A statistical methodology for the socio-spatial assessment of neighborhood life quality

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Abstract: Many housing projects suffer from striking dissonance between the physical built environment and their social life. Accordingly, there is a significant need to deduce socio-spatial assessment tools that can predict the resulting community satisfaction based on realizing their psychological and social needs (nonphysical aspects) in terms of the components forming the built environment (physical aspects; architectural, urban design, and planning) to provide an acceptable level of social life quality. From this view, this paper presents a statistical methodology for predicting these qualitative aspects through conducting a questionnaire on four neighborhoods of intermediate social housing level, in Egypt.

Subjects: Development Studies, Environment, Social Work, Urban Studies; Urban Studies; Development Studies

Keywords: socio-spatial analysis; weighed satisfaction; physiological need; social needs; neighborhood; sustainability assessment tools

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- Assessment of Neighborhoods Theoretical Models According to Comparative Measurement Tool.
- Statistical Assessment for The Role of Neighborhood Facades in Social Satisfaction: Case Of 6th October City.
- The Concept of Social Sustainability in The Context of Neighboring Residential Design.

This research is a new step in her scientific work towards social sustainability in built environment.

PUBLIC INTEREST STATEMENT

Life quality, which reflected on human stability in built environments and sustained communities, was a difficult assessment because of its tangle with many fields such as environment, economic, decision-making, culture, etc. This perspective article deduces socio-spatial assessment tools that can predict resulting life quality in neighborhoods based on realizing residents psychological and social needs. It was found that the models presented a method for calculation of either the psychological or the social aspects or the total of both of them within the given values of one or all of the neighborhood’s built environment components. The research was studied for the types of intermediate social housing level. The findings imply the decision makers and governmental authorities should use the deduced socio-spatial assessment tools as a significant guide for setting their priorities and orienting investments within defined milestones that target community satisfaction in the first place.
1. Introduction
The concept of “urban life quality” emerged during the late 1960s and early 1970s when the environmental crisis became a major global issue. Since that time, the term continues to be used by behavioral scientists, government personnel, design practitioners, and others. It always refers to whether people live well or poorly (Proshansky & Fabian, 1986). Urban life represents more than integrating a variety of physical configurations; it incorporates a social life that implies the necessity of satisfying psychological, and social community needs.

In order to investigate the vitality of the psychological, and social neighborhood – nonphysical – aspects (qualitative and subjective dimensions) in relation to its physical ones (quantitative and objective dimensions) and the significance of their correlation on the resulting life quality that is interpreted through the residents’ satisfaction and to test this through statistical measurable methods, it is essential to elaborate on the basic concepts of the neighborhood as an urban and a social entity and shed light on its assessment tools. The research consecutively includes the two sets of variables, and then tests the validity of these variables to be included within the statistical model that digitally deduces the effect of the physical aspects as independent variables on the nonphysical ones as dependent variables.

The model is tested on two types of intermediate social housing levels: the first is referred to as the free housing type and the second is the institutional one. In the former, the local authority of the city provides land lots’ subdivisions with infrastructure and public services, ready to be sold for residents. In the latter, an institution such as a bank or a social organization establishes all the neighborhood (house buildings, public services, infrastructure, …etc.) and puts up for sale the residential units for inhabitants.

2. Literature review: neighborhood quality of life’s aspects
Neighborhood formerly embodied the smallest unit of the city from as early as 1920. For the social and urban experts, this concept expressed the total territory of life in the local level (Mann, 1970). The definition of the neighborhood was consecutively addressed in many fields:

In the psychological science, “Ruth Glass” described it as a distinct territorial group of people representing specific physical characteristics for its area and other specific social ones for the inhabitants (Smith, 2010), aiming at satisfying main human needs (Mann, 1970), with intensive face-to-face social interaction. (Glass, 1948; Smith, 2010; Suttles, 1972). Moreover, “Ross & Reimer” added that it should accommodate a chance for relaxation and stress relief. (Mann, 1970).

As for the social science: it is rather viewed as a simple built environment (incorporating houses, school(s), playground(s), shopping center(s), and transportation station(s)) in which a mother feels her children are safe (Gallion & Eisner, 1963; Girling & Kellett, 2005). In addition, its size is relevant to motivate neighbors’ interaction (Deng, 2011), and enhance good communication among them for a healthy social and physical life (Gallion & Eisner, 1963).

In the urban environment management science: it is conceived as the smallest local geographic area in the city with homogeneous characteristics (Deng, 2011; Frey, 2005; Gallion & Eisner, 1963), possessing a census tract, ZIP Code, physical boundary, and with almost the same demographic characteristics (National Institute of Justice (NIJ), 2009).

Generally, all definitions of the neighborhood concentrated on physical built environment and human social life as explained by the theorists, such as Hall who mentioned than the visual and aesthetic harmony in built environment reflects on the emergence of a harmonious social order (Hall, 2002), while Lefebvre confirms that the society’s spatial refers to the physical manifestation of areas (Lefebvre, 1991), whereas Gehl classified human activities according to opportunities in the built environment (Gehl, 1987). From this view the quality assessment of neighborhood as built environment mainly has social aspects.
The neighborhood quality assessment, planners and environmentalists began to investigate this issue in the 21st century, in an attempt to achieve sustainability, with its focus on three main aspects (Litman, 2008):

First, environmental aspects: including natural environment, pollution, climate change, and biodiversity. Second, economic aspects: including economic efficiency, productivity, business, employment, and taxes. And finally, social aspects: including social welfare, justice, human health, cultural and historical identity, and participation.

Other neighborhood sustainability assessment tools were investigated in the United States with the National Environmental Policy Act (NEPA) in 1969, a project for environmental impact assessment. It was mainly developed to test the effect of the economic and social transformations of the twentieth century on human environment (Costanza et al., 2007). Most of these relevant tools prioritize the environmental aspects, with less focus on social ones; concerned with achieving justice, and social and psychological community satisfaction.

Many researchers studied the quality assessment of neighborhood life with focus on the built environment and people, which is named quality of urban environment life (QOUL). QOUL is related to linking the objective dimensions of the urban environment and people’s subjective evaluations of the urban environment (McCrea, Marans, Stimson, & Western, 2011a). The objective dimensions include the characteristics of the urban environment while the subjective ones focus on the notion of satisfaction with place or where one lives in the urban environment (McCrea, Stimson, & Marans., 2011b).

Objective dimensions refer to the physical features of the neighborhood. It can be mainly measured by units such as distances, and densities. According to Roderick Peter McCrea, it is related to distances from services and facilities; distances to rural and semirural land; and distances from the coast; population, housing and road densities. Thus, they include land use and planning transport infrastructure in the form of three main sets: first, accessibility measured by the straight-line distance (in meters) between the respondent’s residence and the closest facility of type, with four variables: secondary school distance, regional shopping center distance, sporting facility distance (including parks, swimming centers, bowling centers, golf courses, rifle ranges, soccer fields, and tennis courts), and hospital distance. Second, objective density was measured with two variables: Population density (per square kilometer), Dwelling density (per square kilometer). Third, cost of housing was measured with two variables related to the cost of renting: the cost of purchasing dwellings in the resident’s Census Collection District, the cost of renting, and the percentage of rented dwellings (McCrea, Shyy, & Stimson, 2006). Whereas, the objective social dimensions are related to household structure; socioeconomic environments; disadvantaged environments; and ethnic environments (McCrea, 2007).

As for the subjective dimensions that represent people satisfaction in urban features, they included three groups. (Sirgy, Rahtz, Cicic, & Underwood, 2000). First, business-related services (e.g., banks, restaurants, hotels, radio stations, television stations, private schools, etc.). Second, government-related services (e.g., law enforcement, fire department, rescue squad, public schools, public hospitals, social services, etc.), and third, nonprofit services (e.g., religious organizations, and services supporting the vulnerable segments of the community such as children, the poor, etc.). Sirgy and Cornwell introduced subjective dimensions into three major categories: physical, social, and economic (Sirgy & Cornwell, 2002). The physical ones include: upkeep of homes and yards, landscape in the neighborhood, the street lighting in the neighborhood, crowding and noise level, nearness of neighborhood to facilities needed, and quality of the environment in the community. Social include: social interactions with neighbors, the outdoor play space, living in the neighborhood, relations within the community, rate of crimes, racism, and privacy satisfaction. And finally, economic: home value in the neighborhood, cost of living in the community, socio-economic status of neighborhood, and neighborhood improvement. Other categorization was introduced by Diener,
et al. including: Pleasant effect; for example, joy, elation, contentment, or indeed happiness as a feeling. Unpleasant effect: for example, shame, sadness, and anxiety, and finally life satisfaction, either overall life satisfaction or satisfaction in particular life domains (Diener, 1984; Diener, Suh, Lucas, & Smith, 1999). Michalos and Zumbo defined a five-group subjective: housing, recreational activity, transportation, government services, and residential area (Michalos & Zumbo, 1999), while McCrea and his colleagues have examined different geographic levels of subjectivity including regional services; such as health and education, the cost of living, neighborhood crime, and public facilities (parks, libraries, etc.) (McCrea, Stimson, & Western, 2005).

Turksever and Atalik used seven indicators as subjective dimensions: health, climate, crowding, sporting, housing conditions, travel to work, and environmental pollution (Turksever & Atalik, 2001). Whorton and Moore studied six dimensions related to the community development, leadership development, and industrialization, including concern for: crime, the availability of jobs, access to adequate health care, available housing, satisfaction with public education, and satisfaction with community (Whorton & Moore, 1984).

The measurement of QOUL depends on subjective and objective urban environment indicator evaluations. McCrea has examined them at a broad level by investigating the relationships between objective density and subjective overloading where he presented a composite measure content pollution, loss of natural areas, traffic congestion, and cost of housing as urban problems (McCrea, 2007).

The studies which focus on objective QOUL typically include many objective characteristics of the urban environment, often through combining or weighting objective indicators by using index for ranking places. Other studies also emphasized the trade-off between positive and negative aspects of urban living (McCrea et al., 2011b). For example, Blomquist et al have modeled the trade-off between housing costs, wages and amenity. Hedonic wage and rent equations were used to derive implicit prices for various urban amenities (Blomquist, Berger, & Hoehn, 1988). Cicerchia et al. have theorized the trade-off between city effect and urban load. City effect relates to “access to superior urban functions, opportunities and services” available by virtue of a city’s size. Urban load relates to a number of negative consequences of urban growth, for example, congestion and environmental degradation (Cicerchia, 1999).

Subjective involves both feelings and subjective judgments, they relate to evaluations of satisfaction with various aspects of life in psychological processes (McCrea et al., 2011a). For example: Sirgy et al. divided subjective measures into two major groups: global and facet based (Sirgy, Widgery, Lee, & Grace, 2010). Global subjective measures of community well-being focus on global satisfaction with one’s community, perception of community quality of life, and perceived community quality of life, while facet-based measures of community well-being can be categorized in terms of deductive versus inductive. Deductive facet-based measures of community well-being are formative measures in which the dimensions involved in the measure are theory driven. In contrast, inductive measures are based on a review of past research or the judgment of a panel of experts.

Generally subjective and objective dimensions relate with each other in evaluations, via the satisfaction of the social needs in urban environment, such as favorable neighborly relations and a sense of community (Davidson & Cotter, 1991, 1991; Farrell, Aubry, & Coulombe, 2004; Farrell et al., 2004; Sirgy & Cornwell, 2002, 2002). On the other hand, the evaluation of the QOUL (subjective and objective dimensions), was done through using index for the chosen subjective indicators depending on people satisfaction through evaluations, whereas objective indicators are quantitatively measured (McCrea et al., 2005; Michalos & Zumbo, 1999; Sirgy & Cornwell, 2001; Sirgy et al., 2000; Turksever & Atalik, 2001). Another method was examined using GIS, which requires geometric location information for mapping and analytical purposes, to link objective information about the urban environment with people satisfaction subjective evaluations (McCrea et al., 2006).
Generally, the prior studies focused primarily on the subjective evaluation of QOUL and have found that people’s subjective evaluations of many aspects of the urban environment correlate with their overall life satisfaction and specifically about urban living (McCrea et al., 2011b). Moreover, differences between residents’ preferences and their consequent selection for their accommodation may weaken the relationships found between proximity to natural environments and subjective evaluations of the urban environment (McCrea et al., 2011b). Subjective evaluations have been shown to be more significant in predicting neighborhood satisfaction than objective measures (Gant & Alaimo, 2006).

Accordingly, most of the previous studies have investigated the subjective assessment of residents for the physical/objective aspects in view of their satisfaction, neglecting the subjective measurement for their perception of its existence, and its significance in the built environment. In other means, the existence of a certain element (e.g. landmarks) may not prove to be significant or even perceived for some residents in unplanned areas although it might meet their satisfaction if existing. On the other hand, establishing a space for urban farming as a secondary economic revenue or a social gathering node between buildings would be much more significant. This is crucial especially in unplanned areas in developing countries with limited resources, where quality of life possesses different means of satisfaction.

From this view, the research will accordingly present a socio-spatial assessment tool for the neighborhood in the form of statistical models, to reach a formula correlating the degree of social satisfaction quantitatively represented by the nonphysical aspects (immaterial), and which are related to human feelings: happiness, safety, sense of belonging, and psychological satisfaction), as a function of physical aspects (that are not typically measured but rather interpreted from the subjective assessment of residents unlike prior studies), and which are related to the components of built environment on the three design scales: architectural design, urban design, and urban planning through statistical method in an attempt to present an adequate guide for decision makers to prioritize the physical aspects that strongly affect the residents’ satisfaction.

3. Methodology
The authors have developed an action-ethnographic research based on measuring the physical and nonphysical (objective and subjective) variables using the concept of ‘weighed satisfaction’ to cross reference the qualitative data with the quantitative ones. This method has been selected in response to the fact that life quality assessment, is considered one of the essential attributes in the built environment for the neighborhood.

3.1. Study context and data collection
In order to deduce the statistical models previously referred to, that incorporate the physical and nonphysical (immaterial) aspects of the neighborhood, the empirical study would thus focus on:

- Deducing the variables representing the physical aspects from previous literature review and theories, together with other relevant sustainability assessment tools on the neighborhood scale, together with those representing the nonphysical aspects from human needs, and urban sociology theories.
- Determining how to measure the above variables depending on the concept of ‘weighed satisfaction’ as will be explained in the following sections.

3.2. Predicting variables

3.2.1. Physical aspects
Incorporate the three components of the built environment with all its design scales:

- Urban planning component: includes the variables representing the general living conditions of the neighborhood, such as: land uses; site planning characteristics, streets’ network, amenities, ... etc.
- Urban design component: includes the variables representing the urban form incorporating the visual composition of the urban environment of buildings and spaces, and their elements (Sert, 1956).

- Architectural design component: that focuses on the building as a single unit (Moore, 1979). This incorporates variables decomposing the exterior and interior design elements of the housing buildings.

All these previous components are adequately divided into subcomponents incorporating measurable variables, that are deduced based on many previous studies including: “Clarence Perry,” “N. Carpenter,” “Duany Plater-Zyberk,” “Clarence Stein & Henry Wright,” “Wales Charles,” “Peter Calthorpe,” “Green Neighborhoods,” “Gated Communities,” and “Liveable Neighbourhoods” (Aditjandra, Mulley, & Nelson, 2013; Atkinson & Blandy, 2006; Calthorpe, 1993; Duany & Plater-Zyberk, 1994; Frey, 2005; Furuseth, 1997; Girling & Kellett, 2005; Mann, 1970; Neal, 2003; Russ, 2009; Towers, 2005; Walters, 2007); together with other relevant tools of sustainability assessment at the neighborhood scale such as; Leadership in Energy & Environmental Design for Neighborhood Development (LEED-ND), Building Research Establishment Environmental Assessment Methodology for communities (BREEAM Communities), The Japanese Comprehensive Assessment System for Building Environmental Efficiency for Urban Design (CASBEE-UD), Building for Life, Pearl Community Rating System, Sustainable Renovation of Buildings for Sustainable Neighbourhoods (HOE2R), The Sustainable Project Assessment Routine (SPAR), Neighbourhood Sustainability Framework (NSF) in New Zealand, and One Planet Living (OPL). (LEED, 2009; for neighborhood development, 2013; BREEAM Communities, technical manual, code for a sustainable built environment SD202-0.0:2012, www.breeam.org BREEAM for Communities, 2008; www.breeam.org; www.buildingforlife.org; Dall'O, Galante, Sanna, & Miller, 2013; Giordano, 2010; Castaneda, 2013; Deng, 2011; Commission for Architecture and the Built Environment (CABE), 2001).

3.2.2. Nonphysical (immaterial) aspects
Representing the residents' psychological and social satisfaction. It incorporates two main components:

- Psychological component including self-initiatives, motives, affecting the human behavior and that can be translated into a set of personal impressions and feeling; happiness, satisfaction, optimism, … etc.

- Social component including social interactions such as: friendships, enhancing the sense of belonging, cooperation, safety, … etc.

The nonphysical aspects are deduced from different human needs' theories, with their different categories and levels such as: physiological satisfaction, safety, self-esteem, self-fulfillment needs “Maslow, A. (1943–1954)” (Layne, 2009); others such as feeling the joy of achievement, authority, affiliation, and motivation (McClelland, 1961), or existence, relatedness, and maturity. “Alderfer, 1969” (http://www.yourcoach.be/en/employee-motivation-ebook). Moreover, Findley pointed out the physical, psychological, social, and self-fulfillment needs. Human needs’ matrix incorporated: being, having, interacting, together with subsistence, protection, affection, understanding, participation, leisure, creation, identity, and freedom (Costanza et al., 2007; Max-Neef, 1991). Therefore, it is evidently clear that they all incorporated two main dimensions: the psychological and social ones, and these two components constituted the nonphysical aspects analyzed in this research, whose subcomponents are proposed from these theories and literature review.

Accordingly, the research deduces the subcomponents of the physical and nonphysical aspects as shown in Tables 1 and 2 with total of 71 and 12 respectively and can be summarized as follows:
### Table 1. The components of the physical aspects

| Component       | Subcomponent      | Variables                                                                                                                                 |
|-----------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Urban planning  | Site              | Neighborhood location in relation to the city center (scale from near to far)                                                                 |
|                 |                   | Accessibility to the city center (scale from easy to difficult)                                                                                   |
|                 |                   | Neighborhood boundaries’ types (roads, green, fences, … etc.)                                                                                   |
|                 |                   | Topography of neighborhood (without contour – one level – several levels)                                                                        |
| Neighborhood size |                  | Neighborhood area (30–160 acres)                                                                                                               |
|                 |                   | Neighborhood population number (3,000–10,000 inches)                                                                                                |
| Roads’ network  |                  | Roads’ network hierarchy (all streets are with same, different streets’ width)                                                                  |
|                 |                   | Segregation between pedestrians’ paths and cars’ routes (without any segregation, or completely segregated or between)                        |
|                 |                   | Traffic density (low to high)                                                                                                                   |
|                 |                   | Allowed Speed in roads (slow to fast)                                                                                                            |
|                 |                   | Accessibility to the surrounding areas (easy to difficult)                                                                                      |
|                 |                   | Walkability in neighborhoods (easy to difficult)                                                                                                 |
|                 |                   | Existence of speed limit elements (without speed limit, many or few speed limit elements)                                                    |
|                 |                   | Existence of street light poles (none to many)                                                                                                   |
|                 |                   | Existence of sitting areas (none to many)                                                                                                       |
|                 |                   | Existence of plantation elements (none to many)                                                                                                  |
| Land uses       | Percentage of residential uses as compared to other uses in the neighborhood (low to high)                                                    |
|                 | Existence of education services (none to many)                                                                                                  |
|                 | Existence of playground areas (none to many)                                                                                                     |
|                 | Existence of religious services (none to many)                                                                                                    |
|                 | Existence of mixed use buildings (none to many)                                                                                                   |
|                 | Existence of residential buildings with mixed uses in ground floors only. (none to many)                                                        |
| Public spaces’ ownership | Existence of private ownerships for public spaces (none to many)                                                                                  |
|                 | Existence of illegal possessions for public spaces (none to many)                                                                                   |
|                 | The number of participants in the public spaces possessed illegally (none to many)                                                                    |
|                 | Existence of aesthetical and/or historical features (none to many)                                                                                   |
| Services and facilities | Availability of services (none to many)                                                                                                           |
|                 | The distance between the service and residential use (near to far)                                                                                   |
|                 | Participation in social activities (none to many)                                                                                                   |
|                 | Participation in local governance activities (none to many)                                                                                         |
|                 | Efficiency of facilities (poor to good)                                                                                                           |

(Continued)
| Component      | Subcomponent          | Variables                                                                 |
|----------------|-----------------------|---------------------------------------------------------------------------|
| Urban design   | General form          | Existence of pollution in the neighborhood (none to big percentage)       |
|                |                       | Maintain the buildings in good condition (poor to good)                  |
|                |                       | Existence of landmarks (none to many)                                    |
|                |                       | Existence of natural views (none to many)                                |
|                |                       | The view facing the residential use (poor to good)                       |
|                |                       | Orientation of building facades toward the desirable prevailing wind direction (poor orientation to good) |
|                | Number of facades’ openings (few to many) |                                                                  |
| Urban blocks   |                       | The number of units in residential buildings (6 units or less to 20 units or more) |
|                |                       | The number of units in each floor (one unit to 4 units)                  |
|                |                       | The area of building’s land (small to big)                               |
|                |                       | The distribution of residential buildings (attached to separated)        |
|                |                       | Existence of different levels of housing units (one level to three levels) |
|                |                       | Existence of public spaces in services’ area (none to many)             |
| Open spaces    |                       | Gardens and open areas (without to many)                                 |
|                | Gardens’ facilities   | (sitting areas, children’s playgrounds, … etc.) (none to many)          |
|                | The distance between  | the residential use to the nearest open area (near to far)              |
|                | the residential use to |                                                                         |
|                | the nearest open area |                                                                         |
| Street facilities | Existence of facilities for the handicapped. (none to many)        |                                                                  |
| Architecture   | Existence of facilities for pedestrians. (none to many)             |                                                                  |
| design         | Existence of parking areas. (none to many)                          |                                                                  |
|                | The distance between  | the parking area and the residential use. (near to far)                  |
|                |                       |                                                                         |
|                | Existence of public transportation stations. (none to many)         |                                                                  |
|                | Types of facilities   | existing in the public transportation stations. (none to many)          |
|                | The distance between  | the public transportation station and the residential use. (near to far) |
|                |                       |                                                                         |
|                | Existence of control systems for energy consumption. (none to many graded according to condition) | |
|                | Existence of control systems for water consumption. (none to many graded according to condition) | |
|                | Appropriateness of architectural areas and number of rooms. (bad to good) | |
|                | A separate space for  | each use in house. (one space for two or more uses to one space for one use) |
|                | the present and future |                                                                         |
|                | requirements (ranging from non satisfying to completely satisfying) | |
|                | Existence of natural ventilation systems (low to high performance levels) | |

(Continued)
The subcomponents of physical aspects are:

First: The Urban planning component constituting six subcomponents: site, neighborhood size, street network, land use, the property, and services and facilities.

Second: The urban design component constituting four subcomponents: general form, urban blocks, open spaces, and street facilities.

Third: Architectural design component constituting three subcomponents: optimal performance of the buildings, interior design of housing units, exterior design of housing buildings.

The subcomponents of nonphysical (immaterial) aspects are:

First: The ‘psychological’ subcomponent including six elements (variables): a comfortable shelter, life privacy, appropriate social level (comfortable and healthy environment), friendly

Table 2. The components of nonphysical aspect

| Component | Variables |
|-----------|-----------|
| Psychological | Existence of comfortable shelter. (ranging from nonsatisfying to completely satisfying) |
| Psychological | Existence and feeling of life privacy. (low to high) |
| Psychological | Sustaining a satisfying life quality level. (low to high) |
| Psychological | Feeling the intimacy of places. (low to high) |
| Psychological | Creativity and artistic expression. (low to high) |
| Psychological | Feeling the ingenuity of the place. (low to high) |
| Social | Feeling the sense of belonging and friendship. (low to high) |
| Social | Security inside the housing dwelling. (low to high) |
| Social | Security inside the neighborhood. (low to high) |
| Social | Feeling the sense of justice among members of society. (low to high) |
| Social | Feeling the sense of self-realization and self-independence. (low to high) |
| Social | Participation in society and public life. (low to high) |
places, creativity and artistic expression, and feeling the spatial ingenuity. These variables can rather be explained as follows:

- A comfortable shelter: means having a safe shelter enhancing relaxation feelings.
- Life privacy: quiet and saving from external intrusion.
- Appropriate social level (comfortable and healthy environment): having suitable income and adequate standard of living.
- Friendly places: feeling the intimacy of places.
- Creativity and artistic expression: enhancing the sense of uniqueness, and creativity.
- Feeling the ingenuity of the place: enhancing a sense of being distinguished by living in this place.

**Second: The social subcomponent including six elements (variables):** friendship, security inside the neighborhood, security inside the dwelling, sense of justice among members of society, self-independence, and participation in society and public life. These variables can rather be explained as follows:

- Friendship: enhancing friendship making, sense of belonging, interaction, and cooperation.
- Security inside the neighborhood, and the dwelling: feeling safe from danger, threat, risk, or injury inside the house and the neighborhood.
- Sense of justice among members of society: represented by inhabitants being equal in rights.
- Self-realization and self-independence: enhancing trust, respect and admiration.
- Participation in society and public life: social communication through participation in community and public life.

3.2.3. **Measuring the variables (physical and nonphysical) depending on the concept of “weighed satisfaction”**

Since the life quality assessment, considered as one of the essential attributes in the built environment for the neighborhood, includes various physical and nonphysical components, so measured in a quantitative way would not be sufficient to yield precise results for assessing their effects on the residents' satisfaction. This is attributed to the fact that every resident possesses his/her own preferences based on his/her cultural and social background. Accordingly, measuring the satisfaction degree for an element would not yield reliable results unless they are correlated with its degree of importance for that resident.

Consecutively, in this research, the neighborhood quality assessment will be performed using the method of Raphael's weighed equivalence tool, which is used in measuring the quality of life profile-adolescent version to ensure the accuracy of results. The quality of life profile-adolescent version contains three components (Raphael, Rukholm, Brown, Hill-Bailey, & Donato, 1996)

- Being: involving “physical, psychological, spiritual" attributes to reflect how a person is.
- Belonging: involving “urban, social, community” attributes that represent the relevance of the person to the environment.
- Becoming: “practical, entertainment, growth” attributes that refer to the activities carried out in everyday life.

Each component is divided into three subcomponents: each of them includes six elements, with total of 54 elements. This scale provides importance and satisfaction ratings along a 5-point Likert for each element. The quality scores are calculated as follows: (the quality = (importance score/3) *
The scores ranging from −3.33 (not at all satisfied with extremely important for the resident) to 3.33 (extremely satisfied and extremely important for the person) (Smith & Briers, 2001).

According to the research’s variables, it incorporates two main groups (physical and nonphysical). Each is measured along a 5-point Likert, but differ in assessment levels. In the physical aspects, each element is estimated through two levels (degree of importance, and degree of satisfaction if it exists). This aspect includes three components as previously indicated (architectural design, urban design, and urban planning); each is divided into 3, 4, and 6 subcomponents, including 15, 24, and 32 variables, respectively. In nonphysical aspects, each element is estimated through one level determining the degree of residents’ satisfaction about each element in the neighborhood. This aspect constitutes two components (psychological and social); each is divided into six variables.

3.3. Case study

In order to measure the previously deduced variables, a questionnaire has been designed to incorporate all these indicators, and to be applied in Sheikh Zayed and 6th of October cities, representing one of the Egyptian new cities. They were established in 1979. According to 2016 census statistics, the city achieved 53.43% of its full-targeted capacity in 2000 (General Authority for Urban Planning [GAUP], 2018).

These case studies are selected mainly because they represent one of the most important satellite cities lying to the west of Cairo, that were mainly constructed to accommodate the over population in unplanned areas in Cairo, yet they failed to attract the targeted population as indicated despite their satisfaction for many life quality aspects.

Therefore, applying the proposed methodology for assessing the socio-spatial life quality on such areas would be significant. In addition, the intermediate housing was selected as it represents the main housing category established by the government through two methods: the free housing type and the institutional housing one, which represent the only existing housing typologies for that housing level. The high and low level in these cities incorporate many market and uncontrollable aspects that would affect the final deduced model, and thus were excluded.

The research incorporates two types of intermediate social housing level: the free housing type and the institutional housing one, as previously indicated. The same size of sample was taken for each type of housing level as two neighborhoods for each type, for an easy comparison between them. The first sample representing the first type are taken from two residential neighborhoods in 6th of October, whereas, the second sample representing the second type are selected from two residential neighborhoods in Sheikh Zayed.1

This is based on a uniform distribution of neighborhoods only representing these types under test after excluding the under-construction neighborhoods as a systematic random sampling. Sample size; to ensure the accuracy of the questionnaire results, 30 inhabitants at least have to be questioned (Charles & Mertler, 2002; Creswell, 2002; Gall, Borg, & Gall, 1996; Gay & Airasian, 2003; McMillan & Schumacher, 2001), so the final sample size taken in this research is 50 inhabitants for each neighborhood with different ages ranging from 20- to 60-year-old males and females that are randomly selected to ensure incorporating different rational perspectives for residents. Accordingly, the total number of samples is 200. The data were collected by personal interview with each individual to complete the questionnaire.

3.4. Questionnaire

The questionnaire form constitutes three parts: the first part incorporates the general information about the participants and their residences (profession, age, gender, current and previous addresses, the area and number of rooms in the residence, … etc.).
The second part includes measuring the physical features of the neighborhood depending on residents' opinions, incorporating three components (architectural, urban design, and urban planning) with their subcomponents and elements with a total of 71. Each element is measured in respect to its importance, and degrees of satisfaction from the residents' points of view.

The third part includes measuring the nonphysical aspects representing the residents' feelings about their neighborhood, incorporating two components (psychological and social) with their subcomponents and elements with a total of 12. Each element is measured in respect to its degree of satisfaction from the residents' point of view. These two parts constitute five degrees' scaled measurement for each question representing the Likert scale. (Appendix A shows the questionnaire)

3.5. Data analysis
Since the main aim of the research is to deduce a model for the neighborhood life quality assessment using qualitative measurable methods, the two categories of components and their integrated variables are analyzed as follows:

**First, the physical aspects’ group** is analyzed based on the weighed satisfaction score method previously explained for each variable, then followed by calculating the sum for each component (architectural, urban design, and urban planning) (Appendix B shows the physical attributes' photos of the case study), as indicated in these five steps:

I. Finding ‘weighed satisfaction score’ for each variable according to this equation:

\[
\text{weight. s.x1} = \left(\frac{I.x1}{3}\right) \times (S.x1-3)
\]

Where: \(\text{weight.s.x1} = \) weighed satisfaction for variable \(x1\), \(I.x1 = \) the importance of variable \(x1\), \(S.x1 = \) the degree of resident satisfaction with variable \(x1\).

II. Finding adjusted standard score for the variable: this incorporates converting the negative values of the weighed satisfaction scores to positive values; in accordance with Raphael's law where the values of each variable may be positive or negative, to ensure having an accurate result when calculating the sum of the weighed satisfaction scores for each component.

- The standard score can be calculated as follows: (Carey et al., 2007; Kurpius & Stafford, 2006).

\[
Z = \frac{(X-\mu)}{\sigma}
\]

Where: \(z = \) standard score, \(x = \) original degree, \(\mu = \) arithmetic mean, \(\sigma = \) standard deviation

Then: \(Z\text{weight.s}.x1 = (\text{weight.s}.x1-\mu)/\sigma\)

Where: \(Z\text{weight.s}.x1 = \) standard value for variable \(x1\), \(\text{weight.s}.x1 = \) weighting satisfaction for variable \(x1\)

- **Adjusted standard score** (Carey et al., 2007; Kurpius & Stafford, 2006)

\[
T\text{-scores} = (z * 10) + 50
\]

Where: \(T\text{-scores} = \) adjusted standard score, \(Z = \) standard score

Then: \(\text{standard.w.s}.x1 = (Z\text{weight.s}.x1 *10) + 50\)

Where: \(\text{standard.w.s}.x1 = \) adjusted standard score for variable \(x1\)
III. Finding the relative importance of each variable:

This step is mainly intended to deduce the relative importance of the variable to represent its calculated weight in relation to the importance of the other variables, since each variable differs in its importance, and this is done through the following formula.

\[
\text{Weight. I.x1} = \frac{I.x1}{\text{total. I.x}}
\]

Where: \(\text{weight.I.x1}\) = relative importance of variable \(x1\), \(I.x1\) = the importance of variable \(x1\), \(\text{total. I.x}\) = the sum of the important values of all variables included in the component containing variable \(x1\).

IV. Calculating the specific gravity for each variable, which means the value of the variable with respect to the other variables in its component.

\[
\text{Weight. IS.x} = \text{weight.I.x1} \times \text{standard.w.s.x1}
\]

Where: \(\text{Weight. IS.x}\) = specific gravity for variable \(x1\), \(\text{weight.I.x1}\) = relative importance of variable \(x1\), \(\text{standard.w.s.x1}\) = adjusted standard score of variable \(x1\).

V. Calculating the total value of each component:

\[
\text{Total.IS.y} = \sum_{x=1}^{k} \text{Weight.IS.x}
\]

Where: \(\text{total.IS.y}\) = the total value of component \(y\)

Second, the nonphysical aspects' group is analyzed by repeating the same previous steps as follows:

The total value of each component (psychological and social) is calculated by adding the elements of each one.

\[
\text{Total.y} = \sum_{y=1}^{6} y1\quad (y = 1 \rightarrow 6)\text{ for the psychological component}
\]

\[
\text{Total.c} = \sum_{c=1}^{6} c1\quad (c = 1 \rightarrow 6)\text{ for the social component}
\]

The total value of the nonphysical aspects, which represent the residents' feeling towards their neighborhood (measuring the neighborhood social life quality), is calculated by adding the total values of the psychological and the social components.

\[
\text{Total.y.c} = \text{total.y} + \text{total.c}
\]

Where: \(\text{total.y.c}\) = values of the nonphysical aspects' two components.

3.6. Statistical analysis

All the above calculated variables are further statistically analyzed using the statistical package for social sciences (SPSS) version 18, in an attempt to deduce a statistical model where the social life quality (nonphysical) variables represent dependent variables and the other physical aspects' variables represent the independent (predicting) ones; and therefore having a precise tool for the assessment of the social life quality of the neighborhood. To achieve these aims, three steps are performed:

First: Testing the validity and reliability of the used scale for the nonphysical aspects' components' measurement by calculating the correlation between the average of each of the
psychological and social component and its integrated variables using Spearman’s rank order, and the reliability is calculated for each of them by using Cronbach’s alpha.

Second: Testing the correlation between the nonphysical aspects (and its components) and each of the components of the physical aspects (architectural, urban design, and urban planning), by using Spearman’s Rank Order Correlation (rho) to calculate the relationship between the variables of nonparametric type.

Third: If the correlation test is significant, that validates the use of the previously deduced variables as dependent and independent variables, in multiple regressions. Stepwise regression method that is used to determine how well a set of variables is able to predict a particular outcome (Pallant, 2005), therefore, the multiple regression is performed between:

- Each component of the nonphysical aspects as dependent variables and each of the components of the physical aspects, as independent variables.
- The total of the nonphysical aspects as dependent variables and each of components of the physical aspects, as independent variables.

4. Results
The results of the statistical analysis indicated above can be explained as follows:

First: the results of step one:

The validity test, illustrating the correlation between the average of the psychological component and its integrated variables ranging from 0.536 to 0.854 with significance at the 0.01 level, and between the average of social component and its integrated variables ranging from 0.542 to 0.755 with significance at the 0.01 level, which means all these variables are valid.

The reliability test; the Cronbach’s alpha for the psychological component equals 0.837, and for the social component equals 0.761. if the values of the Cronbach’s alpha are 0.7 or higher it will be enough to accept the internal consistency reliability (Pallant, 2005). This means all results are reliable.

Second: the results of step two indicating the correlation between all components are shown in Table 3 for the two tested areas.

From these tables, it is evidently clear that all correlation tests have resulted in significant values, consequently, all nonphysical aspects’ components and its integrated variables (representing the neighborhood social life quality) can be predicted through the physical aspects’ components using the multiple regression method.

Third: the results of step three: where multiple regression is used to deduce the targeted statistical models using stepwise method. It is worth mentioning that in most of the resulting models in this step, two formulas are accepted where the value of ANOVA test is less than 0.0005, and the final resulting model is selected based on the higher percentage of which the independent variables can predict the dependent variable. All final mathematical formulas are shown in Table 4 for the two tested areas.

5. Discussion of findings
The above-illustrated results reveal the following facts:

I. Since the social aspects of the neighborhoods represented by the human needs’ social and physiological satisfaction constitute an important attribute in the factors affecting sustainability
and life quality of the neighborhood, however, it is very hard to scientifically measure these qualitative aspects, in addition to their deviated variances among residents as they are relevant to their preferences from one side and occupy different degrees of vitality or importance for each resident from another side. Accordingly, the research has initially succeeded in the deduction of measurable quantitative variables that are represented by the psychological and the social components and which take into consideration residents’ preferences by using the ‘weighed scale’ method, and these sets of components were rather tested to ensure their validity and reliability through statistical tests.

II. Despite the general conception of the vitality of giving important consideration to the social sustainability attributes of neighborhoods, very few researches have studied the break down of the components of the neighborhood as a social entity versus these components as a physical entity comprising the architectural, urban design and urban planning components, to deduce the strength of the correlations existing between each one of them on the social sustainability of the neighborhood and to test their variance according to the level of housing and whether

| Table 3. Correlation value between nonphysical and physical aspects’ components |
|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                                   | Physical aspects                  |                                   |                                   |                                   |                                   |
|                                   | Architectural component           | Urban design component            | Urban planning component          |                                   |                                   |
|                                   | Area 1   | Area 2   | Area 1   | Area 2   | Area 1   | Area 2   |
| Psychological component           | 0.681** | 0.520** | 0.514** | 0.438** | 0.519** | 0.386** |
| Social component                  | 0.568** | 0.451** | 0.441** | 0.660** | 0.531** | 0.461** |
| Nonphysical aspects               | 0.641** | 0.556** | 0.525** | 0.651** | 0.567** | 0.514** |

Area 1: 6th of October (free housing typology)
Area 2: Sheikh Zayed (institutional housing typology)
** Correlation is significant at the 0.01 level

| Table 4. Multiple regression resulting formulas between nonphysical and physical aspects’ components |
|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                                   | Physical aspects (architectural, urban design, urban planning) components |
|                                   | Psychological component (dependent variable) | Area 1 | Area 2 | Psychological component (dependent variable) | Area 1 | Area 2 | Psychological component (dependent variable) | Area 1 | Area 2 | Psychological component (dependent variable) | Area 1 | Area 2 |
|                                   | Total.y = −6.824 + 0.368 * total.IS.a + 0.206 * total.IS.p | | | Total.y = −13.877 + 0.353 * total.IS.a + 0.374 * total.IS.p | | | Total.y = −13.603 + 0.698 * total.IS.u |
| Social component                  | Total.c = −9.963 + 0.374 * total.IS.a + 0.241 * total.IS.u | | | Total.c = −9.963 + 0.374 * total.IS.a + 0.241 * total.IS.u | | | Total.c = −9.963 + 0.374 * total.IS.a + 0.241 * total.IS.u |
| Nonphysical aspects               | Total.y.c = −16.787 + 0.742 * total.IS.a + 0.446 * total.IS.p | | | Total.y.c = −29.772 + 1.017 * total.IS.u + 0.457 * total.IS.p | | | Total.y.c = −16.787 + 0.742 * total.IS.a + 0.446 * total.IS.p |

Area 1: 6th of October (free housing typology)
Area 2: Sheikh Zayed (institutional housing typology)
Where:
Total.y is the total of psychologically component
Total.c is the total of socially components
Total.y.c is the total of nonphysical aspect (the neighborhood social life quality)
total.IS.a is the total of architectural components
total.IS.u is the total of urban components
total.IS.p is the total of planning components
they differ among the same level with its different housing types, as this would ultimately influence the investment plans oriented to each of the physical components.

According to the statistical results, the following findings can be discussed as follows:

I. There is a medium and strong positive correlation between the nonphysical aspects (and its components) and the physical aspects' components in the tested intermediate social housing level, for the free housing type and the institutional housing one, as shown in Table 3 for 6th of October and Sheikh Zayed respectively, as they have near values ranging between 0.4 and 0.6, implying the capability of deducing a precise statistical model in which the nonphysical aspects can be predicted by the physical ones.

From here, it is essential to discuss the implications of these correlations. First, the architectural component appears to achieve the highest correlation values with the psychological component in each of the intermediate social housing level types, in general, having higher values in 6th October (free housing) than Sheikh Zayed (institutional housing), holding the values of 0.68, and 0.52 respectively, due to the fact that in the former every resident is totally free to design his/her unit compared to the prototype design of the latter.

As for the urban component, it achieves the highest correlation value with the social component in the institutional housing type in Zayed as compared to the free one in 6th of October, holding the values of 0.66, and 0.44 respectively. This is attributed to the fact that urban design features were completely neglected in the free type where many of its streets are not paved, and where some urban spaces and greenery areas were relatively better in the institutional one. Therefore, the architectural component still holds the strongest correlation in the free type as the residents compensated the mess in urban features by satisfying their architectural desires.

As for the planning component, it is evidently clear that it did not achieve higher values than either of the architectural or the urban design component in the two tested study areas due to the dominance of the architectural component in the free type and the urban design component in the institutional type.

Consequently, the nonphysical aspects as a whole (social and psychological components) are deduced to be highly correlated with the urban design component in the institutional housing type, and the architectural component in the free housing one. This implies the necessity of having an efficient architectural design for the housing units that make use of areas and satisfies the needed number of rooms for the targeted families, or else all psychological and social needs will not be satisfied and the housing type will either be subject to deformation or complete abundance. Consequently, governmental authorities should pay attention to the investments extensively oriented for streets’ network without providing an efficient architectural design or vice versa as this would result in collective residents’ rejection and waste of resources.

This can be easily interpreted in the predicting models giving precise deduction for the resulting nonphysical aspects that are rather hard to predict upon the design of any neighborhood except after establishment, and this is considered to be the added value of this research.

II. To further highlight the resulting equations, it is worth mentioning that all the models presented in the above section illustrate a method for calculation of either the psychological or the social aspects or the total of both of them within the given values of one or all of the physical components (architectural, urban design, and urban planning) using regression methods that normally ignore independent variables that are strongly correlated with each other, and keep the most influential variables that can best predict the dependent variable. This fact justifies the absence of some components form the final equations illustrated in the previous section of results.
III. The above findings would certainly guide decision makers during their design of neighborhoods to make justified priorities for the implementation of the different physical components especially if there are few available investments to overcome the common problems in developing countries of investing in noneffective physical components without focusing on important architectural or urban design details that most affect the social satisfaction of targeted residents, the fact that leads to either of total abundance for the whole neighborhood. As the case in many new settlements constructed in the new cities to accommodate millions of population transferred from informal areas whether inside or surrounding the central business districts in cities and metropolitan areas especially in Egypt, for example there are many governmental economic districts and youths’ accommodation areas constructed by the central government, or the other situation where the community find appropriating solutions to satisfy their social needs. The latter result is evidently clear in the case of Zeinhom in Cairo, that despite the great investments done for the regeneration and upgrading of this informal area on the physical scale, none of the social aspects of the population were satisfied especially those concerned with their social daily life habits that were not totally considered during regeneration processes. For example, they created their own semipublic spaces in front of their doors in the streets, which were not initially designed by the government leading to undesirable visual and urban forms informally created by the community. Thus, all governmental plans should be subject to more dynamic and flexible solutions rather than creating prototype housing projects and getting external funds for their establishment without a profound socio-spatial analysis to guarantee wise investments’ allocation together with community satisfaction and providing sustainable solutions for the urban sprawl and informalities’ invasion.

6. Conclusion
Creating healthy and livable communities has become a priority in establishing sustainable neighborhoods especially in new cities that aim to reduce the urban sprawl in cities and accommodate the relocated population in informal settlements. Despite the sustainability that incorporates urban, economic, environmental, and social dimensions, the first three of these have frequently been dealt with in many researches as they can be easily transformed into quantitative variables that can be easily measured and thus controlled. Yet, the social ones have been rarely addressed within a precise measurable tool that can predict the effect of the built environment including all the physical aspects on the resulting community satisfaction for their psychological and social needs such as enhancing the sense of belonging, safety, social interaction, fostering creativity, … etc. Moreover, such social dimensions are always difficult to measure as they vary according to resident’s social and cultural background from one side and according to personal preferences from another side. Therefore, there is a crucial need for socio-spatial analysis and assessment tools to precisely measure the effect of physical aspects on the nonphysical ones.

Consequently, from this view, and within the focus of the paper to emphasize the concept of neighborhood as an interactive social moderator between the physical environment spatially and their daily life practice, the paper has initially deduced the variables representing the physical aspects, within three main components of the built environment in the neighborhood: architectural design, urban design, and urban planning, with a total of 71, and those representing the nonphysical ones that are related to immaterial human beings’ requirements within two main components: psychological and social with a total of 12 variables. The latter were measured using the concept of the ‘weighed satisfaction’ to overcome the personal preferences issues.

In the empirical study, these variables were measured through conducting a questionnaire on two types of intermediate social housing level (free housing type and institutional housing one) in 6th of October and Sheikh Zayed city respectively in Egypt, with a total of 100 in each. These measurements were analyzed using statistical methods that first started with proving the validity and the reliability of the deduced variables in the two sets, and then proceeded to measure the correlation existing between each of the components comprising each set of variables, and finally
ended with deducing mathematical formulas that can predict values of social and psychological community satisfaction, as dependent variables, in terms of physical attributes of the built environment, as independent variables, to act as a socio-spatial assessment tool.

The results yielded medium and strong positive correlations between each of the three components of the physical aspects and that of the nonphysical ones together with their cumulative variable in each of the housing types, with the dominance of the architectural component in the free housing type and that of urban design in the institutional type, whose housing units are prototypes with relatively better developed urban spaces. These correlations act as a guide to design the models for socio-spatial assessment by using multiple regression-stepwise method. The paper has finally presented three models for each type: illustrating the mathematical formula between the physical aspects’ components, and each of the psychological, and social component representing the nonphysical ones, and then with their cumulative effect together.

The research findings imply the strong recommendation for the decision makers and governmental authorities to use the deduced socio-spatial assessment tools as a significant guide for setting their priorities and orienting investments within defined milestones that target community satisfaction in the first place rather than the ambitious motivation to finish the establishment of the built environment and infrastructure that don’t meet community expectations leading at the end to either deformation or complete abundance with ultimate waste of resources without providing any sustainable solutions for relieving the urban sprawl in cities or relocation from informal settlements. Further, future researches should test this deduced tool on other levels and types of housing.

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**Notes**
1. It is worth mentioning that the selected two neighborhoods in Sheikh Zayed city are the only ones representing the typology in this city, until now.

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Appendix A. The questionnaire
The first part: The general information about the participants and their residences, The name: ………………. (optional)

|   | The gender | Female | Male |
|---|------------|--------|------|
| 1–1 | The gender |        |      |
| 1–2 | The age    | <25    | 25–45|
| 1–3 | The education | Do not read and do not write. | without a degree | Qualified average |
|     |            | Above average | Bachelor's degree | Postgraduate studies |
| 1–4 | The Job | Government employee | private sector employee | Employee pension |
|     |            | Free business | Literal | Do not work |
|     |            | Still studying | Other |      |
| 1–5 | Residence data | The city | The district |
| 1–6 | How long have you been staying here? | <5 | 5–10 |
| 1–7 | The ownership of the unit in which you live | Owner | Tenant |
| 1–8 | How many persons to housing | <2 | 2–4 |
| 1–9 | Approximate housing area | <4 |      |
| 1–10 | Number of rooms | 2 | 2–4 |
|     |            |        | >4   |
The second part: the physical features of the neighborhood depending on residents’ opinions

| Factor for achieving social sustainability | The number | Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents’ point of view |
|-------------------------------------------|------------|---------------------------------------------|---------------------------------|--------------------------------------------------------|
|                                           |            |                                             | 1 The lowest                     | 2 3 4 5 The highest                                    |
|                                           |            |                                             | 1 The lowest                     | 2 3 4 5 The highest                                    |
| Building efficiency                       |            | Optimal performance of building             |                                 |                                                        |
| A1                                        |            | Existence of control systems for energy consumption. |                                 |                                                        |
| A2                                        |            | Existence of control systems for water consumption. |                                 |                                                        |
|                                            |            | Interior design of houses                   |                                 |                                                        |
| A3                                        |            | Appropriateness of architectural areas and number of rooms. |                                 |                                                        |
| A4                                        |            | A separate space for each use in house.     |                                 |                                                        |
| A5                                        |            | Satisfaction of the house for the present and future requirements. |                                 |                                                        |
| A6                                        |            | Existence of natural ventilation systems.   |                                 |                                                        |
| A7                                        |            | Appropriateness of residential and services’ uses areas. |                                 |                                                        |

(Continued)
| Factors for achieving social sustainability | The number | Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents' point of view |
|---------------------------------------------|------------|---------------------------------------------|---------------------------------|---------------------------------------------|
|                                             |            |                                             | 1 The lowest                     | 2                                           |
|                                             |            |                                             | 3 The lowest                     | 4                                           |
|                                             |            |                                             | 5 The highest                    | 1                                           |
|                                             |            |                                             | 2 The lowest                     | 3                                           |
|                                             |            |                                             | 4 The lowest                     | 5                                           |
|                                             |            |                                             | 5 The lowest                     | 1                                           |
|                                             |            |                                             | 2 The lowest                     | 3                                           |
|                                             |            |                                             | 4 The lowest                     | 5                                           |

Audio comfort

A8 Nonexistence of noise pollution transmitted from the outdoor to indoor.

Exterior design of housing buildings

A9 Use of architectural decorative elements in facades.

A10 Satisfaction about facades' design.

Natural lighting

A11 The availability of natural lighting during the day.
Factors for achieving social sustainability

| Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents' point of view |
|--------------------------------------------|-------------------------------|----------------------------------------------------------|
| A1  | The number of floors available for residents. | 1 | 5 |
| A2  | The distance between corresponding facades. | 2 | 4 |
| A3  | The distance between adjacent facade entrances. | 3 | 3 |
| A4  | Existence of visual privacy. | 4 | 4 |
| A5  | Efficiency of facades' finishing materials. | 5 | 5 |

Characteristics of the urban environment

| Characteristics of the urban environment | General form | Used materials |
|------------------------------------------|--------------|----------------|
| U1 | Existence of pollution in the neighborhood. | Maintain the buildings in good condition. | Lead materials |
| U2 | Maintain the buildings in good condition. | | |

(Continued)
Factors for achieving social sustainability

| Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents' point of view |
|--------------------------------------------|---------------------------------|----------------------------------------------------------|
| The number                                  | 1 The lowest                    | 1 The lowest                                             |
|                                            | 2                               | 3                                                         |
|                                            | 4                               | 5 The highest                                            |
| U3  | Existence of landmarks.          |                               |                                                          |
| U4  | Existence of natural views.     |                               |                                                          |
| U5  | The view facing the residential use. |                             |                                                          |
| U6  | Orientation of building façades towards the desirable prevailing wind direction. | |                                                          |
| U7  | Number of façades’ openings.    |                               |                                                          |
| Urban blocks                               |                                 |                                                          |

(Continued)
(Continued)

| Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents’ point of view |
|--------------------------------------------|---------------------------------|----------------------------------------------------------|
| The number                                 | 1 The lowest                    | 1 The lowest                                           |
| U8  | The number of units in residential buildings. | 2                                  | 2                                                  |
| U9  | The number of units in each floor.           | 3                                  | 3                                                  |
| U10 | The area of building’s land.                | 4                                  | 4                                                  |
| U11 | The distribution of residential buildings.   | 5                                  | 5                                                  |
| U12 | Existence of different levels of housing units. |                                  |                                                     |
| U13 | Existence of public spaces in services’ area. |                                   |                                                     |
| U14 | Open spaces                                 |                                     |                                                     |
Factors for achieving social sustainability

The degree of importance

| Element | The lowest | 1 | 2 | 3 | 4 | 5 | The highest |
|---------|-----------|---|---|---|---|---|-------------|
| U14     | Gardens and open areas. |   |   |   |   |   |             |
| U15     | Gardens' facilities (sitting areas, children's playgrounds, etc.). |   |   |   |   |   |             |
| U16     | The distance between the residential use to the nearest open area. |   |   |   |   |   |             |
| U17     | Existence of pedestrians' network connecting the different parts of the neighborhood. |   |   |   |   |   |             |

(Continued)
### Factors for achieving social sustainability

| Factors for achieving social sustainability | The number | The degree of element importance | The degree of satisfaction from the residents’ point of view |
|--------------------------------------------|------------|----------------------------------|----------------------------------------------------------|
|                                            |            | 1 The lowest                     | 2 3 4 5 The highest                                      |
|                                            |            | 1 The lowest                     | 2 3 4 5 The highest                                      |

- **Street facilities.**
  - **U18** Existence of facilities for the handicapped.
  - **U19** Existence of facilities for pedestrians.

- **Public facilities**
  - **U20** Existence of parking areas.

- **Private transport facilities**
  - **U21** The distance between the parking area and the residential use.

(Continued)
| Factors for achieving social sustainability | The number | The degree of element importance | The degree of satisfaction from the residents' point of view |
|--------------------------------------------|------------|----------------------------------|----------------------------------------------------------|
|                                            |            |                                 |                                                          |
|                                            |            | 1 The lowest                     | 2 | 3 | 4 | 5 The highest | 1 The lowest | 2 | 3 | 4 | 5 The highest |
| U22                                        | Existence of public transportation stations. | | | | | | | | | |
| U23                                        | Types of facilities existing in the public transportation stations. | | | | | | | | | |
| U24                                        | The distance between the public transportation station and the residential use. | | | | | | | | | |
| P1                                         | Neighborhood location in relation to the city center. | | | | | | | | | |
| P2                                         | Accessibility to the city center. | | | | | | | | | |
| Site                                       | | | | | | | | | |

(Continued)
Factors for achieving social sustainability

| Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents' point of view |
|---------------------------------------------|---------------------------------|----------------------------------------------------------|
|                                             | 1 The lowest 2 3 4 5 The highest | 1 The lowest 2 3 4 5 The highest |
| Neighborhood boundaries' types. P3          |                                 |                                           |
| Topography of neighborhood. P4              |                                 |                                           |
| Neighborhood size                           |                                 |                                           |
| Neighborhood area. P5                       |                                 |                                           |
| Neighborhood population number. P6          |                                 |                                           |
| Roads' network                              |                                 |                                           |
| Roads' network hierarchy. P7                |                                 |                                           |
| Segregation between pedestrians' paths and cars' routes. P8 | |                                           |
## Factors for achieving social sustainability

| Factors for achieving social sustainability | The number | The degree of element importance | The degree of satisfaction from the residents’ point of view |
|--------------------------------------------|------------|----------------------------------|----------------------------------------------------------|
| Traffic density.                            | 1 The lowest | 2 | 3 | 4 | 5 The highest | 1 The lowest | 2 | 3 | 4 | 5 The highest |
| Allowed Speed in roads.                     | P10        |                               |                                                          |
| Accessibility to the surrounding areas.     | P11        |                               |                                                          |
| Walkability in neighborhoods.               | P12        |                               |                                                          |
| Existence of speed limit elements.          | P13        |                               |                                                          |
| Existence of street light poles.            | P14        |                               |                                                          |
| Existence of sitting areas.                 | P15        |                               |                                                          |
| Existence of plantation elements.           | P16        |                               |                                                          |
| Land uses                                   |            |                               |                                                          |
### Factors for achieving social sustainability

| The number | Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents' point of view |
|------------|--------------------------------------------|---------------------------------|----------------------------------------------------------|
|            |                                            | 1 The lowest                    | 2 | 3 | 4 | 5 The highest   | 1 The lowest | 2 | 3 | 4 | 5 The highest   |
| P17        | Percentage of residential uses as compared to other uses in the neighborhood. |                                | |  |  |  |                                | |  |  |  |                                |
| P18        | Existence of education services.           |                                | |  |  |  |                                | |  |  |  |                                |
| P19        | Existence of commercial services.          |                                | |  |  |  |                                | |  |  |  |                                |
| P20        | Existence of playground areas.             |                                | |  |  |  |                                | |  |  |  |                                |
| P21        | Existence of religious services.           |                                | |  |  |  |                                | |  |  |  |                                |
| P22        | Existence of mixed use buildings.          |                                | |  |  |  |                                | |  |  |  |                                |
| P23        | Existence of residential buildings with mixed uses in ground floors only. | | | | | | | | | | |
|            | Public spaces' ownership                   |                                | |  |  |  |                                | |  |  |  |                                |

(Continued)
Factors for achieving social sustainability

| Factors for achieving social sustainability | The degree of element importance | The degree of satisfaction from the residents’ point of view |
|--------------------------------------------|---------------------------------|-----------------------------------------------------------|
| The number                                 | 1 The lowest                    | 1 The lowest                                              |
| P24 Existence of private ownerships for public spaces. | 2                               | 2                                                          |
| P25 Existence of illegal possessions for public spaces. | 3                               | 3                                                          |
| P26 The number of participants in the public spaces possessed illegally. | 4                               | 4                                                          |
| P27 Existence of aesthetical and/or historical features. | 5                               | 5 The highest                                              |
| Services and facilities                    |                                 |                                                           |

(Continued)
### Factors for achieving social sustainability

| Activities and Services | Community activities | Utilities |
|-------------------------|----------------------|-----------|
| Participation in social activities | Participation in local governance | Efficiency of locallies |
| Availability of services. | | |
| Participation in social activities. | | |
| The distance between the service and residential use. | | |
| Efficiency of services. | | |
| The degree of satisfaction from the residents' point of view. | | |
| The degree of element importance. | | |

| P28 | P29 | P30 | P31 | P32 |
|-----|-----|-----|-----|-----|
| 1   | 2   | 3   | 4   | 5   |

(continued)
The third part: the nonphysical aspects representing the residents’ feelings about their neighborhood

| Evaluate the following from your point of view: | 1 | 2 | 3 | 4 | 5 |
|------------------------------------------------|---|---|---|---|---|
| Psychological                                   |   |   |   |   |   |
| 3–1 Existence of comfortable shelter.           |   |   |   |   |   |
| 3–2 Existence and feeling of life privacy.      |   |   |   |   |   |
| 3–3 Sustaining a satisfying life quality level. |   |   |   |   |   |
| 3–4 Feeling the intimacy of places.             |   |   |   |   |   |
| 3–5 Creativity and artistic expression.         |   |   |   |   |   |
| 3–6 Feeling the ingenuity of the place.         |   |   |   |   |   |
| Social                                         |   |   |   |   |   |
| 3–7 Feeling the sense of belonging and friendship. |   |   |   |   |   |
| 3–8 Security inside the housing dwelling.       |   |   |   |   |   |
| 3–9 Security inside the neighborhood.           |   |   |   |   |   |
| 3–10 Feeling the sense of justice among members of society. |   |   |   |   |   |
| 3–11 Feeling the sense of self-realization and self-independence. |   |   |   |   |   |
| 3–12 Participation in society and public life.  |   |   |   |   |   |

The key of answers:
The first part acts as the general information about the participants and their residences, the person completes his/her information.
The second part measures the physical features of the neighborhood depending on residents’ opinions; the person evaluates each element up to its importance, and degrees of satisfaction from the residents’ point of view. The evaluation has five degrees’ scaled measurement the first degree is (1) it means the lowest value and the last degree is (5) it means the highest value.
The third part measures the nonphysical aspects representing the residents’ feelings about their neighborhood. The evaluation has five degrees’ scaled measurement the first degree is (1) it means the lowest value and the last degree is (5) it means the highest value.
Appendix B. The physical attributes’ photos of case study

| Physical aspects | The elements | Area 1: 6th of October (free housing typology) | Area 2: Sheikh Zayed (institutional housing typology) |
|------------------|--------------|-----------------------------------------------|--------------------------------------------------|
| Urban planning attributes | General considerations (Segregation between pedestrians’ paths and cars’ routes) | Roads not complete yet. | There are pedestrians’ paths behind buildings segregated from car’s routes |
| | The local streets (Existence of speed limit elements) | Roads not complete yet. | In some places, there are speed limit elements |
| | The pedestrian’s traffic network characteristics (sitting areas, plantation elements) | | |

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https://doi.org/10.1080/23311886.2018.1528702
| Physical aspects | The elements | Area 1: 6th of October (free housing typology) | Area 2: Sheikh Zayed (institutional housing typology) |
|------------------|--------------|-----------------------------------------------|------------------------------------------------------|
| Mixed land use   |              | There are no sitting areas and the place for trees has no trees | There are sitting areas, plantation elements |
| Activities and Services | Availability of services. | The neighborhoods' services centers not complete | The neighborhoods' services centers give different services |
### Table B2. Urban design attributes in case study

| Area 1: 6th of October (free housing typology) | Area 2: Sheikh Zayed (institutional housing typology) |
|---------------------------------------------|----------------------------------------------------|
| **Physical aspects**                        | **Urban design attributes**                        |
| Building orientation (The residential use’s view) | The residential use’s view is semi-designed open space |
| Static spaces (Gardens and open areas, its facilities) | Gardens and open areas are semi-designed with limited facilities |
| Dynamic spaces (Existence of pedestrians’ network) | Pedestrians’ network was constructed, but its design is not ideal |

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Table B2. (Continued)

| Physical aspects | The elements | Area 1: 6th of October (free housing typology) | Area 2: Sheikh Zayed (institutional housing typology) |
|------------------|--------------|---------------------------------------------|---------------------------------------------------|
| Private transport facilities | (Existence of parking areas) | ![Image 1](image1.png) ![Image 2](image2.png) | ![Image 3](image3.png) ![Image 4](image4.png) |
|                  |              | There are no parking areas.                  | There are parking areas                           |
### Table B3. Urban architectural attributes in case study

| Physical aspects | The elements | Area 1: 6th of October (free housing typology) | Area 2: Sheikh Zayed (institutional housing typology) |
|------------------|--------------|-----------------------------------------------|-----------------------------------------------------|
| Architectural design attributes | Dwell's Characteristics (Appropriateness of architectural areas and number of rooms) | ![Image](image1) | ![Image](image2) |
| | | There are no modifications in facades referring to unsuitable room's area | There are modifications in facades such as: add a balcony to room area. Which refer to unsuitable room's area |
| The aesthetic aspects | (Use decorative elements in facades) | ![Image](image3) | ![Image](image4) |
| | | The facades' design and its decoration as the owner wants | The decoration was added by resident, restricted to changing wall color |

(Continued)
### Table B3. (Continued)

| Physical aspects | The elements | Area 1: 6th of October (free housing typology) | Area 2: Sheikh Zayed (institutional housing typology) |
|------------------|--------------|---------------------------------------------|---------------------------------------------------|
|                  | Spatial distribution of openings (The distance between corresponding facades, The distance between adjacent façade entrances, visual privacy) | ![Image of 6th of October area](image1) ![Image of 6th of October area](image2) ![Image of 6th of October area](image3) | ![Image of Sheikh Zayed area](image4) ![Image of Sheikh Zayed area](image5) ![Image of Sheikh Zayed area](image6) |
|                  | The distance between facades are diverse. When it is narrow then the visual privacy decreases. | ![Image of 6th of October area](image1) ![Image of 6th of October area](image2) ![Image of 6th of October area](image3) | ![Image of Sheikh Zayed area](image4) ![Image of Sheikh Zayed area](image5) ![Image of Sheikh Zayed area](image6) |

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