

# Slums Issues in Egypt: An Approach to the Application of Green Building Concepts

Waleed Hussein, PhD

Assistant Professor, Department of Architecture, Faculty of Engineering, Fayoum University

Waleed.a.hussien@gmail.com

## Abstract

This paper constitutes an approach to resolving the problem of the spread of slums areas in Egypt. It attempts to identify and apply the concepts and principles of sustainability and green Buildings, define green building issues and objectives, describe environmental design methods and management, outline standard environmental design specifications, and examine green building costs and environmental requirements.

The paper reviews the development stages, general characteristics, and architectural and operational aspects of self-built housing (slums), and looks into the implementation of climate and environmental design concepts as a means for resolving the slums problem.

The importance of the paper is to investigate the sustainability as a solution to the problem of housing in Egypt, including putting this vision in the orientations of the State toward a solution to the problem of slums in Egypt and suggest developing strategies to solve that problem.

## Research Objectives

The paper reviews the development of slum housing and defines sustainability concepts in order to formulate an approach to resolving the slums problem in Egypt based on the implementation of sustainability concepts.

## Keywords

Slums – green architecture – sustainable architecture – climate design systems – resolving the slums problem

## 1. Slums Issues

The slums problem in the Arab Republic of Egypt began with the rapid urban expansion of Egypt's larger cities at beginning of the twentieth century.<sup>i</sup> The concentration of government agencies and large industries in these cities led to the creation of significant employment opportunities, and thus to the increase of internal migration; a rural exodus to cities was created by individuals in search of job opportunities.

Slums areas in Egypt are located on the outskirts of cities, and slum dwellers represent 37% of the country's urban population and 20% of the total population.<sup>ii</sup>

This phenomenon is closely linked to the causes behind Egypt's housing problem and directly affects two of the most important reasons for the problem: rural-urban migration and construction on agricultural land. Because of the limited resources available to them, rural migrants build housing on agricultural land. Twenty-six of the approximately 28 slums areas in the Greater Cairo area are built on agricultural land. The two exceptions (Manshiyat Nasser and Al Fostat) are built on hilly desert land. People choose to build housing on agricultural land for a number of reasons: it is easier to appropriate this land illegally, the unpaved trails connecting different land plots can be used as roads, and water pumps are readily available to provide the water needed for drinking and construction.<sup>iii</sup>

Since only 5% of the country's total land area is suitable for farming, the high rate of infringement on agricultural land eliminates all hope of future food security and self-sufficiency.<sup>iv</sup>

Since all slum housing is located on land where construction is illegal (agricultural land, State-owned land, or unplanned and unregulated land plots), the authorities refuse to extend public services and utilities to these areas. Slum housing is not limited to shared and private housing structures in slum areas; it also includes self-built shelters, huts, tents, cemeteries, rooftops, boats, hideouts (in public parks and basements), shops, stairwells and mosques (particularly ancient ones).<sup>v</sup>

Thus, slums areas and neighborhoods develop with no access to public services and utilities or decent healthcare, no building safety, and no roads other than narrow, barely useable trails and pathways. Statistics indicate that 80% of the housing units that were built in Cairo between the 1970s and the 1990s can be classified as slum housing.vi (**Table 1**)

### 1.1 Definition of “Slums Area”

The term ‘slums area’ refers to the following housing categories:

**a. Temporary housing areas:** Built by the State or by the dwellers themselves as temporary housing for people displaced from the Suez Canal area during the 1967 war, and as housing for the growing number of rural-urban migrants

**b. Housing built on illegally appropriated land:** Structures erected on illegally appropriated public or private land

**c. Semi slum housing:** Refers to housing built on legally owned land, but without legal construction permits and within non-approved zones<sup>vii</sup>

### 1.2 Causes behind the Emergence of Slum Housing in Egypt

The slums phenomenon first emerged in Egypt as a result of the concentration of economic and production activities in the cities, especially in Cairo and Alexandria. The phenomenon became more widespread in the 1970s with the inflation that struck the real estate market (a systematic annual increase of 30% in land prices)<sup>viii</sup>.

Increases in land registration fees, the difficulties involved in obtaining construction permits and the sharp increase in property taxes caused the great majority of those seeking housing (migrants from rural areas as well as native urban dwellers) to resort to self-made solutions to the housing problem. Likewise, a lack of seriousness regarding the application of sanctions and construction laws, the issuance of stay of execution laws for violations of construction and zoning laws, the absence of city planning and of technical personnel capable of formulating comprehensive city plans, all contributed to the spread of the slums housing phenomenon<sup>ix</sup>.

In fact, over the past twenty years, national, urban, economic and social development programs have completely ignored slums areas<sup>x</sup>.

### 1.3 General Characteristics of Slum Housing:

#### 1.3.1 The Urban Fabric of Slum Housing:

A. The Unregulated Model: This model is represented by the slum areas built before 1950, when housing units were built on vacant plots around residential, commercial and industrial facilities. Average street width in these areas is between 2 – 3 meters and 10 meters. (**Figure 1**)

B. The Linear Model: This model is represented by the slum areas built in the late 1960s and early 1970s when housing was built in a more organized manner as people attempted to emulate the established zoning system. Average street width in these areas is between 2 meters and 20 meters. (**Figure 2**)

C. The Refracted Model: Represented by slum housing in agricultural areas, whether inside or outside of the cordon. The difference between this model and the unregulated model lies in the empty spaces between buildings. When the refracted model of slum housing grows, it becomes similar to the linear model. (**Figure 3**)

#### 1.3.2 Condition of Public Utilities and Roads

##### A. Water

Access to water for drinking and construction is one of the most important needs of slum area dwellers. Because of the acute shortage of government potable water network services, inhabitants resort to alternative water sources, such as:

- Water pumps (servicing a single family or a group of families)
- Water tanks delivered by merchants and bought by residents
- Public taps installed by the government and paid for by the residents
- Water taps in mosques, commercial or industrial facilities (in some cases pipes are installed to transport water from these taps to slums residents)

Statistics show that approximately 90% of slums areas have no access to water and about 67% of slum housing is located in buildings where there are no water taps<sup>xi</sup>. Water may be available in limited parts of slums areas as a result of pressures exerted by residents during elections. **(Figure 4)**

#### B. Electricity:

Within a 25-meter range of the power source, individuals may legally obtain electrical power connections from an electricity distribution point. Once a house or two have been provided with electricity, power lines are extended from them to other homes etc. For residents, access to electricity is a less urgent problem than access to water because they can always resort to using small generators or kerosene and gas lamps.

#### C. Sewage System:

In a small number of cases, slums residents use sewer pipes connected to sewer lines on main roads. However, in the great majority of cases, sewer trenches, or sewage septic tanks are used. Sewage and wastewater are pumped out (de-slugged), transported by animal-drawn carts and dumped into canals.

#### D. Waste disposal:

The only available means for disposing of waste is to dump it into canals or onto roads (in both cases this results in pollution).

#### E. Roads and Transportation:

Most slums areas built on agricultural land are located close to main streets or railway lines, and residents walk to the nearest point of transportation. The roads in these areas (originally pathways or trails that marked the boundaries between plots of farmland) are unpaved.

Unpaved roads in slums areas are generally between three and six meters wide and only pedestrians and smaller vehicles can use them. Since unplanned urban expansion does not generally allow for the public services that are provided within the framework of comprehensive planning, there are usually no public facility buildings and social services (schools, hospitals etc), and if they exist, they are insufficient in number. **(Table 2)**

### 1.3.3 Slum Housing Growth Stages in Egypt

Individual efforts are behind the emergence of slum housing with no assistance from official government agencies. When a family first settles in such an area, it builds temporary housing using temporary second hand used materials, which is gradually replaced with permanent construction materials. At this stage, the family will usually use the services of a minor contractor to design and build their housing unit. The family's role is to obtain the building materials and direct the contractor. **(Table 3)**

#### 1.4 General Characteristics of Slum Housing:

Slum housing areas in Egypt share a set of common characteristics and features, most important of which are:

- Dwellers:

Slums area dwellers share many of the social and economic characteristics of people who live in authorized, officially-planned areas; they have the same family structure, the same average annual incomes and they are all usually of rural origin.

- Location:

One of the characteristics of slums areas is the intensive exploitation of location; in most cases, buildings occupy approximately 90% of the land plots and empty spaces are rare.

- Structural properties of slums buildings:

- Temporary housing: These types of buildings are usually built using second-hand or lightweight construction materials, such as tin or used wood, depending on the nature of each site. Population density in temporary housing buildings is high in comparison to that of the city; five to eight people live one room, going about their family activities. These temporary buildings are concentrated on the outskirts of cities, in the proximity of government buildings and close to railway lines<sup>xii</sup>.

- Housing built on illegally appropriated land: The surface area of a housing unit in this type of housing is generally larger than that of a temporary housing unit, giving individuals the leeway to introduce improvements or build additions to the unit according to their needs and financial abilities. Additions to housing units are completed in three phases:

Phase One (Insurance and Stability): Structures are built out of second-hand, flimsy materials until the dwellers feel confident that they have appropriated the land upon which the housing unit is built.

Phase Two (Horizontal Concentration): During this phase, residents ensure their right to live on the land they have illegally appropriated; they confirm their tenure of the land plot by paying a nominal rent per m<sup>2</sup> to the government agency concerned. Residents then begin to introduce some structural improvements to their temporary housing units, generally replacing second-hand, flimsy building materials with more permanent materials (red brick for walls and wood for roofs, for instance).

Phase Three (Vertical Concentration): This phase occurs when the number of newcomers to a slums area increases and the decision is made to expand vertically (additional rooms are built to be rented out or for use by family members).

Semi slum housing: Because it is used by dwellers with higher incomes, this type of housing is composed mostly of concrete structures built according to the construction methods used in officially planned areas. Most residents work in official or unofficial economic sectors, and many of them are people who have come back to Egypt after working in the Arab Gulf countries. An unofficial real estate sector and land zoning companies also exist in these areas. This situation has led to a high construction growth rate and an upgrading of housing quality that is almost equal to that of the official housing market.

## **1.5 Slum Housing Areas are divided into Safe Areas and Unsafe Areas**

### **Unsafe areas fall into the following categories:**

First Degree Unsafe Areas: Areas where dwellers' lives are in danger

Second Degree Unsafe Areas: Inadequate housing conditions

Third Degree Unsafe Areas: Areas where living conditions adversely affect public health

Fourth Degree Unsafe Areas: Areas where the dwellers' have not established their tenure of land plots

## **2. Sustainability**

Sustainability refers to ensuring the needs of the present without affecting the capacity to meet the needs of future generations. It requires the exploitation of natural resources without completely depleting or destroying

them, thus enabling nature to replace the consumed resources and minimizing the polluting effect of human activities.

## 2.1 Principles of Sustainable Architecture

Energy efficiency is one of the most important principles of sustainable architecture. Buildings are designed and built using methods that reduce the amount of fuel consumed and that depend more on the use of natural sources of energy. In architecture, adaptation to climate conditions is related to two main principles: providing protection against climate conditions and thermal comfort in building interiors. Building designs should take into consideration the need to minimize the use of new resources in construction. The emphasis on green architecture and sustainable buildings is relatively recent; it began in the wake of the energy crisis in the 1970s, when architects started to question the wisdom of constructing box-like buildings wrapped in glass and steel with enormous heating requirements and costly cooling systems. Since then, this viewpoint has been incorporated into a number of environmental assessment and building rating systems, such as BREEAM, which was first used in Britain in 1990 and LEED (energy consumption and environmental design standards developed in the United States)<sup>xiii</sup>.

## 2.2 Green Buildings

Green buildings designed and built in keeping with the local climate, aim to establish a balance between a building's natural surroundings and its users. These buildings consume less water and energy than traditional buildings. Inasmuch as possible, they depend on natural ventilation and lighting to reduce both energy consumption and the polluting waste that results from the generation of energy. Green buildings may be defined as buildings that apply natural solutions to raise the efficiency of water, energy and resource consumption and to alleviate the adverse effects of buildings on human and environmental health. This is done by adopting appropriate environmentally friendly building design, construction, operation, and maintenance methods and technologies throughout the building's lifetime, while reducing the consumption of energy, resources and materials, minimizing the adverse environmental effects of building construction and operation and promoting the integration of buildings into their natural environment.

The term 'green building' includes sustainable buildings and high-performance buildings (buildings designed and constructed to minimize the consumption of resources, reduce building operation costs, increase building efficiency, protect users' health, and promote the building's environmental performance).

**Green buildings aim to achieve compatibility between man, society and the environment by bringing together three essential factors:**

Efficient use of resources and materials

Optimal handling of prevailing climatic, geographic and social conditions

Providing the present social and material needs of humans while protecting the rights and needs of future generations<sup>xiv</sup>

### 2.2.1 The Basic Principles of Green Buildings

Green buildings are considered to be environmentally friendly because they use less water and energy. Among the most important principles of green buildings are the following:

Energy conservation

Adaptation to climate

Minimal use of new and untouched natural resources

The application of these principles minimizes the adverse effects of buildings on both the natural and the building environment in their immediate and regional surroundings<sup>xv</sup>.

## 2.2.2 Green Building Objectives

Green building objectives are the efficient consumption of energy and resources; protection against pollution; and achieving environmental integration. They aim to alleviate the adverse effects of buildings on human and environmental health through the efficient use of water, natural resources and land, to protect users' health, to increase the productivity of building users and to reduce waste and pollution emitted by buildings. To achieve these objectives, a triple bottom line for building design was developed. **(Figure 5)** Whereas economic profit is the bottom line in traditional building projects, sustainable projects are based on three intersecting bottom lines:

### 2.2.1.1 Basic Green Building Issues

#### Energy efficiency and renewable energy

- Opting for building orientation that maximizes the penetration of sunlight and fresh air and promotes natural lighting of building interiors

The effects of climate on buildings

- The thermal effect of a building's perimeter
- Appropriate cooling, ventilation and heating system loads
- Reducing electricity loads used for lighting and electric appliances
- Realizing economic savings

#### Direct and indirect environmental effects

- Effect of construction on vegetation
- Using an integrated pest control system
- Reducing water pollution
- Reducing the use of materials with harmful emissions that adversely affect the environment
- Reducing the amount of energy required for building construction

#### Saving resources and recycling

- Bringing the quantity of construction waste to a minimum
- Using recyclable materials
- The re-use of materials and furnishings
- Providing building operators with the necessary recycling facilities
- Using rainwater for irrigation
- Conserving water consumption in building operations
- Installing voice control systems
- Treatment and re-use of grey water

#### Interior environment quality

- Provision of local resources that promote sustainability
- Provision of pedestrian paths and motorbike trails
- Study and enhancement of the perimeter / building relationship
- Determining the climatic conditions of a building's perimeter and the mutual effects between these conditions and the building
- Respecting local laws when using building infrastructure
- Provision of locally manufactured materials<sup>xvi</sup>

### **2.2.1.2 Design and Environmental Management Methods**

Basic standards and methods for green building design

-Adaptation to climate: A sustainable building can withstand climate problems while simultaneously making use of available climatic and natural resources to enhance users' comfort inside the building.

-Energy Conservation and the use of Alternative Energy Sources: The effect of climatic elements on man and the environment is based on the need to use energy for heating, cooling and lighting purposes. The heating and cooling of buildings vary according to the methods and systems of electric and natural energy used (overall, most modern building systems depend on electric energy). Green buildings tend to make use of natural energy sources (solar energy, wind energy and rain) for cooling, heating and lighting.

- Conserving renewable resource and new material use and using environmentally friendly materials: Recycling waste materials and building debris is one of the most important methods used to conserve and reduce the use of new raw materials.

- Water conservation in building interiors: Harvesting rainwater from rooftops and storing it in cisterns to use for flushing toilets, irrigation and other purposes is one of the methods used to conserve water in building interiors.

Recycling grey water involves storing it in underground tanks, treating it and then re-using it in toilets or for irrigation purposes. This can lead to savings of up to 35% of the water consumption of a building.

- Conserving air quality in building interiors: This is done by ensuring that building openings face the direction of the prevailing winds in each location. To create air currents, each space in the building should have more than one opening. Wind catchers may be installed in spaces that do not face the direction of the wind.

### **2.2.1.3 Lighting Techniques Used in Building Interiors**

Lighting in building interiors is based on two techniques; natural lighting and artificial lighting. Natural lighting depends on sunlight and has several forms; direct light, reflected light or dispersed (scattered) light. To avoid visual discomfort, a building's lighting design should ensure that every space has two openings (each on a separate wall). Window distribution should be designed to admit the greatest possible amount of natural light (in all its forms). In addition, open spaces (courtyards, for instance) should be provided to allow sunlight to penetrate building interiors while also ensuring privacy. Building site plans should also consider building height and distances between buildings to ensure that a building does not block the penetration of natural light into a nearby building. Artificial lighting is used when natural light is not sufficient and during the night. Usually, lighting functions can be classified as follows: ambient (or general) lighting, accent (or concentrated) lighting and task (or directed) lighting. Two factors should be considered when selecting lighting units; the light emitted should be as similar to natural light as possible and electricity-saving light bulbs should be used.

## **2.3 Environmental Design Standards**

These refer to rules regulating important architectural features, in particular the outer perimeters of buildings. They concern:

- The distribution and size of openings in proportion to wall size
- The thermal insulation properties of walls and glass layers
- Thermal leakage through wall joints and points of thermal confluence
- Natural lighting
- Natural ventilation
- Energy conservation

### **2.3.1 Green Building Design Requirements**

Climatic zone: The green building design process should consider the following points:

#### 2.3.1.1. Building interiors

- Interior temperatures (winter and summer)
- Expected ventilation and expected relative humidity levels

#### 2.3.1.2. Building exteriors

- Wind speed and direction
- Sunlight: its intensity, the angle at which it strikes, and sun movement

#### 2.3.1.3. Site and geographic orientation

- Mountain top locations are more likely to be affected by sunlight and wind
- Flat lands (beaches and coasts) are moderately affected by sunlight and wind (depending on site orientation)
- Hills, ridges or hillsides are moderately affected by sunlight and wind (depending on site orientation)
- Valleys are (relatively) minimally affected by sunlight and wind –rain

### **The Effect of Building Height on Design**

- Extent of exposure to climatic elements
- Additional attention to design elements if the degree of exposure is high

### **The Effect of Wall Types**

- Rough walls with architectural protrusions in warmer climates
- Smooth walls with no protrusions in cooler climates

### **The Effect of Building Shape**

- Although less energy escapes from higher buildings, they require more services (elevators, for instance) and are more vulnerable to external elements



- More energy escapes from buildings with flat, low ground-plans – natural lighting during the day and natural ventilation are preferable
- Less energy escapes from buildings with deep ground-plans – artificial lighting and mechanical ventilation are needed since some of the building's facades do not face outwards

### **The effect of Roofs**

- Sloping and curved roofs: more shadows and shade
- Arches: care must be taken when designing the orientation of the arches' main axis to optimize their use
- Shade: protects walls against excessive heat and reduces surface temperatures

### **Building's Outer Perimeter**

- Thermal conductivity : Refers to the rate at which thermal power (in watts) passes through the various layers of one square meter of a unit per each degree of air temperature change (inside and outside the building),
- The lower the rate of thermal conductivity, the higher the thermal insulation and the lower the amount of heat energy escaping through the outer parts of a building during heating and cooling processes (higher heat energy savings)

### **Green Building Costs**

Studies have shown that green building costs are almost the same as those of traditional building methods, as long as the necessary sustainable engineering management expertise is used

Green building costs include the basic costs of traditional buildings plus the cost of a project's life cycle<sup>xvii</sup>.

### **3. Methods and Techniques for Applying Climate Design to Green Buildings<sup>xviii</sup> and to Upgrading Slums Areas in Egypt**

Despite the advice and counsel issued by many experts, in conferences and published research, regarding the dangers of the spread of slums areas with their poor living conditions, only limited action has been taken to resolve the problem. Such action that has been taken has been limited to moving these areas to other locations. No action was taken in slums areas on the outskirts of Cairo, because they were not included in the development plans.

This section of the paper will discuss the special architectural and execution considerations that can be used to resolve the slums problem in first-degree unsafe areas (where users' lives are endangered), by building housing units for limited-income residents with a view to upgrading slums areas in Egypt.<sup>xix</sup>

#### **3.1 Architectural Considerations**

These are divided into two main categories; factors related to the planning process and factors related to the design process.

##### **3.1.1. Factors related to the planning process**

The study of planning aspects designed to upgrade these areas

##### **- Economics of land zoning**

Land zoning economics play a central part in reducing the cost of limited income housing projects in slums areas, because land zoning directly affects electricity, water and road network costs as well as long-term

maintenance costs for these networks.

- Quality of services

Reducing water, sewage and road network services:

- Potable water networks:

Studies show that this is the least costly public utility service, and reducing the quality of this service is therefore not recommended. It is also a basic service that directly affects public health.

- Sewage and road networks:

Studies show that sewage and road services are the most costly public utility services (the cost of each service could be as high as 25% of the land's budget). Costs may be lowered by reducing the length of these networks through efficient design in accordance with land zoning economics, and by executing the networks in phases, in order of their importance.

- Nucleus design:

Nucleus design refers to the design of elements that make up a housing unit nucleus i.e. basic utilities (a bathroom, a kitchen, a single room and a fence around the land plot). While these are the minimum elements of a nucleus, their size may be increased according to users' demands and the economic capacity of the project.

### **3.1.2. Factors related to the design process**

Refer the study of factors related to the process of designing a housing structure for limited income users in slums areas.<sup>xx</sup>

- Flexibility

Flexibility refers to the degree to which a housing unit is capable of fulfilling the needs of its users. To ensure flexibility, it is necessary to choose among a number of options during the design process and to ensure that the type of construction is suitable for the unit's spaces, allowing them to be put to the best use. This is particularly true of housing units for limited income users who may have multiple needs related to the evolution of family size and the family's social condition and needs. The flexibility principle should be applied without sacrificing the original objective of the building.

- Distance between load bearing supports

Knowing the distance between load bearing pillars is necessary when deciding upon a type of structure. Certain construction methods may not be suitable for buildings where the distance between load bearing pillars is small; others may not be suitable for buildings with variable distances between load bearing pillars, but quite suitable for buildings with fixed distances between load bearing pillars. Therefore, to select the most suitable architectural technology for constructing this type of housing, it is essential to know the distance between the load bearing supports upon which the structure's spaces will be built.

- The module:

The module for any given space depends on the use that space is designed for and on the type of furniture it will hold. While it must be in keeping with the basic module of the building, it is also closely tied to human energy and physical and mental capacities. The module is one of the most important bases for the design of this type of building because many of its elements depend on life patterns and lifestyles.

- Standardization:

A concept that is very important in manufacturing processes generally and which affects the design of housing structures for limited income users (the subject of this paper) in particular. Without standardization, it is

impossible to determine precise criteria for manufactured products used in building construction.

#### - Structural system and durability

Structural systems have a significant effect on the building design of limited income housing. The more flexible a structural system is, the more architectural spaces a building is able to accommodate, and the more alternative uses a space has, to accommodate the needs of users.

The durability of a structure depends on the type of construction material and the purpose for which it is used. Structural durability refers to the durability of vertical elements (walls and pillars) and of horizontal elements (roofs).<sup>xxi</sup>

### **3.2 Execution Considerations**

The construction of housing units for limited income users in slums areas is divided into a number of stages, directly affected by the construction systems adopted. These stages are:

#### - Site preparation

During the site preparation stage for slums area development projects, it is important to keep costs as low as possible by minimizing the use of mechanical equipment (bulldozers, leveling equipment etc) as much as possible.

#### - Foundation work

Two main factors affect the execution of foundation work: the weight of the structure and the nature of the soil. These factors determine the type of foundation to be used for the structure. The surface area of a single floor and the number of floors in a building determine its weight, which in turn determines the type of foundation to be used.

### **3.3 Housing Unit Production**

#### **3.3.1 Production process and methods**

Using prefabricated elements in construction is an excellent method for the wholesale production of housing units. This method minimizes cost, is speedier than other construction methods (more units are produced in less time), and allows more control over the kind of product used. However, a number of points must be considered; the production of prefabricated elements is a completely mechanized process, which is difficult to provide in developing countries with a low level of technological expertise. In Egypt, however, it is possible to use mechanized processes that are based on mid-level technologies. Another point to consider is that these methods need trained labor to work in factories and less-trained workers to assemble components on building sites. There is therefore a need to organize specialized training programs to develop labor skills in each method used.

#### **3.3.2 Transport**

Three main factors affect the transport of building units from the factory to the project execution site:

Means of transport

Condition of road networks

Distance between factory and project execution site

#### - Assembly and Installation of Building Components

The success or failure of any prefabricated building system depends essentially on the proper connection of load bearing and non-load bearing building parts and components during the assembly and installation stage. The type and number of component connections in a building vary according to the construction system used.

### **3.3.3 Quality of Component Installation**

Building component installation quality in housing units for limited income users in slums areas depends on the connections between the different building parts or components. A connection is the point where two separate structural units (made of a material similar to that used for the building structure) meet or come together (the point where one unit ends and another begins). Because a connection holds together the various components of a building, the success or failure of any prefabricated building system depends primarily on its successful installation. The type of connection is determined by its location in the building structure and the pressures it must withstand. The form and design of connections also determine the length of time required for their installation on site. Also, the kind of adhesive used may affect total construction time to a certain degree.<sup>xxii</sup>

### **3.3.4 Execution Stages**

Project execution stages should be organized according to the priority indicators for each slums area. The first execution stage involves developing slums conglomerations for limited income users for a transitional period during which resident families learn to adapt to the benefits provided by the overall upgrading of the area to be developed. This transitional period ends once the minimum essential equipment is in place and public services begin to operate. It is essential to ensure that travel to and from new housing units does not affect the daily needs (including sources of income) of relocated dwellers.

The second execution stage is that of the integration of the area into the existing urban fabric (provision of health services, water, and transportation, lighting, and sanitation services). Project execution stages are followed by the project assessment stage, during which any needed corrections to the course of future projects can be made.

### **3.3.5 Distribution**

The on site distribution of buildings containing housing units during the execution stages is one of the factors that has the greatest economic effect on the project of upgrading slums areas for limited income users. Within the project, unit distribution can be either horizontal or vertical (from ground level up to the various floors of a building). In the latter case, the influencing factors are the height and weight of the unit or section to be built. Selecting the structural system to be used should be based on the cost of unit distribution (horizontal or vertical).

### **3.3.6 Labor**

Compared to other factors, builders' labor wages constitute a cost factor that has an important economic effect on developing slums areas for limited income users. This is because labor costs often represent a high proportion of total construction costs (30% to 40 %). The exact percentage depends on the construction system used, and can sometimes be as high as 25% of total construction costs. This is why it is best to use easily executed systems for building housing units for limited income users; it enables future dwellers to do the work themselves, with the help of a user's manual for the specific construction system being used.

### **3.3.7 Building Materials**

Different building materials are used for different purposes. The designer must determine which material is best suited to this type of construction and how it is best used. By selecting suitable building materials after studying the properties and specifications of each material and determining which is most economical (highest performance at lowest costs), the designer can play an important role in minimizing the cost of housing unit construction, especially if local building materials are used.

### **3.3.8 Execution Equipment**

Housing unit structures fall into three categories, according to the type of execution equipment used:

- a) Structural systems that depend on manual labor
- b) Structural systems that depend on simple equipment (mid-level technologies)
- c) Structural systems that depend on highly developed technology

### 3.3.9 Final Finishing Works Stage

One of the important advantages to the production of prefabricated units is that some of the work (electric work, plumbing, painting, carpentry ...) that is normally completed during the final finishing works stage can be completed during the manufacture of units (electric and plumbing works, for instance). Another advantage is that since the surfaces of prefabricated units are smooth, no work needs to be done on exterior walls, which can be used in their original concrete color. It is generally enough to paint the interior walls only.

### 3.4 Appropriate Technology for Upgrading Slums Areas in Egypt

A number of different approaches have been adopted by the Egyptian State to provide housing for limited-income users (reducing housing unit size, delivering units with lower quality interior finishing works, or locating housing projects in remote, low-cost sites).

Other solutions adopted were the setting up of projects for services and sites, adopting the 'nucleus housing unit' concept, delivering semi-finished housing units and developing low-cost housing unit modules. It should be noted, however, that none of these approaches to the problem directly addresses the issue of minimizing structural system costs, which constitute as much as 60% of total low-cost housing costs. Since the quality of the interior and exterior finishing of these units is minimal or average, project objectives can be realized by using simple, low-cost building technologies that are appropriate to each location and to the circumstances of the individuals who will benefit from the project.

Organized pre-planned preparation of structural unit production results in saving project cost and execution time, particularly if prefabricated units are used for building foundation and assembly work, or even if foundations are poured during the preparation of project foundations and ground services. xxiii

### 3.5 Types of Structural Systems

First Type: Traditional system (load bearing walls and concrete structures)

Second Type: Traditional method (load bearing walls and prefabricated roofs)

Third Type: Prefabricated system (prefabricated wall and roof systems in various sizes and weights). This system includes many non-traditional construction systems that use simple or mid-level technologies. After studying the technical requirements of these systems, the decision may be made to use either a complete prefabricated system or parts of a system, depending on the economic and technical objectives of the individuals involved in present or future slums development projects. xxiv

## 4. Conclusions:

- There is a need to adopt a scientific method in addressing the slums problem to arrive at solutions and alternatives that are appropriate to individuals and society. The standardization of various structural and architectural elements and the training of technical cadres to implement them, in addition to making use of the material, technical and productive capabilities of individuals during the various stages of construction is one of the most important approaches.
- All government agencies need to work on arresting the growth and formation of slums areas and addressing the increase in the demand for housing. This can be done by selecting, for inclusion in project planning and execution, appropriate structural systems and methods capable of saving time, reducing costs and enhancing housing quality, given that construction costs constitute the greatest part of the overall cost for these types of structures.
- Enabling dwellers to use simple technologies to build their homes increases the number of housing units to upgrade slums areas in Egypt, while reducing the final cost of these units. It is therefore essential to consider the possibilities and capabilities of a slums area's dwellers and to ensure that they have a key and vital role to play in determining and implementing future policies related to this type of housing.
- The primary objectives of designing environmentally friendly buildings include:

- Climate adaptation and users' thermal comfort
- Energy conservation
- Minimizing the use of new resources
- Respect for the site and for those associated with the building
- Use of environmentally friendly building materials
- Study of air movement quality within a building
- Provision of appropriate natural and artificial lighting in buildings
- Good sound design to reduce noise inside buildings
- Protection against natural hazards in the building's perimeter
- Protection against man-made hazards
- Protecting the safety of building users

All of the above contributes to resolving the negative aspects of slums areas and the lifestyles and habits that result from them.

#### **5. Recommendations:**

Slum housing constitutes one of the biggest problems facing Egypt today. It is not only a housing problem, but also concerns slums area dwellers, a class of people forced to live at below decent living standards and who constitute a burden on the government and are considered to be behind many of the dangerous acts taking place in Egypt today, including acts of terrorism. However, the failure to provide appropriate housing for limited income users and the government's neglect of this problem is the reason behind the existence of this class of people. The problem can be resolved by implementing the simplest of architectural principles; the principle adopted by the architect Hassan Fahmy, "Make use of what is under your feet to build". The simplest planning tools can be used to plan the development of these areas, using locally available, natural, environmentally friendly construction materials and applying the principles of green architecture (building orientation, use of wind and solar energy, and optimal use of the local environment). The objective of using the basic principles of green architecture design in the construction of environmentally friendly buildings is to create a balanced local environment that allows for the efficient operation of structural systems with minimal destruction of the environment. These principles can be applied through comprehensive planning that makes use of locally available environmentally friendly elements and methods to construct buildings that are environmentally friendly. The following recommendations can contribute to the realization of this objective:

- Use of local construction materials inasmuch as possible
- Use of renewable and recyclable materials
- Focusing on human and environmental performance as an essential factor for the success of any building
- Making use of vegetation, land layout (topography) and neighboring buildings to minimize the undesirable effects of winter winds
- Making use of vegetation to lower site temperature during the summer season
- Increasing evaporation and water sprinkling for cooling in the summer season
- Multiplying surfaces that reflect the sun's rays in the vicinity of the building

- Limiting the amount of solar radiation reflected from surfaces near the building in the summer
- Making use of topography, layout and neighboring buildings to increase the amount of shade a building receives in the summer
- Making use of vegetation, topography, layout and neighboring buildings to increase wind breezes in the summer
- Ensuring that building orientation and formation serve to minimize the effect of undesirable winds in the winter
- Designing semi-covered exterior spaces to protect buildings against harmful climatic effects
- Designing building space orientation to allow for maximum penetration and absorption of sunlight
- Appropriate use of spaces designed to absorb sunshine
- Taking advantage of the earth's crust and its upper layers to protect the building
- Using concrete flooring on ground floors to combat subsoil heat
- Equipping the building with air ducts to dispose of hot air
- Using covered building entrances
- Using building orientation and formation to minimize the effect of solar radiation in the summer
- Using building orientation and formation to make optimal use of summer breezes
- Using vegetation and trees around the exterior walls of a building
- Using planted rooftops
- Using heat insulating materials to minimize the transfer of heat between the building and the spaces that surround it.
- Further research studies are required to discuss future building economics in the slums in Egypt as well as the legislation to be followed to reduce the development of those areas.
- A solution to the problem of slum dwellers in Egypt needs to search also in how building technology using innovative practical solutions could contribute to solving that problem.

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## Figures and Tables

**Table 1: Ratio of Legal to Illegal Buildings According to Period of Construction<sup>xxiv</sup>**

Period of Construction	Illegal	Legal	Number of Samples
Prior to 1960	43.7%	56.3%	212
1960 – 1970	72.2%	27.8%	133
1971 – 1976	88.8%	11.3%	76
After 1976	.75%	.25%	36

**Table 2: Availability of Services and Facilities in Slums in Cairo Governorate (%)**

	Leased	Owned
Electricity	98.9	95.2
Water	77.3	59.7
Sewage	91.2	72.8
Bath / Toilet	100.00	92.3
Kitchen	95.3	75.5
Public Transport	84.8	74.6
Hospitals / Clinics	90.5	88.4
School / Child Day Care	83.4	79.2

**Table 3: Inventory of Slums Areas and Data across Governorates in the Arab Republic of Egypt<sup>xxiv</sup>**

Governorate	Number of Slums Areas	Estimated Population (thousands)	Estimated Area (km <sup>2</sup> )	Population Density in Slum Areas (1000 inhabitants / km <sup>2</sup> )	Ratio of Slum Dwellers to Urban Dwellers (%)	Estimated Size of Slum Area Development (in million pounds)	Remarks
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Cairo	10	67	79	28	2193	79	22	150	
Giza	4	28	32	44	2259	32	90	923	
Qalyoubeya	-	60	67	20	938	34	64	279.7	
Alexandria	9	31	41	13	1113	85	35	498	
Beheira	10	53	66	12	404	35	43	179	
Matruh	-	*	5	9	31	5	60	28	
Menoufeya	1	23	24	1	32	30	13	5	
Gharbeya	-								
Kafr Sheikh	-								
Damietta	5								
Daqahleya									
North Sinai									
South Sinai									
Port Said									
Ismailia									
Suez									
Sharkeya									
Beni Suef									
Fayoum									
Menya									
Asyut									
New Valley									
Red Sea									
Qena									
Sohag									
Aswan									
Luxor City									
Average Total	8	952	1034	344	11566	31	37%	5267.6	

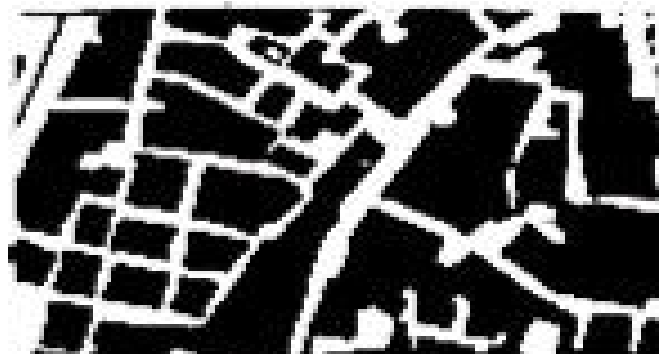


Figure 1: The Unregulated Model



Figure 2: The Linear Model

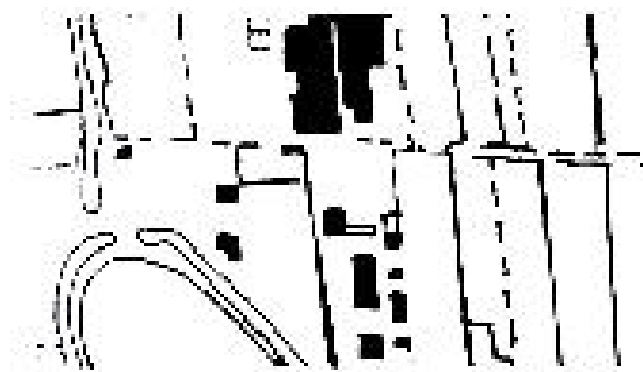


Figure 3: The Refracted Model

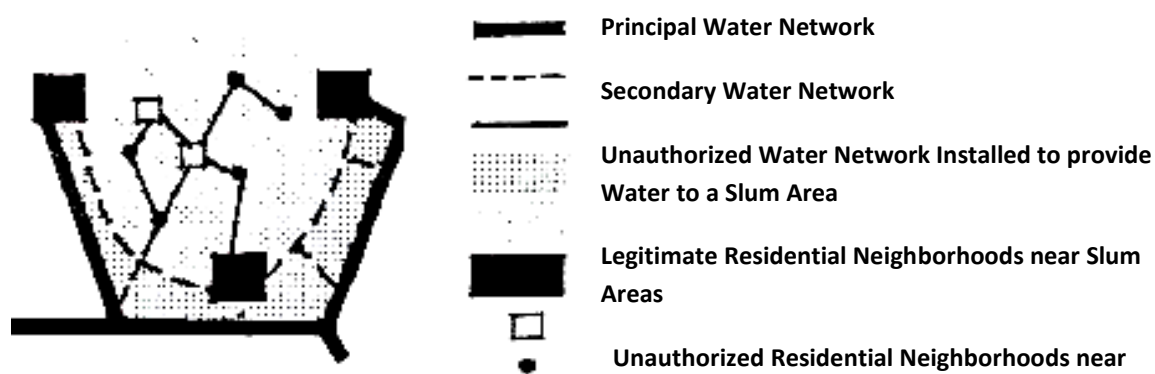


Figure 4: Supplying Electricity to Slum Areas

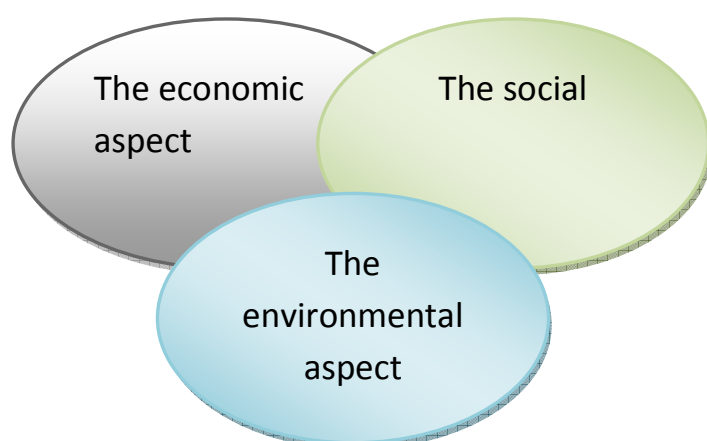


Figure 5: The Triple Bottom Line

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