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The Developing Public Square Into Eco Square (Case Study Of Martyrs Square, Tripoli)

Transforming Martyrs' Square in Tripoli into an Eco-Square: A Sustainable Framework for Urban Public Space Regeneration

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Abstract

This paper will cover the analysis of the possibility of transforming Martyrs' Square in Tripoli into an ecological environmental square that puts into practice the principles of environmental sustainability. Squares are vital components within cities, contributing to enhancing urban competitiveness and forming an important part of the urban, social, historical and cultural fabric of the city. However, with the increasing environmental challenges and the absence of sustainability features in cities, urban planning needs to address this problem by focusing on developing such areas into sustainable ecological areas. Martyrs' Square is one of the most important and largest squares in Tripoli, but it lacks environmental sustainability features.

Through this paper, the theoretical concepts for transforming the urban environment in an integrated manner are reviewed, and the current situation of Martyrs' Square is studied and analyzed. Then, it is proposed to integrate environmental sustainability practices to develop the square into an environmental square. Among these suggestions are the use of solar panels to provide a source of clean and renewable energy, and the use of natural materials and the place to reduce the environmental impact, in addition to relying on local plants to increase biodiversity and add water bodies to moderate the atmosphere and reduce temperatures. By integrating all these elements into the square, Martyrs' Square can be developed into an environmental square that can enhance the principles of environmental and social sustainability. This article has reached the presentation of a model for developing Martyrs' Square into an environmental square that can be implemented, and taken as a model to be followed and implemented in other locations to improve the urban environment by providing a healthy and sustainable environment for its citizens.

The study recommends integrating eco-retrofitting strategies into urban planning policies, promoting renewable energy and green infrastructure in public squares, and strengthening community and governmental support to ensure long-term urban sustainability.

Keywords: Eco-Urban Transformation – Sustainable Public Squares – Ecological Urban Design – Green Infrastructure – Urban Sustainability – Martyrs' Square Tripoli

1. Introduction

The Squares are important components within cities that improve urban competitiveness. These spaces constitute an important part of the urban, cultural, social and historical fabric, in addition to their importance in the visual formation of cities. This article studies environmental spaces and analyzes their characteristics such as providing green spaces,

improving air quality, reducing the heat island effect, enhancing biodiversity, etc. It also studies the importance of integrating them into urban planning and their impact on shaping cities and reducing pollution. It aims to study and explore how to develop Martyrs Square in Tripoli and transform it from a square with limited and unsustainable use into a square that applies sustainable environmental principles as much as possible and improves the quality of life in the city.

With the increasing population in cities and the increasing environmental challenges such as the decline of public spaces due to urbanization, there is increasing pollution, decreased quality of life among citizens, and decreasing levels of environmental resources. There is now, more than ever, an urgent need for intervention regarding these factors to strive for environmental sustainability.. Urban squares in many cities need to be revived and developed into environmental spaces to enhance environmental sustainability. This article came in the context of the urgent need to promote the principles of environmental sustainability in Tripoli, as Martyrs Square is one of the most important, largest and oldest squares in the city. Despite the renovation and development of the square, it lacks the characteristics of environmental sustainability.

A more holistic approach to developing an integrated transformation plan for the study area of Martyrs' Square was undertaken. Related theoretical concepts of urban environmental transformation were reviewed, and then, the site of the square was studied and analyzed. Through this, it was proposed to incorporate environmental sustainability practices through a number of elements, including installing solar panels to provide a renewable and clean source of energy, a water recycling system, and reusing it in the irrigation of green spaces, providing water surfaces for the field. It will be using natural and local materials to reduce the environmental impact, in addition to relying on local plants to enhance biodiversity. The research presented a model for Martyrs' Square in order to apply it to other areas to transform their public squares into environmental squares; this contributes to the improvement of the urban environment and provides a healthy, comfortable environment.

2. Definition of Environmental Design and its Importance.

Environmentally conscious design, or what is known as eco design, is an approach that aims to improve environmental quality and reduce harmful negative effects by designing buildings and spaces that enhance environmental sustainability. Environmental design also targets the characteristics and principles of sustainability, which are energy efficiency, water recycling, the use of environmentally friendly materials, reliance on ventilation and natural lighting, and reliance on renewable resources, which emphasize the importance of achieving a balance between social, environmental, and economic aspects. (Singh , et al.2024)

In the modern context, when the world is facing increasing environmental challenges, environmental design assumes paramount importance. Among its many positives, one of the important aspects of environmental design is improving the quality of life by creating healthy and safe environments, thus enhancing mental and physical well-being. For instance, open green spaces and planting areas are associated with the alleviation of psychological stress and the improvement in the well-being of citizens, (Heymans et al. 2019). Ecological design ensures a future that is economically sustainable through the implementation of energy-saving technologies such as solar panels and natural heating and cooling systems. These bring down the operational and maintenance costs drastically, thereby releasing more finances for investment in other aspects of the community. Moreover, the use of sustainable building materials minimizes the environmental and economic costs associated with the extraction and manufacturing of traditional materials (Russo, & Cirella. 2020).

Eco-design also plays a pivotal role in responding to climate change by integrating sustainable building practices that reduce carbon emissions and, therefore, the negative effects of climate change, hence building resilience within communities to adapt to evolving environmental conditions.

This method, which integrates natural ecosystems and built settings to enhance human well-being and promote sustainability, is fundamental to architecture and urban planning (Raven et al., 2018). Important tactics include integrating green spaces and using sustainable natural materials and systems to increase energy availability, both of which improve living conditions and preserve biodiversity. Examples are that green infrastructure solutions, like green roofs and urban forests, reduce urban temperatures and manage storm water runoff; they therefore reduce the magnitude of the urban heat island effect (Russo, & Cirella. 2020). Besides, environmentally sensitive urban design favors social sustainability through the realization of inclusive public space for community engagement in urban quality. Adopting ecological design concepts is essential as cities grow in order to promote socially and environmentally responsible urban development (Heymans et al. 2019).

3. Basic Principles of Sustainable Environmental Design in eco Squares

The Eco-square, also known eco-neighborhoods or eco-districts, becomes one focal point that answers the functions through adaptation of cities as a function in a variable way. Today, squares serve as open spaces where functions such as shopping, entertainment, and traffic are realized, as well as a gathering area and a point of interest for tourists coming to the city. From time to time, they act like a link between the past and the present, depending on their location. Squares are an identity within a city and also its most visible element.(ERYILDIZ . in press)تراجع

In order to design eco-squares, the basic principles must be taken into account, starting with energy efficiency, as they are designed to optimize energy use through features such as energy-saving technology and renewable energy sources such as solar panels. According to (Heymans et al. 2019), this reduces dependence on fossil fuels. Besides, eco-squares are designed and constructed using locally sourced, recycled, and biodegradable materials and renewable resources also, (Russo & Cirella, 2020). Rainwater harvesting, grey water reutilization and low flow devices are the systems that save water through the rational use of water resources recycling, composting, and waste reduction in construction, in order to achieve near-zero-waste goals. Of importance will be social sustainability since the eco-square is designed to contain public space that allows for community engagement, social interaction, and accessibility for all, improving quality of life (Heymans et al. 2019). By integrating these considerations, eco-squares embody solutions to environmental challenges and become models for sustainable development, proving that environmental care and urban achievement go hand in hand.

4. The importance of rehabilitating the city square in an environmentally friendly way

Eco-retrofitting urban squares refers to a strategic transformation of already existing public areas to become ecologically more viable, socially healthier, and economically viable. The idea is to engage in incorporating green infrastructure, energy-efficient technologies, and sustainable materials in order to upgrade the traditional city square into an eco-friendly hub. The importance of eco-retrofitting in urban planning is underlined by a number of reasons

The main benefits include the reduction of the urban heat island effect. Indeed, retrofitted urban squares with green roofs and other vegetated areas can effectively reduce ambient temperatures, thus increasing the thermal comfort of citizens. These green infrastructures

also contribute to stormwater management through the absorption of rainfall, reducing the risk of flooding in urban areas (Shafique et al, 2020)

On an economic basis, eco-retrofitting may contribute to high energy savings. In a public square, energy-efficient lighting and renewable energy like solar panels minimize operating costs and, hence, reduce the amount of CHG emitted to the environment (Correia & Fazion, 2023). Also, sustainable materials used in retrofitting activities reduce environmental destruction and benefit the local economy by increasing demand for the resource available locally (Kong et al., 2024)

Socially, eco-retrofitted squares offer all-inclusive public spaces that contribute to community interaction and the overall quality of life in an urban setting. The square in an urban setting have been included to reduce psychological stress and increase good mental health among the populace (Heymans et al., 2019). Additionally, these are places where education can occur to heighten awareness toward living more sustainably and cultivating a culture of environmental care.

Another important benefit from the retrofitting of urban squares for eco-purposes: this activity enhances biodiversity in these cities. Native plants, trees, and water features in a retrofitted square facilitate the building of microhabitats within which wildlife thrives in the balance of the entire ecosystem (Raven et al. 2018). Such features provide respite to urban biodiversity as well as improve air quality and give recreational opportunities to residents of the area. Additionally, green and blue infrastructures within city squares are core parts of climate change adaptation as this enhances the resistance of a city against environmental jolts such as extreme weather conditions and temperature rise (Russo & Cirella. 2020).

the eco-retrofitting of city squares is an important intervention in modern urban planning, and thus eco-retrofitting answers to environmental problems, supports economic sustainability, increases social well-being, and strengthens urban biodiversity to create resilient and livable cities.

5. Case Study

The case study of Martyrs Square in Tripoli was chosen due to the great historical and cultural importance of the site in the history of Libya; it has also played a very important role in the social and political life of the city. It is also very centrally located, adding to making it an active and influential center in daily life for its residents of Tripoli. Figure 1 shows an aerial view of Martyrs' Square in Tripoli, showing its central location and the historical landmarks surrounding the area. (Google Earth. 2024) تراجع

Google Earth 2024) Figure 1 Martyrs Square (

5.1. History and Importance of Martyrs Square in Tripoli.

All capitals of the world have a square that holds historical events related to their peoples, and in Tripoli, Martyrs' Square enjoys a special place in the hearts of all Libyans. It narrates different political transformations the country went through and became an open space for their joys and sorrows, gatherings and victories.

Martyrs' Square is considered one of the most important historical and cultural squares in Tripoli, as the square has gone through many different periods of time. It was established in the twenties during the Italian occupation as part of an urban plan to expand the city of Tripoli outside its old walls, and then named "Piazza d'Italia". The square was designed to be a modern urban center, and was also a gathering place for Italian elites, (Anderson .1986) and witnessed many official celebrations. In 1951, after the declaration of Libya's independence, its symbolism changed to become a place that celebrates national sovereignty. The square's name was changed to "Independence Square". Later, it was called "Martyrs Square" in commemoration of 14 Libyans executed by the Italian occupation in the 1930s, making it a symbol of national resistance and dignity. Then the name changed again and became "Green Square". In 1977 when the Jamahiriya regime created it in honor of the color of the state flag and the Colonel's book, which was considered its constitution. Finally, after the revolution of 17 February, the name was changed and returned to Martyrs Square. With each of these names, the square speaks about the history and policies that Tripoli has gone through.(Al-Arab. 2022) & (ALDUWYAB.2019)

The square was and still is a place for various activities ranging from life to politics, religion and society. Before the square was planned and built, it was a shopping area for selling bread, so it was known as the bread market. After it was built. It has been transformed many times into a square for political events and occasions such as military parades or receiving politicians. It has also witnessed tragic events, the most important of which were the executions of Libyans by the colonizer, as mentioned by hanging 14 on a platform erected in the square. It has also witnessed religious occasions, as the Prophet's birthday celebrations were held there. In addition, the square is considered a place for organizing many official and national celebrations (except for the nineties, when the square was unfortunately converted into a bus station)(Tieob. 2020). Figures 2 and 3 show some of the activities taking place in Martyrs' Square.

Besides its historical significance, Martyrs' Square also plays a significant role in the social and cultural life of the city. It is not only a place for celebrations and public gatherings but also considered a meeting point for residents and visitors of Tripoli. Many tourist and cultural landmarks, such as government buildings and museums, are located around the square, making it a center for cultural and tourist activities within the city (Al-Arab,2022).

Figure 3 Italian military parade in 1912 in the square)(Al-Arab, 2022

(Al- Organizing official parties in the square Figure 2 Arab, 2022)

5.2. Current Status and Site Analysis

Site Context

Martyrs' Square is located in the in the center city of Tripoli, the capital of Libya, and is considered the beating heart of the city from a cultural and social perspective. Near the Mediterranean coast, it is adjacent to major landmarks such as Tripoli Castle (Assaraya Al-Hamra) and the Central Bank of Libya. The square extends over a large area of approximately 20,065 sq. meters, making it one of the largest public squares in Tripoli.

As for the perimeter of the square, the garden borders from the north-east, overlooking the Mediterranean Sea, where the buildings that separated the square from the Corniche were demolished during the Gaddafi era. The square also overlooks the traditional market and the Assaraya Al-Hamra Museum from the northwest.

As for the north, it overlooks an artificial lake that was created after filling in large parts of the sea, whose waves were crashing against the walls of the old city. As for the southwest, it is surrounded by some residential buildings and commercial and financial buildings, including the Bank of the Republic, which is a historic building known as the Banco di Roma. As for the southeast, it is surrounded by multi-purpose and multi-storey buildings and some open spaces. The figure4 shows the location of the square and its perimeter. As seen in satellite Figure 4 of Tripoli, Libya, Martyrs' Square are centrally located within the urban fabric (Google Earth, 2025)

Figure 4 Martyrs' within the urban fabric. (Google Earth ,2024)

Sun Pattern and Prevailing Wind Analysis

Martyrs Square is located in Tripoli, which is located at approximately 32.9 degrees north latitude, which affects the path of the sun throughout the year. In the summer, the sun rises on the square from the northeast and sets from the northwest, so the period of sunshine is long and the angle of solar elevation is high at noon. Since Martyrs' Square is an open and unshaded area, it is exposed to intense sunlight throughout the day, especially at noon.

As for winter, the sun rises from the southeast and sets from the southwest with a lower elevation angle, meaning that the square’s exposure to sunlight is less intense than in summer,

but still significant. In general, the square is exposed to high solar brightness throughout the year. (Sun Direction,n.d.).

As for the winds, the north-easterly winds (cold winds) blow in winter, which may make the square cooler and less comfortable for users. In summer, the north-westerly winds (sea breezes) blow, which provide cooling effects to the site. In addition, dusty winds blow, especially in spring and autumn, which affects comfort during these winds.

Figure 5 provides a detailed analysis of Martyrs' Square in Tripoli, illustrating the interaction between solar patterns and wind directions. It shows a visual representation of the sun's path over Martyrs' Square in Tripoli. The yellow areas highlight the sunrise and sunset directions at different times of the year. The blue arrows indicate northeasterly winds, the red arrows represent sea breezes, and the green arrows depict dusty winds.

(Figure 5 Sun and Wind Analysis of Martyrs' Square) 2024Google Earth

Architectural Urban Fabric

The urban layout of Martyrs' Square reflects the diversity of architectural styles. The square is surrounded by buildings from different eras, with narrow, dense and compact streets on the southern and western sides, while the eastern and northeastern sides provide open spaces and organized development. Thus, the square enhances the national, cultural and historical identity of the city and is considered a point of attraction for tourists and social interactions.

Roads and Transportation

The roads surround the Martyrs Square from all sides, as the square is connected to main roads such as Omar Al-Mukhtar Road, Al-Wadi Street, Mizran Street, and Muhammad Al-Maqrif Street. This ensures easy access to it, as well as connecting to the Corniche Road, which is considered a main artery , providing access to coastal activities and linking the different parts of the city. Most of the time these roads witness traffic congestion, especially during rush hour (traffic times to and from work and schools).

Topography

Martyrs' Square has a relatively flat topography, making it ideal for public gatherings and pedestrian traffic. The fountain's location was designed to be slightly elevated from its surroundings.

Current Status of Martyrs' Square

The current situation of Martyrs' Square can be described and analyzed according to the basic elements that are considered necessary and must be available in any ecological square. Then the description is as follows:

Social and Psychological Elements

Martyrs' Square is considered an important social center in Tripoli, where national and cultural gatherings and celebrations are held. The square has great symbolic importance, as it enhances the sense of national belonging and social interaction. However, the square lacks green spaces and infrastructure that contribute to improving the psychological comfort of users.

Physical Elements

The square contains physical elements, such as a fountain that was designed during the Italian colonial period and palm trees, It also has a display screen. However, the square lacks statues and models that contribute to enriching the cultural and visual dimension of the place, it also lacks seating areas. Visual appeal can be enhanced by adding more of these elements and improving their maintenance. Figure 6 shows the fountain and palm trees in the square.

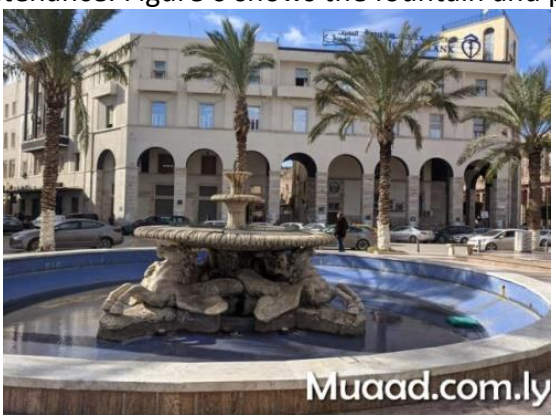

Figure 6 fountain and palm trees (muaad.2024)

Continuity of borders

The Figure 7 shows that the borders of the square are well open, allowing visual and spatial communication with the surrounding streets and buildings. This openness contributes to enhancing the interaction between the square and the surrounding areas, making it an integrated part of the urban fabric. The heights of the surrounding buildings range from low to medium, surrounding the square from three sides, while the fourth side is open to the ground and then the sea, The square is also surrounded by low-rise concrete squares that define the square which contributes to the continuity of the borders and spatial openness.

Figure 7 The boundaries of the martyrs' square are shown. (Google Earth 2024)

Pedestrian movement

The square lacks a clear definition of pedestrian spaces

.**Resistance to vandalism**

Resistance to vandalism is a challenge in Martyrs Square, as it requires better security measures and constant monitoring to maintain the cleanliness and beauty of the square.

Lighting elements

The lighting element is available in the square. The lighting system should be improved to be more efficient and sustainable.

Water element

The water element is available in the square in the form of a fountain located in the southern part of the square. Therefore, it can be said that the water element is available in the square , but not in sufficient quantities.

Green spaces

The square lacks green spaces, plants and trees. There are nothing in the square except for some palm trees in the southern and northern parts of the square.

By analyzing the current situation of the square, it became clear that the square lacks many of the basic elements of square design, as well as the characteristics of the environmental square. The square appears as an open square with a rigid character devoid of natural features that contribute to mitigating the severity of its destructive appearance. Also, the square suffers from visual emptiness and gives an impression of dryness, which makes the square less comfortable and attractive. In addition, the square suffers from the lack of shaded areas, which contributes to the lack of enhancement of the social and aesthetic aspect. It is necessary to focus on adding and improving these elements and characteristics to provide an integrated and sustainable experience for users.

6. Eco retrofitting of city square.

It is clear from the current situation of Martyrs' Square in Tripoli that there is a dire need for development and improvement to realize its full potential as a major environmental square. Given its shortcomings in trying to meet modern standards of urban sustainability, we found that the following suggestions for environmental modernization may contribute to improving and developing the current situation and contribute to enhancing the sustainability aspects of the square. The following figure shows a model of a proposal for developing and modernizing the square.

Figure 8 Proposed model for developing and modernizing the Martyrs' Square

The proposal focused on adding the basic elements of ecological squares that support environmental sustainability. These proposals are as follows:

6.1. LIGHTING AND ENERGY SAVING.

Solar Panel-Based Electricity Poles Installation

Lighting is essential to attract visitors and ensure safety in Martyrs' Square, and it also contributes to enhancing the overall experience of the place. To save energy and transform the square into a sustainable urban space, the use of solar panels is an effective solution. Solar panels provide clean and sustainable energy that reduces dependence on traditional sources, thus reducing the square's carbon footprint.

Accordingly, the researcher proposed the use of solar-powered electric poles. This proposal takes into account the locations of the solar panels to make the most of the sun's rays and avoid shading the buildings. Moreover, the panels are oriented to the south at an angle of 33 degrees in order to obtain the maximum amount of sunlight throughout the day. This not only contributes to energy efficiency, but also makes the square more sustainable and environmentally attractive. Below is an illustration of the proposed solar panel lights in Martyrs' Square.

Solar Panel-Based Shades and Seating Areas

Shading is an important factor that must be available in the square due to its exposure to strong and direct rays, which contributes to reducing the attractiveness of the square due to the lack of means for the comfort of visitors.

To enhance thermal comfort, the researcher suggested adding innovative sunshades as architectural elements equipped with solar panels that adhere to the conditions of the site and the angle of inclination, and other sunshades that rely on natural elements such as trees. These sunshades improve the conditions of sitting and movement and also contribute to reducing the thermal effect reflected from the ground. Not only that, but the sunshades also provide an aesthetic view of the square. As shown in the figure 9.

Figure 9 shade structures

On the other hand, seating areas are important and essential elements that must be available in the square, as they contribute to enhancing comfort and providing a suitable environment for social and recreational interactions. Given that Martyrs Square lacks such areas, the researcher suggested that the chairs be sustainable and equipped with solar panels, which enhances environmental sustainability and provides an innovative environmental dimension, as lighting can be operated or electrical devices charged by relying on the solar panels on the chairs, making the square a smart and environmentally friendly destination. In addition, designing the chairs in a different way than usual enhances the beauty and functionality of the chair, enhances the users' experience, and encourages the use of the square as a place for relaxation and community meetings. As shown in the figure10.

Figure 10 Solar panel shaded chairs

6.2. Water element and water recycling system.

Among the design elements, the water element plays an important role in developing the squares by beautifying the place and adding calm and atmosphere, thus increasing its attractiveness to visitors. Water also enhances the comfort of visitors and creates a comfortable environment where people can stay comfortably and socialize. In addition, recycling and conserving water is an integral part of environmental sustainability in the squares. With a water recycling system, one can reduce water waste for proper use in watering plants and cleaning the area.

Due to the scarcity of rainfall in Tripoli, the proposal to collect rainwater is not applicable. Based on this context, the researcher suggested relying on recycling wastewater (hand washing and washing basins) of the buildings adjacent to the square and using it to water the plants and clean the square. This in turn ensures effective use in an acceptable manner that achieves sustainability and survival Given the important role that the water element plays in

the environmental field and the availability of only one fountain in the field, the researcher suggested adding smart water bodies that regulate the flow of water based on the surrounding environmental conditions and rely on water recycling techniques as well as relying on the energy generated by solar panels to operate them. She also suggested adding small water ponds connected to recycled water to collect water and use it for irrigation, and to provide water for the birds and animals.

In this direction, such measures help increase the sustainability and beauty of the square, reduce water waste and provide an opportunity for innovation in environmental solutions and conservation of natural resources while reducing operating costs in the long term, thus serving as a role model for environmental sustainability. This proposal can be illustrated in the figure11.

Figure 11 Suggested man-made pond and fountains

6.3. Increase Green Spaces.

Arboretum and green spaces are considered essential and important elements in the squares, as green spaces enhance the general environmental quality and biodiversity, increase the beauty and attractiveness of the place, reduce temperatures and absorb carbon dioxide.

Based on the environmental importance and psychological comfort provided by green spaces, and taking into account the current situation of Martyrs' Square in Tripoli, it was suggested to add green spaces based on planting local plants and edible landscapes, which increases the sustainability of the square in terms of saving irrigation water and caring for plants, as local plants require less care and irrigation. Then it was suggested to add a diverse group of trees and plants, including olive and palm trees, which are considered a cultural symbol that expresses the identity of the country. Orange trees were also suggested for the bright colors they provide that enhance the aesthetic appearance of the square and the fragrant scents that provide a unique sensory experience. To increase diversity and beauty, goose trees were added, as they provide a charming aesthetic view, especially when their flowers bloom, which transforms the square from a static space into a natural painting full of beauty.

Not only that, but all of these trees are fruitful and contribute to self-sufficiency, which makes this proposal enhance the social, social and aesthetic aspects. For the field as shown in the figure12 and in Figure 8 also.

Figure 12 Adding local perennial trees

6.4. Waste recycling

Waste recycling represents an important method of realization of environmental sustainability in the public square, which might reduce the waste sent for landfills along with reducing negative environmental impacts linked to solid wastes. Recycling thus raises community awareness and informs them of the paramount importance of environmental preservation besides the adoption of environmentally friendly behaviors.

The recyclable waste can play an important role in keeping places like Martyrs' Square clean and more attractive for visitors, besides reducing costs related to waste disposal and attaining sustainable development goals. It has been suggested by the researcher to distribute recycling containers at different places in the square. The figure 14 illustrates an example of the suggestion .

Waste recycling proposal Figure 13

6.5. Open Spaces

The square hosts many cultural, political, social and entertainment activities. The researcher suggested that the space facing the screen should be empty (except for the places where windmills are placed to provide energy, as this direction is exposed to north-easterly and north-westerly winds) to be a place for parties, gatherings and various events, which enhances cultural activity and stimulates social interaction. Thus, the square becomes not only a place for rest and entertainment, but also a vital place for various activities, making the square a lively attraction.

6.6. Pedestrian and Transportation Movement

Securing the pedestrian engine is an important topic in the ecological square. To provide smooth and safe movement for users of Martyrs Square, the researcher suggested expanding the sidewalks and providing safe and wide walkways for pedestrians. She also suggested creating dedicated paths for cycling and encouraging their use. In addition, due to the heavy traffic, she suggested providing environmentally friendly public transportation to reduce congestion and reduce negative environmental impacts.

6.7. Results and Connections

The proposed measures will rehabilitate and develop Martyrs' Square and transform it into a sustainable and environmentally friendly urban square. Thanks to the integration of photovoltaic panels and wind turbines, the square will rely on renewable energy sources to meet its needs, while reducing its carbon footprint to ensure better energy efficiency. The canopies also provide an aesthetic view that adds to its actual function, in addition to that, the seating areas enhance social interaction and entertainment. Recycling water not only saves water, but also ensures maximum benefit from it by adding a water element to the square to achieve environmental sustainability, and make it more aesthetic.

Likewise, increasing the green space by planting native plants will serve biodiversity, improve air quality, and provide aesthetic and psychological benefits to visitors. In addition, recycling waste contributes to reducing landfill waste, community awareness, and practicing sustainability. Combining these proposals together allows us to develop a comprehensive and sustainable urban environment that meets the needs and functions of contemporary environmental squares, and sets a pioneering example for future urban developments. The interconnectedness of these improvements speaks volumes about the need for a comprehensive approach to urban sustainability in order to achieve long-term environmental, social and economic benefits for society.

7. Opportunities and Challenges

Opportunities

Cultural significance: The Square can act as a hot spot of cultural and historical heritage, allowing for cultural tourism and civic engagement.

Sustainability potential: Incorporating green infrastructure will add to thermal comfort and environmental benefits, such as shade, water features, sustainable paving material, solar energy systems, and reliance on vegetation.

Urban revitalization :Improvements in pedestrian routes and urban furniture can transform the square into an everyday attractive destination. The installations of arts or temporary architecture can turn the square dynamic, capable of change according to various events

Challenges

Traffic congestion: The main roads surrounding the square, including the Corniche Road, as well as the roads around it, can lead to heavy traffic, which can limit pedestrian safety and comfort.

Preservation versus modernization: On the one hand, this involves a balance between the historical and cultural identity of the square and modern urban interventions.

8. Conclusion and Results

Being one of the most prominent public spaces within Tripoli, Martyrs' Square holds a huge historical, cultural, and social significance. Its existing condition lacks any of the essentials of environmental sustainability, in terms of greenery, energy consumption, and people's

comfort-which are usually the core elements that advance the quality of life and experience in urban life.

In this paper, some crucial environmental rehabilitation issues have been proposed for Martyrs' Square: the use of renewable energy sources, water recycling systems, enhancement of green spaces, and development of better waste management in a sustainable manner. The designs included solar panels which would act as a source of light and shadow, new water bodies with their own re-circulating systems, and planting of local and culturally symbolic trees such as olive, orange, and palm trees. These improvements will not only raise the aesthetic and environmental quality of the square but also promote biodiversity, mitigate the urban heating aspect, and socially and culturally engage people.

It called for sustainable seating areas equipped with solar panels, paths specifically set aside for pedestrian and cyclist use, open areas for cultural and social events by the people to encourage community interaction in support of the living city spirit. It also called for education on the environment; a setup of a system for waste recycling and other aspects of sustainability practices that could make the public potentially assume a culture of environmental care.

Outputs

Renewable energy implementation: Solar panels and windmills will carter for clean, renewable energy, reducing the carbon footprint in the square and increasing its energy efficiency.

Water recycling and sustainability: This incorporates water recycling systems to cater for irrigation and cleaning applications, enabling a better usage of the scarce resource to make the square self-sustained.

Increase greenery and biodiversity: Native plants and culturally significant trees will not only increase biodiversity but also help to purify the air, hence making it pleasant for all visitors to enjoy.

More social and cultural areas: Shaded seating, open event areas, and pedestrian-friendly walkways will enhance social interaction and cultural activities, positioning the square as a vibrant and inclusive urban focal point.

Waste Management and Community Awareness: Recycling systems would minimize landfill waste, inculcate better behavior, and raise environmental awareness among the community, adding to the overall cleanliness and attractiveness of the square.

Improvement of Thermal Comfort and Aesthetic Appeal: Shading structures and green spaces proposed would offset the impact of high sunlight and reduce the urban heat island effect to a more comfortable environment for visitors.

In conclusion, these set a broad framework in which Martyrs' Square can be upgraded environmentally to achieve an environmentally-friendly, sustainable public space. These interventions cater not only for the immediate shortages of the Square but also act as models for urban developments in Tripoli and elsewhere. By incorporating these components, Martyrs' Square will serve as a representation of environmental sustainability, cultural identity, and social inclusion that will work together to achieve a healthier, more livable urban environment for future generations.

These will also be useful in data and information that may be used in developing future policies and plans toward the betterment of public squares in cities for sustainability and environmental quality. Giving a model for Martyrs' Square as a sustainable environmental space might mark the beginning of an overall transformation toward more sustainable and environmentally friendly cities, thus helping to improve the quality of life for current and future generations. The study also suggests the need for the adoption of environmental

sustainability practices in urban planning and increasing community awareness of the benefits of such transformations.

Future research should focus on the performance evaluation of eco-retrofitted public squares through post-implementation environmental and social impact assessments, Comparative studies across different Mediterranean and North African cities are also recommended to generalize and validate the proposed framework, Additionally, policy-driven implementation strategies are essential to ensure the integration of sustainable urban design principles into long-term urban governance systems.

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