The concept of "Local Smart Architecture": An Approach to Appropriate Local Sustainable Buildings

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Abstract:
The recent decades have witnessed the widespread manifestation of intelligent building design development around the world. Meanwhile, the concept of smart buildings has stimulated various architects and designers to make use of it for the sake of sustainable building. *Intelligence* is described as "the adaptaption with the surrounding environment", while *Intelligent Buildings* is defined as "It is a sustainable in terms of energy, and water consumptions besides being slowly polluting in terms of emissions and waste, healthy in terms of well-being for the people living and working within, and functional according to the user needs" [1]. The research paper has taken this definition as a point of departure in the subsequent formulation of research objectives and approaches to the study. It focuses on the gap in defining and applying the expression of *"Smart Architecture"* between theory and practice especially in developing countries, owing to the lack of deep consideration of the available technology and local materials for ensuring the *appropriateness* as come of the main objectives of the sustainable smart architecture designs. The study proposes the concept of ***"Local Smart Architecture"*** based on the available technology in less developed countries. It aims to prove that it is not important to own High Technology to build Smart Building, through exploring two Egyptian case studies, which are the architecture of poor in Gourna City by Hassan Fathy, and Architecture of Bedouins in Siwa Oasis. The research ends up with the concept of ***Local Smart Architecture*** through utilization of appropriate vernacular architectural features in smart buildings design in order to achieve sustainability.

Key-words:
Intelligence, Smartness, Local smart architecture, Sustainability, Appropriate, Karna City, Hassan Fathy, and Siwa.

1. Introduction & State of the Art:

Intelligent Buildings have been researched and developed over the last three decades, but in more recent literature, roadmaps and industrial reports the term smart has started to be quoted more regularly. This seems to be the case in all aspects of the built environment sector; smart sensors, and smart materials within buildings are seen to be the latest, most advanced technologies in our efforts to develop high- performing buildings. Smart cities are commonly seen to be the future of the urban built environment, with increasingly populated conurbations, demanding more functionality from more constrained resources and more stringent building regulations [1]. As the wave of smartness expand, the term intelligence loses both meaning and focus; which is contrary to what the updated definitions were trying to achieve.

In 1980, 18 Arab countries concluded an agreement with France to establish the Arabic World Institute. The main purpose was to provide information about the Arab world and set in motion detailed research to cover Arabic and the Arab world's cultural and spiritual values. Jean Nouvel, who is widely known for his particular surface treatment with "smart" materials, and with this kinetic facade for the Arab World Institute, won the design competition. He designed a facade that responds to changing environments. To achieve this, the south facade of the building consists of high-tech photosensitive mechanical devices, which control the light levels and transparency. It interprets traditional wooden Arab latticework screens into a glass and steel construction with 30,000 light-sensitive diaphragms on 1600 elements, which operate like a lens of a camera. The changes to the irises are revealed internally far more than what can be observed from the exterior. The unique use of high-tech photosensitive mechanical devices made this building famous in 1987. Nowadays it's still widely known and has lost its futuristic impression, but **the facade system no longer works** [2]. So, the smart building is not smart anymore after the technical failure of the mechanical system, which prove that constructing smart architecture depending on not economic technology, which couldn't be designed manufactured and maintained is not a kind of smartness.

Moreover, cities in developed countries like United States, Europe, Japan, China, they have comparatively more resources and flexibility to adapt different smart concepts, but for cities in developing countries, it is largely dependent on their development priorities as often confined by their limited resources. So, on one side we find the developed countries can spend huge amount of money on buildings smart systems, besides they already own the appropriate technology to establish and maintain such systems, on the other side developing countries don't have the welfare of spending the same amounts of money.

The research suggests that the developing countries have the right to establish smart techniques and designs to make their residents' life much easier, through this perspective the research proposed the concept of the **"*Local Smart Architecture*"** to encourage the utilization of available technology and appropriate vernacular architectural features in smart buildings design in order to achieve sustainability.

The paper assumes the following:

- Importing inexpensive non-proprietary technology, which can't be managed or maintained is not a kind of smartness.
- As the definitions of intelligent and smart buildings expand, the term intelligence loses both meaning and focus; in contrast of what the updated definitions seek to achieve.
- The concept of the ***Local Smart Architecture*** is an urgent trend, which we have to follow to achieve smart sustainable buildings.

The paper covers the following points:

- The general overview of "Intelligent Architecture" and "Smart Architecture".
- Historical background: the development of intelligence definition in Architecture.
- Shedding light on smart local sustainable initiatives.
- Appropriate features of smart buildings.
- The Analysis & evaluation of the chosen case studies.
- Proposing the concept of "Local Smart Architecture", and the proposed guidelines.

2. The General Overview of Intelligent Architecture and Smart Architecture.

As the wave of smartness expand, the term intelligence loses both meaning and focus; which is contrary to what the updated definitions were trying to achieve. The research depends on the below definition to achieve its goals.

Smart building can decide on time, the most effective ways to create an environment and sustainable responsive, to raise the efficiency of its occupants with the lowest possible costs throughout the life span of the building. So it can be defined as [3]: "The building which accommodates the latest technologies of the age, which make it capable to response the demands of the occupants and adapt internal and external conditions".

Here, the research will try to clarify the progress of the definition from the word **Intelligent** to **Smart** buildings [1]. Look at figure (1). The research will consider definitions 2 and 5 as a mail stone for the hypothesis of the research.

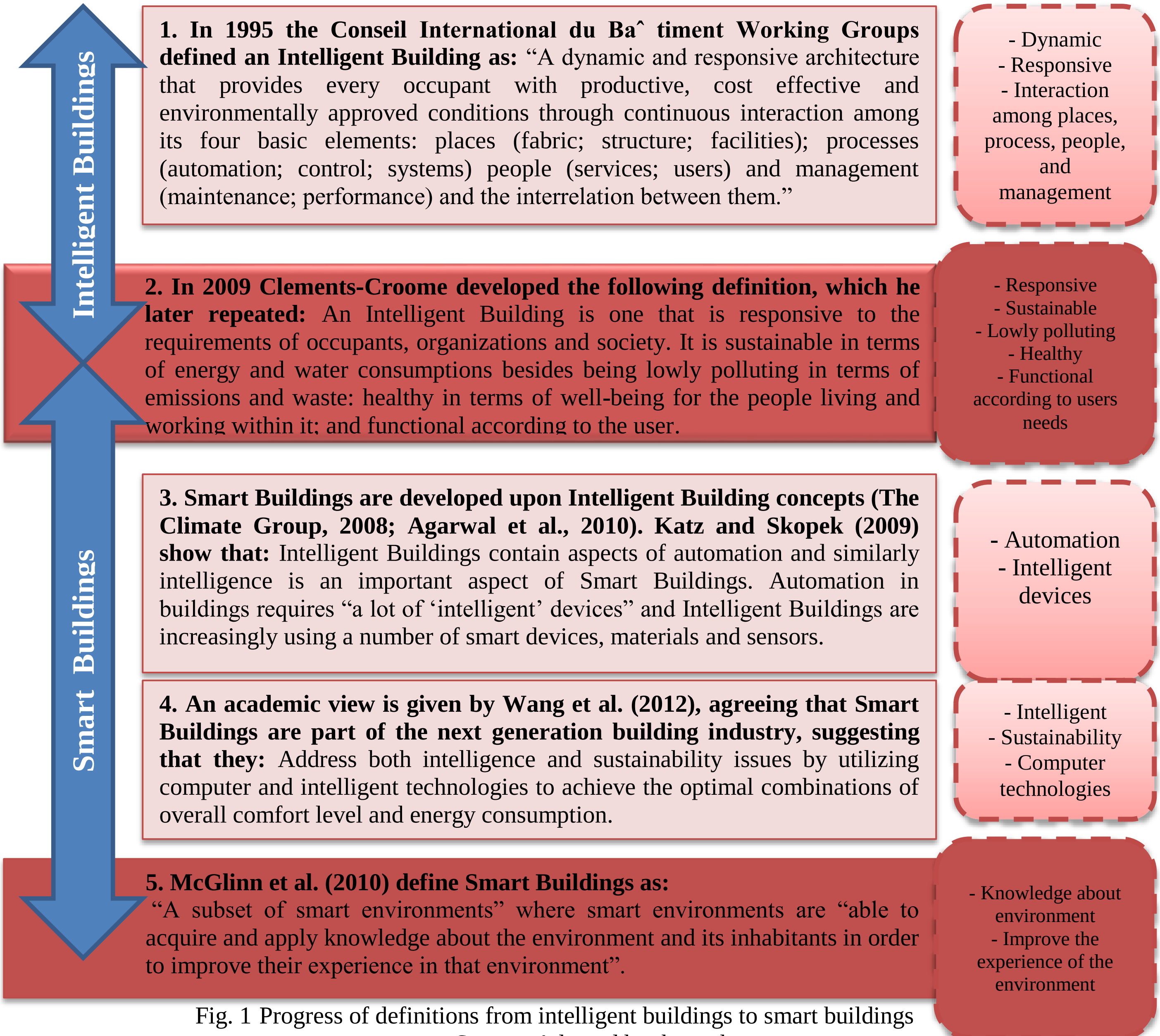

Fig. 1 Progress of definitions from intelligent buildings to smart buildings
Source: Adopted by the authors

3.Historical Background: The Development of Intelligence Definition in Architecture.

In this part, the research presents the historical intelligent features appeared in the old civilizations such as: “Pharaonic, Greek, Romanic, Islamic civilizations”, which made a different creative progress in the design and construction techniques at this time, using the appropriate technology of this era.

3.1. Pharaonic Civilization [4]

a) The Ancient Egyptians used a clever trick to make it easier to transport heavy pyramid stones by sledge. The Egyptians moistened the sand over which the sledge moved. By using the right quantity of water they could have the number of workers needed, as shown in figure (2).

b) Ancient Egyptians cared to achieve thermal comfort of their own homes, as done in Neb Amon House, and contains wind catcher “Malkof” by two openings, one face to the wind and the other for vacuum induced absorption. It is interesting to see the same principle applied in the contemporary design of the University of Science and Technology in Ghana, where used a system of bridges shaped “Y” to guide the movement of air, as shown in figure (3).

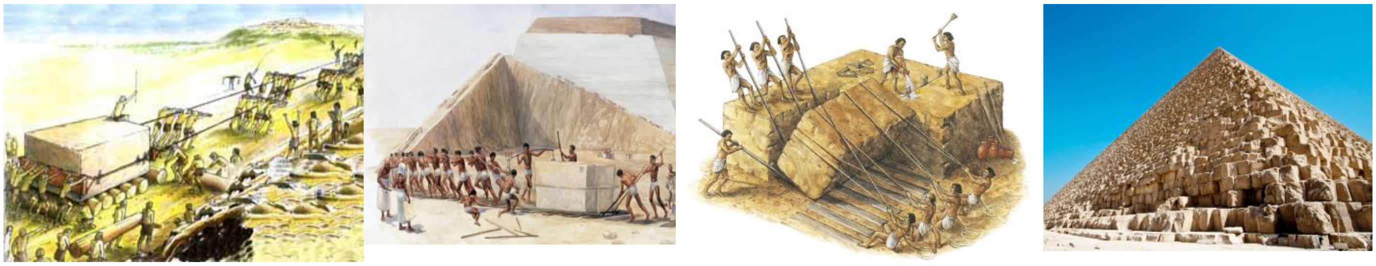

Fig. 2 Smart applications, which were done by the Ancient Egyptians in the Construction Process of the Pyramids
Source: Braun, 2005

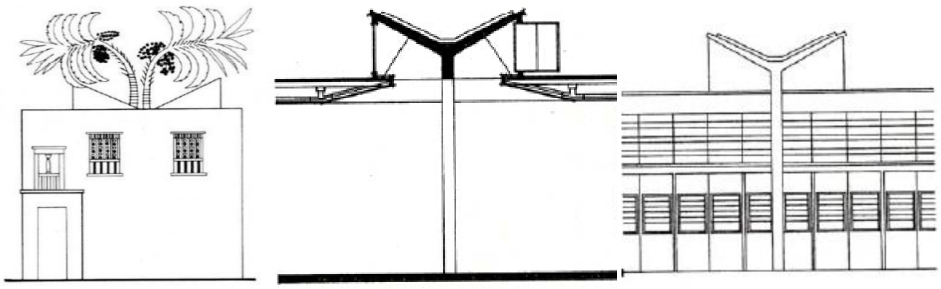

Fig. 3 Malka in the design of the Ancient Egyptian House and its application of the Science University in Ghana
Source: Fathy, 1986

Fig. 4 Abu Simple Temple
Source: Brawun, 2005

c) Solar radiation were employed to give a symbolic effect within the architectural work at Abu Simbel temple, "carved in the mountain" under the guidance indicates the precise calculations of the movement of the sun and the angles of its rays, to carry rays for a distance of 60 meters inside the mountain to the perpendicular on the face of King Ramses II statue and then spread to illuminate the four statues in two days selected on the anniversary of his birthday 21 February, and the anniversary of the day he sat on the throne 21 October of each year, figure (4).

3.2. Greek Civilization [5]

a) In the construction of the Greek open theater, they poured molten lead into the cracks between stones in order to achieve better solidify.

b) In the construction process of the Greek columns, Greeks added steel to the construction materials to increase the strength and consolidation of the column.

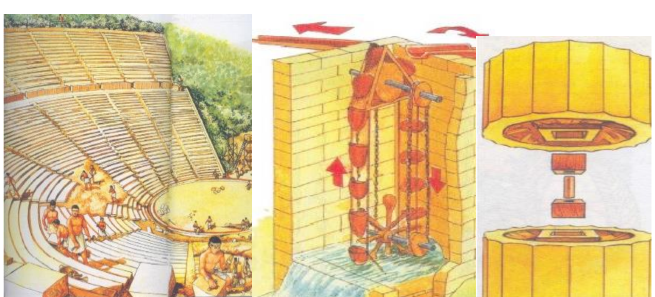

Fig. 5 Inventions in Greek Civilization
Source: Braun, 2005

c) Greek columns were not constructed as one piece but divided into 10-12 cylinder pieces proportionately, collected to each other after being drilled in the center of each square hole where entering the wooden plug assembly between each two syllables, figure (5).

3.3.Roman civilization [5]

a) Romans used cranes to lift heavy stones by the rollers, which is a device to make a circular motion by the workers feet, as shown in figure (6).

b) Roman invented the wooden form, which is a light frame for the arc radius, and used it in the construction of vaults and stones have been placed appropriately not be installed with mortar.

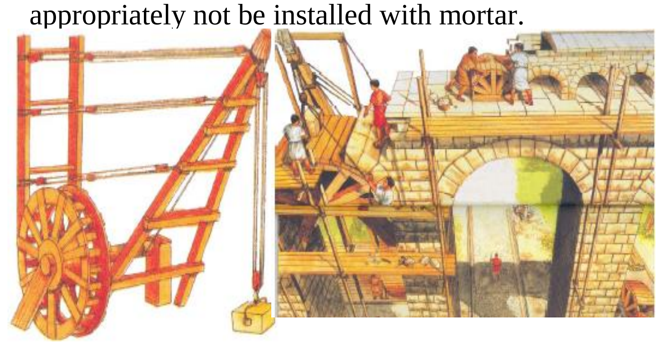

Fig. 6 Wooden forms in Roman Construction
Source: Braun, 2005

c) The use of Roman concrete is an important technical event in that stage; the nature of the ground was characterized with the presence with some volcanoes, where affect the substance of "Buzona" around the city of Naples. Buzona is a volcanic material, when it is mixed with stone; it worked as a kind of very rigid cement.
d) The Roman Pantheon Temple, the dome is 43 meters high, and spans over a space, which is 43 meters in diameter, making it the largest dome in the world until modern times. The dome is made out of concrete, look at figure (7).

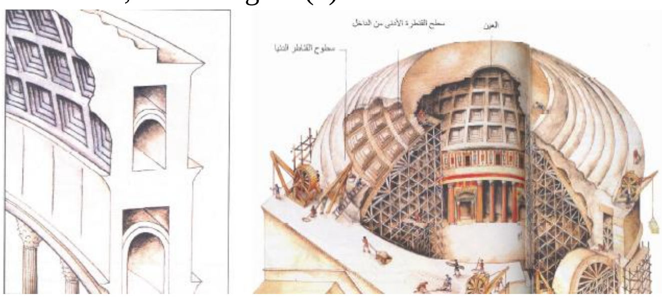

Fig. (7) Concrete Construction of the Dome Pantheon Temple. Source: Brawn 2005

3.4.Islamic Civilization [6]

The development of some architectural treatments that have emerged in earlier civilizations to cope with the harsh weather conditions, and create a good environment for living, such as interior courtyards, air Mlaagaf, domes and new architectural innovations such as: Alshkhchikhh and Mashrabiyya, as shown in figures (8,9,10).

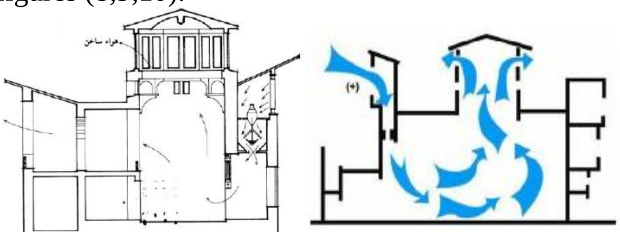

Fig. (8) Cross section of Malkaf, with water carrier and wind exit "Shokhshekha" Source: Fathy, 1986

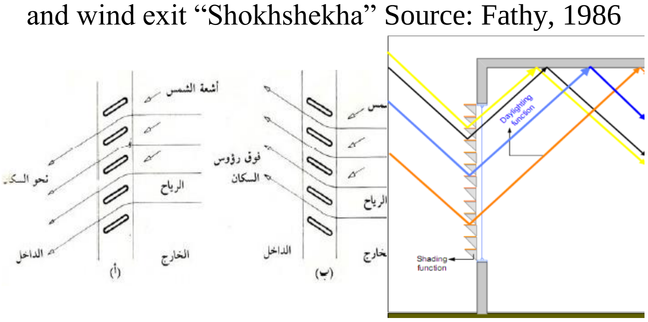

Fig. (9) Shaping louvers according to the desired wind Source: Fathy, 1986

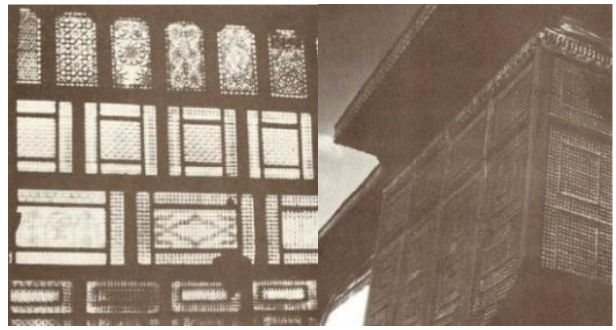

Fig. (10) Mashrabya in El Sehemy House, Egypt
Source: Fathy, 1986

Even though, These solutions they look like traditional now, but in that time was smart, which took advantage of the offer to their potential in the creation of intelligent systems to achieve comfort for the occupants and raising the internal environment of the building efficiency.

4. Shading Light on Sustainable Local Smart Architecture Initiatives.

In this part, the research shades light on the best practices and the most appropriate systems for the *"Local Smart Architecture"*, where were designed, constructed, spread worldwide like Tunisia, India, Yemen, Malay, Mexico, USA, Libya, and Egypt, to eager the benefit from using the appropriate local technologies to achieve smart solutions for the surrounding environment challenges.

By looking at the smart techniques of **"Pueblo Revival architecture in Mexico" [7],** various lessons could be learnt from using local construction materials such as: clay or mud bricks, which are suitable with environment even in hot summers, and cold winters; using various passive design techniques like orientation, ventilation, and heating. The design of the houses was very simple, and not complicated at all to achieve the perfect job of the building in this challenging weather, as shown in figure (11).

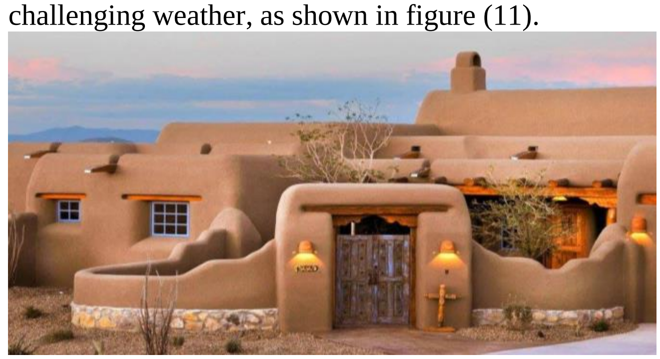

Fig. (11) Pueblo Revival Architecture

Likewise, many lessons could be learnt too from the challenges met by the local old Libyan architecture in the "**Drilling Houses (Dwames) in Gharyan, Libya" [8],** where the architect decided to dig houses underground, because of the harsh weather, which is so cold in the winter and so hot in contrary in the summer. The Drilling Houses were protected from flooding by using cuttings in building a belt or barrier (Alcdoh) around the courtyard to prevent the flooding water entering the house, and there is a hole at the entrance of each house to accommodate the rainwater. The house is inhabited by one family and may be a number of families up to 8 families, descended from one grandparent in the form of local cooperative communion housing, as shown in figure (12).

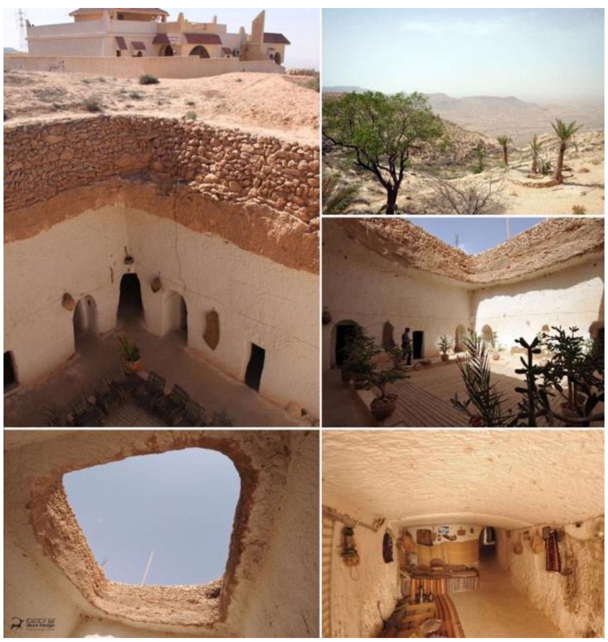

Fig. (12) Drilling Houses in Gharyan, Libya
Source:
https://www.temehu.com/Cities_sites/Gharyan.htm

"Shibam city in Yemen" [9] is often called **"the oldest skyscraper in the world"** or the **"Manhattan of the desert"**, and one of the oldest and best example of urban planning based on the principle of vertical construction. The city has sum of the tallest mud buildings in the world, with some of them over 30 meters high, thus being early high-rise apartment buildings. In order to protect buildings from rain and erosion, the walls must be routinely maintained by applying fresh layers of mud. The city is one of the most accomplished **"traditional examples of Hadrami urban architecture"** both in the grid layout of its streets and squares and of the visual impact of its form. Moreover, it's considered one of the finest examples of the **"Arab and Muslim Construction Techniques"**; the city included a very advanced sewage disposal system, as shown in figure (13).

Fig. (13) Shibam city, Yemen
Source: http://whc.unesco.org/en/list/192

From the same perspective, a real world example of Neo-Vernacular architecture **"El Gouna in Hurghada, Egypt"** [10] was developed on the Red Sea. El Gouna proves that the vernacular architecture does not belong to the poor people, but it turns to be the architecture for the rich "Neo-Liberalism", through using smart technologies to achieve a luxury dimension into the local architecture of El Gouna resort, as shown in figure (14).

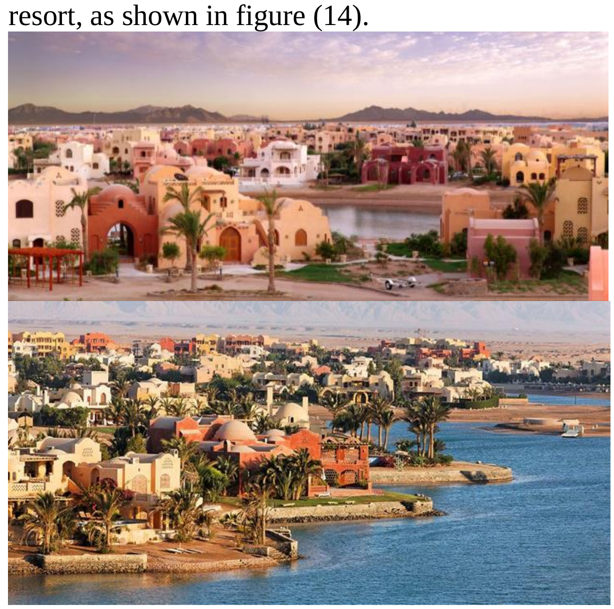

Fig. (14) El Gouna city in Hurghada, Egypt
Source: http://www.elgouna.com

5. Appropriate Features of Smart Buildings.

It means valuable, aesthetic, adaptable, adjustment and achieving useful benefits either one or more benefits [14]. Choosing an appropriate technology was viewed as being the technologies contributing most to functional, formational, structural, technological, social, economical, and environmental objectives. Here, the research will present the different features of appropriation in smart buildings, which is the conducted result of a published research under title [15]: *"Towards Novel and Appropriate Smart Buildings "Beijing Water Cube"*. The research discussed the novel and appropriate features of smart architecture through analysis of the Beijing Water Cube, and ended up with **criteria to evaluate** the appropriation of smart buildings, which is important to evaluate to which limit the smart design depends on appropriate technology. The same criteria will be used to explore the chosen case studies in the next part.

5.1. Functional Benefit: achieving needs through new vision in solving problems.

5.2. Formational Benefit: create space and masses to make mental enjoyment and emotional satisfaction.

5.3. Structural Benefit: designing creative idea to achieve stability and equilibrium; material efficiency; economic methods of construction.

5.4. Technological Benefit: means innovation in using the available technology in the architectural work, within (applied science, material, and human, machine).

5.5. Social Benefit: respecting the social values of the community.

5.6. Economic Benefit: means the ability to produce services, job opportunities on a continuing basis by creative ways.

5.7. Environmental Benefit: means maintaining a stable resource base, avoiding over-exploitation of renewable resource systems.

6. Analysis and Evaluation of the Chosen Case Studies.

After shedding light on various projects of smart local architecture, in this part the research investigates the concept of **"Local Smart Architecture"** through analyzing two Egyptian case studies, which are chosen according to the below criteria:

- Constructed using a local available materials
- Respecting the weather conditions
- Using the updates technology of their constructed time to adapt with the context.

6.1 New Gourna Buildings

Hassan Fathi "The Egyptian architect" studied the old Cairo and Nubia in order to create a local architectural language, which based on employing the traditional elements and techniques in buildings [13]. So the first case study will be as the following:

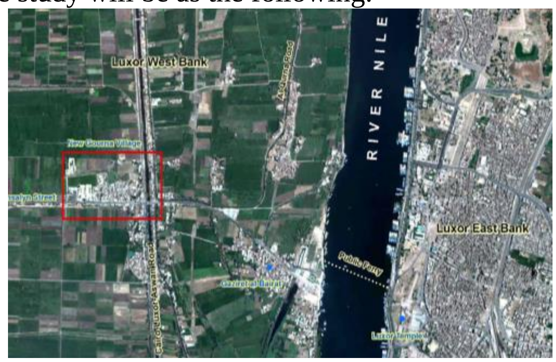

Fig. (15) New Gourna and its environs [16]
Source: Google earth

6.1.1 General information

New Gourna is located on a patch of agricultural land in Luxor's West Bank of Egypt [14], figure (15). The "Old Gourna", which is an archaeological area, contains many thefts of antiquities. Gourna had grown up to serve the antiquities trade, and its inhabitants had been employed as laborers on the excavations and had made a lot of money too by tomb robbing and selling things to tourists. "New Gourna" was developed as the rehabilitation of the "Old Gourna" [15], figure (16).

Fig (16) Part of the demolished Old Gurna Village, where homes are built on top of ancient tombs.
Source:https://mslamli.wordpress.com/2012/01/29/sustainable-architecture-for-the-poor/

6.1.3 Appropriation Features

This project is based on the use of a narrow vocabulary made of morphological and structural elements taken from tradition: parabolic arches, square spaces covered with domes, rectangular rooms or narrow spaces with vaults, courts, local building materials and wind towers [13]. There are seven features for appropriation in these buildings, which are as the following [15]:

1) Functional Benefits

- Orienting the house in the north direction to prevent the reflected radiation and direct radiation from the sun, and to the inside to the "Courtyard", with windowless walls, to promote the social value of "privacy", and thermal comfort.
- Using the element of "Mushrabiya" for privacy, better ventilation, and lighting comfort, figure (17).

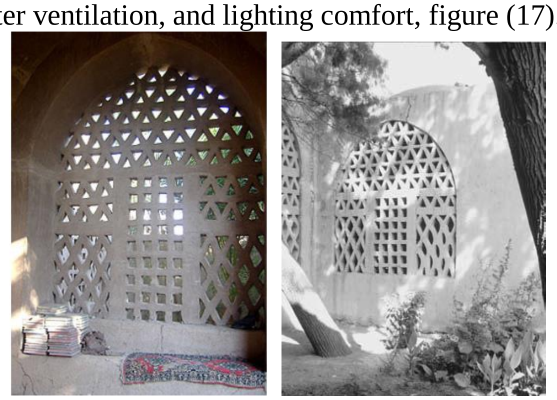

Fig (17) Mushrabiya in New Gourna
Source:http://www.touregypt.net/featurestories/newgournaupdate.htm

- Using "Domes" in roofing the rooms, to allow for high openings above the roofline of the ground floor, and push the hot air to escape from these openings, to allow cold air to enter the space, to achieve better thermal comfort, figure (18).

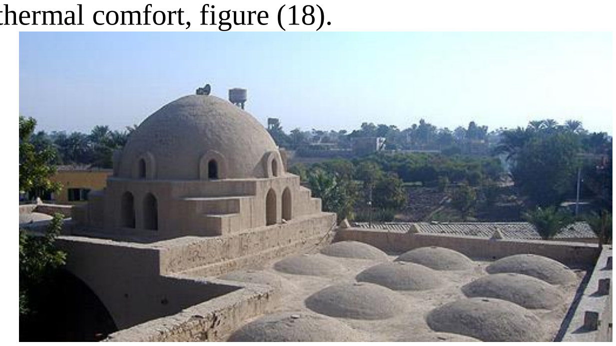

Fig (18) The Roof of the Mosque shows the use of domes for cooling. Source: http://www.touregypt.net/featurestories/newgournaupdate.htm

2) Formational Benefits

Domes, mashrabya, malkaf, and courtyard are environmental elements, which are used to achieve the thermal comfort, turns to be unique formational elements, and featured pattern for Hassan Fathy's architecture.

3) Structural Benefits

- Providing stability and balance by building maximum height of one or two floor, as the innovative technique in constructing the domes with a transition from a square to octagonal to circular shape, fig. (20).
- Using arch system for domes and volts to provide the stability for the buildings, as shown in figure (19).

Fig. (19) A dome-ceiling room

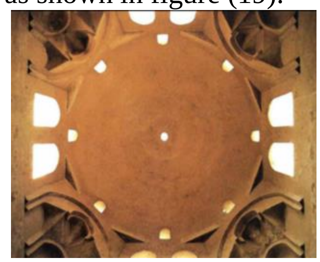

Fig. (20) The Dome in new Gourna

Source: http://islamic-arts.org/2012/elegant-solutions/

- Efficient use of building materials by using "Sun-dried earth brick", local building materials as "mud" which is a poor heat conductor, it retains heat for a long time, as shown in figure (21).

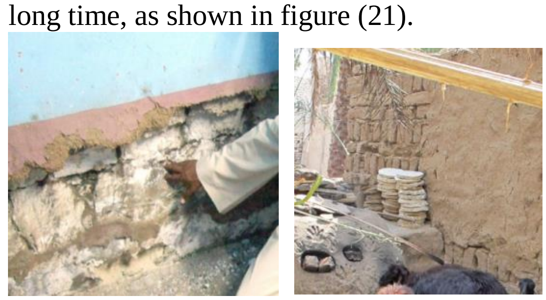

Fig. (21) Walls from mud and sun dried bricks [17]
Source: Robert W. Wilson, March 2011

4) Technological Benefits

- Using adobe as a main construction material after measuring its maximum strength and durability of under different loading conditions, which done by soil mechanics specialists.

5) Social Benefits

- New Gourna is very much a close-knit community in which residents have formed strong networks of communication and sharing, from bread baking to money lending. The family social glue is strongly effective within the village, the people still in the same village after marriage and across generations.

- Using local traditional Egyptian elements for obtaining the most efficient use of it, which make Gournis live better and easier.

Fig. (22) Mastabas made from palm trees in a New Gourna yard, while women care for children, tend animals, bake bread, and manage household [17]
Source: Robert W. Wilson, 2011

6) Economical Benefits

- Seeking to traditional techniques that extremely reduce the use of machinery and exploit what is available in a cheap way: earth, straw, man's labour, and stones. The brick is in fact the only material used in his works, as shown in figure (22).
- The total population of the Gournis was 6,394; there were at least 3,000 people who was working in agriculture, and the rest of populations who would have to support themselves in some other occupation. So, the new village would become a tourist base for visits to the valleys of the tombs, if the Gournis became mostly craftsmen. As they have their remarkable skill in faking antique statuary and scarabs, and besides this they used to turn alabaster vases, weave some very fine woolens, and make pottery. They also supported a number of silversmiths.
- The Gournis learned making quarrying, brick, lime firing, bricklaying, plumbing, and plastering. They also are taught to make straw mats, baskets, rugs, tapestries, good tableware and Jewelry. There have a small Workshop for making stained glass windows. This will save money of importing labours from outside the city.

7) Environmental Benefits

- Decreasing the heat transfer, and achieving the desirable noise isolation by using courtyards, plants, water features, think walls in the external walls.
- Protecting the building from dusts and insects by utilizing the concept of courtyard and bent entrance (for dust) and wire mesh on the small openings and wind catcher openings, as shown in figure (23).
- Protecting the building from sun heat by using the roof garden, domes and vaults as roofing systems, exposed masses in the form of corbel, courtyard, arcades, and mashrabiya.

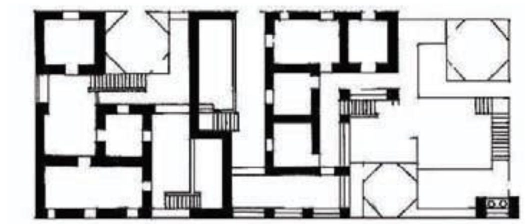

Fig. (23) Thick walls of New Gourna houses [16]
Source: Tarek Abdelsalam, 2014

-Promoting natural ventilation through utilizing wind catchers, mashrabiya and small openings in the external facades and respecting the orientation of the prevailing wind.
- Using the element of "Malqaf" which is a wind catcher and has three main functions: directing airflow downward using direct wind entry, directing airflow upwards using a wind-assisted temperature gradient, or directing airflow upwards using a solar-assisted temperature gradient.
- Using of local available materials in the constructing process made an environment friendly city.

6.2.Siwa Oasis Residential Buildings

It has been selected for the remarkable blend of the building with the surrounding natural environment and landscape.

6.2.1. General Information.

It is located in a unique place in the western desert of Egypt. It is about 60 feet below the sea level, surrounded by sculpted limestone, 75 acres of palm and olive trees, salt rocks and clay, aimed to best use the available local building materials available in the surrounding environment, [16] see figure (24).

So the second case study will be as the following:

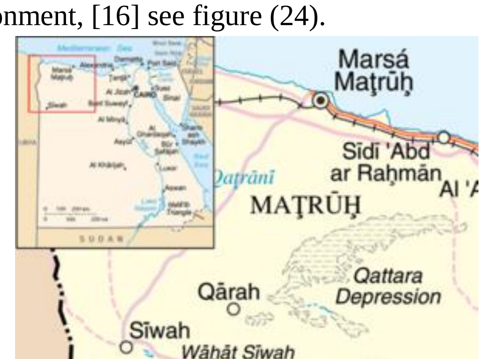

Fig. (24) Map of the Oases of the Western Desert
Source: https://www.googleimages.com.eg

6.2.2. Appropriation Features.

Siwa oasis has a dry hot summer reaching 39°C and cool winter reaching 5°C [19]. Siwa is popular for its palm and olive trees due to its location and the presence of hundreds of fresh water streams and springs, thus considered to be an agricultural oasis. It is one of the few Egyptian oasis communities that have managed to retain most of its traditional characteristics. There are seven features for appropriation in these buildings, which will be discussed through the analysis of three residential buildings named: *Haj Ali, Shali Lodge, and Adrere Amellal eco-lodge building* as the following [20]:

1) Functional Benefits

- Respect the "privacy social value" through designing a guest room called "AL-marbouaa" for the visitors, and the storage rooms located in a place closed to the entrance area, *such as done in Haj Ali house*, fig (25).

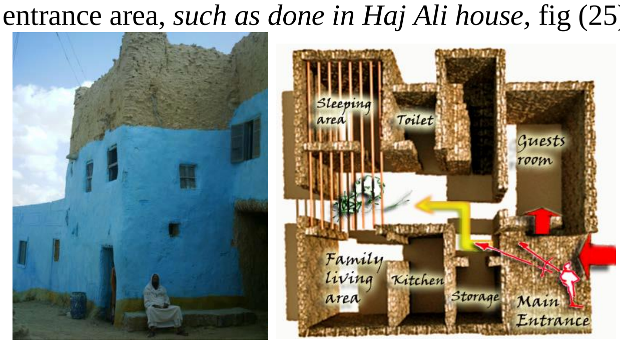

Fig. (25) Ground floor plan of Haj Ali house
Source: Ahmed, 2014

2) Formational Benefits

- Designing a comfort style of building, which is respecting the environment, *such as done in Adrere Amellal eco-lodge building.*
- Respecting Siwa's culture, pattern, and norm, *such as done in Adrere Amellal eco-lodge building.*
- Using of Alcoves as "old Siwan vocabularies" were grooved on the walls for storage or decorative purpose, *such as done in Shali Lodge building*, fig 26.

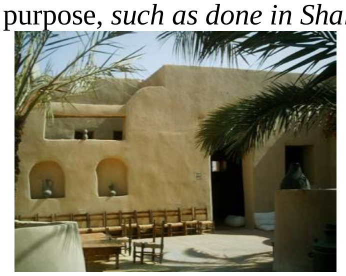

Fig. (26) Al coves grooved in the walls

Fig. (27) The lamp made from salt

Source: Ahmed, 2014

- Windows were designed to be very small in size and imbedded in the very thick Kershef walls, figure (28).

Fig. (28) Small windows imbedded in the thick walls.
Source: Ahmed, 2014

3) Structural Benefits

- Providing Stability, balance, and efficient use of building materials.
- Using the wet mud from the salt rich soli after dehydration via leaving it in a direct sun exposure, to avoid heavy unusual rains, which damaged the dwellings, *such as done in Haj Ali house*.
- They supported the walls with palm wood trunks connections on roofs to achieve straight endings of the building's walls, which was used as decorative element for interior design as well [22], *such as done in Haj Ali house*.
- Different forms of palm trees' layout were designed for ceiling construction, *such as done in Haj Ali house*, as shown in figure (29).

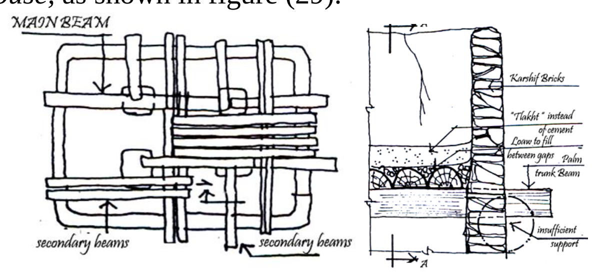

Fig. (29) Looking up view and section of the palm trunks' roof.
Source: Ahmed, 2014 [19]

4) Technological Benefits

- Using modern technology to enhance the past: through not using electricity, to make travellers experience nighttime and daytime to help them to feel harmony with the nature, *such as done in Adrere Amellal eco-lodge building.*
- Creating an affordable lighting pipe for maximize the use of sunlight during the day.

5) Social Benefits [22]

- Promoting gender quality and better quality of life, *such as done in Adrere Amellal eco-lodge building.*

- Giving opportunities to the Siwan women to gain employment, which is a new prospect that was previously un-heard of in the male dominated society, such as done in Adrere Amellal eco-lodge building, *such as done in Adrere Amellal eco-lodge building.*
- Promoting the awareness of less energy consumptions, protecting the non-renewable resources of Oasis and the climatic responsive architecture among the society through giving workshops, *such as done in Shali Lodge building*.
- Giving trainings to the Siwan workers to perfect the construction process, *such as done in Shali Lodge.*
- Decreasing the land reclamation by agriculturalists to become 25.000 after 250.000.
- Investing in projects for preserving Siwa's wealth of natural assets and cultural heritage, which aiming to reduce poverty in Siwa, *such as done in Shali Lodge.*
- Encourage the social gathering among the family by designing a central court in the house, and more for the society members by providing an out door area, *such as done in Haj Ali house*.
- Promoting the value of "Public Participation", which is support, the success of any development project, *as done in Adrere Amellal and Shali eco-lodge.*

6) Economical Benefits

- Creating economic job opportunities for the local people, *such as done in Adrere Amellal and Shali eco-lodge building,* as shown in figure (30).
- Marketing local products with the international market, and supporting position Siwa on the international stage, *such as done in Adrere Amellal eco-lodge building.*

Fig. (30) Creating job opportunities for the locals
Source: Hana Alamuddin, 2001

- Encouraging the Siwan people to be engaged in other activities, like kershaf construction, palm trees roof construction, sand furniture and products, *such as done in Adrere Amellal eco-lodge building.*
- Using of local cheap responsive available building materials, *such as done in Adrere Amellal eco-lodge.*
- Constructing a contracting company for Kershaf to support the society business.

7) Environmental Benefits

- Using of the friendly environment local materials, such like kershaf, palm trees trunks, and stones, and salt furniture for climate responsive, and zero carbon emission buildings and good finishing appearance, *such as done in Adrere Amellal and Shali eco-lodge.*
- Using of passive cooling via separating the building with narrow alleys for creating wind currents and cross ventilation techniques, *such as done in Haj Ali, Adrere Amellal and Shali eco-lodge building.*
- Decreasing solar radiation through painting the external walls, *as done in Haj Ali house.*
-Minimizing the energy consumption through building separate bedrooms, roofed ones for the winter and un-roofed for the summer times, to replace the use of any mechanical modes, *such as done in Haj Ali house.*
- Using of vegetation beside the openings and hence improving cooling the air before passing through the windows, *such as done in Shali Lodge building.*

6.3. Facts and features of the case studies.

In this part, the research will present some facts and features of the pros analyzed case studies:

1. Achieving a better quality of life
2. Establishing an economic base for the locals
3. Provide job opportunities
4. Enhancing community's social connections
5. Achieving thermal comfort
6. Using environmental local resources
7. Using the latest techniques at this time
8. Achieve healthy productive life
9. Eradicate poverty and disparities in living standard
10. Conserve earth eco-system
11. Decrease costs for building construction
12. Saving consumption energy
13. The importance role of public participation

Here, the research will evaluate the case studies, on the evaluation criteria from the appropriate features of smart buildings, as shown in table (1).

Table 1 Evaluation of the case studies

Appropriate Features of Smart Buildings.	Gourna City	Siwa Oasis
Functional Features	✓	✓
Formational Features	✓	✓
Structural Features	✓	✓
Technological Features	✓	✓
Social Features	✓	✓
Economical Features	✓	✓
Environmental Features	✓	✓

From above, the case studies are achieving the appropriating features of the smart building.

7. Proposing the Concept of "Local Smart Architecture".

From all above, we can define the concept of the local Smart Architecture as:

Local Smart Architecture is using the latest appropriate technology to fulfill the physical and non-physical needs and values of a certain community in a specific context at specific period, all above to **'Sustain the Life Conserving System'**, to achieve a valid design for the upcoming generations, which is defined world widely as **Sustainability**.

- Local Smart Architecture is based on the concept of "the Vernacular Responses", where materials, resources, and productions are becoming the world's foremost source in the area.
- Seeking for: better climate conditions, conserving culture heritage, saving energy, and sustainability.
- Fathy believed in the importance of human values, in the use of technology suitable to time and place [that is climate and local economies], in the need for socially-oriented cooperative construction techniques. He assigned an essential role to tradition and hence to the re-establishment of a national cultural pride, a goal to attain by means of the act of building.

8. Conclusion

- Spreading and expanding of the concept of ***"The Local Smart Architecture"***, between architects and users, is a must.
- The role of sustainable architecture and appropriate technology is achieving the needs of local communities and building on their skills, while also minimizing the impact on the environment.
- Importance of using modern, innovative technologies, along with traditional and culturally sensitive materials and know-how to meet the needs of local communities while also preserving the past.

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