

"A methodology for assessing to what extent are resilient cities facing and adapting to risks"

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Abstract: Cities are complex systems in constant confrontation with dangers, due to the many dangers that cities are exposed to, the most important of which are: Economic (lack of resources), risks and natural disasters, where natural disasters are among the most severe types of risks to which the globe is exposed, climate change and its natural threats, human risks and disruption of ecosystems. These factors all bring about drastic changes in the city, urban components and fixed assets. Natural phenomena are considered one of the most important dangers and challenges facing the human race throughout its history. Many societies in the Arab countries have suffered and are still suffering from the occurrence of these phenomena and the resulting serious social, economic and psychological effects. Recent years have seen an increasing convergence between disaster risk reduction and climate change adaptation, but they have not fully overlapped. In general, disaster risk reduction addresses all risks, while climate change adaptation addresses risks associated with climate changes. Resilience is the ability of a system, entity, society or person to withstand shocks while maintaining its basic functions. It is the ability to recover quickly, effectively and with greater strength from disasters and the ability to withstand greater stress. The research concludes with extracting the evaluation methodology for the risks faced by cities through a set of dimensions, indicators and criteria for resilient sustainable development, and extracting the extent to which the city achieves the elements of sustainable resilience.

Keywords: natural hazards, human hazards, climate change risks, resilient cities, urban, ecological and engineering resilience, characteristics of resilient cities, resilient urban design, resilience and sustainability, dimensions, indicators and criteria of resilient sustainable development

1.Introduction

Disasters have caused significant unrest in both low- and middle-income countries, rapidly eliminating populations and increasing disasters in developing countries. Earthquakes include in (early 2010), more than 220,000 people killed, and in Indonesia (2009) more than 1,000 killed. Cyclone Nargis in Myanmar (2008), which killed more than 138,000 people and the Sichuan earthquake in China (2008) (1), which killed more than 87,000 people. Finally, the earthquake in Syria and Turkey (2023), which killed 22,000 people and left tens of thousands injured, and its effects spread to millions of people in the two countries. On average, about 82,000 people are killed annually due to disasters, with most deaths concentrated in low- and middle-income countries (2).

2.Causes of risks in the urban environment

1-Increasing urban population density, which increases pressure on land and services, and in areas exposed to dangers.

2- Concentration of resources and capacities at the national level, lack of clear mandates for disaster risk reduction and response.

3- Non-participation in local governance by local stakeholders in urban planning and management.

4-Inefficient management of water resources, sewage networks, and solid waste management.

5-The deterioration of environmental systems as a result of human activities such as: road construction and wetland reclamation, which threatens the ability to provide basic services.

6-Dilapidated infrastructure and unsafe building materials, which may lead to the collapse of buildings.

7-Uncoordinated emergency services, which reduces rapid response capacity and preparedness.

8-The harmful effects of climate change that may lead to a rise or fall in temperature, and an increase or decrease in precipitation, depending on local conditions.



Fig-1: The city of Jakarta blocked drainage channels leading to floods

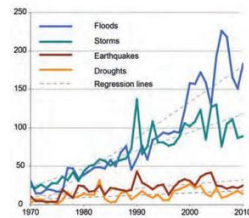


Fig-2: Number of disasters recorded worldwide.

3- Risks of the urban environment

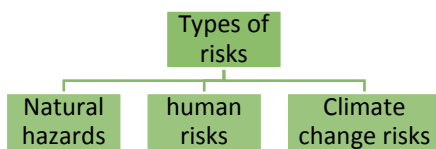


Fig-3: Types of risks

3-1- Definition of risks:

Risks are the events that occur in the environment as a result of natural or human factors or climatic changes that result in human and material losses, some of which are very dangerous, medium, weak or low risk, and some of them directly or indirectly affect lives and property and some have no effect.

3-2-Risk classifications:

- 1- A classification according to the factors causing the occurrence of natural hazards.
- 2- A Classification according to the speed of impact of risks.
- 3- A Classification according to being normal, semi-natural, human.
- 4-Classification of risks into (biological, geophysical, meteorological, hydrological and climatic risks).

3-3-Natural hazards and their different sources:

Natural hazards are one of the results of natural phenomena that occur when the earth dumps a very small part of its enormous energy on the surface of the earth, and natural phenomena have several sources that cause human and material losses.

3-3-1-Types of natural hazards (3):

Natural hazards	The description
Earthquakes 	They are considered sudden vibrations of the earth's surface, accompanied by a release of energy, and this energy erupts through a sudden disturbance in the layers of the earth.
Volcanos 	It is a conical mountain with a crater connected to a reservoir in the ground containing molten lava. Volcanoes erupt when the gas pressure is high.
Tsunamis 	It is a group of intense waves emanating from the movement of a large area of water, such as the ocean. Tsunamis arise from earthquakes, volcanic eruptions, and eruptions under or on the surface of the water.
Landslides 	It is the movement of rocky or dirt masses on the mountain slopes due to many factors, and they vary in speed from slow creep to violent sliding.
Floods 	Water affects human life, whether it is little or a lot. If the water is too little, it is a cause of drought, and if it is too much, it is likely to lead to floods and torrents, and in both cases it poses a threat to societies.
Sand storms 	It is fast winds loaded with fine sand coming from the deserts. They are formed when there is loose soil devoid of vegetation and winds exceeding 5 meters per second.
Desertification 	It is the transformation of large areas of fertile arable land into lands poor in plant and animal life. Desertification is a creeping phenomenon in arid and semi-arid regions.
Hurricanes 	A violent storm that arises in the tropics, accompanied by high-speed winds, heavy rains that cause floods, and sea waves that sweep the coasts.
Wild fires 	It is the outbreak of fires in the vegetation cover, resulting in flames, intense heat, thick smoke, and light.

Tab.1: Types of natural hazards.




3-4- Human Risks:

These are the risks that occur as a result of human actions and various activities, such as the use of pesticides, or

radioactive leakage from nuclear power plants. These risks are represented in the sources of environmental pollution. Environmental pollution is the presence of highly polluting substances in different concentrations that are harmful to living organisms, soil, water, and air (4).

3-4-1-Types of Human Risks:

Environmental pollution is the presence of highly polluted substances in different concentrations that are harmful to living organisms, soil, water and air. They may be natural and unnatural sources and cause great harm to the environment. Below are the types of human pollution (5).

Human Risks	The description
 <p>Marine pollution</p>	the harmful effects resulting from the entry of waste or chemicals, whether industrial, agricultural or human, with the entry of gaseous pollutants into the ocean, where 80% of marine pollution comes from land.
 <p>Air pollution</p>	Air pollution means the combination of pollutants in the air, such as vehicle exhaust and smoke. Air pollution may occur Various natural sources, such as: storms, thunder, rain, earthquakes and floods. People contribute to it
 <p>Soil pollution</p>	Environmental pollution is closely linked to the general environmental system, as the efficiency of the system decreases significantly when a change occurs between the various elements, which causes a defect in the environmental system.

Tab.2: Types of Human Risks.

3-5-Climate change risks

Climate change has harmful effects that may lead to a rise or fall in temperature, and an increase or decrease in precipitation, which has a significant impact on the frequency of floods and climate-related disasters. In addition to the rest of the natural phenomena associated with climate change, it was therefore important to know the phenomenon of climate change and adapt to it.

3-5-1-Definition of climate change:

It is a change in the climate that extends for several decades or more, and is caused by natural hazards or human activity hazards. Where the Earth's climate changes continuously, and all components of the system develop during different periods of time, and changes in the atmosphere take a few hours, and it is difficult to predict the weather situation for more than a few days, and the layers of the upper oceans change during a few seasons, while changes in the depths of the oceans take several centuries. Animal and plant life that affects precipitation and temperature changes over decades (6).

3-5-2-Types of climate change:

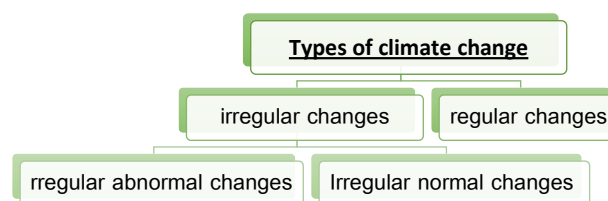


Fig.4: Types of climate change.

First: Regular climate changes: They are the changes that occur periodically as their amount and time of occurrence can be determined, for example: the change in temperature throughout the day, we find that it has a maximum end during the day and a minimum end during the night, and this means that there is a daily change in temperature whose value and time of occurrence are determined.

Second: Irregular climate changes: They are the changes that occur and it is difficult to determine the amount and places of their occurrence, for example: a rise in the temperature in the winter or summer than its normal rates for a period of time and then returns to normal. This type is divided into two parts:

A. Irregular natural changes: These are the changes whose occurrence and regularity are unknown in time, and the outcome of their impact has not been identified.

B. Abnormal irregular changes: These are the changes resulting from human activity, and if these changes continue for long periods (about 100 years) and over a large area (7).

3-5-3-The issues represented by climate change globally:

A. High temperature:

Global warming will range from 1.4 to 5.8 degrees Celsius between 1990 and 2100, and this is indicated by current climate models. These projections are due to a number of key assumptions affecting future emissions, such as: population growth and technological change. The value of the potential rise will be greater than any rise in a century, and these projections take into account the impact on the oceans (8).

B. Environmental disruption of ecosystems:

It is defined as human interference in the environment in an unintended way and causing a change in its elements, which leads to disturbance in the interrelationships between the parts of the system and the emergence of environmental problems. The geographic composition of ecosystems will change in response to the conditions

resulting from climate change. The human mass response may decrease and species that do not adapt quickly enough may become extinct for good.

C. Sea level rise:

It is expected that the average sea level will rise from 18 to 59 cm by the year 2100, and the thermal expansion of the upper layers of the ocean is caused by the melting of glaciers, and with the increase of large and variable ocean currents, land subsidence and local and regional factors, it will cause a rise more or less than the average height global sea level.

D. Beach erosion:

It is the phenomenon resulting from the erosion of waves on the beaches and results in the displacement of sand from one area to another, and its rates increased after the construction of the High Dam due to the loss of the available environmental balance due to the silt deposited on the beach.

3-5-4-Adaptation and prevention of climate change risks:

a. Adaptation from the risks of climate change: It is the modification of natural or human systems in response to actual or expected climatic stimuli or their effects, and this works to reduce damages or seize beneficial opportunities.

B. Climate Change Risk Prevention: It is an approach that seeks to integrate climate change issues into policies and programs and analyze them in relation to the current and future challenges posed by climate change. Adaptation to climate change works to make adjustments in natural or human systems in response to expected climatic stimuli, and to exploit beneficial opportunities.

3-6-Reducing and adapting to disaster risks:

Disaster risks are the expected losses resulting from the disaster (natural or human), in the lives of people, their livelihood, their health status, their properties and their services, which occur in particular in a society in a clear future period. In order to face these risks, the definitions of disaster risk reduction must be known.

3-6-1-Definition of Disaster Risk Reduction: This concept explained systematic efforts to analyze and manage the factors that cause disasters, including clarifying the reduction of exposure to risks, reducing the vulnerability of property, governing management, and preparing to face negative events.

3-6-2-Risk management and the importance of its management (9):

Risk management is a set of procedures necessary to deal with an abnormal situation with the aim of minimizing damage to the maximum extent, by addressing the risk, and there are three stages to confront the risk, which are as follows:

A. The pre-risk stage. The stage of adopting prevention methods and planning to face expected future risks, educating citizens, and paying attention to warnings.

B. danger stage. Determining the necessary procedures to confront risks, reduce their effects, provide relief to those affected, and restore normal life for them.

C. Post-hazard. The procedures used to rehabilitate and rebuild the buildings at risk, then re-populate the abandoned human communities, and isolate the danger from the rest of the parts and regular activities.

3-7-Problems of not investing in resilience:

Failure to pay attention to risk reduction leads to many problems, as follows:

- 1- A severe deterioration in the economy and environmental systems, and a loss of confidence on the part of the population and investors.
- 2- Recurrence of disasters with a small and medium impact, as one major disaster may lead to paralysis of the means of life in society.
- 3- Investors and the private sector may evade these cities for their lack of interest in disaster risk reduction.

3-8-The ability to confront in different fields (10):

The ability to confront in different fields	
Institutional political field:	<ul style="list-style-type: none"> - Enhancing coordination between departments and leadership to reduce disaster risks. - Enhancing institutional capacity building and resource allocation. - Regulating urban and local development in line with the principles of risk reduction.
Social field:	<ul style="list-style-type: none"> - Ensure access to basic services for all, and provide safety nets after disasters. - Allocate safe lands for all strategic activities and housing. - Encouraging the participation of stakeholders in all stages and strengthening alliances and social networks.
Environmental field:	<ul style="list-style-type: none"> - Protect, restore and enhance ecosystems, drainage, unstable slopes, and coastal areas. - Participate in ecosystem-based risk management.

	- Commitment to reduce pollution, improve waste management, and reduce greenhouse gas emissions.
Economic field:	- Protect, restore and enhance ecosystems, drainage, unstable slopes, and coastal areas. - Participate in ecosystem-based risk management. - Commitment to reduce pollution, improve waste management, and reduce greenhouse gas emissions.

Tab.3: The ability to confront in different fields

Through the above, it can be concluded that a city that is able to face disasters is a city in which the impact of risks is minimal, and it has an efficient and accountable local government, and it takes steps to mitigate the effects of risks, and the authorities and residents are aware of the risks, and are able to respond and implement recovery strategies. immediate, and its residents are empowered to participate in decision-making, so it was important to study the ability to cope in various fields (environmental, economic, political and social).

4-Definitions of resilience, its origin and important theories:

Resilience is the ability of a system, society or person to withstand shocks while maintaining its basic functions. It is the ability to recover quickly, effectively and with greater strength from disasters and the ability to withstand greater stress. So building resilience makes people, communities and systems better prepared to withstand disaster risks. Man is not born with an innate ability to be flexible. Rather, it learns and adapts to it, as well as in organizations and societies. In times of disasters, local governments are the first line of response when it comes to management and disaster risk reduction, and they have great responsibilities but insufficient capacities to deal with disasters.

4-1- Resilience theories (11):

In an article by Folke in 2010, the most prominent characteristics and theories of resilience were explained. He said that “flexible thinking addresses the dynamics and evolution of complex social-environmental systems.” He identified three basic characteristics of resilience:

First: the ability of resilience. It is the ability of social-environmental systems to constantly change and adapt.

Second: the ability to adapt. It represents the ability to adjust responses when external stimuli change, and to return to a state of equilibrium and stability.

Third: the ability to transform. It is the ability to overcome and overcome obstacles in the paths of new development.

It is important to realize that resilience is not related to the continuity or strength of disturbance only, but rather to the opportunities that such disturbances provide for restructuring and the development of ecosystem renewal processes.

4-2-The genesis of resilience (12):

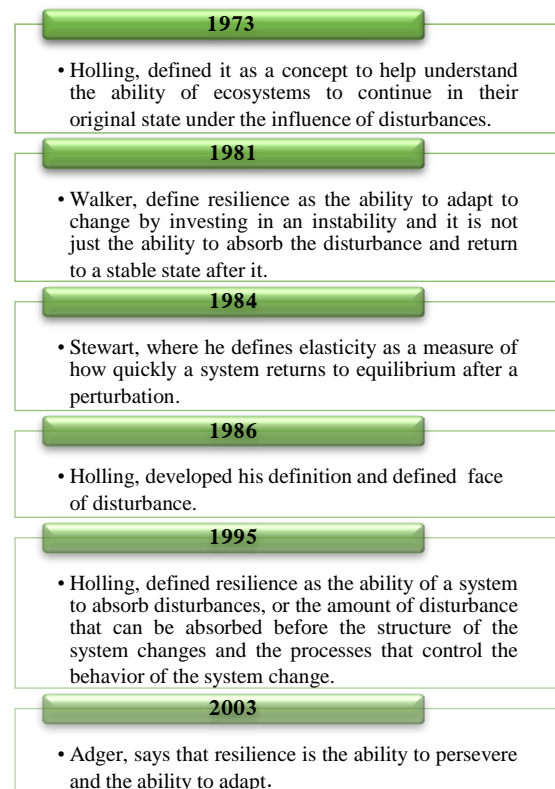


Fig.5: The genesis of resilience.

4-3-Characteristics and benefits of Resilience cities (13):

As there are a set of main characteristics and advantages in cities that can be considered flexible, and below we will get to know each of them:

Characteristics	Definitions
Flexibility and diversity	The ability to perform essential tasks under any circumstances, transforming assets and properties to provide new ways to achieve the basic goals of resilience. And the distribution of assets so that not all of them are affected by a particular risk that occurred at any time.
Adaptable	It takes into account not only expected risks, but also current and future risks. As it diversifies its services by creating alternatives, and transforming change into an opportunity.
Persistent	The city of perseverance anticipates impacts so that it can prepare for current and future shocks.

Inclusive	An inclusive city is people-centered, understanding that resilience entails protecting people from any negative impact. It strives towards social inclusion, equality, and the development of resilience.
Redundancy, modularity	-The ability to accommodate emergencies, mounting events, and high pressures, creating multiple options for delivery Services, Or interacting components consisting of similar parts that replace each other if one or many fail.
Safe failure	The ability to absorb the shocks and cumulative effects of slow-onset challenges in ways that avoid disaster failure.
Resourcefulness	The ability to conceptualize, act, identify problems and priorities, and mobilize resources.
Responsiveness and rapidity	The ability to organize and quickly return it, and establish the job in a timely manner before and after failure.
Integrated	Resilient cities are characterized by the concept of integration, where integrated operations are brought together with city systems to promote decision-making, exchange of information between the components of the system to work on the speed of response.
Learning	Through formal processes absorb past experiences and change strategies based on knowledge and experience.
Reflective	Resilient cities are reflexive as people and institutions learn from past experiences, learning and enlightening for future decision-making.
Robustness	Resilient cities are resilient as physical assets are designed and maintained in high impact weather events.

Tab.4: Characteristics and benefits of Resilience cities.

4-5-Dimensions, indicators and criteria for resilient sustainable development (14):

The dimensions of sustainable and resilient development are divided into five main sections, and each of them is a set of indicators and criteria.

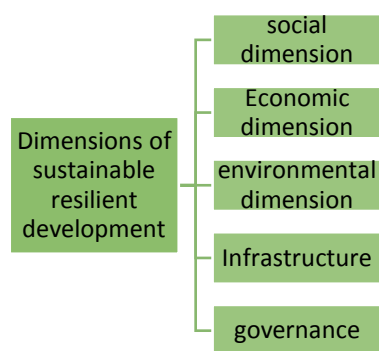


Fig.5: Dimensions for resilient sustainable development

4-5-1- The social dimension:

This dimension receives great attention in urban resilience frameworks, due to its strong impact on achieving social resilience. This dimension is divided into several indicators that include a set of criteria.

4-5-2-Economic dimension:

The economic dimension of resilience includes criteria related to the structure and stability of the economy. Economic flexibility depends on the ability of the working population to support dependents. Providing well-paying jobs is associated with flexibility.

4-5-3- Environmental dimension:

The criteria of the environmental dimension are related to the ecosystem and to the quality, availability and accessibility of natural resources. Environmental elements play an important role in increasing the resilience of societies. Availability and access to clean resources is important for the survival of human societies and for the resilience of societies.

4-5-4- Infrastructure dimension:

The infrastructure is long-lived. Therefore, it must be taken care of to avoid the risks of its vulnerability. Emphasis was placed on transportation and communication systems, and communication and information exchange is essential to achieving flexibility.

4-5-5- Governance dimension:

It is the dimension that includes many interrelationships with the other previous dimensions. Here, the governance standards become clear and institutions, which can be used to assess the efficiency and effectiveness of relationships between and within community organizations.

4-6-Dar es Salaam city as case study:

First: an overview of Dar es Salaam:

Dar es Salaam is the former capital of Tanzania, located on the country's eastern coast on the Indian Ocean. With an area of 1,350 square kilometers, it is the largest city in Tanzania in terms of population. It is also the most important economic center in the country and the largest population. This makes it the third fastest growing city in Africa. More than 70% of the population of Dar es Salaam live in slums and unplanned settlements that lack services and infrastructure, and more than half of them live on approximately one dollar a day. City authorities face significant challenges in providing or even maintaining new infrastructure services (1).

The case study summary provides a comprehensive overview of the intersection between climate change and

disaster risk in Dar es Salaam. It seeks to understand the following:

1-The main aspects of vulnerability of the urban population in the city, climate change increases with this vulnerability.

2-Policies and programs that can be developed that reduce the vulnerability of the poor, taking into account current and future climate change.



Fig.6: Primitive image, poverty and drought as a result of disasters.



Fig7: View of the old city of Dar es Salaam.

Secondly: dangers to which the city was exposed (15):

Floods-Drought-Landslide-Extreme temperature.

Third: The main results of the study (16):

1- Rapid unplanned urbanization in Dar es Salaam has led to flood risks in many slums, in addition to health and population related problems.

2- Lack of understanding of the hydrological and environmental role of wetlands in urban development planning.

3- Disaster risk management is not addressed as it must be integrated into all aspects of urban planning.

4- Poor sustainability of infrastructure development and maintenance initiatives.

5- Industries should be moved away from residential areas, and access to waste collection area.

6- Programs to raise awareness at the local level and improve sanitation practices.



Fig.8: The problems of sewage.



Fig.9: Problems resulting from the floods.

4-7-Apply dimensions, indicators and criteria for sustainable and resilient development:

Through the application of dimensions, indicators and criteria for sustainable and resilient development in the city of Dar es Salaam as a case study for a city that has been exposed to certain types of risks and the extent to which these dimensions are achieved to assess the city's resilience, these dimensions, indicators and criteria represent a methodology that assesses the extent of the city's resilience.

4-7-1-The social dimension (16):

The social dimension of sustainable and resilient development is divided into a set of indicators and criteria, which are illustrated in the following table:

Dim	Indicators	Criteria	Achieved or not	Percent %
The social dimension contains (5 indicators and 20 criteria), the share of the social dimension is 20 points				
The social dimension	First: Social and Economic Characteristics:	- demographics.	✓	1.5
		- Language abilities.	✓	1.5
		- Ownership of land, house and car.	✓	1.5
		- Various skills at the time of disaster.	unknown	Zero
	Second: Community Links, Social Support, and Social Institutions:	- The degree of interconnectedness of the layers of society and memories.	✓	1.5
		- Volunteering and civic participation in social networks.	✓	1.5
		- Shared assets, strong international civil organizations.	✓	1.5
		- Existence of conflict resolution mechanisms.	unknown	Zero
		- Participation of vulnerable groups.	✓	1.5
		Third: Safety and Quality of Life:	- Security services such as the police and crime prevention and reduction.	✓
	- Preventive health measures and response to events.		✓	1.5
	- Physical and mental health.		✓	1.5
	Fourth: Local Culture and Traditions:		- Previous experience in disaster recovery.	✓
		- Learning from the past, preserving cultural and historical identity.	✓	1.5
		- Awareness of indigenous knowledge and traditions and respect for local culture and characteristics.	unknown	Zero

	- Social and cultural norms and positive behaviour.	unkno wn	Zero
Fifth: Equity and Diversity:	- Racial equality and minority participation.	✓	1.5
	- Cultural diversity of the workforce.	✓	1.5
	- Norms and gender equality.	unkno wn	Zero
	- Affordability and access to needs and infrastructure.	✓	1.5
The overall percentage of urban resilience assessment for the social dimension is 30%			22.5%

Tab.5: indicators and criteria for The social dimension.

4-7-2-The Economic dimension:

Dim	Indicators	Criteria	Achieved or not	Percent %
The economic dimension contains (3 indicators and 16 criteria), the share of the economic dimension is 16 points				
The Economic dimension	First: Building:	- Employment rate, opportunity, and income (parity, multiple sources).	×	Zero
		- Qualifications of the population of working age.	×	Zero
		- Individuals with high and multiple skills.	✓	1.5
		- Literacy (education).	unkno wn	Zero
		- Functional density (proximity between housing and work, and ease of movement).	✓	1.5
	Second: dynamism:	- Domestic investment, investment in the green economy.	✓	1.5
		- Integration with the global and regional economy.	unkno wn	Zero
		- The diversity of the economic structure	✓	1.5

	and livelihood strategies.		
	- Encouraging small projects, financing them, and self-employment.	✓	1.5
	- Public-private partnership, supply and demand balance.	✓	1.5
Third: Security and Stability:	- Collective ownership of community assets.	✓	1.5
	- Savings of individuals and society (stocks of supplies, cash, etc.).	unkno wn	Zero
	- Business easing and redevelopment.	✓	1.5
	- Insurance (local and non-local) and social care.	✓	1.5
	- Financial instruments (emergency funds and capital).	✓	1.5
	- Stability of prices, income and property value.	✓	1.5
The overall percentage of urban resilience assessment of the economic dimension is 24%			16.5%

Tab.6: indicators and criteria for The Economic dimension.

4-7-3- Environmental dimension:

Dim	Criteria	Achieved or not	Percent %
The environmental dimension contains (8 criteria), the share of the environmental dimension is 8 points			
Envi ron men tal dim ensi on	-Monitoring and protecting the ecosystem.	✓	1.5
	- Using local materials and types.	✓	1.5
	- Protection from corrosion.	unknown	Zero
	- Protecting wetlands and coasts.	✓	1.5
	- Reducing environmental impacts	unknown	Zero

(different types of pollution).			
- Availability of and access to resources (air, energy, water, food and soil).	✓	1.5	
- Quality of resources, biodiversity and wildlife conservation.	✓	1.5	
- Materials and resources management (production, consumption, conservation and recycling).	✓	1.5	
Overall percentage for assessing sustainable resilience for the environmental dimension 12%			9%

Tab.7: Criteria for The Environmental dimension.

4-7-4- Infrastructure dimension:

Dim	Indicators	Criteria	Achieved or not	Percent %
The Infrastructure dimension contains (5 indicators and 18 criteria), the share of the Infrastructure dimension is 18 points				
Infrastructure dimension	First: Infrastructure Efficiency:	- Monitoring, maintaining and modernizing infrastructure, sanitation, water supply, and waste management.	×	Zero
		- Promoting effective infrastructure (technological modernization, measurement,..)	✓	1.5
		- Modernization and renewal of the urban environment.	×	Zero
	Second: Information Technology Infrastructure:	- Enhancing reliable information and communication technology networks.	✓	1.5
		- Infrastructure for emergency communications (before and after the disaster).	✓	1.5
	Third: The durability of the vital infrastructure:	- The abundance of infrastructure and facilities.	✓	1.5
		- The spatial distribution of the infrastructure and its durability and fortification.	✓	1.5
		- Integration of important facilities and cooperation between service providers.	unknown	Zero
		- Accommodation facilities and services.	✓	1.5
		- Multiple functions for spaces and	✓	1.5

		facilities.		
Fourth: Transportation Structure:		Comprehensive and diversified transportation networks and facilities.	✓	1.5
		- Capacity, safety, integration, connectivity and transmission efficiency.	✓	1.5
Fifth: Land Use and Urban Design:		- Access to basic needs and services.	✓	1.5
		- Site selection and avoiding vulnerable areas.	✓	1.5
		- Street type, development intensity, public spaces and community facilities.	✓	1.5
		- Percentage of unstable surfaces and mobility on foot.	✓	1.5
		- Natural temperature control based on natural elements, natural lighting, passive heating (non-energy dependent).	unknown	Zero
	- Passive cooling (not dependent on energy).	unknown	Zero	
The overall percentage of urban resilience assessment for the infrastructure dimension is 27%.				19.5%

Tab.8: indicators and criteria for Infrastructure dimension

4-7-5-Governance dimension:

Dim	Criteria	Achieved or not	Percent %
The dimension of governance contains (4 criteria), the share of the dimension of governance is 4 points			
Governance dimension	- Citizen participation in decision-making to enhance the legitimacy of the procedures.	✓	1.5
	- Building a common vision and directing all community activities. This is to enhance flexibility.	✓	1.5
	- Organizational communication and the existence of interconnected networks are important to enhance flexibility	✓	1.5
	- Collaboration and exchange of information and knowledge, which are important elements in resilience planning.	✓	1.5
The overall percentage of urban resilience assessment for the governance dimension is 6%.			6%

Tab.9: Criteria for The Governance dimension.

4-8-Results:

From the previous five tables, the percentage of flexibility for each of the dimensions of flexible sustainable development for the city of Dar es Salaam was reached, as shown in the following detailed table:

dimension	The number of points for each dimension according to the number of criteria	Dimension Percentage %	Dimension achievement %
Social dimension	20	30%	22.5%
Economic dimension	16	24%	16.5%
environmental dimension	8	12%	9%
infrastructure	18	27%	19.5%
governance	4	6%	6%
Total percentage of Dar es Salaam city achieving resilience %			73.5%

Tab.10: The resilience ratio of each dimension in resilient sustainable development and the final resilience ratio of the city.

And from the previous table resulting from analyzing the information obtained for the flexible sustainable development of the city and linking it to the dimensions, indicators and criteria for the flexible urban development of the city, and from the previous table, we can say that the city of Dar es Salaam achieved an urban flexibility rate of (73.5%).

4-9-Conclusion

Cities are complex systems in constant confrontation with risks, due to the different types of risks that cities are exposed to, whether natural, human, or climate change risks. At the beginning of the research, the causes of risks in the urban environment were addressed, including the risks to which cities are exposed, which are represented in natural and human risks and the risks of climate changes, where the risks and their different descriptions were defined, including the types of natural risks, which are represented in (earthquakes, volcanoes, tsunamis landslides, floods, sandstorms, desertification, hurricanes, and forest burning), Then, human hazards and their types were identified, such as (marine pollution, air pollution, and soil pollution). Finally, defining climate changes and their types in terms of whether they are regular or irregular, and identifying the issues that climate change represents globally, such as (high temperatures, disruption of ecosystems, sea level rise, and coastal erosion). Learn about adaptation and prevention of climate change risks as well as disaster risks. Learn about risk management, the

importance of its management and the three stages of its management (The pre-risk stage, danger stage, Post-hazard). And learn about the concept of flexibility and the different areas that concern them (the political, social, environmental, economic), And knowing Definitions of resilience, its origin and important theories (the ability of resilience, the ability to adapt, the ability to transform). And Characteristics and benefits of Resilience cities (Flexibility and diversity, Adaptable, Persistent, Inclusive, Redundancy, modularity, Safe failure, Resourcefulness, Responsiveness and rapidity, Integrated, Learning, Reflective, Robustness). And Finally Dimensions, indicators and criteria for resilient sustainable development (The social, Economic, Environmental, Infrastructure, Governance) When applying these dimensions, indicators and standards to the city of Dar es Salaam, the city achieved the social dimension 22.5%, The Economic dimension achieved 16.5%, The Environmental dimension achieved 9%, The Infrastructure dimension achieved 19.5%, The Governance dimension achieved 6%, and from the previous table, we can say that the city of Dar es Salaam achieved an urban flexibility rate of (73.5%).

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