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Integrated procedures for sustainability in buildings' roofs

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ABSTRACT

Sustainability with its environmental, social, and economic dimensions has been an important aspect in many areas, including buildings and architecture. It shows the importance of the environmental dimension to ensure compatibility and conservation of resources for the other generation through the application of a set of integrated Procedures, this paper tries to investigate of integrated processors followed by designers in the roofing of their buildings to achieve sustainable, The theoretical framework of the paper is based on previous studies to determine the concept of sustainable building design and its particular in roofing design and comprehends is achieved for sample sustainable buildings to obtain a set of technical and formality that adopted by designers to achieve sustainability.

Keywords: Sustainability, Sustainable Building, Roofing, Integrated Procedures Techniques.

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1. Introduction

The urgent need for the sustainability of the environment and the protection of its resources led to the design and construction of buildings that meet these needs and fit the needs of the human environment, economically and socially, and therefore we find the designers' attempts to use integrated treatments in the design of buildings and parts, including roofing systems to achieve the principles of sustainability in those buildings, which aim paper To discover it, the paper methodology is based on analyzing a group of sustainable and functionally different buildings with different roofing systems and extracting the most important integrated treatments that designers resort to. The paper assumes a technically integrated design and processors designers use to achieve the sustainability of their buildings

1.1. Sustainability and architecture

The origin of the word "sustainability" comes from the Latin origins of the term "hold up" [1]. Many studies have defined the concept of sustainability, but the definition developed by the World Commission on Environment and Development in 1987 presented sustainability as meeting the needs of the present for generations without compromising their future needs [2]. Four Sustainable Eternal Goals have been identified under the Organization for Economic Co-operation and Development (OECD). Efficiency Sources, Energy efficiency, Environmental compatibility, Integration, and curriculum organization (including environmental management regulation) [3].The term sustainable architecture is used to describe the movement associated with an architectural design that is

concerned with everything related to the environment and describes the real sustainable architecture that we get what we need from the universe and this realization forces us to respond with interest and organization in the use of those resources [4, 5]. Kim explained the principles to promote environmental sustainability through the resource economy and the life cycle Design - in design, construction, operation, maintenance, recycling, and reuse of architectural resources [6]. It is clear to us that the impact of the principles of sustainability on architecture has created a sustainable design, show Figure 1:

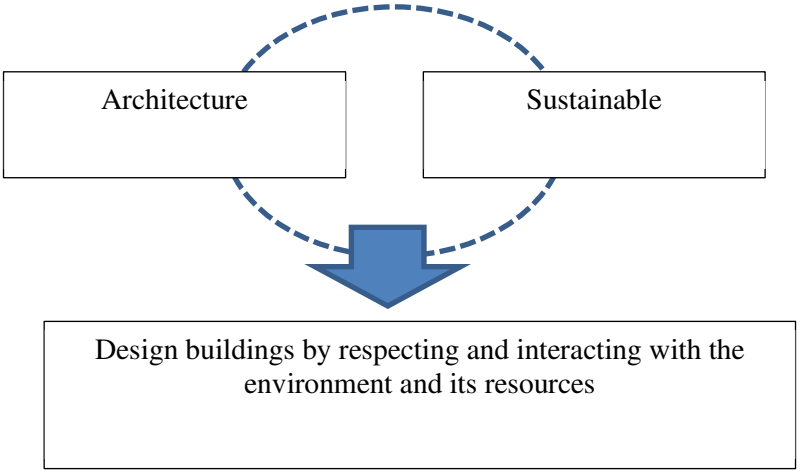


Figure 1. the impact of the principles of sustainability on architecture (researcher)

1.1.1. Previous studies

In this section, the paper will discuss a set of studies that deal with the principles of sustainability in architecture to draw the theoretical framework and its vocabulary.

- Akadiri and other 2012

The study presented the most important concepts for achieving sustainability in buildings. They represent the basic principles of sustainable building, which are to conserve resources and resources, reduce the economic cost and design that meets the human needs and comfort, and through which designers achieve the basic principles of environmental, economic and social sustainability [7].

- Ahmad 2012

The study stressed the need to adopt new methods to provide solutions to the problems of energy waste and not to benefit from environmental data. It also stressed the application of sustainability as one of the components of the architecture of advanced technologies that save energy and increase the life of the building and make it suitable for future generations. High-tech building was considered the core of green architecture [8].

- Hassan 2017

The study confirmed that the facades are the link between the internal environment of the semen and the outer environment. To achieve sustainability, the architect must analyze the architectural characteristics of the building. It stressed that the sustainability of the facades is part of the overall sustainability of the building and is working to provide energy and achieve thermal comfort for users [9].

Previous studies emphasized the importance of achieving environmental and economic concepts of sustainability in the design of buildings and their parts by conserving resources and rationalizing their consumption, which contributes to providing comfort for the occupants.

1.2. Sustainable design

Sustainable design is defined as design that is integrated with nature and is done in environmentally responsible ways and using a combination of high or traditional technical processes in the infrastructure and the different systems of the building and its shape [10] it aims to create a healthy environment suitable for human beings based on the use of natural resources and respect for the environment [11-13]. The studies presented a set of principles represented by sustainable design.

4.1. Integration with Nature

Sustainable design focuses on the importance of integrating buildings with nature as the foundation for human learning and development. It is an inexhaustible source of ideas, forms, systems, and mechanisms through (green spaces horizontally and vertically throughout the life cycle of a building, the formal metaphor of nature, integration, and harmony with it and produces forms. Free (organic, streamlined, dynamic).

4.1.2 Simulation of living natural forms (animal, plant)

4.1.3 Integration with nature through the introduction of green spaces and water pools, the use of open spaces, visual communication between the inside and outside .

4.1.4 Site topographic simulation produces (streamlined, graded form) [14].

4.2 Energy efficiency and conservation of non-renewable resources, optimal use of natural energy, water conservation, and recycling, use of environmentally friendly materials that can be recycled.

4.3 Provide the health, environmental, social, and economic needs of users [15].

Envelop of the building is the first or primary responsibility for the protection of the building in external conditions and provide thermal comfort to its users, as it organizes the thermal regulation of the building by facing all its components (external surfaces, internal surfaces, roofing, building materials)for external climate influences Figure 2.

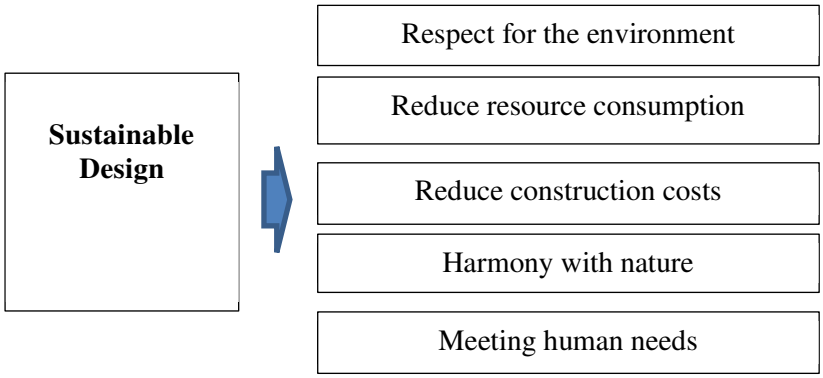


Figure 2. Principle of Sustainable Design (researcher)

This paper will focus on the technical treatments used in sustainable building roofing as part of the exterior of the building exposed to external environmental influences.

2. Sustainable roofing

Roof systems can be sustainable when they achieve the concepts of general sustainability discussed in many studies, So the best definition of these systems is in the workshop held in 1996 in the Oak Ridge National Laboratory [16], and considered that (a roofing system that can be constructed in ways and materials that can rely on efficient resource conservation, environmental preservation, maintenance, and rehabilitation is a sustainable roofing system), Because the roof as part of the building envelope responsible for exposure to the surrounding environment, which required the attention and investment of the space by the designers to convert it from the function of protection from environmental elements to the addition of sustainable construction techniques such as green roof and rainwater collection and solar energy collection [17].

2.1. Green roofs

It is one of the techniques used to control the heat inside buildings and green roofs are defined as the process of replacing the land that was cut to the epidemic planted areas and compensate the vital areas that have been removed from nature, a green area that is planted on the roofs of buildings [18]. The green roofs aim to achieve aesthetic goals in addition to achieving psychological and functional goals such as protecting the building from sudden changes, saving energy consumed inside the building, reducing the rate of air pollution in addition to moving the garden from the ground to higher levels to provide a natural environment suitable for man and his psychological balance and link to the land [19-21].

5.1 use of solar energy

The idea of the use of solar energy appeared in the roofs of buildings with the emergence of energy problems, but the roots of the idea historical with the architecture of the first civilizations dealing with natural conditions and develop a set of methods to deal with environmental problems and the use of solar energy [22].

5.2 Use of wind turbines

Wind energy is used to move wind turbines to generate clean, non-polluting electrical energy by incorporating technical processes such as the use of wind turbines in parts of the building [23]

5.3 Rainwater treatment

through the collection of rain on the roofs of buildings and collected in underground tanks to be filtered and treated and then reused in a way that achieves sustainability [24].

5.4 Use of sustainable materials

There are roofing systems used by a sustainable architecture based on the quality of the structural material used and the structural system was represented by the system of folds, gables, vacuum components, crustal system, tent, and inflated system [25]. These systems have used construction materials with sustainable potential that have

adopted a change in properties such as smart materials or environmentally friendly materials such as natural materials or those that reduce gas emissions.

Table 1. Integrated procedures for sustainability in buildings' roofs

Formal Procedures	Type of swap	organic	
		geometric	
		streamlined	
	Simulator of site	With site	
		Out of site	
	The material used in forming roofing	Traditional materials	
		Smart materials	
		Restorative materials	
	Forming processors to employ energy	slop	
		Fraction	
		Curved	
Technical Procedures	Energy sources process	Solar energy processors	Using PV
			Using double roof
			Shading
		Wind energy processors	Turbine wind
			Open courts
		Rain st processors	Collection container
		Green roof	
		Recycling of exchange	
	Control system	Fixed	At the whole level
			At the segment level
		Moving	At the whole level
			At the segment level

3. Practical study

The paper in his practical study select a group of different buildings, As shown in Table 2, and the paper examined the vocabulary presented by the theoretical framework, which was ascertained in Tables 1

Tables 2. Group of building

	Building' name	Subhead
A	Swiss Rebuilding 	The roof is divided into triangular units and consists of two layers of smart glass with a cavity that can break the intensity of solar radiation, which helps to reduce energy consumption by 50% compared to any building like it [26].

B	Eco-friendly residential complex project in China, 	The environmentally-friendly residential complex, Using solar cells, cultivate surfaces, and use ponds to collect Concrete structure with solar cells and green plants [27].
C		The building is more than 100 meters long and 150 meters wide. It was constructed according to an engineering design that reflects the nature of knowledge and religion to be one of the most prominent landmarks in Doha. The idea is based on the concepts of enlightenment and science [28].
D	Eden Project 	A huge industrial environmental complex with several domes The project does not need to use a large amount of water to maintain sufficient types of plants and uses a rainwater treatment system and recycled rain water for humidification It is a good example of borrowing ideas from biology and using less resources [29].
E	California Academy of Sciences 	It looks like a piece of garden, This surface absorbs the rainwater used to irrigate plants and drink organisms within the project and provides six kilowatts of electrical energy from solar energy, glass domes in the ceiling to enter the light and put a biodegradable container made of rubber and coconut husk and used from the ceiling to provide insulation and as For birds, the roof has vents that allow the passage of sunlight, photoelectric cells. The air enters through the skylights openings of the roof [30-32].
F	Island city central park GRIN 	Three natural underground spaces comprising a group of subtropical plants as well as a variety of flowers and indoor garden domes covered with glass ceilings separated by oval skylights allow the passage of the largest amount of radiation for the growth of plants and natural lighting. The project consists of a series of hills connected along the lake as part of Natural hills. The skylights are automatically controlled according to ambient temperatures [33].
G	Xieli Garden / UDG + SEU 	This building is a three-story spiral-shaped building that aims to create an ideal learning environment directly linked to the outdoor space and abundant in sunlight. The building is designed in the form of an elliptical mounting ring planted with greenery to create an ideal learning environment for children through direct contact with the outer spaces and provide natural daylight. This oval shape wraps around an inner courtyard providing daylight and natural ventilation [34].

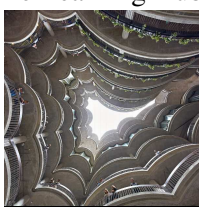
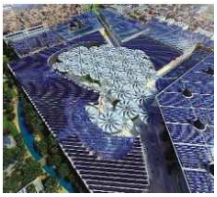
H	The Learning Hub" 	Delivering many first-of-its-kind eco-friendly features and innovative solutions that embody the spirit of modern-day learning, the 61-angle concrete columns have a distinctive wavy fabric developed specifically for the project. Curved facade panels have a unique horizontal pattern, with ten cost-adjustable silicone molds, to create a complex 3D texture. As a result of the various rough treatments of the building in the building, it seems that the entire project is handmade from wet clay. With year-round temperatures in Singapore between 25 ° C and 31 ° C, it was important to maintain student comfort while achieving sustainable energy use [35].
I	Telstra stadium (stadium Ausralia), Sydney 	The building is designed to be more energy-efficient than any other stadium where: . The building is provided with natural ventilation to reduce the use of air conditioners through openings in the ceiling and walls Provide natural lighting instead of industrial lighting through glass walls • Provide thermal insulation to reduce the need for energy by having sensors • A digital control system regulates air conditioning and lighting systems and extinguish them in unoccupied spaces Efficiency of water use through the dual supply of water In this system, the toilets are connected to water supply other than drinking cycles, which is the treated water, where the water falling on the building is collected by waterways underneath four large reservoirs underground used to irrigate the gardens of playground gardens [36].
J	Vincent Callebaut 	A group of connected buildings interspersed with 9 giant trees An integrated complex of high-end residential services It is a green architectural design - environmentally friendly - solar energy system - solar water heating - wind energy system - landscaping and green walls - suspended roof gardens [37].
K	Masdar city 	A city-based on clean and renewable energy, a sustainable residential complex that uses carbon management techniques, water conservation, green footprint, rapid urbanization, reduced energy and water consumption, pollution, and waste reduction [38].
L	Sustainable city 	The sustainable city produces all its energy from renewable sources, where solar energy is invested and converted into electricity. A system provided by DEWA to generate electricity on the roofs of residential and commercial units is utilized., Provide electricity and water consumption waste treatment, in addition to the recycling of wastewater and watering, and the reduction of the number of carbon emissions [39,40].

Table 3. Procedures using in buildings' roofs (researchers)

				Projects											
				A	B	C	D	E	F	G	H	I	J	K	L
Formal Procedures	Type of swap	organic		*							*				
		geometric			*			*		*				*	*
		streamlined				*	*		*			*	*		*
	Simulator of site	With site			*	*	*	*	*		*		*	*	
		Out of site		*						*		*			*
	The material used in forming roofing	Traditional			*			*		*	*				
		Smart		*		*	*		*				*	*	*
		Restorative										*			
	Forming processors to employ energy	slop								*					
		Fraction			*						*			*	*
		Curved		*		*	*	*	*			*			*
Technical Procedures	Energy sources process	Solar energy	Using pv	*	*				*			*	*	*	
			Using double roof	*	*		*				*	*			
			Shading		*						*		*	*	*
		Rain processors			*		*	*	*	*	*	*	*	*	
		Green roof			*		*		*	*	*		*		*
		Wind energy	Turbine wind										*		*
			Open courts			*		*	*	*	*	*	*	*	
	Control system	Fixed	At the whole level		*					*	*		*		
			At the segment level	*			*								
		Moving	At the whole level			*		*	*			*		*	*
			At the segment level												
total				**7**	**10**	**6**	**8**	**7**	**9**	**8**	**10**	**8**	**12**	**9**	**9**

4. Results

- Discussion of the results of formal techniques: The results of the application of the Type of ship variable showed that the use of streamlined form by 50% of the selected projects the most used style of sustainable building roofings and designers relied on the simulation of the site by 66.6% to form their roofing dominated by the use of smart materials and by 58.3% while the modulation processors to employ energy forms The most commonly used mechanism for sustainable building roofs was 58.3%.

- Discussion of the results of technical treatments: Concerning energy sources treatments, 90% of the selected projects relied on the use of solar energy in the design of their sustainable roofs through the use of (PV) 50% as the most commonly used treatment, while 75% of the projects adopted rainwater harvesting treatment and 58.3% used green roofs. Wind energy treatments were mostly made using the open courtyard by 66.6% and the use of control systems for sustainable roofings was evenly distributed using some of them moving and fixed.

5. Conclusions

This paper presented an important aspect in the design of sustainable buildings and parts of the building through the definition of sustainable roofings of buildings as an important part of the buildings to achieve the concepts of sustainability and reviewed the paper a group of buildings that adopted sustainable design, including roofs Sustainability. These Processes adopted by designers in the design and construction of roofs sustainable buildings is one of the important design aspects in achieving the concepts of sustainability. Designers adopt technical treatments for sustainable roofings through the use of energy and sources more than formal treatments for sustainable roofing.

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