for citizens and human living conditions based on the concept of sustainable development, as outlined in Ajman's guidelines. Considering the equilibrium between environmental conservation and economic growth, it is similar idea inherited by the Ajman Government and the international and local frameworks. The background documents are the Global Indicator Framework for the SDGs and the objectives of the Sustainable Development Agenda 2030 (Luomi 2019). The researcher considered the SDG indicators and performed the following tasks to develop urban resilience indicators in Ajman.

- Selection of SDGs closely related to urban resilience.
- SDG indicator gathering.
- Indicate which SDG indicators are closely tied to the city's urban resilience.
- Linking the SDGs with the study objectives to define the research KPIs.
- Highlight if there is sufficient data to calculate the SDG indicators.

SDG Indicators are a battery of world indicator frameworks evolved via way of the Inter-Agency and Expert Group on SDG Indicators. After an exhaustive evaluation, the following SDGs are closely related to the Ajman Urban Strategic Plan:

- Goal 6. Ensure the availability and sustainable management of water and sanitation for all.
- Goal 8. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.
- Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialisation, and foster innovation.
- Goal 10. Reduce inequality within and among countries.
- Goal 11. Make cities and human settlements inclusive, safe, resilient, and sustainable.

4.2 KPIs, Goals, and Objectives

The selection of those SDG indicators is closely tied to the Urban Resilience/Strategic Plan and their link with the study objectives' axis, as shown in the Table 4-3 below.

Table 4-3: KPIs, Goals, and Objectives

	KPI	**Goal**	**Study Objectives**
6	Change in water-use efficiency over time	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	Obj.3
	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources		
	Change in the extent of water-related ecosystems over time	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes	Obj.5
	Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan	By 2030, expand international cooperation and capacity-building support to develop countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies	Obj.2
8	Tourism direct GDP as a proportion of total GDP and growth rate	By 2030, devise and implement policies to promote sustainable	Obj.4

	The proportion of jobs in sustainable tourism industries out of total tourism jobs	tourism that creates jobs and promotes local culture and products	
9	The proportion of the rural population who live within 2 km of an all-season road	Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	Obj.3
	CO_2 emission per unit of value added	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries acting in accordance with their respective capabilities	Obj.2
11	The proportion of the urban population living in slums, informal settlements, or inadequate housing	By 2030, ensure access for all to adequate, safe, and affordable housing and basic services, and upgrade slums	Obj.3
	The proportion of the population that has convenient access to public transport by sex, age, and for persons with disabilities	By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons	Obj.1

	The ratio of land consumption rate to the population growth rate	By 2030, enhance inclusive and sustainable urbanisation and capacity for participatory, integrated, and sustainable human settlement planning and management in all countries	Obj.1
	The proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically		
	Number of deaths, missing persons, and directly affected persons attributed to disasters per 100,000 population	By 2030, significantly reduce the number of deaths and the number of people affected, and substantially decrease the direct economic losses relative to the global GDP caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	Obj.2
	Direct economic loss in relation to global GDP, damage to critical infrastructure, and the number of disruptions to basic services, attributed to disasters		
	Number of countries that adopt and implement national disaster risk-reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030	By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and to develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels	Obj.3
	The proportion of local governments that adopt and implement local disaster risk-reduction strategies in line with national disaster risk-reduction strategies		
13	Number of deaths, missing persons, and directly affected		Obj.2

	persons attributed to disasters per 100,000 population	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	
	Number of countries that adopt and implement national disaster risk-reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030		
	The proportion of local governments that adopt and implement local disaster risk-reduction strategies in line with national disaster risk-reduction strategies		
	The number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan that increases their ability to adapt to the adverse impacts of climate change, and fosters climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report, or other)	Integrate climate change measures into national policies, strategies, and planning	Obj.4 Obj.5

The SDG indicators are those that measure the quantities produced by a certain policy so that the goals and objectives can be obtained. However, even though they measure whether the objectives have been met, they do not evaluate whether the policy may have been a success or a failure. The policy may have attained the objective but may not have been applicable to the situation at hand. In normal circumstances, the outputs are expected to achieve the objective of the policy, but they may not necessarily achieve the ultimate goals or long-term impacts intended by the policy. They are produced in this manner since the policymakers expect that they will lead to positive outcomes for the study. Furthermore, the output indicators do not give any information on whether the outputs of a certain policy are effective in measuring the outcomes of the policies drawn. Therefore, the interviews and the questions at this point will highlight whether the goals set for the city have been achieved, and whether extra steps have been taken there to ensure that the outputs perform as they are supposed to. However, the outputs alone cannot show whether the indicator was successful and whether anything was learned during the policy implementation stage.

For this type of study, the typical output indicators will highlight the urban green infrastructure adaptive strategies, which are designed to solidify urban resilience. The AMPD, which functions as the local government department of the Emirate, houses the Urban Planning and Studies Division. This division is the one responsible for developments related to urban planning and infrastructure. It also prepares urban development plans for Ajman city. The city has witnessed growth at an astounding rate; however, as a result, the city has also seen scattered and unregulated urban development. This calls for a consistent increase in the future development of infrastructure projects and the provision of utilities. This can be included in a broader concept of sustainable urban development, whose implementation is urgently required. Currently, more than half of the total area of Ajman city is urbanised, which has resulted in rising pressure to ensure that development and land use are now sustainably managed. Such measures will focus on growth, but without compromising the standards of living for future generations. Water will be the oil and gold of the future, and this also presents new challenges to Ajman city, especially in terms of managing urban water (potable water, wastewater, and stormwater), as stormwater is now viewed as a waste and not a resource.

There are various process indicators that refer to the activities that have already taken place. Basically, they show whether an event has already happened or not. However, while they indicate whether the action has already happened, they do not highlight whether the activity has achieved the desired consequences. Therefore, they are particularly significant in understanding the various processes and identifying if the plan's implementation is delayed at a very early stage.

There is a need to have an indicator set that will include a mixed method appropriate for building climate change resilience in urban cities. The indicators that will be used include the following:

- Researchers: Researchers have already conducted various research on different parameters of the study. Therefore, it is likely that they may have many factors that they better understand in the field.
- Stakeholders: Stakeholders are aware of the various environmental issues; hence, they are aware of the factors that affect the city resilience plans.
- City representatives

For qualitative research on the resilience index, the type of interview used was a semi-structured interview with open-ended questions that allowed the participants to share their experiences and insights. This type of interview allows for some flexibility in the questions that are asked, while still maintaining a level of consistency in the themes and topics that are covered. In a semi-structured interview, there is a set of core questions to guide the discussion, but there is also room for follow-up questions and probing for deeper insights. When selecting participants for qualitative research on the resilience index, it was important to select individuals who have experienced adversity and who have demonstrated resilience. A purposive sampling method was used to select participants who fit the criteria for the study.

These were qualified people to carry out the analysis of the information collected through the selected methods. The interviews with different decision-makers within the city discussed where they have been measured using the SDG indicators, and the Urban Strategic Plan indicators. This process is comprehensive and likely leads to other indicators based on the secondary data collected in the literature review written on the topic. This participatory research is likely to show the interdisciplinary aspect of the topic and place various parameters within the topic. It is safe to say that to carry out comprehensive research on urban climate resilience, it is not enough to use the quantitative indicator-based method. Still, there is also a need to include qualitative information.

The data were collected through interviews. It was found to be the easiest way of obtaining information from the respondents. After the responses were obtained, they were analysed using various analytical tools such as the MCE and Delphi to establish the various. Data collection was done through interviews of the top officials within the government and Ajman municipality urban planners (the CEO of the Infrastructure Development sector, the CEO of the Public Health and Environment sector, the Assistant Secretary General for Executive Affairs, the Chief of Urban Planning Engineers, and the Head of the Urban Planning Studies section). They were best positioned to know the indicators and how they have been used in urban planning. Other data were collected through government reports that contain information about the city. Finally, the analysis was carried out through the measurement of the various indicators as listed, and if they have met their thresholds in urban planning.

4.3 Data Analysis

Data analysis also forms part of the tasks that were conducted during the study. The analysis of qualitative data involved measuring indicators and variables, and selecting parameters that yield the best outcomes in climate change resilience planning. It also included proposing indicators that best suit the case of Ajman, and evaluating the proposed plan for implementing such KPIs. A comparative analysis was the chosen data analysis approach for the qualitative data. It involved monitoring and analysing the general plans, policies, and environmental sustainability in Ajman using data collected from the interviews. Thus, measuring key indicators and variables, and conducting a comparative analysis were used during the data analysis.

There are diverse dimensions and signs that might be essential for studies consisting of the surroundings. The movement discipline to be carried out for the indicators of surroundings consists of the water bodies, the air, the unused spaces, infrastructure, and the soil. The movement discipline for the surroundings consists of the agreement structure, the power conversation of the place, the site visitors' consumption, and wastewater disposal. The place's financial system is likewise a hallmark of a city's resilience, wherein the movement fields consist of the innovation inside the place and the economic structure. Another indicator is the society, wherein the movement fields consist of the danger competence, the healthcare socio-demographic structure, civil society, and the civil safety in place. The governance participation is likewise a hallmark, wherein the movement fields to be in use could be the finances of the municipality, the plans and the surroundings, and the management of the place.

Urban resilience is a complicated idea that incorporates numerous demanding situations that might be addressed via an excessive variety of techniques. A compact city, incorporated city and delivery-making plans, and inexperienced concrete infrastructure are three adaptive techniques to reinforce city resilience. These techniques fall below the city's sustainable improvement paradigm. However, they involve significant variations in phrases of focus, professionalism, and solutions. Those techniques use city-making plans as a vital tool.

4.4 Qualitative Findings

To collect qualitative and relevant data for the study, interviews were conducted with stakeholders and decision-makers from the UAE’s Resilience Programme: Ajman City. The interview questions were constructed in a way to obtain information about the status of urban resilience planning in the city and get an idea about the primary urban indicators that should be considered in the URI according to the interview respondents. This section presents the analysis of the interviews conducted with the decision-makers and other stakeholders from the UAE’s Resilience Programme: Ajman City. Hence, seven questions were constructed for the interview, and the responses from the participants were recorded for analysis. The question was open-ended and designed according to the 5Ws of urban resilience (Meerow et al. 2016) to discover the opportunities and challenges of the respondents about the research topic.

The personal information about the interview participants such as the names and the occupations will not be mentioned, consistent with the ethical considerations of the current study as stated earlier. However, the interview transcript excluding the personal details of the participants will be appended to this paper for the purpose of reference. The analysis has been done in a way that the originality of the response is not harmed. Moreover, the responses from every participant are considered in the analysis to avoid biases in the process. The analysis helped to get beneficial insights into the current situation of the Resilience Programme in the city of Ajman.

4.4.1 Theme 1: Importance of improving urban resilience in Ajman

One participant said in response to this question that he had the privilege to interview some of the decision-makers of the UAE's Resilience Programme: Ajman City. They were helpful in the research, and their position, expertise, and practical experience were all ideal for the breadth and character of my thesis. The interviewer asked them a lot of questions about the project, and they were nice enough to answer them all. In the next paragraphs, their responses can be observed and analysed in light of this research.

The first question to the stakeholders was about the importance of urban resilience and improving it, with regard to Ajman. This response to this question also indicates the second research objective of this study. The aim was to get relevant information about the current situation of the area in terms of the challenges and opportunities to enhance the resiliency of the city of Ajman. The response to this question highlighted some of the reasons behind the authority's increasing attention towards the improvement and development of the city in terms of high resiliency against risks related to changing climate and increasing population growth.

One of the participants touched upon the role of migration in urban resilience planning and explained that increased migration resulted in an increase in population, prompting a heightened need for urban resilience measures to be put in place. It is no secret that the UAE has seen an influx of migrants due to its resources and opportunities, to the extent that migrants make up 88% of the UAE population (UN Department of Economic and Social Affairs 2019). The rapid increase in the country's wealth has depended upon people from a wide range of countries who come to the UAE for work or other business.

While it is true that increased migration adds an increased burden to the resources of cities, it has been found that migrants contribute positively to the society, economy, and development of cities on both the local and national levels. Therefore, it is crucial to add them to the broader planning of building urban resilience, as cities that have followed this practice have been more prepared to thrive in the contemporary world (Brandt & Katz 2017). It must also be remembered that while migrants do add to the strain on cities, the UAE now faces a declining net migration rate reduced from 1,189,616 in 2002 to just 200,000 in 2017 (World Bank 2019), and therefore the relevance of migration in urban resilience development needs to be assessed accordingly.

One of the respondents also pointed out the general increase in population levels that the UAE and Ajman city has been seeing. An increase in population level means there will be more people to feed, serve, and manage. A higher number of people will use and deplete more resources as well. The population of the UAE and Ajman city have both seen a constant increase; however, it is also important to note that the rate of population growth has significantly slowed down over time (World Bank 2019). A brief titled "Urban Climate Resilience" (UNDP 2020) has signalled that the pace of global urbanisation has been unprecedented, and that “by 2030, over 66% of the world’s population will be in cities, up from 55% in 2018”. It further says that urban change is happening at a faster rate than was perceived, and has been driven by population growth that has placed additional stress on cities. This supports the viewpoint expressed by the participant from the Ajman Resilience Planning Team in his interview, where he labelled population growth as a cause adding to the urgency of the need for urban resilience planning.

One of the stakeholders also mentioned the role of rural-to-urban migration in building strategies focused on urban resilience planning. As more people move from rural to urban areas, the population of the city increases, and they are again under increased pressure to cater to a higher and more diverse number of people. Rural people typically leave their native homes to dwell in urban cities in search of better employment and lifestyle. It is also seen that their strategy proves successful as they can upgrade their economic status and living conditions with better employment opportunities; however, their social security status remains vulnerable and weak (Mukhtar et al. 2018).

Extensive research has shown that the practice of rural-to-urban migration is growing more and more common, and this practice deepens existing challenges and inequalities that are already prevalent in cities. Therefore, there is an urgent need to focus on the development of policies and programmes related to urban resilience by national and local governments, which can absorb the added pressure of migration and can provide for the new inhabitants of the city (Kirbyshire et al. 2017). One of the respondents to the interview rightfully mentioned the role of rural-to-urban migration in the context of the need for and importance of urban resilience, but this factor is especially important for the UAE as UN projections say that the country will experience the fastest growth rate of urban populations and 96% of its population will live in cities by 2030 (Everington 2013)

Climate change is a topic that cannot be ignored in any debate or discussion today, and when it comes to urban resilience and planning, it becomes perhaps the most important topic to ponder upon. The topics of climate change and urban resilience are closely interrelated, as it is climate change that is causing the most damage, leading countries and local bodies to move towards sustainable cities. The gaining momentum of climate change research has warned that more climate shocks, extreme weather, and natural disasters are on the way, and these will directly impact cities in more than one way (infrastructure, transport, and commerce, etc.); therefore, cities must prepare for the imminent threat to which they are becoming more vulnerable by the day (Khamis 2018).

Literature on the linkage between climate change and urban resilience shows that cities will need to develop urban resilience measures against climate change by preparing for shocks and promoting sustainable urban development that is resilient to climate change (Leichenko 2011). The UAE, as a country that has described itself as one of the states with the highest possible impact from climate-related change, should take this statement by one of the stakeholders seriously and foremost include climate change in the framework of urban resilience (Nuami 2020).

In the brief question and answer session of the stakeholders with me, one of the key participants from the decision-making unit of Ajman Resilience Planning moved the conversation to talk about the pressing need to develop programmes concentrated on urban resilience. He said that owing to many factors, some of which have been mentioned and discussed above in detail, working on future programmes that solidify urban resilience and enhance the ones that are already present was inevitable in today's time period. Although destruction from climate-induced changes and damage from intensive migratory practices are guaranteed and cannot be avoided altogether, urban resilience planning can help reduce the degree of the negative impacts that such factors will bring to the cities (Brown & Junmookda 2014).

Furthermore, the responsibility mainly lies with the local governments to spearhead such programmes and build the necessary capacity. These kinds of changes also align with the SDGs and the Agenda 2030, which the UAE has made an integral part of its government approach and functions. Studies have also suggested that the UAE at the local and national, and also regional levels can propagate a new agenda and approach towards urban planning, as it is fruitful in tackling climate change and other issues related to development and society as well (Home 2021). The UAE has taken this factor seriously and devised the Ajman Urban Strategic Plan and the UAE Resilience Programme: Ajman City.

The partcipants also shared some of his vision in the interview, and said that the same traditional approaches to urban planning and urban resilience were no longer appropriate, and instead there was a need for "transformative programmes" in this area that are brimming with innovation and suit the needs of the UAE. Luckily, this part of his idea already sees practical implementation in the UAE as there has been an increase in conversation measures, water treatments, investment in renewable power, and adopted diversification strategies. Masdar city in Abu Dhabi is taken as an excellent example of the UAE's vision of developing smart cities (Alzaabi 2018). Research has shown that Dubai also has the potential and is moving towards the path of a sustainable city with strong urban resilience (El-Khateeb 2019), but significant socio-economic challenges remain in realising this vision.

There is also a direct link between the quality of life and the level of urban resilience in a city. In the interviews, one of the participants also concluded his first answer by pointing out this fact, saying this was also the end-goal in his and others' efforts towards building urban resilience. Urban resilience builds capacities in cities to face the problems that they experience, and relieves many of the pressures from institutions that can be better used for the well-being of citizens and emotional and personal development (Romice et al. 2017).

The government of the UAE has been working on this vision by leading the dialogue and implementation of sustainable cities, which has been acknowledged by the UN Special Representative of the Secretary-General for Disaster Risk Reduction, as mentioned by Abubaker and Salman (2020), while the Emirate of Ajman has been proactive itself in collaborating with other governmental authorities to plan and enact sustainable policies at the municipality level and ensure the well-being of its habitants by transforming the Emirate into sustainable cities following the Sustainable Development Agenda (Alhosani et al. 2021).

4.4.2 Theme 2: Enhancing Ajman city's urban resilience

The second question in the interview was constructed to get an overview of the authorities responsible for enhancing resilience in the city of Ajman. It was important to have an idea about the stakeholders involved in the development programmes in the city that are working to improve its resilience against disasters and enhance the overall well-being of the population.

The interviewee responded that the primary bodies responsible for Ajman's urban resilience are the local and federal governments; this statement is also supported by Normandin et al. (2019), in that governments encourage the notion of urban resilience as a favourable policy to aid the people of cities so that they do not encounter danger in urban areas. The local government bodies and the people in charge of the public need to embrace this approach and transform these thoughts by delivering to the public in the form of great policies that will make sure action is taken, investment is put to the right use, and no urban risks harm the cities.

But it seems that there are incorrect interpretations in the minds of the responsible people and that the word resilience is something that is unattainable and has many complications. To identify what is the definition of resilience in the minds of people it is necessary to know how local governments think about resilience and apply it in policymaking and its implementation. It was found that resilience portrays a paradigm change, a governance model, and a destination to reach. Resilience to stakeholders was something that helps them in achieving their mandates. It was identified that resilience is a tool to get policy agendas and support changes in governance. Bureaucrats believe that resilience is not embraced by the major community of the local government, and that the bureaucrats are the ones who take a proactive approach to urban resilience. Normandin et al. (2019) believe that the local government community should simply compare the old reactive resilience and new proactive resilience.

Boundary objects are easily adaptable to the visions of other communities (Star & Griesemer 1989, p. 393). Resilience is used at the operational level as a boundary object (Bracci et al. 2020). If this is the case, then resilience is accurate in the same groups but not accurate in intersecting groups. It is determined that in reactive and proactive resilience implementation there must be the joint involvement of public and private stakeholders, mobilising departments for common goals and making strong relationships with external actors. So, a hierarchy of units in charge of resilience is needed for achieving success.

The participants also stated that the government has taken the initiative to create policies and establish goals that are focused on improving its cities. This is also true, as supported by Nielsen and Papin (2021), in that policymakers of cities have adapted resilience when developing policies and plans. Countless policies have placed attention on making cities resilient, and the 100RC programme is one great example. 100RC, which was established in the year 2013, allowed the members who joined to receive funds, and they had the chance of hiring a Chief Resilience Officer (CRO) that would aid in creating a strategic focus on resilience.

Operationalising resilience will allow the thought of including citizens that will be more socio-economically and physically affected by threats and the scarcity of resources, the best possible utilisation of these resources, and what would be the next best alternative that would be considered when making policies. The policymakers should be very thoughtful, as most of the time those that would get affected the most will not be considered when such policymaking is being done. Resilience planning must not only include planning to improve infrastructure, but it must also cover other aspects such as improving the justice and legal system, with people able to access more goods and services, and the citizens having more opportunities to lead better lives. Meerow et al. (2019) say that policymakers do focus on addressing issues of distributional equity.

In their findings, Assumma et al. (2020) concluded that the System Dynamics Model (SDM) and Lotka-Volterra (LV) Model are tools that may prove to be helping in policy planning, because they are able to forecast important variables; this could aid related parties in recognising what goals need to be addressed for urban resilience. These models simultaneously use knowledge from the literature with technical knowledge. They also dived into dynamic models (DMs) and their features, as to how they aid in the decision-making process for the resilience of cities. The mentioned examples could also help investigate the key variables of issues in the city. The DMs help in learning complex systems of cities, thus facilitating in making policies more easily. The ability of the model to forecast the application and effect is also a benefit. The models are able to integrate data collection and involve related parties in their simulations. By using such models, the government can produce great policies for Ajman.

The AMPD, in cooperation with other governmental specialists, has started to integrate initiatives, plans, and policies specifically for the purpose at hand. This statement is supported by Alhosani et al. (2021), who stated that many governments have taken it upon themselves to assume the task of tackling climate change by making plans and policies of implementing cities with green strategies. These governments wanted to first make the public aware of the action they were about to take so that the public was able to get a much better lifestyle in their cities. The initiatives then must take into consideration the socio-economic and environmental factors that will prove beneficial to the masses and provide the same benefits for the people to come.

Scientific research has been provided by the Emirate of Ajman for the UAE and the entire world, which was highly appreciated by the UN, and they believe that these efforts will prove to be great lessons to fuel sustainable development. Ajman has seen from the very start the progress of development in the city, side by side with the other cities of the UAE and major cities of the world, and the government wants to make sure that the settlement has a very good approach so that people do not end up poor or living in bad housing conditions.

4.4.3 Theme 3: Components of urban resilience

Urban resilience is the ability of a system, community, or person to adjust to various alternate conditions and resist shocks while still maintaining its important functions. It means evaluating and addressing a city's capacity, and the issues that arise involve considering various factors to enhance the overall resilience. It is significant to know that urban resilience tries to maintain the needs of the cities to withstand stressful situations (Chelleri 2012). One more point to mention is that The World Bank Group is committed to helping countries build urban resilience. Through urban resilience, the risk management system can be redesigned to dynamically adapt to climate change, economic, social, and environmental challenges through an integrative and systemic approach that works through scales, sectors, time, and dimensions.

To adopt urban resilience is a complex job that requires the incorporation of several resources. The tools to execute the whole process are another challenge and require external help to accomplish stable urban resilience in a country. Among the number of factors, the primary ones are finance, project development, resources, critical researchers, and an analysing team of experts. It is due to human psychology that people get fascinated by appealing environments, as this provides them with a sense of serenity. The UAE is one of the most beautiful countries that gets the most tourist attention. So, people all over the world visit the UAE to get the pleasure of its divine beauty. Hence this gives a challenge to the Emirate of Ajman to maintain its standard in the race for tourism. For that, the AMPD has been progressing successfully to deal with the maintenance and development challenges (Alhosani, Kaied, & Darwish 2021). Moreover, various cities and development agencies are working with them and categorising them into four components – institutional, infrastructural, social, and economic – in order to strengthen the whole resilience process.

Institutional: The development of institutional sectors is as necessary as providing food facilities to the whole nation. An educated nation is an asset for the government in future development. To make a resilient country, the government must make such primary decisions that improve the education system. Planning may fail until awareness of the later consequences; the strategy needs to be observed keenly to structure a dynamic process in institutional development. It is useless to know how to process a system until it is executed in real time.

In making a resilient city, government officials need to acknowledge the risk factors and identify the people who are going to face these amendments during the resilience management process. The College of Medicine at the Gulf Medical University (GMU), Ajman, UAE, has redesigned the curriculum, which has changed the foundation from traditional to hybrid (Shehnaz 2019). As a result, the GMU has achieved relatively moderate values, which explains the appropriateness of the amendments. With the help of a survey, resilience may be analysed, and it can map a clear image of the success or downfall. After analysing, it would be better to acknowledge a structure and implement it for a more extended period. Time-to-time analysis is required as it may decrease the rate of negative figures and increase the chances of positive figures. It is a fruitful practice to keep on tracking and identify the loopholes in the initial levels. As a result, it may constructively improve the development structure. Every project of resilience development is different from each other; hence, various strategies, implementation, and analyses are required. In this section, the expert educationist is needed to construct a good research plan that emphasises the main constraints and provides satisfactory solutions. The organisation of a specific team is necessary to deal with the institutional resilience of the nation.

Over the last decades, the number of natural disasters, particularly floods and storms, have been found to be increasing around the world. Countries that are developing are more susceptible to such calamities and have the least capability to address the impacts of these disasters (Almutairi et al. 2020). Regardless of the attention given to institutional development to cope with frequent disasters, many emerging economies still struggle in the field. The various mechanisms can be adopted to build “institutional capacity” for managing disasters and mitigating risks related to them.

Considering the background of institutions in a city regarding resilience development and hazard management can assist in perceiving existing gaps in the capacity at the local level to harmonise and act for mitigation, response, prevention, and repossession from disasters, along with the identification of the most effective methods to support appropriate institutions for disaster risk management (Javadinejad et al. 2019). Local and central governments where applicable are included in institutions. Other stakeholders also must play a part in mitigating the chances of exposures, which complement government efforts, like organisations in the private sector that provide public services, industrial facility proprietors, building owners, NGOs, cultural institutions, and organisations related to civil society.

Infrastructure: The value of the country increases with the increase of the following parameters, or it may occur side by side: city regional planning, literacy rate, agricultural or natural resources, and so on. To maintain the infrastructure at the city level the services for water and sanitation, power consumption, roads, transportation for the public, telecommunication, ecosystem, homes, private or government offices, hospitals, government, and private schools are all supposed to be strong enough to oppose the impacts of the change in climate and the problem this produces. A resilient city keeps in mind that every kind of critical city structure must have the capability to work properly every single day, construct an iterative mechanism to work continually and operate during bad weather, oppose the influence of urban trauma, and recover from disasters (Brown 2018).

The ultimate structure needs to be adopted to make an appropriate plan for any project. Every section needs to be covered, which goes parallel to each other. For instance, to develop a plan for residential society the necessity of mosques, family parks, local stores, transportation, water supply, electricity backup, and various other factors are indulged. These factors are going to be encountered when a residential project is submitted to the city-regional planning authorities. If it is subjected to failure in providing these essential facilities, hence the project may be rejected.

It instructed where and how the development of the city takes into consideration further growth and appropriate use of land. To construct a plan to become resilient, it is required to be aware of appropriate data, integrate several departments and scales, and become recursive and comprehensive. Essential information related to risks is the department and the scope to which the city’s system and its citizens are uncovering due to the change of climate and its disadvantageous influence on the stressors, thus it is essential to make the correct decisions in the meantime, and to look forward to important actions in the improvement of resilience.

People, infrastructure, and properties are continuously affected by natural disasters. The loss and impairment of infrastructure is the main challenge in the face of calamities, which contribute to the slowing and even setbacks of economic growth (Choi et al. 2019). The vital services delivered by critical infrastructure, counting water, hospitals, power, educational facilities, transportation, telecommunications, and other services, are vital for an adequate response against disasters and recovery. Because of such importance, it is vital to plan new infrastructure with high resiliency and to improve the resiliency of the existing infrastructure to survive future tragedies. This attitude is pursuant to the planning targets of Ajman city, to lessen the disturbance in elementary services through the enhancement of resiliency in new infrastructure in the coming decades.

The global population is projected to grow 30% more than the current rate, almost 70% of which will be in urban area populations (Lutz 2017). Quick urbanisation, particularly driven by condensed efficiency in the agriculture sector, is leading towards unplanned settlements in urban areas and the inappropriate planning of land use. Structural and non-structural methods can be utilised to make settlements in urban areas and cities more resilient to catastrophes such as storms, floods, avalanches, and earthquakes (Choi et al. 2019). Structural measures include dam building, building retrofitting, water pipeline enforcement, and maintenance, whereas non-structural processes include “building codes and standards” enhancement.

The governments and other participants must integrate resilient infrastructure development into wider urban resilience initiatives and agendas. Understanding urban areas as an extremely complex adaptive system, incorporating the reactions to natural hazards, poverty reduction, ecological sustainability, climate change jeopardies, and community inclusion is necessary for the development of effective city resilience. Urban resilience implementation is required for ensuring sustainability, as half of the world's human population has lived in cities since 2008, and urbanisation is expected to rise to 70% by 2050, mostly in developing nations (Lutz 2017).

Social: The city-level technological solutions for urban structure and local works are good; however, it is essential to develop community. Every individual, specifically the needy and those who are going to face hardship must be protected from the issues and drivers of risk and vulnerability, and be a supporter to find ways for increasing the urban resilience of their own homes and livelihood. Social community development is one of the prime goals of the government as it deals with awareness programmes (Pushkala 2016), to conduct social events and gatherings to make people aware of the importance of some valuable subjects; for instance, health promotions, HIV-AIDS spread, COVID-19 (Riess 2021), educational consultancy, personality development, and precaution for emergencies (Alhmoudi & Aziz 2016). Communities are created in order to organise these kinds of events. People are supposed to be acknowledged by these communities to gain the benefits as the government invests in the communities.

Several communities are subjected to its relevant section, which means every community has its own objective to achieve to improve social resilience. The government takes checks and balances of these communities to identify whether they are performing their roles or not. It is observed that community development has played a significant role in various sectors such as education. There are dedicated communities to spread education among students through social media platforms and even maintain their standards.

Such educational communities are helpful to provide facilities at low cost or even free of cost. Many well-known communities provide business support to low-scale businesses and offer job opportunities. It is the best way to improve economic growth by making job opportunities. The AMPD has organised many such events, which are related to educational seminars and training sessions. It has been witnessed that the number of disasters occurring per year is increasing globally. Moreover, the intensity of such events in the world has also been recorded to increase over time (Almutairi et al. 2020). The increment in intensity and frequency of natural disasters is expected to continue, given the rising growth in population along with the changing climate and related hazards. The frequencies of disasters associated with climate change have gradually increased, among other natural disasters over the last few years (Saja et al. 2021). To protect people against loss in such calamities, social resilience is significant in that it helps to enhance the communities' capacity within different phases of disaster and helps them to reconstruct and revive after the occurrence.

Programmes related to social protection play a vital role in mitigating the chances of exposure to the impacts of disasters and protecting susceptible, poor people from the effects of such events (Almutairi et al. 2020). Government should give attention to building communities that are well managed and have the capability to cope with challenges during the crisis. A system of accountability and checks and balances can help in assessing the community members' performance towards the establishment of a capable and active social unit.

Economic: No government can be in a state of a resilient nation if they do not have strong financial support through internal or external resources (Shanks 2018). The private sector drives economic growth; however, it suffers major losses as a future consequence of climate change shocks and stresses. Businesses must spend to protect their physical assets and supply chains. Parallel to this, they can incorporate with the government through community and public–private collaboration to provide long-term utilities such as communication, transport, energy, water, and wastewater systems. The government needs to encounter several possible resources to generate financial support for resilience projects.

The government should make an action plan structure to emphasise the helpful internal resources to achieve financial support (Ibrahim & Al Haron 2018). This is another challenge to cope with that any country that is likely to have efficient financial resources to initiate a project needs to plan wisely to utilise. However, it is going to be an enormous loss for the nation when a resilient project fails. There is an option for those countries who would like to be in the race for resilience, whereby they can request funds and loans from The World Bank (Tadele & Kalyebara 2020). To be considered for funds, various strict policies cannot be violated. The government needs to share its action plan with complete details of how they are supposed to execute the project and what benefits they are likely to achieve after the implementation. Once the request is approved, they can initiate the project as per policies. In the case of violence, the project may be asked to stop or omit the constraints to accomplish its goal. It is a positive sign when the nation has internal resources as they are not bound to other resource providers' policies.

The well-being effect of a tragedy does not only rely on the physical features of the occurrences, or the direct effects in terms of assets and life losses. Well-being impacts also rely on the capacity of the economy to address, mend, and restructure, and consequently to reduce collective welfare losses (Rose 2017a). This capacity can be regarded as economic resilience against disasters created by various factors. There are two components of economic resilience: prompt resilience and dynamic resilience. The instantaneous form of resilience refers to the ability to limit the scale of instant losses in the production of a certain amount of losses, whereas dynamic resilience is about the capability to mend and recover (Noy & Yonson 2018). Well-being impacts are also related to the microeconomic resilience that relies on the loss's distribution and on the susceptibility of households, for instance, their income before the disaster and aptitude to mitigate shocks with the passage of time with the help of savings, insurance, and borrowing. The system of social protection, or in another way the methods of distribution of risks across the community, can also assist in lowering the impacts of disasters on an individual household.

The risks to the economy of an area after a disaster can be mitigated by reducing the susceptibility or exposure of assets and people, and growing the economic resiliency of a region through various techniques and institutional developments (Evenhuis 2020). Studies show that the main cause of risks from recent disasters has been the extensive assets and population growth, and areas with high risks. For instance, movement to coastal regions and the expansion of urban centres in flood plains, along with unsuitable building structures, are some of the leading causes of the increasing risks from disasters (Noy & Yonson 2018). Better infrastructure development and urban planning can mitigate risks to the economy and other aspects of life from disasters. Resilience enhancements enable cost-effective recovery from calamities, and natural hazards are better coped with through high resiliency (Rose 2017b). Economic resiliency mitigates the aggravation of harsh situations and avoids macroeconomic stagnation in an area.

4.4.4 Theme 4: Interrelationship between climate change and urban resilience

This question was included in the interview to obtain insights about the level at which the Ajman development planning authorities give importance to resilience enhancement and their understanding of the climate change relation with resilience. Moreover, this question enabled the researcher to get information about Ajman's projects to tackle the challenges related to a changing climate and their plan for the future. As one of the respondents informed:

> *AMPD's main aim in relation to climate change is to implement innovative initiatives and policies focused on reducing emissions, minimising wastes, promoting clean air through technology, and enforcing Ajman and UAE federal level regulations, legislations, and directives.*

The response to this question also provides quite a good response to one of the research questions (In the context of urban resilience, how might climate-sensitive knowledge be translated into enhancing strategies?), which was beneficial.

Climate change is one of the most pressing worldwide issues threatening urban resilience, since it poses a risk of natural catastrophes and other negative consequences. In terms of climate change, AMPD's major goal is to develop creative programmes and policies aimed at lowering emissions, eliminating waste, promoting clean air using technology, and implementing Ajman's and the UAE's federal rules, laws, and directions. The AMPD has also introduced waste management methods such as the 3Rs approach to eliminate landfills. Waste management's overarching goals are to reduce untreated waste, improve service delivery, investigate residual waste treatment alternatives, and build new infrastructure for future usage. These activities, taken together, have a beneficial influence on pollution in the air, water, and land, therefore increasing urban resilience and quality of life.

The Ajman 2021 Strategy aims to create a happy community that will contribute to the development of a green economy, backed by a distinguished government that is in line with the UAE Vision 2021, National Agenda, and Union Spirit. A content society, according to the Ajman 2021 Plan, is a cohesive community with a good spirit and attitude that is proud of its heritage and values, and communicates with its surroundings. It asserts that society's people are well educated, ambitious, and actively involved in achieving a full and balanced development. It defines the green economy as an active economic movement that promotes sustainable development with the goal of creating success in many sectors. Modern and comprehensive policy decisions and incentives should be used to promote the green economy. It claims that the government of Ajman is notable because its activities are efficient and reflect the needs of society and the economic environment. Smart guidelines, as well as regulations and guidelines, regulate the processes of the Ajman Government agencies.

Most of the world's population today lives in towns and cities disproportionately located near beaches and rivers, putting them in danger from hydro-meteorological shocks and pressures. Furthermore, metropolitan areas with fast, unplanned expansion often have significant socioeconomic vulnerability, such as urban poverty, informal settlements, a lack of municipal services, land tenure difficulties, and so on, which are worsened by climate-related shocks and stressors. This has sparked interest in the idea of urban climate change resilience (UCCR), which acknowledges the complexities of increasing urbanisation as well as the uncertainties that come with climate change.

Many development organisations have established UCCR frameworks in collaboration with their member nations and partners. These frameworks emphasise that, while technology and infrastructure are critical to improving UCCR, addressing a wide variety of concerns (institutional, financial, geographical, and social) is just as important. Meanwhile, scholars and development groups are beginning to investigate practical ways to improve UCCR. One of the most important themes in today's public policy is the notion of a sustainable and smart city. In the 1990s, the concept of smart and sustainable cities was born. Because of lifestyle advances and the effects of climate change on the economy and society, it became a government objective. According to the Ajman Emirate Population Fund's 2008 study, by 2050, 70% of the world's population will be living in cities. However, more than 830 million people are still without appropriate housing, and their living conditions are unsatisfactory.

Many worldwide actors, such as politicians and developers, have become more aware of advanced sustainable cities and the resulting sustainability implications on urban transformation because of the growing discussion on environmental sustainability. There is a relationship between smart technology and creating sustainable cities, although smart technologies may be employed without addressing sustainability improvements. Buildings are thought to account for 70% of primary household energy consumption, posing energy and environmental issues. Then, there is the requirement for energy-efficient structures. It is believed that to achieve power sustainability in buildings, sustainable energy supplies must be addressed.

Around 2050, over 70% of the world's population will be living in cities, compared to 50% currently. Cities are responsible for more than 70% of global carbon emissions. Information and communication technologies (ICTs) are used in smart, sustainable cities to enhance infrastructure facilities and life quality. ICTs are already improving energy efficiency, traffic safety, and notifying the police in some places. The Internet of Things, artificial intelligence, and smart grids are all speeding up the development of smart cities throughout the world. To establish a perfect balance between economic and social growth, the UAE government has set the main goal of ensuring sustainable development while protecting the environment.

To this end, the government has established an aim to improve air quality, preserve water resources, increase clean energy, execute green growth plans, and improve the quality of life of its inhabitants. Ajman, the smallest emirate of the UAE, is undergoing urbanisation in the same way that the rest of the developing world is. Simultaneously, the Ajman Government guarantees that settlements go through a systematic procedure to eliminate urban poverty and informal housing. In a short period of time, the AMPD has implemented innovative methods that have emphasised sustainable advances in many aspects. The AMPD, on the other hand, is looking for a framework model that includes successful characteristics to improve the government's programme for creating a sustainable, smart Ajman city.

The SDGs were established by the UN to rehabilitate the environment and ensure peace and prosperity for future generations. The UAE is one of the countries that has backed these aims. In this regard, Ajman has proposed measures to demonstrate its commitment to sustainability by analysing the SDGs and mapping materials and initiatives to them. Through innovative methods and activities, the AMPD aims at contributing to the national efforts to decrease the impact of climate change considerations on decreasing emissions, as well as minimising waste with a target of zero landfills, using the latest technologies to ensure clean air, and non-harm to the environment by complying with UAE’s federal and the Ajman-level legislation, regulations, and directives. Sustainable energy provides affordable, accessible, and reliable energy services that meet the economic, social, and environmental needs within the overall developmental context of the society for which the services are intended, while recognising equitable distribution in meeting those needs. The following goals have been proposed: low or zero carbon dioxide emissions, no avoidable ecological harm, improving energy transit security, lowering energy production costs, and increasing the use of green technology. Maintaining energy efficiency in both residential and industrial sectors is one of the AMPD's key goals. This is intended to guarantee that all implementations and achievements adhere to industry best practices. By enhancing performance and maintaining a high degree of efficiency in all areas, it has been able to save a substantial quantity of energy.

Poverty and a lack of essential amenities – such as transportation, banking, healthcare, and social protection – are major indicators of climate change susceptibility. To put it differently, the poorer a community is, the more affected by climate change it will be. Without ensuring that high-vulnerability populations have the financial, technological, and institutional resources they require to adapt, no adaptation plan will be effective. Households and businesses must improve their adaptation strategies: many already have incentives to adopt, but they require assistance in overcoming hurdles such as a lack of knowledge and funding, as well as behavioural biases and flawed markets. Governments can make climate risk information public, explain the responsibilities and obligations, encourage innovation and access to the best technology, and guarantee that funding is available to everybody, particularly for solutions with significant upfront costs. They will also need to offer direct assistance to the world's poorest people, who cannot afford to invest in resilience yet are the most susceptible to climate change's catastrophic impacts.

Governments must preserve public investments, assets, and services, in addition to providing direct assistance to individuals and companies. Because urban and land use plans have a significant impact on huge private investments in housing and productive assets, it is critical that they adapt to the developing long-term climate hazards to prevent trapping people in high-risk regions. Risks and consequences cannot be eliminated entirely. Governments must devise plans to guarantee that, in the event of a disaster, individuals and businesses can survive without long-term damage and recover swiftly. Physical damage and economic losses are reduced by preparations like better hydro-meteorological data, advanced detection, and emergency management systems.

Coping with the effects of climate change in one economic sector is difficult enough. Dealing with the effects of climate change in all sectors at the same time necessitates high-level strategic planning. Floods, for example, have an influence on house values, while changes in ecosystems have an impact on agricultural production. The macroeconomic position and tax revenues will be affected by climate change. The trade balance and capital flows of a country can be affected by the effects on important industries (particularly exporting ones). And, on top of existing contingent liabilities and current debt levels, spending demands for adaptation and resilience must be added, putting further strain on public budgets. The interaction of these variables might create new threats to macroeconomic stability, public finances and debt sustainability, and the financial system. These dangers will have to be managed by governments. Because macroeconomic estimates of future climate change impacts are fraught with uncertainty, strategies to strengthen the economy's resilience, particularly through suitable diversification of the economy's structure, export composition, and tax base, are especially appealing in the short term.

Governments must not only prioritise activities so that they are compatible with existing resources and capabilities, but they must also build a strong institutional and legal framework, as well as a consistent monitoring mechanism. The main goal of an adaptation and resilience strategy is to ensure that all government departments and public agencies adopt and mainstream the strategy in all their decisions, as well as governments continuously monitoring and evaluating the impact of their decisions and actions so that they can address any challenges and adjust their actions accordingly.

4.4.5 Theme 5: Distinguishing resilience, disaster risk reduction and sustainability

This question was addressed to representatives from Ajman's planning authority, and their replies were useful in gaining insight into their perspectives of resilience. One of the participants offered a quick explanation of the terminology in his response:

> *Sustainability is focused on identifying activities that would provide a long-term solution for diminishing natural resources, whereas disaster risk reduction is primarily concerned with reducing the effects of catastrophic events.*

Resilience combines these two elements, and goes beyond them with proactive and holistic solutions that address an urban area's short- and long-term challenges.

While catastrophe risk reduction primarily focuses on reducing the effects of catastrophic occurrences, sustainability focuses on finding activities that will provide a long-term solution for diminishing natural resources. Resilience combines these two elements and goes beyond them with proactive and holistic solutions that address an urban region's long- and short-term issues. The over-exploitation of natural resources has a negative impact on an ecosystem's health and human well-being. People must take action in the face of environmental crises and growing inequality, such as developing extended producer-responsibility and supply chain legislation, ensuring green public procurement, supporting technical innovation to improve resource circularity, and implementing decision-making processes that include and treat women with respect, particularly indigenous and local communities.

Sustainability entails satisfying one's own needs without jeopardising future generations' capacity to meet their own. They require social and economic resources, in addition to natural resources. Concerns for social equality and economic growth are found in most definitions of sustainability. Resilience has risen to prominence and increasingly dominates discussions about how to handle the dangers that humanity faces. Climate change, natural disasters, vital infrastructure, security and terrorism, and other types of hazards have all made resilience an appealing concept.

The notion is currently widely discussed on a global scale, and it plays an important role in international, national, and municipal policy and development. The capacity of a system, group, or civilisation to resist, absorb, accommodate, and recover from the impacts of danger in a timely and efficient manner, including via the preservation and restoration of its fundamental basic structures and functions, is referred to as resilience. It is no surprise that the concept of resilience is taking centre stage in the global economy, given the increasing exposure of people and assets to an ever-increasing number of risks, as well as the intensifying hazards brought about by human inputs into the environment, such as the increasing threats of climate change, ecosystems' decline, and environmental pollution, which are exacerbated by an increasingly interconnected global economy.

The ability of a system or individuals to absorb stress and adapt to the condition that will exist after the shock is what resilience adds to previous notions such as sustainable development or catastrophe risk reduction. In some ways, it is an extension of the notion of sustainability, as well as an application of climate adaptation to problems that are not caused by climate change. Disaster risk reduction is obviously a part of resilience, but resilience adds more to DRR. Anticipating and absorbing shocks is a similar but different method to risk reduction. In DRR, for example, individuals may create early warning systems concentrating on lowering population vulnerability in anticipation of the effects of a hazard, such as an oncoming storm.

They focus on redundant and/or dispersed warning systems for increasing resilience, concentrating on the system's vulnerability as well as the vulnerability of the people. The focus on the unknown danger is the motivation for this strategy to create resilience. Whereas DRR focuses on specific known risks, resilience considers the unknown future and considers all threats and combinations of dangers.

Climate change adaptation and resilience are both defined by the same characteristic of a shifting future danger. As a result, parts of developing adaptive capacity in systems and individuals are similar to both. The ability to acquire and store information and experience, flexible decision-making, problem-solving, and responsive power structures that address the interests of all stakeholders are the most prevalent aspects of adaptive capacity. The key distinction is that climate change adaptation is solely concerned with the consequences of climate change, whereas resilience is concerned with any shock.

Reducing vulnerability among individuals, the economy, and ecosystems is a common theme in developing resilience and sustainable development. People and economies that are stronger are better able to foresee and absorb many types of shocks. Both have characteristics of diversification and inclusivity in common. Diversified economies, which include trade, guarantee that shocks to specific sectors have a lower impact on the whole economy. Inclusiveness guarantees that the benefits of economic progress reach the most disadvantaged people. When resilience encourages redundancy and centralised methods, the two notions diverge. Promoting redundancy appears to advocate for costly and needless duplication in a globalised society where supply lines and supply chains are thin. Centralised and freestanding systems, on the other hand, forego the benefits of a worldwide market economy. So, while resilience and sustainable development are related, they are not the same thing.

Individuals, communities, organisations, and nations' capacity to adapt to and recover from hazards, shocks, or stressors without jeopardising long-term development prospects is characterised as disaster resilience. Disaster risk reduction, on the other hand, attempts to minimise socio-economic vulnerabilities to disasters by addressing environmental and other risks. In terms of development, the strategy is to promote resilience and disaster risk reduction as a cross-cutting aim and target that benefits all elements of development. This will be the main strategy for achieving resilience. In this approach, the emphasis is on essential aspects that contribute to shock resistance, such as encouraging sufficient and diverse incomes, guaranteeing specific levels of economic and ecological variety, and having flexible and inclusive governance structures.

Individuals, communities, organisations, and nations must be able to adapt to and recover from risks, shocks, or stressors without jeopardising long-term development possibilities. At the international, regional, national, and local levels, disaster resilience is defined by the ability of individuals, communities, and public and private organisations to organise themselves to learn from past catastrophes and minimise their risks from future disasters. Individuals, communities, governments, and institutions' ability to absorb and recover from shocks, while constructively adapting and altering their structures and ways of life in the face of long-term changes and uncertainty, is referred to as disaster resilience.

Climate change adaptation is adapting lifestyles and social and economic activities to the conditions predicted in the future climate, which includes a world with higher sea levels and more intense weather. Building structures on higher elevations, erecting sea barriers, creating artificial islands, making more effective use of water during droughts, and cultivating drought-resistant crops are all examples of this adaptation. A country's capacity to adapt to changing climates is determined by its technical and economic skills, as well as its cultural flexibility and physical mobility. Natural hazards such as earthquakes, volcanoes, and hurricanes may create catastrophes, and disaster risk mitigation includes analysing and decreasing the possible damage or danger.

It entails educating the people, establishing effective government institutions that can respond swiftly and efficiently, and constructing infrastructure that can survive the effects of natural disasters, such as earthquake-resistant structures. Disaster risk reduction and climate change adaptation are both responses to natural disasters that pose a hazard to humanity. Climate change adaptation, on the other hand, is a response to a specific large-scale threat to humanity that involves permanent changes to the planet's environment, whereas disaster risk reduction is concerned with mitigating or responding to any disaster, regardless of the scale or the long- or short-term effects. Human well-being is dependent on natural resources. People cannot survive without breathing clean air, eating plants, or drinking clean water. To put roofs over their heads and heat their houses, they rely on natural resources. They require them in order to survive and grow.

Trees and plants, for example, are renewable resources because they recover fast. Copper and oil, for example, require a long time to produce and are thus termed non-renewable. Natural resources generate a complex web of interdependence when they are combined, producing ecosystems that include humans. As a result, resource distribution influences the face of the globe and the uniqueness of local ecosystems. People have established a variety of cultural, religious, and subsistence-based connections with the natural world, adopting mindsets that go beyond financial frameworks. Human growth is made possible by nature, but the unrelenting demand for the planet's resources is hastening extinction rates and wreaking havoc on the planet's ecosystems.

In the course of its efforts to promote decolonisation in the 1960s, the use of natural resources was long considered an element both of human rights and economic development that led Ajman city to state that the right of people and nations to permanent sovereignty over their natural assets and resources must be exercised in the interests of their national development and the well-being of the citizens. Natural resources are frequently seen as essential assets that drive wealth growth. The consumption of resources has risen over time because of growing industrialisation. In several situations, resource extraction levels have exceeded natural regeneration rates. Such overexploitation jeopardises the lives and well-being of people who rely on these resources, as well as the ecosystem's health. This risk of resource depletion, which has shown itself in the form of fisheries' crashes, highlights the need for natural resource usage to be regulated in order to better protect supplies and their ecosystems.

4.4.6 Theme 6: Primary indicators for Ajman resilience index

The above question enabled the researcher to engage stakeholders in identifying indicators for resilience in the case of Ajman city. The responses from the participants highlighted some of the relevant indicators' primary indications for the city. The participants mentioned that policies regarding the environment are among the primary indicators of resilience, and therefore can be included in the development of the resilience index for Ajman. A response from one of the key participants was as follows:

The primary urban indicators that should be included in Ajman's resilience index are the quality of the ecological environment, environmental policies, land use, public service amenities, policies on hazards and management planning, critical city infrastructure, and disaster response and reduction framework.

The overarching theme of this research concerns itself with the development of a URI, which includes climate change as the dominant factor. This index is explicitly designed for Ajman city. It will keep the conditions and nuances of Ajman city in mind, although it will be available for wide use once it is completed. To build such a compelling and coherent index, which will be unique, an essential part is the identification and utilisation of correct and relevant indicators that will form the index. Indicators are the central part of making this index, and the latter is also highly dependent on the former to ensure that it works well and functions correctly.

While the identification and decision on indicators touch upon and influence all the sub-questions of my research, it especially forms the entire basis of the research sub-question number 5, which is, “Which urban indicators are the most appropriate for generating the city's finest urban resilience index?”. And of course, as mentioned before, all research regarding indicators aligns heavily with the main research question.

As discussed above, indicators are a vital part of the development of any index, and therefore their need and importance swell for my project, too. Indicators are a systematic and consistent way of measuring the influence of one variable over the other, and finally formulating a score that reflects the big picture. They also help to clarify how much weight is attached to one variable in a particular study, explaining its effect and importance in a particular index/study, while providing us with a qualitative and measurable impact, adding a more scientific approach to the study. Using indicators marks the addition of numbers and evidence in the study, which is always more welcome to precisely explain the nature of things to all concerned stakeholders. They also help by providing a criterion through which the actual implementation of the policies and programmes designed for urban resilience can be measured against, and therefore make any governance regarding the final index easier (Feldmeyar et al. 2019).

I am now going to mention and dissect the seven primary urban resilience indicators for Ajman that were suggested by the stakeholders, which are the quality of the ecological environment, environmental policies, land use, public service amenities, policies on hazards and management planning, critical city infrastructure, and disaster response and reduction framework.

The quality of the ecological environment refers to the health of the ecological system from a range of complex factors, including biological factors, development status, population, and others. The quality of the ecological environment signifies the health and well-being of the entire community and city, and will also encompass a range of sub-factors that will deserve my attention too. The ecological environment also plays a distinct role in determining the resilience of any urban area, as cities with better ecological conditions are less vulnerable to being affected by climate change disasters, are able to absorb more shocks, and have a better capacity to tackle the needs of a growing population as well.

Focusing on the ecological environment and raising its quality over time will lead to what academics have called 'ecological urban resilience' as well. This means that they will also be able to tolerate and adjust to structural changes and tackle disruptions. This is really something to note in the ever-developing world of today, impacted by sudden disturbances of various nature, which require updated planning all the time (Zhang & Li 2018). This also explains why it is important to include the 'quality of the ecological environment' as one of the prime indicators in the index that research is developing.

The next possible primary indicator pointed out by one of the participants was the environmental policies of the city. Probably at this point, it does even need to be stressed how important environmental policies are in developing and planning urban resilience on any level. Most of the institutionalisation and evolution of urban resilience has been due to the rising threats posed by climate change and the multifold increase in the number and occurrence of natural disasters due to the reasons mentioned earlier. Such calamities (such as hurricanes, storms, flooding, intense weather, increased rain and snow, aridness, and droughts) give rise to direct threats to city infrastructure, put additional strain on already scarce resources, and reduce the quality of life for the inhabitants of the city.

Research has also widely agreed that policies about the environment and climate change now need to be mixed with sustainable urban development so that sustainability and resilience to climate and environmental change are embedded into the master plan, expansion, and any future projects linked to the city (Velasco et al. 2018). Environmental policies also encourage newer forms of governance and flexibility in governance models. Therefore, its inclusion guides the indicator of adaptive planning and governance, and makes it more comprehensive too.

Competent environmental policies will result in better urban resilience and increasing well-being for a particular community or city, and therefore it is crucial to include ‘environmental policies’ as a primary indicator in building the URI for Ajman city.

Another indicator that should be included and was a prominent part of the respondents’ answers was the use of land in the context of urban design and planning. Land use refers to the ways and means that the land is being used for, and the goals that are being realised through the government's use of land. It also includes the factors that are being awarded weight when the allocation of land is being decided upon. While this factor may be ignored in preliminary and primary studies, it is but a defining factor in the management and governance of cities, and a highly significant topic for students of urban design and planning such as me.

Poor land use does not only create expected and real problems such as congestion, poor flow of traffic, and the risk of hazards, cluster, and a dip in the aesthetics of the city, but there are more severe effects of the use of land without giving it a proper thought. The poor use of land may translate into systemic inequities within the population, lack of public space for citizens, an absence of recreational opportunities, lack of urban connectivity, unequal access to employment, the degradation of public goods and services, and more such serious repercussions that do not seem tangible at first. (Drewes et al. 2018). Land use is, therefore, a serious business and should be considered by experts based on spatial planning principles, forward planning, and smart land management (Abdul & Yu 2020). There is a high linkage between land use and urban resilience, and without the inclusion of it as an indicator, any index would be rendered incomplete.

The provision of public services and amenities has been touched upon before in this part, and there is a need to shed more light on it here as a primary indicator for my study and index. In this context, the research will include both the provision and availability of basic utilities and public spaces in the category of public service amenities. In terms of utilities, it is evident that resources are scarce, and it is already difficult to divide them equally and efficiently between the existing populations. Water, especially, is a source of content for the future as cities have started to run out of freshwater supplies. This will need a review of bridging gaps between water supply and demands, and also lead to efforts and initiatives designed for water conservation.

Furthermore, the city should be adapted so that there is less water needed and water wastage is reduced. The example above from Copenhagen will serve well in the case of Ajman as well. Advanced planning and preparation against power failures and outages, extreme weather, and climate hazards can also contribute to a more resilient electricity and utility system (Zamuda et al. 2019). The second aspect in this regard is public spaces, which provide a vast opportunity in the bid to build urban resilience and improve the planning of a city. They can be used to develop all sorts of resilience, playing a part in dealing with social, climate, mental, and physical resilience (Peinhardt 2021). This will require more adaptation of public spaces to urban resilience methods and bolstering more innovative approaches. The topic of 'public service amenities' has a paramount nature, and therefore was suggested by the stakeholder from the Ajman planning team as well. It has a massive role in the URI.

The next category, as per the answer of the participants, is the policies of 'hazard management'. This, in itself, can be called a sub-field within urban planning, and therefore requires my attention again. In the research, a URI has been created to manage and guide urban resilience programmes and projects, but this does not mean that future hazards will not happen altogether. In an ideal world, it can be considered to be free of hazards, but in this reality – with the rapid pace of urbanisation, migration, urban development, population increase, and climate change – hazards are bound to happen, and therefore it is pivotal to have systems in place to face these hazards and incite a greater degree of resilience in urban areas (Etinay et al. 2018). This should be of great interest to urban planners and academics in today's age. A plan for risk management will need to be designed and put into place, but a robust system for the identification of hazards will also need to be developed (Almeida et al. 2020). 'Hazard management' could be an important primary indicator for an index like this.

Infrastructure is an area that is naturally strongly connected to the whole domain of urban planning, and therefore plays an imperative role in the efforts to build and plan for urban resilience as well. Critical city infrastructure is the life of the city, and therefore it is at the core of my whole study and dissertation as it forms a large component of the idea of urban resilience. There has been a significant transition towards 'green infrastructure' in recent times, in order to cope with the perils of climate-induced changes and create a sustainable pathway fit for future generations. There needs to be a focus on ensuring that the evolution of green infrastructure is inclusive and planned to fit into the already existing complex infrastructure systems. The positive aspect is that green infrastructure has been a valuable addition to the levels of urban resilience and leads to the general safety of the public (Staddon et al. 2018).

Infrastructure does not play a role in housing and transport alone, but the magnitude of its effects extends to affect inequality, employment, diversity, wildlife, energy, social capital, health issues, population welfare, and much more (Parker & Simpson 2020). A multidimensional approach that focuses on all aspects, types, and effects of building infrastructure will be needed to ensure that no injustice takes place and urban resilience is elevated (Zuniga-Teren 2020). The vast literature on 'infrastructure' and its primacy in cities, complemented by the respondents' answers, means that infrastructure will be a core part of any URI.

The last category derived from the articulate answers of the participants is disaster response and reduction. A framework must be devised for disaster response and reduction as disasters – both natural and anthropogenic – are imminent, but systems need to be in place to tackle them properly. These include warning, rescue, and mitigation systems, and policy proposals that plan on reducing the occurrence and impact of future disasters. This category is different from 'hazard management' because, while hazard management talks about the risks from hazards and the way to deal with them, this factor includes the application of a framework that responds when these disasters occur and also works on reducing them. This part calls for the use of experience, scientific information, and damage intensity to build on adaptation and resilience schemes that will benefit the city in the long run (Chen et al. 2020). The process of advancing disaster risk and reduction is a complex one and includes all elements that have already been discussed in this section, and also throughout this thesis. To summarise here, the disaster response and reduction framework is also a recognised factor that will be an absolutely essential primary indicator in an index of urban resilience.

This discussion of 7 suggested primary indicators from the stakeholders' answers includes the reasons for inclusion and the prime importance of these indicators, and also sheds ample light on them to justify their inclusion in my study and index. However, the researcher wishes to write for the record that while each one of these indicators carries enormous weight and consequences of its own, none of them can provide us with the whole picture of urban resilience planning and policymaking in isolation; rather, it is the combined use of all these (and potentially more indicators) that can provide a holistic view of urban resilience and subsequently fulfil the requirements of building such an index. It is also worth mentioning that these indicators are all very closely linked to one another, and therefore should be studied together by exploring one's causations and effects on the other to design a complex and sophisticated system of urban resilience that does not fail. Indices that will take all these factors into account, along with other relevant factors, will be helpful to Ajman city and will also stand the test of time.

4.4.7 Theme 7: Current measures and plans for Ajman urban resilience index

I asked the following question of a participants from Ajman city, and the majority of the participants were found to be optimistic about the region's resilience-building activities. One of the participants replied that the AMPD's SDGs align with those of the UAE and the UN, both of which strive to repair the environment and improve the quality of life for current and future generations. As a result, a commitment by the local and federal governments, as well as associated institutions, to execute laws, regulations, and plans in Ajman will improve the city's URI.

There is a rising debate globally on sustainable development for complex sustainable cities; many professions such as development practitioners, urban planners, and policymakers have focused on this subject to study the impacts of sustainability on urban transformation (Zaneldin & Sivaloganathan 2018). The Government of the UAE has planned to give attention to enhancing the cities and the quality of life of citizens by providing quality air, clean and green energy, preserving water resources, and the execution of a plan related to green growth. For this purpose, the Ajman Emirate has taken the initiative, in policymaking for an urban resilience plan in collaboration with different authorities and the government of the UAE (Zaneldin et al. 2020). On the other hand, the AMPD is facing challenges in the city's planning due to the increasing population and expanding industrial activities, which affect the society's urban environment and well-being.

These challenges are in line with international and national goals and strategies that aim to target contemporary social, environmental, and economic issues. Consequently, the Government of Ajman Emirate has planned to set the main objective to implant a sustainability agenda for every aspect of life by assuming that sustainability is a fundamental part of its mission and vision

(Alzaabi et al. 2019). Moreover, improvement in the performance indicators of sustainability will be integrated into all activities and its aspect to guarantee the standard of living and well-being, and the transformation of Ajman into the frame of sustainability (Matz 2018).

The assessment of urban resilience would help authorities to get an understanding of the capacity of urban cities to recover from challenges in order to identify the increasing needs of residents. All the challenges related to urban resilience are complex due to the city's threat from diverse sources, the ambiguity of future events, and the components of multiple urban sources (Therrien et al. 2017). The theories of urban resilience suggest that an urban incorporation system is a complex system; thus, there is inconsistency in "urban resilience assessment" to monitor urban settings.

To address the threats and challenges, there is an Integrative Urban Resilience Capacity Index (IURCI) to measure the urban restoration capacity for all threats. In order to enhance the quality of "urban resilience assessments”, the IURCI will address certain factors, which are the physical urban form, future framework, spatial structure, and performance, to assess restorative capacities after implementation such as mitigation, adaptation, absorption, and mitigation (Fu 2018). A Scenario-Based Planning Support System (SB-PSS) is required, which is an outline and independent system that amalgamates the IURCI with situation creation, monitoring, analysing, and modelling, and is used to notify the different stakeholders such as the general public and urban planners regarding the outcomes of diverse policies of planning, and to support them through decision-makers to execute a preferred situation (Alsharhan & Rizk 2020).

To analyse the contemporary interventions and plans of the Ajman Emirate would help in improving the URI. Initially, people have to look at the goals and plans of the Ajman Emirate. The strategic goals of the Municipality of Ajman are designed to implement the Sustainable Development Agenda 2030 (Mittal 2017). This agenda has seventeen development goals and is intended to preserve the environment and create peace and prosperity for future generations. The UAE is one country among several nations that are the signatory of the Sustainable Development Agenda 2030 and has devised policies to achieve this. The Ajman Emirate set up plans to achieve its pledge towards sustainability by monitoring strategic measures and material projects. The contemporary strategic measures taken by the Ajman Municipality are going to be discussed, and are based on five comprehensive goals (Greek & Colombo 2021).

One of the primary objectives is to discuss the concept of a sustainable environment, with a particular emphasis on how residential and infrastructure integration can be incorporated into the planning of a recent development in Ajman. This goal is related to SDGs 7 and 11, which are focused on “affordable and clean energy” and ‘sustainable cities and communities”, respectively. Secondly, goal two is defined as protecting and qualifying the environment, which is related to SDGs 2 and 13, which are “zero hunger “and “climate change” (Therrien et al. 2017). The third goal is about the waste management's efficiency and effectiveness, associated with SDGs 11 and 12 that is "responsive consumption and production".

The fourth goal aims to develop integrity and transparency in biological diversity, which is linked with SDGs 11, 15, and 16 that are “life on land” and “peace justice, and strong institutions”. The fifth goal is to ensure better use of resources connected with SDGs 6 and 11. Lastly, the sixth goal is about belonging and loyalty related to SDG 5 on "gender equality and women empowerment". From the broad perspective to the minor lens, the Emirate of Ajman is majorly focused on material projects such as dealing with the issues of traffic congestion, solid waste management practices, quality resources, secure food and air quality, efficient energy, and climate change (D’Auria et al. 2018).

In terms of the policies and devices for maintaining the air quality of the Ajman Emirate, the AMPD has a unique approach to assist the air quality. Raising awareness techniques for maintaining vigorous air quality is being implemented regarding the possible air quality for upcoming generations (Bakkensen et al. 2017). Planning new policies and implementing the existing ones is the priority strategy for the AMPD. By realising this objective, the local government has deployed Continuous Ambient Air Quality Monitoring Stations at places that have sensitive locations in the city of Ajman (Greek & Colombo 2021). These stations work in a way that observes parameters like SOx, ozone, CO_2, NOx, and various elements present in the atmosphere of Ajman.

Furthermore, the local government has planned for the installation of air quality monitoring stations in different areas and sensitive locations. It is the responsibility of the municipalities to ensure that the quality of air is regulated properly and to support a quality control system (Matz 2018). Therefore, the AMPD is engaged in "delivering the required solutions & consultancies, by the right way, on time in a cost-effective manner" in a way to participate in the government's campaigns to support the sustainable environmental goals (Zaneldin & Sivaloganathan 2018).

The environmental desire of Ajman's management and in order to bind unconventional energy to assist the environment protection, the Agriculture and Public Parks Department in the Public Health and Environment sector at the AMPD has initiated environmentally responsive "hybrid vehicles" to direct, organise, and instruct tourists in the tourist sites of Ajman and the public facilities. The aim is to facilitate the provision of renewable energy to the urban environment, as part of a wider strategy to promote sustainable development (Alzaabi et al. 2019).

From the past years, it is observed that the trends of population growth and industries are rising day by day, which has become the cause of the production of a huge amount of waste. In the UAE, the transferring of waste into landfill sites has a consequence of increasing greenhouse gases and air pollution (Matz 2018). Thus, in order to solve these issues, the Municipality of Ajman started projects for waste management contained within the UAE Vision 2021, which aims to decrease waste by 75% by 2021. The designed strategies feature modern techniques to reduce waste, for example, the 3Rs and redirecting the waste from garbage stations (Al-Dabbagh 2021). Furthermore, two ideas are adopted for the management of waste. First is the installation of incineration plants for medical waste and non-substance waste that helps to trim down the mass waste disposed in the landfill sites. The second choice is the segregation of waste. It will be done by separating the non-recyclable waste and recyclable waste. This segregation makes it easy to separate the recyclable waste to be either sold or dumped (non-recyclable) into landfill sites. The AMPD has a plan to treat the liquid form of waste with the collaboration of the private sector and the use of technology (Alsharhan & Rizk 2020).

According to the AMPD's initiatives regarding sustainable waste management, comprehensive objectives are built into the Waste Management Plan in Ajman. Implementation of this objective should improve the city's conditions and facilitate its residents with a better and clean environment (Al-Dabbagh 2021) to achieve urban resilience and strengthen the planning process, which is the basis of sound analysis, mainly the dependable source of available data, estimation of alternatives for facility development that aims for driving waste management up and addressing the hierarchy of waste. Mainly, it is crucial to establish a precise timeline for the strategic visions, whether they are long-term or short-term, which should align with regional and local prospects. Additionally, it is essential to create a plan that conforms to the current federal and local waste management frameworks, while also incorporating the best global practices wherever applicable, as noted by Greek and Colombo (2021). The plan has further identified the role of the municipality to promote societies, communities, and businesses to handle garbage in more sustainable ways. It also recognises the need to establish guidelines and principles to practise over the upcoming years (Zaneldin et al. 2020).

4.5 Summary

Data collected from different participants was very critical in the research. Interviews were used to get the data. It was discovered to be the most convenient method of asking respondents for information. Following the collection of the replies, several analytical techniques, including the MCE and Delphi, were used to analyse them in order to determine various. Top government officials, including the CEOs of the infrastructure development and public health and environment sectors, the assistant secretary general for executive affairs, the chief of urban planning engineers, and the head of the urban planning studies section, were interviewed for the data collection. They were in the best position to understand the indicators and how urban planners had employed them.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 Introduction

The goal of the discussion is to interpret and characterize the relevance of your findings in light of the existing knowledge about the research topic under investigation, as well as to explain any new knowledge or novel insights that have emerged regarding the subject as a result of the review of the findings.

5.2 Urban Studies, URI, MCE, & Delphi Analysis for Ajman

A structured evaluation of the interview results provides pointers about underlying issues. Consequently, reviewers should engage in forecasting to influence decisions. The question-and-answer session was undertaken by a panel and yielded valuable insights about the Ajman city resilience indices, for example, the quality of the ecological environment, environmental policies, land use, public service amenities, hazards and management planning policies, critical city infrastructure, and disaster response and reduction framework. The Delphi assessment focuses on KPIs influencing the city under the review's sustainability. The answers show that the city's sustainability hinge on the provision of critical services. A common theme from the results is that proper planning is essential to developing Ajman city's resilience. The information can guide decisions on appropriate land use leading to productivity and sustainability in the future. As an illustration, demarcating industrial and residential zones is an activity that can benefit from the interview analysis. Thus, policymaking within Ajman city is an undertaking that can be implemented through the question-and-answer session. The results show that ecological challenges will undermine the city's resilience. The data should influence the development of mitigation measures targeting the environment at the personal and organisational levels. Developing an efficient and friendlier transport system to cater to Ajman's increasing population and environmental concerns is necessary. Customising the results obtained for Ajman for adjacent cities, since they share similar characteristics, is a practical approach to determining the efficiency of the sustainability measures. Consequently, stakeholders should engage in comparative analysis based on the data acquired from the Delphi analysis to influence decision-making. Interviews provide systemic evaluations about issues of concern within society.

5.2.1 MCE & Delphi Analysis for Ajman

Table 5-1: The Need to Improve Urban Resilience Planning

Dimension	**Cause**	**Impact**	**Contribution**	**Potential Resilience Pathway**
Need to improve urban resilience	Increased immigrant population (88% of the local UAE population)	Pressure on existing urban resources and infrastructure	They contribute to socioeconomic development and should be included in resilience planning	To reduce net migration. It has already declined from 1,189,616 in 2002 to just 200,000 in 2017
	Total population growth	The increasing population needs more social infrastructure to support them	Population increase provides labour to meet the rapid socioeconomic development	Include measures to control population growth, which is already declining
	Urban population growth. By 2030 66% of the population will be living in cities	Growing pressure on urban resources and social and economic inequalities	Urbanisation creates a new one-way movement to urban centres, which provides cheap labour for economic development	Include strategies to control rural–urban migration to reduce the impact on town resources

	Extreme weather and natural disasters	Damage to city infrastructures such as roads, power and water supplies, and business supply chains	Increased costs to maintain and expand urban infrastructure. Introduce technology to develop more resilient infrastructure	Include climate mitigation strategies as a part of the urban resilience planning
	Decreasing quality of life in urban centres	They pressure the government to spend additional resources to provide social safety structures	High population increase and urbanisation creates economic inequality, which impoverishes many people	Include strategies to narrow social inequalities as a part of urban resilience

Table 5-2: Key Actors in Urban Resilience

	Key Actors	**Role/Responsibility**
Whose responsibility for overseeing resilience?	Local and federal government bodies and agencies should take the leading role in planning and implementing urban resilience planning	Policy formulation, goal development, and resource mobilisation
	Expatriates	Research and policy formulation
	Citizens	Participate by improving behaviours to reduce the misuse and overuse of public utilities and infrastructure

Table 5-3: Components of Urban Resilience

	Components	**Focus Areas**	**Rationale/Actions**
Components of Urban Resilience	Institutional	Social institutions such as health and education	Empowering citizens to make positive choices and support resilience planning. Put up structures such as hazard prevention to deal with natural disasters
	Infrastructural	Public utilities and infrastructure	Improve the supplies and distribution of water and sanitation, power for consumption, roads, transportation, and telecommunication to support the increasing population
	Social	Improve social aspects to improve well-being	The focus is on health promotion and the expansion of accommodation facilities to reduce inequalities

	Economic	Improve revenue generation for government and private institutions	Provide the infrastructure to support business and incentives to attract more investments in the city

Table 5-4: Climate Change and Urban Resilience

	Causes	**Impact**	**Urban Resilience Planning**
Impact of Climate Change	Natural catastrophes	Destruction of urban infrastructure Population displacement	Policies to lower emissions and eliminate waste, to promote clean air using technology. Waste management methods such as the 3Rs

Table 5-5: Primary Indicators Included in Ajman's Resilience Index

	Indicators	**Description and Rationale**
Primary Resilience Indicators	Quality of the ecological environment	They include biological factors, development status, population, and other factors. The quality of the ecological environment signifies the health and well-being of the entire community and city.
	Environmental policies	Policies to address calamities such as hurricanes, storms, flooding, intense weather, increased rain and snow, aridness, and droughts.
	Land use	Policies to regulate land use and the goals that are being realised through the government use of land.
	Public service amenities	Poor land-use policies can lead to problems such as congestion, poor flow of traffic, risk of hazards, cluster, and a dip in the aesthetics of the city.
	Policies on hazards and	It is a sub-field of urban planning. The city must ensure its high URI, indicating the ability to withstand natural disasters

	management planning	in the future and reduce their impact on people and infrastructure.
	Critical city infrastructure	Infrastructure such as transport and public utilities provide the foundation for city development, facilitate resilience to natural disasters and population increase, and can narrow the inequality gaps.
	Disaster response and reduction framework	Frameworks to mitigate natural and anthropogenic disasters are necessary to increase resilience. They include early warning systems, rescue, mitigation systems, and policies to prevent or minimise the effect of future disasters.

5.3 Resilience Indices for Ajman City

Table 5-6 summarises the main KPIs that Ajman city needs to focus on to meet the desired URI to be used in climate change policies in the city's future plans. Their respective target values where applicable are also indicated.

Table 5-6: Resilience Indices for Ajman City

Dimension	Indicator	Interpretation	Unit	Potential Resilience Pathway	Target KPI	Sources
Ecological-physical conditions	Landscape shape index	Used to measure the landscape fragment	mm	ABS MIT	4.03	Venturelli and Galli (2006)
	Urban ecosystem service value	Used to measure the ecosystem service value in monetary terms	million dollars	ABS MIT	US$25 million	Feng et al. (2014)
	Runoff generation	Refers to the surface runoff generation	mm	MIT	10–20 mm	Wang and Jin (2001); Wehmeyer et al. (2011)
	Impervious surface ratio	Refers to the ratio of an urban area's	N/A	ABS MIT	1:2	Fu et al. (2016)

		impervious surface area compared to the total area				
Economic conditions	Residential water use	Used to determine sustainable water use by households in the area	N/A	ABS MIT	120 gallons per househol d per day	Gonzalez et al. (2011)
	Energy consumption	A pertinent aspect account for residential energy use plus commercial and industrial use of land	Terawatt-hours	MIT	23,845 terawatt-hours	Fu et al. (2016); Rosales (2011)
	Potential for renewable energy	Determines different renewable sources	N/A	MIT	N/A	Gonzalez et al. (2011)
	Cost of infrastructure	Accounts for costs of road construction	Million dollars	MIT	US$1.5 million per km	Fu et al. (2016)
Institutional service	Hazard mitigation strategy	Accounts for local strategies tackling specific hazards specific to a particular region, e.g., sandstorms in Ajman city	Sum of total observat-ions	MIT	N/A	Cox and Hamlen (2015); Cutter et al. (2008)
	Warning and reporting system	Presence of a real-time warning mechanism that will also provide instantaneous reporting	Sum of total observat-ions	MIT	N/A	Chen et al. (2008)
	Fire and police	Quantifying the presence of fire departments and the police stations	Sum of total observat-ions	MIT	N/A	Cox and Hamlen (2015); Hung et al. (2016)
	Evacuation routes and training	Quantifying the presence of evacuation routes plus the	Sum of total observat-ions	MIT	N/A	Chen et al. (2008); Cutter et al. (2010)

		population training				
Social capacity	Population density	A ratio of the population to the total residential area of an area	The total number of people per sq. mile.	ADA MIT	118 per km²	Cox and Hamlen (2015); Hung et al. (2016);
	Land-use mix	Refers to the Land Use Mix Index as formulated by Maghelal and Capp (2011)	N/A	ABS MIT	Increased use of land (commercial: 45%, residential: 45%, industrial: 10%)	Maghelal and Capp (2011)
	Accessibility to open space	Refers to the distance that residents have to follow to reach an open space	Sum of total observations	ABS MIT	N/A	Fu et al. (2016)
	Adaptive strategy	Refers to the proactive plans and strategies that should be taken during disaster	N/A	ADA	N/A	Hung et al. (2016)
	Understanding of risks	Refers to the awareness and experience of local residents about local risks	Sum of total observations	MIT ADA	N/A	Cutter et al. (2008)

ADA means **absorption.**

MIT means **mitigation.**

ABS means **adaptation.**

Landscape shape index incorporates characteristics such as size, shape, number, and spatial combination to reflect the complexity in the type and arrangement of landscape patches. Landscape shape indices are used to measure the landscape fragment.

Urban ecosystem service value is information that conveys ecosystem service features and trends, enabling decision-makers to comprehend the state, trends, and pace of change in ecosystem services. They are employed to calculate the monetary worth of ecosystem services.

Runoff generation is a significant part of the hydrologic cycle that occurs when water from snowfall, precipitation, and glacier melt flows across the ground. It is also called surface runoff.

Impervious surface ratio is the proportion of the gross land area to the total impervious surface area on a site. It is calculated by dividing the square footage of the site's total impervious surfaces by the site's total gross land area.

Residential water use is also referred to as domestic or household use, and determines the sustainable use of water by households in a particular area.

Energy consumption describes the relationship between energy usage and the activities of human beings in a disaggregated context.

Potential for renewable energy can be potentially replenished fairly rapidly through natural processes. It determines different renewable sources.

Cost of infrastructure refers to the price associated with creating, establishing, or maintaining civil works, for example, roads.

Hazard mitigation strategy explains how local tactics are used to combat threats unique to a given area, such as sandstorms in the city of Ajman.

Warning and reporting system refers to the existence of a real-time warning system that will also deliver immediate reporting.

Fire and police refer to measuring the number of police stations and fire departments available.

Evacuation routes and training measure the number of population training and evacuation routes available.

Population density refers to the number of people in a region's total residential area.

Land-use matrix describes the most prevalent land uses for development in conformity with the plan's zoning goals. It is an indicator of the land-use mix developed by Maghelal and Capp (2011).

Accessibility to open space refers to the path that residents must take to get to a public space.

Adaptive strategy refers to the preparedness measures that should be taken in the event of a disaster.

Understanding of risks refers to residents' knowledge of and experience with local risks.

Table 5-7 highlights the similarities/differences between the proposed KPIs and those of other similar countries (based on the Literaure Review).

Table 5-7: Similarities and Differences between Proposed KPIs and those of Other Similar Countries

Similarities between proposed KPIs and those of other similar countries	**Differences between proposed KPIs and those of other similar countries**
The population of employees working in both Ajman and other similar countries is expected to increase. For instance, the percentage of employees working in Ajman is currently at 54%, and the target KPI is 80%.	The population increase of employees may differ depending on the job opportunities created.
The population is expected to rise in the Ajman Urban Strategic Plan and other similar countries. The current KPI of the Strategic Plan is 490,035, and the target is 1,265,001.	The growth of the population may differ due to factors such as the difference in the birth rate, death rate, and immigration.
The current provision of public transportation to the population of Ajman	The provision of public transport in Ajman city may differ from those of other similar

Municipality is 20%, and the target is 35%. Countries similar to Ajman are also expected to increase their provision of public transport.	countries due to factors such as safety and reliability.
Ajman's Urban Strategic Plan and similar countries' high-building models are expected to rise. The current KPI of the high-building models is 85.7, and is targeted at 130.	Factors such as the site staff competency levels and design of the site layout may cause differences between the high-building models of Ajman city and those of similar countries.
The mixed-use developments in Ajman and other similar countries are expected to increase, as indicated by the current and targeted KPI of the Ajman Urban Strategic Plan.	Security issues may cause differences in mixed-use development, which possess a threat when planning mixed-use development.

The analysis of collected data on urban resilience indicators presented in Table 5-7 provides beneficial insights and implications to complement and add to previous studies, along with the provision of direction for future researchers and practitioners in this domain. The indicators that are existing are a good starting point, but the adaptation and extension of them is crucial for the context at hand. There are various indicator sets for assessing urban resilience that provide a decent basis for developing indicator sets. Nevertheless, most of the indicators evaluated in the literature review were intended for cases from emerging countries.

For adapting indicators that have been identified in the review for the context of Germany, several considerations were important that include the discounting of indicators that do not permit adequate distinction among cities. For instance, the literacy rate is preferred as an indicator in various cases, but the literacy rate is high in the case of Ajman and there is a marginal difference between regions. The indicators for which limited data are available are disregarded in the case of Ajman. The indicators for fields of action that are found to be important in the literature, and consideration towards municipalities, were the main player in the adaptation towards climate change. The indicator sets need to be manageable in terms of calculation and data availability.

Resilience indicators that can be applied to Ajman for urban planning include measures such as the availability of evacuation routes and emergency services, the ability of the city to recover from natural disasters, the redundancy and diversity of critical infrastructure, participation in planning processes, and the levels of community engagement. Additionally, the ability of the city to provide basic services such as healthcare, housing, and education to its residents also forms part of the resilience indicators that the city can fine-tune to ensure that it becomes more resilient. Aside from the above, greening the city spaces can also contribute towards improving the resilience of the city, as well as strengthening the community connectedness, level of social cohesion, and level of economic opportunities and diversity.

Urban planners and policymakers can focus on the resilience indicators highlighted above to determine the level of urban resilience and identify areas that need improvement. These indicators are very important for a city like Ajman whose administrators and leaders are keen on ensuring that the city remains resilient long into the future. Understanding the strengths and weaknesses of the city is important for the city planners, who can then use this information to make tailored decisions on how to design and develop the built environment in such a way that it will promote resilience. Some measures that can help Ajman to enhance its urban resilience include greening its infrastructure, improving the city's emergency preparedness plan, and increasing the availability and affordability of decent housing. Since resilience indicators are not static, city planners ought to periodically monitor and update the indicators to ensure that they align with the resilience plan for the city.

The analysis of existing researchers in the context of city resilience development depicts that at present there is a lack of sufficient investigation and research that could interpret the development of frameworks to evaluate urban resilience quantitatively. Many of the existing methodologies are summarised, predominantly, to theoretical constructions. This is replicated in the information that much of the published research regarding the issues related to urban problems in Ajman has given attention to the sustainability concept and its assessment using different scales instead of focusing on the context of resilience applied to urban systems. This practice presents two main concerns related to the current theory of resilience and application related to the development of cities in the UAE.

The first issue is that many activities regarding resilience development for urban areas have their basis in assumptions related to the social world, which impose a basic framework that is supported by more complex and interrelated action fields, meanings, and values. Secondly, the existing method for a quantitative resilience index for cities is very generalised and cannot reveal the specificities of each city fully, and hides more information than it reveals, thus resulting in an incomplete indicator. While the urban resilience concept refers to a comprehensive set of basic features, there are insufficient tools that integrate them. Therefore, this limitation of methods and shortage of operational tools for evaluating the city's potential resilience depict a gap in the literature in this field, creating a problem along with the opportunity to work further in this field.

Keeping the evaluation of existing work regarding urban resilience developed by experts in consideration, several challenges and opportunities were determined in the context of urban resilience, such as the identification of evaluation criteria for city resilience based on several dimensions including economic, social, institutional, and infrastructure. The use of a hierarchical scale is also included for the classification of local requirements that determine the specific compositions and demands in various contexts, evaluation metrics development that is easy to replica and measure, and building conceptual outlines that are quite simple yet adequately robust for non-specialists' understanding and utilisation, and appropriate for self-evaluation measures.

Measures to assess the linking susceptibility, adaptive and mitigation capacity are also included in the conceptual frameworks for evaluating city resilience, along with the development of tools for measuring urban resilience of an "iterative nature" that is applicable to the city at various stages. The tool can also meet the continued requirement of re-examining planning methods related to urban resilience in the context of disruptions, blockages, or interruptions in systems that are probable to occur or have occurred already. The interpretation of city resilience is also covered in the current work, and a meaningful policy response development is also considered within a specified scenario, both from the governance level and technical perspective. It can help authorities in monitoring and evaluating programmes related to city resilience enhancement and determine improvement opportunities.

To tackle these challenges and to exploit the opportunities, an initial step can be taken by combining several experiences, whether within or among cities. The integration of various knowledge types and a combination of approaches will be required in which experts, authorities, and the public cooperate to develop not only contextual, but also systematically reliable, applicable, and publicly robust knowledge. Hence, the integration of diverse knowledge areas, and the creation of clear operational definitions and tangible baselines, will address the current "imprecision" level related to urban resilience and the disconnection at the local level.

This implies that a better understanding is required about the selection of measures that are influential in terms of enhancing urban resilience, as well as the way measures can be better implemented and upheld to make urban systems, cities, and their citizens more resilient towards issues in urban centres. From the outline of the opportunities and challenges associated with the meanings, characteristics, and dimensions of city resilience presented in the literature, a compelling case can be formed that will motivate the creation of an operational instrument to assess urban resilience. Hence, bearing in mind a disruption, an urban system is impacted and offers effects of a wider range that can be analysed and measured, thus generating a possible misbalance in the operation of the arrangements.

Approaches of ecosystem management for city resilience utilise the current natural infrastructure and might potentially decrease the costs of the project related to urban infrastructure. This method presumes that no engineered infrastructure can be used to decrease the vulnerability of cities to disasters. An integrated urban resilience package should, therefore, incorporate environment management within conventional, long-standing approaches to reduce disasters. There are numerous strategies for ecosystem management that are applicable to urban resilience and, more generally, disaster risk reduction such as coastal zone management, watershed management, green infrastructure, urban landscape design, and environmental shields.

Projects related to urban system management usually incorporate a mixture of available policies and apparatuses for disaster reduction. The management of ecosystems needs an understanding of the services related to ecosystems and the urban environment at the local level, and there are methodological frameworks that can assist to incorporate ecology with city resilience. The current research highlighted the way that an understanding of ecosystem management can be utilised as an approach for enhancing urban resilience and providing significant co-benefits such as improving the well-being of people. These approaches should be a well-planned strategy and must involve the community continuously, instead of implementing a one-off construction programme.

Sustainable ecosystems reflect the collaborations between adaptation towards climate change and disaster risk mitigation. This also explains how to include ecosystem management in urban infrastructure projects to improve resilience. As part of their resilience interventions, local governments should include ecosystem management initiatives in their overall development and land-use plans. When it comes to catastrophe risk management, ecosystem methods must consider geographical dimensions that are typically larger than individual towns.

Furthermore, it is critical to comprehend and assess the amount of urban resilience of these occurrences across several dimensions. Thus, determining urban resilience entails determining if an urban system can be sustained, recovered, adapted, or changed, returning to the initial system (in equilibrium) or the system in different phases, that is, with varying degrees of equilibrium, or even suffering a state transition. As a consequence, resilience evaluation tools should be able to generate a set of adjustments to the system's circumstances, as well as identify challenges and opportunities that arise from reduction and preventative efforts, and the possibility of modifying the systems' operation.

There is no one indicator, or combination of indicators, that can be used to quantify universal sustainability or resilience. The results are heavily influenced by methodological assumptions and norms. As a result, our findings must be seen in the context of a variety of data constraints and methodological assumptions. The first stumbling block is the magnitude and sample size of the URI. While statistics' databases are typically accessible for larger areas such as provinces and nations, this is not necessarily the case for municipalities. The URI, which was created to evaluate urban resilience for the Ajman Emirate, is widely relevant to the UN environment and may be translatable to another geographic location if the index is streamlined.

One of the most challenging issues faced while creating composite indicators, and one of the primary challenges people encountered when doing this research, is a lack of appropriate data to feed the indicators. When no data were available, factors that the literature identified as impacting resilience, such as organised citizen organisations, were removed from the index, potentially biasing the conclusion. As more data becomes available, the suggested resilience index might be further improved and enhanced, and the resulting ranking could shift. The theoretical framework that was created, focused on what should be measured rather than what indications are accessible. However, because research on urban social-ecological resiliency is a relatively young topic in ecology, there is not currently an agreement on which elements have the most impact on resilience. As a result, finding and linking the various elements that impact urban resilience was a difficult endeavour, perhaps skewed by the author's understanding and the literature examined.

According to the research, implementation is a critical problem not just for how cities respond to threats, but also for how people interpret the idea of urban resilience. The concept, much like urban resilience, is complex and subject to intense debate, making it challenging to offer clear direction on its implementation. Building on the policy literature, this study argues that implementing urban resilience generates its own set of conceptual issues that must be addressed. Furthermore, the implementation process poses difficulties for practical attempts to improve urban resilience.

Extensive coordination, flexibility, varied time horizons, and a variety of outcomes are among the obstacles. Through implementation, governance systems automatically generate barriers to change, flexibility, and adaptation, which is known as resistance. Fatigue, apathy, and complacency are three essential components of resilience resistance. The implementation process, on the other hand, might have unintended beneficial consequences for a city's ability to prepare for and respond to shocks. Scholars and practitioners must be aware of the problems and consequences of implementation for urban resilience, and interact with them. Implementation challenges, roadblocks, and realities may eventually compel a rethinking of how urban resilience is conceptualised, conveyed, and practised.

Cities are recognised as essential actors in active participation towards sustainable paths in contemporary global development agendas, such as the UN's SDGs. This frequently entails major changes in the way cities operate. Non-linear representations of complex interactions and effects of a wide variety of activities are seen as non-linear manifestations of urban changes towards sustainability. This recognises sustainability as a process rather than a destination, and hence as a moving objective. As a result, people emphasise that the goals of Urban Sustainability Transformation (UST) may differ from one city to the next.

They vary from infrastructural and transportation system improvements, to food security and health concerns, as well as climate change. This means that UST should be seen as an overarching framework rather than a specific approach. It must consider local settings, engage a diverse set of players, and result in decent living conditions. This research focuses on climate change to demonstrate this strategy. According to a study, out of the many possible urban ideas, two must be applied to attain UST in the face of climate change: the Resource Efficient City for mitigation and the Resilient City for adaptation. Today, there is widespread agreement that the ambitious but essential climate goals can only be met by pursuing both reduction and adaptation methods simultaneously. As a result, there are synergies and interconnections between the Resource Efficient City and the Resilient City ideas. Their implementation necessitates significant modifications to current urban development pathways. As a result, the Resource Efficient City and the Resilient City highlight the key features of UST. Understanding how these two ideas are used will help us better comprehend the central mechanics and procedures of UST in general.

Aside from the ‘narrow’ definitions of the Resource Efficient City and the Resilient City as climate change mitigation and adaptation methods, both ideas may be interpreted more widely and might relate to financial resource efficiency or political instability resilience, for example. The focus of the conference is on contributions that look at UST in everyday life. People are primarily concerned with the conceptual framework, as well as how technological feasibility and political will are addressed. Additionally, the extent to which civil society is engaged is taken into account, along with their perspectives, attitudes, and values. Furthermore, behavior and requirements are considered, as well as the potential issues or barriers that may arise. As a result of continuous urbanisation processes, competition for resources such as land, drinking water, energy, and ecosystem services is intensifying. In response to these trends, the idea of Ajman as a Resource Efficient City focuses on the link between an increasing number of urban residents, their unique needs, and the intense use of resources. As a result, a more equitable and sustainable way of life and consumption is required, and therefore how resources are utilised, for example in the water–energy nexus, is critical for existing and emerging urban changes.

According to studies, Ajman's urban resilience aims to enhance the urban system's resistance to disruptions, as well as to build functions and structures that are less susceptible in the event of a crisis or catastrophic event. Resilience is "conceived as an expressly desirable condition" that must be reached "and, as a result, should be bargained among those who empirically execute it". Creating resilience in complex systems, such as cities, also necessitates trade-offs. Attaining resilience on one scale might have a negative impact on resilience on another. Consolidating Ajman's resilience is considered a critical component of urban changes in general. Persistence, transition, and transformation are three processes or routes to urban resilience, signifying a continuum of behaviours ranging from resistance to change, to dramatic transformation. Today, the Resilient City is frequently addressed in relation to climate change, with a growing call for resilience to be seen as a comprehensive concept. Cities are beginning to move towards transformational adaptation in the face of climate-related disasters and hazards, where adaptation is acknowledged for its ability to overcome gaps in sustainable development. In contrast to incremental adaptation, which aims to preserve current systems, this form of adaptation is defined as a non-linear modification to entire systems. However, there is little information available on the fully accomplished evolution process.

Nonetheless, there is a large corpus of practical ideas for resilient cities, and measures are being implemented in the form of trials, urban design showcases, and individual initiatives. As a result, these measurements are not often codified or included in overall adaptation plans, and they are not always connected to UST. As a result, technical methods such as dikes and dams, water recycling, or a better water–energy nexus to adapt to climate change impacts, as well as new techniques such as ecosystem service value to boost resilience, are available. According to studies, toolboxes on how to build a climate-change-resilient city have been produced at both the local and international levels. Sectoral climate change plans are being developed by a growing number of municipalities in the Global North, as well as less wealthy municipalities in the Global South. This shows that, while Ajman is not yet a regular feature of global municipal politics, the political desire to produce adaptation plans is increasing in a growing number of places. There is no shortage of viable technology and urban planning concepts and views for what Ajman should look like, as per the results concerning the Resource Efficient City. The political will and leadership for the Resilient City are becoming increasingly obvious.

This study revealed that technical experience is the most prevalent and argues that either technological, political, or environmental solutions alone are not adequate in the context of urban climate governance. Similarly, the research claims that there is no one-size-fits-all approach to urban resilience due to “different inertias characteristic of urban systems”, but instead a combination of such factors is needed like “self-ordering properties, adaptive learning, positive feedback and diversity of processes, institutions, and culture”. Even in places where the political will and capacity to execute current Resilient City toolboxes exist, significant implementation gaps are apparent, particularly in terms of their successful integration into overall sustainable urban development initiatives. Furthermore, as seen in the following, the successful implementation of measures by individuals in everyday life is difficult. ‘Adaptation mainstreaming in general, and eco-system-based adaptation, are in their infancy’, according to several Ajman municipalities.

In Ajman, ‘one of the major challenges of climate policy is moving beyond good intentions into transformative practices’, and path-dependent urban planning practice ‘significantly limits the realisation of novel adaptive planning’ by failing to observe synergies between adaptation and other political goals. These examples provide us with some fascinating insights, but they don't allow us to create a broad picture that can be generalised. More comprehensive, context-specific perspectives on the numerous situations would be required in this case. In summary, it is clear from the findings of the literature review that, despite the current knowledge of possible technical solutions and, at least in some cities, the presence of a political will, the two concepts of a Resource Efficient City and Resilient City remain unrealised throughout everyday life. According to research, the implementation gap is caused by a lack of adequate involvement and information among the local people. In terms of the positives, openly expressing and promoting the consequences of essential changes towards Ajman as a Resilient City on the living circumstances of urban inhabitants can improve knowledge and acceptance, as well as helping the final implementation of resilience and resource efficiency.

There are examples of procedures that have been effective when they are based on inclusive methods and involve or are initiated by the local community. People see these people-centred transformation processes as a viable alternative to top-down and technocratic approaches to smart or green city concepts. Furthermore, residents' aspirations for better living conditions for themselves and future generations could be the primary driver and requirement for UST to make Ajman a Resilient City. Local populations should be actively involved in achieving fundamental changes towards a more sustainable form of urban development, even if it is not done in a systematic manner. This, in our opinion, extends beyond the Resource Efficient City and the Resilient City to all types of fundamental changes.

Returning to the example of Ajman's transition from centralised to decentralised water management, its organisation through educational measures will hopefully lead to more sustainable forms of water management, while also influencing urban residents' living conditions through empowerment and local solutions' awareness. New notions, such as the 'right to infrastructures', which is related to Lefebvre's (1968) article 'The right to the city', also offer intriguing beginning points.

5.4 Summary

Overall, broadening the idea of the right to infrastructure to include the "right to sustainable infrastructures" appears to be promising. This is also related to the notion of co-creation spaces, such as the Urban Living Labs platforms, which involve stakeholders in real-life situations to test breakthrough concepts and assess their potential value for society, with users becoming producers, or so-called "prosumers". Such encounters can demonstrate a favourable influence on the local population's daily lives. In this sense, behavioural adjustments in Ajman have the potential to become a long-term part of UST.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

Urban resilience relates to the capacity of the systems, institutions, businesses, individuals, and communities found within a city to adapt, survive, and thrive regardless of the stresses and shocks that might come their way. This study looked at Ajman's urban resilience as the Emirate experienced challenges that were occasioned by factors such as the rapid growth in population, the industrial revolution, way of life, and improved social conditions. Incidentally, these challenges are not unique to Ajman, as they align with national and international challenges faced in other places. These challenges have prompted different stakeholders to come up with solutions aimed at addressing the identified issues. Therefore, the primary aim of this study was to come up with a URI for Ajman city that can be relied upon for future planning.

After establishing that the research objectives properly align with the aim of the study, the researcher formulated four research questions that were to guide the study and ensure that the objectives and the aim were met. The first question looked at how climate-sensitive knowledge could be translated into enhancing strategies for the city. It emerged that this is possible when the leaders of the city leverage the knowledge of climate-sensitive adaptation. The second sought to establish how climate change adaptation influenced the quality of life and how this led to the adoption of climatic responsive or resilient urban design. Following this, the next question aimed at establishing the urban regulatory tactics that the city can adopt as it works towards coming up with longer-term solutions. The final question aimed at finding out the urban indicators that were the most appropriate for generating the city's finest URI.

To address the research questions, the researcher went on to define the various dimensions under which the KPIs fell. The dimensions chosen included social capacity, institutional services, ecological-physical conditions, and economic conditions. The results from these dimension indicators were used to determine whether the city is meeting the KPI targets set for each indicator such as energy consumption, residential water use, cost of infrastructure, and the potential for renewable energy. All of these KPIs relate to the economic conditions that were used to check whether the scarce resources are being used in an economical and sustainable way. The landscape index, which is used to measure the landscape index; the urban ecosystem service value, which is measured in monetary terms; and runoff generation, which is used to measure surface runoff and impervious surface ratio, fall under the ecological-physical conditions. Institutional services such as emergency response, fire, police, warning, and reporting systems are important in ensuring that the city is resilient and ready to handle any challenge that comes its way. Social capacity, which entails KPIs such as population density, accessibility to open spaces, understanding risk, adaptive strategy, and land-use mix, looks at how the population is distributed and the various activities they are engaged in.

In a bid to achieve the aim set for the study, the researcher selected five key objectives to direct the study.

1. The first objective relates to the investigation of how climate-responsive knowledge can be translated for the enhancement of the various strategies being pursued by Ajman city in line with the goal of urban resilience. Climate responsiveness was addressed by looking at climate change adaptation.
2. The second was to find out how adapting to climate change affects the quality of life, leading to a resilient Ajman city urban design. Adapting to climate change was also addressed under the sub-heading on climate change adaptation through green infrastructure planning.
3. The third was to come up with urban regulation strategies that Ajman city planners need to consider when taking more sustainable measures for the future.
4. The fourth was to identify what measures and climate adaptation policies need to be acknowledged in Ajman city. This was addressed by looking at how such policies have been handled elsewhere.
5. Finally, the fifth objective was to find out the most adequate urban indicators that should be included in Ajman city's URI. From the discussion, it can be seen that there is no single unifying index that could be used. Instead, a mix of indices can be used together as components of the city's URI.

6.2 Recommendations for Policy Makers

Ajman's Urban Strategic Plan reveals that city planners have been able to translate climate-sensitive knowledge into enhancing strategies for the city. Secondly, climate change adaptation in the city has helped to improve the quality of life by encouraging citizens to responsibly utilise the scarce resources found within the city. Thirdly, the city has also adopted urban regulatory frameworks to ensure that there is compliance, in line with the sustainability policy set for the city. Finally, several KPIs have been suggested for use in coming up with the city's finest URI. The findings of this research confirm that there is no single indicator that has the capacity to capture all the facets of urban resilience, and therefore there was a need for multiple indicators (17 KPIs), as presented in the study. These indicators can be relied upon by the city planners in coming up with urban resilience plans. Each of these KPIs is implemented and monitored using the baselines established, and any variances are interrogated.

Again, policymakers should continue to leverage climate-sensitive knowledge in enhancing strategies for the city. This includes incorporating climate change adaptation measures and promoting responsible resource utilization among citizens. Ajman city should ensure the effective implementation of urban regulatory frameworks that promote sustainability. Compliance with these frameworks will help in maintaining and improving the quality of life for residents while fostering long-term resilience. Continued monitoring and evaluation are highly relevant. Thus, policymakers are inherently obligated to implement robust mechanisms for monitoring and evaluating the implementation of resilience plans. This will enable them to track progress, identify areas for improvement, and make informed decisions on resource allocation and investments.

6.3 Recommendation for City Planners

City planners should leverage climate-sensitive knowledge in enhancing strategies for the city. This includes incorporating climate change adaptation measures and promoting responsible resource utilization among citizens. Ajman city should ensure the effective implementation of urban regulatory frameworks that promote sustainability. Compliance with these frameworks will help in maintaining and improving the quality of life for residents while fostering long-term resilience. Continued monitoring and evaluation are highly relevant. Thus, policymakers are inherently obligated to implement robust mechanisms for monitoring and evaluating the implementation of resilience plans. This will enable them to track progress, identify areas for improvement, and make informed decisions on resource allocation and investments.

6.4 Recommendations for Future Research

As a recommendation for future work, the KPIs in the strategic plan need be updated, in line with the other KPIs that are used to determine the resilience index. This study has revealed that there is potential for future research. The URI can be used as a benchmarking tool for other cities to assess their own resilience, and to compare it with other cities. By adopting the methodology and indicators used in the Ajman city study, other cities can conduct their own assessments and gain a better understanding of their strengths and weaknesses in terms of resilience.

The URI can help cities identify areas where they need to improve their resilience and prioritise investments to address these areas. It can also be used to track progress over time and measure the impact of resilience-building efforts.

In summary, the URI can be adapted and used by other cities to assess their resilience and make informed decisions to enhance this. It can also be used as a benchmarking tool to compare the resilience of cities, and as a resource for national and international organisations focused on promoting sustainable urban development and resilience.

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APPENDICES

Appendix A

State of Art

No.	Author	Research Title	Aim	Country of Research	Main Findings
1.	Abdullah (2017)	Private firms to manage Ajman's waste	The study focuses on developing a green economy to enhance sustainable growth.	UAE	Friendly technology permeates the preservation of health and safety. Implementation of international standards to improve cleanliness.
2.	Abunnasr (2013)	Climate change adaptation: A green infrastructure planning framework for resilient urban regions	The research analyses the different aspects of the green infrastructure organisation framework for climate change resilience in an urban location.	United States	The application of green technology should correspond to each zone. Conservation of forested areas to buffer the existing climate change problems.
3.	Artuch-Garde et al. (2017)	Relationship between resilience and self-regulation: A study of Spanish youth at risk of social exclusion	The report tests the hypothetical relationship between self-regulation and resilience.	Spain	Learning from past mistakes was important towards compiling resilience and tenacity mechanisms. The levels of self-regulation were relative to resilience.
4.	Bhattacherjee (2012)	Social science research: Principles, methods, and practices	The book introduces doctoral and graduate students to scientific research in the social sciences, business, education, public health, and related disciplines.	United States	The book introduced a concept that helps learners think like researchers, and also scientific theories.
5.	Blais (2010)	Perverse cities: Hidden	The book aims to shed light on the	Canada	The market-based approach would be

		subsidies, wonky policy, and urban sprawl	factors that contribute to urban sprawl, and argues that many of the policies and subsidies provided by governments and institutions actually encourage urban sprawl, despite the negative environmental, economic, and social consequences associated with it. Blais suggests that there is a need for more sustainable policies and practices that promote compact, walkable, and transit-oriented development.		suitable to counter the failures in government policies. The presence of hidden costs makes it difficult for decision-makers to make influential policies. The market-based approach is prescriptive than the current regulative methods.
6.	Christina (2017)	LUE User Guide: A tool to calculate the Land Use Efficiency and the SDG 11.3 indicator with the Global Human Settlement Layer	The study calculates the indicators on the change of land in an area of interest.	Luxembourg	Between 2001 and 2014, there was an increase in the LUE indicators in the city. There was an overall increase in the indicators between the years chosen in 1990–2000 and 2000–2014.
7.	The New Climate Economy (2014)	Better growth, better climate: The new climate economy report	The report analyses the significance of important partnerships among nations for better growth and climate.	N/A	The research advocates for the conservation of afforested areas and increased agricultural productivity. The study also identifies the existing dilemma between encouraging industrialisation and environmental conservation.

8.	Childers et al. (2014)	Advancing urban sustainability theory and action: Challenges and opportunities	The article explores the industrial, sanitary, sustainable city transition to include non-sanitary cities.	United States	Urban sustainability should focus on intercity comparisons. Sustainability problems should integrate new approaches relative to modern research.
9.	Figueiredo et al. (2018)	Indicators for resilient cities	The report aims to provide approaches to strengthen and monitor urban resilience through the use of indicators.	N/A	Local authorities should develop practices for urban resilience based on social-economic aspects. Local authorities cannot account for strategies that are tailor-made for their policies.
10.	Folke (2016)	Resilience (republished) ecology and society	The article aims to capture the resilience of social-ecological systems and finding ways for people and institutions to govern social-ecological dynamics for improved human well-being.	Sweden	Resilience thinking should be considered as a sustainability approach. As a sustainability approach, resilience should be combined with social-ecological aspects of the people.
11.	Folke et al. (2016)	Social-ecological resilience and biosphere-based sustainability science	The article identifies the intertwined nature of social-ecological systems and emphasises that they operate within, and as embedded parts of the biosphere.	N/A	Sustainability practices such as health, inequality, power, justice, and human rights are comparable with the biosphere. There are current problems in understanding some of the predictors of the biosphere and the reality of the Anthropocene.
12.	Fu (2018)	Developing an integrated scenario-based urban resilience	The study looks at the application of eco-aesthetics as a theoretical basis for planning urban	China	Eco-aesthetics' approaches are suitable for urban resilience and incorporating new

		planning support system	resilience, with a composite URCI		strategies. Eco-aesthetics' theories could also help planers develop realistic solutions.
13.	Glaeser (2015)	The urban imperative: Towards competitive cities	The book incites the debate on further research between a city's physical entity and its people.	Uganda	Adopt a multidisciplinary approach. An improvement in the urbanised society would help improve the appearance of a large audience. Provide suggestions on changing the economic landscape for urban centres in terms of sustainability and essential features.
14.	Heaphy (2014)	Modelling and translating future urban climate for policy	This thesis looks at the practice of climate modelling at the urban scale concerning projections of future climate.	United Kingdom	The current climate-based assessments are vulnerable because they focus on a quantitative approach to understanding climate change.
15.	Ilgen et al. (2019)	City-to-city learning for urban resilience: The case of water squares in Rotterdam and Mexico City	This paper presents an analysis of how policy-relevant knowledge on the notion of 'Water Squares' is exchanged between Rotterdam and Mexico City.	Netherlands	Learning is significant towards resilience, building an aspect such as academics in bilateral networks should be considered. Diversion of institutional governance could affect the implementation of new ideas.
16.	Kadir (2013)	Universal design is a significant component of sustainable life and social development	The purpose of this conceptual study is to explore the concept of universal designs as a significant aspect of social sustainability, based on professional	Malaysia	Universal designs form a significant component of sustainable development due to the roles they play in an individual's living space. Social aspects of sustainability should be considered

			practitioners' and scholarly views.		in social communications spaces; they form an important aspect of human behaviour.
17.	Leitner et al. (2018)	Globalising urban resilience	The paper analyses, develops and circulates urban resilience assessment tools, and creates a market catalysed by the notion of a resilience dividend.	United States	Philanthropic organisations such as the Rockefeller Foundation form an urban complex to resilience, which influences the global scale.
18.	Lenton (2016)	Earth system science: A very short introduction	The text provides a short introduction to the Earth's biosphere, ocean, rocks, and systems that interact.	United Kingdom	Human activities influence the Earth system science because their activities are unconscious of the Earth's setup. The book proposes the need for self-regulation as it helps to maintain habitable conditions.
19.	Luomi et al. (2019)	Arab Region SDG Index and Dashboards Report 2019	The report provides a conversation opener about priority areas, policies, and actions.	UAE	The region exhibits sustainable development outcomes related to gender equality and food production. The region has maintained momentum for positive development.
20.	Meerow et al. (2016)	Defining urban resilience: A review	This paper reviews the scholarly literature on urban resilience and concludes that the term is not well explored.	United States	The presence of six conceptual tensions alters the meaning of urban resilience. Urban resilience encompasses the aspects of the person benefiting from the strategies and the plan.

21.	Nop & Thompton (2019)	Urban resilience-building in modern development	The paper analyses the current climate-related hazards and their impacts on urban livelihoods in selected urban communities in the city of Phnom Penh.	Cambodia	Urban approaches to modernisation have little effect on the lives of the poor. Risk related to climate change is steadily increasing and affecting sustainable development.
22.	OECD (2013)	Urbanisation and urban forms, OECD regions briefly	OECD research shows that underperforming regions can become competitive, given the right mix of policies and coordinated efforts across all levels of government.	N/A	39% of employment growth and 42% of GDP rise in OECD countries were accounted for by just 10% of regions. Spending by OECD authorities constituted 17% of GDP, 40% of public costs, and 72% of investments.
23.	Oriangi et al. (2019)	Testing the proposed Municipality Resilience Index to climate change shocks and stresses in Mbale Municipality in Eastern Uganda	This study proposed and tested a Municipality Resilience Index (MRI), which employed a subjective method to assess the resilience of Mbale Municipality in Eastern Uganda against climate change shocks and stresses.	Uganda	The findings indicate the spatial change in resilience scopes within the geographic location. The findings depict the negative and positive impacts of the proposed MRI.
24.	Rosenzweig (2015)	ARC3.2 Summaries for city leaders climate change and cities: Second assessment report of the Urban Climate Change Research Network	The paper sections lay out what cities need to achieve their potential as leaders of climate change solutions.	United States	There is a projected increase in climatic extremes such as heatwaves, droughts, and coastal flooding in the locations. Currently, urbanisation is intertwined with elevated conditions known as heat islands.

25.	Sachs et al. (2019)	Sustainable development report	The report describes the universal agenda that applies to and must be implemented by all countries. Sound metrics and data are critical for turning the SDGs into practical tools for problem-solving.	N/A	The lack of political commitment in the regions is affecting the proposals set for sustainable development in agriculture and health policies. High-income regions produce relative environmental and socio-economic spillover effects
26.	Sharifi and Yamagata (2016a)	Principles and criteria for assessing urban energy resilience: A literature review	This paper reviews the literature associated with energy resilience to develop a conceptual framework for assessing urban energy resilience, identifying planning and design criteria that can be used for assessing urban energy resilience.	Japan	An investigation between the elements of the resilience framework revealed that decision-making relative to one component affected the other, and could be positive indicators that drive the elimination of CO_2 from the environment.
27.	Sharifi and Yamagata (2016b)	Urban resilience assessment: Multiple dimensions, criteria, and indicators	The report analyses extensive literature on urban resilience. The report also assesses and provides a set of principles, and indicators for developing an urban resilience assessment too.	Japan	Appropriate resource protection and management practices should be adopted to achieve resilience. Respecting local cultures is important towards comprehending some of the practices that enhance the adaptation of resilience.
28.	Suárez et al. (2016)	Towards an urban resilience index: A case study in 50 Spanish cities	The report develops a methodological framework to measure urban resilience, define the URI, and apply it to Spanish	Spain	The findings indicate that cities are far from achieving resilience, as most of the practices are centred on urban locations.

			provincial capitals as a case study.		Initiatives such as minimising resource utilisation and allowing local trade were influential in building resilience in some of the regions.
29.	UAE National Committee on SDGs (2017)	UAE and the the Sustainable Development Agenda 2030: Excellence in implementation	This annual report details the efforts of the National Committee in its first full year as a steward of the SDGs in the UAE.	UAE	The regions have changed their perspective on human rights, hence permeating the preservation of basic rights. The Zero Carbon initiative is one of the suitable development initiatives that assist the people to work together for sustainability by reducing carbon emissions and promoting the use of clean energy sources.
30.	Environment 2016	UAE State of Green Economy Report	The report aims to help the country make advancements towards a green economy, which is defined by the United Nations Environment Programme.	UAE	Both indicators for the study showed a significant improvement from the previous years.
31.	UN-Habitat (2014)	Construction of more equitable cities	After comparing the trends for inequalities, the study determined the factors that caused them. This book teaches about the establishment of a new governance paradigm that coordinates efforts and strengthens formal coordination	N/A	Local governments and authorities could implement policies to minimise the existing disparities. The impacts of existing disparities remain anonymous in some of the regions such as violence, crime, stress, social problems, and the loss of social cohesion.

			mechanisms to eliminate inequalities.		Social-economic well-being, such as income per capita, has significantly grown.
32.	UN-Habitat (2018)	Tracking progress towards inclusive, safe, resilient, and sustainable cities and human settlements	The paper monitors universal and transformative goals and targets, and commits to working tirelessly for their full implementation	N/A	At local levels, cities should collect information on safety and for the construction of public spaces. Cities should enhance their reporting on safer city's safety in public spaces.
33.	Zheng et al. (2018)	Development as adaptation: Framing and measuring urban resilience in Beijing	The study analyses the megacity of Beijing as an example and conducts mixed-methods research to explore the linkage between resilience and development.	China	There are different motivators for resilience. For example, urban generic depends on the social-economic well-being, while climatic conditions are relative to environmental factors. It is critical to explore the relationship between resilience and geographic factors other than the economic condition.

Appendix B

Data Collection Tool-interviews

Data collection tool for interviews aimed at gathering information on urban planning and climate change resilience in Ajman city:

Interview Questions on Urban Planning and Climate Change Resilience

Can you briefly introduce yourself and your role in urban planning and climate change resilience efforts in Ajman city?

How would you describe the current state of urban planning in Ajman, especially in relation to climate change resilience?

What are the key challenges or issues that Ajman city is facing concerning climate change and urban resilience?

Are there any ongoing or planned initiatives or projects related to climate change resilience in Ajman? If so, could you provide some details?

In your opinion, what are the most critical urban resilience indicators that should be considered for Ajman city?

How do you envision the future of urban planning in Ajman in the context of climate change and resilience? What goals or objectives should be prioritized?

Are there any successful case studies or best practices from other cities that Ajman can learn from in terms of climate change resilience and urban planning?

What role do you see data and research playing in improving urban resilience strategies for Ajman city?

How can the community and stakeholders be actively involved in the process of enhancing climate change resilience in Ajman?

Lastly, do you have any additional insights or recommendations regarding urban planning and climate change resilience that you would like to share?

Thank you for your participation in this interview. Your input is highly valuable to our research efforts.

Appendix C

Consent Letter

[Your Name]

[Your Title]

[Your organization]

[Date]

[Recipient's Name]

[Recipient's Title]

[Recipient's Organization]

Subject: Request for Consent to Participate in Research Study

Dear [Recipient's Name],

I hope this letter finds you well. I am writing to seek your consent for participation in my research study titled "Urban Resilience Index for Ajman City." Your valuable input and expertise in the field of urban resilience and sustainability are crucial for the success of this research.

The purpose of this study is to develop a comprehensive assessment framework for measuring the urban resilience of Ajman City, with a focus on its response to climate change and sustainability. Your knowledge and insights in this area will contribute significantly to the research objectives.

I want to assure you that all information collected during the study will be kept confidential and used for research purposes only. Your name and affiliation will not be disclosed in any publications or reports arising from this research. You have the right to withdraw your consent at any time during the study without any repercussions.

Your contribution to this research will greatly enhance our understanding of urban resilience in Ajman City and help in the development of strategies to enhance sustainability and resilience in the region.

If you agree to participate, please sign the attached Consent Form and return it to me at your earliest convenience. If you have any questions or require further information about the study, please do not hesitate to contact me at [your contact information].

Thank you for considering participation in this research. Your expertise and insights are highly valued, and your participation will be instrumental in advancing the field of urban resilience.

Sincerely,

[Your Name]