



# Towards A Reference Framework for the Sustainability of Informal Settlements Upgrading

E. Badawy and N. Mohamed

## KEYWORDS:

*Informal settlements; Upgrading; Sustainable*

**Abstract**— Egyptian cities suffer from the spread of informal areas, which include many urban and environmental problems. The government makes efforts to upgrade the informal areas. Yet these efforts lack the sustainability dimension. Thus, the paper aims to create a reference framework for the upgrading of informal settlements to create sustainable communities. By suggesting elements for assessing sustainability that help to upgrade informal settlements and involving users in the priority problem-solving to include Egypt's 2030 Vision.

The main research problem is the absence of sustainability in urban upgrading projects of informal settlements areas.

The research methodology depends on the theoretical, analytical, and applied approaches; the theoretical approach reviews the definition of slums and informal settlements, studies Egypt's 2030 Vision and the previous literature on the sustainable development of informal settlements to conclude criteria for assessing sustainable informal settlements, and then uses the analytical approach to analyze two informal settlements in Egypt, which Fayoum governorate, El Alwaia and al- Hakora areas, The reference framework is then applied to these areas to measure their effectiveness.

The research concludes that informal settlements in Egypt need to apply sustainability principles to solve their problems, it is difficult for informal settlement dwellers to pay the cost of using solar cells and some sustainability applications, so developers and the government must sponsor and help implement sustainability in informal settlements.

Some users practice some sustainability applications without realizing it, such as selling waste (cartons and plastics), but there is no waste separation, which makes it difficult for the individuals who work there.

## I. INTRODUCTION

**E**GYPT suffers from the harmful effects of informal settlements, and there are many ways to deal with them. The most important of these methods is the use of the urban upgrading policy, which includes several overlapping policies, such as the settlement and replacement

policy, which depends on completely removing the site, re-planning, and building that is in line with regional plans and modern planning trends. Moreover, the policy of reform and renewal depends on improving buildings, streets, corridors and restructuring the informal areas. These policies can gradually work simultaneously in the informal settlement area to resettle the population, own land for residents, and improve

Received: (04 November, 2021) - Revised: (02 January, 2022) - Accepted: (19 February, 2022)

\* **Corresponding Author:** E. B. was with Fayoum University. She is now with the Architecture Department, Faculty of Engineering, Beni Suef University, Beni Suef, Egypt (e-mail: Eng.eman\_aser@eng.bsu.edu.eg)

Nesma Mohammed Abd El-Maksoud, Architecture Department, Faculty of Engineering, Beni Suef University, Beni Suef, Egypt, (e-mail: Nesma011315@Eng.Bsu.Edu.Eg)

infrastructure networks. Residents have accessibility to urban infrastructures such as water supply, sanitation, electricity, and transportation.

In recent periods, sustainable development has been the newest strategy to solve informal settlements problems, so Egypt put Egypt Vision 2050, which includes the strategic vision for the sustainable development of Egypt 2030.

According to the informal settlements Development Fund, in the project to develop the Qohafa and Al-Saifieh areas in Fayoum Governorate, the efficiency of the sewage network and the drinking water network was raised traditionally by the network. Without using recycling or other sustainability applications, this is what happened too. In street lighting, there is no use of renewable energy, so the importance of this paper is to make a sustainability reference framework able to be used in informal settlements to upgrade informal settlements to apply the Egyptian visions of 2030.

The purpose of this paper is to make a sustainability reference framework, which consists of metrics for assessing the sustainability of informal settlements. According to the indicators of sustainable upgrading in informal settlements, in addition to the statistical analysis method and the importance and credit weight of elements. Then applied to informal settlements to measure their effectiveness.

## II. SLUMS AND INFORMAL SETTLEMENTS

The definitions of slums are based on some of the characteristics that characterize slums, such as being illegal, lacking infrastructure [1] [2]. The informal settlements are considered as a type of slum. Informal settlements areas are divided into unplanned and unsafe areas. This paper focuses on random areas illegally planned by inhabitants who suffer from very high crowding rate (number of residents/room), lack of essential urban services, and the accessibility or connectivity with formal fabric. [3]

According to the UN-Habitat definition of slums and Unsafe areas are regions where 50% of the housing structures have one or more of the following conditions: Limited living space, insufficient water, insufficient sanitation, building instability, and insecure tenure. [4]

The construction of informal settlements is described by two separate patterns: unplanned urban expansion, primarily by the subdivision of agricultural land in violation of existing laws; and inadequate or temporary structures in inner slums, hazardous, and unsafe sites, or suburban areas lacking access to basic amenities.

## III. THE EGYPTIAN VISION 2030 AND 2050

Egypt Vision 2050 aims to deal with unplanned areas through a detailed plan for upgrading within a specific time frame based on: Increasing access to these areas by opening main and secondary roads with minimal demolition, Providing alternative housing units for the affected groups, Regulating

ownership, and enabling tenure, Providing essential services for vacant plots of land, Raising the standard of living to the international level, Improving the environment and increasing green areas, Establishing public parks and a local park for each neighborhood, relocating polluting activities outside the area, Converting some streets and roads into footpaths, and utilizing public transport services and limiting the entry of cars [4].

It is a sustainable development strategy (SDS) that aims to by 2030, the new Egypt will have developed into a competitive, balanced, and diverse economy, defined by justice, social equality, and entrepreneurship. With a balanced and diverse environment.

The strategic vision for the sustainable development of Egypt 2030: The dimensions of the strategic vision for the sustainable development of Egypt 2030 include the environmental dimension (urban development - the environment), which depends on upgrading the quality of the built environment that leads to reliance on traditional resources, energy efficiency, and renewable energy sources [5] [6]. (Figure 1).

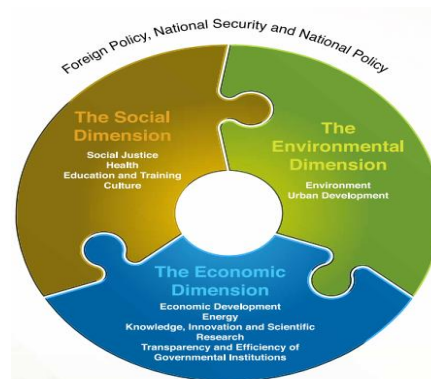


Figure (1) main dimension the sustainable development strategy (sds): Egypt vision 2030, Source: [7]

**The Environment Dimension:** This aims for a clean, safe, and healthy environment that fosters a diverse range of productive resources and economic activities. To preserve natural resources and support their optimal use and investment, the environment is incorporated into all economic sectors, while also ensuring the rights of future generations. [7] Environment strategies until 2030 are enhancing the institutional and legislative structure of the water quality management system, building infrastructure to sustainably support water systems and encourage sustainable consumption, raising public awareness of the need to protect the environment and natural resources, developing a sustainable solid waste management system, and developing infrastructure to reduce pollution and prepare for climate change. [8]

**Urban Development Strategy:** The planning and management of urban development are governed by a governance structure. Avoiding infringement in new urban communities, as well as minimizing informal settlements and unstable places Substituting and upgrading infrastructure and increasing utility services in new areas, promoting the use of green and sustainable building technologies, enhancing and

improving city transportation, and enhancing construction capabilities in new urban areas are some of the initiatives being undertaken.

**IV. UPGRADING INFORMAL SETTLEMENTS:**

Upgrading informal settlements means improving the infrastructure network of roads, water, and others, improving urban and architectural spaces and their formations [9] [10]. Upgrading strategies are of three types: Comprehensive Upgrading Strategy, Partial Upgrading Strategy, and the strategy of keeping the situation (Figure 2).



Figure (2) upgrading strategies Source: researchers

The strategy of keeping the situation depends on maintaining the policies as they are. Therefore, this strategy is of limited intervention in nature. Consequently, the partial upgrading strategy, which includes the partial upgrading process, is the most suitable technique for upgrading the informal settlements sector (upgrading urban structure) [11]. It is the development of urban areas planned to achieve the rationalization of energy, water, and control of wastes from population activity, with the collective participation in its problem.

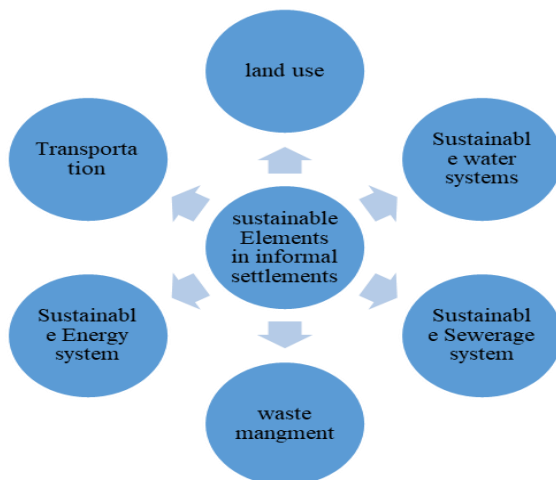


Figure (3) sustainable Elements in informal settlements, Source: researchers

Sustainable urban development can be defined based on the three pillars of sustainability (environmental-socio-economic). By focusing on the environmental aspect, urban sustainability means organizing development processes for the city without excessive reliance on natural resources, and this means its dependence on alternative and renewable energy sources to reach a reduction in its environmental footprint with less production of pollutants, more efficient use of urban land and greater reliance on recycling processes [11].

**V. THE REFERENCE FRAMEWORK FOR THE SUSTAINABILITY OF INFORMAL SETTLEMENTS UPGRADING**

The reference framework consists of evaluation Elements, statically analysis method, and Importance and credit weight of elements.

*A. Evaluation Elements of Reference Framework :*

Although sustainable evaluation approaches aim to enhance the environmental performance of built environments, informal settlements lack even the most basic needs, such as access to water, sanitation [12], and energy. Consequently, the importance of developing metrics for assessing the sustainability of informal settlements [13].

According to the indicators of sustainable upgrading in informal settlements (Figure 3), the main environmental dimensions of sustainability include land use, water system, sewage systems, energy system, transportation networks, and waste management.

Elements for assessing sustainability in informal settlements were extracted from previous literature, green assessment systems, and Egypt Vision 2030 and 2050, and are as follows:

*1) Land Uses*

The following elements can be used to assess the effect of land use planning on sustainability informal settlements, such as: Confirming the boundaries of the residential complex and securing it in its location away from exposure to natural disasters, implementation of Laws governing land use, Building patterns for community (urban fabric - the lengths of existing blocks), Large divisions of land with a high crowding rate (number of residents/room), Providing a central service area, distribution of housing according to its heights and making use of it visually, The multiple use of spaces and their functional flexibility (compact mixed use) [14]. The multiplicity and diversity of housing patterns, The clarity of the urban structure, the emphasis on the local identity, the unification of the architectural style, reducing infrastructure extensions, and relying on pedestrian traffic, Using the modular units in planning, Flexibility and versatility of residential spaces, multiplicity of use , utilization of external spaces, functional

distribution of benefits and their spatially interconnectedness, providing areas for future expansion, separating polluted uses with green zoon, supplying all lands with facilities and improving the infrastructure [15], and preserving valuable lands (heritage or Agricultural).

2) *Sustainable Water System:*

The water system is a vital resource for societies. So, highly efficient systems [15] are required to save water consumption [16]. As flowing: Constructing a clean water network, reducing of water [17], Water network maintenance. [7] Gray water reuse such as landscaping irrigation, percentage of the population that has access to quality and healthy drinking water [18]. Utilization of new water sources [15], Avoiding pollution of water supplies [19], Measuring water device leakage and wastage, Developing strategies to ensure the long-term viability of water resources [20] [21], Matching drinking water with Egyptian drinking water specifications, Sustainable Water Use [22], and providing main tanks for clean water.

3) *Sustainable Sewage Systems:*

Sewage Systems Plans should be implemented to advantage from sewage water and to allow the availability of sewage networks for the population, by focusing on the following points: Constructing a sewer system, Sanitation Management [22]., Sanitation network maintenance [23], Waste-based energy generation [24], safe drainage system [25], Control of sewage disposal methods, [7] the sewage system dodoesot pollute water supplies [26] and percentage of the population that uses sanitation facilities in a healthy.

4) *Waste Management:*

Controlling the waste management [22] would contribute to achieving sustainability by applying that: availability of recycling facilities for waste, reuse of waste [27], waste marketed [28], choosing the landfill's site, people aware of the importance of waste separation [29], landfills located away from populated areas, protection of water source from waste pollution, reducing emissions caused by waste burning, and evaluation of the landfill's effectiveness in terms of environmental impact. [7]

5) *Sustainable Energy System*

The energy system is the most crucial resource for societies. To achieve sustainability in informal settlements, the following elements are required: establishing the electricity network, raising the electrical network's performance, appropriating energy costs concerning individual income, locally sourced construction materials [30], the use of environmentally friendly building materials, [31]using natural lighting [31] [32], utilizing natural ventilation, and energy performance [33] [34] [35] [36], using renewable energy sources [7] [37] [38], the electrical network's performance, percentage of total energy consumed from renewable energy sources, [7] production of clean energy, and implementing electric energy rationalization policies.

6) *Transportation Networks:*

It is important to use sustainable transportation [39] [40] to reduce fuel consumption. Especially in informal areas to protect the environment and human health, so controlling these elements is very required and It can be achieved through that:- people have access to public transportation, Main roads are well maintained and paved, [7]Control the amount of noise generated by the transmission, Emphasizing on public transport and providing multiple transportation options, the proportion of pedestrian paths to achieve the comfort of movement, cycling paths and priority to the pedestrian network and providing the closest and easiest ways to reach services, Improving the quality of fuel used in transportation [41], designing roads which help in reducing car speed, the gradual distribution of roads within the community (major-minor), determining parking spaces, reducing parking [42] lots and focusing on accessing services by walking), The extent of the quality of the transportation network, the determination of the size of the street widths, and the volume of traffic movement.

B. *Statically Analysis Method :*

To achieve the objectives of the research and analyze data on the case studies (selected models), the statistical methods are used in data analysis as follows:

The data were coded and entered into the computer according to the five 'Likert scale', and to determine the length of the five 'Likert scale' (the lower and upper limits) used in the application criteria for the measurement matrix, to determine the upper limit for the first period as shown in (Table1):

TABLE (1)  
EVALUATION PERCENTAGES ACCORDING TO THE MEASUREMENT MATRIX

Standard	period average	The relative weight	percentage of each element	Total percentage
<i>The percentage of applying the standard</i>	5.0:4.2	≤100 Excellent≤84	The percentage of applying the standard = the average = the sum of the percentages of applying the elements of one standard ÷ the number of its elements*100	Total application of standards = average = percentage of standards implementation * Weight of elements
	4.2:3.6	84< Very good ≤68		
	3.4:2.6	68< good ≤ 52		
	2.6:1.8	52< Acceptable ≤ 36		
	1.8:1	36< poor ≤ 20		
	1:0	20< None ≤ 0		

C. Importance and Credit Weight of Elements

The study compares the relative weights of the LEED cities system [43], the green pyramid for Egypt [44], and identifying the opinions of the region's residents about their priorities, then determining the weights of the reference framework (Figure 4).

The relative value of the specified criteria and weights for the reference framework elements (table2), which considers all previous systems, energy, was given the highest priority, given the same priority in the reference framework. However, in this reference framework, the water and sewage system are equivalent to energy due to the importance of providing

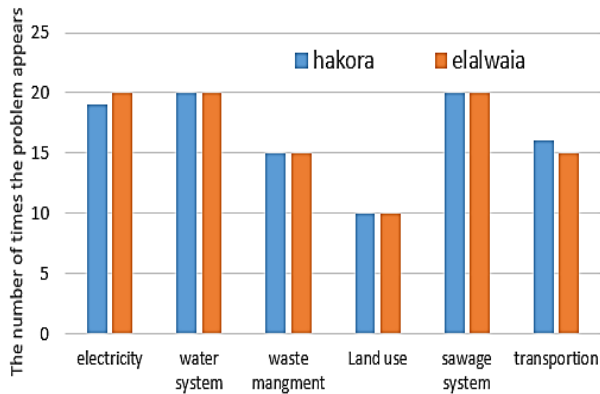


Figure (4) the result of the questionnaire for priority intervention in solving problems, Source: researchers

Infrastructure in the 2030 Agenda. Some of the elements and the criteria upon which the assessment systems in this reference framework are different because of the various economic, social techniques and lack of awareness of its importance.

D. Questionnaire

The sample size of the questionnaire is 30 individuals from Hakora, 18 males and 12 females, 13 of whom have a university education, 10 with an intermediate education, and 7 illiterates.

El Alwaia's sample size is 35 people. 20 males and 15 females. Twenty of them have a university education, 12 have an intermediate education, and three are illiterate.

The aim of the questionnaire is to focus on the extent to which the residents accept sustainable solutions. And the resident's needs and priorities.

It is clear from the questionnaire that 18% of the population gives energy the number one priority in solutions in the Hakora area and 20% in the upper area, with water almost equal in priority to get 20% of the sanitation, then waste and transport are followed by 15%, and land use by 10% (Figure 4).

As a result of the questionnaire, which asked people about the upgrading of sustainability, it was found that 100% of the sample were interested in reducing their energy consumption, especially with the new electricity metric systems that work by card. But all of them are traditional methods, such as not using artificial lighting during the day and using it at night only.

It is clear from the questionnaire that 18% of the population agree to use solar cells to solve power outages and agree to learn how to maintain them.

As for separating waste, 100% of the population does not do it. And they see it as a necessity because some of the resident work selling waste. There are some residents who work by collecting and selling plastic, as well as collecting and selling paper and cardboard.

As for the water, sewage, and electricity systems, users said that they require an additional cost that they cannot afford if they are provided by the state or development partners. They are ready to learn how to maintain them.

TABLE (2)  
IMPORTANCE AND CREDIT WEIGHT OF ELEMENTS. SOURCE: RESEARCHERS

	LEED		Green pyramids		Survey		Reference framework		Comment
	Credit	Imp.	credit	Imp	credit	Imp	credit	Imp	
Land Use	18	2	15	3	10	3	15	2	Irregularities in land use after the revolution of 25 Jan.
Transportation					15	4	10	3	One of the biggest problems in informal settlements
Energy	31	1	25	2	30	1	20	1	In response to the rising energy crisis
Water system	12	4	30	1	15	2	20	1	Providing infrastructure is the goal of the 2030 Agenda
Sewage system					20	2	20	1	
Waste management			10		15	2	15	2	One of the biggest problems in informal settlements
Material & Resources	11	5	10	4			0		Included in all elements
Quality of Life	10	6	10	4			0		Included in all elements

## VI. CASE STUDY

The case study is based on two areas classified as informal settlements by those responsible for decision-making, the study cases were chosen in the Fayoum governorate, where the percentage of informal settlements is 61.7% from the urban cluster of the governorate.<sup>(1)</sup> Consequently, this paper focuses on the environmental and urban dimensions to achieve sustainable upgrading.

### A. Description of Case Study

The study applies the proposed reference framework in two informal settlements in Fayoum Governorate, the first region is Alwaia Qaid and Ezbet Mamoun, and the second region is Al-Hakoura (Figure 5). The following is a description of them:

#### 1) Case 1: Alawaia Region

Alawaia Qaid - the main road (Sheikh Hassan Al Jadeed) separating into two parts then ending by Fayoum Tabhar Road, which connects it to the Ring Road of Fayoum. From the south, there is a street with the main bank of the area.

Population: 14,124/ Area: 37 acres. The most important problems of this region are the lack of infrastructures such as electricity, water, sewage, and garbage. Such as Urbanism is dilapidated, lacks identity, unsuited units, roofs are destroyed, and the spaces are not suitable for human accommodation. Interfaces deform due to dilapidated sanitation factors. Buildings encroach on farmland. The lack of suitable and safe bridges for use by children means they pass over them daily. Drinking water is polluted. The high cost of services about the level of services, and the lack of job opportunities with fixed salaries. (Figure 6).

#### 2) Case 1 Al-Hakoura Region

The main road passed nearest Al-Hakoura region is Al-Salakhana Street and opposite Sheikh Hassan Mosque and connected to the Ring Road of Fayoum by Bahr abagy and Samah Street. Population: 4,681 people, Area: 33 acres.

The region is exposed to problems that need rapid Intervention, garbage, the lack of an infrastructure network like electricity, water, sewage, poor roads, and a lack of offers. In addition to the entrances being crowded and the safety elements Unavailable, the roads are narrow and unpaved. Inconsistent

uses and workshops with residential, unorganized random markets, The accumulation of garbage in the street, the difficulty of accessing fire trucks due to the narrow streets, Frequent power cuts due to overloads on transformers The drains are open and garbage is thrown into them, causing the presence of insects that affect the health of residents, in addition to the drowning of many children in them due to the lack of a protective fence. The compact urban fabric and poor gradation of the road network are obvious from the area map. The roads in the area are very narrow and not suitable for cars to enter, which means ambulances and fire trucks can't enter (Figure 7).

### B. Results of Case Study

The analytical and applied analyses of case studies, as well as their comparison with the reference framework, reveal various results, including the following: The case studies share strengths and weaknesses that mainly affected their Characteristics, which are represented in obtaining acceptable rate in land use only while having poor rate in transportation, water system, energy system, and having non-existent in Sanitation and waste management (Figure 5) (table 3).



Figure (5) the location of the case study in Fayoum Governorate  
Source: Planning Authority in Fayoum Governorate (2016)

Their Table of land use lies in an acceptable score, which is 43% in Elalwaia and 37.5% in Hakora.

In transportation, the rate is 35% in Elalwaia and 30% in Hakora, while the water system is evaluated 27% in Elalwaia and 28% in Hakora, which is a poor rate in both elements.

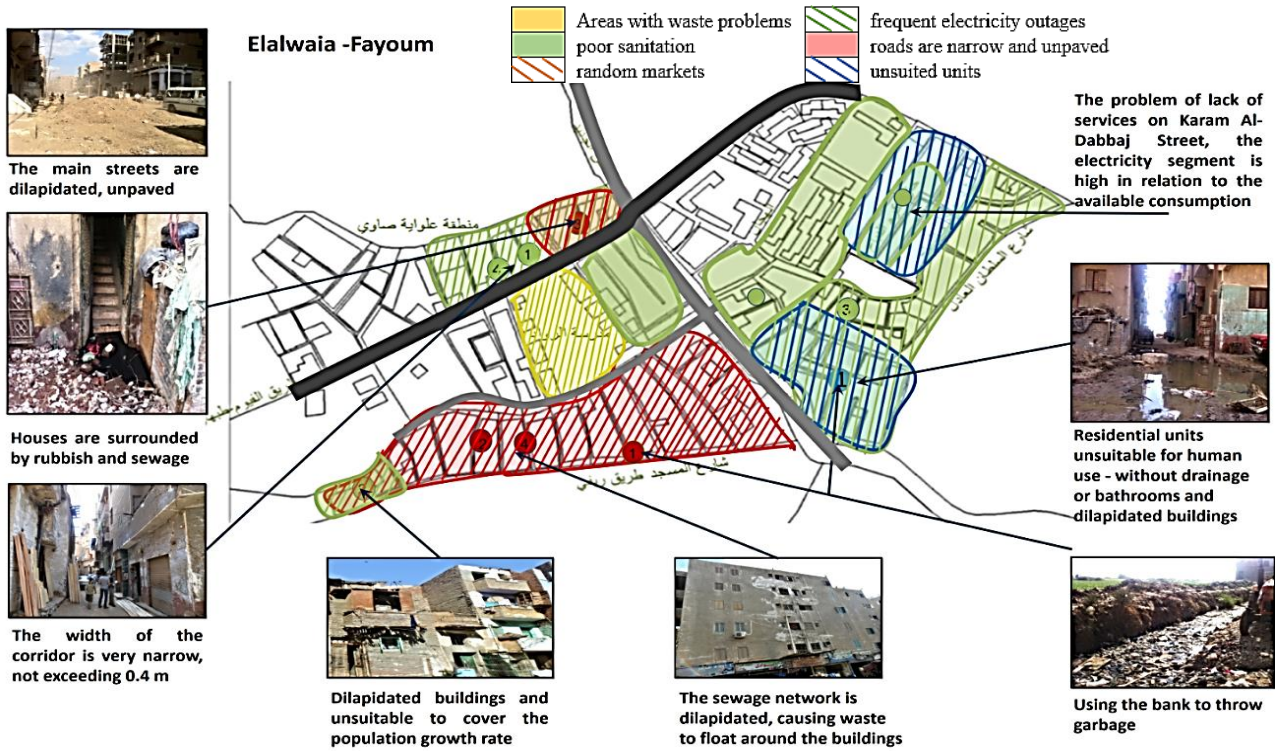


Figure (6) distribution of problems on the map of the region, Source: researcher

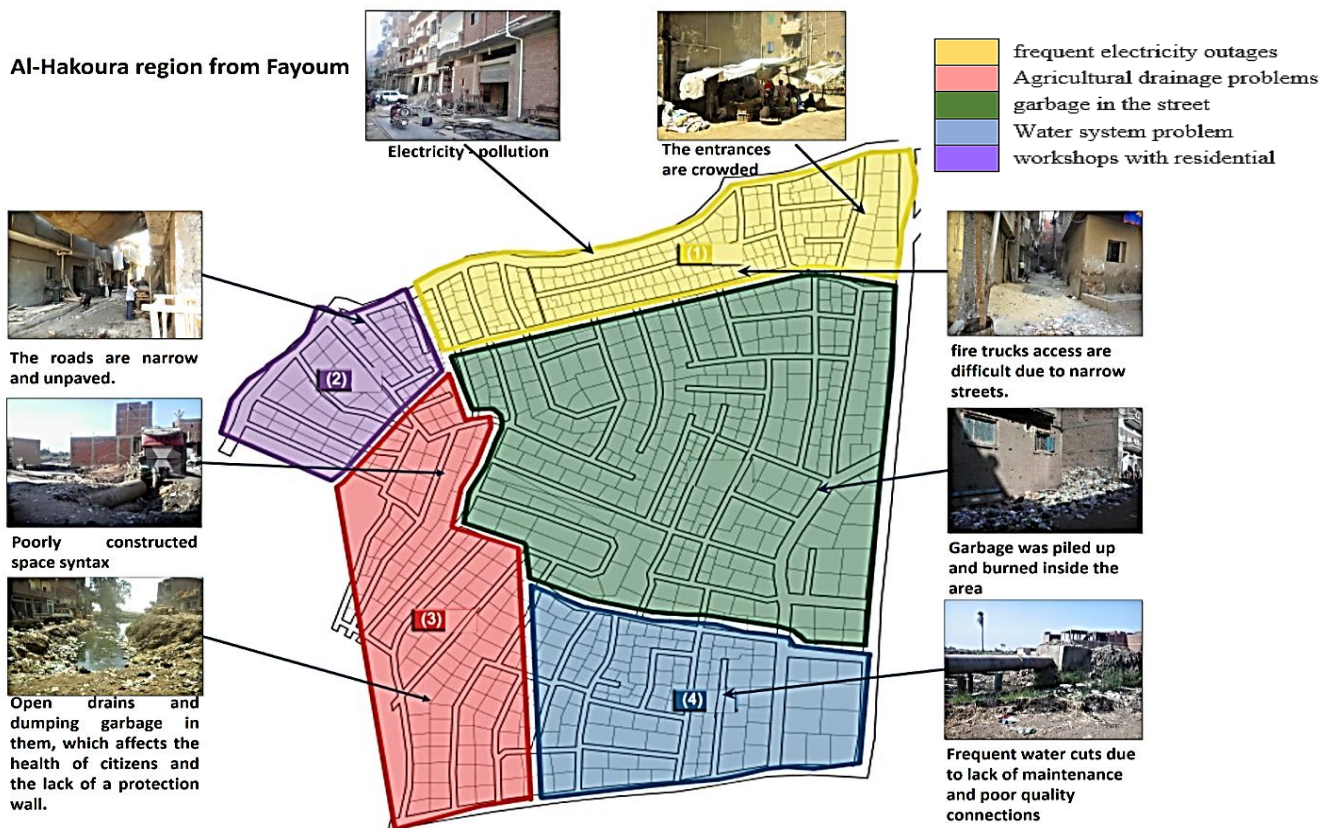


Figure (7) distribution of problems on the map of Hakora area, Source: researcher

TABLE 3  
THE EVALUATION OF CASE STUDIES (ELALWAIA AND HAKORA)

	Evaluative Elements	El Alwaia	The Hakora
<b>Land Use</b>			
1	implementation of Laws governing land use	6	4
2	Building patterns for the community (urban fabric	5	7
3	Providing a central service area	5	1
4	distribution of housing according to its heights and make use of it visually	2	2
5	The multiple uses of spaces and their functional flexibility	4	2
6	The multiplicity and diversity of housing patterns	4	6
7	The clarity of the urban structure, the emphasis on the local identity	6	4
8	unification of the architectural style, and emphasis on the local identity	2	2
9	Reducing infrastructure extensions	6	6
10	Using the modular units in planning	5	6
11	functional distribution of uses and their spatial interconnectedness	6	4
12	separating polluted uses with green zoon	0	0
13	preserving valuable lands (heritage or Agricultural)	5	5
	<b>Total Points</b>	<b>56</b>	<b>49</b>
<b>Water System</b>			
1	Constructing a clean water network	5	5
2	Water network maintenance	1	0
3	Gray water reuse such as landscaping irrigation	0	0
4	Water rates in regarding the individual income in these regions	6	7
5	Percentage of the population that has quality drinking water	5	6
6	Utilization of new water sources, Avoiding Pollution of water supplies	2	2
7	Measuring water device leakage and wastage	0	0
8	Developing strategies to ensure the long-term viability of water resources	3	3
9	Matching drinking water with Egyptian drinking water specifications	5	5
10	Providing main tanks for clean water	0	0
	<b>Total Points</b>	<b>27</b>	<b>28</b>
<b>Sewage System</b>			
1	Constructing a sewer system	2	3
2	Sanitation network maintenance	0	0
3	Waste-based energy generation	0	0
4	safe drainage system	1	2
5	Control of sewage disposal methods	2	5
6	the sewage system does not pollute water supplies	2	3
7	Percentage of the population that uses sanitation facilities in a safely	2	5
8	the sewage system does not pollute water supplies	2	2
	<b>Total Points</b>	<b>11</b>	<b>20</b>
<b>Waste Management</b>			
1	Availability of recycling facilities for waste and locating recycling centers	0	0
2	places for dumping waste in a healthy	0	0
3	Reuse of waste	0	0
4	Waste marketed	2	2
5	no sewage disposal in water source	2	3
6	Choose the landfill's site	0	0
7	People aware of the importance of waste separation	2	2
8	Landfills located away from populated areas	0	0
9	Protection of water source from waste pollution	1	2
10	Reducing emissions caused by waste burning	3	2
11	An evaluation of the landfill's effectiveness in terms of environmental impact.	0	0
	<b>Total Points 110 Point</b>	<b>10</b>	<b>11</b>
<b>Sustainable Energy System</b>			
1	Establishing the electricity network	7	7
2	raising the electrical network's performance	2	2
3	Appropriate energy costs about individual income	7	7

(Continued on next page)



TABLE (3): CONTINUED

	Evaluative Elements	El Alwaia	The Hakora
4	Locally sourced construction materials and the use of environmentally friendly building materials with durability and high quality that does not require continuous maintenance and make the most of climatic factors	0	0
5	Making use of natural light, Allow for natural ventilation and shading	3	5
6	The electrical network's performance	4	2
7	Percentage of total energy consumed from renewable energy sources	0	0
8	production of clean energy	0	0
9	Implementing electric energy rationalization policies.	2	2
	<b>Total Points 90 Point</b>	<b>25</b>	<b>25</b>
	<b>Transportation Networks</b>		
1	people have access to public transportation	5	2
2	The main roads are well-maintained and paved	5	6
3	Control the amount of noise produced by the transportation	3	2
4	Emphasizing public transportation and providing multiple transportation options	5	6
5	Percentage of pedestrian paths to achieve comfortable movement	6	4
6	Providing cycling paths and priority to the pedestrian network and providing the closest and easiest ways to reach services	0	0
7	Improving the quality of fuel used in transportation	2	2
8	Road design for cars to help reduce internal speed	4	4
9	Gradual distribution of roads within the community (main - secondary) and the extent of their connection to the main entrances	4	3
10	Determine parking spots, and reduce car parks	1	1
11	quality of transportation network	2	2
12	reducing entering Cars	5	4
	<b>Total Points 120 Point</b>	<b>42</b>	<b>36</b>
	<b>Total Points 720 Point</b>	<b>208</b>	<b>197</b>

TABLE4  
RESULTS OF THE EVALUATION OF CASE STUDIES (ELALWAIA AND HAKORA)

Evaluative Elements	Region	Total Points	Weight Percent	Percentage of Application	Relative Weight of
<i>Land use</i>	El Alwaia	56 from 130	43%	6.5%from 15%	Acceptable
	the Hakora	49 from 130	37.5%	5.6% from 15%	Acceptable
<i>Water system</i>	El Alwaia	27 from 100	27%	5.4% from 20%	poor
	the Hakora	28 from 100	28%	5.6% from 20%	poor
<i>sewage system</i>	El Alwaia	11 from 80	13.75%	2.7%	none
	the Hakora	20 from 80	25%	5%	poor
<i>Waste management</i>	El Alwaia	10from 110	7.3%	1%	none
	the Hakora	11 from 110	8.1%	1,2	none
<i>sustainable Energy system</i>	El Alwaia	25from 90	27.7%	5.5%	poor
	the Hakora	25 from 90	27.7%	5.5%	poor
<i>Transportation networks</i>	El Alwaia	42 from 120	35%	3.5	poor
	the Hakora	36 from 120	30%	3	poor
<i>Total evaluation</i>	El Alwaia	208 from 720	29%		poor
	the Hakora	197 from 720	28%		poor

The energy system gets a rating very close to the water system in both regions, where the electricity rating is poor at 27.7% in Elalwaia and Hakora. (Table 4)

The sanitation system in Elalwaia is ranked 13.75%, which means non-existent, but Hakora is 25%, which is a poor rate. However, waste management is assessed non- in Elalwaia and Hakora, which are 7.3%, 8.1%, respectively (Figure 8).

Finally, both regions obtain a poor ranking for adopting sustainability principles, with 27.7% in Elalwaia and 26% in Hakora.

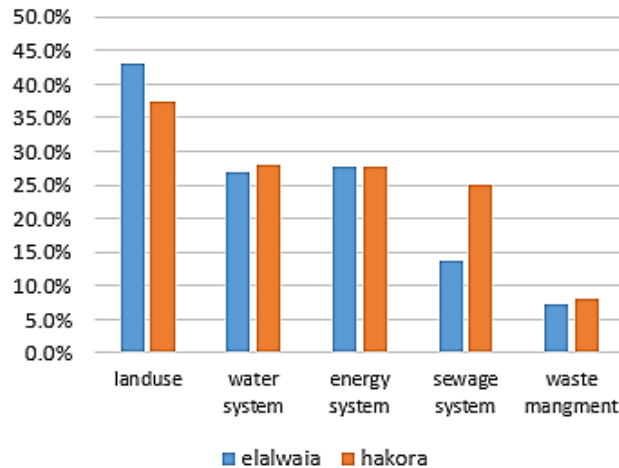


Figure (8) Results of apply reference framework in case study  
Source: researchers

## VII. RESULTS AND DISCUSSION

The research concluded with significant results, which are: We are conducting a questionnaire to know the users' needs and priorities before starting rehabilitation and upgrading from an urban and environment results in a feeling of belonging and a successful development process, because the negative interaction of the uses resulted in environmental, urban, and health problems in the area, so questionnaires must be made to the population's requirements in degraded areas before setting goals and directions for the upgrading and rehabilitation process. Users need awareness campaigns to know the meaning and objectives of sustainability.

There was a clear lack of a sustainability concept in many informal settlement upgrading projects. The informal settlements' upgrading projects' role should be to develop an integrated system to ensure sustainability and change any negative trends, which could be in urban, environmental, social, or economic terms. Thus, contributing to the well-being of all informal settlements. The role of development policies should not be limited to providing clean water, sanitation, or residences.

Therefore, a basic database must be provided for each informal settlement, updated, and converted into sustainable indicators required to upgrade the area. To assist in

developing a general framework governing the sustainable upgrading of informal settlements based on a complete methodology of field survey of urban, environmental, social, and economic structure data for the area, allowing us to determine the requirements of the area and its residents from a sustainable point of view and provide them.

The assessment matrix is one of the mechanisms for the development of informal settlements in Egypt. It supports applying sustainability, which can measure the extent of urban development plans, upgrading, and rehabilitating informal settlements on sustainable trends. Consequently, evaluating case studies that measure informal settlements' comprehensiveness based on sustainable upgrading standards and keeping pace with future life changes proves the necessity of utilizing the sustainability reference framework to upgrade informal settlements.

This paper proves that informal settlements in Egypt lack general orientation towards sustainable development, precisely, sanitation and waste regulations, which necessitate a thorough investigation to resolve negative consequences and consider visions and future developments.

The use of renewable energy, energy conservation methods and other sustainability principles will help solve frequent electricity shortages in informal settlements in Egypt. Informal settlements in Egypt suffer from a waste problem. By applying sustainability principles, waste can be turned into one of the income sources that will help advance the region.

Users Practice some sustainability applications such as selling cartons and plastics, but there is no waste separation, which makes it difficult for the individuals who work in.

The general reference framework for the urban upgrading method in degraded areas must be defined from a sustainable environmental perspective that is translated into detailed plans and implementation projects commensurate with each degraded area's characteristics, So the reference framework (evaluation tool) aims to provide solutions that provide continuous capabilities after implementing the first stages of solutions and upgrading the region, to activate this, the following must be done:

Setting sustainable standards for preserving the environment in the informal settlements represents an essential step and has priority to complete the development plan and the process of development and upgrading.

The frame of reference for upgrading must be easily implemented.

Flexibility must be taken into account in upgrading plans to ensure they do not conflict with sustainability trends.

Controls must be established for the periodic maintenance of the area to become more sustainable.

Imposing penalties for neglecting or mishandling waste, and it must be recycled.

We are introducing intelligent and sustainable technologies into maintenance, energy saving, water system, and transportation operations.

Using materials with durability standards and the quality

of environmentally friendly building materials in upgrading buildings.

Following the concepts of sustainable development in the informal settlements, upgrading areas must be making sure pedestrian and cycling-friendly areas and public spaces are open to all.

#### AUTHORS CONTRIBUTION

1. Conception or design of the work: *Eman Badawy*
2. Data collection and tools: *Eman Badawy- Nasma Mohamed*
3. Data analysis and interpretation: *Eman Badawy- Nasma Mohamed*
4. Funding acquisition: *Eman Badawy- Nasma Mohamed*
5. Investigation: *Eman Badawy- Nasma Mohamed*
6. Methodology: *Eman Badawy*
7. Project administration: *Eman Badawy*
8. Resources: *Eman Badawy- Nasma Mohamed*
9. Software: no
10. Supervision: *Eman Badawy*
11. Drafting the article: *Eman Badawy- Nasma Mohamed*
12. Critical revision of the article: *Nasma Mohamed*

#### FUNDING STATEMENT:

"NO financial support or the research, authorship and/ or publication of his article"?

#### DECLARATION OF CONFLICTING INTERESTS STATEMENT:

"No potential conflicts of interest concerning research, authorship or publication of his article"

#### REFERENCES

- [1] A. & B. L. M. Sahasranaman, Life Between The City And The Village: Scaling Analysis Of Service Access In Indian Urban Slums., *World Development*, 142, 105435., 2021.
- [2] U. & A. J. . Adrien, Hierarchy Clustering Of Dwellings Inside Informal Settlements Case Study: Biryogo Residential Precinct, Kigali City–Rwanda., *Urban And Regional Planning Review*, 8, 50-72., 2021.
- [3] R. A. A. & E.-D. A. S. Ghanam, "Upgrading Urban Spaces In Slums As A Tool To Achieve Social Sustainability (Making Slums Livable)-The Case Study Of Meit-Elwan Slum-Kafr El Sheikh City-Egypt.," *Mansoura Engineering Journal(Dept. A). Mej.* , 46(2), 2021.
- [4] Aymanel-Hefnawi, " [https://Mirror.Unhabitat.Org/Downloads/Docs/8635\\_42944\\_AymanElHefnawy.Pdf](https://Mirror.Unhabitat.Org/Downloads/Docs/8635_42944_AymanElHefnawy.Pdf) 1," [Online].  
[4] UNICEF. (2013). Informal Settlements Development Facility. *Egypt Multidimensional Child Poverty in Slums and Unplanned Areas in Egypt, UNICEF Egypt and ISDF, Cairo*. Dr. Youssef Diab, Dr. Baher El Shaarawy, and Dr. Salma Yousry, February 2020, Towards Arab Cities without Informal Areas" United Nations Human Settlements Programme (UN-Habitat) Headquarters
- [5] H. A. A.-H. K. S. & H. A. E. . Alana, A Framework For Architects' Role In Attaining Sustainable Community Development In Heritage Areas: Al-Darb Al-Ahmar, Islamic Cairo, Egypt As A Case., *Egypt: Alexandria Engineering Journal*, 58(1), 333-343., (2019).
- [6] J. & C. R. . Bolleter, A Critical Landscape And Urban Design Analysis Of's New Administrative Capital City., *Egypt: Journal Of Landscape Architecture*, 16(1), 8-19., 2021.
- [7] M. a. A. R. Egypt Ministry of Planning, "Sustainable Development Strategy: Egypt vision 2030," *Egypt Ministry of Planning, Monitoring and Administrative Reform, Egypt*, MAY 2016.
- [8] N. El-Megharbel, "Sustainable development strategy: Egypt's vision 2030 and planning reform. the Ministry of Planning, Monitoring and Administrative Reform.," *Integrated Approaches to Sustainable Development Planning and Implementation (New York)-Ma*, 2015.
- [9] M. T. A. K. I. & K. C. French, "Climate Resilience In Urban Informal Settlements: Towards A Transformative Upgrading Agenda. In Climate Resilient Urban Areas," *Palgrave Macmillan, Cham*, pp. Pp. 129-153, 2021.
- [10] & S. A. & L. M. Abdul-Moneim M., "Urban Upgrading To Develop Slums Into A Sustainable Urban Environment (Al-Hawari Case Study)," *The Second Engineering Conference Of The Syndicate Of Engineering Professions In Zawiya*, 2019.
- [11] & H. H. Muhammad A., " Selection Of Urban Sustainability Indicators For Al-Hilla City.," *Journal Of Engineering And Sustainable Development, Volume 20, Issue 3.*, 2016.
- [12] A. & A. M. H. . Abiko, "The Sustainability Guidelines For Slums Upgrading Projects.".
- [13] J. C. I. & Z. A. Montoya, " Indicators for evaluating sustainability in Bogota's informal settlements: Definition and validation.," *Sustainable Cities and Society*, 53, 101896., 2020.
- [14] usgbc, " <https://www.usgbc.org/leed/rating-systems/leed-for-cities>," 2016. [Online].
- [14] Abdel-Moneim, N.M., Khalil, H.A.E.& Kamel, R.R. (2021) Developing QOL Index for Resettlement Projects of Unsafe Areas in Egypt. *Urban Forum*, 32(3), pp. 349-371. <https://doi.org/10.1007/s12132-021-09419-7>
- [15] X. L. Q. K. S. & K. O. I. Xiang, " Urban water resource management for sustainable environment planning using artificial intelligence techniques.," *Environmental Impact Assessment Review*, 86, 106515., 2021.
- [16] LEED, "LEED v4 for NEIGHBORHOOD DEVELOPMEN," 2018.
- [17] S. M. B. C. S. M. X. C. J. M. & G. J. Arden, "Onsite Non-potable Reuse for Large Buildings: Environmental and Economic Suitability as a Function of Building Characteristics and Location.," *Water Research*, 191, 116635., 2021.
- [18] H. E.-M. M. H. O.-R. I. & V. J. Amin-Salem, "Sustainable development goal diagnostics: the case of the Arab Republic of Egypt.," *World Bank Policy Research Working Paper*, (8463)., 2018.
- [19] E. I. & S. A. G. . Unit, " European Green City Index: Assessing the environmental impact of Europe's major cities, 2009.," 2009.
- [20] A. K. Winter, "Review of the European reference framework for sustainable cities.," *International Journal of Community Well-Being*, 1(1), 83-86., 2018.
- [21] H. D. A. E. A. N. P. D. M. T. W. & Q. R. S. Price, "Daily changes in household water access and quality in urban slums undermine global safe water monitoring programmes.," 2021.
- [22] G. M. Elrayies, "Rethinking Slums: An Approach for Slums Development towards Sustainability," *Journal of Sustainable Development*, 9(6), 225, 2016.
- [23] J. & E. Batten, " Sustainable cities index 2016.," *Arcadis Global*, 10, 40., 2016.
- [24] K. S. L. M. J. G.-S. A. G. H. H. J. . & D. M. Dianati, "A system dynamics-based scenario analysis of residential solid waste management in Kisumu, Kenya.," *Science of the Total Environment*, 777, 146200., 2021.
- [25] M. N. I. M. R. & A. S. B. Haque, "Assessing the water supply, sanitation and waste dumping condition of urban slum: a GIS based approach.," *The Jahangirnagar Review, Part II: Social Sciences*, 52, 223-236., 2020.

- [26] A. S. S. M. F. G. & B. D. . Casal-Campos, " Reliable, resilient and sustainable urban drainage systems: an analysis of robustness under deep uncertainty.," *Environmental science & technology*, 52(16), 9008-9021., 2018.
- [27] An EIP Water Action Group of the European Commission, " An EIP Water Action Group of the European Commission, The City Blueprint® Approach- Improving Implementation Capacities of Cities and Regions by sharing best practices on Urban Water Cycle Services. At Website: <https://www.eip-water.eu/sites/default/file>," [Online].
- [28] K. W. J. M. P. L. S. & O. S. Buyana, "City residents, scientists and policy-makers: power in co-producing knowledge.," *Urban Transformations*, 3(1), 1-22., 2021.
- [29] B. D. S. L. F. & C. R. G. G. Azevedo, " Urban solid waste management in developing countries from the sustainable supply chain management perspective: A case study of Brazil's largest slum.," *Journal of cleaner production*, 233, 1377-1386, 2019.
- [30] E. Z. A. & B. E. . Okba, " Sustainable infrastructure assessments in remote areas in Egypt.," *HBRC Journal*, 17(1), 231-253., 2021.
- [31] E. A. L. S. M. Ahmed, "Designing bio-inspired adaptive climatic façades and its effect on daylighting performance of building.," *International Journal of Engineering and Technology (IJET)*, 2020.
- [32] LEED, "LEED, U. 2018. LEED v4 for BUILDING OPERATIONS AND MAINTENANCE Updated," 2018. [Online].
- [33] E. B. Ahmed, "The effect of thermal insulation on building energy efficiency in northern Upper Egypt.," *Int J Innov Res Sci Eng Technol*, 8(6), 6575-6583., 2019.
- [34] A. M. E. M. M. A. & A. E. B. Ismail, "Localized green building standards: the anti-globalization thesis. International Journal of Innovative Research in Science.," *Engineering and Technology*, 4(9), 8024-8032., 2015.
- [35] C. C. E. & A. P. . Planas, "Effects of the type of facade on the energy performance of office buildings representative of the city of Barcelona.," *Ain shams engineering journal*, 9(4), 3325-3334., 2018.
- [36] S. B. P. & W. S. Shamout, " The shift from sustainability to resilience as a driver for policy change: A policy analysis for more resilient and sustainable cities in Jordan.," *Sustainable Production and Consumption*, 25, 285-298., 2021.
- [37] A. V. F. A. B. H. P. & S. M. C. Gabaldón Moreno, " How to Achieve Positive Energy Districts for Sustainable Cities: A Proposed Calculation Methodology.," *Sustainability*, 13(2), 710., 2021.
- [38] K. D. R. & K. R. . Van Dijken, " The reference framework for sustainable cities (RFSC): Testing results and recommendations.," *Nicis Institute: Den Haag, The Netherlands.*, 2012.
- [39] V. S. A. R. T. K. & P. P. D. Gahlot, "Sustainable transportation systems to improve road safety situation.," *Helix*, 10(01), 194-199., 2020.
- [40] T. S. & I. A. H. Mahmood, "Land use of Al-Ramadi City and its Impact on Sustainable Transport Strategies Using (AHP). In IOP Conference Series.," *Materials Science and Engineering (Vol. 737, No. 1, p. 012139)*. IOP Publishing., 2020.
- [41] U. & M. M. S. Illahi, "Sustainable Transportation Attainment Index: multivariate analysis of indicators with an application to selected states and National Capital Territory (NCT) of India. *Environment*.,," *Development and Sustainability*, 23(3), 357, 2021.
- [42] A. K. C. M. S. H. O. P. K. A. & S. G. G. Onac, " Rethinking the campus transportation network in the scope of ecological design principles: case study of Izmir Katip Çelebi University Çiğli Campus.," *Environmental Science and pollution* 1-20, 2021.
- [43] usgbc, "<https://www.usgbc.org/leed/rating-systems/leed-for-cities>," 2018. [Online].
- [44] T. H. a. B. N. R. C. I. c. w. T. E. G. B. Council, "The Green Pyramid Rating System (GPRS), The Arab Republic of Egypt Ministry of Housing.," *Utilities and Urban Development*, First Edition, 2011.
- [45] 1. Aymanel-Hefnawi, [https://Mirror.Unhabitat.Org/Downloads/Docs/8635\\_42944\\_AymanEl-Hefnawy.Pdf](https://Mirror.Unhabitat.Org/Downloads/Docs/8635_42944_AymanEl-Hefnawy.Pdf) 1.
- [46] "7 Aymanel-Hefnawi, [https://Mirror.Unhabitat.Org/Downloads/Docs/8635\\_42944\\_AymanEl-Hefnawy.Pdf](https://Mirror.Unhabitat.Org/Downloads/Docs/8635_42944_AymanEl-Hefnawy.Pdf) 1," [Online].

#### TITLE ARABIC:

نحو إطار مرجعي لاستدامة تطوير المناطق العشوائية

#### ARABIC ABSTRACT:

تعالى المدن المصرية من انتشار المناطق العشوائية التي تشتمل على العديد من المشكلات العمرانية والبيئية. تبذل الحكومة جهداً لترقيتها. وبالتالي، تهدف الورقة إلى إنشاء إطار مرجعي للارتقاء بالمستوطنات العشوائية وإنشاء مجتمعات مستدامة. من خلال اقتراح عناصر لتقييم الاستدامة تساعد على الارتقاء بالمناطق العشوائية وإشراك المستعملين في تحديد أولويات حل المشكلات لتحقيق رؤية مصر 2030. تتمثل إشكالية البحث في غياب الاستدامة في مشاريع التطوير العمراني الحكومية للمناطق العشوائية. تعتمد منهجية البحث على المنهج النظري والتحليلي والتطبيقي. يستعرض النهج النظري تعريف العشوائيات والمستوطنات العشوائية، ويدرس رؤية مصر 2030 والدراسات السابقة حول التنمية المستدامة للمناطق العشوائية لاستنتاج معايير تقييم العشوائيات المستدامة، ثم يستخدم النهج التحليلي لتحليل منطقتين عشوائيتين في مصر هما العلوابة وحكورة بمحافظة الفيوم. ثم يتم تطبيق الإطار المرجعي على هذه المناطق لقياس مدى فعاليتها. خلص البحث إلى أن المناطق العشوائية في مصر تحتاج إلى تطبيق مبادئ الاستدامة لحل مشاكلها، ومن الصعب على سكان المناطق العشوائية دفع تكلفة استخدام الخلايا الشمسية وبعض تطبيقات الاستدامة الأخرى، لذلك يجب على المطورين والحكومة رعاية تنفيذ الاستدامة في المناطق العشوائية. يتبع لمستخدمين بعض تطبيقات الاستدامة مثل بيع النفايات ولكن لا يوجد فصل للنفايات، مما يجعل الأمر صعباً على الأفراد الذين يعملون فيه.