Politecnico di Torino

MSc in Architecture, Construction, City

Master's Degree Thesis

Key Performance Indicators Selection for a Middle East and North Africa Urban Context in the Framework of Sustainability

A Sustainability Measurement Framework For Cairo, Egypt

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CONTENT

Abstract

One of the key concerns characterizing today's human-environment relationship is urbanization. The fundamental problem for today's cities is to manage their reliance on ecosystem services, which results in the depletion of natural resources and biodiversity, as well as efforts to mitigate and adapt to climate change while prioritizing public health and quality of life. Sustainability, according to experts, is determined by social, economic, environmental, and governance issues. Using appropriate sustainability indicators. There is a common lack of knowledge of contextual meaning and how socioeconomic groups and countries differ. The purpose of this thesis is to address this issue by creating a framework for measuring sustainability in Cairo, Egypt, as the first step toward establishing an assessment system for the city's progress toward sustainability.

The methodology for constructing the framework begins with a comparison of existing internationally recognized assessment tools LEED for Neighborhood Development and CESBA MED, followed by a process of filtering the generated indicators using the Sustainable Development Goal 11 as a criterion for focusing the result framework on specific targets in connection to the demands of the social housing sector; and finally, a contextualization of the framework supported by The Green Pyramid Rating System (GPRS).

The methodology provided a framework consisting of a number of indicators to quantify sustainability in relation to SDG 11. The scope of the analysis is focused to measuring movements at an urban scale, which is the ideal scale for applying an evaluation framework and modifying urbanistic legislation and policies.

Keywords: Indicators, Sustainability, SDG 11, Assessment tools, Social housing, Urban.

1. Introduction

1.1 Problem statement

The total number of disasters has nearly doubled around the globe since the 1980s. Meanwhile, the average number of natural disasters in the Middle East and North Africa (MENA) has nearly tripled during the same time period.

Rabid urbanization in the Arab world exposes people and economic assets to severe disasters. Cities in the Arab world are vulnerable because they are not prepared for a disaster and may cause economic and financial losses due to inadequate coping and adapting capacities. So far, land use and urban planning policies in the MENA area have mostly neglected basic climate change adaptation demands. Climate change impacts, such as sea level rise, increasing intensity and frequency of hot days, and storm surges, are directly threatening an estimated 75% of the region's buildings and infrastructure. Transportation systems, power plants, water supply and waste-water networks will all be effected. Climate change adaptation strategies for infrastructure and buildings are critically needed, the sustainable development will remain poor unless capabilities are developed.

It is evident that governments play a critical role in urban development, and government actions will, to a considerable extent, decide whether SDG 11 'Make cities and human settlements inclusive, safe, resilient, and sustainable' and its aims are met.

Housing is crucial for achieving SDG 11, and one of the fundamental urban development challenges identified in Egypt's Sustainable Development Strategy: Egypt's Vision 2030' is a shortage of affordable quality housing support.

1.2 Research objective

To enable city planners, managers, and policymakers to assess the socioeconomic and environmental impact of urban sustainability concerns the use of indicators is needed. "Indicators are selected to provide information about the functioning of a specific system, for a specific purpose — to support decision-making and management. An indicator quantifies and aggregates data that can be measured and monitored to determine whether change is taking place. But in order to understand the process of change, the indicator needs to help decision-makers understand why change is taking place." (Indicators – what are they? FAO, 2002). They enable the diagnosis of problems and pressures, and therefore the identification of regions that would improve from good governance and science-based solutions.

As a result of what has been stated above, to overcome the previously addressed challenges in the Arab world, we must identify a set of Key Performance Indicators to evaluate the sustainability of social housing projects in Cairo within the framework of SDG11 "Make cities and human settlements inclusive, safe, resilient, and sustainable, "which is the objective of this research.

1.3 Research questions

Given the research's objective and the resources accessible in Cairo within its context, the thesis raises three questions that will be discussed in the results:

- Based on the existing and approved evaluation methods, what is the first step towards sustainable development in Cairo, Egypt?

- How can sustainability measurement be included into existing policies, developments, and projects?

- In the pursuit of sustainable development, which criteria and planning methods in urban development may be employed to establish integration across all scales?

To structure the research questions, we started with the analysis of the background where the problem is placed. Which is the Middle East and North Africa region.

2. Literature review

2.1 The sustainable development state of art in MENA region

Sustainable development has been described and defined as a basic strategy framework for dealing with risks to human well-being and communities.

In MENA, progress has been made in reducing extreme poverty (SDG 1) and encouraging affordable and clean energy (SDG 7). Energy security has improved in numerous sub-regions as a result of increased energy efficiency and renewable energy diversifying the energy mix. Affordable and environmentally friendly solutions have been created to improve rural and underserved people' access to modern energy services. These modernized services also support the reduction of poverty (UN 2018, Saab and Sadik 2016). However, the overall objective for education (SDG 4) is far from being met, in Northern Africa and Western Asia, participation in preschools and primary school was just 52% in 2016. In comparison, the region remains below the global average of 70% in 2016. Figure (1) illustrates an overview of SDGs.

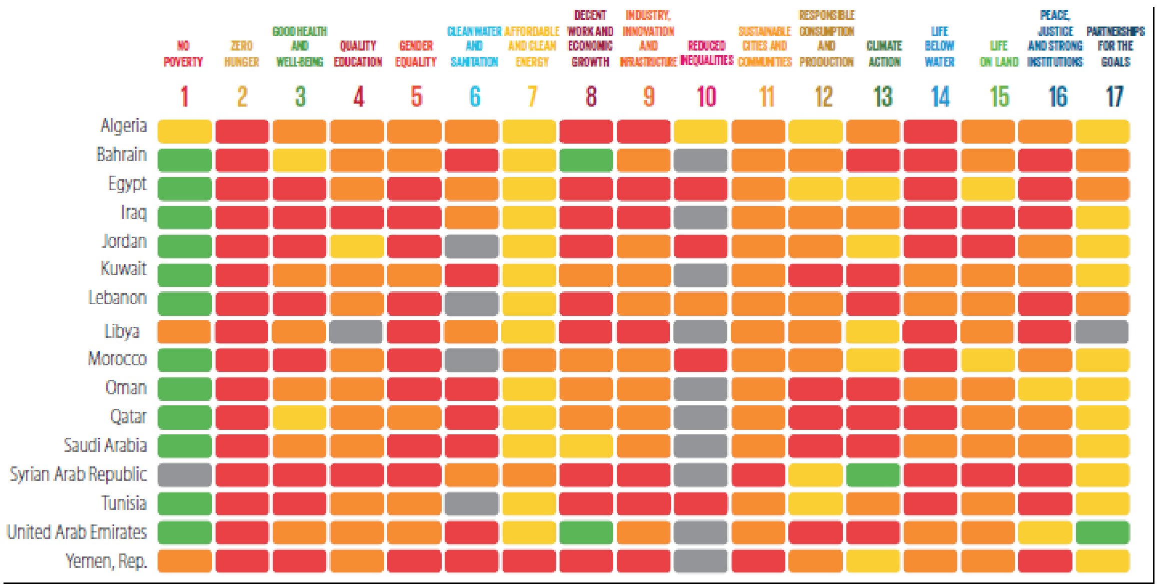

Figure 1. Note: A green rating on the SDG Dashboard shows SDG achievement and is provided to a country only if all of the indicators under the target are rated green. Yellow, orange, and red represent increasing distances from SDG achievement. Source: Sachs et al. (2018: 26).

However, the most problematic challenges for several MENA countries are the targets to eliminate undernourishment (SDG 2), as the Arab region has a growing undernourished population, and to ensure access to safe drinking water (SDG 6). In terms of environmental targets, most countries in the region have deteriorated, including SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). Some of the most advanced countries have considerable spill-over effects, such as increased resource use, which reduces their overall performance. Other shortcomings include gender equality (SDG 5) and wealth disparity (SDG 10).

Regarding trends for sustainable cities (SDG 11), it must be stated that the MENA region showed an increase between 2000 and 2014 from 46 to 61 million people living in slums. The mean level of air pollution (target in SDG 11) was in 2016 more than five times the guideline value defined by the World Health Organization. This means that nine out of ten people living in urban areas lacked clean air.

MENA is not a unified region, each Arab country's economic, political, social, cultural, and natural conditions are different and must be evaluated separately. These distinguishing conditions are also the source of various requirements and, as a result, disparate strategies for attaining sustainable development. As countries in other areas of the world have demonstrated the SDGs can only be implemented successfully if the local context and individual situations are carefully recognized. Despite their differences, all countries face similar issues. The MENA region and its societies must deal not only with the previously stated multiple crises, but also with a young population suffering from high rates of unemployment, inadequate research and development capabilities, a lack of public participation in development decision-making, and insufficient institutional and policymaking capacities. All of these difficulties are considerably greater for women. If the SDGs are to be met, their implementation must be related to "effective participation of non-state sectors, job creation, home-grown science, data collection and monitoring capabilities, and institutional and public policy capacity building" (Saab and Sadik 2016: 6). In Egypt, for example, agriculture is a significant economic sector that employs 55 percent of the population. It employs 30% of the working force, generates 20% of exports and foreign exchange revenues, and accounts for almost 14% of GDP. The Egyptian government implemented a multi - dimensional strategy to improve socioeconomic development, employing a policy mix that includes increased employment opportunities as a result of prioritizing economic growth, improved land and water use, increased yields, income, and food security as a result of efficiency improvements, and more participatory governance.

2.2 Social housing policies in Egypt

One basic urban development concern identified in Egypt's Sustainable Development Strategy (Egypt's Vision 2030) is a lack of public housing support for lower-income populations. To tackle this, the Sustainable Development Strategy specifies two goals for housing policy: "change the institutional framework in the housing sector" and "build a new generation of new cities on the new national roadways." (Arab Republic of Egypt, 2015).

The case study was chosen with the intention of building a system that may help enhance sustainable development in communities in the Middle East and North Africa, inspired by the implementation of the UN's Sustainable Development Goals.

Globally, urban sustainable development has risen to the top of policy discussions as countries try to maintain or boost economic growth without affecting the future. Nowhere is the problem more severe than in Egypt, where metropolitan areas and economy are set to expand dramatically in the coming decades.

Cairo is Egypt's capital and one of Africa's largest cities. Cairo has stood on the banks of the Nile for over 1,000 years, mainly on the eastern coast, some 500 miles (800 km) downstream from the Aswan High Dam. Cairo, located in the country's northeast, is the gateway to the Nile delta, where the lower Nile divides into the Rosetta and Damietta branches. It is surrounded by eight new cities (satellite and towns), New Cairo and the other new urban settlements to the east, in addition to the sixth. October City and its environs to the west (New Towns include New Cairo, Shorouk, 10th Ramadan, El Obour, Badr, 15th May, 6th. October, and El- Sheikh Zayed.). The main goal of the new cities along the GCR is to deflect population expansion away from fertile land and into the deserts to the east and south-west. The first generation of these towns was viewed as economically independent new towns that struggled to recruit citizens. The following wave was based on creating new satellites that were closer to the urbanized area, and it began attracting residents when the settlements were replaced by the private sector that will create higher suburban communities with better services for low-income populations. This transition occurred at El-Sheik-Zayed, New Cairo, Shorouk, and a portion of 6th October city (GOPP, UNDP, 2008).

On a local community level, one of Cairo's six key axis is housing and informal settlement, and it states the principles of adequacy in urban housing and slum

upgrading. Vision 2050 proposes the movement or 'decentralization' of households from central Cairo to the suburbs. The establishment of social housing units within these new urban developments may threaten the requirement for appropriate housing, which requires housing to be located near public transportation, services and employment opportunities. The proposal aims to offer 2.5 million households with international-standard services and transportation by 2050. (Arab Republic of Egypt, 2011).

Rent control was the first social housing intervention in Egypt in the early 1940s, and it has stayed in effect for decades. In addition to rent control legislation, Egypt has established a number of housing-development schemes for low-income families. The state's provision of housing units peaked during President Nasser's era, in keeping with the state's important role, although the policy has shifted significantly in recent years.

Egypt's National Housing Project (NHP) aimed to create 500,000 units between 2005 and 2011. The NHP relied on the private sector and resident self-construction for 95,000 and 100,000 units, respectively. With only 360,000 units completed, the NHP fell short of the 500,000 units committed. Around 50,000 of these 360,000 units lack basic services and are underutilized. Following the completion of the National Housing Project in 2011, the Social Housing Project was launched in 2012, with the goal of constructing 200,000 homes per year for low-income Egyptians by 2017. While intended for low-income households, the cost of a social housing project unit places was out of reach for the 20% of Egyptians who cannot afford it.

It should be noted that social housing units are 270 % more expensive than normal National housing project units, making the new system even more unaffordable for low-income people. Furthermore, the requirement to show one's income excludes the vast majority of Egypt's labor, who work in the informal sector. These two reasons weaken the Social housing project's effort to provide appropriate housing for low-income Egyptians, and hence the housing units in the program benefit middle-income households rather than low-income households. Behind this fact is the SHP's failure to meet its construction targets. The presence of informal housing in Egypt is a result of insufficient housing regulations that created market distortions and failed to develop enough units to meet the demand for low-income housing.

3. Methodology

As stated previously, the methodology's objective is to establish a framework for assessing sustainability while keeping the context in consideration. The solution to the need for developing a framework for measuring sustainability needs to be precise and simple to implement. Following that, the existing frameworks chosen to establish the process for creating a new one are detailed in further detail to provide a better understanding of the logic behind the proposed approach.

3.1 Theoretical approach

Policymakers and city administrators are now confronted with a variety of sustainability indicator frameworks. These differ in their essential goal, approach to monitoring sustainability, scale, and, of course, indicator selection. The common ground is that all of these frameworks strive to enhance sustainable urban development by consolidating disparate data into focused and practical knowledge (Hiremath et al., 2013). Indicator frameworks accomplish this by minimizing the amount of data required to depict urban sustainability and allowing for the transmission of that information to a wide range of audiences (Keirstead, 2007).

So, how do you choose amongst these frameworks? Understanding the many objectives for which indicators might be utilized is perhaps the most useful place to start. They can be used in three ways fundamentally: as explanation tools, pilot tools, or performance assessment tools (Shen et al., 2011). Performance assessment is often recognized as the most critical aspect for sustainability indicators (Hiremath et al., 2013).

Choosing an indicator framework entails deciding which categories are most relevant for monitoring progress toward sustainable development. There is some agreement that the four components of sustainable development, are environmental, economic, social, and governance (Hiremath et al., 2013). Some scholars claim that the EU indicator systems place little emphasis on the social and governance aspects of sustainable development (Adelle & Pallemaerts, 2009), while others claim that social and economic issues are under-represented (Lynch et al., 2011). Almost all indicator sets prioritize the environmental aspect of sustainability, often at the cost of other categories (Shen et al., 2011). Most indicator sets, in general, and most critically, do not capture how the sustainability pillars are linked (Adinyira, Oteng-seifah & Adjei-kumi, 2007).

Standardization and data availability are two less essential considerations to consider while selecting an indicator collection. Because one of the primary reasons for utilizing sustainability indicators is to analyze performance, it is critical to be able to compare performance across similar urban regions. Indicator sets can be validated and improved in this manner, revealing light on complicated and abstract policy concerns (Yigitcanlar & Lnnqvist, 2013).

Standardization also benefits collaboration and knowledge sharing inside and between local governments (Moreno Pires, Fidélis, & Ramos, 2014).

Another key factor to consider when choosing an indicator system is data availability. These frameworks are created by a variety of organizations and individuals, including government agencies, non-governmental organizations, and universities (Sébastien & Bauler, 2013).

Nations have created indicators based on their local or national interests (Shen et al., 2011). While urban sustainability performance is monitored globally, no single set of indicators can be applied for all urban regions (Shen et al., 2011). Common measures are required for comparing and ranking cities and countries. It is critical to remember that sustainability indicators are really a means to an end, not the end aim in and of themselves.

The indicator framework selected must reflect the geographical and socioeconomic environment of the urban area under consideration (Moreno Pires, Fidélis, & Ramos, 2014; Hiremath et al., 2013).

As a result, in developing countries, the implementation of sustainability assessment methodologies should be accompanied by the identification of local urban challenges that differ from those in developed regions. This is especially critical for densely populated cities dealing with increasing urban challenges now and in the future. Therefore, there is an urgent need to create an effective and locally applicable paradigm for assessing urban sustainability.

Unfortunately, indicators are typically intended for use after a project has been completed, despite the fact that they can be employed during the design process (Wedding and Crawford-Brown, 2007).

At the building scale, different sustainability rating systems (e.g., BREEAM, CASBEE, Green Star, LEED, ITACA) have been established to aid in the process of lowering energy use and environmental impacts during the construction, management, and operational phases. Different performance indicators are included in the systems, which are used as metrics to determine how well the sustainability goals have been accomplished, to ease decision making, to analyze specific project requirements, or to assure compliance with legislation and norms.

Several urban-scale systems have been developed, including BREEAM Communities, CASBEE for Urban Development, LEED for Neighborhoods, and Protocollo ITACA Urban Scale. The fundamental components of sustainable cities cover equivalent performance indicators as building scale, but include additional categories such as urban transportation, supply and distribution networks, social issues, and so forth.

CESBA- MED is an initial concept of the evaluation method and tool, which was originally designed for the building size and then extended to the urban scale. Six national versions of the tools have been produced and are available in a variety of languages; they are contextualized to national (local) priorities and have been successfully tested in pilot projects in Croatia, France, Greece, Italy, Malta, and Spain.

The initial stage in developing this strategy was to analyze 14 transnational European projects and public assessment systems to generate a representative list of indicators at the building and urban scale that address the fundamental sustainability pillars. During the subsequent work, a total of 216 indicators at the building and urban scale were discovered and considered for organizing the various performance indicators under the primary sustainability challenges. The method's overall structure is divided into Issues, Categories, and Criteria-Indicators.

The "Issues" section identifies the broad issues that are critical for assessing sustainability at the building and neighborhood levels. "Categories" define certain features of an Issue by grouping relevant criteria and indicators. From the beginning of the assessment process, the "Criteria" explain the specific aspects of a category and comprise the key assessment entries used to characterize a structure or an urban area. The

"Indicators" quantify performance against each criterion. In theory, numerous indicators can be associated with the same criterion because multiple methodologies can be defined to quantify the performance of a building or urban area in relation to a certain criterion. A limited number of key performance indicators (KPIs) were selected from the various indicators as mandatory minimum requirements in order to be able to address the main sustainability issues. See figure (2).

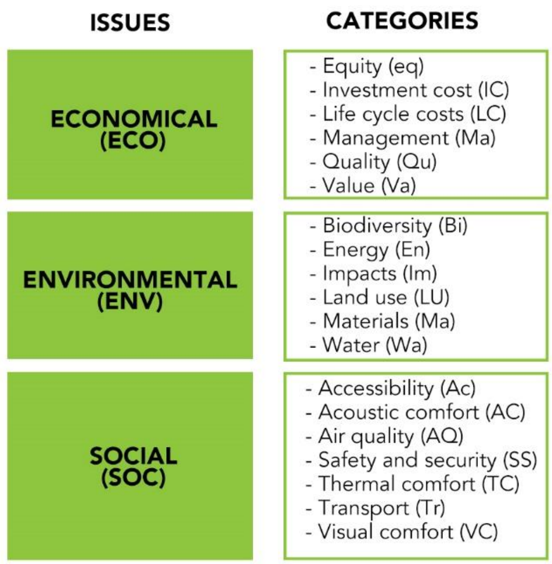

Figure2. Issues and corresponding Categories (listed in alphabetical order) of indicators.

In order to achieve a broader general agreement, the work progress on the performance indicators and proposed KPIs was also reviewed and elaborated with other European experts and project representatives during working sessions at two sprint workshops organized by CESBA (Common European Sustainable Built Environment Assessment in Bezau, Austria (September, 2017) and Gozo, Malta (October, 2017). (November, 2018). Following nine national pilot tests conducted by partners in seven European nations, the final list of KPIs for building and neighborhood scale was determined. Some KPIs were removed owing to a lack of available data. Following a similar approach ITACA, each indicator value is rescaled in an interval from -1 (performance below standard) to +5 (advanced performance).

The United States Green Building Council created LEED as a framework for identifying, implementing, and measuring green building and neighborhood design, construction, operations, and maintenance. LEED is a voluntary market-driven, consensus-based instrument that serves as a guideline and assessment system. LEED grading systems are applicable to commercial, institutional, and residential structures, as well as community developments.

LEED for Neighborhood Development (LEED ND) was designed to inspire and assist in the creation of better, more sustainable, well-connected communities. It considers entire communities rather than just buildings.

The LEED-ND grading system is made up of 56 prerequisites and credits divided into three categories: smart location and linkage (SLL), neighborhood pattern and design, and green infrastructure and buildings. Two additional categories address the innovation and design process, as well as regional priorities.

LEED strives to maximize the use of natural resources, encourage regenerative and restorative solutions to reduce the negative effects of the construction industry on the environment and human health, and to create high-quality indoor environments for building occupants. LEED has set seven goals to achieve the goal: to reverse the contribution to global climate change; to improve individual human health and wellbeing; to safeguard and restore water resources; and to protect the environment. to encourage material resource cycles that are sustainable and regenerative; to create a greener economy; and to improve social fairness, environmental justice, community health, and quality of life. See figure (3).

LEED FOR NEGHBOURHOOD DEVELOPMENT'S CRITERIA	CREDITS
01. Smart Location and Linkage	28
02. Neighborhood Pattern & Design	41
03 Green Infrastructure & Buildings	31
04 Innovation & Design Process	6
05 Regional Priority Credits	4

Figure 4. Table of LEED for Neighborhood development's categories.

LEED-ND also encourages affordable housing in a variety of ways (Chen, 2012), while Garde (2009) found it "alarming" that projects might be certified without being obligated to provide affordable housing (which is a voluntary measure under the current system). The United States Department of Housing and Urban Development (HUD) now requires applicants for its Choice Neighborhoods Planning Grants to have a community plan conditionally approved by LEED-ND. LEED-ND points can be gained for mixed-income housing, closeness to employers, schools, and local food, all of which can help with affordability by lowering commute expenses.

The use of LEED-ND to map development suitability for a whole region is uncommon, but has been attempted on a broad scale in a few cases. These have frequently been in combination with sustainability programs, such as Minneapolis' regional planning endeavor (Slotterback, 2011). Other instances are King County, Washington, and Grand Rapids, Michigan (Woycke, 2011). (Lazar & Murtha, 2009). LEED-ND has also been utilized in scientific applications, such as identifying walkable urban neighborhoods, which are subsequently used to examine additional consequences such as physical activities (e.g., Stevens &Brown, 2011).

International efforts have been made to unify and exchange urban evaluation techniques (Shen, Ochoa, Shah, & Zhang, 2011). Japan's Comprehensive Assessment System for Building and Environmental Efficiency (CASBEE) for Urban Development and the United Kingdom's Building Research Establishment Environmental Assessment Method (BREEAM) Communities are both relevant at the neighborhood scale (see Haapio, 2012). However, there is some doubt that evaluation criteria can be considered universally relevant (Säynäjoki, Kyrö, Heinonen, & Junnila, 2012). Although the USGBC offers LEED-ND certification outside of the United States, others contend that it is primarily applicable in the United States (Haapio, 2012).

The European Union played a key role in establishing the global 2030 Agenda and is a leader in the long-term implementation of the SDGs, which are improved by EU policies and incorporated into all of the Commission's priorities.

The Sustainable Development Goals of the United Governments are an update to the expiring Development Millennium Goals, which were a compromise reached by various nations to combat extreme poverty, hunger, and illiteracy through 2015. In 2016, the 2030 Agenda, often known as the Sustainable Development Goals, was launched. The agenda calls on countries to meet 17 long-term development goals during the next 15 years. The goals aim to eradicate global poverty and inequality while also promoting economic growth and combating climate change. The SDGs are offered as a roadmap for countries to adopt policies in order to align with global commitments, but it is ultimately up to each government to develop plans, policies, and programs. see figure (4).

Figure 5. The United Nations' Sustainable Development Goals.

SDGs cannot be fulfilled through intergovernmental institutions alone; instead, new agents such as business, cities, and civil society must be activated. Concluding that SGD may be used to guide governments into a vision that promotes sustainable development, and that it can be used to implement successful policies that constitute a competitive advantage in working towards sustainable development.

Depending on why a location determines the need to evaluate and assess its sustainability, it is critical to select a method capable of assessing relevant factors for the context; this is why an Egyptian framework has been designed.

As part of the Ministry of Housing, Utilities, and Urban Development's general sustainable development program, the Egyptian government was interested in fostering green building. In early 2009. The Housing and Building National Research Center established The Egyptian Green Building Council (GBC-Egypt) in accordance with the policies of the Ministry of Housing, Utilities, and Urban Development to meet the demand for a standardized system for rating building green credentials.

The Green Pyramid Rating System's First Edition was released in April 2011. It is based on revisions to a draft document created in May 2010, and it, like any legislation, evolves over time. Given the urgency of the difficulties, as well as the rapid development of the tools available to Egypt to tackle them.

The Pyramids are regarded as the most appropriate symbol of green building because they involve a sustainable structural system that has required little or no maintenance; they are built with natural materials; they rely on natural ventilation and light; and they are in harmony with their surroundings.

The objectives of the Green Pyramid Rating System are to develop rating criteria that reinforce and improve National standard regulations, to promote a rating system that is understandable, achievable, and challenging, to raise awareness of resource scarcity and ways to mitigate demand for these resources, and to achieve best environmental practice in the design, construction, and use of buildings.

The Green Pyramid Rating System is intended for use in new construction projects. The Rating can be used to evaluate specific new buildings during the design and Post construction stages. The system consists of seven rating Categories, each of which has sub-categories.as illustrated in figure (5).

To gain Green Pyramid certification, a project must meet all of the aforementioned Mandatory Minimum Requirements and may receive Credit Points if certain conditions are met. Projects will be rated depending on the number of Credit Points earned using the following scoring system:

40-49 credits for GPRS certification
60-79 credits for the Gold Pyramid
Green Pyramid: 80 credits or higher
50-59 credits for the Silver Pyramid

The Green Pyramid Rating System Categories	Weight
1. Sustainable Site, Accessibility and Ecology	**15%**
2. Energy Efficiency	**25%**
3. Water Efficiency	**30%**
4. Materials and Resources	**10%**
5. Indoor Environmental Quality	**10%**
6. Management	**10%**
7. Innovation and Added Value	**Bonus**

Figure 5. Table of Green Pyramid Rating System categories.

However, the indicators, in general play an important role in identifying the problems that pose a higher challenge in achieving sustainability. They do not assist in identifying specific problems within the topics or in generating answers. The indicators' role is also to aid in the evaluation of the city's progress when implementing sustainability policies.

3.2 Methodology development

The proposed methodological approach consists of three analytical phases followed by consulting the opinion of experts regarding the final recommended index in order to validate the study and analysis in order to achieve the aim of this research. The final outcome will be an index of indicators grouped into categories and criteria that will serve as a contribution to the GPRS assessment tool. The fundamental concept is to use existing international sustainability measurement frameworks as a starting point to develop one that may be adapted to the context of Cairo, Egypt the case under research, given that no progress has been made in directing urban and social housing developments toward sustainability outside of its environmental dimension.

The following are the methodology's general steps:

Step 1. Compare sustainability assessment approaches (LEED & CESBA- MED).

Step 2. Choose indicators that are focused on SDG 11 “Make cities and human settlements inclusive, safe, resilient and sustainable”.

Step 3. Compare indicators to GPRS Egyptian methodology and establish the suggested index's categories and indicators.

Results: Establish the Proposal index in the Egyptian environment, as well as urban development initiatives and evaluation.

Future development: Request opinions from expertise on the relevance of the proposed indicators and the best tool to use to put the prepared framework into action. See figure 6.

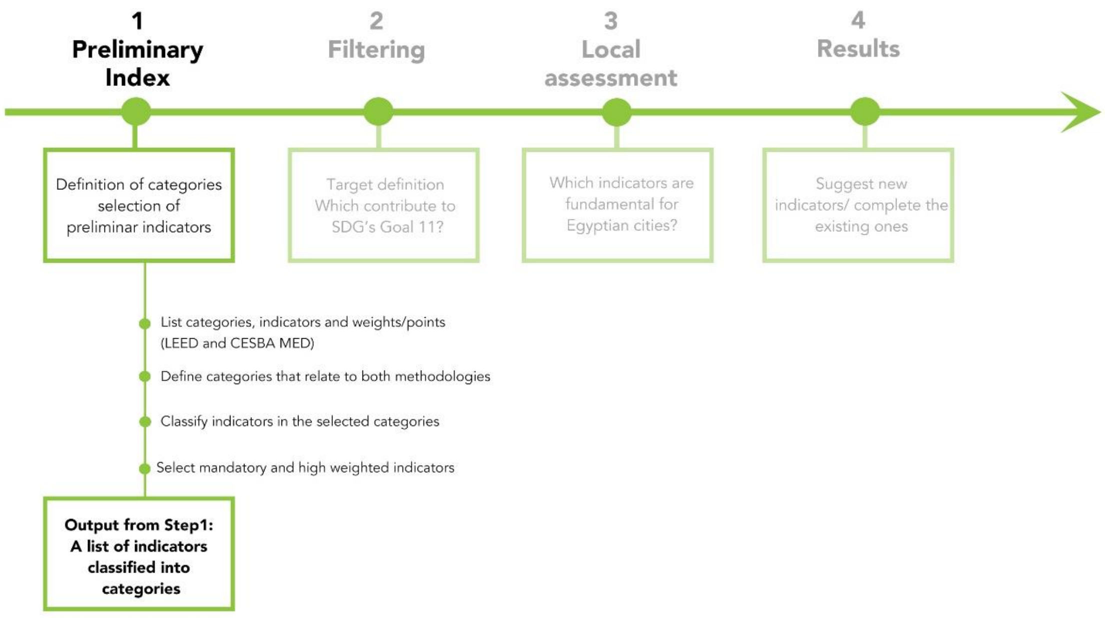

Figure 6. Scheme of General steps and specification of the procedure done in step 1 of the development of the methodology.

The comparison is performed at the neighborhood/urban level since the objective is to analyze the development of the city's social housing developments toward sustainability. The indicators are classified into three categories that correlate to the three sustainability pillars: environmental, economic, and social.

As noted previously, the frameworks chosen were LEED for Neighborhood Development and CESBA-MED, as they are two of the recognized and developed tools for sustainability measurement. and also considering the scale of evaluation, it is critical to comprehend the reasons behind the development of a sustainability evaluation method, especially given that it is a new concept that has yet to be objectively defined, yet it is more practical to adapt current methodologies.

According to Verma and Raghubanshi (2018), indicators are a tool to measure progress toward achieving a goal, in this case defining targets for sustainability, and help to inform the authorities that create policies to get a more real overview of the current state of the place, orient development using the advantages that a place can provide, and identify weaknesses.

The comparison is made by listing each indicator in both methodologies, taking into account that each methodology has a different classification for the indicators.

To accomplish an objective comparison, it was critical to find a categorization that could respond to the criteria and indicators from both approaches in order to avoid confusing what each methodology identifies differently.

Indicators from one approach can replace several from another, grouping them into one indicator can help to limit the list as much as practical. One method for limiting the number of indicators is the scale for which they were designed, which is for both cases neighborhood/urban small developments, because the resulting framework is to be implemented on a city scale.

Nevertheless, several indicators designed on a smaller scale have coherence and can be developed on a bigger scale, such as energy strategy, land use, and public space access. The criteria recommended by these indicators can be applied to the urban scale because the strategies for their development are similar; what differs in this case are the parameters of evaluation and benchmarks, which will be modified and taken further into the development of the methodology by measurements used in cities.

LEED For Neigborhood Level

01. Smart Location and Linkage	28
Sub- indicators	**Credits**
Smart Location	Required
Imperiled Species and Ecological Communities	Required
WetlandS and Water Body Conservation	Required
Agricultural Land Conservation	Required
Floodplain Avoidance	Required
Preferred Locations	10
Brownfield Remediation	2
Access to Quality Transit	7
Bicycle Facilities	2
Housing and Jobs Proximity	3
Steep Slope Protection	1
Site Design for Habitat or Wetland and Water Body Conservation	1
Restoration of Habitat or Wetlands and Water Bodies	1
Long-Term Conservation Management of Habitat or Wetlands and Water Bodies	1
02. Neighborhood Pattern & Design	**41**
Sub- indicators	**Credits**
Walkable Streets	Required
Compact Development	Required
Connected and Open Community	Required
Walkable Streets	9
Compact Development	6
Mixed-Use Neighborhoods	4
Mixed-Use Neighborhoods	7
Reduced Parking Footprint	1
Connected and Open Community	2
Transit Facilities	1
Transportation Demand Management	2
Access to Civic & Public Space	1
Access to Recreation Facilities	1
Visitability and Universal Design	1
Community Outreach and Involvement	2
Local Food Production	1
Tree-Lined and Shaded Streetscapes	2
Neighborhood Schools	1
03 Green Infrastructure & Buildings	**31**
Sub- indicators	**Credits**
Certified Green Building	Required
Minimum Building Energy Performance	Required
Indoor Water Use Reduction	Required
Construction Activity Pollution Prevention	Required
Certified Green Buildings	5
Optimize Building Energy Performance	2
Indoor Water Use Reduction	1
Outdoor Water Use Reduction	2
Building Reuse	1
Historic Resource Preservation and Adaptive Reuse	2
Minimized Site Disturbance	1
Rainwater Management	4
Heat Island Reduction	1
Solar Orientation	1
Renewable Energy Production	3
District Heating and Cooling	2
Infrastructure Energy Efficiency	1
Wastewater Management	2
Recycled and Reused Infrastructure	1
Solid Waste Management	1
Light Pollution Reduction	1
04 Innovation & Design Process	**6**
Sub- indicators	**Credits**
Innovation	5
LEED® Accredited Professional	1
05 Regional Priority Credits	**4**
Sub- indicators	**Credits**
Regional Priority Credit: Region Defined	1
Regional Priority Credit: Region Defined	1
Regional Priority Credit: Region Defined	1
Regional Priority Credit: Region Defined	1
Project Totals (Certification estimates)	**110**

Certified: 40-49 points, Silver: 50-59 points, Gold: 60-79 points, Platinum: 80+ points

Table 1. List of indicators from LEED for ND.
Source: Reference guide for LEED v4 for Neighborhood development.

ECONOMIC (ECO) ISSUE						
Category	Criterion	Indicator (units)		Building (B) and Neighbourhood (N) scale		
				B	N	B&N
Equity	Housing value	1	Affordability of housing property (m^2)		◆	
		2	Affordability of housing rental (%)		◆	
	Local economy	3	Support to local economy (%)		◆	
	Prevention of prejudice	4	Prevention of prejudice		◆	
	Social & Economic cohesion	5	Future evolution and modularity		◆	
		6	Gentrification index (-)		◆	
		7	Labor force participation (%)		◆	
		8	Potential Employment (%)		◆	
		9	Social housing ratio (%)		◆	
		10	Social mixing and solidarity based economy		◆	
		11	Unemployment rate (%)		◆	
Investment Costs	Capital cost	1	Additional costs for energy efficiency and sustainability (€)			◆
		2	Investment costs (€/m^2)			◆
		3	Investment costs aggregated (€)		◆	
		4	Participation of local authority in the total investment cost (%)		◆	
	Performance	5	Return on investment (%)			◆
Life cycle Costs	Benchmarking & Targeting	1	Verifiable sustainable targets			◆
	Cost benefit	2	Cost benefit analysis focused on sustainability			◆
	Energy cost	3	Operational energy costs (€/m^2)			◆
		4	Operational energy costs aggregated (€)			◆
	Non- Energy cost	5	Operational non-energy costs aggregated (€)		◆	
	Total cost	6	Cost in operational phase (€)			◆
		7	Life cycle costs (-)	◆		
		8	(€)			
		9	Life cycle costs aggregated (€)		◆	
Management	Building operation	1	Communication and information management (%)			◆
		2	Information and participation of users			◆
		3	Synergy management (-)		◆	
		4	User information (-)	◆		
	Social & Economic cohesion	5	Environmental activities in primary school (%)		◆	
Quality	Architectural	1	Aesthetic quality (-)		◆	
		2	Enhance architectural, cultural and landscape patrimony (yes/no)		◆	
	Benchmarking & Targeting	3	Setting verifiable environmental targets (-)	◆		
	Building energy performance	4	Energy optimization during planning (-)	◆		
	Cultural heritage	5	Monument or monumental value / Historical value (-)			◆
	Process & Planning	6	Building works quality control	◆		
		7	Community management (yes/no)		◆	
		8	Community planning (yes/no)		◆	
		9	Finalising the design phase (yes/no)		◆	
		10	Integrated design in the planning process (-)		◆	
		11	Plus 6 (+6) project management (yes/no)		◆	
		12	Process and planning quality (-)			◆
		13	Project management (yes/no)		◆	
		14	Working with skilled professionals (yes/no)		◆	
	Risk management	15	Long term stability of value (€)			◆
		16	Risk management (-)		◆	
	Territorial management & Urban design	17	Urban complexity, Shannon-Wiener index (-)		◆	
Value	Flexibility & Adaptability	1	Flexibility and adaptability, during the life of the project (yes/no)		◆	
		2	Flexibility and adaptability, programming (yes/no)		◆	
	Process & Planning	3	Assessing the current situation (yes/no)		◆	
		4	Competent professional team		◆	
		5	Economic advantage of cluster in comparison to single buildings (-)		◆	
		6	Equipment and services pooling		◆	
	Social & Economic cohesion	7	Tourist frequency trends, seasonality overnight stays (%)		◆	
		8	Tourist frequency trends, seasonality tourists (%)		◆	

Table 2. List of Transnational Economic Indicators and Assessment Methods for Buildings and Urban areas Version 1.5 from CESBA MED. Source: Reference guide FINAL- V1.5 2017.

ENVIRONMENTAL (ENV) ISSUE						
Category	Criterion	Indicator (units)		Building (B) and Neighbourhood (N) scale		
				B	N	B&N
Biodiversity	Building site	1	Ecological quality of the building site (-)	◆		
	Land preservation	2	During programming, design and before the beginning of the works; the land is maintained through mowings, prunings, maintenance of canals and hedges (yes/no)		◆	
	Public spaces	3	Change in ecological value of the site, species(-)			◆
		4	Connectivity of green spaces (%)		◆	
		5	Diversity (yes/no)		◆	
		6	Ecological corridors and continuity (yes/no)		◆	
		7	Use of local plants (%)		◆	
		8	Vegetal areas (%)		◆	
Energy	Building vertical transportation	1	Escalators and moving walks design and efficiency (-)	◆		
		2	Lift design and efficiency (-)	◆		
		3	Stairs and ramps planning (-)	◆		
	Embodied energy	4	Embodied energy demand (kWh/m^2)	◆		
	Final energy	5	Annual heat generation for space heating and			◆
		6	Cooling demand (kWh/m^2)	◆		
		7	Delivered energy demand (kWh/m^2)			◆
		8	Energy consumption (Toe/inhabitant)		◆	
		9	Heating demand (kWh/m^2)	◆		
		10	Peak energy demand			◆
	Primary energy	11	Abiotic Depletion Potential (kWh/m^2)	◆		
		12	Consumption of non-renewable primary energy			◆
		13	Operational primary energy (kWh/m^2)			◆
		14	Primary energy for cooling (%)		◆	
		15	Primary energy for heating (%)		◆	
		16	Primary energy for public lighting (%)		◆	
		17	(kWh/yr)		◆	
		18	Total primary energy demand (kWh/m^2)			◆
	Renewables	19	Renewable electricity production (%)		◆	
		20	Renewable energy on site (%)			◆
		21	Share of renewable primary energy in total primary energy demand (kWh/m^2)			
		22	PV-power plant (kWh/a)			
	Virtual power systems	23	Electric energy and Virtual power systems		◆	
Impacts	Eco-mobility	1	Eco-mobility potential of a building in its context (km/unit)			◆
	Effects on surrounding buildings	2	Impacts on surrounding buildings (%)		◆	
	Emissions	3	Acidification potential (kgSO$_2$-eq/m2)			◆
		4	Acidifying emissions, Intensity (%)		◆	
		5	Annual CO2 emissions (kgCO$_2$/m2)			◆
		6	CO2 emission factor heat supply (kg/kWh)			◆
		7	CO2 emissions (tonnes CO$_2$-eq/yr)		◆	
		8	Eutrophication potential (kgPO$_4$-eq/m2yr)			◆
		9				◆
		10	Global Warming Potential		◆	
		11				◆
		12	Intensity of GHG emissions (%)		◆	
		13	Ozone depletion potential (kgR11-eq/m^{2}yr)			◆
		14	Photochemical Ozone creation potential (kgC$_2$H$_4$-eq/m^{2}yr)			◆
		15	Photo-oxidants emissions, Intensity (%)		◆	
	Light pollution	16	Light on properties (lx)		◆	
		17	Light pollution		◆	
		19	Luminaire intensity (cd)		◆	
		20	Luminance (cd/m^2)		◆	
		21	Upward Light		◆	
	Outdoor conditions	22	Monitoring of air quality (%)		◆	
		23	Thermal comfort of outdoor areas (%)		◆	
	Raw materials	24	Abiotic Depletion Potential elements (kgSB- eq/m^{2}yr)			◆
	Solid waste management	25	Accessibility to differentiated waste collection (%)		◆	
		26	Accessibility to waste sorting facilities (%)			◆
		27	Composting (-)			
		28	Construction and demolition waste generation (kg/m^2)			◆
		29	Recyclable waste storage (m^2)			
	Water pollution	30	Water pollution due to material leaching (mg/m^2 yr)			◆
Land Use	Preservation	1	Conservation of built environment (%)		◆	
		2	Preservation of land (%)			◆
	Quality	3	Site quality (-)		◆	
	Soil sealing	4	Permeability of site / land (%)			◆
	Spatial planning	5	Change of land use (-)		◆	
		6	Imperviousness change, Imperviousness coefficient (-)		◆	
	Urban design	7	Green zones & recreation areas (m^2/inhabitant)		◆	
		8	Green zones & recreation areas density (%)		◆	
		9	Green zones & recreation areas proximity (%)		◆	
		10	Outdoor space (-)		◆	
		11	Population density (inhabitants/ha)		◆	
		12	Urban compactness		◆	
		14	Urban context (-)		◆	
		15	Urban conversion (%)		◆	
Materials	ECO materials	1	Low-pollutant and low-emission materials (-)			
	Emissions	2	Building materials and construction, OI3 index (-)			◆
Water	Embodied water	1	Embodied water use (m^3/m^2)			◆
	Freshwater	2	Intensity of water treatment (%)		◆	
		3	Operational water use (m^3)			◆
		4	Water consumption (l/inhabitant day)		◆	
	Rainwater	5	Dedicated network (yes/no)		◆	
		6	Intensity of rainwater usage (%)		◆	
		7	Landscaped and accessible retention ponds and ditches (yes/no)		◆	
		8	Rainwater collection from roofs (%)		◆	
		9	Respecting streaming continuity (yes/no)		◆	
	Total water use	10	Operational water use and waste water (m^3)			◆
	Wastewater	11	Intensity of wastewater treatment (%)		◆	
		12	Waste management & removal		◆	
		14			◆	
			Wastewater management			
						◆
		16	Water consumption & use of rainwater (-)			

Table 3. List of Transnational Environmental Indicators and Assessment Methods for Buildings and Urban areas Version 1.5 from CESBA MED. Source: Reference guide FINAL- V1.5 2017.

SOCIAL (SOC) ISSUE						
Category	Criterion		Indicator (units)	Building (B) and Neighbourhood (N) scale		
				B	N	B&N
Accessibility	Broadband communication network	1	Access to a broadband communication network, areas (%)		◆	
		2	Access to a broadband communication network, population (%)		◆	
	Flexibility	3	Flexibility of residential buildings (%)			◆
		4	Flexibility use (%)		◆	
	Public space planning	5	Access to parks and open spaces (-)		◆	
		6	Adaptation to users practices (yes/no)		◆	
		7	Availability of green spaces (%)		◆	
		8	(m²/inhabitant)			
		9	Barrier-Free accessibility of the district (%)		◆	
		10	Community gardens (yes/no)		◆	
		11	Parks and vegetated spaces network (yes/no)		◆	
		12	Public space quality (yes/no)		◆	
		13	Shared community spaces (yes/no)		◆	
	Services & Leisure facilities	14	Access to services and facilities (%)		◆	
		15	Collective facilities and outsourcing of services (%)		◆	
		16	Community support (yes/no)		◆	
		17	Proximity to leisure facilities (%)		◆	
		18	Proximity to services (%)		◆	
		19	Proximity to services and leisure facilities (%)		◆	
		20	Social gatherings and common cluster activities (-)		◆	
	Street network	21	Cyclomatic complexity of the street network (-)		◆	
	Urban planning	22	Development and integration of land parcels (%)		◆	
		23	Homogeneity of the urban fabric (%)		◆	
		24	Mixing functions (yes/no)		◆	
Acoustic Comfort	Noise - Indoor	1	Indoor A-weighted sound pressure level (dBA)			◆
		2	Weighted sound pressure from ventilation (dBA)	◆		
	Noise - Outdoor	3	Building area over noise limit (%)		◆	
		4	Noise pollution, silence quality – day (%)		◆	
		5	Noise pollution, silence quality – night (%)		◆	
	Noise pollution management	6	Accoustics studies (yes/no)		◆	
Air Quality	Indoor air quality	1	Concentration of pollutants (μg/m³)			◆
	Outdoor air quality	2	Number of days with bad air quality (days/yr)		◆	
		1	Objective/subjective safety measures (-)		◆	
	Green production	2	Local production of food (m²/inhabitant)		◆	
	Mobility	3	Pedestrian safety paths (%)		◆	
Thermal Comfort	Indoor conditions	1	Predicted Mean Vote (-)			◆
		2	Predicted Percentage Dissatisfied (%)			◆
		3	Thermal comfort in summer (-)	◆		
	Outdoor conditions	4	Exploitation of local resources: sun, daylight,		◆	
		5	Heat island effect (-)		◆	
		6	(yes/no)			
		7	Microclimate Index I (-)		◆	
Transport	Mobility & Alternative transportation	1	Availability of safe bicycle routes (m)		◆	
		2	Bicycle and pedestrian network quality (-)		◆	
		3	Bicycle facilities (-)		◆	
		4	Car sharing pool/station (yes/no)		◆	
		5	Contiguity of bicycle and car routes (%)		◆	
		6	Pedestrian streets and walkways, area (%)		◆	
		7	Pedestrian streets and walkways, length (%)		◆	
		8	Proximity to bicycle lanes and paths (%)		◆	
		9	Shared mobility (%)			◆
	Parking facilities	10	Parking facilities (number/dwelling)		◆	
		11	Parking facilities, Off-street parking spaces		◆	
		12	Parking places with innovative features (%)		◆	
		13	Bicycle Parking (%)	◆		
	Public transportation	14	Access to public transport nodes, areas (%)		◆	
		15	Access to public transport nodes, population (%)		◆	
		16	Access to public transport, District Accessibility Index (-)		◆	
		17	Accessibility of public transport, stops and frequency (-)	◆		
		18	Accessibility to public transport, Lense index (-)			◆
		19	Dwellings with access to public transport (%)		◆	
	Street network	20	Connectivity of the street network		◆	
		21	Cul-de-sac roads and path ratio (%)		◆	
		22	Scale of the street network (m)		◆	
		23	Traffic modal split (%)		◆	
Visual Comfort	Artificial lighting	1	Illuminance (lx)			◆
	Daylighting	2	Daylight factor (%)			◆

Table 4. List of Transnational Social Indicators and Assessment Methods for Buildings and Urban areas Version 1.5 from CESBA MED. Source: Reference guide FINAL- V1.5 2017

	CATEGORIES	LEED INDICATORS	CESBA- MED INDICATORS
ENVIRONMENTAL	WATER	WetlandS and Water Body Conservation	Intensity of water treatment (%)
		Indoor Water Use Reduction	Operational water use (m^3)
		Outdoor Water Use Reduction	Water consumption (l/inhabitant day)
		Rainwater management	Dedicated network (yes/no)
		Wastewater Management	Intensity of rainwater usage (%)
			Landscaped and accessible retention ponds and ditches (yes/no)
			Rainwater collection from roofs (%)
			Respecting streaming continuity (yes/no)
			Operational water use and waste water (m^3)
			Intensity of wastewater treatment (%)
			Wastewater management
			Water consumption & use of rainwater (-)
			Water pollution due to material leaching (mg/m^2 yr)
	LAND USE	Local food Production	Conservation of built environment (%)
		Floodplain Avoidance	Preservation of land (%)
		Preferred Locations	Site quality (-)
		Housing and Jobs Proximity	Permeability of site / land (%)
		Steep Slope Protection	Change of land use (-)
		Site Design for Habitat or Wetland and Water Body Conservation	Imperviousness change, Imperviousness coefficient (-)
		Restoration of Habitat or Wetlands and Water Bodies	Green zones & recreation areas (m^2/inhabitant)
		Long-Term Conservation Management of Habitat or Wetlands and Water Bodies	Green zones & recreation areas density (%)
		Compact Development	Green zones & recreation areas proximity (%)
		Connected and Open Community	Outdoor space (-)
		Visitability and Universal Design	Population density (inhabitants/ha)
		Neighborhood Schools	Urban compactness
		Smart location	Urban context (-)
		Reduced Parking Footprint	Urban conversion (%)
		Mixed- used neighbourhood	
	ENERGY	Certified Green Building	Annual heat generation for space heating and
		Minimum Building Energy Performance	Delivered energy demand (kWh/m^2)
		Optimize Building Energy Performance	Energy consumption (Toe/inhabitant)
		Building Reuse	Peak energy demand
		Historic Resource Preservation and Adaptive Reuse	Consumption of non-renewable primary energy
		District Heating and Cooling	Operational primary energy (kWh/m^2)
		Renewable Energy Production	Primary energy for cooling (%)
		Infrastructure Energy Efficiency	Primary energy for heating (%)
			Primary energy for public lighting (%)
			Total primary energy demand (kWh/m^2)
			Renewable electricity production (%)
			Renewable energy on site (%)
			Electric energy and Virtual power systems
	IMPACT AND CLIMATE CHANGE	Heat Island Reduction	Eco-mobility potential of a building in its context (km/unit)
		Light Pollution Reduction	Impacts on surrounding buildings (%)
			Acidifying emissions, Intensity (%)
			Annual CO2 emissions (kgCO$_2$/m2)
			CO2 emission factor heat supply (kg/kWh)
			CO2 emissions (tonnes CO$_2$-eq/yr)
			Eutrophication potential (kgPO$_4$-eq/m2yr)
			Global Warming Potential
			Intensity of GHG emissions (%)
			Ozone depletion potential (kgR11-eq/m^{2}yr)
			Photochemical Ozone creation potential (kg C_2H_4 eq/m^{2}yr)
			Photo-oxidants emissions, Intensity (%)
			Light pollution
	WASTE	Wastewater Management	Accessibility to differentiated waste collection (%)
		Solid Waste Management	Accessibility to waste sorting facilities (%)
			Composting (-)
			Construction and demolition waste generation (kg/m^2)
			Recyclable waste storage (m^2)
			Wastewater management
SOCIAL	MOBILITY	Bicycle Facilities	Availability of safe bicycle routes (m)
		Walkable Streets	Bicycle and pedestrian network quality (-)
		Transportation Demand Management	Bicycle facilities (-)
		Tree-Lined and Shaded Streetscapes	Car sharing pool/station (yes/no)
			Contiguity of bicycle and car routes (%)
			Pedestrian streets and walkways, area (%)
			Pedestrian streets and walkways, length (%)
			Proximity to bicycle lanes and paths (%)
			Shared mobility (%)
			Parking facilities (number/dwelling)
			Parking facilities, Off-street parking spaces (%)
			Parking places with innovative features (%)
			Access to public transport nodes, areas (%)
			Access to public transport nodes, population (%)
			Access to public transport, District Accessibility Index (-)
			Accessibility of public transport, stops and frequency (-)
			Accessibility to public transport, Lense index (-)
			Dwellings with access to public transport (%)
			Connectivity of the street network (number/m^2)
			Cul-de-sac roads and path ratio (%)
			Scale of the street network (m)
			Traffic modal split (%)
	ACCESSABILITY	Access to Civic & Public Space	Access to public spaces
		Access to Recreation Facilities	Access to Services & Leisure
			Development and integration of land parcels
ECONOMIC	EQUITY	Housing and Jobs Proximity	Affordable housing
		Community Outreach and Involvement	Local community support
			Future evolution
			Labor force participation
			Social mixing and solidarity based economy
			Unemployment rate (%)
			Potential Employment (%)
	PUBLIC MANAGEMENT	Innovation	Environmental activities in primary school (%)
		Community Outreach and Involvement	Community planning (yes/no)
			Process and planning quality (-)
			Project management (yes/no)
			Working with skilled professionals (yes/no)
			Risk management (-)

Table 5. Indicators classification. The highlighted indicators are the most important and high-ranked.

CATEGORY	CRITERIA	INDICATORS
Energy	Energy Supply	Energy Consumption (renewable and non- renewabale)
		Energy Performance
Water	Water Supply	Water consumption reduction
		Use of rainwater
		Wetlands and water body conservation
	Water pollution	Wastewater management
Land- use	Population Density	Reduce overcrowding of inhabitants per m2
	Housing	Meet housing demands
	Good Planning strategy	Access to Green zones and recreactional areas
		Access to services
		Mixed- used neighbourhood
		Connected and Open Community
		Floodplain Avoidance
Waste	Waste management	Waste sorting facilities
		Waste recybility
		Reduce waste production from construction
Natural Hazards	Adaptation to Climate Change	Heat Island Reduction
		Reduce GHG emissions
Mobility	Transport system	Walkable Streets
		Access to public transportation
		Bicycle Facilities
Public Management	Economical Impact	Local community support
		Housing and Jobs Proximity
		Risk management
		Innovation

Table 6. Result of Step 1 of the methodology. A summarized table of the main indicators in LEED and CESBA MED.

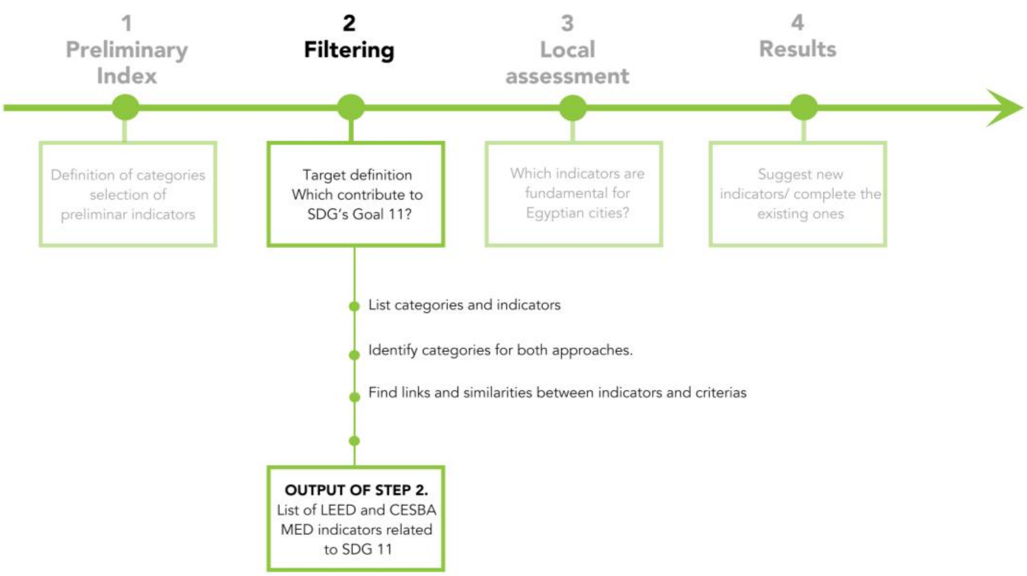

Figure 7. Scheme of General steps and specification of the procedure done in step 2 of the development of the methodology.

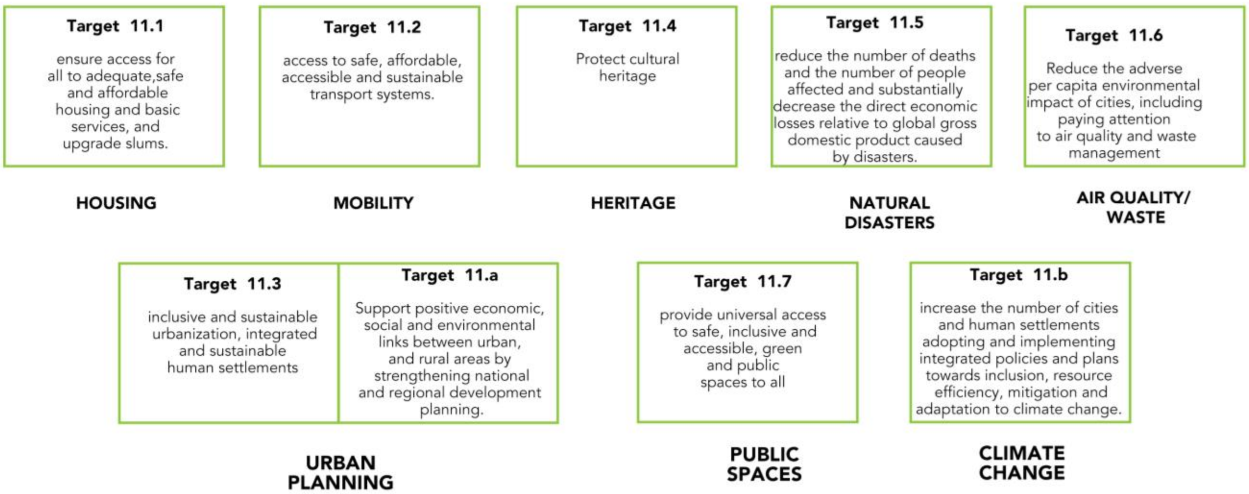

Figure 8. SDG11 targets related to the environment and attributed to categories.

Figure 9. The categories that are contained in the generated framework of step 1 and SDG 11 are shown in the diagram above.

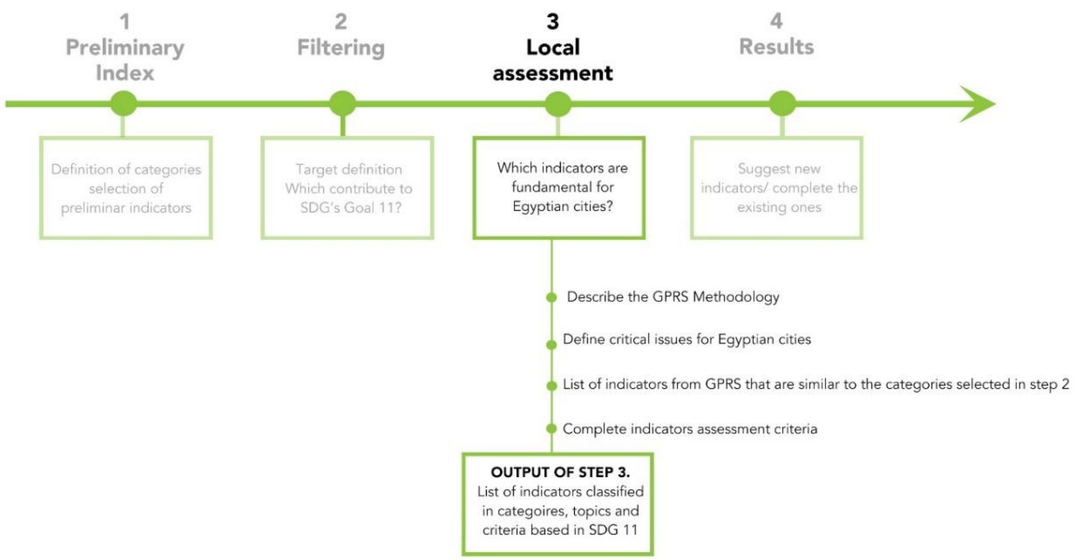

Figure 10. Step 3 of the methodology procedure flowchart.

CATEGORY	CRITERIA	NEW INDICATOR
Land- use	Population Density	Reduce overcrowding of inhabitants in the neighbourhood
	Housing	Meet housing demands
	Good Planning Strategy	Access to Green zones and recreactional areas
		Access to services
		Mixed- used neighbourhood
		Connected and Open Community
		Floodplain Avoidance
Waste	Waste management	Waste sorting facilities
		Waste recybility
		Reduce waste production from construction
Natural Hazards	Adaptation to Climate Change	Heat Island Reduction
		Reduce GHG emissions
Mobility	Transport system	Walkable Streets
		Access to public transportation
		Bicycle Facilities

Table 7. The outcome of step 2 is a table of indicators that measure sustainability on a neighborhoods and Social housing projects in the city size, and is only related to the UN's goal 11, but it still lacks context with the case study, which is crucial to boost the accuracy of the assessment. Step 3 is the contextualization of the indicators in the city, based on other investigations. (See Table 7.)

CATEGORY	INDICATORS	SUB INDICATORS
1. SUSTAINABLE SITE ACCESSIBILITY AND ECOLOGY	Site Selection	Desert area development
		Informal area redevelopment
		Brownfield site redevelopment
		Compatibility with National Development Plan
	Accessibility	Transport infrastructure connection
		Alternative methods of transport
	Ecological balance	Protection of habitat
		Respect for sites of historic or cultural interest
		Minimising Pollution during construction
2. MANAGEMENT	Site Provision	Containers for site materials waste
		Employing waste recycling workers on site
		Access for lorries, plant and equipment
		Identified and separated storage areas
	Site Environmental	Project Waste Management Plan
		Engaging a company specialized in recycling
		Protecting water sources from pollution
		Control of emissions and pollutants

Table 8. Step 3. List of categories and indicators from the **GPRS assessment system** that could be important to achieve sustainability of social housing Projects within the framework of SDGs 11.

4. Results and Discussion

CATEGORY	CRITERIA'S	INDICATORS
LAND USE	Site Selection	Desert area development Informal area redevelopment Brownfield site redevelopment Compatibility with National Development Plan
	Population Density	Reduce overcrowding of inhabitants in the neighbourhood
	Housing	Meet housing demands
	Good Planning Strategy	Access to Green zones and recreactional areas
		Access to services
		Mixed- used neighbourhood
WASTE	Waste management	Waste sorting facilities
		Waste recybility
		Control of emissions and pollutants
		Reduce waste production from construction
MOBILITY	Transport system	Transport infrastructure connection Alternative methods of transport
		Access to public transportation
		Bicycle Facilities
ENVIRONMENTAL IMPACT	Site Environmental Impact	Engaging a company specialized in recycling Protecting water sources from pollution
	Adaptation to Climate Change	Heat Island Reduction
		Control of emissions and pollutants

Table 9. Resulted framework for sustainability measurement for social housing projects in Cairo context.

The methodology's output, as shown above, is a table including 21 indicators to quantify sustainability in relation to SDG 11, with an emphasis on the social housing sector.

5. Conclusion

This thesis is an examination and recommendation of a framework for the selection of indicators that assess sustainability with a focus on SDG 11 and social housing projects in Cairo, Egypt.

The introduction emphasizes the importance of evaluating and assessing sustainability development in Middle East and North Africa cities and countries, as well as the role that the SDGs play in establishing the primary aims and problems to tackle in the pursuit of a more sustainable future. As stated in the problem statement, the evolution and application of policies between scales is the challenge with the SDGs and the assessment of sustainability.

The technique consists of three processes that conclude in a final framework of sustainability evaluation based on SDG 11. The procedures include a review of existing sustainability evaluation techniques, LEED ND, CESBA- MED and the GPRS methodology to provide a list of indicators that are contextualized in accordance with the case study.

The methodology's steps include an analysis of LEED and CESBA- MED, which results in a list of indicators classified in categories and described in detail that are common to both methodologies and constitute mandatory criteria to one or both methodologies; to filter the selection of indicators, the criteria used is that the indicators must be related to the United Nations' Sustainable Development Goal 11 Sustainable cities and communities; and finally, the indicators are constrained.

The end result is a collection of indicators that are just linked to goal 11 and compatible with the needs of social housing projects in Egypt.

The recommendation for future developments is to encourage local governments and entities to invest in plans for urban planning that are focused on sustainable development. The first step in directing policy toward sustainable alternatives is to recognize sustainability as a matter that impacts all dimensions of a city, not only new development of individual buildings or residential compounds.

The next step for the city is to design and implement an assessment tool and method that includes all dimensions of sustainability and urban dynamics as part of the normative protocols to ensure the application of the measurement as a mandatory feature in all planning and resource distribution instruments, relying on the sustainable development goals and a stakeholder's analysis to define more precise targets.

Bibliography

1. 2019 The Future of Cities Opportunities Challenges and the Way Forward Luxembourg Publications Office of the European Union

2. Abdel Latif Amira Diana Magdy Karim El Sharkawy Marlene WillIam and Mohamed Magid 2018 Egypt SDS 2030 Between Expectations and Challenges to Implement The Public Administration

3. Ameen Raed Fawzi Mohammed and Monjur Mourshed 2019 “Urban Sustainability Assessment Framework Development The Ranking and Weighting of Sustainability Indicators Using Analytic Hierarchy Process” Sustainable Cities and Society 44 January 356–66 httpsdoiorg101016jscs201810020

4. Analysis of Heat Waves and Urban Heat Island Effects in Central European Cities and Implications for Urban Planning 2020 Washington DC The World Bank

5. Balaras C A K G Droutsa E G Dascalaki S Kontoyiannidis A Moro and E Bazzan 2020 “A Transnational Multicriteria Assessment Method and Tool for Sustainability Rating of the Built Environment” IOP Conference Series Earth and Environmental Science 410 January 012068 httpsdoiorg101088175513154101012068

6. Berisha Erblin Caterina Caprioli and Giancarlo Cotella 2022 “Unpacking SDG Target 11a What Is It about and How to Measure Its Progress” City and Environment Interactions 14 April 100080 httpsdoiorg101016jcacint2022100080

7. Goll Edgar 2017 Future Challenges of Climate Change in the MENA Region Vol 7 MENARA Future Notes

8. Goll Edgar Andre Uhl and Jakob Zwiers 2019 Sustainable Development in the MENA Region Vol 20 MENARA Future Notes

9. Haapio Appu 2012 “Towards Sustainable Urban Communities” Environmental Impact Assessment Review 32 1 165–69 httpsdoiorg101016jeiar201108002

10. O’Neill Daniel W Andrew L Fanning William F Lamb and Julia K Steinberger 2018 “A Good Life for All within Planetary Boundaries” Nature Sustainability 1 2 88–95 httpsdoiorg101038s4189301800214

11. Regional Office for Arab States 2020 Review 2020 UNHabitat

12. Review of Social Housing in Arab Region and Overview of Policies for LowIncome Households’ Access to Adequate Housing 2017 August

13. Rezaallah A C Bolognesi and R A Khoraskani 2012 Review of LEED and BREEAM Comparison between Policies Assessment Criteria and Calculation Methods May

14. Sachs Jeffrey D Guido SchmidtTraub Mariana Mazzucato Dirk Messner Nebojsa Nakicenovic and Johan Rockström 2019 “Six Transformations to Achieve the Sustainable Development Goals” Nature Sustainability 2 9 805–14 httpsdoiorg101038s4189301903529

15. Soliman Ahmed M nd Urban Informality Experiences and Urban Sustainability Transitions in Middle East Cities

16. Talen Emily Eliot Allen Amanda Bosse Josh Ahmann Julia Koschinsky Elizabeth Wentz and Luc Anselin 2013 Review of LEEDND as an Urban Metric Landscape and Urban Planning July

17. Tawfik Elewa Zeinab 2020 "Economic Development in Africa Applying to Egyptian Experience in Light Sustainable Development Strategy Egypt Vision 2030" L' Egypte Contemporaine 111 539 546–74 httpsdoiorg1021608espesl2020213856

18. The Green Pyramid Rating System GPRS 2011 The housing and Building national research center

19. Autor University Of The West Of England Uwe Science Communication Unit Intrasoft International and European Commission DirectorateGeneral For The Environment 2018 Indicators for Sustainable Cities Editorial Luxembourg Publications Office

20. Bakar Aisyah Abu Mariana Mohamed Osman Syahriah Bachok Mansor Ibrahim and Mohd Zin Mohamed 2015 "Modelling Economic Wellbeing and Social Wellbeing for Sustainability A Theoretical Concept" Procedia Environmental Sciences 28 286–96 httpsdoiorg101016jproenv201507037

21. ElKholei Ahmed O 2019 "Are Arab Cities Prepared to Face Disaster Risks Challenges and Opportunities" Alexandria Engineering Journal 58 2 479–86 httpsdoiorg101016jaej201904004

22. Siragusa A P Vizcaino P Proietti and C Lavalle 2020 European Handbook for SDG Voluntary Local Reviews Luxembourg Publications Office of the European Union

23. The Arab Strategy for Housing and Sustainable Urban Development 2030 nd League of Arab States

24. Verma Pramit and AS Raghubanshi 2018 "Urban Sustainability Indicators Challenges and Opportunities" Ecological Indicators 93 October 282–91 httpsdoiorg101016jecolind201805007

25. Woetzel Jonathan Dickon Pinner Hamid Samandar Hauke Engel Mekala Krishnan Brodie Boland and Carter Powis 2020 Climate Risk and Response Physical Hazards and Socioeconomic Impacts McKinsey Global Institute