

## **Spatial Assessment for Open Spaces in Residential Areas: Case of Sheikh Zayed City, Egypt**

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### **Abstract**

Open spaces have one of the most essential roles in social communications and people relaxation. However, the design of its locations and relations with the surroundings neglect this role, especially in Egypt. Here, we aimed to support the configured structure of spaces and its potential impact as a suitable place for social life, communication, relaxation, playing, . . .so on, in an institution housing topology.

This paper is applied in a neighborhood of intermediate social housing level: dealing with which surround the open space; whether they are streets, buildings' walls, another space, or buildings' entrances. Concentrating on two main variables: the relationship between the open spaces and the movement networks, and the pattern of house buildings' distribution, which have an effect on the segregation degree of space and its role in social settings.

This practical study uses a collection of programs software, mainly depending on Space Syntax methodology for understanding a network of spaces by using DepthmapX software, auto cad, and excel software as aid programs.

The results show the difference in the space location's integration values, and from this the guide lines for a good open space location in residential areas were determined.

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### **Keywords**

DepthmapX software; movement networks; neighborhood; open space; residential areas

### **1. Introduction**

The residential areas as an urban environment may entail clear patterns depending on the social and cultural conditions (Nas & Schut, 2011). The design processes of these areas must support people life, especially through the design of new communities to be sustained as residential social areas.

The good residential areas are more comfortable for people daily life, as "Gallion and Eisner, (1963). (&) Girling and Kellett, (2005)" described it; safe for children, having a plot area for children, having good and safety movement networks, provide parents with a good social and friendly relationship with their neighbors by interactions face to face, and in it all residents can enjoy leisure and relaxation time (Gallion & Eisner, 1963); (Girling & Kellett, 2005); (Glass, 1948); (Suttles, 1972).

That means design residential areas must give a good social life for people. This can be achieved by dealing with the physical residential areas' components especially its spaces.

Two main components form the residential areas: buildings blocks and spaces between them.

a. The buildings block: refers to the rows of houses buildings and its arrangement. These blocks close and define spaces among them, which are considered the second component.

b. The spaces: it is the essential stuff of a very fundamental and universal form of communication (Lawson, 2001). These include the streets, and the open spaces and corridors within them (Newman, 1996).

Streets are the most vital in communities. They should be designed as channels for movement, as well as supporting the open spaces' social role.

Open spaces are areas outside buildings and corridors within them. These spaces are the actual social communication areas and permit interaction face to face among residents.

Generally, the role of open spaces in the social communications are affected by two points:

- Its distribution between buildings (in the front, back, or next to a building).
- Its relationship with movement networks (streets).

This paper focuses on open spaces and tests its suitability for people's social lives.

## 2. Open spaces overview

Open space is the place where people walk around (Duff, 2014), sit as a group or with an individual for talking, reading and so on, and spending leisure time.

The open spaces were studied and classified in different views by concentrating on their general physical features, "Greater London Council" defined spaces according to: ((G.L.C.), 1978).

- Encouraged activities: static and dynamic space,
- The level of available vision: closed, semi closed, and open space.

While "Norberg-Schulz" studies the ratios between the two dimensions of space in plan: corridor, wide, and deep space (Norberg-Schulz, 1966).

Another study concentrated on the scale of space which related to the dimensions of space and human visual abilities; friendly, human, memorial scale (Spreiregen, 1965). And added the classification of the sense of space in three dimensions which were named the containment; the degree, the form, and the visual sense (Norberg-Schulz, 1966) ; (Spreiregen, 1965).

Recently, the general study of the open spaces' characteristics in 2003 view that; the open space can be considered in terms of "positive" and "negative" space (Carmona, Heath, Oc, & Tiesdell, 2003):

Positive, relatively enclosed, outdoor space has a definite and distinctive shape. It is "conceivable", can be measured, and has definite boundaries. It is closed, static, but serial in composition (Carmona et al., 2003).

Negative space is shapeless, e.g. the amorphous residue left over around buildings which are generally viewed as positive, it is "inconceivable"- continuous and lacking in perceivable edges or form. It is difficult to conceive of the space (Carmona et al., 2003).

Accordingly, most previous studies have showed the open spaces in general, concentrated on physical features and its effect on human sense. Although the design process for good social open spaces, especially in the residential areas, involve:

- The space location: means what will surround it (street, another space, buildings' walls, buildings' entrances, . . . . . and so on).
- The physical features of space: means space's dimensions, area, shape, the height of space walls -the height of building surrounding-, . . . . .and so on.

- The space's equipment: which means landscape elements and its distribution.

However, the main role of open space in social life, was not discussed. So, this paper views and studies the space location: how the location of open spaces in residential areas support its use by people.

### **3. Empirical Study Methodology**

From this view, the author uses Space Syntax theory as a tool for thinking the relationship between space and society via the DepthmapX program, where DepthmapX software helps to understand the configuration structure of urban spaces and its potential impact on social behavior and economic activity (AL\_Sayed, Turner, Hillier, Iida, & Penn, 2014); (Hillier, 1996).

This paper tries to classify the open spaces in residential areas according to its location's characters and relates with its chance of being a good social space, by following steps:

- Theoretical study for the types of open spaces in residential areas.
- Case study:
  - Defined the open space locations.
  - Defined the integration and segregation space by using DepthmapX software.

#### **3.1. Theoretical study for the types of open spaces in residential areas**

The successful open spaces in residential areas achieve four key attributes: comfort and image; access and linkage; uses and activity; and sociability (Carmona et al., 2003). The space locations affect them, which mainly relate to buildings and movement networks.

- The open space's relation with buildings' blocks: the buildings' blocks use different models to create variety in space location (Biddulph, 2007) .
  - a- The narrow blocks: configure housing in long blocks with a minimum back-to-back dimension.
  - b- Periphery blocks: the blocks are arranged in a deformed grid of streets; the fronts of buildings should face the public space and the private backs of buildings.
  - c- Apartments in periphery blocks with shared open space: apartment buildings have the courtyards which are introduced into the center of the blocks as a semi-private open area. Sometimes it is possible for non-residents to enter the courtyards, but in other designs courtyards are only available to residents.
  - d- Housing in periphery blocks with private gardens and shared open space: periphery blocks may also have housing with private gardens, but behind the private gardens a communal space.
  - e- Apartments in periphery blocks with private gardens and shared open space: the ground level apartments in periphery blocks can have private gardens to their rear, and then residents who live on other floors have access to a communal space.All of the above models showed how private space is considered in a periphery block, while the open spaces for public sometimes are beside the private space, in the back, or in the fronts of blocks which give a physical form to the street environment.
- f- Free standing blocks: apartments are arranged in free standing or point blocks by using a high free-standing block or free-standing blocks of about five floors to allow residents a more immediate relationship with neighboring spaces.

g- Linear block arrangements: this is a configuration of housing or apartments, in such a configuration the backs of houses can face the fronts of others, or the houses can face each other across a traditional street or pedestrian route.

h- Super blocks: configured blocks of housing, typically in the form of apartments, to form super blocks which encircle or 'protect' other types of housing or open spaces.

From this view, there are three main types of open spaces' locations related to buildings: in front of, in back of, or next to. But these types create others by using integration between them, meaning space may be in back of a building and next to another building from the same side of the space.

- The open space's relation with movement networks (streets): the streets have the potential to be designed and enhanced for meeting the desires of adjacent residents and function foremost as a support for open space (as a space for recreation, socializing, and leisure).

There are four principle forms of streets' networks: the grid, the tree, the closed loop, and Radburn: (Biddulph, 2007).

a- The grid; it has a long tradition of use in all forms of urban planning and design in relation to what surrounds it. Where the streets intersect in the form of network, grids can provide an even pattern of access between urban blocks, although the profile of streets and spaces can vary.

b- The tree: This design creates a series of quiet cul-de-sacs, where the pattern of buildings allows access in the form of a tree.

c- The closed loop; it is a form of access that allows a residential area to connect to its context at a more limited number of locations, although circulation within the scheme might be as efficient and direct as a grid.

d- Radburn: a radburn layout involves creating a form of block where one side of a home faces the vehicle access and parking, whilst the other side faces pedestrian routes and community spaces.

From this view, the open space's location relates with streets in two positions: the space next to a street, or the space faraway from a street. Accordingly, the streets may surround a space from more than one side.

The integration between: open space's location relating with buildings, and streets give, as a simple example, four alternatives for each space side. It may be: street, building's wall whether side or back, building's entrance -building front-, or another open space.

By overview open spaces' locations from all sides, the previous four alternatives create many patterns of locations. The location pattern of open space means the location which is defined with limits surrounding it.

For example, If the space in simple form is a rectangle or square shape, it will have four sides, each side having a number of possibilities which will limit it: may be:

- One limit: street, space, building's wall, or building's entrance.
- Two limits: space-building's wall, space-building's entrance, or building' entrance-building's wall.
- Three limits: space-building's wall-building's entrance.

The possibilities of the space's location pattern can be calculated according to three levels for each side: first level includes four possibilities, second level includes six, and the third level includes four possibilities. That means all possibilities for each side have fourteen possibilities. (Fig. 1).

Note: In second level, existing street with any others (in case of simple space form) means this street is cul-de-sac.

The simple space form has four sides, so all possibilities for the space location pattern equal 14 combination four ( ${}^4C_4$ ), which equal 1001 possibilities.

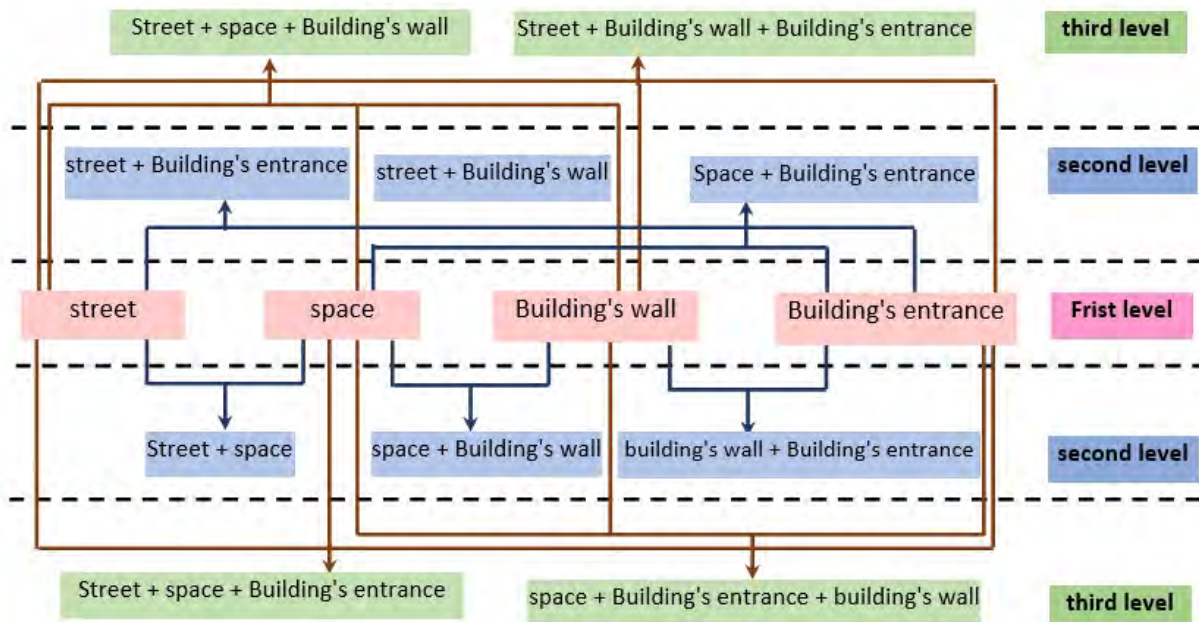


Figure 1. The possibilities of a side limits for space location pattern

### 3.2. Case study

Sheikh Zayed city represents one of the Egyptian new cities, which was established in 1995. (of Housing & for Urban Planning (GAUP), 2010). This paper studies open spaces in a neighborhood of housing typologies for intermediate housing level, for institutional housing which has a lot of open spaces between residential buildings, about 166 spaces in a simple form (almost of them are divided to rectangle and square shape) act as 36 groups of location patterns. The neighborhood is the third neighborhood in Sheikh Zayed city's first district, and was designed and implemented by Housing and Development Bank.

Through the practical study, the location characters of open spaces in resident areas are defined and linked with its integration and segregation for social life.

#### 3.2.1. Defined the open spaces' location patterns

The following table shows the distribution of spaces according to its location pattern, into three columns; first showing the number of location pattern group, second showing the description of the location pattern, and the third showing the number of open spaces in the locations pattern. (Table 1, Fig. 2)

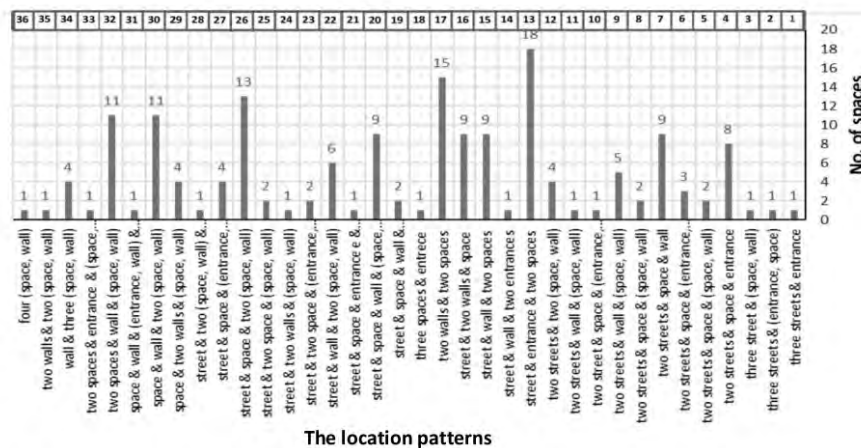
Table 1. The spaces location patterns groups

Space group no.	Description of location pattern	No. Of spaces	Space group no.	Description of location pattern	No. Of spaces
1	Three streets & entrance	1	19	Street & space & wall & (entrance/ space)	2
2	Three streets & (entrance/ space)	1	20	Street & space & wall & (space/ wall)	9
3	Three street & (space/ wall)	1	21	Street & space & entrance & (space/ wall)	1

*Continued on next page*

Table 1 continued

4	Two streets & space & entrance	8	22	Street & wall & two sides (space/ wall)	6
5	Two streets & space & (space/ wall)	2	23	Street & two space & (entrance/ space)	2
6	Two streets & space & (entrance/ wall)	3	24	Street & two walls & (space/ wall)	1
7	Two streets & space & wall	9	25	Street & two space & (space/ wall)	2
8	Two streets & space & (space/ wall)	2	26	Street & space & two sides (space/ wall)	13
9	Two streets & wall & (space/ wall)	5	27	Street & space & (entrance/ space) & (space/ wall)	4
10	Two street & space & (entrance/ space/ wall)	1	28	Street & two sides (space/ wall) & (entrance/ space/ wall)	1
11	Two streets & wall & (space/ wall)	1	29	Space & two walls & (space/ wall)	4
12	Two streets & two sides (space/ wall)	4	30	Space & wall & two sides (space/ wall)	11
13	Street & entrance & two spaces	18	31	Space & wall & (entrance/ wall) & (space/ wall)	1
14	Street & wall & two entrances	1	32	Two spaces & wall & (space/ wall)	11
15	Street & wall & two spaces	9	33	Two spaces & entrance & (space/ wall)	1
16	Street & two walls & space	9	34	Wall & three sides (space/ wall)	4
17	Two walls & two spaces	15	35	Two walls & two sides (space/ wall)	1
18	Three spaces & entrance	1	36	Four sides (space/ wall)	1



The location patterns

Figure 2. The spaces' location patters classification in the third neighborhood in Sheikh Zayed city's first district

3.2.2. Defined the integration and segregation space by using DepthmapX software

The practical study for neighborhood’s open spaces includes two phases:

- Examined the integration and segregation for space according to street as an application of "axial map".
- Examined the integration and segregation for space according to other surroundings: space, and building’s entrance, as an application of "convex map".

The total integration for space will be the average of two values.

3.2.2.1. Phase 1: Examined the integration and segregation for space according to street

Spaces and streets linked together in single movement series, each street reaches another street or space and each space reaches another, and so on. By using the integration and segregation test, we had a value for each space, which indicates the degree of its integration with street and space beside.

3.2.2.2. Phase 2: Examined the integration and segregation for space according to other surrounding; space, and building’s entrance

Spaces were linked to other attached spaces and buildings’ entrances. By using the integration and segregation test, we had a value for each space, which indicates the degree of its integration with buildings’ entrances and space beside.

**4. Results**

The spatial analysis indicated above yielded the following results:

Generally; the values of integration and segregation tests showed: (Table 2)

Table 2. the results of space’s integration and segregation tests

Group no.	The integration for space according to surround buildings’ entrances & spaces (0: 2.25)	The integration for space according to streets (1.3647: 2.844)	The average of integration for spaces. According to buildings’ entrances, space, and streets (0.87891: 2.172005)	Range mean
Group 1	0: 0.45	1.3647: 1.66056	0.87891: 1.137529	The lowest integration
Group 2	0.45: 0.9	1.66056: 1.95642	0.517238: 1.396148	
Group 3	0.9: 1.35	1.95642: 2.25228	1.396148: 1.654767	
Group 4	1.35: 1.8	2.25228: 2.54814	1.654767: 1.913386	
Group 5	1.8: 2.25	2.54814: 2.844	1.913386: 2.172005	The highest integration

- A narrow range between the maximum and the minimum into each test,
- All values in each test are different.

So, the author divided the results of each test into five groups.

First: The results of measuring the integration for space location according to surround buildings’ entrances and spaces show; (Table 2, Fig. 3)



- The value ranges from 1.3647 to 2.844
- The maximum value is recorded by the location pattern groups no. 4, 7, 9, 13, 16, and 26, but these groups don't record maximum absolute values, they take low, moderate and high values.
- The minimum value is recorded by the location pattern group no. 24, its limits are; street, two sides walls, and (space/ wall).
- Most of the location pattern groups recorded multi range in integration values from low to high such as group no. 7, 13, and 16.
- Most of the location pattern groups recorded moderate and a tendency to low in integration values, these groups are no. 3, 8, 9, 11, 15, 17: 20, 22: 25, and 27: 36.

Third: The results of the average of integration for space location according to buildings' entrances and streets: (Table 2, Fig. 5)

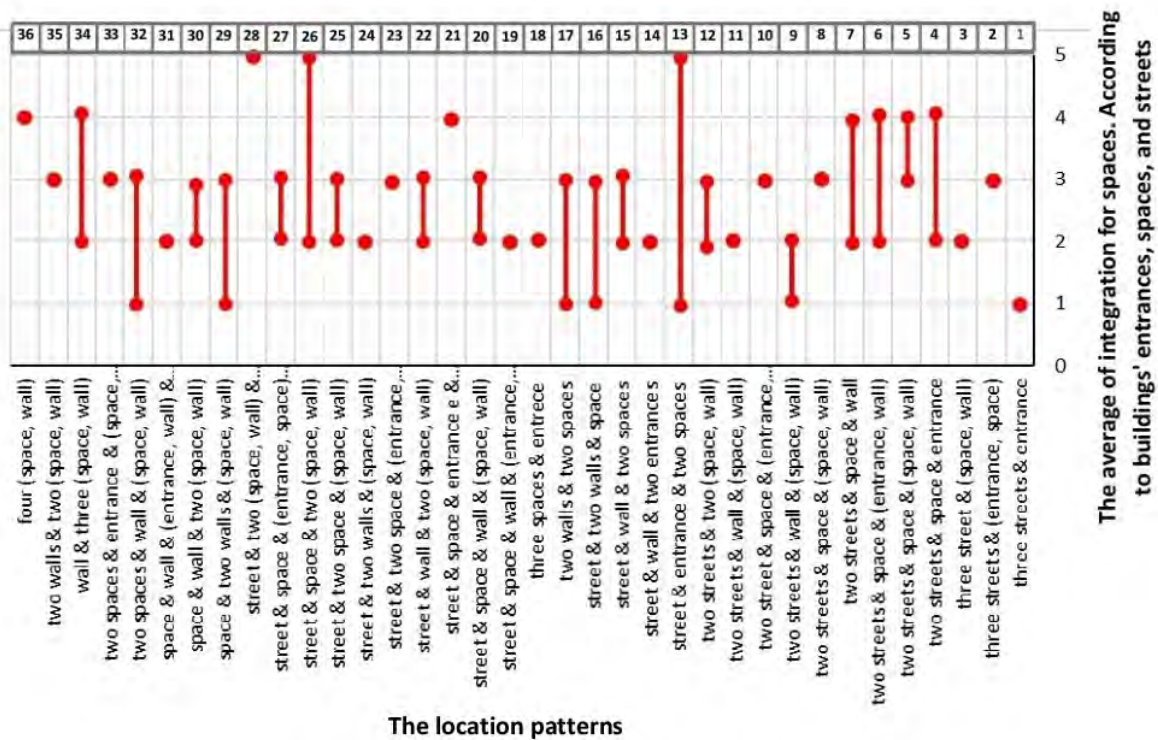


Figure 5. The relation between the space location patterns and the average of integration for space according to surrounding buildings' entrances, spaces, and streets

- The value ranges from 0.87891 to 2.172005
- The maximum value is recorded by the location pattern groups no. 13, 26, and 28, but the groups 13, 26 do not record maximum absolute values, they take low, moderate and high values.
- The minimum value is recorded by the location pattern group no. 1, its limits are; three streets, and entrance.
- Two groups of the location patterns groups recorded multi range in integration values from low to high. They are groups no.13, and 26, their limits; street, space, and two sides (space/ wall); and street, entrance, and two spaces, respectively.
- Most of the location pattern groups tend to moderate integration values, such as 2, 8, 10, 23, 34, and 35.

## 5. Discussion of Findings

1- From the integration value for space according to buildings' entrances and spaces:

- The spaces, which are in the same group of location pattern, have approximately the same integration values, such as location pattern group no. 13 which included maximum number of spaces and its limits are; street, entrance, and two spaces.

- Using the high level of side limits for space location pattern (figure 1) records the high value of space integration. Such as location pattern:

- Street, two sides space/ wall, and entrance/ space/ wall, which equal first level, second level, second level, third level as the sides limits,
- Wall, and three sides space/ wall, which equal first level, second level, second level, second level as the sides limits.

- The space, which is surrounded by other spaces, has a high probability to record high integration value. Such as location pattern;

- Two streets, space, and entrance/ wall,
- Street, two spaces, and space/ wall,
- Two streets, space, and space/ wall,
- Street, space, and two space/ wall,
- Street, space, entrance/ space, and space/ wall,
- Space, wall, and two sides space/ wall,
- Two spaces, wall, and space/ wall, and
- Wall, and three sides space/ wall.

- The difference between the integration spaces values, which are in the same location pattern, refer to the variety in integration values of linked surrounding limits.

- Increasing the number of streets and buildings' walls as limits for the space location reduce the space's integration values, such as:

- Three street, and space/ wall,
- Street, two walls, and space/ wall,
- Two streets, space, and wall,
- Two streets, wall, and space/ wall,
- Two street, space, and entrance/ space/ wall,
- Two streets, wall, and space/ wall, and
- Space, wall, entrance/ wall, and space/ wall.

2- From the integration value for space according to streets and spaces:

- The combination between streets and spaces as limits of the space increase the value of space integration. Such as:

- Two streets, space, and entrance,
  - Two streets, space, and wall,
  - Street, space, and two sides space/ wall,
  - Two streets, wall, and space/ wall,
  - Street, entrance, and two spaces, and
  - Street, two walls, and space.
- The spaces in the same location pattern group have a great diversity in spaces integration, that act as a result of the integration variety in linked streets and spaces, such as:

- Two streets, space, and entrance,
  - Street, wall, and two sides space/ wall,
  - Two streets, space, and wall,
  - Two streets, wall, and space/ wall,
  - Two streets, and two sides space/ wall,
  - Street, entrance, and two spaces,
  - Two spaces, wall, and space/ wall,
  - Street, two walls, and space,
  - Wall, and three sides space/ wall, and
  - Two walls, and two spaces.
- Increasing the number of buildings' walls as limits for the space location reduce the space's integration values, such as:

- Street, two walls, and space/ wall, and
- Street, wall, and two entrances. Note; existing buildings' entrances in this test has no effects.

3- From the average of the integration value for space according to buildings' entrances, spaces, and streets:

- The combination between integration values of space location limits confirms that:
- The high levels of sides limits for space location pattern increases the value of space integration. such as: street, two sides space/ wall, and entrance/ space/ wall.
  - Increasing the number of spaces and streets as limits for the space increases the space's integration values, such as: street, space, and two sides space/ wall. And street, entrance, and two spaces.
  - The wide range of the integration spaces values in the same location pattern group refer to the variety in integration values of linked surrounding limits, such as:

1. Two streets, space, and entrance,
2. Two streets, space, and entrance/ wall,

3. Two streets, space, and wall,
4. Space, two walls, and space/ wall,
5. Two spaces, wall, and space/ wall,
6. Street, two walls, and space,
7. Wall, and three sides space/ wall,
8. Two walls, and two spaces,
9. Street, space, and two sides space/ wall, and
10. Street, entrance, and two spaces.

– Using the buildings' walls as limits for space reduces the integration values, such as;

1. Street, wall, and two sides space/ wall,
2. Street, two walls, and space/ wall,
3. Two streets, wall, and space/ wall,
4. Space, two walls, and space/ wall,
5. Two streets, and two sides space/ wall,
6. Space, wall, and two sides space/ wall,
7. Street, two walls, and space, and
8. Two walls, and two spaces.

- The surrounded space with three streets or more reduces its integration value in comparison to that surrounded on one or two streets and spaces.

- The combination in space limits between which reduce the integration (as buildings' walls) and which increase the integration (as spaces) that make the space integration record moderate values. Such as:

1. Street, two walls, and space/ wall,
2. Two streets, space, and space/ wall, and
3. Two walls, and two sides space/ wall.

- Generally, the main limits of space (included in the first level [Figure 1] as a side limits for space); street, space, building's wall, and building's entrance have different effects on space integration value, as follows:

- Street, change from negative to positive and return to negative effect on increasing integration. That means if a space is surrounded by streets from all sides that will reduce its integration. And, if surrounding streets are decreased to be from two sides (as an example) the integration will increase. And, when the space is not surrounded by any street the integration value will once again decrease.
- Space, has a positive effect on increasing integration.
- Building's wall, has a negative effect on increasing integration.
- Building's entrance, has a neutral effect on integration.

## 6. Recommendations

Guide lines for designing the public open spaces in residential areas:

- Support reaching to spaces by pedestrians' roads, will create a good social space. But it must take care as these roads are related to buildings' entrances.
- Avoid the space which is surrounded by buildings' walls; where it will cause segregation space.
- Avoid the space which is surrounded by streets from many sides or has a long side face street, where although that increases the spaces' integration it may affect its safety for children and the residents' privacy.

For testing these guide lines (Fig. 6, Table 3) show five alternative models for the same plot, each model has two cases: the first case; the buildings' entrances face spaces, the second case; the buildings' entrances far away from spaces and face streets.

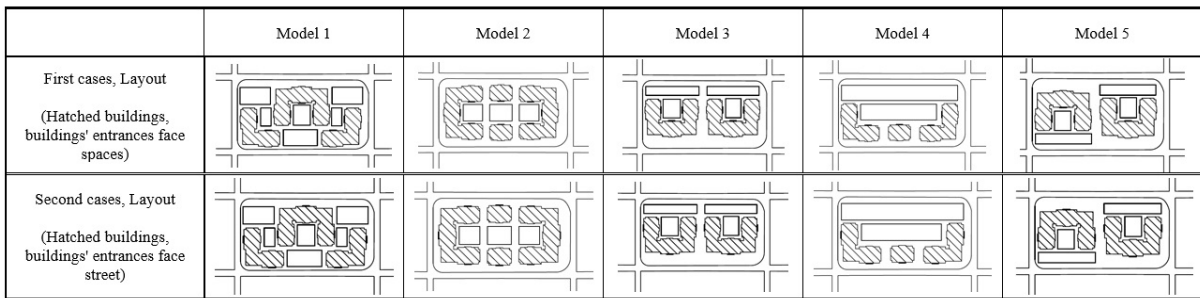


Figure 6. The layouts of tested models

Table 3. The results of models' test

		Model 1	Model 2	Model 3	Model 4	Model 5
First cases, Layout (Hatched buildings, buildings' entrances face spaces)	The integration according to surrounding buildings' entrances & spaces	0: 0.703987	1.47447: 2.21171	0.91667: 1.1	0: 1.01895	0: 0.703987
	The integration according to streets	2.630315: 4.75265	0	4.84692: 6.087135	5.60723: 8.700075	4.128575: 4.91518
	The average of integration. According to buildings' entrances, spaces, and streets	1.3151575: 2.626325	0.737235: 1.105855	2.881795: 3.5935675	2.803615: 4.8595125	2.0642875: 2.8095835

*Continued on next page*

Table 3 continued

Second cases, Layout (Hatched buildings, buildings' entrances face street)	The integration according to surrounding buildings' entrances & spaces	0: 0.210897	0: 0.210897	0.333333: 1	0	0
	The integration according to streets	2.630315: 4.75265	0	4.84692: 6.087135	5.60723: 8.700075	4.128575: 4.91518
	The average of integration. According to buildings' entrances, spaces, and streets	1.3151575: 2.4817735	0: 0.1054485	2.5901265: 3.5435675	2.803615: 4.3500375	2.0642875: 2.45759

The models' test shows;

- Conforming first and second point of guide lines:

- All models in the first case recorded integration values higher than the same model in the second case.

- Conforming third point of guide lines: the first case tests this point.

- The integration according to surround buildings' entrances and spaces, model 2 has the highest values, where all spaces attach and have a direct link with all buildings' entrances.
- The integration according to surround streets, model 4 has the highest values where the spaces have a long face of streets and a good connect with it. These spaces have low privacy and safety.
- The average of integration according to buildings' entrances, spaces, and streets, model 4 has the highest values, but the model is the least beneficial in achieving privacy and safety. Model 5 has the next highest value but it also has a long face of streets, which means low privacy and safety.
- The increase in the average value of integration is caused by the high value of integration according to surround streets.
- The average of integration according to buildings' entrances, spaces, and streets, model 3 has the moderate values. But it still has high values for integration according to surround streets.
- The average of integration according to buildings' entrances, spaces, and streets, model 2 has the lowest values, because it has zero value for integration according to surround streets.
- The average of integration according to buildings' entrances, spaces, and streets, model 1 records the moderate values. It has moderate values for both; integration according to surround buildings' entrances and spaces, and integration according to surround streets among modes.

So, both model 1 and model 3 are good designs for achieving social open spaces in residential areas.

## 7. Conclusion

The open spaces in residential areas have a main role in social life, this role is supported by its: location, physical features, equipment.

This paper studied the open space location alternatives and their effects on a space's integration and segregation. It concentrated on 36 groups of location patterns from 1001 groups, which are included in the neighborhood case study.

This paper reached some results and discussed them, they lead to the guidelines for designing a good location of open space in residential areas, in order to support people's social life, as follows:

- Should be as a unit within the continuous spaces' series, not as a separated space surrounded by buildings' walls (back or side).
- Be careful in designing the length of spaces series because the long series may have a negative effect on internal spaces, which cause vague and poor use for open spaces between the blocks and suffer from poor surveillance and under use.
- Should be next to a street from one of its sides and be careful of the safety and quiet in space and the street speed limits.
- Should have a variety of surroundings; other spaces, buildings' entrances, streets, and buildings' walls, and use various combinations for each space side.

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