



# Evaluation of the Sustainable Building Materials for Economic Housing in Egypt

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## Abstract

Buildings are considered nationally valuable assets that need to be preserved and maintained, because of their functional, civilizational, or historical value. The buildings are suffering from design problems, such as architectural drawings and decisions that take extended periods of implementation and maintenance by the implementation of the structure of buildings and finishes ...etc. Sustainable housing development has become an important issue that needs to be taken into subject to provide adequate housing for families, but methods of work are still inadequate for the needs of users. The importance of this subject is to find suitable solutions to provide adequate housing for low-income families through the availability of appropriate methods and materials that achieve the appropriate cost, quality, and sustainability. In Egypt, people suffer from providing suitable housing for the social and making the buildings environmentally friendly and administratively successful. Egypt is characterized by a continental climate with strategic locations distinct from any other location and has the most important natural resources that can be used but quickly can be used badly the buildings are incompatible with nature and lack of respect for the site, and this negatively affects the community. The problem is the failure to take advantage of local materials that help to reduce costs, time, and the completion of the implementation period. The research **aims to** identify the housing projects in Egypt and the extent to which sustainability criteria are met or not available. Consequently, the focus of this study is not only to look at these projects in problems but also to focus on developing future visions.

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and how to implement sustainability elements, especially the idea of sustainable construction of the construction industry as well as on individuals and construction processes. This paper presents studying and analysis of economic housing projects in Egypt and evaluates the elements of sustainability achieved or vice versa, such as using local building materials and how to apply them to achieve the sustainability of those projects and the users' requirements. The research finds that the lack of use and utilization of local materials leads to inflated costs of housing units and increasing problems, which need to be maintained periodically because of the inability of those materials to weather conditions.

## Keywords

Purchasing power • new cities • Local materials • Economic housing

## 1 Introduction

The way of adequate housing to obtain them is a real problem for many sectors of households in Egypt, especially those with low incomes. All families are facing many of difficulties in providing the required physical housing. The principle of facilitating access to housing includes the provision of multiple housing patterns, different levels of costs that can all meet the needs of multiple segments of households and provide housing to low-income families (Simms & Kamal, 2008). The mechanism should be including programs to develop the use of housing project sites, adjust building densities and requirements to achieve higher a measure of the economic side of the adoption of these programs for flexible policies for the development and maintenance of existing residential buildings (Qutb, 2013).

The problem is also the lack of use of local materials that help to reduce costs, time, and completion of the

implementation period that leads to people resort to slowness and encroachment on the land because of their inability to bear the costs without the existence of mechanisms to reduce them and the occurrence of thefts from energy sources, such as: electricity, water, lack of knowledge and awareness of the role that sustainable design strategies play in minimizing these impacts as shown Fig. 1.

In recent years, urban sectors are also having lack of non-renewable sources of energy as the result of increased daily consumption to provide for user needs and appear in the pressing environmental issues. The states are seeking to develop strategies to control environmental and energy problems to meet user needs and leave part for future generations. Technology and rapid development have also emerged in many sectors to provide for the needs of users including: (agricultural, industrial, commercial ... etc., which have led to environmental problems and increased pollutions rates, leading health, social, cultural ... etc. (Mayson, 2014). All of which need to develop strategies, foundations, standards and how to apply sustainable development housing (UN Habitat Housing, 2019) as shown Fig. 2.

The research is based on the following questions:

- i. What is the reflection on the dimensions of sustainable development in housing projects?
- ii. What are the tasks of the role of the state in reviewing the housing problem and amending the legislation in housing projects?

## 2 Methodology

### A. Theoretical Approach

It includes a comprehensive theoretical study of housing problems, the relationship of low-income housing problems with income source and sustainable housing.

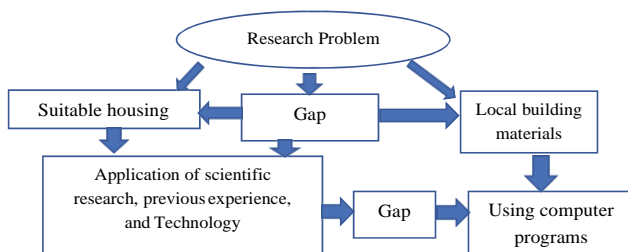


Fig. 1 Problem of providing suitable housing and using local materials.

### B. Comparative Analytical Approach

The study includes a comparative and analytical framework for analysis study of economic housing projects in new cities in Egypt and make of comparison and evaluation of the local examples in Egypt that suffer in achieving the housing projects for sustainable design and the availability of sustainability criteria from its components and services.

## 3 Housing Problems

Young people are the future of the state to achieve their needs, requirements, psychological comfort to help them to work and production significantly (Ahmed et al., 2012). The problem of housing is the increasing of population, internal and external migration, which led to the inability of the state to control of this problem of this phenomenon and the delay of legal procedures; thus, the absence of a future plan is to achieve adequate housing units for young people.

Housing projects were established in Egypt, but these projects were failed to meet these basic needs of citizens, so these problems are:

1. The internal space area in houses is small, within each unit of housing that does not suit most people and their needs to enlarge the space to make easy movement and make their lives better.
2. The weakness of using building materials and finishing materials, which expose these establishments to environmental factors and therefore the occurrence of erosion and the appearance of cracks on the façades, which cause danger these facilities and the lives of citizens.
3. Facades are exposed to weather conditions, such as high temperatures inside spaces and direct lighting, which makes users feel discomfort inside spaces and thus the use and consumption of electric power, such as air conditioners for cooling spaces.
4. Lack of suitable open areas, such as public parks, services and long distance from their homes and places of work.

The process of building design and implementation is important to have direct and indirect effects on the environment, where the life cycle of buildings is affected by humans and the environment that need to provide principles and strategies to develop the process of sustainable architectural design (El-Attar et.al, 2018) as shown Fig. 3.

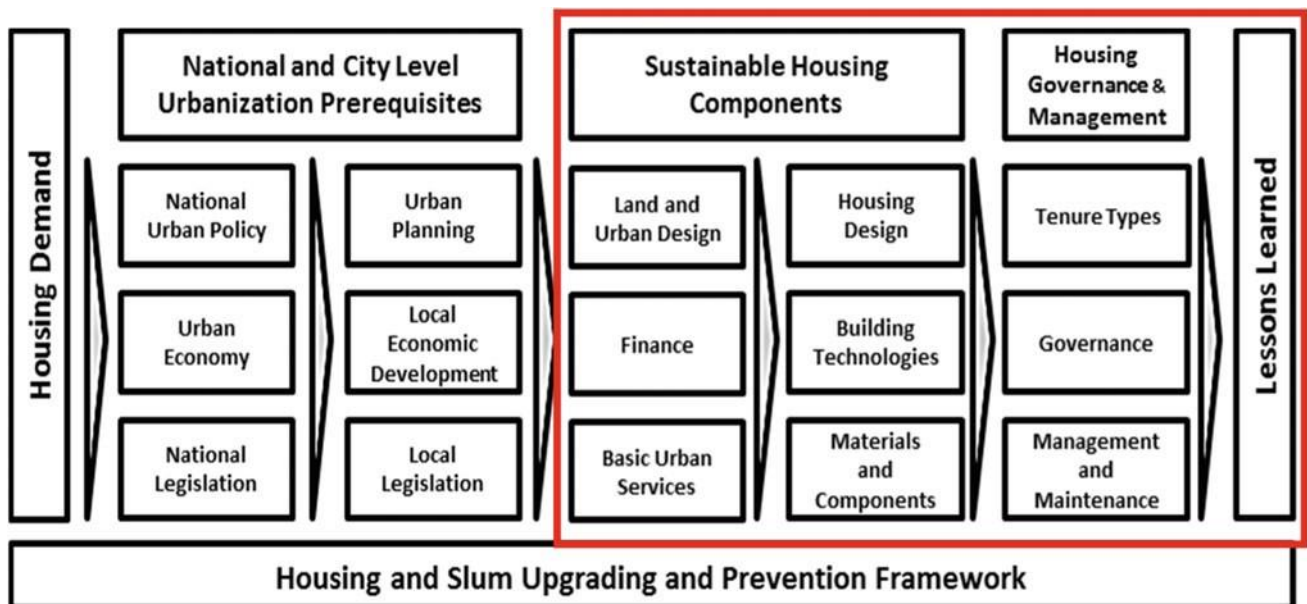


Fig. 2 Housing and slum upgrading and prevention framework for sustainable housing components.

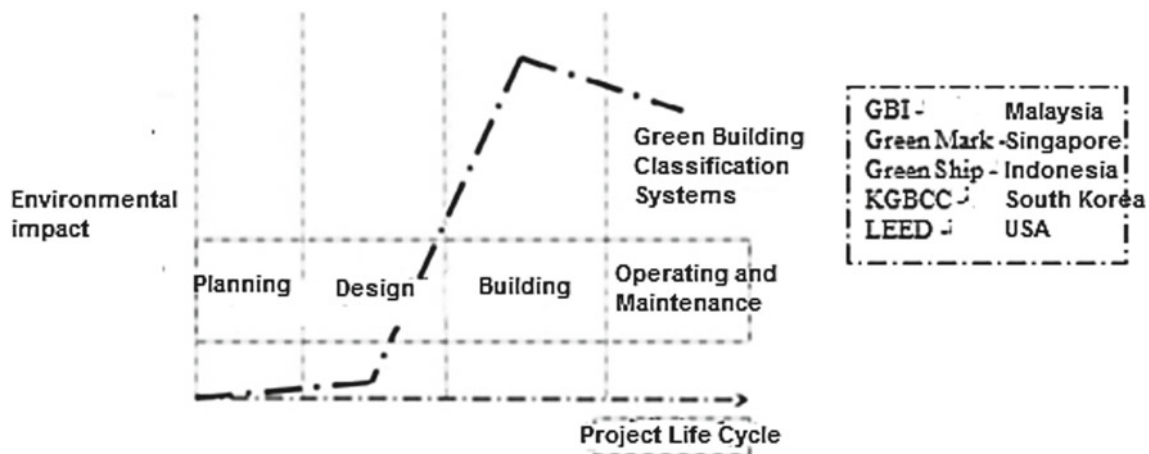


Fig. 3 Impact of buildings on the environment during the life cycle of building

#### 4 Relationship of Low-Income Housing Problem with Income Source

Economic studies in low-income Egypt are defined as groups whose income level does not match their living requirements and have no savings or possibilities to access adequate housing through the formal housing market mechanisms. Previous research has indicated that the low-income population may reach 50% of the total households, while about 48.5% of Egyptian households see the source of income as insufficient for their purchasing power and monthly needs (Shawkat, 2014).

The Central Agency for Public Mobilization and Statistics (CAPMAS) has pointed out through income and expenditure research indicators for 2013, ranging from 400 to 1500 LE per month, representing 40% of the total population (Musa et al., 2014).

The problem of housing has increased of low-income people, which prevents their ability and access to adequate housing that meets the minimum basic requirements, which led to the resort to informal areas; the problem is shown by the following facts:

The first fact: There is a tight crisis in the housing of this category despite the large supply in the real estate market and manifestations of this crisis emerged in random gatherings.

The second fact: The prevailing levels of income in society are representing a social and economic dimension of low-income housing and lack of jobs opportunities on the level of housing that the family budget cannot bear on the one hand to increase the gap what families can be afford to own or value rent of the dwelling.

The third fact: It is related to the development of the housing unit cost which reached the cost of the housing unit from the popular housing in 1975 about 2800 pounds, which means that the cost of the housing unit increases every period with the stability of income and the magnitude of the problem and get the housing unit.

## 5 Sustainable Housing

It is the dwelling that follows the basic principles of design from the compatibility and observance of the natural environment with all elements: natural and industrial to achieve functional and environmental efficiency by providing comfort to users and reduce the negative impact on the environment and public health (Samir, 2018) as shown Table 1.

## 6 Analysis Study of Economic Housing Projects in New Cities in Egypt

The research includes the application of the foundations of sustainability criteria, which is a measurement on the samples of existing and new Egyptian cities that are selected according to the criteria contained in the research study as follows: (Jomaa & Mohammed, 2017).

1. The city should be able to accommodate as much of the population with the provision of suitable areas for them and take a reserve to provide spaces for increasing the population to accommodate the future population.
2. The city should exist with the requirement of different housing types (economic, medium, and high) with no focus only on a particular housing type.
3. The target population should not be less than 500,000.
4. The project should be implemented at a rate of 60–70% of the city plan within a certain period.
5. The occupancy rate should be 60–70% of the city plan.
6. 60–70% of the facilities and infrastructure of the city plan are being implemented.
7. The services in the plan should be in suitable areas to meet the needs of the population.

### 6.1 First Project: Al-Sayeda Zeinab Kindergarten (Tal Al-Aqarib Project): A Step in the Development of Slums

The Rawdat El Sayeda project was built in Tal Al-Aqarib in El Sayeda Zeinab district in Cairo, on an area of 7 and a half acres to save the nest population that was erected on this place after removing the hill, as part of the slum development plan. It was one of the unsafe slums in the Sayyida Zeinab neighborhood. The gravity was classified as “inadequate housing” and is completely erected on a limestone hill, with a population of approximately 3500, representing about 500–600 families (Al Asmarat Project, 2019). It was planned that the citizen would receive his fully finished unit, fully furnished, “on the key,” with a simple rent provided that the inhabitants of the same area, who were confined before the temporary transfer procedures. The building consists of a ground floor and 5 recurring floors. The buildings were designed according to three models that cater to the needs of the citizens living in the region as shown Fig. 4.

The quality of the finishing is done by luxury finishing system compared to social housing, adding that the facades of residential blocks are finished with Hashemite stone. Mashrabiyyat was established in the outlets to take the Islamic form in architecture, pointing out that this architectural character is not designed in another project as shown Fig. 5 (El Mahrousa Project, 2019).

### 6.2 Second Project: Al Asmarat Project in Mokattam

In May 2016, President Abdel Fattah El Sisi was inaugurated the first and second phases of the project “Long live Egypt” for social housing in Asmaraat district in Mokattam. The Asmarat project is considered one of the most important national projects implemented in Cairo governorate (Grape Gheit Project, 2019). The project “Asmarat” is implemented by the Cairo governorate in cooperation with the fund (Long live Egypt) and the engineering authority in Mokattam to move the population of dangerous slums and is the hope of many eagerly waiting for completion to transfer to their new homes. It was built on an area of 65 acres. There are 124 buildings in the project. The number of housing units is 7304 housing units and 176 shops. The number of floors in each building in one building (ground + 9 typical floors) is shown Fig. 6 (Hilal and Mahdi, 2014).

**Table 1** Basic principles of sustainable housing

Basic principles of sustainable housing	Energy efficiency	Efficient material handling	Efficient water handling	Sustainable architectural design	Functional efficiency—environmental quality
Site	<ul style="list-style-type: none"> <li>– Accurate location selection</li> <li>– Take advantage of the natural potential of the site</li> </ul>	<ul style="list-style-type: none"> <li>– Use of natural materials</li> <li>– Use local materials to reduce transportation distances and cost</li> </ul>	<ul style="list-style-type: none"> <li>– Choose local plants with low water consumption.</li> <li>– Take advantage of rain and flood water</li> </ul>	<ul style="list-style-type: none"> <li>– Respect for the characteristics of the site (terrain - soil - climate)</li> <li>– Respect for ecosystems</li> <li>– Design to resist</li> </ul>	<ul style="list-style-type: none"> <li>– Responsibility to site markers in design</li> <li>– Distance from dangerous and unhealthy areas</li> </ul>
The climate	<ul style="list-style-type: none"> <li>– Control the building envelope to reduce thermal loads.</li> <li>– Employ climatic characteristics in energy production</li> </ul>	<ul style="list-style-type: none"> <li>– Use of climate-friendly materials</li> <li>– Good exploitation of materials and raise its thermal performance</li> </ul>	<ul style="list-style-type: none"> <li>– Use of plants that tolerate local climatic conditions</li> </ul>	<ul style="list-style-type: none"> <li>– Design compatible with climate characteristics</li> </ul>	<ul style="list-style-type: none"> <li>– Utilization of natural resources and good exploitation in the design (solar radiation - lighting - ventilation)</li> </ul>
Technology	<ul style="list-style-type: none"> <li>– Efficiency of operating systems technology</li> <li>– Using renewable energy technology</li> </ul>	<ul style="list-style-type: none"> <li>– Use of economic technology (recycling–reuse)</li> <li>– Accurate execution and operation</li> </ul>	<ul style="list-style-type: none"> <li>– Improve the efficiency of health systems.</li> <li>– The use of economic irrigation systems in the work of site</li> </ul>	<ul style="list-style-type: none"> <li>– Use simple local technology. - Introduction of local arts and crafts in design</li> </ul>	<ul style="list-style-type: none"> <li>– The use of clean technology and away from materials that harm the environment, which produces emissions and pollutants</li> </ul>
Community culture	<ul style="list-style-type: none"> <li>– Use and develop community technologies in energy production to improve efficiency</li> </ul>	<ul style="list-style-type: none"> <li>– The use of local labor trained to deal with materials.</li> <li>– Reuse materials for old buildings or waste</li> </ul>	<ul style="list-style-type: none"> <li>– Raise awareness of water efficiency</li> <li>– Improve water handling behaviors</li> </ul>	<ul style="list-style-type: none"> <li>– Design related to the culture of the community (materials–labor–techniques)</li> <li>– Respect local and cultural character</li> </ul>	<ul style="list-style-type: none"> <li>– The need for popular participation in the design process</li> <li>– Achieve needs and functions at a lower cost in buildings for the population</li> </ul>

The project is divided into (Asmarat 1, 2 and 3). The units of this project are designed in a distinctive architectural style suitable for the Egyptian citizen and provide all services, facilities, recreational units, and sales outlets, as well as job opportunities for its inhabitants as shown Fig. 7.

### 6.3 Third Project: Grape Gheit Project (Bashair Al-Khair) in Alexandria City

It is located in the area of Karmouz—Alexandria City, one of the oldest popular neighborhoods. Recently, it was a slum area, and it is now an example of the ability of Egyptians to turn the dream of a decent human life into a reality for the people of this region today. President Abdel Fattah El Sisi signaled the start of the project to transform the slums of grape ghetto into a sophisticated residential and service community. (Ministry of Housing Utilities and Urban Communities, 2020a, b, c).

Bashair Al-Khair consists of three phases completed by the Northern Military Area in cooperation with several civil society and business community the first phase: Bashair Al-Khair 1, which was inaugurated by President El Sisi in 2016; the second phase: Bashair Al-Khair 2, included 37 buildings including 1870 residential units at a cost of LE 400 million, and the third phase: Bashair Al-Khair 3 in 110 buildings including 5840 housing units, a mosque and the development of Qabbari Youth Center at a cost of 2 billion and 325 million pounds as shown Fig. 8 (Simms and Kamal, 2008).

### 6.4 Fourth Project: “El Mahrousa 1 & 2” Project, Al-Nahda City, Al-Salam Second Neighborhood

The Ministry of Housing, Utilities and Urban Communities is currently completing the work of finishing about 4900 housing units in 2018, shops, offices and administrative units.





Fig. 4 Al-Sayeda Zeinab Kindergarten (Tal Al- Aqarib Project)



Fig. 5 Residential blocks are finished with (Hashemite stone and Mashrabiya)

Fig. 6 Layout of Al Asmarat project in Mokattam





Fig. 7 Residential buildings Al Asmarat Project in Mokattam

in the project “Mahrousa 1 and 2” in the city of Al-Nahda, Al-Salam neighborhood in Cairo (Tal Al-Aqrab Project, 2019).

The area of the project is 60 acres including 34.7 acres for buildings and 14.2 acres for services, 8.4 acres for roads and footpaths besides 2.7 acres for green areas and public spaces. Al-Mahrousa 1 project includes the construction of 128 buildings 63 m<sup>2</sup> (114 residential buildings (90 buildings—ground + 5 typical floors), and (24 buildings—basement residential + ground + 5 typical floors) - 14 commercial residential building (basement shops + ground + 5 typical floors) + building women breadwinner. The total number of units is (3157 housing units 63m<sup>2</sup> + 72 housing units for breadwinners + 84 stores + 39 administrative offices) as well as the work of connecting the facilities what is currently.

being completed is the completion of service buildings, paving roads, and site finishes as shown Fig. 9 (UN Habitat Housing, 2019).

## 7 Results and Discussion

There are studies and research that have analyzed the problems of not applying sustainability standards in architectural housing projects because there is high initial cost of green building projects that use the latest technologies to achieve sustainability.

The classification process is complex, requires time and procedures by using of modern sustainability technologies that are far from the identity and culture of society to



Fig. 8 Residential buildings Grape Gheit project (Bashair Al-Khair) in Alexandria City





Fig. 9 Residential buildings El Mahrousa 1 and 2 project, Al-Nahda City, Al-Salam Second neighborhood.

decrease energy saving standard and make more of awareness in prioritizing users, so the constraints are to assessing the sustainability of architectural design in Egypt:

- a **Administrative constraints:** The most important administrative obstacles can be insufficient sources of funding needed to achieve sustainable development and lack of support from developed countries by providing support to assist developing countries.  
There are non-application and amendment of laws and legislation related to the specifications of green architecture that led to negligence of the state in addressing environmental problems and increasing their accumulation without imposing sanctions on consumers, also the existence of cumulative organizational problems starting with the emergence of the Unified Building Law No. 119 issued in 2008 and did not take any consideration of the concepts of sustainability.
- b **Technical constraints:** Many of designers use on two-dimensional schemes such as AutoCAD, which have many design problems and the lack of use of modern technology such as BIM, which reduces errors in designs, which saves cost and time, but did not adopt the state of modern technology and they are high cost of those modern programs and devices  
The disproportionate number of special devices and tools required for evaluation with the high building density in Egypt is specialized companies in green construction; also, they have lack of simulation programs to analyze results and develop alternatives and solutions to problems.
- c **Artistry constraints:** There are not include the concept of sustainability in the architectural education in the

stages of education continuously and focus on environmental design only and lack of attention on the cultural and social dimensions that led to lack of experience sufficient technical expertise did not a day in the process of evaluation of the buildings despite the presence of engineering experts in Egypt for green architecture, but did not benefit them at the design and executive level and lack of availability of architecture skills that are necessary for green architecture techniques.





The following table shows a study of comparison and evaluation of the local examples in Egypt that suffer in achieving the housing projects for sustainable design and the availability of sustainability criteria from its components and services, which are summarized as Table 2 follows.

The analytical study of the four cases and the evaluation of the elements of sustainability show that Al Asmarat and Grape Gheit Projects had poor of public areas like green areas, so green areas are benefit to reduce pollution and high sun rising and provide shading and natural ventilation.

The general form of the housing project in Al Asmarat and Basheer Al-Khair neighborhood is considered of the buildings that were built in the form of blocks without playing in the design of the blocks form that play the important role in providing shade to reduce sunlight and provide nature ventilation, but those buildings were created to sell these residential assets for investment. They were constructed of building materials from concrete and iron, not using recycled, local, and renewable materials that caused the high prices of housing units, so in new cities still need more awareness of the principles of sustainability, which consider and develop a vision for sustainability.



**Table 2 Comparison and evaluation of the local examples in Egypt that suffer in achieving the housing projects for sustainable design**

Project name	Al-Sayeda Zeinab Kindergarten (Tal Al-Aqarib Project)	Al Asmarat project	Grape Gheit project (Bashair Al-Khair)	El Mahrousa 1 and 2 project
Date of establishment	2018	2016	2018	2018
Location	Is located in Al-Sayeda Zeinab Kindergarten, Cairo, Egypt	Is located in Mokattam, Cairo, Egypt	Is located in Karmouz, Alexandria, Egypt	Is located in A1-Nahda City, Al-Salam Second neighborhood. Egypt
Project type	New urban civilization	New urban civilization	New urban civilization	New urban civilization
The project area	The total area of the city is about 7 and a half acres	The total area of the city is about 65 acres	The total area of the city is about 13 acres	The total area of the city is about 60 acres
Project objectives	Provide adequate housing to reduce overcrowding in the capital area. pressure on facilities and improve production	Provide adequate housing to reduce overcrowding in the capital area, pressure on facilities and improve production	Provide adequate housing to reduce overcrowding in the capital area, pressure on facilities and improve production	Provide adequate housing to reduce overcrowding in the capital area, pressure on facilities and improve production
Availability of sustainability elements of energy and water recycling	The project uses local and renewable materials like Hashemite stone. Mashrabiyyat was established in the outlets to take the Islamic form in architecture and not reuse of water	The project did not use recycled, local, and renewable materials and not reuse of water	The project did not use recycled, local, and renewable materials and not reuse of water	The project did not use recycled, local, and renewable materials and not reuse of water
Availability of public services and facilities	They had poor of availability of public services like green areas	They had poor of availability of public services and facilities to the growth of people	They had poor of availability of public services and facilities	They had availability of public services and facilities about 142 acres for services
Use local materials	The project uses local and renewable materials like Hashemite stone	The project did not use local and renewable materials	The project did not use local and renewable materials	The project did not use local and renewable materials
Photo of project				

## 8 Conclusions

The results were obtained that the research concluded studying of local experiences of the problems in housing for the possibility of achieving sustainable construction in housing.

After studying the Egyptian experiences and examples, the research found that the economic housing is present in the existing cities that have been implemented in the projects in the past years; it lacks the principles and criteria of sustainability and the increase of problems in it from the lack of renewable energy sources and increased consumption. However, in the new cities that are still under construction, there are some sustainability criteria, but these projects are aimed at distinguished housing, and there is no economic

housing for the purpose of profit and financial gain and investment only.

The selection of materials is carried out in the feasibility stages of the new buildings, especially in the new cities, where the architect must collect information and data for the specifications of the materials and choose them as available in the local market, which suits the cost and environmental sustainability. The community did not participate in the planning and design process in the new cities despite the agreement of experts and land owners in the preparation of plans and people did not participate, where the investment and sale of these buildings for profit, where the government and the private sector only provide housing models, but the materials used are high cost and therefore not The ability for families to buy those housing.

## 9 Recommendations

1. The necessity of the state's interest in the design and implementation of buildings in the consideration of sustainable building materials and taking appropriate decisions after studying them to operate these buildings without a negative impact on users and the environment to achieve high-efficiency buildings.
2. Modify and implement legislation that includes green architecture, where companies working in the field of construction are obliged to apply these concepts with the need to issue codes related to green and local architecture.
3. Provide and develop sustainable building strategies for companies and design offices to implement these standards.
4. Develop a system of sustainable materials for application in existing and new cities in Egypt.
5. Develop an urgent plan to activate renewable energy sources (such as windmills and solar power plants), especially in new cities today.
6. Activate and develop the recycling system for building waste instead of importing materials from abroad, thus reducing costs and maintenance.
7. Respect and consider the great diversity and variability between the different climatic regions to apply the tools of assessment of sustainable buildings and the selection of available local materials.

**Acknowledgements** First of all, I am thanking *my God* Almighty for accomplishing this modest work, hoping that holds the good for the scientific researchers and students locally and internationally. Deep respect and gratitude to my honorable *Professor Dr. Hossam Eldin Hassan Othman Elborombaly* for his valuable instructions and for being my ideal ethically and scientifically. I would like to acknowledge to *Assoc. Prof. Dr. Ali Kamal Ali Altwanasy* under whose supervision this paper was accomplished.

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