Directing the Economic Aspects of Sustainability in Architecture

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Abstract:
The research discusses how to integrate the economic aspects of sustainability within the scope of architecture to suit within the current economic conditions. Integrating all economic aspects are best suited through identifying the concepts and aspects of sustainability with a focus on economy through: ventilation of internal spaces; controlling humidity; controlling temperature; directing natural and artificial lighting; directing the economic sustainability of systems used in interior architectural spaces; renewable energy production and solar energy. Finally the research was proposed a checklist for: designing, implementing, and operating in order to control the resources used and the outputs of different processes in the life of the building while reaching a range of findings and recommendations from the research parts.

Keywords:
Sustainable development, Economic Aspects, Sustainability.

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1. Introduction:
The research deals with one of the fields that have lately proven its importance in the scientific and research fields. This field is related to the interaction between human and architectural vacuum where there is a growing interest in human characteristics and how it is compatible with these vacuums. We should consider the economy being a community of services that thrives in a secure natural environment. From this perspective, sustainable development must be redefined as "a development that meets the needs of the present, while at the same time it preserves the life support system on earth, upon which the well-being of the present and future generations depends."
This indicates the importance of paying attention to directing the sustainable economic dimension to architecture and knowing the determinants of achieving this. How it can be achieved will be shown through the research's sections.

2. Research problem:
Economic sustainability in countries' policies could only be achieved relatively. The environmental dimension has not been devised as a starting point for development processes, nor have the economic policy mechanisms been designed to serve real development rather than political aspirations and the struggle for power.

3. Research Goal:
Showing how to include the economic dimension of sustainability within what suits the current situations. That can be done through developing a checklist for design, implementation, and operation.

4. Literature Review
4-1 Sustainable Economic Development - Towards a Better Economic Community:
Sustainable development is a term that points to development (environmental, social and economic). It meets the present's needs without affecting the coming generations' ability to fulfill their own needs. Sustainable development is not a fixed state of harmony but it is a process of change, exploiting resources, directing investments, technological development, and institutional changes that are in line with future needs as well as current needs. This paper will discuss the economic dimension of sustainability which aims to achieve economic housing that saves energy. Economic housing is built using materials that do not harm the environment, is flexible and developable with the increase of the population's needs, and is close to services and facilities to reduce the use of transportation - which in turn increases energy consumption.

5. Applying the sustainable economic dimension to Architecture:

This will be addressed through:

A- Ventilation of internal spaces:

It is shown here the importance of directing the building's openings to the direction of the prevailing wind with attention to the existence of more than a hole in the architectural spaces to create a suitable air stream. Some techniques can also be used such as hooks and towers above the roofs of buildings to face the prevailing winds and pull them to the interior of buildings. The openings' shapes and treatment should be considered to give performance efficiency in terms of heat transfer or insulation, as well as light and solar radiation treatment. (Usama Konbr, 2000).

B- Adjusting the level of humidity:

Here, porous materials can be used taking into account the conditions they should be used; without covering or painting them with paints that fill their pores at night, when humidity is higher. This moisture is released from the pores of these materials during the summer, which helps relatively improve the air quality and the sense of thermal comfort. (Murad Abdelkader, 1998).

C- Adjusting the temperature:

According to the climatic data, the periods of excessive heat stress for more than half of the year are observed, which requires the need to reduce the temperature in the internal spaces as one of the forms of achieving air quality in the interior spaces.

This can be achieved through ventilation, taking into consideration the color of the exterior walls. In case of white color, the ventilation at night is more effective in cooling the interior spaces. (ibid. p. 1)

D- Directing natural lighting:

Buildings should rely on natural lighting whenever possible. Natural lighting is the best in terms of quality and environment resulting from as a way of lighting. Besides, it is the most widespread and comfortable, and it can be said that it is the most important from the perspective of sustainability in terms of: (David Rousseau, 1986)

1- It is almost cost-free (economic dimension), whereas lighting consumes 40% -50% of the total energy consumed by architectural interior spaces.
2- The absence of its side effects (environmental and social dimension) along with continuity and sustainability.

E- Directing artificial lighting:

It is important to use artificial lighting units that are the energy saving type. (Yehia Wazeri, 2003). Moreover, it is also important to use photovoltaic cells as a renewable resource to supply the energy needed for lighting. It is characterized by its low need for maintenance and that it can be added as a component of the building itself (openings - roofs - facades, etc.). The light colors can be selected to paint the architectural blanks to increase the reflectivity of light on the surfaces.

When taking sustainability and economizing into account, it is important to refer to smart and electronic technologies in the electrical system where self-locking switches can be made and set to suitable working periods for some purposes.

F- Directing the economic sustainability dimension of the systems used in internal spaces:

For example, the water system is treated in internal spaces through water conservation by controlling the water system setup, and by conserving the energy consumed in the setup and in heating the water in the hot water networks. The solar water heaters can also be used to heat water (Yehia Wazeri, 2003) as a type of sustainable implementation that is not costly. This can be done taking into consideration the current expenses of operation considering solar determinants, as well as the possibility of using photovoltaic cells in a sustainable manner to generate the electricity needed to operate some devices in the same system.

G- Directing the economic sustainability dimension of the building materials' system used in buildings:

The economic dimension of building materials can be considered through:

First: Building materials of lower energy:

The energy involved in building materials can be conserved through the recycling and operation of materials. Thus, the most common building materials, including concrete, iron, glass, etc., can reduce the absorbed energy by recycling.

Second: Natural building materials:

Generally, these materials are less energy consuming in manufacturing and less toxic or nontoxic compared to manufactured materials. Besides, it requires less operation and has less negative impact on the environment. It can be said that the inclusion and integration of natural materials into buildings makes it sustainable, provided that consumption rates do not exceed production rates. (Code of Practice for Sustainable Construction, 2003).

Third: Energy efficient materials:

Energy efficiency is one of the most important characteristics of building materials to be considered environmentally sustainable. It is preferred to select materials that can respond to new and renewable energy systems. Along with those which react with passive solar design concepts such as heat-insulating materials, heat

insulation outside and selecting glass quality which is heat absorbent or heat inverter or the energy producing type (Photovoltaic cells) ... etc.

Fourth: Materials with less resulting residual during manufacturing:

In terms of the economic dimension, the building material is more sustainable if it can reduce its residual in the process of construction. Thus reduce the demand for resources in its raw state, such as the manufacture of standard operating panels.

Fifth: Materials with less residual during construction:

As it avoids the need for space and landfill to collect waste and refuse and thus reduces costs. The manufacture of some building materials on the site may contribute to the process of conservation.

Sixth: Materials of local sources:

Its main advantage is to reduce the fuel used and the transport waste, as well as keeping the capital in the construction areas themselves as an economic dimension, which contributes to the support and sustainability of the construction process.

Seventh: strong, durable and long-lasting materials:

Strong and durable building materials are selected as well as low maintenance materials when used in terms of performance, cost, aesthetics and conservation (Andy Rigg, 2000). Sustainability is achieved through durable construction materials as it has an effective role in reducing the demand for resources as well as the amount of money needed for the construction and labor wages as well as the maintenance items. Besides, replacing durable materials is less due to the lack of the need for waste collection sites resulting from the replacement of these materials. (D.A.langford, X.Q.Zhang, T. Maver, I. Macleod, and B. Dimitrijevice, 1998)

Eighth: Reused and recycled materials in the construction of buildings:

Building materials that can be reused are preferred to conserve materials, and provide cheaper products. Reusability of building materials is related to the strength and durability of materials. It is worth mentioning that there are no limits to how these materials can be used, it depends on the creativity of the designer and the architect.

6. Project Analysis:

A residential community project - Greenwich millennium village – London:

This proposal was selected as it stands out in the environmental trend and its adoption by the evaluation system "bream" to achieve environmental performance through good design rather than high cost solutions. The village has received an excellent mark at each stage. (John Prescott, 2004).

The proposal includes 2,700 new low-cost housing units containing 13,000 apartments on 29 hectares, 20% of the area (6 hectares) with 4500 square meters of commercial space, public facilities, schools, health centers, restaurants and an environmental park. In addition to other open spaces that have been created using the best of the most advanced technology as it seeks to create new ways of sustainable construction in the future.

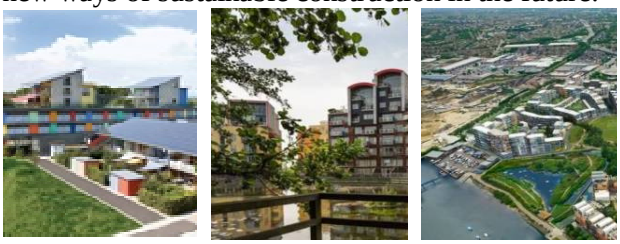

Figure (1) General location and a range of different facades of buildings in the village of Greenwich, source www.egretwest.com

- **Project Objective: (John Prescott, 2004):**

There are many goals in creating a new vibrant society that works for people and gives the priority to pedestrians rather than cars. Besides, conservation of nature elements like climate, energy, geology, etc., and improving the efficiency of the project's sustainable design on the infrastructure levels including district heating, electricity distribution and water discharge, roads, gas, noise pollution, individual satisfaction, air quality and thermal control. 80% reduction in primary energy consumption, 50% reduction in construction waste, 30% reduction in water use, 30% reduction in construction costs, 25% reduction in project duration (building duration), 25% reduction of carbon dioxide.

This was achieved through the use of sustainable methods, including the use of solar heaters, photovoltaic cells, biomass, waste, wind energy, natural ventilation and the use of sustainable construction materials in building.

- **Sustainable methods used:**

1- Treatment and reuse of sewage and rainwater: (Kyung – Bae Kim, 2005):

In order to reduce water consumption by 30%, rainwater is collected and treated in a variety of ways in basins. Then it is channeled to be used in green areas and agriculture. Afterwards, it is processed so that they can be used in toilet flush tanks, thus reducing water consumption.

Sewage water is treated and this leads to fewer pollutants and will also give us the best remaining products, known as reusable sludge in agricultural

land.

2- Production of new and renewable energy and the use of solar energy: (Kyung – Bae Kim, 2005):

New and renewable sources of energy have been used to make the city a better place to live. The buildings have been converted to central heating. They have used various types of supplies such as photovoltaic cells and solar heaters. The residents of the region will produce half of the energy they need by taking advantage of current energy for treatment of water and generating energy from waste combustion. The electricity and heat needed for the village is created at the site through a small-sized gas-operated workstation where heat and energy are combined.

Positive and negative solar energy were used. Solar heaters were used to heat the water and photovoltaic cells were used to generate electricity. The residential units were directed to obtain as much sunlight as possible in the winter and to block it in summer, in addition to benefiting from and depending on natural ventilation inside buildings.

3- Building Materials used:

Buildings are currently being built from environmentally sustainable, recycled and locally produced materials. Materials are used wherever possible to provide 35% of building materials and save time by 45%.

Security has been taken into account in the design process, where innovations have been made in the project related to reducing building costs. These include; using pre-fabricated steel structures, and network layouts that allow for subsequent change to achieve flexibility in use according to new needs.

7. Proposed Methodology:

This list is benefited from on the economic side by means of a scale that evaluates the various elements and stages of the architectural design and the extent of their achievement. The scale is a hexagonal scale (0%, 20%, 40%, 60%, 80% or 100%). It can also be developed through other studies and researches.

Elements of the proposed methodology:

The levels that we want to measure are divided into 6 levels (laws and regulations, pre-design stage, architectural design phase, executive design stage, implementation stage, operation phase). table1

table1: Elements of the proposed methodology, source: researchers. 2018

level		Methodological evaluation elements		Evaluation of methodological elements (percentage achieved)						Notes
		No.	Element	0%	20%	40%	60%	80%	100%	
The First	Rules and regulations	1-1	Appropriate construction rate							
		1-2	Building heights and set backs							
		1-3	Percentage of green areas							
	Pre - design									
The second	1- site selection	2-1-1	The actual need for the project							
		2-1-2	Site features							
		2-1-3	Aspects of vulnerability and risk							
		2-1-4	Geological characteristics							
		2-1-5	Environmental impact assessment							
	2- Site analysis	2-2-1	Climate effects							
		2-2-2	Surrounding urban environment analysis							
		2-2-3	Urban style							
		2-2-4	Soil Properties and its availability for agriculture							
		2-2-5	Topography							

	3- architecture l Project Program	2-3-1	Owner requirements Standard design requirements							
		2-3-2	Spacing program							
		2-3-3	Vertical and horizontal project components distribution							
		2-3-4	Group common items							
		2-3-5	Feasibility study							
	Architectural Design									
The Third		3-1-1	Distributing functional spaces to achieve the best of available environmental aspects							
		a	Natural ventilation							
		B	Natural lighting							
		3-1-2	Layout design							
		3-1-3	Design flexibility							
		A	Division availability							
		B	Growth and future expansion							
		C	Multiple applications							
		3-1-4	Design alternatives							
		3-1-5	The choice of the optimal solution that achieve :							
		A	Harmony with the local urban environment							
		B	Energy saving							
		c	Reduce water							
		D	Advantage of topography							
		E	Environmental quality for indoor environment							
		3-1-6	Plans design:							
		A	rules and regulations for spaces design							
		B	Design module							
		C	Orienting voids and windows to achieve natural ventilation and lighting							
		D	Different insulation methods							
		E	Grouping of Shared Services							
		3-1-7	Design of exterior facades of the building:							
		A	Architectural style							
		B	void and solid ratio							
		C	Selected of appropriate window types							
		D	Control of solar radiation inside the building							
		E	thermal insulation of facades							
		F	Architectural Formation that is benefiting from solar radiation and rain water							
		G	Design module							

	The working drawing :									
The Fourth	Structure System	4-1-1	appropriate construction materials							
		4-1-2	Structural flexibility							
		4-1-3	Structural module							
		4-1-4	Building safety							
	Finishing materials	4-2-1	Environmentally Compatible Materials							
		4-2-2	Materials from the local environment							
		4-2-3	Recycled materials							
		4-2-4	Recyclable materials							
		4-2-5	All the voids are treated thermally and thermally isolated							
	The working drawing of plans	4-3-1	Match architectural and structural module and repetitive system for prefabricated units							
		4-3-2	Internal court							
		4-3-3	Fixed and movable furniture							
	The working drawing of elevations	4-4-1	The rhythm							
		4-4-2	Revising the climatic treatments for indoor spaces							
		4-4-3	Treatments of surface exposed to solar radiation							
		4-4-4	Building urban integration with site architectural fabric							
	The working drawing of layout	4-5-1	Air dynamics around the building							
		4-5-2	Control of external noise							
		4-5-3	Finishing materials for the corridors and roads of the project							
		4-5-4	Distribution of water elements							
	implementation :									
The fifth		5-1-1	Optimal exploitation of drilling products							
		5-1-2	Prevent drilling in special environmental areas							
		5-2-1	Internal roads pavings propably							
		5-2-2	Using proper mechanical methods for execution							
		5-2-3	Using skilled labors							
		5-3-1	Using finishing materials properly							
	The operation:									
The Sixth	Periodic maintenance	6-1-1	Power units							
		6-1-2	Cooling and heating units							
		6-1-3	Fresh water supply system							
		6-1-4	Internal Networking system							

		6-1-5	Wastewater treatment							
	Replacement and renewal	6-2-1	Internal maintenance							
		6-2-2	External maintenance							
		6-2-3	Layout maintenance							
	Environmentally hazardous processes	6-3-1	Storage and transport of hazardous materials							
		6-3-2	Changing air filters							
		6-3-3	Wastewater treatment							

8. Results and Recommendations:

8-1-First: Results:

- The process of cost reduction is achieved by improving efficiency and lower consumption of energy and raw materials.
- We find that the exploitation of renewable sources of energy and relatively cheap in replacing traditional energy will provide economic returns. That in addition to the important daily benefits, especially the use of modern technology and reduce the proportion of pollutants in the atmosphere and provide the appropriate climate. Economic assessments of most of the renewable energy systems, especially solar energy systems have indicated its effective economic return during the micro-operating period, and if it increases, its economic returns will increase.

- Sustainable economic design and construction can be defined as the application in which every effort is made to achieve full quality in terms of economic performance. Therefore, the logical and rational use of natural resources and the management of construction will contribute to the conservation of scarce resources, reduce energy consumption and improve the quality of the environment. Sustainable construction involves taking into account the entire life cycle of the building as well as environmental quality, functional dimension and future values. General objectives for sustainable buildings are determined as follows:

1- Address the concept of resource efficiency.
2- Energy efficiency and pollution prevention.
3- Compatibility and harmony with the environment and the achievement of integrated and systemic approaches.

In terms of economic dimension and its relation to building materials, it has the following characteristics:

1- To support urban development in new urban communities with sustainable construction, in which the economic dimension is an important priority as one of the main pillars of the system.
2- In terms of the high prices of building materials and the cost of buildings in general, there was a pressing need to rationalize spending in this sector (construction) as it is related to various resources such as building materials, energy and water. In addition to rationalization in the operations of the construction industry itself as well as maintenance in the stages of operation.
3- The ideas of communication in the field of construction, such as the use of local and renewable building materials, reuse and recycling, etc., are all successful in the construction system from an economic point of view.

Economic efficiency with its main determinants (time, performance, cost) is closely related to the efficiency of economic sustainability:

1- The efficiency of economic sustainability is inversely proportional to time. The more time it takes to construct buildings, the less efficient it is.
2- The efficiency of economic sustainability is directly proportional to performance. The more efficient the performance is, the more efficient the economic sustainability becomes.
3- The efficiency of economic sustainability is inversely proportional to cost. The higher the cost is, the less efficient the economic sustainability becomes.

- Economic efficiency is the development of the concept of the architectural economy in a more comprehensive concept that depends on the overall performance (environmental, technical, and economic) without relying only on the technical performance. It is not intended to achieve the highest performance at the lowest cost but to obtain the best performance at the appropriate cost within a suitable amount of time. Thus, time is an added element that determines the relationship between performance and cost in the field of urban and architectural economy. This is

evident in the project "Greenwich millennium village - London"

8-2-Second: Recommendations:

The research recommends the following:

1- The use of renewable energies and materials that can be obtained in a sustainable manner.
2- Utilizing all available resources and possibilities close to the cities and new urban communities to achieve the highest performance. This can be achieved by studying the economic feasibility of the project site and its relation to the neighboring areas in terms of (human energy - local building materials - methods and means of implementation) as well as choosing a method of construction compatible with these conditions.
3- Buildings are a fertile environment to benefit from the experience of using economic sustainable elements and should be recommended to designers to study and simulated in their designs.
4- Activation of the evaluation mechanism using the checklist as a key component of the accreditation of new projects.
5- To focus on introducing international and local project experiences that rely on the principle of sustainable development as guiding models in new projects and in architecture colleges.

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