Renewable Energy Applications In Heritage Spaces With Digital Solutions

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Abstract:

In our live issues, we are always looking for new things. This is indicated, for example, in our dealings with technological devices. But when it is related to smart applications, our aspirations towards innovation are renewed; as our Arab culture still refuses to venture into this field. As a result, the forms of urban spaces in our Arab world have remained limited to the traditional forms, while the world has opened up to other forms characterized by cheap costs, good quality, rapid delivery and rationalization of energy consumption.

This research represents a brief overview of the current progress in using smart applications in urban spaces, which is considered as a new and rapidly developing area. This area is based on the broader concepts of the term "response", which identifies smart applications, shows how they affect the comfort of users, rationalize the energy consumption and renew the energy in urban space, through an applied analysis of these smart applications in this areas of (Kaaba - Medina). This is to reach the development of the system and strategy of the region in a way that leads to the possibility of controlling the rates of energy consumption and reduction by using environmentally innovative architectural processors, which does not affect the heritage of Saudi Arabia, but confirms its historical features and contributes to achieve &develop the mental image that has been drawn in the conscience of visitors.

One of the most important findings of the research is the extent to which the use of smart applications and sustainable interactive designs of urban spaces affect the energy consumption to provide convenience for users. The most important obstacles that affect the uncommon use of smart applications at the local level are also identified, in addition to some recommendations designed to use this sophisticated type of smart applications in the local environment while maintaining the Saudi heritage of the Kingdom Vision of 2030.

Key Words:
Contemporary Architecture – Sustainability- Heritage Identity.

Introduction:

The environment is the vital framework of human life on Earth. The more important it is, as a source of life, the more it represents a necessity of life sustainability. Different forms of life on Earth require the use of different energy patterns and alternatives, but overuse has led to take some measures to improve energy efficiency and reduce consumption.

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The growth rate of intelligent technologies in today's world is accelerating in a way that combines the vast spheres of the world and is linked by different knowledge bases and information reflecting a vivid picture of interactive cities of knowledge. New Urbanism is one of the planning approaches based on making the urban environment more energy efficient through how to create places as urban spaces of daily interaction to improve the quality of life. Therefore, modern urbanization has given high priority in planning and architectural formation for a group of squares to host public life and make the spaces as an external living room in order to achieve the comfort for users and energy consumption with a view to create a comfortable atmosphere for those who use these spaces.

I. **Definition of energy efficiency:** Energy efficiency is the optimal use of electrical energy resources, which considered as a set of procedures or technologies that reduce energy consumption without affecting the comfort or productivity of individuals and using the energy when it is really needed. Improving energy efficiency and rational consumption does not mean preventing energy consumption as much as using it in a more efficient manner that minimizes waste[1], as shown in Figure 1 and 2.

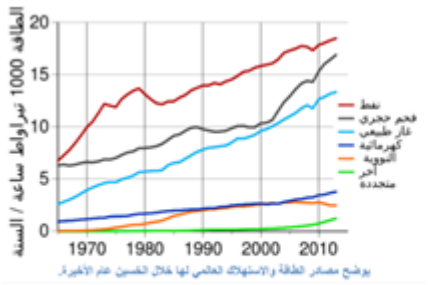

Figure (1): Energy source & global consumption

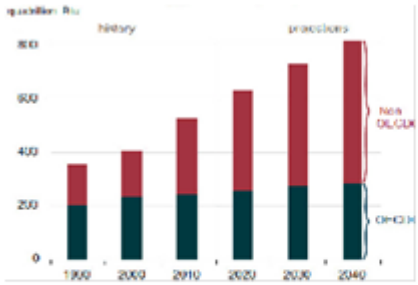

Figure (2): Increase Global energy consumption is expected to increase by more than 50% from 2000 to 2040[9].

II. Types of energy and renewable energy

First: Natural Energy: The building should be designed and constructed in such a way as to reduce the use of non-renewable energies and relying more on natural and renewable energies, including: Solar energy - wind energy - underground energy - biomass energy[2].

Second: Alternatives of Natural Energy[3]:

1. Waves energy at sea: This energy is produced by a device called Al Mahar (oysters) with flexible fins moved by waves at a depth of 50 feet under sea and 500 meters from the beach. Thus, the oyster device can pump energy to a power plant on the beach. as shown in Figure 3. One oyster can generate 315 kilowatts of power, which is enough to generate and bring electricity to 40 homes.

Figure (3): Waves energy at sea

2. Biofuel energy of algae: Biofuels are produced from bioethanol or biodiesel extracted from corn, wheat, sugar cane, rapeseed and soy crops. Seawater algae can produce clean water free of nitrates, phosphates and bacteria. It also

Figure (4): Biofuel energy of algae

can treat sewage and produce biofuels. (Figure 4.)

3. Virus energy, the strangest sources of renewable energy: Scientists have invented the M13 virus, which can produce electric charges when pressed. This virus multiplies inside the bacteria, making it easier to produce devices to produce electricity by simply pressing the screen with our finger. For example, once the virus is sprayed on the chair's surface, electricity is produced as soon as it is seated directly, as shown in Figure 5.

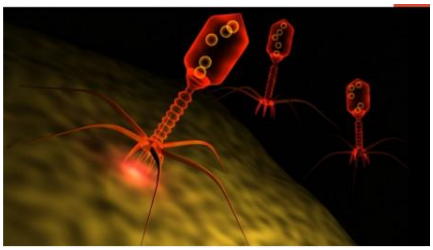

Figure (5): Virus energy

4. Volcano Energy: Volcano energy is used to produce energy from geothermal energy by pumping water into tunnels with depth of3-9 km into the earth where the temperature is too high, leaving the water vapor at a temperature of 450 degrees Celsius. This latter is used to operate turbines capable of producing 10 times the amount of electricity produced from power plants, (Figure 6).

Figure (6): Volcano Energy

The system of designing urban spaces in the light of the modern urbanization directions with low energy consumption with an original heritage identity

The idea of designing modern urban spaces can meet all the design requirements by combining: directions of modern urbanism, elements of urban formation and elements of heritage identity, as indicated in Figure (7) and by:

1. Protecting from solar radiation and thermal gain.
2. Trying to generate and maintain the energy from renewable energies.
3. Utilizing the capabilities of intelligent systems and smart materials to reduce energy consumption.
4. Preserving the heritage identity in achieving and developing the mental image drawn in the conscience of the visitor.
5. Meeting the convenience of spaces' users by adjusting the effect of natural forces on these spaces (thermal, visual and audio comfort).

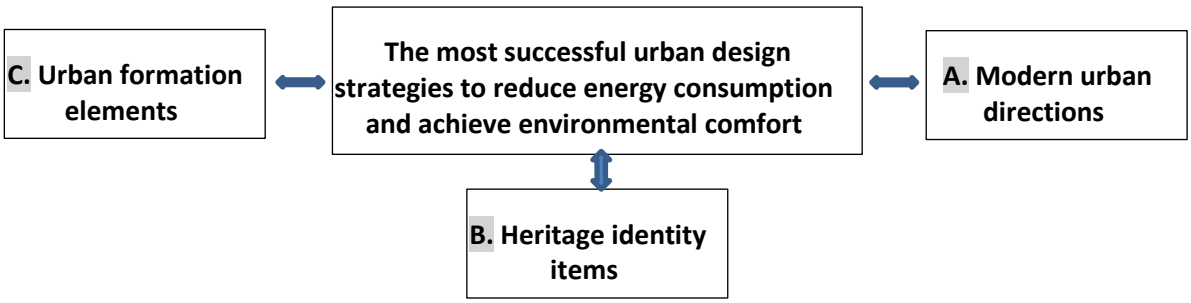

Figure (7): The system of designing urban spaces in light of the modern urbanism directions

A. Basic principles of modern urban directions (sustainable planning of cities and its relationship to environmentally friendly cities):

1. Interconnection of urban design elements: Modern urbanization is exactly achieved in proportions and measures that lead in turn to achieve the beauty of urban formation elements: (buildings - paths - public spaces - elements of site coordination - means of transport and movement), as illustrated in Figure (8).

2- Infantry: The pedestrian distances of modern urbanization include: pedestrian pavements, green belts, car parking, bicycle paths, blank brushes and tracks, as shown in Figure 9.

3- Different Uses: The city's components are interconnected by pedestrian paths, public spaces, car parking and public transport stations. The city is extended vertically rather than horizontally, as shown in Figure 10.

Figure (8): Interconnection of urban design elements

Figure (9): Different motion paths

Figure (10): Different Uses

4- Sustainable Buildings (Green Urbanism): The environmentally friendly buildings and areas are designed to reduce the negative impacts on the environment and provide all its local needs "water, electricity and food", as shown in Figure 11.

Figure (11): Green Urbanism

5-Sustainable Transportation Means: It is considered as means of transport that have a low impact on the environment through: walking, cycling, car sharing, protection of fuel transportation systems and using electric cars & trams, as shown in Figure 12.

Figure (12): Sustainable transportation

6- Life Quality: The life quality is achieved in accordance with quantitative and qualitative standards at the individual and social level, as follows:

Figure (13): Life quality

1. Qualitative standards: At the level of the individual (satisfaction with life, a sense of happiness, ...). At the level of society (the ability to participate and influence, the amount of interdependence between the individual and the community ...), as shown in Figure 13.

2. Quantitative standards: At the individual level (measuring educational life, skills ...). At the social level (measuring the environmental and economic status.).

7- Waste Disposal and Recycling: Greatly contributing in maintaining the environmental quality by reducing energy & materials, consuming carbon-purified water, reducing or avoiding all forms of waste and pollution resulting from it such as methane gaze and recycling waste to extract raw materials that can produce new materials, as shown in Figure 14.

Figure (14): Water conservation and recycling in fountains, agriculture and water saving latrines.

B. Basic elements and standards of heritage identity:

Architectural heritage is considered as a part of the cultural heritage of a certain group of mankind. It is defined as: physical display and expression of individualized human components. Therefore, the preservation of architectural heritage is an integral part of that of human identity. Heritage areas should be reused in a deliberate manner, by elaborating precise and cautious criteria for the amount of interventions to be carried out on these heritage areas. Some of the key criteria to keep in mind when designing are:

Historic Value- Social Value- Urban Value- Architectural Value- Symbolic Value- Traditional Value.

C. Urban Formation and Coordination System (Site Coordination Elements):

Concept of urban formation: Urban formation is defined as the fundamental matter for the urban identity formation of cities and neighborhoods through the formation of physical environment to live and improve the general appearance according to the function. The urban formation elements include the following formative and coordinating elements:

1. Plant elements: Plants are considered as the basic elements that make up the urban spaces, including: trees - shrubs - plant tissues - climbers - half-water plants - green areas ..... etc.

2. Structural elements: It is architectural spaces supplements which include: Pedestrian corridors - seats and seating places - umbrellas (pergolas) - Other elements, such as: (trash cans and baskets - Guiding signs) - Elements of support services include: (guard room - warehouse - room mechanical and electrical equipment) - lighting elements - surfaces –kids corner - public service items (toilets for males and females - buffet for serving light food and drinks –mosque - fences and entrances).

Modern environmental architectural directions for smart applications of urban spaces and its application to the urban spaces of the study area "Quba district" in Madinah - Saudi Arabia.

A. Definition of Intelligent Technologies:

Systems that respond to environmental influences, such as temperature, light condition, humidity, or electric and magnetic fields with certain changes in some variables with the aim of: human comfort and user needs[10], intelligent technologies can be classified according to the main components of the vacuum to:

1. **Floors that produce electric power (Pavegen tile)**: The kinetic energy is used to produce energy through finishing tiles with dimensions of 60 × 45 to convert the kinetic energy into electrical energy and store the resulting energy in the units of the bottom of the cobble for use in various activities, where one step produces about 7 watts of electricity due to the weight of the human, (Figure 15.17.18.). It is made from recycled rubber and other recycled materials and the tile is designed to be transportable from one place to another, Figure 16.

Figure (15): **Vertical sector of**

Figure (16): **The main components of the cobble**.

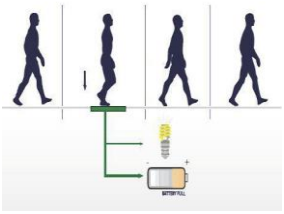

Figure (17): **The kinetic ener is used to produce ener**

Figure (18): **Cobble in reality**.

2. **Solar roads**: The solar road consists of modules of silicon crystalline solar cells, which are combined with a concrete layer covered with a thin layer of energy-producing glass that absorbs sunlight during daylight hours, and when it is dark the light shines to illuminate the streets at night, in road signs, lighting lamps and buildings as well[4], Figure 19.20.21.

Figure (19): The smart road stores energy during the day and then glows during the night

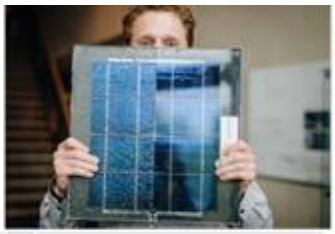

Figure (20): Sample of solar glass Product.

Figure (21): Modules of silicon crystalline solar cells, which are combined with a concrete layer.

3. **Hologram boards**: Flat tiles that are square or rectangular with dimensions of 12 × 21 inches straight or curved half-inch thickness, tiles contain a three-dimensional image of high purity and aesthetics of color. These units are considered weak in their own right so they are merged or inserted with other materials such as: glass to produce tiles or glass panels Hologram, as shown in Figure 22.23.

Figure (22): The way of hologram boards work.

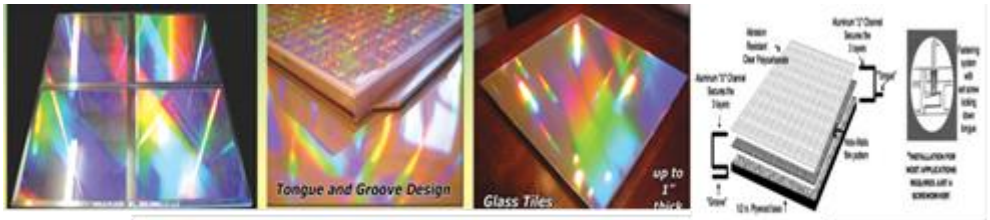

Figure (23): Producing tiles or glass panels hologram

4. **Advanced Curtain Wall System**: The smart walls are designed with the utmost transparency of the dynamic and interactive presentations that are able to interact with what is happening inside the building and outside in public squares, turning the facade of the building into an interactive environment which its widths, shapes and colors vary according to the movement of those around it and their activity, as shown in Figure 24.

It is a technology system developed by adding photovoltaic cells to curtain wall glass, so that solar energy is stored in the daytime and converted to a giant media display at night on the glass wall, or acts as a regulator and energy store made of LEED lighting units, usually manufactured from traditional materials or curtain fabric that is triple layers or leather, and all reduce sound and light[11].

Figure (24): Advanced Curtain Wall System developed by adding photovoltaic cells to curtain[8]

5. **Smart lamp**: LEED lamp lighting, power generation relies on wind turbines and solar cells by integrating smart lighting systems with motion sensing systems that respond to traffic and individuals. Smart street lighting poles are also equipped with remote-controlled digital billboards, the lamp works with stored energy for three nights of self-control without wind or sun[5], as shown in Figure 25.

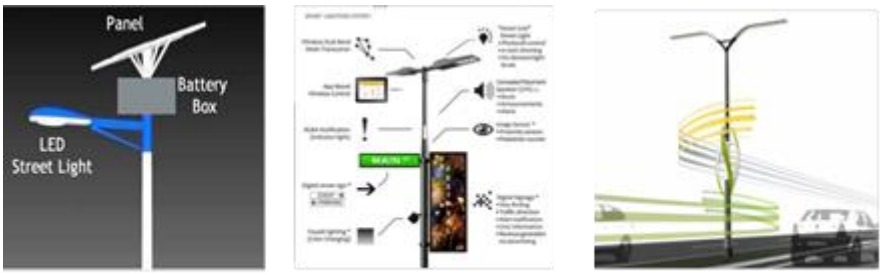

Figure (25): Smart lamp

6. **Solar Umbrellas**: In order to maintain a relaxed atmosphere, the sun umbrellas, a giant mobile sunshade inspired by the idea of a sunflower, can be used to shade the squares and public places in the city center in the morning, in addition they absorb the heat of the sun, then close themselves in the evening and turn the heat energy absorbed to keep the squares cool[6], as shown in Figure 26.27.

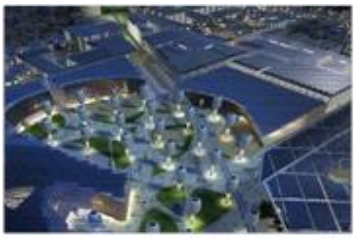

Figure (26): the unit use as lamp in the evening

Figure (27): Solar Umbrellas in the

7. **Digital Fountain**: The digital fountain consists of crystal units that are attached to metal cables. Black aluminum was used as the main material for the fountain and was installed on a granite base known as 'rills', it is 12 meters high, on the surface shows the shape of the digitally flowing water and is presented as an audiovisual image of a piece of art in the vacuum[7], (Figure 28).

Figure (28): Digital Fountain

8. **The smart seat:** Smart solar chairs rely on solar energy, it is a solar powered rocking chair with a smart generator that illuminates the roads and the electricity grid, (Figure 29).

Figure (29): Smart solar chairs

B. Applied study:

1- Definition of the area:

"Quba Avenue" in the Medina - Saudi Arabia, located in Quba Road, Mughaisla district, one of the neighborhoods of Medina located in the south of it.

Called "Quba": because of the well was called by "Qubar", so the people alienate of it, then called Quba, and until recently was a group of farms connected, spread among their houses, or gather in the form of small neighborhoods, now the urbanization has spread in Quba and spread in all directions and farms were shrunk, orchards and what remains there gives the region beauty and spread good humidity.

Figure (30): Quba Avenue-in the Medina

2- Reasons for choosing the area:

- It is the prophetic path from the Haram al-Sharif to the mosque of Quba.
- An attractive tourist environment that embraces culture, art and creativity.
- The difference in uses in the area gives the architectural space a distinctive pattern in the process of constructional formation.

3- The most successful constructional design strategies to reduce energy consumption and achieve environmental comfort for the users of space in the study area " Quba Avenue".

i) As trends of modern urbanization of the reality of the city:

(1) Single use of buildings, shops and multiple uses of land, which helps to achieve the highest rate of short distances to reach the required uses.

(2)The absence of dedicated pedestrian paths in the area linked to urban spaces.

(3)The region lacks sustainable internal and external public transport.

(4)Exploiting large parks through offering them to the private sector for investment.

(5)Lack of public services in urban areas.

ii) As elements of urban formation of the reality of the city:

(1)The design lacks a distinctive architectural character and urban style to form the neighborhood buildings, and despite the efforts to address the place, it needs more emphasis on the distinctive heritage identity.

(2)The absence of a gradient in the pattern of urban spaces.

(3)Not to rely on the scientific basis for the establishment of open urban areas.

(4)The area Lacks sections for large green areas and children's play areas.

(5)Lack of pedestrian paths separate from the movement of electric vehicles.

(6)Fully rely on private mobility and private vehicles.

iii)As modern environmental architectural directives for smart applications of urban spaces:

Some smart applications were used in processing such as:

Electric Power Producing Floors - Advanced Curtain Walls - Smart Lamp - Solar Umbrellas - Digital Fountain - Intelligent Mobility Unit.

Figure (31): The design of a smart seating unit inspired by one of the Saudi heritage symbols, created using a solar chip to convert solar energy to electrical energy and lighting the square unit inside the seating unit, and for fast charging for some devices such as smart phone.

Figure (31): Design of a smart seating unit.

Figure (32): A smart seating unit design inspired from an Arabic alphabet, made of light-emitting acrylic. The seating unit turns into a luminous piece of art at night after the sun's day heat is converted into electrical energy to illuminate the unit.

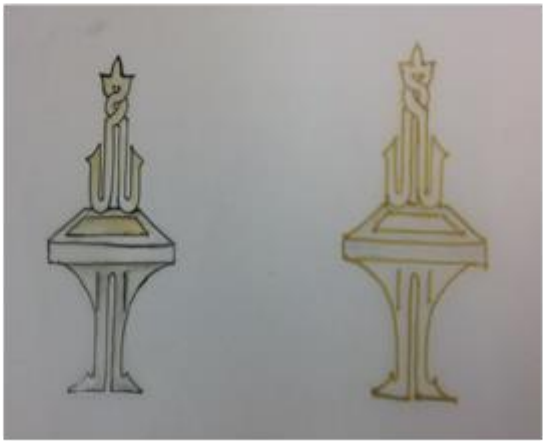

Figure (32): Design of a smart seating unit.

Figure (33): The design of a driverless vehicle unit to navigate the walkway, supported by a smart screen with maps and help to locate any shops in the walkway. Movement tracks supported by a magnetic field which are assigned to ensure that the vehicle does not depart from the track. The trolley is charged to its designated parking area via electric power batteries converted from smart floors along the walkway.

Figure (33): Design of a driverless vehicle unit.

Figure (34): The design of the digital fountain is inspired by Islamic lines and geometry. It also relies on the interactive design so that its energy represented by the “sound of water - simulating the movement of water” which is derived from the weight falling on it through the interaction of children with movement on the drop part of the fountain on the ground.

Figure (34): **Design of the digital fountain.**

Figure (35): The open-air theater design; it is an outdoor cultural hall whose roof is built from solar panels to store energy to support all the general needs of the project, such as the operation of 3D displays below the stage.

Figure (35): The open-air theater "outdoor cultural hall.

C.

D.Conclusion:

"It is true that there are things still require a long time to achieve them, such as the sensitive doors of voices, while we are really closer to achieving other things" says Frank Ailch.

In general, the evolution towards intelligent architecture is going faster than most people think, and the buildings in which our children will live will be different from those we live in today, as a luxury, tomorrow is a prerequisite, because its long-term benefits.

The results:

1- The creation of eco-friendly cities is very necessary and expensive, but it is a new discovery of real, sustainable and reliable wealth for self-sufficiency of energies later.

2- Importance of the anchoring on the basic principles of modern urban trends while designing smart and environmentally friendly cities.

3- There are many forms and types of smart applications for energy production, but the choice of the best application and how to use it in the vacuum is the precise point that must be taken into account so as not to lose our Arab identity.

Recommendations:

1- The need to rely on intelligent design environmentally friendly as a design priority in the treatment of modern urban spaces. Save effort, time and money according to the vision of environmentally friendly cities.

2- Attention to recreational areas in a way that achieves the quality of life because of its positive impact on society in all respects.

3- Importance and necessity of humanization of heritage areas and the use of all smart green means that achieve quality of life and user satisfaction.

4- Develop a specific geographic time plan to start the transformation of urban structures towards sustainability that achieve rapid service investment for renewable energy stocks.

5- The importance of studying modern applications produced in the field of production of renewable energies to start the process of industrialization and maintenance, and the possibility of continuing to see the transition towards environmentally friendly cities so that there is a distinctive identity and environment through the elements of urban construction with emphasis on adherence to the principles of modern construction.

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