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Towards Sustainable New Settlements in Egypt: Lessons Learned from a Comparison between Traditional and Modern Settlements in Greater Cairo Region - Egypt

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Abstract

The last few decades, Egypt drawn into a dramatic socio-economic change that causes a relative change in adopted development patterns. Different typologies of new residential districts have turned from globalized westernized world into Egyptian context. Planners and authority thought that changing adopted development patterns from traditional to modern neighborhood could provide solutions for old town's problems. On the other hand, different scholars have emphasized that traditional compact, mixed use, high-density urban forms are important for reaching sustainability goals in term of environmental, economic and social advantages. Based on a comparison of the sustainability of three case studies Shubra, Heliopolis, and new Cairo city; this research examine analyze the sustainability of New Egyptian Settlements. The analysis depends on observation and spatial analysis to investigate the variations of performances between the three case studies in terms of urban, social, environmental, and economic sustainability indicators. The research aims to assess the sustainability of moving from traditional to modern urban form in GCR' new towns and to extract development criteria and lessons learned from traditional urban form to enhance the sustainability of modern settlements. The research concluded that both traditional early developed settlements like Shubra and new planned settlements like new Cairo recorded low performance in sustainability issues, each one in its own way; and that early planned settlements like Heliopolis recorded moderate performance in sustainability issues, this paves the way for criteria to prepare new plans of new settlements and provide intensification repair tools to fix existing new settlements.

Keywords: Traditional Versus New Settlements, Greater Cairo Region GCR, Sustainable Development indicators, sustainable urban form.

1. Introduction

Cairo exposed to different dramatic shifts that produced different typologies of adopted urban development patterns that are different in density, land-use pattern, housing income pattern, and street network pattern. The wright choice of development pattern is important to positively affect communities' development. It should be chosen to fit its region unique characteristics in term of social, economic and environmental circumstances to achieve better urban development. Accordingly, all decision makers and planners proposed different development patterns in an attempt to satisfy the required development.

Lately, Egyptian authorities adopted modern neighborhood with hope to introduce better solution to solve the problems of traditional cities. Unfortunately, their socio-spatial characteristics cause many development problems to the social-spatial fabric of new Egyptian cities. As a step to achieve applicable sustainability guidelines for developing new settlements in Egypt, the research aims to compare the sustainability of traditional settlements with modern new settlements in Egypt to detect lessons learned from traditional urban form to enhance the sustainability of modern settlements.

1.1 Research Problem

The second half of the twentieth century, Egyptian context of modernization turns the concepts of development and its patterns to western modernization; that turns the current settlement strategy in Egypt to be borrowed from UK (Shalaby, 2003). Different typologies of new residential districts have turned from globalized westernized world into Egyptian context. Almost all the plans of the new cities based on the modern theories of residential

district with segregated land uses pattern, of pure residential clusters, with services concentrated in centers. The state started to transplant neighborhood models within unique context like Egypt, without making the proper attempt to test their compatibility for development in Egypt. These patterns borrowed from environments that are not similar to local circumstances, and may not be suitable for application in Egypt.

1.2 Research Aim and argument:

Some development patterns could enhance urban sustainability, whereas others do not. Identifying how some neighborhoods can provide more sustainable development than others is important to improve urban development. The study compares the sustainability between old and new Egyptian settlements, according to the three cases of Shubra, Heliopolis and New Cairo City. In addition, it aims to extract development criteria to enhance the sustainability of modern settlements based on lesson learned from traditional urban form. The research argues that changing urban form from the traditional in old Egyptian cities to modern urban form in new Egyptian settlements rather than be the solution for traditional cities problems of development, it becomes part of new settlements problems of development. It would make them less sustainable in terms of environmental, social and economic aspects.

1.3 Research Methodology

The research adopts a deductive method with descriptive and comparative analysis, to establish a sense of anti-thesis criticism of modern and traditional settlements. The first part of the paper discusses factors of sustainable urban development in term of urban, social, economic and environmental dimensions. Secondly, the paper introduces a comparative analysis to deduce the main socio-spatial differences between modern and traditional urban form, in micro and macro scale in the Egyptian context. The third part of the research critically projects the sustainable development indicators to Shubra, Heliopolis and new Cairo city in order to analyze and assess their contribution to urban development. The analysis depends on observation and spatial analysis to investigate the variations of performances between three case studies in terms of urban, social, environmental, and economic sustainability indicators.

2. Sustainability of Urban Form (Theoretical Review)

The United Nations World Commission (1987) defined sustainability as the development that satisfies current needs of cities without compromising the ability of future generations to meet their own needs. On the other hand, Rio Declaration on sustainability Agenda 21(1992) defined sustainable development as a global strategy for planners to address human development effects on the environmental crisis. Later on a wider scope about sustainable urban development concerns an idea beyond the focus on ecology and the natural environment; it includes social, economic and institutional dimensions. It concerns the long-term prospect for future existence of urban development to meet the needs of the present without compromising the ability of future generations to meet their own needs (United Nations. 1987, UN Habitat 1996, Sustainable Cities Programmed). The UN Habitat's Program for Sustainable Cities, define a sustainable city as a city where achievements in social, economic and physical development made to last. Sustainable urban development aims to achieve urban sustainability in developing urban areas with improving urban context in environmental, economic and social dimensions (Martino 2009) (Leed-ND, 2010). The following principles are derived to achieve sustainability:

2.1 Environmental Sustainability

An environmentally sustainable city considers reducing the overall impact of the built environment on human health and natural environment in terms of three dimensions. First, in terms of efficiency in using, minimizing, saving, reusing, storing, recycling, reserving, and gathering energy, water, and other resources consumption. Second, in terms of protecting occupant health and improving their productivity. Third, in terms of protection of the environment and reducing waste and pollution output of heat, air, noise and water .

2.2 Social Sustainability

A socially sustainable city must achieve social equity and equal opportunities in the distribution of development benefits and costs. Social sustainable urban form refers to the ability of a city to sustain orderly relationship among its diversified residents and to meet their hierarchy of needs. First: it depends on economic efficiency in the use of resources provided by natural resources. Second: it depends on economic growth with ensuring social equity in distribution of land uses and housing types. Third: it enhances public realm to support opportunities for economic exchange (Pongsmas, n 2004).

2.3 Economic Sustainability

An economic sustainable system must achieve efficiency in using development resources. First: in term of equity,

that refers to the fair distribution and access to resources among individuals and groups; to facilitate full participation and collaboration, in their community and have opportunities for personal development and advancement. Second: In term of social inclusion and interaction, refer to both the right and the opportunity to participate and enjoy all aspects of community life and interact with other community members; where the environment enables individuals to celebrate their diversity and react and act on their responsibilities. Fourth: Adoptability and resilience, refers to the individual groups ability to respond to change.

Sustainable movements described the ideal performance of a city, i.e. how the city should function, what it should provide for its citizens and what the relationship should be with the natural environment. The research found achieving sustainable development rests on four easy-to-investigate indicators: urban and functional, social, economic, and environmental indicators (Ghonimi I. 2013). They will be used to assess the contribution of early developed, early planned and new planned Egyptian settlements to achieve sustainability (as in table 1):

- Functional and Urban sustainability indicators can be investigated in terms of successful integration with the city, permeability, connectivity, proximity, efficient movement behavior, short distance low frequent trips, efficient and sufficient provision of services, parking requirements and low traffic cognition (Ghonimi i. 2011; Ghonimi, I. 2017 a; Ghonimi, I. 2017 c Urbed 1997; Landman, K. 2004).
- Social sustainability indicators can be investigated in terms of social interaction, sense of community, Safety and security, and social diversity (Ghonimi, i. 2011; 2017 a; 2017 b).
- Environmental sustainability indicators can be investigated in terms of achieving confortable environmental conditions in building and community scale, reduce air and noise pollution, and reduce of fuel, water and resources consumption (Bentley I, 1990; El-Zamly, H, A. 1994; Newton, Peter. 2000; Ghonimi, I. 2017 a).
- Economic sustainability indicators can be investigated in terms of efficient and equitable use of resources, reduction of commuting and cooling cost, and enhance economic interaction (Ghonimi, I. 2017 a).

Table 1. Sustainable development criteria (Ghonimi, 2017 a).

SUSTAINABILITY PRINCIPLES		
Urban and Functional Sustainabilty	Fu1	Integration with the city.
	Fu2	Connectivity , Permeability, accessibility and proximity.
	Fu3	Movement Behavior (Trip Distance, Trip Frequency, Alternative Mode Choice)
	Fu4	Streets Efficiency and Traffic Cognition
	Fu5	Suffeceint and Effeceint Services Provesion
Social Sustainabilty	So1	Encourge Interaction.
	So2	Safety and Security.
	So3	Encourage Diversty.
Environmental Sustainability	En1	Confortable Condition.
	En2	Air and Noise Pollution Reduction
	En3	Resource consumption Reduction
Economic Sustainability	Ec1	Efficient use of Resources.
	Ec2	Equitable use of Resources.
	Ec3	Reduce Commuting and Cooling Cost
	Ec4	Economic Interaction

3. The Case Study of Greater Cairo Region

Cairo has been exposed to different dramatic shifts that produced deferent typologies of urban development patterns that are different in density, land-use, housing income and street network. In an aim to achieve sustainable new settlements in Egypt, the case study compares the sustainability of traditional with new Egyptian settlements. To achieve this goal the case study will go through two steps after case study selection: First, the socio-spatial features of micro and macro community are measured, analyzed and compared. Secondly, the impacts of socio-spatial features on sustainable urban development are examined in three typologies of urban form the traditional early developed, the traditional early planned, and the modern new planned.

- The traditional early developed districts that informally grow over green land, and initially developed with mixed use, high density, mixed housing income and grid street network pattern, like Shubra, Abassia.
- The early planned districts that have developed at the end of 19th and the early 20th century. Those are initiated and planed based on garden city style and transformed over time into traditional one based on different process of intensification and change in land use types. Part of them are developed and planned by private developers in the end-18th and the early-19th century like Khedewi Cairo, Maadi, EL Muhandssin, and Heliopolis; other part are developed and planned by government in the mid-19th century like Nasr city.
- The modern new-planed Egyptian settlements surrounding Cairo, that are based on the modern theories of residential district with segregating land use patterns, of pure residential clusters, with separate use services concentrated in centers, low density, separate housing income and hierarchical street network pattern; like New-Cairo, El-Shorouk and El-Obour to the east and Six-October and Sheikh-Zayd to the west.

Figure (1) includes a representation of the two types of settlements in Greater Cairo Region, the traditional central one and the flourish new settlements to the west and the east.

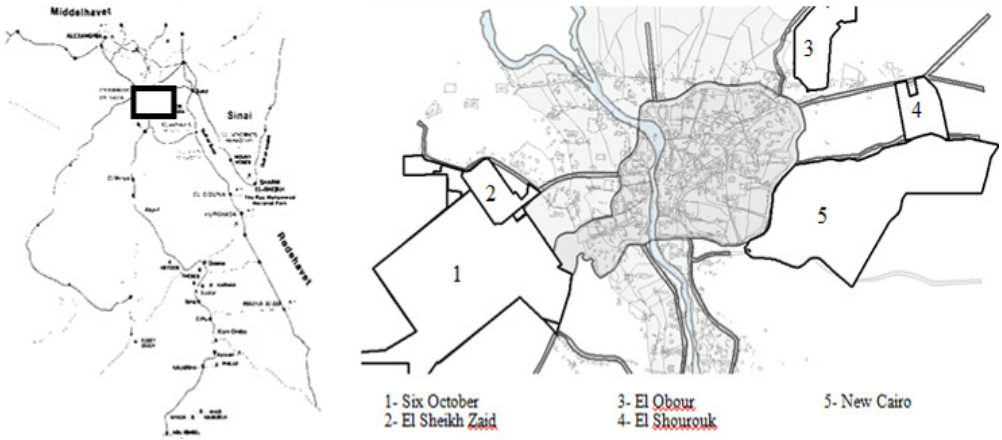


Figure 1. Traditional (early developed, early planned) city and flourish of New planned Settlements in GCR.

3.1 Case Study Selection

Figure (2) represent the selected case studies concerns of three types of neighborhoods to present different urban planning patterns; the traditional early developed Shubra, the traditional early planned Heliopolis and the modern new planned New-Cairo City:

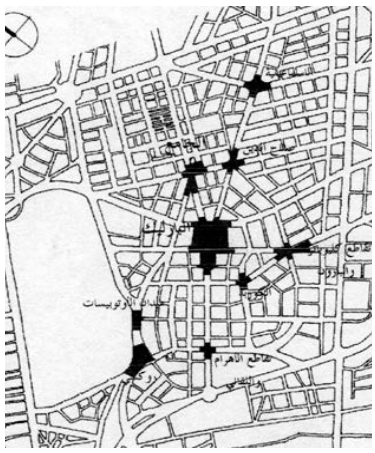
Shubra is selected to present early developed settlements. In the early ninetieth century, Mohamed Ali the founder of modern Egypt built his palace in Shubra and extended Shubra Street, the straightest and widest street at that time, to pave the way to his palace. A gradual growth has developed over agriculture lands adjacent to Shubra streets to provide lands for the elites to build their palaces. Later on, a spontaneous growth without plans happened over agriculture land on perpendicular streets depending on resident's incremental needs. It is developed on traditional manner based on compact mixed land uses, with high density, mixed housing income (Moore, J. 2013, Sallheen, M.,2003, Abu-Lughod, 1971).

Heliopolis is selected to present early planned settlements that have transformed into traditional cities. At the beginning of the twenties century, Baron Imban initiated Heliopolis in the east desert borrowed from Paris style that obeyed socio-spatial form of European middle age cities. Its original plan developed based on garden city model. By the mid-5th decade of the twenties century, the gradual development and growth of Cairo followed by high land value, caused a gradual growth that neglected garden city concept and followed the traditional socio-spatial patterns in all its growth, extension and infilling with traditional intensification methods of mixed use, increased building density, Floor area ratio and residential density (Sallheen, M., 2003, Abu-Lughod, 1971).

New Cairo city is selected to present the new settlement waves. It is one of GCR new towns, that has developed at the end of twenties century. It is initiated as modern neighborhood developed to reject traditional solutions and depend on industrialism, societal community, and new technology. The current new settlement strategy in Egypt is borrowed from UK, almost all plans of new cities based on modern theories of residential district with segregating land uses, pure residential clusters, with all their services concentrated in centers, and developed in low density and low buildup area and low buildings height (Shalaby 2003, A Ibrahim, 2007).

Early developed high fine grained urban form.

Shubra 1890



Early planned fine grained urban form.

Heliopolis 1910

New planned Super block urban form.

New Cairo 1990

Figure 2. Selected case study Heliopolis and New Cairo City.

3.2 Analyzing the Conflict of Traditional versus Modern Urban Form

This section explores the spatial and socio-spatial difference between traditional and modern settlements in Cairo in both micro and macro scale. The analysis depends on measuring the following urban form characteristics:

1) Street network pattern can be classified under three categorize between the grid to the hierarchical as (grid, loop, and cul-de-sac) patterns. Their spatial structure can be classified under heading of type of street, linear meter of streets, number of blocks, Intersections density, number of access point, number of cul-de-sacs, percentage of streets area per community area, and number of continuous routes (Ghonimi 2014).
2) Land use pattern can be classified under heading of land-use type, variation and density. They can be measured using the length in meter of (dividing vs. connecting) line between different land-use represents the degree of land use mix vs. separation (Ghonimi et.al, 2011).
3) Housing pattern can be classified under heading of housing type, variation and density; They can be measured using the length in meter of (dividing vs. connecting) line between different housing types represents the degree of housing exclusion vs. segregation (Ghonimi et.al, 2010).
4) Community density range between low density (60 -150 Person/Fedan) in new Cairo city, Middle density (300 -600 Person/Fedan) in Heliopolis and High Density (800-1500 Person/Fedan) in Shubra. Also community size is measured and ranged between small, medium and large community size.

3.2.1 Micro Scale Comparative Analysis

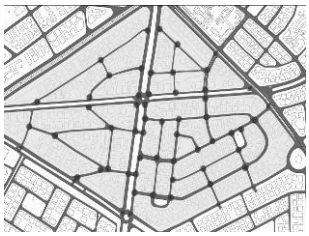
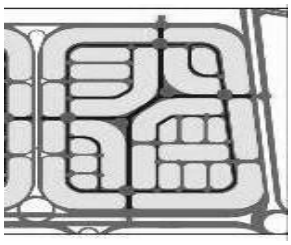
Micro socio-spatial analysis of Shubra Table (2) reveals grid outward street network, with higher number of intersections and access points, small lots with high fine-grained urban fabric, and no boundaries or barriers. Micro socio-spatial analysis of cases is illustrated in Table (2). It depends on diverse mixed land use with high quantity of connecting lines between residential and other commercial uses that reflects expanded transit commercial axis, which combines different vertical mixed uses in building level. The social fabric of Shubra reveals diversity and intermixes of low and mid income residents and records very high density (1200 person/fedan) with high community sizes.

On the other hand, micro socio-spatial analysis of Heliopolis Table (2) revealed a process of modification for garden neighborhood model that reveals radial grid outward oriented street network, with relative high node density, high number of access points, moderate lot size, with moderate fine-grained fabric, and removed boundaries and barriers. The spatial fabric provides better integration with adjacent urban fabric as an organic part of the city. Regarding land use pattern, observation and spatial analysis revealed locating services and shopping facilities on linear axes to the perimeter of main roads, with internally point distribution of services inside the neighborhood this give live, accessibility and connectivity to the community but at the same time provide limited privacy for the neighborhood core. Regarding social fabric of Heliopolis, it reveals relative high density (500 person/fedan) with relative high community size that is caused by intensification and increasing buildings height. Regarding housing mix, most of the land originally developed for high income as separate

villas the increased land-value caused a process of intensification and transformation from separate villas to high rise multi store apartment buildings with wide range of apartment areas that give rise to mid and upper mid income to provide residential units adjacent to high income residents in the same area.

On the contrary, micro socio-spatial analysis of New Cairo Table (2) reveals hierarchical inward oriented street network using loops and cul-de-sac. The arterial streets acted like semi defined boundaries that implicitly create barriers to restrict the connection with the external community and keep out the unwanted through traffic. It creates cellular cell isolated and separated unit from the city that breaks residential developments into relatively large lots of uniform size and shape inward looking units and semi internally focused, separated cellular cell. Regarding land use pattern, it depends on single land-use mostly residential. It aims to separate services from residential area. Regarding social fabric of New Cairo, it depends on relative homogeneity of housing type. It depends on low densities, single housing type, and detached single-family homes.

Table 2. Comparing urban form of traditional versus new settlements (micro scale)

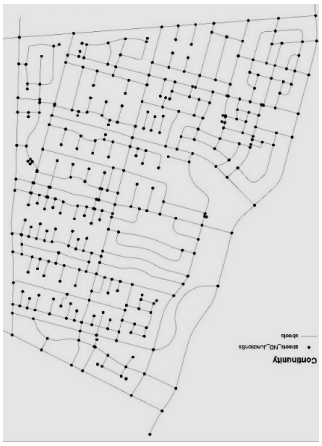
		Traditional Early Planned	**Traditional Early Developed**	**Modern New Planned**
		Khalafawy- Shubra	Medan El Gama - Heliopolis	Jasmine , New Cairo City
	Micro Scale			
Street network pattern	Type	Grid	Grid	Herarchial (Loops & cul-de-sac)
	Orintation	Outward orinted	Outward orinted	Inward orinted
	Relation	Continuity with surrounding	Continuity with surrounding	Contrast with surrounding
	No. of access point	72	31	4
	No. of continuous	53	14	2
	No. of intersections	107	55	16
	No. of loops	0	0	8
	No. of cul-de-sacs	0	0	0
	No. of blocks	180	63	20
	Road percentage	10-20%	20-30%	30-40%
Land-use Pattrn	Type	Varied land use type	Varied land use type	Single land use type
	Density	High density	Midium density	Low denisty
	Mix	Mixed uses	Mixed uses	No variation& nor mixing
Housing Pattrn	Type	Varied housing patterns	Varied housing patterns	Single housing pattern
	Density	800 -1600 p/fed High density	400 -600 p/fed Midium density	60-120 p/fed Low denisty
	Mix	Mixed housing type	Mixed housing type	No variation & no mixing

3.2.2 Macro Scale Comparative Analysis

The previous micro socio-spatial analysis of Shubra and Heliopolis revealed integrated organic micro communities of a city that has blurring boundaries with fine-grained free large number of entrances, it influences macro spatial fabric of macro scale in table (3). It creates continuous, overlapping and interweaving spatial fabric that connects a fractal city with pedestrian transportation web that is inclusionary of others and oriented toward the public domain and human dimension. It implies heterogeneity and ample multi-family residential uses. Theoretically, it fit the theoretical fractal, connected and regional city model. The road network and spatial structure of the city are composed of public road network.

On the other hand, macro socio-spatial analysis of new Cairo city revealed an isolated and inaccessible super-blocks islands inside urban fabric; it influences the macro spatial fabric of New Cairo city, as in table(3). It destructs the continuity and connectivity of urban fabric. The road network and spatial structure of the city composed of structure of super-block that is implicitly controlled with low number of entrances. Arterial roads become boarders that disengage from the rest of the region. It is composed of inward oriented isolated entities that usually try to isolate them self out from their broader city context, so they reinforce spatial segregation with land use orientation and street network. It reduces the relation, connectivity, continuity and interaction between city parts and increase segregation [Ghonimi, 2010].

Table 3. Comparing urban form of traditional versus new settlements (macro scale)

		Traditional Egyptian city Early developed development (Shubra)	Traditional Neighbourhood Early planned development (Heliopolis)	Modern Egyptian Settelments New Planned development (New Cairo)
Macro Scale[1]				
		Connected fine grained public urban form.	Connected fine grained public urban form.	Divided Super block public urban form.
Street	Street network	Fine grained street network	Fine grained street network	Super block
	Street network	Transit oriented Development	Transit oriented Development	Treed inward oriented
	No. of intersections	Fine grained street network	Fine grained street network	Super block
Land use	Land use variation	Varied	Varied	Single Use
	Land use mix	Mixed	Mixed	Separate Use
	Land use density	High	Mid	Low
	Services	Complete	Complete	incomplete
Housing	Housing variation	Varied	Varied	Single
	Housing type	Mid, Low	High, Mid	High
	Housing mix	mixed	mixed	Separate
	Housing density	800 -1600 p/fed High density	400 -600 p/fed Midium density	60-120 p/fed Low denisty

4. Comparing Sustainability of Traditional Versus Modern Settlements in GCR

This part assess cases of Shubra as early developed traditional city, Heliopolis as early planned traditional city and New Cairo city as modern new planned settlement, in term of two evaluation criteria theories of sustainable urban form versus local context in term of social, economic and environmental dimensions. It aims to deduce their role in achieving sustainability in unique context like Egypt. It depends on spatial analysis and observation to compare variation between three case studies in achieving sustainable development indicators.

4.1 Urban and Functional Sustainability Indicators (F.I)

Functional and urban sustainability considers achieving successful spatial encourages integration, interaction and relation between city parts. It aims at making the city work as integrated organism not standalone entities (Jacob 1961). It depends on linked, multilayered and fine grained structures to facilitate choices, promote transit, continuous fabric (Salingaros, 2004; Calthorpe, 2004; Leyden 2003). It considers appropriateness to socio-cultural conditions of Egyptian society that implies benefits of social and economic interaction, equitable accessibility to services and facilities, and to provide not only sufficient services provision due to the benefits of economic of size but also to provide efficient diversity of services due to the benefits economics of diversity. It considers making it easy to connect people with each other and to facilities (Evans 2001, Ian Bertly 1990). It considers reducing travel distance, time and cost, in addition to reduce traffic volumes and to discourage private mobility and to facilitate alternative modes of movement including walkability, non-motorized mobility, and public mobility (Masnavi, 2000).

[1] Ibrahim, A. (2017) "street networks between traditional and new Egyptian developments, problems and learned lessons", environmental sciences vol. 37.

Functional Sustainability indicators can be used to investigate the variations of functional performances between three case studies in terms of traffic cognition, sufficient parking requirement, efficient movement behavior, short distance low frequent trips, and efficient and sufficient provision of services. The following part shows the analysis and observation of such indicators with in Shubra, Heliopolis, and New Cairo.

4.1.1 Successful Connected Spatial Fabric

The spatial analysis of Shubra and Heliopolis in Table (2, 3) records a grid street network pattern that has high intersection density (107, 55 respectively), high number of egress points (72, 31 respectively), high number of blocks (180, 63 respectively), and high number of street continuity with surrounding area (53, 14 respectively), accordingly it would create high fine-grained spatial fabric with outward oriented street network with blurring boundaries that achieve well connection with adjacent and surrounding urban fabric. These factors will ensure high overlap, interweave with surroundings, and enhance relation, connectivity and continuity with the city. It aims to make neighborhood as part of city and make pressure on the public domain to create linked structures, multilayered transportation network that facilitate choices and promote transit continuous fabric, figure (3).

The spatial analysis of New Cairo in Table (2,3) records hierarchical street network pattern that has low number of intersections (16), low number of egress points (4), low number of street continuity with surrounding area (2), accordingly it would create super block spatial fabric with inward oriented street network with rigid boundaries that creates self-contained internally focused unit of the city that intends isolation and separation from the city and intends to keep out unwanted and use arterial roads to form borders to isolate the neighborhood residents from the surrounding urban fabric. In addition, it locates services area at the center of the neighborhood and removes uses from arterial roads and neglects macro scale and public domain and restricts face-to-face interaction to community residents, and avoids adjacent areas, as shown in figure (3).

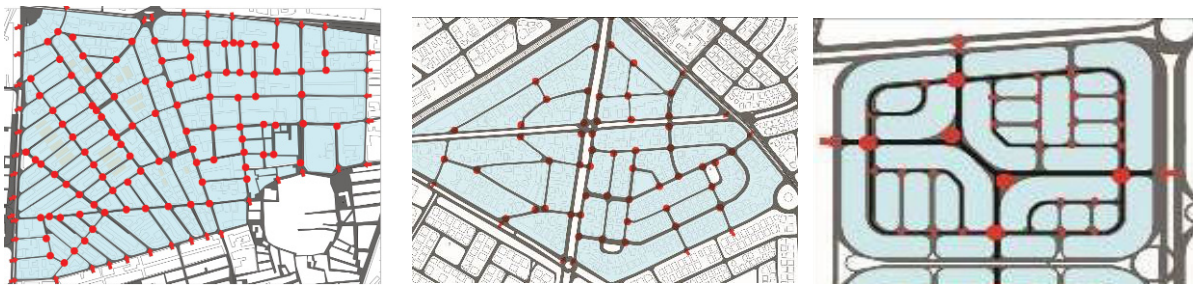
a) Shubra fine grained connected fabric b): Helioplis fine grain connected fabric c): New cairo super block islands

Figure 3. Comparing variation between three case studies in achieving connectivity with surrounding.

4.1.2 Permeability and Connectivity

In Figure (4 a,b), the spatial analysis of Shubra and Heliopolis records grid fine-grained street network pattern with high value of intersections, egress points, blurring boundaries and connection to the surrounding. These factors increases urban permeability, connectivity and accessibility inside spatial fabric and causes high proximity to every place inside urban fabric, and allow many choices and alternatives paths and shortcut roads that revealed high proximity to all facilities and services, and main roads and bus station. In addition, its mixed use of services with residential buildings reduces travel distance and encourages residents to depend on walkability and public transportation and to reduce relying on private cars. Accordingly, it enhances sustainable urban mobility (Ghonimi, I. 2017 c).

In Figure (4,c),Spatial analysis of New Cairo records hierarchical super-block street network using loops, cul-de-sac with low number of intersections and egress points, with implicit boundaries represented in arterial streets. These factors reduces urban connectivity, permeability and discourage public accessibility to reach services, amenities and urban space, it causes low proximity to every place in urban fabric. These factors increases the way urban forms restrict movement of people in different directions and limit choices of paths and increase trip distance and discourage pedestrian, bicycles, car alternatives. In addition, its separation of services from residential area reduces accessibility to services and make streets mono use that are not vibrant and in long distances that make residents depend solely on private cars (Ghonimi i. 2011; Ghonimi, I. 2017 c).



a) Shubra high permeability b) Heliopolis medium permeability c) New Cairo low permeability

Figure 4. Comparing variation between three case studies in achieving permeability and connectivity.

4.1.3 Movement Behavior

Observation of Shubra and Heliopolis streets revealed pedestrian oriented streets, safe for pedestrian, and compatible with alternative public transportation, private car become unwelcomed solution. It causes short distance and low frequent trips. Residents perform daily activities without use private car. This can be explained as follows: Its radial grid street network pattern with high connectivity, permeability, accessibility and proximity provides access for transportation and services especially daily one within walking distance and avoid longer distances and time consumption. Its mixed use provides security and attractiveness for streets that become full of life, encourages walkability at any time of the day, especially with defining arcaded shaded walkways for pedestrians that provide safe paths for them. Its relative high density and community size increase feasibility to encourage public transportation and diversity of public mobility bus, metro and subway provide diversity of public mobility, enhance movement behavior and discourage private car (Ghonimi, I. 2017 c).

Observation of New Cairo streets revealed car oriented streets that discourage walkability and cycling and make public transportation as unacceptable solutions for commuting. A high frequent long distance trips, high traffic cognition at main streets and at peak hours. This can be explained as follow: Its treed street network with low proximity and connectivity make residents forced to move longer trip distance and higher frequent trips that consume more travel time, cost and effort to reach services. Its single use extends distance between services and residential units that make daily needs not met in neighborhood, services are positioned at large distance; beside streets lack surveillance attractiveness and reduced sense of safety and security. Its relative low density reduces community size, reduces feasibility of public transportation, reduces public choices and increase private choices.

a) Shubra streets welcoming for pedisterians (b): Helioplis welcoming for pedisterians. (c): New cairo discourge walkability.

Figure 6. Comparing Walk score (https://www.walkscore.com).

According to walk score, Shubra and Heliopolis record highest walkability score 90 and 95 of 100 respectively, these locations are walking dependent neighborhoods. On the other hand Jasmine recorded lowest Walk Score of 4 out of 100. This location is a Car-Dependent neighborhood so almost all residents depend on cars as shown in figure (6).

a) Shubra streets welcoming for pedisterians (b): Helioplis welcoming for pedisterians. (c): New cairo discourge walkability.

Figure 5. Comparing variation between three case studies in achieving better movement behavior.

4.1.3 Parking Demand

Observation of Shubra and Heliopolis revealed lack of car parking demand this is because of the high residential density that increase car demand even though a relative low rate of car ownership one car per family in Shubra and two cars per family in Heliopolis is recorded. In addition, observation revealed minimum dependency on private car and most reliance to alternative public transportation starting from Trams, Metro, Microbus and Buses that could contribute to solve the problem of traffic cognition (Ghonimi i. 2017 a; Ghonimi, I. 2017 c).

Observation of New Cairo revealed a huge lack of car parking demand, this is because plans of new Cairo was developed to accommodate one car per family and due the impracticality of public transportation and unsafe walkability and the high reliance to private car; the actual rates of car ownership are doubled from one car/family to two to three cars/family that require large number of parking and cause low efficiency in meeting resident's huge demand of car parking, in addition that most owners ignored housing regulations and convert parking basements to another function (Ghonimi i. 2017a; Ghonimi, I. 2017 c).

4.1.4 Traffic Cognition

Observation of Shubra and Heliopolis revealed high traffic cognition due to two reasons; the first based on diversity of land uses and facilities within the surrounding area that increases both areas attractiveness for adjacent community and result in traffic jams. The second, based on the high density and high community size that increase traffic volumes moving in narrow streets that cannot meet such traffic volumes accordingly a high traffic jam is recorded especially in most of Shubra narrow streets. It is clear that resident's movement behavior can contribute to reduce traffic jam especially if more part of their trips relies on walkability and public transportation, also recorded high community density that increase feasibility of public transportation and recorded high accessibility with short distance to public transportation could contribute to reduce traffic cognition by facilitating residents reliance to public transportation. Even though, a huge part of such traffic volumes caused by residents who are not welling the low quality public transportation; so an enhancement of the quality of public transportation could increase resident's dependency on mass transportation and reduce private cars and accordingly reduce traffic jams.

Observation of New Cairo reveals high traffic cognition, this is due to the spatial structure that cause low density and community size that reduce feasibility of providing public transportation and single use that reduce safety and livability of walkability and increase the distance to bus stations accordingly make it hard for residents to use public transportation or walkability and increase private car ownership, dependency, and increase frequent long distance trips caused high traffic congestion especially on arterial roads and at peak hours greater than traffic cognition that take place in traditional cities.

4.1.5 Sufficient and Efficient Provision of Services

Observation of Shubra revealed sufficient provision and efficient diversity of services; this can be explained as follow: It revealed relative high density and community size that create sufficient dense concentration of people that increases feasibility of providing sufficient services and viability of providing diverse range of services and public transportation. An expanded transit commercial axis with diversity of commercial uses is placed in buildings ground floor. In addition, its relative mixed-use and mixed-housing-income facilitate efficient diversity and choices of services and public transportation options, as shown in figure (6 a,b).

Observation and spatial analysis of Heliopolis, reveals that spatial fabric provides better integration with adjacent urban fabric. With considering to locate services and shopping facilities on linear axes to the perimeter of main roads, with internally point distribution of services inside the neighborhood this give live, accessibility and connectivity to the community but at the same time provide privacy for the neighborhood core.

Observation of New Cairo revealed insufficient provision and inefficient diversity of services, this can be explained as follow: Its relative low density and community size do not support sufficient viable range of services provision, and feasible public transportation. Its relative separate use and separate housing income lake efficient diversity, choices, and variation of services and public transportation options, as shown in figure (6 c).

a) Shubra mixed use on buildings scale (b): Helioplis mixed use on main streets scale (c): New cairo Separate use

Figure 7. Land use analysis of three case study areas.

4.2 Social Sustainability Indicators (S.I)

Social Sustainability considers the appropriateness of new development patterns to socio-cultural fabric of Egyptian society that implies religion, culture and social aspects and Egyptian people preferences. Traditions, advice that stability of society depend on good social relations among members of the society. Egyptian people prefer their city to be filled of life and abundant with activities to be safe and to achieve Ulfa, Lama, and Wanass (Ghannam 2002). They prefer familiarity and intimacy created through the gradual rootedness in a specific place to a long period based on gaining knowledge of others, place each other, know each other, and being able to place them. They prefer to feel satisfaction that comes through gathering people into one place. It aims to gather different population that brings good and bad together (Abdel khalek 2009). It aims to encourage public participation with other diverse community levels it considers a link to vital social life to enable the city to develop social relations and promote sense of engagements, involvement, and responsibility (Blokland-Potters, 2005; Reijndorp, 2004; Putnam, 2003). In addition, it considers engaging citizen into the society politically and psychologically (Sennett, 76). It aims to provide sense of safety and security for their residents and to self-reduce crime opportunities, surveillance, and territoriality without using reinforcement methods and physical instruments. Finally it aims to promote integrated mixed socio-economic diversity environments to create diversity of the amount housing types and the kind of human activities, i.e. walking, sitting, exchanges, and talking shared interests between them (Bahamam 2001; Camona 1997).

Social Sustainability indicators can investigated in terms social interaction, safety and security and diversity of the community. The following part shows the analysis and observation of such indicators with in Shubra, Heliopolis, and New Cairo.

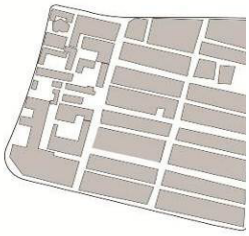
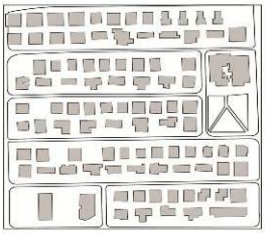
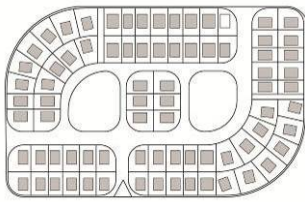
4.2.1 Social Interaction

Spatial analysis and observation of Shubra and Heliopolis revealed high accessibility and permeability fine grain spatial fabric and successful travel routes, shaded sidewalks that encourage walkability and increase accessibility to public transportation and services, in the other hand observation revealed welcoming public domain accessible for everyone and do not exclude any. All these factors generates large common ground shared by all community residents, adjacent community residents and passengers and different social groups for gathering them to exist inside common area in streets and urban spaces. It increases accidental and intentional chances for interaction between neighbors for meeting each other, connect to their community, know their neighbors and trust them. Accordingly streets work as social space that make interaction more likely happens intentionally and accidental.

In addition, it revealed relative high density and community size that creates proper dense concentration of people that increases chances of interaction between residents and make them able to know each other. In addition, it revealed relative mixed use that provides diversity and variety of commercial activities, inhabitants, visitors, tastes, and needs that creates attractiveness and safety that encourage gathering residents inside urban spaces to know each other. Finally, it revealed mixed housing income that gives residents the chance for diverse interact between residents and increases chance to exchange their experiences with other social groups. It could become an effective place for socializing future generation, and for exchange and contact of knowledge, experiences, and information with other diverse social groups as shown in figure (8 a,b) (Ghonimi I. 2017 d).

Observation of New Cairo revealed unwelcoming streets; sun shiny sidewalks and unwelcoming public domain that discourage walkability and reduces chances for meeting residents and knowing each other. Accordingly, social interaction is more likely occur by invitation, not by chance encounter. In addition, it revealed low accessibility and permeability in spatial fabric and low walkability and excluded public transportation that cause an exclusion not only of adjacent area residents but also community residents are excluded from streets and urban spaces, streets become traveling routes and left over's and out of life from residents and diminish its social role as part of public life. In addition, it lacks common shared public spaces by residents as in traditional cities, which increase the distance between community residents. In addition, it revealed single housing income and single use that increase distance between different social groups and discourage interaction of diverse resident's participation in social life. It revealed relative low density and community size that lack sufficient viable range of social interaction between residents. It revealed relative separate use and income that lakes the efficient provision of diversity and choices of social relations between diverse groups, as shown in figure (6c) (Ghonimi I. 2017 d).

Table 4. Comparing the variation between case studies in achieving social interaction.

Spatial parameters			
Walkability score	90%	95%	4%
Accessible Shared spaces	90%	60%	20%
Residential density	800 -1600 p/fed	400 -600 p/fed	60-120 p/fed
Mixed use streets	95%	75%	5%
Diversity of housing income	40%	80%	10%
			
	a) Shubra intensive social interaction	b) Heliopolis welcoming for interaction.	c): New Cairo discourages interaction.

4.2.2 Safety and Security

Observation of Shubra and Heliopolis revealed a common sense of safety and security between residents in their homes and in streets and public areas. It revealed mixed use that encourages walkability and public realm and attracts people continuous movement during day and night that provide continuous surveillance. It revealed relative high density and high community size that provide sufficient dense concentration of people that avoid empty spaces and make them full of people and provide a relatively high degree of continuous natural surveillance that provides residents with sense of safety and security. The high relationship exist between their residents make them define strangers and define criminals, accordingly reduce crime rates. On the other hand, the highly increased density in Shubra makes residents hardly know each other and acknowledge strangers than Heliopolis that revealed medium density that provide natural surveillance of streets than new Cairo and make residents define strangers than Shubra (Ghonimi i. 2017a; Ghonimi, I. 2017 b), as shown in figure (8 a,b).

Observation of New Cairo revealed a general sense of insecurity between residents in their homes and in streets and public areas. It revealed separate use that split service area from residential area and reduces through movement of people and cannot animate streets, it loses life and makes streets empty. Its relative low density and community size make streets empty of passengers, accordingly reduce natural surveillance and supervision all day and night and reduce sense of safety and crime rates. In addition, residents hardly know each other and lake trust and faith in their neighbors and hardly recognize strangers and offenders (Ghonimi i. 2017a; Ghonimi, I. 2017 b) , as shown in figure (8c).

a) Shubra (b): Helioplis (c): New cairo

Figure 8. Comparing variation between three case studies in achieving sense of security and safety.

4.2.3 Community Diversity

Observation of Shubra and Heliopolis revealed a general diversity and mix in building types, heights, shapes, functions, uses and diversity of people who are using urban spaces and accordingly diversity of activities and mode choices. It also encourages public domain with commercial axis that makes streets abundant with life and encourages public spaces as place of resident's interaction, involvement and participation. This can be explained as follow: Its mixed use including retail, shops, education facilities, and other services mixed with residential units makes it provide all sufficient and efficient diversity of activates. Diversity and mix make streets become vibrant that mostly enough walkability. Its compact mixed-use urban form with services in walking distance reduce travel distance and become welcoming for walkability that increases resident's chances for meeting each other in services area and while they are walking. In addition, its mixed housing income and diversity welcoming public spaces encourages relation between rich and poor and increase the social capital of the city.

Observation of New Cairo revealed a sole limitation in building types, heights, shapes, functions and type of people who are using streets and spaces. Accordingly streets public urban spaces are negatively affect livability of the city; isolating public streets from its life and creates post-public spaces that are limited to collect people mostly who can pay. This can be explained in term of four causes: first, new Cairo spatial segregated urban form cuts the continuity between residents; second, new Cairo low density reduces opportunities, choices and chances of types and quantities of human networks and reduces interaction; third, the reliance on single housing income, spelt-diversified residents for homogeneity and limit social interaction inside community to specific social group and exclude the others; Finally, Its separate use reduces diversity and variation in urban, visual and social relations. New Cairo city relies on single housing income and single use to reduce diversity and accessibility to exclude different housing income groups from urban spaces.

a) Shubra welcoming for inclusion of different housing groups. (b) Helioplis welcoming for inclusion of different housing groups. (c): New cairo discourge social cohesion and exclusion.

Figure 9. Comparing variation between three case studies in achieving diversity of public life.

4.3 Environmental Sustainability Indicator: (E.I)

GCR new towns are developed in the desert to the east and the west of old Cairo. They are categorized as an arid hot dry regions where a clear skies bring substantial high mean duration of sunshine in daytime, high level of solar radiation, excessively daytime temperature that mostly exceed 40°C, and a steep drop in night time temperatures, minimal rainfall, water scarcity and deficiency of suitable land for agriculture (El-Zamly H., 1994; Newton P., 2000; Engwicht D., 1992). Environmental Sustainable urban form in hot arid zones aims to reduce uncomfortable environmental conditions created by extremes heat and dryness, reduce resources consumption, and protect the environment by reducing pollution: It aims to acheive residents needs to perform daily uses commuting, thermal comfort and others, without consuming resources (energy and material), and without generating low emissions and producing little waste:

- Comfortable oriented urban form mitigates the impacts of environment conditions on outdoor and indoor built environment; its aim is to reduce uncomfortable environmental conditions created by location climate, to consider thermal comfort zone that make residents perform their daily life task in an efficient way. It aims to control thermal comfort by reducing heat gain caused by increased solar radiation SR, reduced wind flow WF, and increased relative humidity RH.
- Energy efficient urban form reduces commuting energy consumption and reduces cooling energy consumption. It aims to reduce cooling energy consumption due to solar heat gain. And reduce commuting energy consumption due to movement behaviour. And aims to reduce Commuting Resource consumption: (number of intersections, number of agrees, and continuity, distance to public transportation). Mechanical resource consumption (indoor environmental qualities, outdoor environmental quality).
- Low carbon emission oriented urban form avoids causing air and noise pollution, minimum waste. the impacts of emissions, either as air pollutants or as waste heat release

Environmental Sustainability indicators can be investigated in terms of achieving indoor and outdoor comfortable conditions, reduction of air and noise pollution, and reduction of energy consumption. The following part shows the analysis and observation of such indicators with in Shubra, Heliopolis, and New Cairo.

4.3.1 Achieving Confortable Indoor and Outdoor Environmental Conditions

In order to assess heat gain performance for indoor and outdoor built environment in hot arid zones, it depends on three main factors solar radiation SR, wind flow WF, and relative humidity RH. Controlling these factors could reduce heat gain inside buildings and accordingly achieve comfortable conditions. Reducing heat gain by conduction of solar radiation and by convection of air cooling can be explained as follow:

- Improving heat gain by exposed solar radiation depends on the conduction heat flow rate = A*U*ΔT. Where A is the area directed to solar heat, U heat transferee factor, and ΔT the temperature difference between indoor and outdoor. Exposed area for direct heat depends on street width, building heights; building density, these factors reflect the impacts of solar radiation on the amount of heat gain inside buildings in the three case studies (Koenigsberger, 2011).
- Improving passive cooling by introducing airflow between buildings depend on the convection heat flow rate = 1300*V*ΔT. Where V is ventilation rate, ΔT is temperature difference. To control the impacts of air movement on heat gain in indoor and outdoor environment; it highly depends on urban form where wind speed depends on distance between buildings, and buildings height; wind return to its speed after distance equal to 5to7 times building height. Regardless of good street orientation to wind direction, increasing distance between buildings could introduce more wind and air movement into the site, which improves natural ventilation and increase passive cooling inside buildings and urban spaces (Tendulkar, R. 2017)

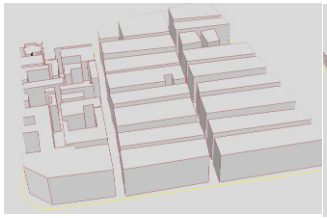
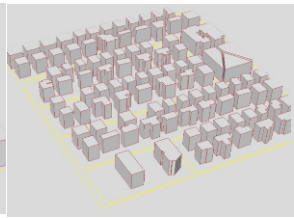
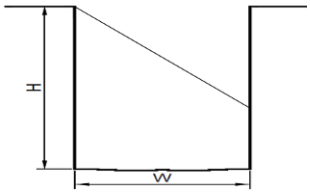
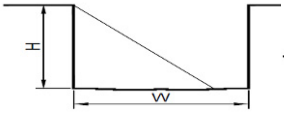
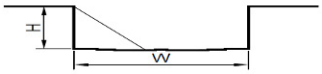
Table (5) provides spatial assessment analysis of the variations of heat gain and passive cooling performance between the three case studies.

Observation of Shubra revealed high protection from solar radiation and lower values of air movement that cause moderate heat gain inside buildings and inside streets urban spaces. Shubra narrow streets, compact urban form with close buildings distance, from the first hand it reduces buildings exposure to the solar radiation to protect it from direct heat gain and provides maximum shaded streets and spaces to protect from solar radiation and allow minimum reflection in streets and open spaces and reduce indirect solar radiation to avoid heating the air. The high shade density in streets and buildings facades provide obstacles for direct sunlight before it could warm the building and protect it from direct heat gain, and provide high protection from solar radiation, accordingly enhances thermal performance and reduces mechanical ventilation inside buildings. On the other hand, site high building density and buildings close proximity reduces wind speed and reduces air movement and reduces buildings exposure to wind that negatively reduce passive cooling and increase relative humidity and increase thermal island effect.

Observation of New Cairo revealed uncomfortable climatic conditions inside buildings and inside streets urban spaces in term of heat gain and a high performance of air movement. This can be explained as follow: Its large width streets and large distance sprawled buildings increase heat gain and allow maximum reflection in streets, and maximize direct solar radiation that heat buildings. Streets and open spaces don't provide shaded walkways rather it is exposed to sun all the day. Its typically wider streets standalone separated buildings increase exposed direct solar radiation and increase heat gain accordingly reduce achieved confortable conditions and make residents search for mechanical alternatives. New Cairo low proximity increase heat gain by solar radiation but at the same time reduces heat gain by air movement.

Observation of Heliopolis revealed efficient heat gain performance due to moderate building density and moderate distance between buildings that give the chance for relative low exposure to sun solar radiation than new Cairo that reduce heat gain and allow better protection from sunshine, and give the chance for relative high air movement than Shubra that increase passive cooling and heat loss by ventilation, and enhance heat gain performance and reduce cooling energy consumption.

Table 5. Comparing the variation between case studies in their performance in reducing heat gain by solar radiation and increasing passive cooling by air movement

Spatial parameters			
Buildings Foot print	80%	50%	25%
Building height	8-10	6-8	2-3
BuildingS density (FAR)	800%	400%	50%
Heat gain by solar radiation	30%	70%	100%
Sadow density on buildings	100%	75%	10%
Shadow Desnity on streets	100%	75%	10%
			
H/W ratio	4	1	0.5
Air movment H/W ratio	20%	50%	90%
Direct heat to streets	36	24	12
Reflected heat gain	12	3	0
			
Solar radiation	Lower exposure to the solar radiation.	Moderate exposure	Very High exposure
Air movement	Low possibility of air movement	Acceptable wind movement	Easy and open wind movement
Passive cooling and heat gain	Acceptable thermal performance in term of solar radiation and weak performance in term of air movement.	Acceptable thermal performance in term of solar radiation and air movement.	Weak performance in term of solar radiation and acceptable in term of air movement.

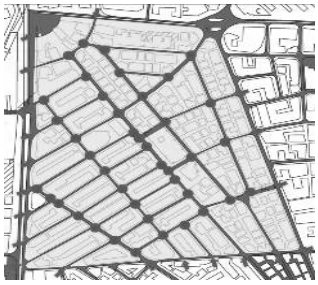
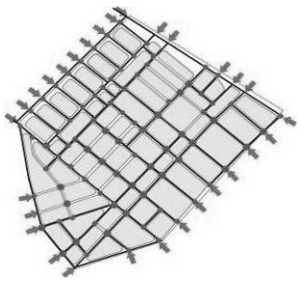
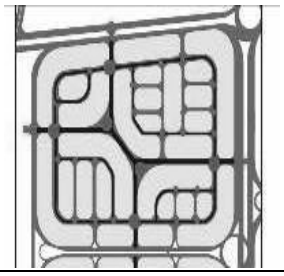
Furthermore a comparison of typical street section reveals that Shubra provide high H/W ratio of 4 that increase shaded streets and increase shades of buildings to each other and accordingly increase protection of streets and buildings from direct solar radiation. On the other hand New Cairo provide H/W ratio of 0.5 that reduce protection of streets and buildings from solar radiation and increase heat gain. In the other hand it worth impacts residents welling to walk, accordingly impact high energy for commuting and for cooling architecture spaces. On the other hand Heliopolis provide an optimum solution for H/W ratio that give moderate shading values with better air flow on the other hand most of its streets designed with arcade to provide shaded areas for pedestrians.

4.3.2 Resources Consumption

Regarding commuting energy consumption, observation of Shubra revealed reduced commuting energy consumption compared to Heliopolis that reveled moderate commuting value followed by New Cairo that records higher commuting values. This can be explained due to its compact form, high population density and mixed short distance services that are in walking distance that generate short distance trips in welcoming street that encourages walkability, increases feasibility of public transportation and reduce car dependency; accordingly it reduces travel distance, fuel consumption and commuting cost. Overall, its low rates of car ownership and low dependency on private car and reliance to walkability and public transportation reduce energy consumption.

On the contrary, observation of new Cairo revealed high commuting energy consumption due to its low density, large sprawl areas, separated large distance buildings and sprawled homes located at great distances from services out of walking distance; that causes long distance trips that make residents make commuting depends mainly on private cars and discourage walking. In addition it creates bad movement behavior that create more frequent long distances trips accordingly, it causes excessive consumption of commute energy, times, cost, and cause traffic congestion. In addition to its high rates of car ownership that put pressure on commuting energy consumption. It is predictable to generate huge daily and weekly trips.

Table 6. Comparing movement behavior between three cases studies

			
Type	Grid	Grid	Herarchial (Loops & cul-de-sac)
Orintation	Outward orinted	Outward orinted	Inward orinted
Relation	Continuity with surrounding	Continuity with surrounding	Contrast with surrounding
No. of access point	72	31	4
No. of continuous	53	14	2
No. of intersections	170	55	16
No. of loops	0	0	8
No. of cul-de-sacs	0	0	0
No. of blocks	180	63	20
Road percentage	10-20%	20-30%	30-40%

a) Shubra.

(b) Helioplis.

(c): New cairo.

Regarding cooling energy consumption, based on the deduced impacts of urban form on heat gain performance, it can be concluded that Shubra revealed low cooling energy consumption, due to buildings low proximity that achieve lower heat gain in term of reduced solar radiation and reduce energy consumption to provide cooling. On the contrary New Cairo revealed higher energy consumption due to buildings large distance that increase its exposure to outer environment accordingly, it fails to reduce heat gain inside buildings especially in cases of bad orientation of buildings, hence it increase cooling energy consumption. Heliopolis revealed efficient cooling energy consumption due to the moderate buildings proximity that give chance for relative low exposure to the environment than new Cairo and relative high air movement than Shubra, and accordingly enhance performance of reducing heat gain by solar radiation and increase heat loss by air movement and accordingly reduce cooling energy consumption, as shown in table (4).

Regarding land consumption, observation of Shubra revealed large footprint more than 70%, high building height (7 to 10 floors), high building density and accordingly high residential density of 1000to 1400 person per fedan, accordingly it records lower land consumption factor. On the other hand Heliopolis records moderate footprint 50%, moderate building height (5 to 8 floors) and moderate building density that records moderate residential density of 300to 500 person per fdan, accordingly it records moderate land consumption factor. Finally New Cairo city recorded lower foot print not exceeding 25% foot print, lower building height (2 to 3 floors) and lower building density (FAR) that create low residential density not exceeding 120 person/fedan accordingly it records very high land consumption factor.

Regarding water consumption, observation of Shubra reveals a small green areas restricted to separate distributed trees is observed that revealed relative low water consumption. Observation of Heliopolis revealed relative medium green area with moderate density to total area. Observation of new Cairo revealed higher water consumption based on large open spaces with no shaded spaces mostly includes large green areas.

4.3.3 Environmental Pollution

According to the functional analysis of traffic cognition, it is observed that Shubra and Heliopolis revealed high noise and air pollution due to the high recorded traffic jams. Observation of New Cairo revealed in one hand lower air pollution in micro level on the other hand it revealed higher noise and air pollution on macro scale level. Observation revealed increased co2 emission, air and noise pollution during much of the day.

4.4 Economic Sustainability Indicators: (EC.I)

Economic Sustainability considers the appropriateness of new development patterns to socio-economic aspects of Egyptian community that implies both efficient economic aspects and the equitable social aspects of using environment resources. An environmental-economic sustainable settlement is the one that create environment compatible planning that can reduce energy consumption to fit climate impacts hence reduce using mechanical ventilation, cooling and lighting, and encourage residents to reduce relying on private cars and depend on alternative modes including walking, cycling, and public modes of transportation. Such modes reduce energy consumption and can reduce traveling distance, fuel consumption, and travel cost. Besides, it reinforces street as public spaces that encourage pedestrian travel and bring people together, to encourage economic arrangement, facilitate street activity and support retail businesses. It is efficient in increasing opportunities of exchange, public life and streets activities (Jacobs, 61). In addition, a social-economic sustainable settlement is the one that comes through equitability in economic growth regarding resources distributions, citizen participation, access to services, and concern for all members of the community.

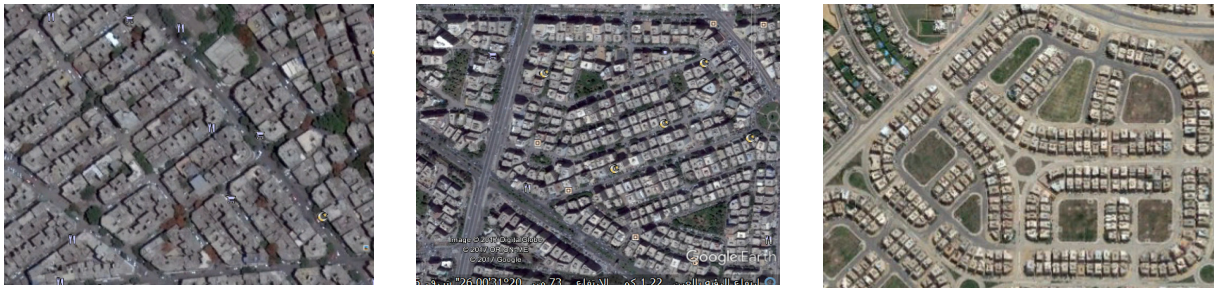
Economic Sustainability indicators can be investigated in terms of reduction of commuting energy, reduction of cooling energy. The following part shows the analysis and observation of such indicators within Shubra, Heliopolis, and New Cairo.

4.4.1 Efficient Use of Resources

Based on spatial and environmental analysis of Shubra, it revealed low passive cooling with low heat gain by solar radiation that make residents reduce cooling energy consumption, especially in streets that have good orientation to wind direction, otherwise a high cooling consumption is recorded. On the other hand it makes residents rely on non-mechanical or public travel behavior that reduces commuting energy consumption, cost and time in settlement scale. In addition, it reduce energy, land, and water consumption in comparison to modern settlements. It revealed low development, construction, infrastructure, transportation, and operation cost.

On the contrary, based on spatial and environmental analysis of New Cairo, it revealed high passive cooling that can fix heat gain by solar radiation and make residents reduce cooling energy consumption, but in cases of bad buildings and streets wind orientation a high cooling energy consumption is expected to overcome the excessive heat gain; on the other hand it make residents rely on travel modes and travel behavior that consume high commuting energy consumption in settlement scale. It caused a huge energy, land and water consumption in comparison to traditional settlements.

Based on spatial and environmental analysis of Heliopolis, It revealed moderate efficiency in reducing heat gain caused by solar radiation and revealed moderate efficiency in passive cooling caused by good orientation due to relative acceptable distance between building accordingly it causes a relative efficient use of resources. On the other hand it gives residents the choice to use public travel behavior and reduce commuting energy consumption, cost and time in settlement scale. In addition, it optimizes energy, land, and water consumption in comparison to modern and traditional settlements. It revealed relative low development cost.



a) Shubra (b) Helioplis (c): New cairo

Figure 10. Comparing variation between three case studies in achieving efficiency of using resources.

4.4.2 Equitable Management of Resources

Observation of Shubra and Heliopolis revealed equitable growth for all community members including all different income groups. It revealed equal access to urban spaces, streets, services and facilities. On the other hand it revealed feasibility of affordability and variety of housing sizes and prices to achieve balance of housing distribution especially for low income. It revealed a reduction in housing production and operation cost, where high building density, high residential density, low land consumption, shorter roads and infrastructure make it more affordable for low-income people. In addition it revealed low operation economic cost in terms of low cooling and commuting energy consumption, low provision cost of services and public transportation in terms of high economic feasibility in high density.

On the contrary, observation of New Cairo revealed inequitable growth for all community members, and exclusion of mid and high income. It revealed limiting access to urban spaces, streets, services, and facilities to high income groups who can contribute more than mid and low income to growth. In addition, it revealed high housing production and operation cost, where low building density, low residential density, high land consumption and longer roads and infrastructure make it less affordable for low-income people. It revealed high operation cost, in term of high commuting and cooling energy, high provision cost of services and public transportation in terms of low economic feasibility in low densities. It revealed a housing imbalance for low income groups.

(a) Shubra (b) Helioplis. (c): New cairo.

Figure 11. Comparing variation between three case studies in achieving equity of income distribution.

4.4.3 Economic Opportunities:

Observation of Shubra and Heliopolis revealed reinforcement of street as public spaces that encourage pedestrian and biking travel and aims to bring people together to support economic activities. It revealed relative high density and community size that increases the economics of size to support sufficient viable range of economic activities. Finally, it revealed relative mixed use and mixed housing income that also increases the economics of diversity to support efficient diversity, choices, and variation of economic activities. All these factors encourage exchange, economic arrangement, street activity, and retail businesses to support economic opportunities.

On the contrary, observation of New Cairo revealed fail to reinforce streets as public spaces so it dislodge pedestrian and biking travel and fail to bring people together, which could discourage economic activities. In addition, it revealed relative low density and community size that reduces the economics of size to fail to support sufficient viable range of economic activates. It revealed relative separate use and separate housing income to reduce economics of diversity that lake efficient diversity, choices, and variation of economic activities. These factors discourage opportunities of exchange, economical arrangement, and street activity to dislodge economic opportunities.

(a) Shubra (b) Helioplis. (c): New cairo.

Figure 12. Comparing variation between three case studies in achieving economic opportunities.

4.5 Overall Sustainability and Learned Lessons from Traditional Cities

To summarize, modern neighborhood compared to traditional one did not solve the urban, functional, social, and economic problems of old towns rather it becomes part of a relevant development problems of new settlements. When measuring new settlements to sustainable development indicators it is found to stand short to achieve them as the comparison is summarized in table (7).

The early developed neighborhood like Shubra provides efficient values in term of functional connectivity, permeability, and proximity within micro and macro community. It revealed sufficient services requirements and efficient diversity and choice of public transportation mode choices and services. It seems to enhance urban mobility, mode choices, trip distance and frequency. Social wise, it seems to achieve high social interaction between residents and provide them with high sense of safety and security based on high surveillance and social relations and contraction between residents, and mostly it encourage residents to exist in urban spaces and encourage diversity inside urban spaces. Furthermore, it depends on reducing distance between buildings and reducing exposure to the environment and increasing shade density to buildings and to streets accordingly it cause lower heat gain by high protection of solar radiation accordingly it cause lower cooling energy. Economic wise, It provide economic opportunities for economic interaction and building work opportunities and increase land value. On the contrary, It is concluded to achieve some development problems in term higher traffic cognition, lower parking area, lower air movement that reduce passive cooling performance and cause high air and noise pollution.

On the contrary, New Cairo proved to achieve development problems; it failed to provide people with alternative varying transportation options, it discourages the public realm, walkability, and it increases reliance on private car with increasing private car trip frequency and distances and increase cognition. Beside it cause a shortage in parking areas, high frequent long distance trips, high traffic cognition at main streets, and high traffic cognition at peak hours greater than traffic cognition that take place in old traditional Cairo. In addition, it did not provide sufficient interaction between residents, and reduces sense of safety and security in streets and in buildings, and probably increase crime rates. It is not efficient in using resources, and not equitable in distribution to all community members. In addition, it does not consider the negative impacts on the environment and do not save their resources. New Cairo revealed increased fuel, energy and resource consumption, and sprawl and needs much more green, trees, and shading elements. Finally, it consumes high communizing cost it reduces equitability of residents to all services and facilities, it reduces economic of size and diversity that reduces benefits of sufficiency and efficiency of economics of providing services and public transportation. On the contrary, new Cairo proved to achieve some positive impacts, it provides sufficient parking areas with lower traffic cognition, good air quality with minimum air and noise pollution.

Heliopolis revealed relative efficient sustainability than the two extremes of new Cairo and Shubra. Regarding functional sustainability performance, it provides sufficient dense concentration of people that provide sufficient services than new Cairo and in acceptable limit to provide green spaces of beatifications than Shubra; In addition it encourage walkability and public transportation than new Cairo in the same time it provide private cars availability. Regarding social sustainability performance, it provide relative high sense of safety and security based on the high continuous surveillance of streets than new Cairo and provide relative high sense of security based on neighborhood familiarity in defining intrusions and criminals than Shubra, and accordingly enhance social performance. Regarding environmental sustainability performance, it provides relative high performance in protection of solar radiation than new Cairo and at the same time provides relative high performance in increasing passive cooling through air movement than Shubra. In addition, it provides moderate concentration of people with relative low noise and air pollution than Shubra. Regarding Economic sustainability, it provides relative low commuting cost than new Cairo.

Table 7. Comparing Sustainability of Shubra, Heliopolis, and new Cairo settlements

	Sustainability Principles	Shubra (Early Developed District)	Heliopolis (Early planned District)	New Cairo (New Planned District)
Urban Sustainabilty	**Integration with city.**	Encourage and Facilitate the integration.	Encourage and Facilitate the integration.	Discourage the integration.
	Connectivity , Permeability	Increase permeability, proximity and accessibility.	Control permeability, proximity and accessibility.	Reduce permeability, proximity and accessibility.
	Movement Behavior	Encourage walkability and cause short distance low frequent trips	Encourage walkability and cause short distance low frequent trips	Encourage private car and cause long distance high frequent trips
	Traffic Cognition	Cause high traffic cognition	Cause high traffic cognition	Cause high traffic cognition
	Sufficient services	Provide sufficient services within walking distance	Provide sufficient services within walking distance.	Fail to provide required services
	Efficient services	Provide high range of diversity of services within walking distance	Provide range of diversity of services within walking distance	Fail to achieve diversity of services
Social Sustainabilty	**Social interaction.**	Depend on public realm and enhance face to face interaction	Depend on public realm and enhance face to face interaction	Reject public realm
	Safety and security.	Provide high surveillance during day and night	Provide high surveillance during day and night	Unsafe for their residents
	Encourage diversity.	Include different land uses m housing types	Include different land uses m housing types	Mono use depend on residential units
	Social appropriateness.	Well preferred by Egyptian residents.	Preferred by Egyptian residents.	Disappointed by Egyptian residents.
Environmental sustainability	**Consider the environment.**	Consider the dry hot climate with scarcity of water.	Consider the dry hot climate with scarcity of water.	Neglect the strict climatic conditions of hot arid climate
	Comfortable Condition	Passively create indoor and outdoor comfortable environment, reduce heat gain caused by solar radiation.	Passively reduce heat gain of solar radiation and increase heat loses by air movement.	Create uncomfortable high heat gain that requires mechanical alternatives.
	Reduce Commute Energy	Reduce trip distance, frequency and reduce reliance on private car.	Reduce trip distance, frequency and reduce reliance on private car.	Increase trip distances, frequency, and depend on private cars.
	Reduce Cooling Energy	Minimize consumed energy, as it provides passive confortable conditions.	Minimize consumed energy, as it provides low heat gain in term of solar radiation and air movement.	Maximize cooling energy consumption based on high exposed solar radiation.
	land, water, energy consumption	Minimize land, water, and energy consumption	Minimize land, water, and energy consumption	Maximize land, water, and energy consumption
	Reduce air and noise pollution	Increase air and noise pollution	Mediate air and noise pollution.	Reduce air and noise pollution.
Economic sustainability	**Efficient use of resources.**	Reduce energy. land and water consumption	Reduce energy, land and water consumption	High rate of energy land and water consumption
	Equitable use of resources.	Provide houses for different income in affordable construction, operation cost	Provide houses for diverse income in affordable construction, operation cost	Provide houses for single housing groups with high construction, operation cost
	Economic interaction	Enhances economic interaction	Enhances economic interaction	Discourage economic interaction
	Commuting Cost	Consume lower commuting cost	Consume low commuting cost	Consume high commuting cost
	Benefit economics of size	Increased community size increase economics of providing services and public transportation.	Increased community size increase economics of providing services public transportation.	Low community size limits its resources, and fails to provide services public transportation.
	Benefit economics of diversity	High community size with mixed income groups increase viability to provide diversity of services	High community size with mixed income groups increase viability to provide diversity of services	Rely on single housing types that discourage diversity and fail to benefit of economics of diversity.

5. Conclusion

This paper compares the sustainability of traditional versus modern urban development patterns in order to deduce strategies for management of sustainability of new settlements in Greater Cairo Region. It introduces some evaluation indicators that are derived from two evaluation criteria, modern theories of sustainable urban form versus local context in terms of unique environmental, social, and economic circumstances. The paper reveals that New Egyptian settlements have no design reference in theories of sustainable development; new settlements stand short when measured to UN principles for sustainable communities. It is also concluded that traditional settlements could provide better solutions for new settlements development.

The analysis of the sustainability of new towns shows that adopted modern neighborhoods in New Egyptian settlements generate fundamental problems which bring into doubt that new towns can achieve sustainability rather they are not suitable for development in a unique context like Egypt; they are not compatible with environmental, social, and economic context. New community's socio-spatial features have a deep impact on spatial and social fabric of our cities; accordingly, they have deep impacts on sustainable urban development, which can revolve around four main axes:

- In term of Functional sustainability, new settlements in comparison to traditional cities have no design reference in theories of successful spatial fabric and could build week spatial fabric, it create low permeability, connectivity, and accessibility and could increase travel distance and make it hard to reach places inside urban fabric. In addition, it could affect sustainable mobility and could increase trip distance, frequency, and make modes choices depend mainly on private alternative and discourage public transportation and walkability, In addition it reveled high traffic cognition and high number of parking requirements but do not meet the high rate of car ownership.
- In term of Social sustainability, new settlements in comparison to traditional cities have no design reference to social sustainability and to local social context. It could reduce the chances people can meet each other and discourage interaction and face-to-face contact. In addition, it reduces safety and security issues, it could make streets as empty as to reduce surveillance and accordingly could facilitate crime and reduce resident's sense of safety. In addition, it does not provide the required diversity, and variation required in urban and architecture forms, and lake social relations between residents of diverse social groups, and lake alternatives forms for movement behavior and transportation options.
- In term of Environmental sustainability, new settlement in comparison to traditional cities, don't consider climatic condition of Egyptian desert and don't regard the environmental concerns that have been recommended for arid regions. It failed to passively provide confortable conditions inside buildings and in urban spaces, accordingly it consume more energy to replace the natural environmental solutions with mechanical artificial energy consuming solutions. It causes high energy consumption to meet the high motorized commuting modes reliance and high commuting trips, and to meet the mechanical ventilation that are used to face the uncomfortable conditions caused by excessive heat gain. In addition, it causes air and noise pollution.
- In term of Economic sustainability, new settlements in comparison to traditional cities have no design reference to economic sustainability and local economic conditions in Egypt. It could reduce equitability of resource distribution, increase commuting energy, time, and cost. It reduces the economics of diversity that fail to provide sufficient provision of services for its residents. In addition, it failed to provide efficient diversity of services within walking distance.

There is a need for developing new communities based on a deep awareness of the impact that new patterns could impose on urban development in Egypt environmental, social and economic unique circumstances. Municipality should consider the impacts of neighborhood model on the achieved sustainable development when they are preparing urban legislation and design regulation tools.

The research concluded that both traditional early developed settlements like Shubra that has extremely high residential density (1200-1500 person/fedan), compact high building density (FAR 500-600%), foot print (80%), height (8-12 floor), high fine grain street network (high intersection density), high mixed use (80-100% mixed use) on most of the buildings, and mostly rely on single low and lower middle income; and the new planned settlements like new ciao city that have has extremely low residential density (50-100 person/fedan), sprawled low building density (Far 50-100 %), foot print (25%), lower height (2-4 floors), lower mixed use on community scale (8%), and rely mostly on single housing income, both of them have negative impacts on sustainability, each one in its own way. Furthermore, the early planned settlements like Heliopolis that originally planned as garden city with low residential density, building density, building height, in separate use; and that have transformed

with process of intensification into mixed use at most of main streets, moderate building density (FAR 200-300%), moderate building height (5-8 floor), moderate residential density (400-500 person/fedan), that also provide mixed housing income near each other could provide optimum performance for sustainability indicators.

The research recommends a partial return to traditional mixed-use, high density, and fine-grained outward oriented and integrated with the city with high connectivity and permeability to get lessons to build new communities. This give site in to how to pave the way to plan new settlements and how to repair the existing new settlements. The built and occupied new Egyptian cities need to consider partially or fully a process of intensification by increasing residential density, building density and building heights, and force mixed use and remove parries and change boarders into services and commercial activities and encourage connectivity and permeability of urban fabric. There is a need for intensification toolkit repair tool to enhance movement behavior, based on pedestrian encouragement, public transportation feasibility, to encourage resident's interaction and to reduce negative impacts on the environment and reduce resources consumption.

The study draws lessons from traditional settlement in their aim to achieve sustainability, livability, healthy community, and drawn lessons from Heliopolis that have been transformed with intensification, change to mixed use and building intensification form early planned garden city model to traditional one, as a way for curing the contemporary problems of development:

- Adopting conventional grid street network patterns to increase urban permeability, connectivity, accessibility and proximity inside urban fabric that could enhance movement behavior and reduce trip distance and frequency, and make mode choices depend on walkability and public transportation. In addition, it socially affects resident's interaction and environmentally reduces resource consumption and economic wise reduce commute cost, time, and effort.
- Adopting relative high density to increase feasibility of public transportation and increase density of services, accordingly enhance movement behavior of residents and reduce their need for long distance and high frequent trips and make them rely on public transportation and walkability. In addition it could increase their interaction and sense of safety since it increase surveillance to streets, beside it benefits of economic of size to have all their daily needs within walking distance.
- Adopting relative mixed use to positively affects movement behavior and makes it safe for resident to rely on walkability and discourage private cars and support public transportation. It increases the chance of meet neighbors, knows them, and accordingly increases the social aspects of sustainability.
- Adopting relative mixed use and high building compaction to increase environmental appropriateness, reduce heat gain, increase passive cooling, and reduces energy consumption in New Cairo city on the other hand it aims to reduce commuting energy consumption and travel time and cost.
- Adopting relative mixed use and relative mixed housing income to increase diversity of the community and provide attractiveness and diversity of building types and heights, diversity in social relations, diversity of provided transportation options and efficient diversity of services.

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