Resilience of Cities in the Face of Disaster Risks as a Pathway to Achieving Sustainability: A Study Using the United Nations Scorecard in city Mohammedia, Morocco

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Abstract. The city's ability to be resilient and withstand dangers, especially natural hazards, is one of the most important features of sustainable development in this era. The United Nations recognized this in the preparatory committee for the conference on housing and sustainable urban development. In 2015, within the Sendai Framework, resilience was defined as the capacity of a system, community, or group exposed to hazards to resist, absorb, adapt to, transform, and recover from them efficiently and in a timely manner. This includes preserving essential structures, functions, and material entities. The resilience measurement card is a tool used to assess a city's resilience and its capacity to withstand hazards. It also helps local authorities monitor progress and challenges in implementing the Sendai Framework for Disaster Risk Reduction. Furthermore, it assists in developing local strategies for disaster risk reduction. The resilience measurement card was applied to the city of Mohammedia in Morocco to measure the city's resilience in the face of potential hazards, particularly natural ones. Mohammedia faces various natural hazards, making it important to assess its capacity to understand and address disaster risks. This card was developed through consultations and discussions with stakeholders and actors in the city, each contributing their expertise. It also involved reviewing documents, projects, and measures that align with the measurement indicators. The gathered responses, conclusions, and findings were then compiled to answer the 47 indicators in the measurement card, which evaluate the ten foundations of a city's resilience capacity.

Keywords: Mohammedia City; Resilience; Risk; Disaster Resilience Scorecard; UN.

1 Introduction

The term "resilient city" is one of the modern concepts that has emerged in urban planning and organization, particularly in the face of increasing disasters, both natural and technological, as well as acts of terrorism and the impact on economic systems, among other factors, which have affected many cities. Therefore, it has become necessary to direct urban development pathways in order to build the concept of resilience and the ability to withstand challenges. Cities with these characteristics are capable of facing challenges and minimizing damage in the event of a disaster. Given the importance of these features in cities today, especially with their high population concentrations, a disaster in a city can affect a large number of residents due to interconnectedness and resource sharing, making them vulnerable to high levels of human and economic losses in the event of a disaster. Hence, the concept of a resilient city represents a new way of thinking to achieve sustainable development goals for cities in light of current changes and unexpected crises. Most Arab cities, in general, lack the necessary urban resilience mechanisms to cope with shocks and pressures, whether they are currently experiencing them or potential ones in the future. This hinders the ability of urban systems to effectively respond, adapt, and grow in the face of pressures and shocks. Therefore, the importance of this study lies in deriving a set of recommendations and proposals for decision-makers and city officials to work on the indicators identified in the study. These indicators can enhance the city's resilience and capacity to withstand risks, aiming to avoid danger or at least minimize the damage, Especially the city of Mohammedia it contains the causes of natural or technological hazards[1].

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[1] Jadouane, A., Chaouki, A. (2022). Simulation of the Flood of El Maleh River by GIS in the City of Mohammedia-Morocco. Lecture Notes in Civil Engineering, vol 178. Springer, Singapore. https://doi.org/10.1007/978-981-16-5501-2_8

1.1 Definition of resilience

The word "resilience" indeed has its roots in the Latin word "RESILIO," which means rebound[2]. In Arabic, it has various synonyms such as "ALLYONA" and "ALROJOIAA." It is defined in Arabic dictionaries as follows: "MOROUNA" (noun) is derived from the source "MARIN", and in the context of nature and physics, it refers to the ability of a body to change its shape and size after the removal of the cause of the change. It can also refer to the flexibility or elasticity of a body, such as the resilience of wood and metal. When referring to a person's body, it means agility, ease of movement, and flexibility. Resilience has a limit that must be observed, and in the field of nature and physics, it refers to the maximum stress a resilient body can withstand without resulting in a permanent change in its shape[3].

The definitions in Western dictionaries are quite similar, and here are some examples:

- Cambridge Dictionary: Resilience is the ability to quickly return to the usual shape after bending, stretching, or compressing[4].
- Merriam-Webster Dictionary: Resilience is the inclination to recover and adapt easily in the face of misfortune or change[5].
- Collins Dictionary: Something that is resilient is strong and not easily damaged by injury, stretching, or pressure, and it can quickly and easily recover from harmful events[6].

As a term, "resilience" first appeared theoretically in the field of environmental studies before transitioning to other specialized fields such as urban studies, planning, and urban design. In the environmental context, it initially implied the fundamental capacity of an ecosystem to maintain and adapt to environmental changes, human exploitation of its resources, and the preservation of the regenerative systems of the ecological system[7]. Resilience was described as a city's ability to absorb disturbances while preserving its essential functions and infrastructure. This definition is an evolved and similar concept to ecological resilience[8]. In essence, resilience, in this broader sense, refers to the ability of systems, whether natural or human-made, to withstand and adapt to various stresses, disturbances, and changes while maintaining their core functions and structures. This concept has gained significance in various fields, including urban planning and design, as it emphasizes the importance of building cities and systems that can effectively respond to unexpected challenges and crises. The term "resilience" in the context of cities focuses on the ability to withstand and bounce back from all kinds of acute shocks, whether they are natural or human-made. These shocks can include floods, earthquakes, hurricanes, forest fires, hazardous material spills, power outages, and more. Additionally, it encompasses chronic pressures that occur over longer time periods, such as groundwater depletion, deforestation, social and economic issues like homelessness and unemployment.

In the framework of the United Nations' "Sendai Framework for Disaster Risk Reduction," a "resilient city" refers to a city that assesses, plans, and works on preparedness and response to all types of risks, whether they are sudden or gradual, expected or unexpected[9]. This definition underscores the importance of cities being proactive and adaptable in the face of various risks and challenges to ensure the safety and well-being of their residents.

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[2] Klein, R. J. T., Nicholls, R. J., (2003). "Resilience to natural hazards: How useful is this concept?" Environmental Hazards, 5(1), https://doi.org/10.1016/j.hazards.2004.02.001

[3] Shadi Raba, Hussein Dridi, Definition and Meaning of resilience in the Comprehensive Dictionary of Meanings.

[4] Dictionary cambridge Meaning of resilient , https://dictionary.cambridge.org

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[8] Holling, C. S. (2001). "Understanding the Complexity of Economic, Ecological, and Social Systems. Ecosystems", 4(5), 390–405. https://doi:10.1007/s10021-001-0101-5

[9] United Nations Office for Disaster Risk Reduction (2017) "Empowering Resilient Cities Local Government Leaders Guide", contribution to the global campaign My City Gears Up 2010-2020, Geneva-Switzerland.

According to various definitions, resilient cities are cities that possess a set of characteristics and strategies that enable them to absorb, accommodate, and adapt to environmental, social, and economic disruptions and challenges. These definitions emphasize the city's ability to withstand a wide range of shocks, stresses, and pressures. Here are some key aspects of these definitions:

1. **World Bank Definition:** Resilient cities, according to the World Bank, are cities that have the capacity to absorb, adapt to, and prepare for future disruptions economically, environmentally, socially, and institutionally. This capacity is seen as promoting sustainable development, well-being, and comprehensive growth[10].
2. **OECD (Organization for Economic Co-operation and Development) Definition:** OECD defines resilient cities as cities with the ability to absorb future shocks and prepare for them economically, environmentally, socially, and institutionally. The goal is to enhance sustainable development and overall well-being[11].
3. **Researcher's Definition:** One specialized researcher defines urban resilience as the ability of a city or urban system to withstand a wide range of shocks, stresses, and pressures. This definition emphasizes the city's capacity to resist, absorb, adapt to, transform, and recover from hazards while preserving its essential functions and physical entities[12].

In essence, these definitions all converge around the concept of a city's ability to withstand and recover from various risks and challenges. Resilience has become a critical aspect of sustainable development in today's world, acknowledged by the United Nations and integrated into discussions related to housing and sustainable urban development. It emphasizes the importance of communities, systems, and cities being able to effectively respond to, recover from, and adapt to various hazards while maintaining their essential functions and structures[13].

2 Characteristics of a resilient city

There are many pillars that guide cities towards achieving comprehensive resilience, including environmental, economic, social, political, institutional, and urban resilience. This was indicated by the Third United Nations World Conference on Disaster Risk Reduction regarding a set of supports that assist cities in becoming more resilient towards environmental, social, economic, and political determinants. In 2015, the United Nations provided support for implementing the Sendai Framework for Disaster Risk Reduction, alongside participation from a group of more than 100 cities. The ten essentials for empowering cities to become resilient were adopted as a first step to measure the application of resilience in these cities, with a commitment from participating governments to follow these ten essentials as a second step in their dissemination to other countries[14].

The ten essentials for empowering cities to build resilience provide extensive coverage of the various issues that cities need to address to become more resilient. Essentials 1 to 3 cover governance and financial capacity, while essentials 4 to 8 cover disaster planning and preparedness. Essentials 9 to 10 focus on disaster response and recovery, as illustrated in the following table[15]:

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[10] Bank, W. World Bank Database, 2011, Available from http://data.worldbank.org

[11] https://www.oecd.org/dac/conflict-fragility-resilience/risk-resilience/

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[15] UNISDR, 2017. How To Make Cities More Resilient. A Handbook for Local Government Leaders. P.32

Table 1. The Ten Essentials for Making Cities Resilient.

	Essentials for Making Cities Resilient
1	Organize for disaster resilience.
2	Identify, understand, and use current and future risk scenarios.
3	Strengthen financial capacity for resilience
4	Pursue resilient urban development and design.
5	Safeguard natural buffers to enhance the protective functions offered by natural ecosystems.
6	Strengthen institutional capacity for resilience
7	Understand and strengthen societal capacity for resilience.
8	Increase infrastructure resilience.
9	Ensure effective preparedness and disaster response.
10	Expedite recovery and build back better.

UNISDR, 2017. How To Make Cities More Resilient. A Handbook for Local Government Leaders. P.32

The ten essentials for empowering cities to build resilience aim to achieve cities' ability to withstand disasters and crises. Each of these essentials ensures that the city possesses the following characteristics:

1. Strong leadership, clear coordination, and well-defined responsibilities, including effective stakeholder engagement, policy formulation, task distribution, efficient communication channels, and effective management mechanisms.
2. Modern knowledge about risks, including routine risk assessments that form the basis for urban planning and long-term development decisions, as well as current and future investment decisions that contribute to resilience.
3. Adequate financial planning that complements and supports mechanisms for enhancing resilience activities.
4. Urban planning based on up-to-date risk-related information, with a focus on areas and groups most vulnerable to damage. It also involves the application and enforcement of realistic and hazard-resistant building regulations to effectively mitigate physical risks.
5. Identification and monitoring of natural ecosystems within and around the city to preserve their protective characteristics as natural barriers.
6. Support for all institutions related to urban resilience to provide them with the necessary capabilities to fulfill their roles.
7. Social cohesion and a culture of mutual assistance through community engagement, education, and media communication channels.
8. Strategies for protecting and upgrading critical infrastructure to ensure the continuity of services and increase resilience against hazards and climate change impacts.
9. Emphasis on effective disaster response through the development and regular updating of preparedness plans, integration with early warning systems, and capacity-building related to emergency management through preparedness exercises.
10. Alignment of post-disaster reconstruction, rehabilitation, and recovery strategies with long-term planning, aiming to create a better environment for the city after the disaster events.

3 Measuring Urban Resilience

The measurement card for urban resilience is designed based on the Ten Essentials for Empowering Cities to Build Resilience, initially developed as part of the Hyogo Framework for Action in 2005 and later updated to support the implementation of the Sendai Framework for Disaster Risk Reduction for the period 2015-2030. The goal of creating the measurement card for urban resilience is to assist local authorities by monitoring the progress made and the challenges faced in implementing the Sendai Framework for Disaster Risk Reduction. Additionally, it helps in developing local strategies to reduce disaster risks. It's worth noting that Morocco is actively engaged in this framework and has achieved significant results in reducing disaster risks[16]. This measurement card consists

[16] Standards & Regulations for Urban Resilience Program (2020), "Safe and Sustainable Buildings to Strengthen Urban Resilience", Evaluation of the Moroccan Regulatory Framework for Risk Prevention in Land

of indicators derived from the Ten Essentials, providing a set of assessments to help decision-makers monitor and review the progress and challenges facing cities. It comes in two different types based on the desired results[17]:

1. The first type is a primary level measurement that aligns with the main goals and indicators of the Sendai Framework, along with some critical sub-issues. It includes 26 indicators organized into four major axes, as illustrated in the following table.
2. The second type is a detailed evaluation measurement, which is somewhat more in-depth compared to the primary measurement. It is intended for stakeholders and decision-makers and forms the basis for creating a detailed plan for urban resilience. It includes 117 indicator standards, each categorized into five major axes.

These measurement tools provide valuable insights and data for cities to enhance their resilience and better prepare for disaster risks.

Table 2. Evaluation indicators to measure the resilience of cities "initial level".

Essentials for Making Cities Resilient		Measurement Indicators
1	Organize for disaster resilience.	1. Developing a Strategic Plan to Mitigate Risks for the Purpose of Ensuring the Protection of Development Goals. 2. Ensuring that the city has the authority and necessary resources to meet local needs for risk mitigation. 3. Developing a mechanism to allocate resources according to priority for effectiveness in reducing risks identified by local assessments.
2	Identify, understand, and use current and future risk scenarios.	4. Conduct a technical analysis to identify current and future threats and hazards. 5. Incorporate information related to exposure to risks and vulnerability into long-term city planning. 6. Learn from the experiences of cities that have a similar risk profile.
3	Strengthen financial capacity for resilience	7. Prepare a financial plan and appropriate procedures and allocate resources to enable capacity-building activities for resilience. 8. Ensure the availability of suitable financial support mechanisms to address risks. 9. Establish a specific budget, provide necessary resources, and make arrangements for the Emergency Risk Reduction Fund.
4	Pursue resilient urban development and design.	10. Regularly update urban plans with the latest information related to risks. 11. Incorporate any cross-cutting issues related to building urban resilience in urban plans. 12. Ensure the existence of mechanisms and processes for urban planning that take into account risks. 13. Regulate, develop, update, and implement building laws and standards as they relate to relevant hazards and the impacts of climate change.
5	Safeguard natural buffers to enhance the protective functions offered by natural ecosystems.	14. Protecting and preserving environmental systems to adapt to current and future risks and mitigate their impacts. 15. Developing solutions to address current and future environmental risks through nature-based or environmental protection solutions.
6	Strengthen institutional capacity for resilience	16. Enhancing the knowledge and skills of common stakeholders in building resilience to disasters.

		17. Leveraging the capabilities of the private sector and civil society in reducing disaster risks.
7	Understand and strengthen societal capacity for resilience.	18. Providing social support to the most vulnerable individuals. 19. Strengthening social cohesion and fostering community participation. 20. Promoting a culture of disaster risk reduction in educational programs and other awareness initiatives, along with providing training for it.
8	Increase infrastructure resilience.	21. Developing an infrastructure plan or strategy and implementing it to protect critical infrastructure, facilities, and essential services. 22. Ensuring the existence of resilient infrastructure to mitigate risks and maintain its upkeep.
9	Ensure effective preparedness and disaster response.	23. Preserving a disaster management plan to mitigate the impact of local emergencies, preparedness for them, and response to them. 24. Taking crisis arrangements for the continuity of vital functions in emergency situations.
10	Expedite recovery and build back better.	25. Completing post-event assessments to analyze failures and capabilities, and documenting the lessons learned for incorporation into recovery and reconstruction processes. 26. Developing strategies for recovery and reconstruction after disasters, including the essential societal and economic aspects required to restore services.

Disaster Resilience Scorecard For Cities, Preliminary Level Assessment ,UNISDR 2017

3 Work Methodology

The preliminary measurement tool was applied to the city of Mohammedia to assess the city's resilience in the face of potential risks. This was done following consultations and exchanging opinions with stakeholders and actors in the city, each according to their expertise, by conducting interviews with them. Additionally, documents, projects, and measures that intersected with the standard indicators were reviewed. Subsequently, the responses, conclusions, and findings were gathered to address the indicators present in the measurement card, which consists of 47 indicators, as illustrated in the 47 responses that make up the assessment of the ten foundations of the city's resilience, as outlined in the final report in Figure 1. (The resilience measurement card for cities was developed by the United Nations Office for Disaster Risk Reduction (UNISDR), with support from USAID, the European Commission, IBM, and AECO, to support the preparation of national reports for the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030.

This card covers the cities' ability to understand disaster risks that they may face in order to mitigate and respond to potential disasters, thus reducing direct and long-term losses, including the number of fatalities, preserving livelihoods, infrastructure, economic activities, and the environment, among others. It should be noted that chronic pressures can affect the likelihood and severity of acute shocks, as illustrated in the following figure.
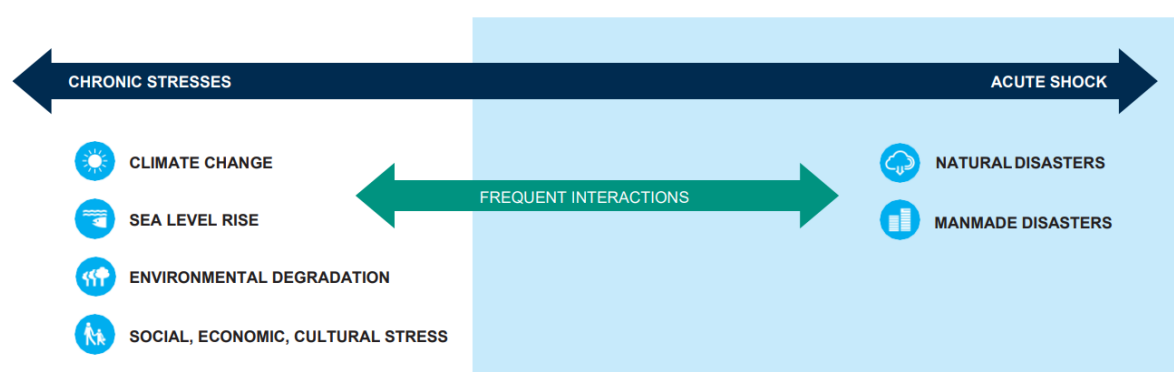

Figure 1. Scope Of The Scorecard, (UNISDR 2017)

4 Results

The final results obtained by the city of Mohammedia in terms of measuring resilience are based on official statistical data for the year 2014. The General Census of Population and Housing for the year 2014 for the city of Mohammedia was used as the main source of data and figures for the performance card. Based on the answers and conclusions reached through interviews, the city of Mohammedia achieved a score **45/141**.

The result 45/141 cannot be considered as either good or bad in general terms because the objective of the City Resilience Measurement Tool is to monitor the progress made by cities in implementing disaster risk reduction projects and programs, as well as to identify weaknesses and challenges in implementing the Sendai Framework. It also aims to help develop local strategies for cities by extracting plans for implementing resilience-enhancing projects.

The next steps after conducting this assessment involve identifying the weaknesses highlighted in the report and working on them. Over time, this card is updated to evaluate the progress made. The question becomes whether the resilience rate has increased or decreased.

It's worth mentioning that the city of Mohammedia has begun to participate in the campaign for resilient cities. It took part in the regional conference on urban resilience in the Middle East and North Africa in 2019[18] and engaged in several consultations and meetings with representatives from the World Bank to frame and finance various programs in Mohammedia aimed at reducing disaster risks in the city.

By comparing Mohammedia result with several other cities that used the same performance card, we can see that the scores differ. However, this doesn't reflect the degree of resilience because risks vary from one place to another, and each city has its unique characteristics. For example, Amman scored 141/77, and Khartoum scored 141/61, indicating that the risks in these cities are real and affect them. Therefore, efforts have been made to strengthen the foundations to address them, particularly in the areas of enhancing resilience-related infrastructure and effective response to mitigate their impact. It's important to note that most of these projects and programs receive external funding[19].
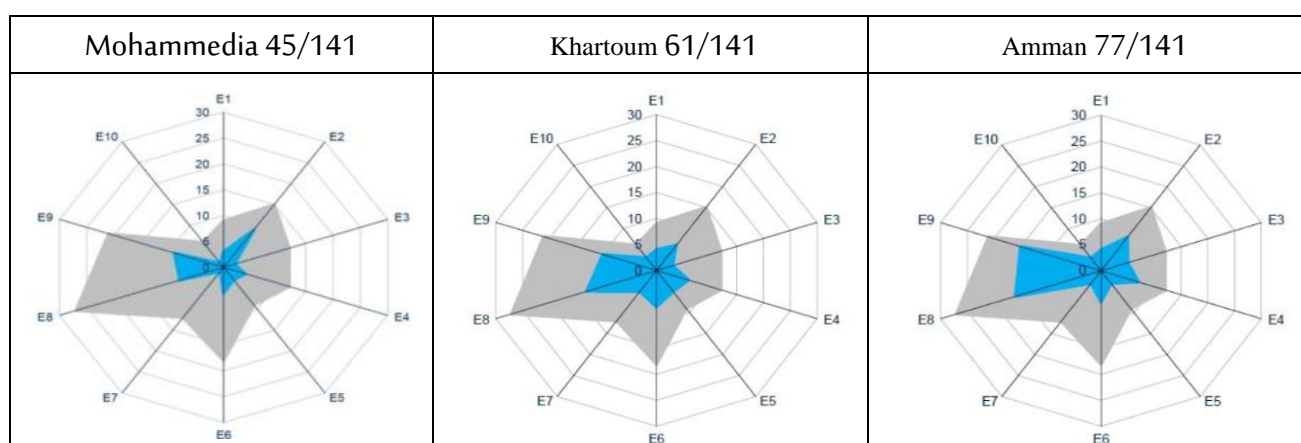

Figure 1. The resilience performance scorecard results for both Amman and Khartoum in the year 2017.

Due to the specificities of Arab countries and the interplay of influence and impact among them in the event of risks, stemming from social, geographical, political, natural, economic, and climatic interconnections, ideal objectives have been formulated through the aforementioned indicators (represented in gray) with the aim of enhancing the resilience of the Arab region. These objectives seek to mitigate the impact of interdependence among countries and cities, especially concerning the pressures imposed by migration, urbanization, political instability, climate change, and armed conflict.

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[18]Conference Proceedings: Regional Conference on Urban Resilience in the Middle East and North Africa, April 4-6, 2019, Beirut, Lebanon.

[19] Eltinay, Nuha. (2019). **"City-to-city exchange: redefining "resilience"** in the Arab region". International Journal of Disaster Resilience in the Built Environment, 10(4), 222–238. https://doi:10.1108/ijdrbe-05-2019-0028

Table 2. Results of the evaluation of the scorecard for the city of Mohammedia with the most important observations.

	Essentials for Making Cities Resilient	Assessment Points	Observations
1	Organize for disaster resilience.	3/9	The complete absence or lack of clarity in disaster risk reduction plans and strategies within the city's management methodologies hinders the effective implementation of the Sendai Framework. This, in turn, jeopardizes the city's preparedness for resilience.
2	Identify, understand, and use current and future risk scenarios.	9/15	There is a general understanding of potential risks to the city among various stakeholders, but there is no agreed-upon plan for updating information and developing scientific scenarios for the entire city.
3	Strengthen financial capacity for resilience	2/12	The budget allocated for disasters is often enhanced effectively in the aftermath of risks. However, having a protected and pre-allocated budget for disasters outside of emergencies lacks a clear plan in this regard.
4	Pursue resilient urban development and design.	4/12	In terms of land use zoning based on risks, it takes into account risk conditions and contributes to their mitigation. However, it may lack depth in terms of construction standards and may not be based on resilience principles.
5	Safeguard natural buffers to enhance the protective functions offered by natural ecosystems.	3/9	Awareness and understanding of the functions of natural capital in the city are not comprehensive, and they are often limited, especially in the context of green spaces within the urban area and infrastructure projects.
6	Strengthen institutional capacity for resilience	5/18	There is a lack of training and exchange of useful information among institutions regarding risks, despite the city having the skills and expertise to respond to disaster scenarios, with the potential to benefit from neighboring cities' experiences and knowledge.
7	Understand and strengthen societal capacity for resilience.	1/12	Civil society participation is very limited and seasonal, and it does not deeply and practically understand the concept of disasters, often addressing them as environmental risks. This limited participation affects residents' involvement in disaster risk reduction efforts, which tends to be weak or non-existent.
8	Increase infrastructure resilience.	8/27	A significant part of the city is not protected from known hazards, although some critical infrastructure types have an understanding of risks. This situation could lead to a loss of energy sources and some services, especially healthcare services, as some service infrastructure does not meet the needs of the population in terms of quantity and quality.

9	Ensure effective preparedness and disaster response.	9/21	The city has an emergency operations center equipped with communication capabilities designed to handle the most severe scenarios. However, there is an issue with routine simulation, and the training on how to use it is not clear with partners.
10	Expedite recovery and build back better.	1/6	There is no comprehensive recovery and rebuilding plan in place for the economic and social aspects following a disaster, except for the presence of a national property insurance system, which is not locally based. Some lessons have been learned, but not in a systematic and in-depth manner to ensure effective utilization.

5 Conclusion and Recommendations

In this chapter, we have explored a new concept that is increasingly discussed today, which relies on assessing cities' readiness to cope with shocks, crises, and disasters. This concept can be quantified using various indicators that cover all organizational, legal, financial, and social aspects, enabling cities to enhance their resilience. The positive aspect is Morocco's overall engagement and the specific involvement of the city of Mohammedia in the global context of resilient cities. Although they are at the beginning of this journey, they seek to learn from other cities, especially those facing similar risks, and benefit from their experiences. This is further supported by financial and technical assistance. Some important areas that require improvement and can be considered recommendations based on the findings of this study include:

1. **Utilize the Results of the Ten Essentials**: The city of Mohammedia should utilize the results of the ten essentials assessment conducted in this study as a foundation for future planning. It is crucial to address the identified weaknesses by providing the necessary financial and human resources to strengthen the city's resilience.
2. **Engagement of Local Authorities**: Local authorities, especially the municipal council, need to be actively engaged in disaster risk reduction initiatives. This includes incorporating disaster risk reduction into their action plans.
3. **Conduct Regular Disaster Drills**: The city should regularly conduct disaster drills and simulations to ensure effective coordination and use of resources. These exercises should involve all stakeholders, including residents and civil society.
4. **Public Awareness and Education**: Public awareness and education campaigns should be created, focusing on disaster knowledge and preparedness. This should target all age groups, with an emphasis on those living in high-risk areas.
5. **Incorporate Disaster Risk Reduction in Education**: Disaster risk reduction should be integrated into educational curricula at all levels. This will help raise awareness and build a culture of resilience from a young age.
6. **Government Investment**: The government should allocate resources to support disaster risk reduction activities. Adequate funding should be provided for these initiatives, especially those related to infrastructure and public safety.
7. **Partnerships**: Encourage partnerships with local and international private sectors and organizations experienced in disaster risk reduction. Leveraging their expertise and resources can enhance the city's resilience.
8. **Insurance Against Disasters**: Encourage individuals, especially those in natural disaster-prone areas, to adopt disaster insurance policies to aid recovery after disasters.
9. **Communication and Early Warning Systems**: Strengthen communication and early warning systems by utilizing information technology, websites, mobile apps, and social media. This will help build trust and ensure residents receive timely information during emergencies.
10. **Community Involvement**: Promote community involvement in disaster risk reduction. Engage residents in identifying and mitigating risks, and empower them to take an active role in enhancing the city's resilience.

By implementing these recommendations, the city of Mohammedia can work towards becoming more resilient and better prepared to face future disasters and crises. It should also continue to learn from other cities and share its experiences to contribute to the global effort of building resilient urban areas.

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