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Crisis engineering Strategies for dealing with natural disasters. (Earthquakes as a model)

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Abstract— With the increasing incidence of disasters and emergencies in the world and their increasing risks and negative impacts on humans, buildings, and cities, the concept of crisis engineering has emerged as a vital field of study that focuses on preparing innovative precautionary designs and developing appropriate solutions for them. To address the unique challenges posed by this type of disaster with a focus on rapid response, adaptability, and cooperationWith the real attempts made by crisis engineering to provide solutions to protect people and reduce the damage caused by natural disasters in buildings, roads and spaces, but at the same time it perpetuates the reactive approach to disasters and crises, therefore it is important that the research highlights the strategies used in global experiences towards natural disasters. , especially earthquakes, their consequences and effects, and access to design and planning innovations that would mitigate the impact of natural disasters and ensure rapid recovery and resilience of affected communities, as the research identified a problem of demonstrating the importance of crisis engineering in recovering from disasters and crises and the strategies used to enhance the required flexibility in interior spaces. And the exterior of buildings and cities after natural disasters and earthquakes in particular. The research also assumes that crisis engineering and determining appropriate strategies for dealing with natural disasters are of great importance in reducing the effects of these disasters on humans, architecture, and urban design.

Keywords— Crisis engineering, Natural disasters, Resilient space, Resilient cities.

1. Introduction

Many previous studies have addressed the concept of crisis engineering and strategies for dealing with post-disaster spaces, examining a set of precautions used to reduce the effects of natural disasters such as earthquakes, floods, and droughts, in addition to other risks such as explosives. These studies also addressed the possibility and ways of improving urban structure, which would significantly reduce the negative impact of disasters on humans, architecture, and cities.[16 ,23 ,11]

Other studies dealt with the effects of natural disasters in various global experiences, such as earthquakes, hurricanes, floods, etc., strategies for dealing with these disasters in these experiences, and the possibility of reducing and containing their negative effects in times of disaster. And after[26,10,4,32]

Other studies have explained the concept of growth and development and what it shows to be the main challenge faced by government organizations in responding to such disasters, highlighting the dangers of neglecting to address natural disaster risks and the continued unsafe use of land and improper building design in disaster situations. exposed areas.[12 ,2 ,14]

Despite the large number of these studies that dealt with the concept of crisis engineering and global experiences that were exposed to the effects of natural disasters and their attempts to deal with these effects, they did not address the comprehensive strategies used in architecture and urban design and the attempt to investigate these experiences and come up with indicators and recommendations that can be adopted and benefited from in vulnerable countries. natural disasters and then reduce their negative effects.

After studying and analyzing previous literature, the research problem can be diagnosed and identified, which is the lack of explanation of the importance of crisis engineering in recovering from disasters and crises and the strategies used to enhance the required flexibility at home and abroad. Spaces of buildings and cities after natural disasters and earthquakes in particular. Therefore, the research assumes that crisis engineering and determining appropriate strategies for dealing with natural disasters are of great importance in reducing the effects of these disasters on humans, architecture, and urban design.

The research objectives are:

Highlighting the most important global experiences that have been subjected to repeated natural disasters and showing the extent of their negative effects on humans, buildings, and cities, including earthquakes, hurricanes, and epidemics

Discussing the strategies used in these experiments to reduce the effects of natural disasters, the results of these experiments, and the extent of their benefit at the level of architectural and urban design

We emerge from these global experiences with indicators and a set of recommendations that can be used within what is known as the concept of crisis engineering in the future.

2. Natural disasters.

Serious natural catastrophes, including earthquakes, tsunamis, floods, and storms, have happened often throughout the world in recent decades with devastating effects. They also aided in our comprehension of how crucial coordination and excellent communication are for carrying out rescue efforts during a crisis [15]. The Earth is exposed due to the change of the rock layer under the surface of the Earth or when there is volcanic or geological action resulting in vibrations that lead to significant negative effects, with increasing numbers of deaths and injuries as well as significant damage to property and buildings, loss of housing and means of livelihood, and disruption of basic infrastructure. Hurricanes and their negative effects also appear in many countries and represent the greatest forms of tropical storms, which are strong spiral air storms resulting from a group of thunderstorms with winds up to 119 km/h and more.

One of the negative effects of natural disasters is that they are often difficult to predict and monitor, while man-made disasters can be prevented and controlled if it is possible to take the right behavior and prevention methods in time. Disaster reduction is the key to measuring natural disasters rather than avoiding them. Natural disasters related to the city include earthquakes, fires, floods, storms, and geological disasters.

Since the 1960's, there has been a discussion about life in large cities after natural disasters, where housing is the first and most pressing issue because it is one of the basic human needs for physical protection and survival that is constantly evolving [8].

Global urban disasters have been a reflection of people's awareness and action on urban disaster prevention. The urban government and citizens devote themselves more and more to the dissemination of knowledge and action on disaster reduction and evacuation, making citizens and the urban environment more harmonious [11].

Other forms of disasters and crises appear all over the world and throughout history and cause great loss of life and property. Where natural disasters can cause the collapse of buildings, damage to equipment, fires, floods, gas explosions, as well as the spread of other secondary disasters, such as landslides, mudslides, liquefaction of the Earth, and may aggravate the destruction of the collapse and destruction of the building. Secondary disasters also appear, beginning with a primary major disaster, such as a fire or tsunami caused by an earthquake. Secondary disasters often cause much more damage and problems than primary ones. It is also called a (ddisasterocollector, here landslides, mudslides, tsunamis, floods, epidemics, fires, explosions, gas leaks, the spread of radioactive substances, etetc. onclude secondary disasters of earthquakes.

Scientific planning and the construction of urban shelters are important for urban disaster prevention. It can greatly reduce property losses and injuries and improve the efficiency and safety of evacuation after a disaster [13].

In many cases, secondary disasters are caused by the destruction of buildings or facilities and often cause more damage and problems than a primary disaster. It is worth noting that the fire disaster is the most common secondary disaster and the most dangerous due to earthquakes. After the earthquake, poor environmental health caused some severe pathogens caused by microorganisms, such as bacteria and viruses, which were not controlled until they caused infectious diseases. Flooding: earthquake-induced vibrations that can lead to the destruction of dams and floods [11]

The United Nations' international strategy emphasizes the importance of cooperation in disaster relief. However, recent societies are increasingly aware of the role of architects in minimizing crises' effects and preparing for them, particularly in the housing sector. This specialization is crucial for rebuilding infrastructure, providing shelter, and rehabilitating destroyed areas, facilitating the return of the population to normal life. (Alcoran and Naces, 2016)

Resilient building design involves considering typical usage scenarios, stress points, and environmental disaster scenarios to ensure structural integrity and safety. [9]

3. Crisis engineering.

Crisis engineering means the set of preventive measures adopted to reduce the impact of natural disasters such as earthquakes, floods, droughts, etc., as well as other threats such as explosions, etc., which contains a set of targeted plans by which it is possible to significantly reduce human impotence against the impact of these crises along with the enrichment of urban structures [23]. More recently, disaster mitigation has been seen to ward off unavoidable disasters with minimal harm compared to disaster prevention [25].

Many countries have gone through disasters of different impacts, which could be classified in the previous chapter, which were dealt with according to different solutions and strategies to reduce the effects of crises and then recover from them later, and if it was possible to avoid the

occurrence of these negative effects, which became known as crisis engineering, where natural and human disasters such as hurricanes, earthquakes, floods, wars, fires, as well as heat stress, throughout history, had a clear impact on increasing the number of displaced people by double over the past twenty years, which was the main challenge for governments and competent authorities in Fig. figuring out what needs to be done to increase the resilience of communities and people's homes and infrastructure. To achieve this, the government and community-based organizations often struggle to develop effective strategies to prevent or mitigate the effects of these disasters before they occur and prepare for long-term recovery afterward. The main obstacle that these agencies must overcome in such disasters is growing development, where scientists identify whole-system hazards related to the design of the built environment as the main causes of vulnerabilities that need to be addressed, including unsafe settlement patterns and building design in disaster-prone areas [4].

It shows, for example, that the United States of America presented its climate action plan in 2008 to address meteorological disasters by taking advantage of the idea of resilient cities. Modern cities deal with increasing uncertainties that can have a significant impact on their future and the future of their citizens, so the idea of resilient cities has gradually become a key element in urban planning.

In 2011, the Greater London Authority launched a risk management plan and increased resilience by increasing the number of urban parks and green areas to reduce city flooding. The experience of Singapore is also shown by the launch of the Cities of Tomorrow program in 2017 with the aim of creating resilient cities that can withstand the uncertainties caused by the challenges ahead [33].

And also, when building with a modular approach, interior components like furniture, equipment, and power are first built in a factory using cubic unit modules. These modules are then quickly put together for use and may be taken apart once again. Because of its speed and cost viability, this kind of design is increasingly used in various settings, especially residential and commercial structures [43].

To enhance pre-disaster and post-disaster resilience, cities should take into account the idea of disaster-sensitive open spatial spaces and landscape design solutions connected to the physical environment for each step of the disaster life cycle (mitigation, readiness, response, and recovery) [3].

The post-disaster design presents a unique, time-limited, and diversified issue, requiring inclusive treatment, housing provision, and architectural practice reforms. However, each instance highlights the complexity of post-disaster rehabilitation, which involves transformational claims and equity and is multifaceted due to its multifaceted nature [7].

From an economic point of view and in terms of the viability of space dynamics, having a multi-functional space can function differently in times of disaster. [2]

By tracking the studies that dealt with crisis engineering, it appears that there must be three characteristics for the success of this type of engineering to deal with disasters and crises, namely:

1. Production and maintenance by using little energy.
2. Modification of the basic parts and their resiliency in order to accept changes.
3. The possibility of modifying the original scheme.

And also, an example where resilience and compact design plays a decisive role in solving many problems in design practice with modern architecture [6]. Another benefit of resilience design is that it enables users to change, use and control space according to their needs through user interaction.

Housing is also the clearest example of the need to have resilience spaces in order to be able to accept changes and continue to stay alive socially, economically and environmentally, and therefore there must be an inherent ability to adapt, which is capable of different social uses. As well as the inherent ability to resiliency, which is defined as

capable of various physical arrangements (Schneider and Till, 2005)

Resiliency in architecture and in the design of interior spaces in particular is emerging as a new trend or through the development and improvement of experiments of established traditional trends in the design of old dwellings that have resiliency in design (Raviz et al., 2015).

It shows the importance of achieving resiliency in spaces more and is necessary with the occurrence of disasters and crises, which cause major changes that require the ability to adapt and absorb them and then continue to achieve its original function, and therefore it is necessary to study crises and disasters to demonstrate this impact.

Many countries have witnessed a variety of natural disasters and threats as a result of their geopolitical circumstances, and statistics from international organizations have shown that natural disasters have posed a greater threat over the past ten years than any man-made dangers, which also recommended, as a result, taking into account regulations, design specifications and preventive measures in plans and development to reduce the effects of natural disasters such as earthquakes floods, droughts, explosions, etc., where these plans strengthen existing urban structures and avoid developments that would weaken resilience and reduce to a minimum There is a great human vulnerability in the face of such crises that occur in the aftermath of crises [23]

The urban environment can be considered an emergency scene, referring to a state of alert posing immediate danger to individuals, life, or property, or an emergency related to the emergence of a new threat or phenomenon requiring urgent intervention. [10].

Urban planning is crucial for managing site-specific risks, vulnerabilities, response mechanisms, and structures affecting urban development and raising public awareness of natural disaster risks. (León et al., 2019).

To understand the mechanism of dealing with disasters and crises and come up with design recommendations to deal with their effects, several regional and global experiences that have gone through natural disasters will be studied, and their applications will be studied on the design process in buildings or at the urban level to benefit from these experiences and come up with design recommendations that can be used in the future, as they were distributed according to the type of disaster that occurred and its geographical location, as well as trying to cover as many global examples that have dealt with disasters of various kinds, and then reach results that contribute in the future to dealing positively with the effects of these disasters and minimize their negative consequences of the human level the building and the city. The importance of studying the design of resilience spaces that are able to accommodate disasters with minimal consequences has emerged. All humanitarian crises require sustainable strategies and policies from an economic, social, cultural, and environmental point of view. [14]

4. Experiences of countries in dealing with natural disasters.

An earthquake is one of the natural phenomena with the greatest impact on humans and architecture. It occurs when the rocky layer beneath the Earth's surface moves when volcanic or rocky activity occurs, causing the ground to shake suddenly and violently. Earthquakes can cause deaths, injuries, property damage, loss of shelter and livelihoods, and disruption of essential infrastructure.

Three global experiments were chosen in which earthquakes were dealt with correctly and their effects were attempted to be minimized, which can be used to come up with a set of recommendations and indicators that can be used with similar experiments (the Japanese, the Slovenian, and the American). These experiments were chosen because they were experiments with a great impact in terms of the changes that occurred in the cities during and after the disaster, and also because decisions were made in them that led to effective results and flexible spaces that help absorb potential upcoming disasters and reduce the shock factor.

4.1 *Japanese experience in dealing with earthquakes*

An earthquake is a wave-like vibration that travels through the earth's crust. The Earth is a living planet, and forces under the surface layer (the lithosphere) are in constant turmoil, affecting its surface [20]. Earthquakes are one of the worst natural disasters ever, causing damage to homes and infrastructure as well as many injuries and deaths. Therefore, the cultural and social needs of the victims must be taken into account when providing housing for post-earthquake victims. [21] Japan is one of the countries that are highly exposed to the occurrence of frequent earthquakes, which have repeatedly led to the appearance of devastating negative effects on residents and their buildings (Fig. 1). With increasing exposure to this, a set of standards and strategies have been developed to avoid and reduce the effects of earthquakes on them, and many measures have been implemented to mitigate the effects of these disasters. The architectural plans took into account the effects of earthquakes and ways to deal with them geometrically in the designs prepared for buildings, as well as the development of alternative plans to deal schematically with cities and places with high population density by choosing alternative locations that transport victims of earthquakes and hurricanes and are far enough away from disaster sites [24].

Since the Great Kanto earthquake in Tokyo in 1923, urban gardens have been immensely significant and acknowledged as places of shelter in catastrophes. A network of shelters and escape routes was set up in reaction to this earthquake (Masuda, 2014).

1assembly spaces: they are spaces that are physically and intellectually open to everyone and are not like places owned by the government/organization, as they represent platforms / spaces / places that are accessible to everyone, and no one enters them with an advantage over the other.

2public spaces: it is called the planning, spaces and activities

Figure 1: The Great Hanshin-Awaji Earthquake occurred in 1995 destroyed the old wooden buildings.

The negative effects of earthquakes and the destruction of cities, the loss of buildings and residential homes, as they are suitable for living in them, and the increasing numbers of displaced homeless people have led to the emergence of special crisis management teams to meet the needs of the people affected during and after the disaster, and after recovery from it, the development of emergency

plans and the provision of appropriate shelter (Fig. 2), and the development of crisis management work and the emergence of three models or stages to provide appropriate shelter [27], namely:

1. A temporary shelter that can be inhabited for several days or weeks is called an evacuation center in Japan.
2. Temporary housing that can be lived in for a period ranging from one to five or six years, depending on the duration of the construction of prefabricated housing.
3. Permanent and livable housing for long periods

Also, in earthquake-prone areas, architectural designs considered earthquake resistance and preventing the spread of catastrophic fires after it by creating resilience spaces and considering short- and long-term design components such as recovery policies and implementing plans for people who will be affected during the recovery phase that occurs after the majority of disasters. According to the disaster relief law, temporary housing in Japan is routinely built and standardized for immediate use. Improving the living conditions of victims, preparedness for rapid response to disasters, and the architectural life cycle taking into account their disposal after resettlement is also perceived as architectural challenges.

The Japanese government has begun to think about a disaster prevention plan that includes a complex of open evacuation zones, urban disaster facilities, and a number of high-rise buildings that will serve as a 1.2-kilometer firewall aimed at stopping the spread of fires from one crowded part of the city to another in order to reduce possible damage from future earthquakes or a large fire in the area. The plan, now known as the Spiralize Hisashi Disaster Prevention Base, was implemented in 1986. As well as firewalls for important buildings such as schools, kindergartens, hospitals, evacuation zones, storage spaces, water tanks, etc., the Disaster Prevention Base also has a variety of amenities. [24]. (Fig .3)

Figure 2: Temporary housing became necessary as a result of an earthquake Tohoku in 2011, where you try The Japanese government to remove the displaced from the big bunkers

To prevent confusion with simply referring to sites controlled by the government or other organizations, Assembly spaces[1] was used in Japan instead of public spaces [2] because Assembly Spaces are one of the most important categories of spaces that have been repaired and produced. These meeting places are examples of sites that have developed as temporary physical social spaces of resilience throughout the pre-disaster and recovery periods by providing a place for interactions between individuals and groups. These sites act as communities and provide support to the affected community.

According to the studies, the investigations examined how the gathering space recovered after the incident and found three aspects regarding the gathering areas [35].

1. People's relationship to the site
2. The importance of personal routine interactions and their impact on the emotionality and symbolism of the site
3. Relying on these spaces being helpful for many purposes.
4. Many locations may become isolated after an earthquake because of crumbling structures and dead ends. Fortunately, urban planning today prioritizes urban safety as a major concern. Therefore, it's crucial to plan suitable earthquake shelter areas to enable the safe evacuation of inhabitants during a disaster. Following earthquakes, shelters are crucial [5].

5. usually needed after a catastrophic earthquake in a densely populated area: (Fig. 4)

Figure 3: The neighborhood of Harukas Abeno is built Surrounding it shows how it can be organized A huge city Strategies to understand Urban gentlemen

Modified By the Researcher

Figure 4: The first image represents temporary housing,

While the second image shows seismic insulation.

1. Emergency shelters, which are often in the form of temporary tents.
2. Temporary shelters, which are often built to be convenient for a year or two.
3. Long-term housing or shelters.

Due to the short period of use of temporary emergency shelters, which may take place for a few weeks, this type of shelter does not represent a problem from an architectural design perspective, while the second type needs to be reviewed and audited both architecturally and urbanely. Although, on the one hand, it does not need to adhere to the standards of permanent housing, on the other hand, it requires the availability of minimum living standards for its residents.

As for the third type, it must have standards of permanent housing that are applicable in different places for the length of a human's stay there [22].

The study of [11] showed a set of plans and recommendations developed by the responsible authorities in Japan to prevent the effects of natural disasters that occur constantly in Japan and in its external spaces to become resilience spaces capable of absorbing the impact of these disasters and their negative consequences as shown in Fig. 5

After dealing with the Japanese experience in dealing with the effects of earthquakes as one of the types of natural disasters and the solutions it has developed for this, it is possible to come up with a set of indicators according to Table 1.

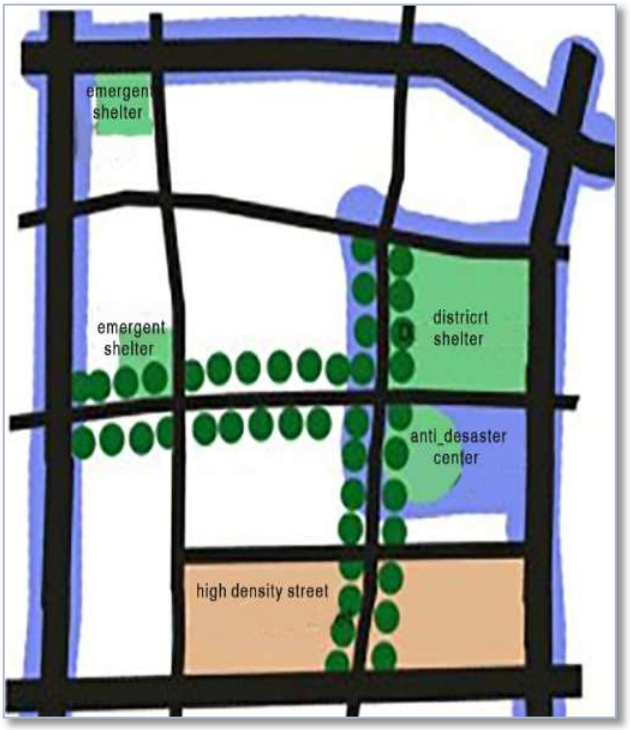

Figure 5: Japanese green space mode

Table 1: Represents applications to architecture and urban design after the earthquake disaster in Japan - (prepared by the researcher)

Location	At the level of housing effectiveness	At the level of decisions effectiveness	Urban-level effectiveness
Japan	1. Apply the concept of evacuation centers that can be used for a few days or weeks. 2. Apply the concept of temporary housing that may be occupied for a stay of between one and five or six years, depending on how long it takes to build a prefabricated house. 3. Application of the concept of long-term housing	Establish specialized crisis management teams to meet the requirements of the affected parties during and after the disaster.	1. Choosing alternative locations that transport victims of earthquakes and hurricanes and are far from disaster sites 2. The use of assembly space instead of public space. Being one of the most important types of repaired and designed areas. 3. Redesign of state parks and large parks that serve as safe sites for disaster relief efforts, including home renovation and urban redevelopment. 4. Encourage local residents to gather in the main parks and try to avoid disasters. 5. The establishment of large-scale shelters in municipal parks in the event of an earthquake or fire, where public parks serve as fortifications for preventive efforts.

4.2 ***The Slovenian experience:***

Multiple natural disasters posed a threat to Slovenian settlements, as old and new maps can be compared to prove that in the past people knew where to build their homes to be safe from natural disasters, as the main purpose of buildings is to protect the lives and property of those who reside inside them, which had to be adapted to the environment. Natural disasters and threats have often changed both the external and internal patterns of entire regions.as shown in (Fig. 6) Even today, the only way to avoid harm is to be aware of the environment, but unfortunately, Slovenian society has not yet fully developed this awareness [17]

Due to the frequent occurrence of earthquakes and their successive negative effects, a series of measures have been taken at the level of buildings and the city, and new methods have been used in order to prevent damage to buildings and provide resilience spaces in Slovenia: [17]
A. Make the center of gravity of the building as low as possible.
B. Strengthen and carve the corners of stone buildings made of large stones intricately, as they are the most susceptible to damage .
C. Provide outdoor balconies, patios, and backyards as well as living, sleeping and kitchen areas.
D. Achieve the necessary resiliency, which will achieve the expansion of the existing structure in the future to meet the needs and enhance the activity.

E. Providing resilience for indoor and outdoor spaces according to activity and daily needs is sufficient, along with creating a sense of space, natural lighting, ventilation, and door and window openings of the appropriate size and height of the rooms.

On the other hand, there are three requirements that must be integrated into the construction of earthquake-resistant structures, according to numerous researches conducted in Slovenia. These requirements are as follows: [30]
A. Knowledge of earthquake-safe buildings, the formation of the appropriate structure, structural details and the choice of a transport system.
B. Compliance with rules and laws (structural and dimensional regulations)
C. The design of earthquake-resistant buildings, resilience architectural design options, compliance with laws and regulations all have an impact on how the structure behaves during an earthquake .
After dealing with the Slovenian experience in dealing with the effects of earthquakes as one of the types of natural disasters and the solutions developed for this, it is possible to come up with a set of indicators according to the following table: (Table. 2)

Table 2: Represents applications to architecture and urban design after the earthquake disaster in Slovenia (prepared by the researcher)

Location	Space-wide effectiveness	Effectiveness at the structural level	Urban-level effectiveness
Slovenia	1. The presence of living, sleeping and cooking areas with access to balconies, courtyards and backyards. 2. Provide sufficient indoor and outdoor space, as well as natural lighting, ventilation, door and window openings of the appropriate size and height of the rooms. 3. Provide an additional basic room in case the House needs to be expanded in the future	1. Lower the center of gravity of the building. 2. He carved reinforced structures as well as the corners of stone buildings built of massive stones. 3. Provide sufficient wall openings for each area to get sufficient amounts of natural light and air flow. 4. The possibility of structural expansion in the future to better serve the activity and meet demands.	1.Construction of separate housing, sanitary facilities, a spacious and open Central Area, front and outdoor open spaces, adjacent common walls, a common place for planting trees. 2.Earthquake-resistant buildings must meet three combined conditions, namely: A _ Understanding the design of earthquake-resistant buildings B _ monitoring regulations and legislation C. access to architectural design alternatives.

4.3 *The United States experience / the 1906 San Francisco earthquake:*

The city of San Francisco had a rich and diverse urban fabric that was unified and refined, but environmental changes led to the creation of a group of neighborhoods associated with this fabric and the emergence of many open spaces that led to the deformation of the network at its confluence with the hills, as shown in Fig. 7. With the occurrence of earthquakes in this city, the multiplicity of neighborhoods and open squares has produced several possibilities to deal with these earthquakes before the availability of official and organized relief efforts. that is, the need for one community to join hands and encourage each other to overcome the effects of this disaster and resume their normal lives [26].

There were several earthquakes, and everyone highlighted the necessity of creating areas that would make it easier for people to evacuate. Using relationship analysis, the case study of the 1906 San Francisco earthquake is exemplary. [29]

On the other hand, the idea of diversity (by which the diversity of form was meant in terms of its ability to encourage social diversity, economic health, or

creativity, and the greater the diversity, the greater the ability of a group or system to adapt to a wide range of different and sometimes unpredictable conditions) was used to describe a key source of future choices and the ability of the system to respond to change and chaos in different ways. The more diverse the group or system, the better its ability to adapt to a variety of different and sometimes unpredictable conditions. Jane Jacobs proposed the following four requirements for urban diversity: multi-use land, multi-use blocks, diversity in construction, and appropriate urban density [26].

Some studies after the San Francisco earthquake in the USA have put forward the idea that squares, parks, and sports fields are necessary for earthquake preparedness, as they are the safest locations during and after the earthquake from its effects such as building collapse, falling debris, and gas leakage (Fig. 8). There was a need for recovery after the earthquake, and parks played a key role as a source of information, community support, and shelter for affected people.

On the other hand, the term accessibility refers to how fast one has to move to get to a place, i.e., it is a measure of how close two places are to each other. It is a resilient and comprehensive term that describes how fast or how far one must travel to reach a secure location. There have been several studies on earthquakes in America that describe this term as an indicator of how close two sites are to each other. When calculating earthquake losses, access to safe places during earthquakes is extremely important.

Figure 7: View of Stockton Street from Union Square after the 1906 San Francisco earthquake and the fires in 1906 after the earthquake

As a result of several studies after the earthquake in America that demonstrate the importance of having enough time to reach evacuation centers during earthquakes, it was discovered that in severe earthquakes, survival rates for those who find it difficult to evacuate quickly decrease. They should be as close to the population as possible in a safe area without hindering traffic, close to medical facilities, security centers, and fire stations. Euclidean distance is also used to analyze three sub-parameters of accessibility: [22]

1. Distance from the main roads.
2. Distance to residential buildings.
3. The distance to get to the service centers (health centers, security stations, and fire stations)

On the other hand, many urban areas act as good barriers during the day but lack sufficient supporting elements at night, so some public areas such as stadiums, public places, etc. Cannot effectively fulfill their roles in disaster prevention. These areas are affected by favorable conditions for disaster prevention, such as accessibility, the availability of open spaces, and the identification of dangerous buildings that are difficult to reach.

Therefore, due to the lack of systematic planning and development of night-specific facilities such as emergency disaster lighting systems, they will significantly reduce the ability of space to prevent disasters. Urban space is only a small part of the ability to prevent disasters and the ability to cause them in the urban environment.

Increasing the disaster prevention capacity of urban space or suppressing the disaster-causing capacity is one of the goals of developing a system for disaster prevention at night. In addition to the fact that more resilient urban areas can prevent disasters at night, at the same time, the initially isolated and restricted disaster prevention space begins to take into account the impact of radiation on the environment and is important for the development of a full-fledged system of relief in the night space. To ensure the success of disaster-related escape attempts. [11]

Figure8 : Ruins near post and Grant Street When viewed from 2,000 feet (610 m) above San Francisco Bay

San Francisco was a city with wide grid streets with alternatives to many modes of transport and a system of uniformly spaced parks that were all left largely undisturbed due to the huge amount of money to be spent on government improvements. The creation of open spaces gave the city plenty of room to roam. The city has long been proud to have the most open space per capita of any city in the United States. Consequently, the city's resilience is constantly being tested by fires and earthquakes.
[26].

After dealing with the American experience in dealing with the effects of earthquakes as one of the types of natural disasters and the solutions developed for this, a set of indicators can be developed according to Table 3

Table 3: Represents applications to architecture and urban design after an earthquake disaster in the USA (Preparation of the researcher)

Location	Urban-level effectiveness
United States of America	**1.** 1. The need to provide open spaces between and around buildings, as they are suitable spaces for gathering when earthquakes occur, away from the effects of the demolition of buildings and their damage and impact on the lives of residents. **2.** 2. The need for open squares and large parks to provide gathering places, an indication for those fleeing from the effects of earthquakes and those affected by them, and the possibility of access for those who are homeless after earthquakes. **3.** 3. Serious thinking about the design of cities, spaces, and paths to achieve the concept of accessibility, i.e., quick access to safe places and evacuation centers, and by covering short distances. **4.** 4. Achieving the concept of accessibility, which is achieved by ensuring the necessary time to walk from buildings to safe areas, calculating the distance between main roads, and achieving the distance between safe areas. **5.** 5. The contribution of proper planning to reduce the effects of disasters, including earthquakes, in terms of the availability of transportation alternatives 6. Applying Jane Jacobs' four requirements for urban diversity, namely: A mixed-use land. B. Diversity in construction Use low-rise blocks. D_urban density

5. CONCLUSIONS

After studying the impact of crisis engineering on architecture through several experiences of natural disasters, the following conclusions were drawn:

1. Through the study of the global experiences of countries that suffered from the effects of earthquakes, found important solutions at the level of urban design and architecture, and clearly showed the realization of the contents of crisis engineering, the following was drawn:
2. At the urban level: the need to choose alternative sites for housing and use state parks as safe sites and provide shelters
3. spread throughout the city, while parks act as fortified sites, as well as showing the importance of designing earthquake-resistant buildings with monitoring legislation, finding design alternatives, and providing open spaces between and around buildings.
4. On the other hand, note the need for alternatives to relocation and the application of the Jane Jacobs concept in the provision of mixed-use land, the use of low-rise buildings and diversity in construction and density.
5. at the level of architecture (residential complexes): the need to achieve a design that ensures the construction of separate dwellings with open and central spaces and the provision of evacuation centers, temporary housing, and long-term housing.
6. at the level of spaces: the need to provide open spaces in addition to the presence of living areas, a kitchen, and easy access to open spaces, with the provision of natural lighting, proper ventilation, and additional rooms for the purpose of expansion.
7. at the structural level: studying the need to achieve a thoughtful structural design considering the reduction of the center of gravity of the building. And provide openings in the wall for lighting rooms with the possibility of future expansion.

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هندسة الأزمات استراتيجيات التعامل مع الكوارث الطبيعية (الزلازل نموذجا) .

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الخلاصة – مع تزايد حدوث الكوارث وحالات الطوارئ في العالم وتزايد مخاطرها وتأثيراتها السلبية على الإنسان والمباني والمدن، برز مفهوم هندسة الأزمات كمجال دراسي حيوي يركز على إعداد التصاميم الاحترازية المبتكرة وتطويرها. الحلول المناسبة لمواجهة التحديات الفريدة التي يفرضها هذا النوع من الكوارث مع التركيز على الاستجابة السريعة والقدرة على التكيف والتعاون. مع المحاولات الحقيقية التي تقدمها هندسة الأزمات لتقديم حلول لحماية الناس والحد من الأضرار الناجمة عن الكوارث الطبيعية في المباني والطرق والمساحات، ولكنها في الوقت نفسه تديم نهج رد الفعل تجاه الكوارث والأزمات، لذلك تأتي أهمية يسلط البحث الضوء على الاستراتيجيات المستخدمة في التجارب العالمية تجاه الكوارث الطبيعية، وخاصة الزلازل وعواقبها وآثارها، والوصول إلى ابتكارات التصميم والتخطيط التي من شأنها التخفيف من تأثير الكوارث الطبيعية وضمان التعافي السريع والمرونة للمجتمعات المتضررة، حيث حددت الأبحاث أ مشكلة تتمثل في بيان مدى أهمية هندسة الأزمات في التعافي من الكوارث والأزمات والاستراتيجيات المستخدمة لتعزيز المرونة المطلوبة في الفضاءات الداخلية والخارجية للمباني والمدن بعد الكوارث الطبيعية والزلازل بشكل خاص. كما يفترض البحث أن هندسة الأزمات وتحديد الاستراتيجيات المناسبة للتعامل مع الكوارث الطبيعية لها أهمية كبيرة في الحد من آثار هذه الكوارث على الإنسان والهندسة المعمارية والتصميم الحضري.

الكلمات الرئيسية – هندسة الأزمات، الكوارث الطبيعية، الفضاء المرن، المدن المرنه .