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ROOFTOP GARDEN IN RESEDANTIAL BUILDINGS

(AMMAN AS CASE STUDY)

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ABSTRACT

This research aims to learn about experiments roof gardens designed in residential buildings in the city of Amman – Jordan, and to study the possibility of utilizing it, taking in consideration the site and the age of building to illustrate the economic, social and environmental benefits as a step toward a sustainable Amman.

By using descriptive analytical methodology, qualitative data collecting and analysis approaches. The researchers divided the work plan into two phases; first phase is involved with sustainability of roof top gardens (environmental, economic and social) in Amman. As a step in enhancing awareness of rooftop gardens and relation to sustainability of Amman city, the researchers are collecting data which includes previous studies, and case studies on roof top gardens in Amman.

Then conducting a systematic analysis for the collected previous studies methodological approaches and founded results.

The second phase is a descriptive and analysis of two case studies in residential buildings private rooftop garden in Amman. First one is for Eng. Rami Abu Gosh and the second for Dr. Yasin Al-Issawi. The data regarding to these two case studies were collected by using interviews with users, colored photos and site visits

The research outcomes are expected to develop design indicators for the utilization of roof top gardens in Amman which response to principles of sustainability, weather social, environmental or economical.

1. Introduction

The climate change and the needs of local materials are a big problem in Arab countries Jordan is one of them (Verner, 2012). Therefore, the green areas with relaxation places have decreased in Amman (Arabnews, 2014; Tawk&Hamadeh, 2014).

The green roof top gardens is one of the most important strategies of green cities in order to reduce the rapid urbanization impacts. (Theodosiou, 2009). The rooftops are currently an untapped resource in the Jordan. Therefore, it must explore specially in residential buildings for creating a new life style (BayLocalize, 2007).

Roofs are important architectural elements for shaping the skyline of the city, and gives the building and protection from heat, rain and sun effects. Therefore, the ideal usage of these roofs are important to produces clean energy (Oberndorfer et al., 2007a).

Also we can say that rooftop gardens are founded to be there as a living, green area, provide play space, give shade and shelter, to the inhabitant, also it's intended to provide increased longevity of the roofing material, lowered urban heat island impacts, improved harvesting rain water, lowered urban heat island effect through their texture and color. On the other hand, the height solar reflected materials are helps in cooling the building, and save energy in a warmer climate, while (Ascione et al. 2013). While, materials with low solar reflectance, like rough, dark, rough rooftops, could help in heating buildings and saving energy in a cold climate. (Oberndorfer et al., 2007b).

There are Two types of green roof exist: extensive and intensive. Our research is about The insensitive green roof includes paving, furniture, built structures, sculpture, and often pools or fountains, flower and plants beds. It's also can provide human interaction like planting, walking, seating, relaxing, eating, playing and socializing …etc. such a project could substantially upgrade Jordanian lifestyle.

1-1 Significance of Research

There are many countries that has adopted the green roof system such as Japan, Egypt, Hong Kong, Emirates, china and others which has known the many benefits of this system however, Jordan still needs a huge improvement when it comes to research methods, policies, technologies and practice in this field. The construction industry in Jordan needs this technology to absorb heat radiated instead of getting absorbed by the roof surface to have a better internal comfort (A. Lu, 2009), reduce the consumption of energy which means low energy bills, improves environment and most importantly reduce urban density and increase green areas.

This study will also add a fresh knowledge to the Jordanian designers regarding the environmental importance of using this system in urban areas, reduce energy use in buildings, especially in urban area in Amman.

1-2 Problem Statements

The climate change, global warming, and ecosystem in the future of green cities are needs to be investigated, on the other hand Jordan is one of the water-scarce countries in the world, and the Jordanians cannot afford expending

precious water on different plants. Therefore, this research are proposed an important questions should be answered as follows:

1-3 Research Questions:

• How we could increase the awareness of the value of rooftop gardens and its environmental, social and economic benefits for the city of Amman?

• What is the design elements of rooftop garden and how could we make it useful?

1-4 Research Objectives

• To increase awareness of the value of roof top gardens and its environmental, social and economic benefits for the city of Amman.

• Identify obstacles and limitations that designers may face when applying a green roof system.

2.Literature Review

2-1 (Oberndorfer et al., 2007a).

The roof aria in Jordanian residential buildings unoccupied even though people in Jordan are facing a hard time in finding green personal spaces therefore, this research is a reminder of these unoccupied spaces that can solve special and environmental problems and at the same time create a green beautiful space. Such a project can significantly improve the Jordanian lifestyle.

Rooftop gardens as a way of building and design proved to be very successful in overcoming many environmental, agricultural, social and economic challenges therefore, the summary of this literature review will present a soled argument to use rooftop gardens in Amman in addition to activating urban agricultural activities in Jordan. (Al-Zu'bi, M., & Mansour, O. (2017).

2-2A Review on Aesthetic, Environmental, Economic and Social Benefits. (2012)

We can have divided the benefits of green roofs in to: ecological, environmental and social aesthetic benefits. There are a many crossovers between them.

Social aesthetic benefits include: health and therapeutic, visual aesthetic and food production value and public relations. Environmental Benefits include: air quality, wildlife value, water harvesting management; insulation of the sound & heat. Economic Benefits include: increased buildings life, insulation and energy efficiency; and green building assessment. (Rahman, A., Rafida, S., & Ahmad, H. (2012).

2-3 Performance Evaluation of the Aqaba Residential Energy Efficiency Pilot Project (AREE). 2010

The roof garden in this project was mainly filled with two kinds of plants: Carpobrptus[1] which works as a coverage for the ground whereas Nerium used for giving color and coverage with height to provide some privacy and isolation from the street. The tests that came after one year of observation shown that there was a great progress in decreasing the indoor temperatures, the plants were growing normally and the irrigation system was working perfectly yet, some common aesthetic problems were shown when some species growing too fast because of excess watering and the lack of iron and micro nutrients since its common when the plants are watered with gray water. (Rosenlund, H., Emtairah, T., &Visser, F. (2010).

2-4 (CSEB, 2017) Urban Agriculture in Amman: a Holistic View" Report (EN).

This report discuss the benefits and challenges of the slow return of urban agriculture in Amman through conducting and documenting some case-studies and the results of interviews with the Stakeholders in this process. The report focused on the household level of urban agriculture and the ways of developing it. (http://www.csbe.org/urban-agriculture 2017)

3.Urban Agriculture In Amman

Urban agriculture is the cultivation of plants and animals in an urban environment. This form of agriculture is integrated system with the urban social, economic and ecological system, by transforms the passive consumer into an active producer. This in turn creates a healthier living.

Green space in Amman does not exceed 2.5% to the total area, which is 1680 km2 (Whitman, 2013). The importance of agriculture in food security on the one hand and maintaining a clean environment on the other hand led the Greater Amman Municipality (GAM) in 2006 to establish a specialized Urban Agriculture Unit with dedicated human and financial resources, The program has beautified the surfacesof 110 homes (rooftop gardens), see Pic (1) Pic (2), in the eastern regions (poor and informal settlements) and included clean surfaces, cosmetic and cultivated. (http://www.csbe.org/urban-agriculture 2017)

3-1 (Gam) Amman's Urban Agriculture Program (2006-2011).

The Greater Amman Municipality (GAM) had developed a few initiatives relating to urban agriculture, the most significant of these projects is one carried out in Amman's Jabal al-Qal'ah district (2010). The project was initiated during the mayoralty of Omar Maani (2006 – 2011). The project initially was intended to simply clean up rooftops in the area from accumulated discarded items and to decorate them with layers of pumice stone sincethe area is located in an important touristic and cultural heritage district of the city, near the Amman Citadel.

The project, however, grew and expanded to also develop rooftop gardens for these houses. GAM enthusiastically embraced the project at that time, and there

[1]Carpobrotusedulis is a ground-creeping plant with succulent leaves in the genus Carpobrotus, native to South Africa. It is also known as Hottentot-fig,[1] ice plant, highway ice plant or pigface and in South Africa as the sour fig

even were plans to extend it to cover 10,000 rooftops in different parts of the city. This, however, was not realized. The Directorate offers items to every resident trying to join the project, along with some plants and various types of watersheds, plastic cups or even water bottles hooked up to the walls, roofs and terraces The proposal has, to date, embellished the roof of 110 residences and approximately 50 have been selected from each of the samples in different parts of the capital, Amman, mostly in eastern provinces. (Stiftung, Friedrich-Ebert (2019)

3-2 JadalFor Knowledge and Culture (2017)

This center, which is located in jabal al uweibdeh,and downtown by using public stairs connecting them. It was designed and built by the Greening the Camps team and implemented during 2017 .this center has a rooftop garden planted with many different organic products .It includes two green houses, one for wicking bed system, and the other for hydroponic methods, in addition to a composting bin. (Stiftung, Friedrich-Ebert (2019)

3-3 Urban Agriculture in Jerash Refugee Camp. 2017

This project are create Rooftop garden in houses of Palestinian's families that are in the refugee camp near jerash. This project are started before two years a go by national volunteers with team of green camping in Jordan, they try to connected with Palestinian refugees with their culture of farming. The project touches on different levels, one of that is access healthy food, security life and there is big aspect of education passed all the knowledge ofPalestinian farmers from the grandmothers and grandfather over to the young children to turn the consumers into active produces to the people can start grown up to save money that they can spends on health care, or better education to have upgrade living .Stiftung, Friedrich-Ebert (2019)

3-4 Case Study Four in Amman, the Belgian Ambassador 2017

Rooftop vegetable garden in private residence building Hendrik Van de Velde the Belgian ambassador in Jordan, One of the biggest fans of green roofs, he created his own garden in collaboration with a professional designer in which he grows produce. The roof garden features around ten modules made of reclaimed palette-wood, and includes built-in seating and lighting.

The ambassador tended to work more in the garden during the growing season which taught him how to grow vegetables and herbs, fix the soil and to protect the plants from disease and wind. This experience conclusion that herbs are easier to grow than vegetables and that roof gardens can supply his family with at least 20% of their needs. As for the composting process, it does not produce smells, nor does it attract flies because the location of the bin on the roof is exposed to windy conditions. As for the garden creation, it was set on ten models each one of them is a raised bed with plastic lining and drainage for excess water. The bed is watered by a plastic pipe placed at the surface of the soil that leads to the bottom of the bed, where it distributes the water to make the water available to the plants by a 'wicking' system near the roots of the plants absorb their water needs through capillary action from the bottom up. This method promotes root growth and limits evaporation, and is ideal for arid climates. As for shade providence by a pergola and by grape vines planted at

the outer edges of the beds. The total budget for constructing this setup, excluding labor, was 2,500 JD. (http://www.csbe.org/urban-agriculture 2017).

4.Methodology

By using descriptive analytical methodology, qualitative data collecting and analysis approaches. The researchers divided the work plan into two phases; first phase is involved with sustainability of roof top gardens [environmental, economic and social) in Amman. As a step in enhancing awareness of rooftop gardens and relation to sustainability of Amman city, the researchers are collecting data which includes previous studies, In addition, to site visit and case study analysis to some of residential buildings in Amman that have green roofs implemented in their design. The data collected is qualitatively analyzed and used to identify indicators that help designers to create sustainable roof top gardens. This part engaged in sustainability main pillars (environment, economy and social) as a pace in improving Amman sustainability.

Then conducting a systematic analysis for the collected previous studies methodological approaches and founded results.

The second phase is descript and analysis of two cases in residential buildings private rooftop garden in Amman. First one is for Eng. Rami Abu Gosh and the second for Dr. Yasin Al-Issawi, the data regarding to these two cases were collected by using interviews with users, colored photos and site visits.

4-1 Local Case Studies in Amman, Description

Amman is Jordan's largest city, and capital. In the last years, population size in Amman has increased and it's now used to four million citizens. Amman's climatic conditions is warm and humid with averages reaching 33 ° C and 33 per cent humidity and temperature in May. Through winter, the average in Jan is as poor as 11 ° C including a humidity levels around 67%. For example the sunshine hours in Amman in June highest 390, see Fig (4), while sunny days in Amman 2019 in the June also 29.3.

4-1-1 First Local Case Study, Small CaseStudy: Roof Garden of Dr Yassin Al-Issawi (2007) Site Location Amman-Jordan, Marj Al-Hamam

This garden was established in 2007, designed by the owner of it Dr. Yassin Al Issawi. It’s a small private sunny rooftop garden in a residential building located in west Amman Marj Al-Hamam, see Fig (1) (2). The location is 8 minutes by car to 7the circle and 27 minutes to Queen Alia airport.

The designer of Green Roof have made the most of its small of only 4.5 by 4.5 meters by cleverly utilizing of his privet contemporary rooftop garden in the third floor of the building see Fig (3) (4). The strong lines of the garden and contemporary limestone patio flooring is broken up by herbaceous and various types of plants were produced like, peppers, radishes, herbs, lettuces cherry tomatoes, green beans, small trees such as lemon, orange etc. See Pic (4), (5), (6), (7), (8), (9), (10), (11), (12). This linear pattern is also echoed in the horizontal slats of the glass fencing, which guide the eye towards the fantastic view of west Amman. See Pic (1). (2), (3)

This rooftop garden have small siting area with glass table & iron chair, see Pic (1). (2). Every family have the same area and rooftop in the residential

buildings can inspired by this economy privet rooftop garden. And also they have traditional fountain designed by Dr. Yassin Al-Issawi.

Fig (1)show the site Location of Dr. Yassin Al Issawi (https://www.google.com/maps)

Fig (2) show Sun path (https://www.google.com/maps)

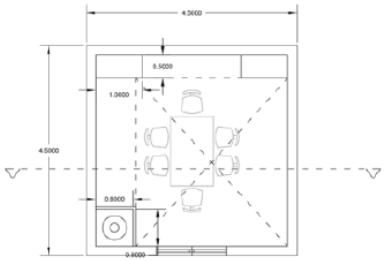

Fig (3) show Plan of Dr. Yassin Al Issawi rooftop garden(by (researcher, 2019)

Section A-A

Fig (4) show Section A-A of Dr. Yassin Al Issawi rooftop garden (by (researcher, 2019)

Pic (1) show seating Area of Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (2) show traditional fountain of Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (3). show basil in of Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (4) show Lemon tree in of Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic. (5)show bougainvillea In Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (6) show Fig. show gardenia in Dr. Yassin rooftop garden (by researcher, 2019)

Pic (7) show Kumquat in Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (8) show cactus flower Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (9) show Fig. show narcissus in Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic.(10) show Agapanthus orientalis in Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (11) show Fig. show Cala lily in Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

Pic (12). show red hot pepper in Dr. Yassin Al Issawi rooftop garden (by researcher, 2019)

4-1-2 Second Local CaseStudy, Medium CaseStudy: Roof Garden of Rami Abu Ghoush

Amman-Jordan, Dabouq 2016/ Design by stone company. Area 232.5 m^2 . This garden was established in 2016 and designed by stones company in Jordan, it's a medium privet sunny rooftop garden in residential building located in west Amman Dabouq, see Fig (5)(6). Its approach form Wasfi Al Tall St. 18 minutes by car and from queen alia airport 39 minutes.

- **The Concept**

The modern styleis characterized by Simplicity and straight lines, this design used module system and geometric shaps issued from grid order. The good view of the building site was exploited by many social Activities as follows: Dining area with barbique in the west zoon.

1. Dining area. See pic (15).
2. Two Seating area& bar unit with pool. See pic (14), pic (16), pic (18)

3. Barbique area. See pic. (13), (17).

In this projects we proposed many vigitation plantsneer the Dining Area and Barbique, also flowers with a green plants in the relaxing rest areas See Fig (13) (14). The designer of Green Roof have made the most of its medium area 232 m2 by cleverly utilizing of the Goush Family privet contemporary roof top garden, see Fig (7) in the third floor of the building, see Fig (8), (9).The strong lines of the garden and contemporary limestone patio flooring is covered by Handmade Terrazzo Tiles. The Designer used a variety of types of flower and small trees. Therefore this rooftop garden needs weekly maintenance. This linear pattern is also echoed in the horizontal slats of the stone fencing, which guides the eye towards the fantastic view of west Amman. This rooftop garden have small siting area with wooden table & chair.

Pic(13) show small swimming pool 2016(by stones Co.)

Pic(14) show TV. & fireplace area 2016 (by stones co.)

Pic (15) show BBQ, Pergola & Dining area 2016(by stones co.)

Pic (16) show TV. & fireplace area 2016

Pic (17) show Handmade Terrazzo Tiles of Rami Abu Ghoush rooftop garden 2016

Pic (18) show Flower beads & main seating area 2016(by stones Co.)

Fig (5) show Sun path
(https://www.google.com/maps)

Fig (6) Approach from wasfi Al Tal st.
(18 min by car
(https://www.google.com/maps)

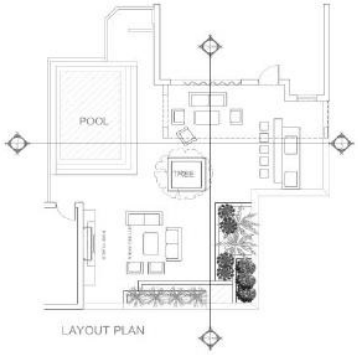

Fig (7) show layout Plan of of Rami Abu Ghoush rooftop garden in residential building 2016

Fig (8) show ElE3, ElE.4 of Rami Abu Ghoush rooftop garden in residential building 2016

Fig (9) show ElE1, ElE.2 of Rami Abu Ghoush rooftop garden in residential building 2016

5.Results:

To attain the research goal (to make people more aware for the value of roof top gardens and their environmental, social and economic advantages to the Amman); thefindings of the study is grouped in three main features to promote sustainability i.e. environment, economy, and social indicators.

5.1 Environment Indicators:

- Rooftop gardens, have a porous material that absorbs rainwater falling on houses.
- Rooftop gardens will reduce the impact of urban heat islands on cities.
- Rooftop soil and plants have insulation effect on roofs and provide more stabilized temperature, thus reducing cooling and heating loads and costs
- Residential buildings in Jordan are widespread, that make the environmental impact of energy consumption reduction due to the use of green roof in residential building significant on city level.

5.2 Economy Indicators:

Rooftop gardens e afford noteworthy cost saving benefits when applied to residential buildings:

- by providing some of household needs of food cultivated locally
- by reducing the cost of heating and cooling. Though many studies provided strong evidence of building energy saving when using the green roofs in proper context (climate, building type, green roof properties) but still difficult to predict eh exact energy saving.

- Green roofs improve the life cycle of the roofs and increase maintenance costs or replacement through helping to protect the architecture from bad weathe. A study by GSA (2011) suggested that buildings with a green roof last on average forty years, compared to an average of seventeen years for conventional roof.
- Green roofs enhance the lifespan of roofs and reduce maintenance costs by protecting the structure from extreme weather factors.
- Due to their popular use in rooftop gardens, tomatoes, green beans, cucumbers, peppers, basil and chives were researched as a successful example.
- Yields and basil biomass were stronger and greater within-ground performance, as well as the results indicate that good management makes vegetable and herbal production achievable and efficient in a large resedantial green roof project. (Whittinghill, L. J., Rowe, D. B., &Cregg, B. M. (2013).
- The analysis demonstrated that green roofs are short-term payback investments in terms of net returns and a are low risk invest The analysis showed that green roofs are quick-term net return investments and minimum-risk investments.

5.3 Social Indicators:

- Rooftop gardens contribute to social sustainability by supplying local food that could contribute to food security and access to better nutrition.
- Culture can be sustained by providing tangible Jordanian heritage such like handmade, reused and recycled items manufactured locally in rooftop gardens.
- Cultural value was assessed by disaggregating it into five components: aesthetic, social, symbolic, spiritual and educational value.
- Aesthetic value is straight forward, being related to beauty, harmony, visual appeal, etc. Guyer, P. (2005). While the Social value is linked to cultural identity and an understanding of the role of culture in society. (Baumeister, R. F., &Muraven, M. (1996).
- Intensive green roofs offer potentially greater visual benefit than extensive green roofs.
- Green roofs have the potential to aid visual green space continuity
- Visual contact with vegetation has proven direct health benefits.
- Psychological studies have demonstrated that the restorative effect of natural scenery holds the viewer's attention, diverts their awareness away from themselves and worrisome thoughts and elicits a meditation-like state
- People living in high-density developments showed to be less susceptible to illness if they have a balcony or terrace garden due to the additional oxygen, air filtration and humidity control that are supplied by plants.
- Aesthetic reactions to roofs dominated by stoloniferous grasses were negative compared to sedum-dominated or mixed perennial roofs.
- Principle component analysis showed that negative aesthetic reactions were associated primarily with a perception of messiness.
- Aesthetic reactions were positively correlated with attitudes and importance placed on the benefits of green roofs. (Jungels, J., Rakow, D. A., Allred, S. B., & Skelly, S. M. (2013).

5-4 The Results of Local Case Studies:

5-4-1 First Local Case Study: Roof Garden Dr Yassin Al-Issawi

This rooftop garden needs daily and weekly maintenance. However, and contrary to the next mentioned study (Rami Abu Ghosh), this Green roof has emphasized on the planting plants that provide a variety of vegetation, see

Pic (12). This is considered a factor which has a high benefit, despite the small space, the designer created an efficient and beneficial project, one which reflects a social benefit, an economic value-variety of vegetables and fruits- and also, there are many variety of flowers, see Pic (3),(4),(5),(7),(8),(9) (there is a sensible environmental value as well, in accordance with the space given, this environmental influence is seen in CO2 emissions and weather improvement. Also, it's worth mentioning that lack of space has been detrimental to create an activity element which is excusably reasonable and not that which the designer can be blamed for.

5-4-2 Second local CaseStudy: Roof Garden of Rami Abu Ghoush

In the second case study, every family have the same area and rooftop in the residential buildings can inspired by this economy privet rooftop garden. In addition, the designer used many ways to increase the efficiency of the green roof, such as using re-useable materials that can be used more than once such as the Jordanian stone that the flower beds, floor, fire place and swimming pool was made by. Used some trees to reduce CO2 emissions and the pool was used to control the heat and the overall atmosphere of the area. However, it's evident in this project that the benefits were mainly social. The plants themselves, for example, were primarily flowers. The green roof was that which mostly fulfilled a social function which helped the residents use the space for a social cause. The design had a beatification influence but perhaps could have promoted more of a moderate input such as planting more plants which implement environmental efficiency and most importantly plants that can grow vegetables which can be used by the residents. This will help promote multiple functions. To use a green roof to answer to different needs and promote new functions increases the efficiency.

6. Conclusion

- Roofs in the Jordanian architecture is a big part of life. It's an addition to the different and complex aspects of architecture and design in the country. Developing and creating green spots has a crucial rule in human life which can be an alternative to the destroyed nature after a house has been built.
- Many technologies and activities are aimed at reducing human effects on earth. The effective use of natural resources in the green rooftop garden and farming without using industrial materials is very important in Amman to be more sustain city.
- Green roof is covered with soil and plants, and it is one of the new solutions for residential areas Humans are now trying to make a connection between green environment and the modern technology to use them both for developing a better place to live in. also using roofs will make a good solution. This way the wasted space at the roofs may turn to little alive gardens.
- Using recycled roof tiles, selecting insulation materials and waterproofing membrane made of recycled materials, could significantly reduce and become closer, in terms of value, to the impact of a green roof.
- A green roof is an environmental technology that can cover all building with different functions. It is formed under natural conditions that are covered by plants, and one of the most important advantages of it is the improvement in air quality by reducing air pollution and CO2. Also, it helps prevent pollution made by dust and petrol which jeopardizes people`s life in different cities.

- Overall attitudes and aesthetic reactions to green roofs are positive. However, negative aesthetic reactions are associated with a sense of messiness. There is a positive environmental effects from green roofs nature. For example, the people who live in apartments, are trying to give a natural spirit and sense of nature to dead and desolate walls of buildings to unify the nature with the rough structures and help create more beautiful places.
- For years green roofs have been used to prevent effects of urban development. Their introduction to the urban landscape in the Arab country is also more common today, getting more popular only through the Arab Green Building Councils in the last few years.
- When sustainable green roofing strategies develop, the approaches for putting t hem into use in the Arab country, especially in Jordan's capital Amman, will ha ve to try keep up with moderate growth and population increase.
- Amman city requires especial designs, with its limited water resources. This is to be accomplished through Innovative drainage methods, specifically water shortage-tolerant plant species, and extended periods of initial irrigation treatment.
- The green roof goals lead to various designs, proposals, and opportunities. Therefore, validity in Amman would change as shown by context and strategies, which could be rain-water management, food production, energy consumption, or urban heat island reduction.
- Green roofs can offer significant directly and indirectly advantages, like summer cooling impact, by covering the roof from full sun radiation. It helps reduce the structure's solar heat benefit; reduce energy utilization for heating in the winter, minimize the impact of urban heat thermal insulation and enhance indoor environments, lessen the impact of impermeability materials, for example.
- It also helps to add value to food production efforts in poor city populations; add green areas, wildlife habitats, ventilation, heat control; and to help to create sustainable societies In spite of to these hot climate and water shortages

7. Recommendations

The following are the special construction requirements and considerations when developing a roof garden.

- Going to protect roof and structure integrity
- Positive drainage
- Lightweight medium seedling
- Irrigation to ensure optimal plant growth and longevity
- Adapt to environmental conditions.
- Selection of hard scape materials (paving, structural materials, site furnishings, and water as design element) as part of a roof garden system and their unique uses and specifications.
- Defense and Public Security.
- Easy maintenance.

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