(Section A: Planning Strategies and Design Concepts)

Open spaces: spatial configuration, visibility analysis and use

Case study of mass housing in Biskra, Algeria

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Abstract: Open spaces provided in mass housing schemes is considered as one of largest issues in public mass housing, and their use by the inhabitants has been a concern and a topic of interest of many fields, where the focus is on inhabitant behavior in space according to either inhabitant/inhabitant or inhabitant/space relation. This open space constitutes a structuring space for the large housing estates, by the ties that connect between the buildings that compose it and the inhabitants who use it. Amongst the various deficiencies that mass housing schemes particular present today is the inability of promoting successful open spaces, which is mainly reflected by patterns of their use, therefore produce an abandoned, deserted, and degraded spaces, this is generally an indication that something is wrong with their layout design, in this regard, this paper revolves around the use of open public space in the 1000 collective housing units in the city of Biskra (Algeria), which provides a variety of open spaces forms, hence; to know how the spatial configuration and the site organization affect the way spaces are used by the inhabitants, based on the hypothesis that the use of open public spaces in mass housing is intimately linked to the visual fields produced by the spatial configuration. The analysis process draws on two methods, an observation in-situ to explore why in the neighbourhood, some parts are more occupied and more preferred by people than others, using the technique of behavioural mapping, i.e. people counting and spatial use mapping, taking into consideration three age groups (children, adults, elderly), further to look for links between visibility and spatial use, a syntactic analysis is carried out to analyze visibility properties using Depthmap software. The results of this study indicate that the visual factor, the buildings arrangements, and the site organization in the mass housing substantially affect the use and the quality of their open spaces.

1.   INTRODUCTION

This paper is about the open public spaces provided in mass housing schemes, which considered as one of largest issues in public mass housing, and their use by the inhabitants has been a concern and a topic of interest in many fields, where the focus is on inhabitant behavior in space according to either inhabitant/inhabitant relation or inhabitant/space relation. This open public space constitutes a structuring space for the large housing estates, by the ties that connect between the buildings that compose it and the inhabitants

who use it, it is a territory where the different social interactions take place, requires a certain characterization of belonging, and a sense of community.

Each urban environment has an existing pattern of solids and voids, and the solid-void relationships formed by the shape and location of buildings, i.e. buildings create open spaces (voids) for the residents (Can, 2012). Lewis (2005) asserts that public spaces are affected by buildings in two main ways: first of all, their use and how they relate with outdoor space, and secondly, their volumes in terms of the enclosure, where fronts and backs of buildings should be defined and differentiated clearly. Therefore defining public and private spaces that facilitate the mediation between these realms, and levels of penetration, permeability, and visibility are the tools for this negotiation (Lewis, 2005).

Currently, housing layout is of various forms, hence, the physical form and arrangement of residential buildings and their relationship with open space should be deliberated in new housing developments (Woolley, 2003). It is necessary to specify the housing layout types and classify dwellings based on common characteristics and forms to clarify the effect of building arrangement within residential areas on the quality, size and form of open space, thus its effect on social life quality and spatial use by the residents. In this context, several urban studies indicated that the configuration of open space between houses and the way a building is arranged on its site is particularly important, as Gehl (1987) states, "Life between buildings is not merely pedestrian traffic or recreational or social activities. Life between buildings comprises the entire spectrum of activities, which combine to make communal spaces in cities and residential areas meaningful and attractive".

In the recent past, enclosure of open space became the basis for a methodology of layout design in public housing, nevertheless Bill Hillier in his research argued that "the enclosure is not the answer to the urban problem, but the problem itself, its indiscriminate use has been responsible for the creation the fragmentary, unintelligible and largely under-used spaces which form a significant proportion of urban environment" (Hillier, 1988) . In other words, the relation between the building surfaces that enclose the space and the openings which connect it to the system need to be provided in a way which reflects the strategic value of the space, its metric size and the kind of informal uses which is intended to support (Hillier, 1996). So the importance of site-layout design in mass housing is to organize the external physical environment in order to accommodate, facilitate and, constrain human behavior i.e. by locating objects and activities in spaces, arranging buildings on the land, and shaping the spaces between buildings (Lynch, Lynch, & Hack, 1984). Moreover, building arrangement and site organization generate visual fields which are of a great importance on how people behave, appreciate and experience the environment and could be determinant factors in designing urban spaces (Bada & Guney, 2009). This research aims to explore the impact of building arrangement and the visibility produced by it on open public space use by residents within a mass housing.

To meet the increasing housing shortage in most Algerian cities, mass housing neighbourhoods (ZHUN) have been built all over the country since the 70's, it consists of a layout of several block units in various configurations, creating loose outdoor spaces intended to carry out social activities of residents. However many ZHUN housing models in Algeria confront an increasing number of problems linked to their design, and various studies have shown the negative effects of such a poor living open space on its usage by the inhabitants; a study in Batna, a city in Eastern Algeria, showed that the degradation observed in the ZHUN in the area results anonymous open spaces

where residents endured difficult conditions, such as deteriorated social cohesiveness, damaged neighbourhood relations, therefore their avoidance (Naceur & Abdellah, 2003). Another study by Mebirouk, Anissa, & Kaddour (2005) in Annaba city, in the North East region of Algeria, showed that outdoor spaces in public mass housing have failed to respond to the resident's public life; dysfunctional, deserted, and unevenly used space.

Against this backdrop, this paper revolves around the use of open public space in the 1000 collective housing units in the city of Biskra (Algeria), which provide a variety of open spaces forms, hence to know how the spatial configuration and the site organization affect the way spaces are used by the inhabitants, based on the hypothesis that the use of open public spaces in mass housing is intimately linked to the visual fields produced by the spatial configuration, using Space syntax method (Depthmap program) to observe the visibility properties and behavioural mapping, i.e. people counting, to observe the spatial use within the case study.

2.   RESEARCH BACKGROUND

2.1   Space syntax and visibility

The space syntax emerges as a set of theories and methods used for the definition of a structural environment and analysis of spatial configurations. At the end of the 1970s, space syntax was first put forward and applied by Bill Hillier and his team, since then many scholars have made a number of extension studies on space syntax, such as the studies on urban traffic, urban street layout, urban space design, and so on. Space syntax is only one way of thinking about space which believes that space has a great effect on people behavior, use of space and movement (Durson, 2007), this is why its techniques are very much used in contemporary studies of the relationship between spatial use and urban form of neighborhoods and public spaces (Novakovic & Djukic, 2015) property that might influence majorly people's spatial experience (Bada, 2012). Hillier claims that the use of open spaces is bound to the visibility field or isovist properties of space. This means that the visual field generated by space and configuration has a great impact on human behavior. In this context, Turner (2003) states: "we might use visibility analysis to talk about morphological properties of the built environment or to talk about how people can move or interact within the visible space or to discover the significance of objects places within that space".

Study of the visibility using Visibility graph analysis (VGA) was developed by Turner et al. (2001) based on space syntax theory (Hillier & Hanson, 1989) and previous studies on visibility fields (Benedikt, 1979; Theil, 1961). Turner et al. (2001) attempted to study the visual experience through buildings or urban environments by analyzing the properties of visibility fields. The concept of 'isovist' (Benedikt, 1979), has had a long history in various fields of research, it centers on visibility analysis, and is defined by Benedikt (1979) as: "the set of all points visible from a given vantage point in space and with respect to an environment". Turner (2001) asserted that isovists are an intuitively attractive way of thinking about a spatial environment because they provide a description of the space from the point of view of users as they perceive, interact with, and move through it (Varoudis & Penn, 2015).

Space syntax uses VGA primarily in architectural and urban space in order to attain how visibility defines relationships of spatial elements, influences movement and contributes to better understanding of space around us. Turner et al. (2001) presented the computational foundations of visibility graphs as a method to record spatial configurations and relationships. Since then, VGA has realised a series of meaningful characteristics and correlations about architectural and urban space, morphology, movement and space usage (Varoudis & Penn, 2015). The VGA method draws from space syntax theory (Hillier & Hanson, 1989) that seeks for answers through the analysis of the configuration of space and it produces a graph of mutually visible locations in a spatial layout termed visibility graph. VGA is implemented through the open source and multi-platform 'depthmapX' spatial network analysis software (Turner, 2001; Varoudis, 2012), where Turner et al. (2001) suggested a number of local and global measures of spatial properties that can be extracted from the graph and compared these with real-life data of usage to "shed light on the effects of spatial structure on social function in spaces" (Turner et al., 2001), then many studies have argued that there is a significant correlation between visibility analysis measures and the way people use spaces (Bada, 2012; Campos, 1997; Desyllas & Duxbury, 2001; Trova et al., 1999; Turner & Penn, 1999). Space syntax method is chosen to be used in this research to investigate the case study mainly because it provides techniques and tools that allow to analyze and to quantify space and also to link its configuration (spatial aspect) with people's behavior (social aspect).

2.2   Open space use in residential environment and visibility features

In line with the objectives of this research, this part introduces some studies that look at how open public space in residential areas is actually used, based on visibility features that produced by the spatial configuration, and the most significant study in recent years was carried out by Bill Hillier in studying a number of open spaces in the City of London, and he claimed that the use of open spaces is bound to the visibility field or isovist properties of space, in other words, the visual field generated by space and configuration has a great impact on its use, and more space is structured and legible, the more it is better lived by the user (Hillier, 1996).

Several research studies confirmed by using different tools and approaches that the main activity for people in open space is to be in contact with others; to be able to see, to hear and to experience other people functioning in various situations (Bada, 2012). This was principally confirmed by Trova et al. (1999) who have studied how the visual fields, linear properties, and socio-spatial boundaries interact to structure the public space of three sets of housing in Athens using syntactic and isovist analysis. The results showed that people converge on the areas of the greatest visual field and where the correlation between the density of people moving and syntactic variables are higher (Trova et al., 1999). In another study, Bada (2012) has studied four plazas that are situated within residential areas in the city centre of Biskra, Algeria, to look into why, within the same plaza, some parts are busier and more preferred by people than others. He investigated the correlation between people's movement and spatial use to the visual fields created by the spatial configuration. The results showed that people come to a public space through linear properties and then choose the location that offers some privacy, so the

spatial use is strongly related to visual considerations relevant to the type of activity.

Gehl (1987), in his book 'Life between buildings: using public space' argued that open spaces between the street and the building create the possibility for residents to spend time together and to socialize, moreover the specific characteristics of that space are very important for encouraging interaction. His main finding is that the key feature of a public space use is the presence of people, a characteristic that can be encouraged through physical planning. According to him, people tend to occupy the curbs (edges of curbs and pillars), especially places where people could sit and face the pedestrian flows, once they are full, the occupation goes gradually inwards; that means people prefer areas that provide good visibility but keep some privacy, an 'edge effect' (Gehl, 1987). Whyte (1980) and his team chose a variety of public spaces like plazas, streetscapes, playgrounds, even entire neighborhoods like Harlem, and set about observing and recording how and why people use them, in particular, to find what physical features would encourage their use. By using an in-situ observation method, the daily recording and interviewing of users was conducted. The main finding of his research is that the most frequented spaces are sociable places, where people select to occupy the dense areas, to stand and have conversations, or sit in the mainstream of pedestrian paths and flows. Whyte (1980) showed the importance of the visual factor, which deduced that the main activity for people is to look at other people. This means the visibility increases the sense of security and therefore is highly preferred by people.

3.   CASE STUDY PRESENTATION

Biskra is a middle city in the Southeastern part of Algeria, located on the edge of the Sahara Desert in a stretch of oases, around 430 km south of Algiers, it is known as the 'gate to the desert' with very hot summers and mild winters. Like most Algerian cities, Biskra has created two Z.H.U.N on the western and eastern peripheries of the city to satisfy the increasing demand for housing. "West Z.H.U.N" was the first Z.H.U.N initiated in 1975 on a surface of 98 hectares of land, and for the purpose of our study we focus on the 1000 collective housing units; in the southwestern part near the city centre of Biskra (*Figure 1*), one of the most important and well-known neighbourhoods in the city, and one of the oldest collective mass housing, which represents the first operation of West ZHUN, in 1979, and stated to be occupied in 1984. The total area of the estate is about 24,663 hectares; it comprises 123 blocks with the total number of flat units being 1000.

The 1000 housing units are located in a dense urban fabric near to the city centre of Biskra and are surrounded by several neighbourhoods and public buildings (*Figure 2*): A regional museum, a handicraft centre and Hakim Saadan high School in the north part, and residential areas in the South, East and West part. It is accessible from the important artery of the city. National Road N° 03 to the North, as well as from the National Road N°46 to the west. It is delimited by the 104 collective housing estate then 'EL Saihi' district in the East. The southern borders are delimited by the 'Ben Taleb' district, and the western ones by the 60 housing units.
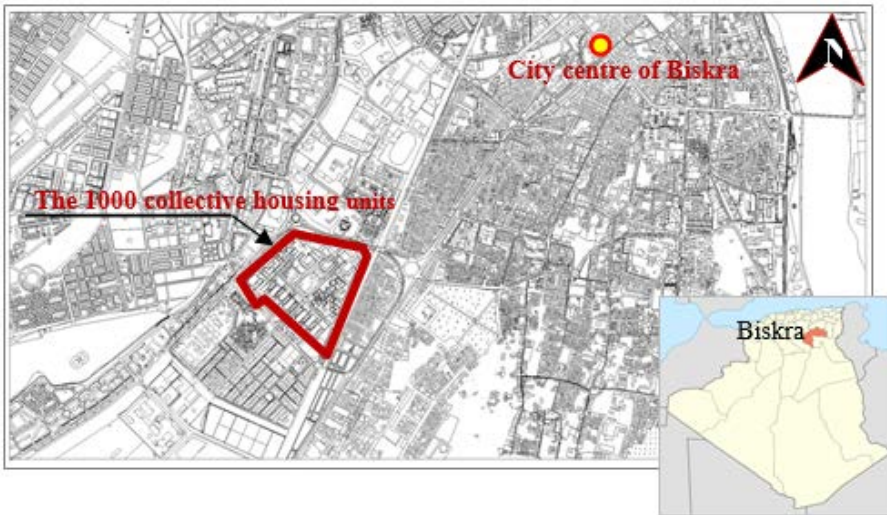
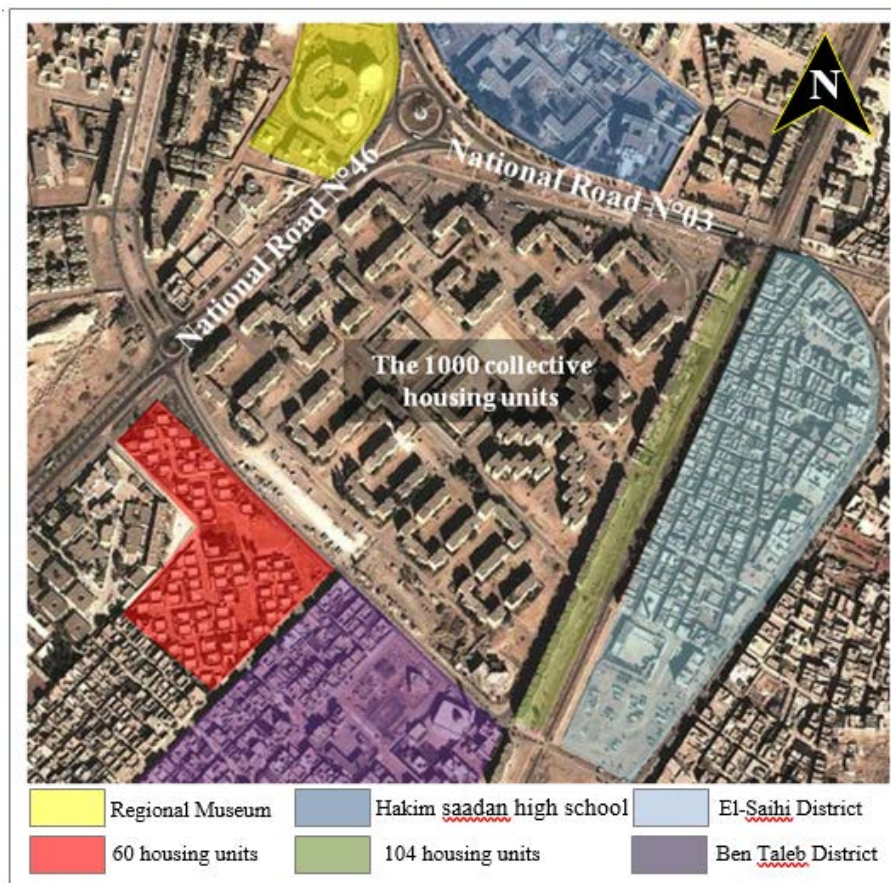*Figure 1.* Situation Plan of 1000 Collective Housing Units in Biskra City.

Figure 2. Ground Plan of the 1000 Collective Housing and Its Delimitations.

3.1   Spatial organization and building arrangement

The 1000 units housing estates contain more than the housing areas, it includes some public and administrative buildings and an outdoor shared space (*Figure 3*), two schools (a primary school and a college) at the centre,

and two soccer fields. At the north-east peripheral axis, there is the urban safety office and the administration building (OPGI), concerning the north-west part, there are the police office and the national gendarmerie. *Figure 3* also shows several types of access to the site, furthermore, all entries to the blocks are oriented toward the inside part of the neighbourhood to preserve the privacy of the residential area.

Figure 3. Spatial Organisation of the 1000 Collective Housing Units

The neighbourhood represents variant configurations of blocks, the most dominant are of a rectangular shape and for the rest are H- shaped. These blocks are arranged into four types of organization:

- I-shaped blocks arranged linearly (*Figure 4* (A))
- Blocks in degraded linear shape are formed by the assembly of H-type units (*Figure 4* (B))
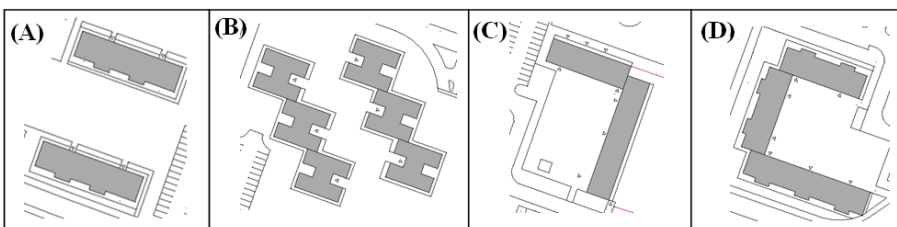- L-shape blocks (*Figure 4* (C))
- U-shape blocks (*Figure 4* (D))

Figure 4. Arrangement Typology in The Mass Housing of 1000 Collective Housing Units, (A): Linear I-Shaped Blocks, (B): Blocks in Degraded Linear Shape Formed by The Assembly Of H-Typed Units, (C) L-Shaped Blocks, (D) U-Shaped Blocks.

The blocks' arrangement shows that the spatial organization of the neighbourhood is based on the principle of centrality and openness, where each number of blocks are organized around a central open public space,

except for blocks in degraded linear shape formed by the assembly of H-type units where the buildings are very close together, structuring a linear public open space.

3.2   Open space classification based on the number of access ways

The arrangement of blocks gives a variety to the estate's open public spaces configuration, which allows them to be group them into three categories (*Figure 5*):
• The open public spaces between the blocks.
• The open public spaces behind the blocks.
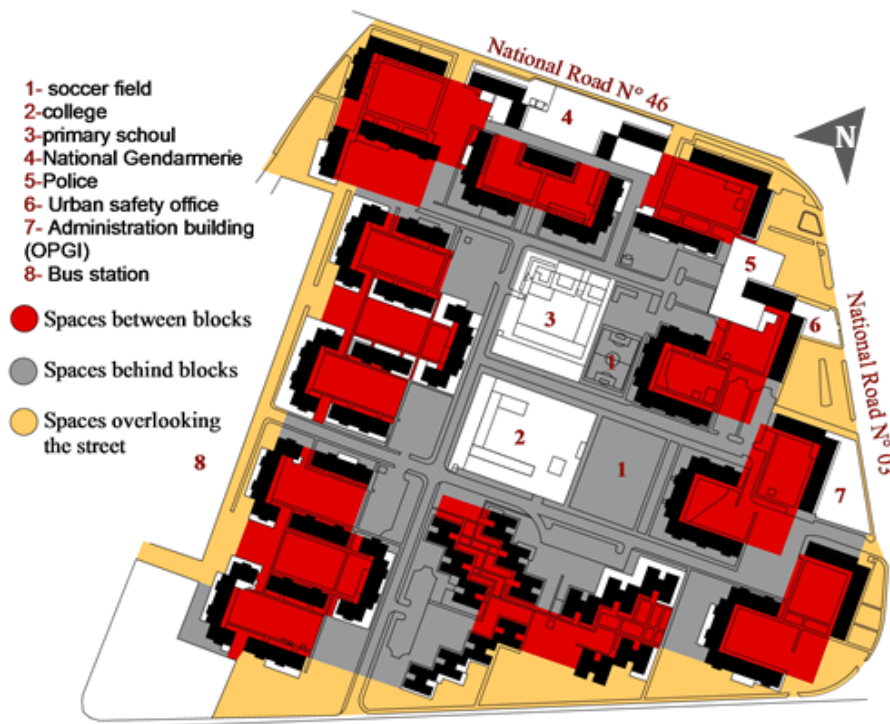• The open public spaces overlooking the street.

Figure 5. Different Types of Open Spaces in The Estate (The Darkest Colour = Spaces Between Blocks/Semi-Dark Colour = Spaces Behind Blocks/Lightest Colour = Spaces Overlooking The Street).

The shapes of spaces between the blocks can be also classified according to their degree of openness and accessibility in three categories (*Figure 6*):
• **Open public spaces provide a low degree of enclosure:** these have more than two large access ways formed by the arrangement of L-shape blocks facing each other with the I-shape blocks.
• **Semi-open public spaces provide an average degree of enclosure**: are accessible by two large accesses in two sides, and which are formed by the arrangement of L-shaped, U-shaped, and degraded linear shape blocks formed by the assembly of H-typed units.
• **Semi-enclosed public spaces provide a high degree of enclosure**: these are public spaces with a single large access way and other narrow access ways, resulting from by the arrangement of three I-shaped blocks; two of them being parallel and the other one perpendicular.

Figure 6. the Classification of Open Spaces Between Blocks of 1000 Collective Housing Units Based on The Number of Access (The Darkest Colour = High Degree of Openness/Lightest Colour = Low Degree of Openness).

4.   METHODOLOGY

The research methodology adopted was divided into three phases according to the objectives to be achieved. The first phase tackles the use of open public space according to three age categories (children, adults, elderly) using the technique of behavioural mapping, the second phase investigates its visibility using space syntax techniques, and the third one is about overlapping the results of the previous phases, therefore to affirm or deny the hypothesis that revolves around the relationship between the use of open space in mass housing, and the visibility produced by the spatial configuration.

4.1   The use of open spaces according to age categories: observation in situ

The use of open space in mass housing requires its frequentation by the inhabitants that varies according to the time of day and day of the week and is affected by 'the affordance' of a given space (Gibson, 1979). The use of open spaces in Biskra city is most affected by the seasons, time of day and prevailing weather and light conditions. In this regard, the method of behavioural mapping was carried out for two days. Tuesday as a day of the week and Friday as a weekend, in March 2017 from 17.00h to 18.00h, for 10 minutes. This period was chosen because it is the time that is conducive to outdoor activities to avoid the impact of climatic factors in the city of Biskra. We repeated the fieldwork several times, in order to see the different behaviours of the inhabitants and try to understand the way of using these spaces. The context of observations included the number of users, and users' age range (children (under 18 years old), adults (18-50 years old), and elders

(over 50 years old)). People counting considered only static people (sitting and standing positions) and dynamic people (people in activity with corporal mobility), while eliminating people crossing the neighbourhood. For the present work, the goal is to look for any link between occupancy of space and the properties of that space no matter what type of people's activities.
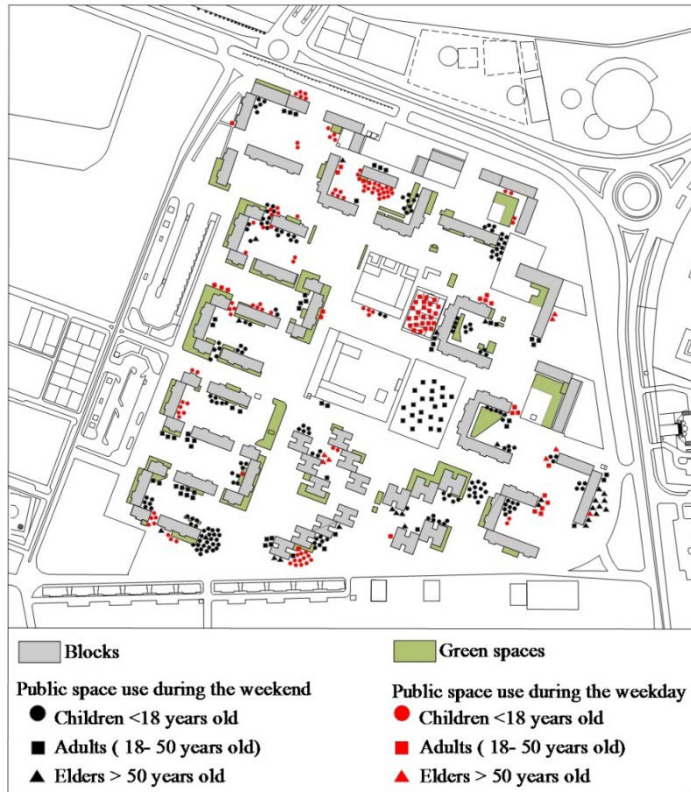

Figure 7. The Use of Open Public Spaces in The Estate, Where The People on The Map Are Represented as Follows: The Child With A Circle, The Adult With A Square, And The Elder With A Triangle, Using Two Colours; Red for The Weekday (Tuesday), And Black for The Weekend (Friday).

The results of the behavioural map (*Figure 7*) show an unequal distribution of users of different age groups (children, adults, elderly) through the open public space, where some places are busier and more used by the inhabitants than others, especially during the weekend, when most inhabitants prefer to pass their time outside instead of staying in their homes, and the number of people with dynamic activities (63,15% of users) on two days is more than the number of people with static activities (sitting and standing) (36.85% of users). This is mainly because of the lack of layout furniture and places of gathering and leisure that can lead to a confusion of use (*Table 1*).

Table 1. Number of People for The Three Age Groups According to Their Activity (Static and Dynamic) on Two Days of The Week (Tuesday and Weekends).

	Static activities			Dynamic activities			Total
	Children (<18)	Adults (18-50)	Elders (>50)	Children (<18)	Adults (18-50)	Elders (>50)	
Tuesday	33	25	08	65	22	00	153
Friday	21	50	27	**167**	27	00	**292**
Total	54	75	35	**232**	49	00	
	164 (36.85%)			**281 (63, 15%)**			445

Table 2. The distribution of users of different age groups (children, adults, elderly), through the different types of open public spaces in the mass housing.

Age categories	Open public spaces of mass housing estate														Total (%)
	Spaces between blocks								Spaces behind blocks		Spaces overlooking the street			
	Open spaces		Semi-open spaces		Semi-closed spaces		Total								
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%			
Children (<18)	71	27.62	75	29.19	**111**	**43.19**	**257**	**89.86**	21	7.34	8	2.80			286 **(64,27)**
Adults (18-50)	16	25.39	20	31.75	27	42.86	**63**	**50.81**	**58**	**46.77**	3	2.42			124 **(27,86)**
Elders (>50)	2	10	**13**	**65**	5	25	**20**	**57.15**	2	5.71	13	37.14			35 **(7,87)**
Total	89	20	108	24.27	**143**	**32.13**	**340**	**76.40**	81	18.20	24	5.40			445

Table 2 above indicates that the vast majority of users of these open spaces are children with a percentage of 64.27%, then adults with 27.86%, and finally the elderly who present only 7.87% of the total number of users during the two days; and this can be explained by the inadequate facilities, security concerns, and a lack of interesting activities appropriate for their age group. It has also been noted that public spaces between blocks are the most frequented and used compared to spaces behind blocks and those overlooking the street. According to their spatial configurations, the semi-enclosed public spaces are more occupied by the inhabitants than semi-open and open spaces, and this allows predicting that the more space is limited by buildings (closed), the more it is used by the inhabitants, as these places can guarantee a good level of security and control, compared to others. Concerning the age groups, the majority of children use semi-enclosed public spaces between blocks, where they occupy areas near the entrances of dwellings, which are bare and large spaces, that allow children to play freely, following their parents' orders mainly to stay under their control and to keep an eye on them from the private interior spaces which provide good visibility (natural surveillance), however, adults prefer to occupy the spaces behind blocks away from the entrances, to keep some privacy, then elderly almost always ignore these spaces, most of them prefer to occupy the semi-open spaces between blocks (*Table 2*).

Although the open spaces were large and the investigation was carried out during two days of the week, the mode of use is still very low. It seems that the inhabitants only use the outside spaces for passage and not for the living and leisure, this is mainly due to the lack of layout furniture, playgrounds with safety standards, and rest areas for any age category, and may negatively affect the security and social control of the district.

4.2   Visibility analysis using syntactic measurements

In term of visual analysis, two techniques will be used to study the visibility in the neighbourhood's open public spaces using space syntax method. Visibility Graph Analysis (VGA) and Fewest Lines Analysis in order

to understand the relationship between the visibility of space and their use, based on the properties of visibility and taking into account visual barriers higher than 1.20 meters where most of these obstacles are informal green spaces. Two syntactic measures are considered, integration that identifies the most visible and accessible spaces, and local measure of connectivity that indicates the visual connections between each space within the neighbourhood, using the "UCL Depthmap" software, from the export of a DXF format file containing the visible limits of spaces.

4.2.1 Visibility graphs analysis

As it can be seen on the Visibility Graph Analysis (*Figure 8*), the values distribution of integration and connectivity are very close. The most integrated and connected areas are located in the centre of the neighbourhood, exactly near the two schools (primary school and College), and this means that these spaces are deeper and more accessible and well connected to other spaces. On the other hand, the spaces overlooking the street are moderately integrated and connected, except the southeastern peripheral axis, which has higher values. The least integrated and connected spaces are those between blocks with low values, especially which are the most closed (*Table 3*).
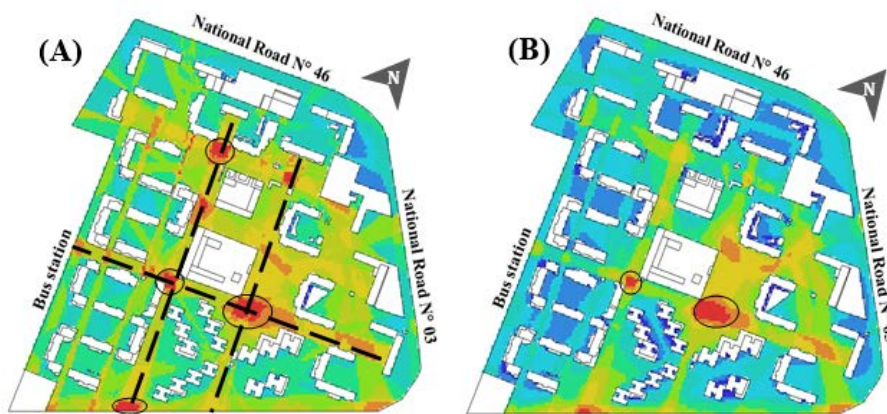

Figure 8. (A) Results of The VGA for The Visual Integration Values of Open Public Space Between The 1000 Collective Housing Units (B) Visual Connectivity of Open Public Space Between The 1000 Collective Housing Units (Red (The Darkest Colour) = High Values)

Table 3. Results of the VGA for The Integration and The Connectivity Values of Each Open Space Type in The Housing Unit Estate.

Visibility Graph Analysis (VGA)	Spaces between blocks			Spaces behind blocks	Spaces overlooking the street
	Open spaces	Semi-open spaces	Semi-closed spaces		
Integration	0.49	0.54	**0.45**	**0.68**	0.46
Connectivity	0.28	0.41	**0.23**	**0.55**	0.33

4.2.2 Fewest Lines Analysis

The Fewest Line Analysis (subsets) allows to give the main axes of the possible movement structure and to understand the spatial system in terms of accessibility and visibility in the neighbourhood. In other words, this analysis

allows identifying the impact of spatial configuration and building arrangement on visibility and visual accessibility of open spaces. It is used to confirm the VGA results.

It is also noted that the values distribution of integration and connectivity in the axial map are very close (*Figure 9*), which highlights that the axis linking the north-east with the north-west (the most integrated and connected), as well as the two axes linking the south-east peripheral axis with the north-east going through the central area (moderately integrated and connected) are the structuring elements of movement in the neighbourhood. Segregated and less connected axes are also located on peripheral zones and in spaces between blocks which are the most closed (*Table 4*).
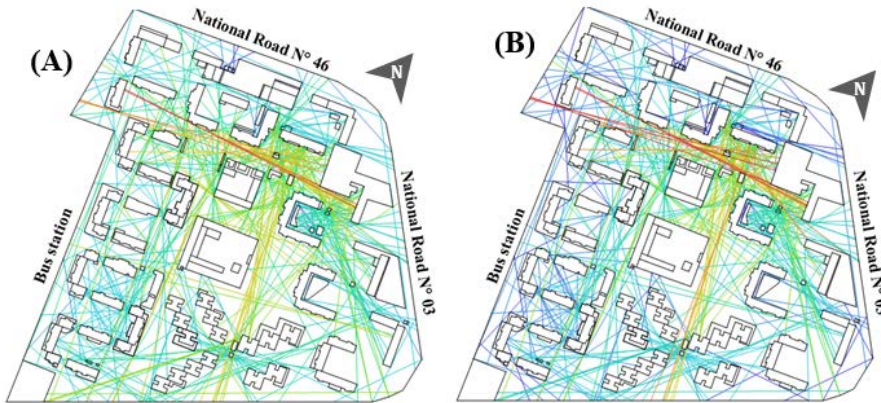

Figure 9. Results of The Fewest Line Analysis (Subsets) for The Visual Integration Values of Open Public Space Between The 1000 Collective Housing Units (B) Visual Connectivity of Open Public Space Between The 1000 Collective Housing Units (Red (The Darkest Colour) = High Values / Blue (Lightest Colour) = Lower Values).

Table 4. Results of The Fewest Lines Analysis for The Integration and The Connectivity Values of Each Open Space Type in The Housing Unit Estate.

Fewest Line Analysis	Spaces between blocks			Spaces behind blocks	Spaces overlooking the street
	Open spaces	Semi-open spaces	Semi-closed spaces		
Integration	0.43	0.42	**0.36**	**0.48**	0.38
Connectivity	0.35	0.38	**0.24**	**0.42**	0.27

4.3   Overlap of behavioural map and visibility

The confrontation of the configurational properties with the use and the occupation of the open public space in the 1000 housing unit estate by the different age groups on two days of investigation, by superposition the VGA and the axial map (Fewest Line Analysis) with the behavioural map, give the following maps shown in *Figure 10*:
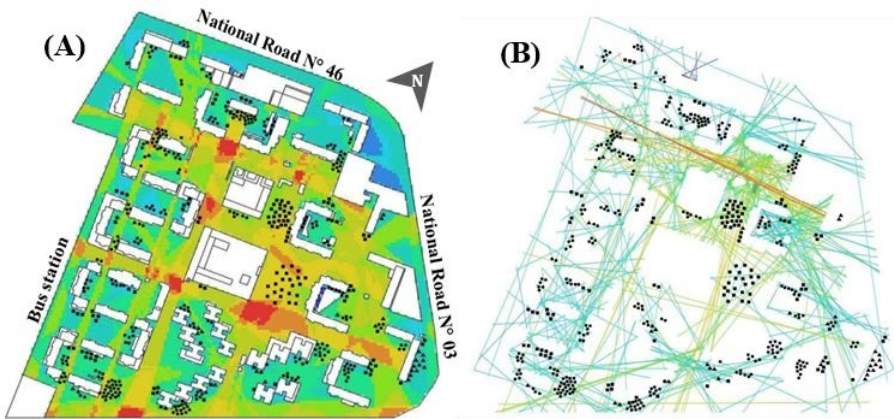

Figure 10. Overlapping People's Spatial Occupation and Visual Integration Map, (a) Overlap of Behaviour Map and VGA Map, (B) Overlap of Behaviour Map and Axial Map (Fewest Line Analysis). (Red (The Darkest Colour) = High Values / Blue (Lightest Colour) = Lower Values). Static and Dynamic People in The Map Are Represented By Dots.

Table 5. The Distribution of Users of Different Age Groups (Children, Adults, Elderly), Through The Different Types of Open Public Spaces in The 1000 Collective Housing Unit Estate, With The Syntactic Measurement (Integration) of Two Analyses; VGA and Fewest Line.

		Open public spaces of mass housing 1000 units				
		Spaces between blocks			Spaces behind blocks	Spaces overlooking the street
		Open spaces	Semi-open spaces	Semi-closed spaces		
The use of open public spaces according to age categories	Children (<18)	71	75	**111 (43.19%)**	21	8
	Adults (18-50)	16	20	27	**58 (46,77%)**	3
	Elders (>50)	2	**13 (65%)**	5	2	13
	Total	89	108	**143**	81	24
Visibility (Integration HH)	VGA	0.51	0.50	**0.45**	0.68	0.46
	Fewest line analysis	0.43	0.42	**0.36**	0.48	0.38

According to the Figure 10, it can be seen that there is a discrepancy between the visual integration values either in VGA or the axial map and the number of users occupying these spaces. From the *Figure 10* (A), the least

integrated spaces are occupied by the inhabitants, especially by children (43.19%) occupying the spaces between blocks semi-closed, with low values (I = 0.45). However, 46.77% of adults prefer to occupy spaces beside soccer fields as well as spaces behind blocks which provide more visibility with higher integration values (I= 0.68), and 65% of elderly occupy the moderately integrated zones (I= 0.50) (*Table 5*).

Same results occurred from the *Figure 10* (B), where most of the children (43.19%) avoid integrated axes and occupy the segregated zones where the mean integration value of axes that pass through these spaces is 0.36, then the 65% of elderly occupy the moderately integrated zones (mean value of axes= 0.42), however 46.77% of adults prefer to occupy spaces which contains a number of integrated axes with high mean integration value (I= 0.48) (*Table 5*).

So, the overlapping of observation data with the visibility graphs (in one map) showed that a large number of inhabitants occupy the most closed spaces which provide less visibility, furthermore, each age group chose to occupy places mainly according to their visibility and accessibility generated by the spatial configuration.

5. DISCUSSION AND CONCLUSION

The results of this research show an inverse relationship between visibility and open space use, where the total users of these spaces in two days of investigation that composed mainly of children occupy the most closed spaces which provide less visibility, and this contrasts somewhat with findings of previous studies (Bada, 2012; Campos, 1997; Desyllas & Duxbury, 2001; Hillier, 1996; Trova et al., 1999) which reported that the more space is visible the more it is occupied by people. We also note that for each age category the preferred places are chosen mainly according to their visibility generated by building arrangement as follows:

Children (under 18 years old) occupy the spaces between the blocks semi-closed and tend to play in areas near the entrances of dwellings that are characterized by very low integration values. It may be that the children occupy these spaces generally according to their parents' orders mainly to stay under their control and for them to keep an eye on them from the private interior spaces which provide good visibility (natural surveillance), moreover to avoid high-visibility and movement spaces for security and control reasons.

Elderly inhabitants prefer to occupy moderately integrated spaces, then adults occupy space at the back edges of blocks that provide good visibility and accessibility, where they can see the pedestrian flows while keeping some privacy, and that is what (Gehl, 1987) called 'edges effects', finding that the edge of the public space is the favorite place for people, because it can offer a better view with extended visual fields. One of the main characteristics of public space is supposed to be its visibility and access by all (Carr et al., 1992; Mitchell, 2003). However, in practice it is not necessarily so, especially in open spaces of mass housing where the visible effects might take form in many different ways, from the use and/or avoidance of use of the space by the inhabitant, to a change in the way that the image of a public space is perceived by different age categories that can reflect socio-cultural consequences.

In conclusion, this study indicates that the visual factor, the building arrangements, and the site organization in mass housing substantially affect the use of their open public spaces by different age categories. Children avoid the places of visibility (spaces between blocks semi-closed), whereas the

adults and the elderly occupy the places with a good visibility (spaces behind blocks and those overlooking the street). So the spatial use is highly dependent on visibility, accessibility and connectivity to the surroundings, thus, on the enclosure, degree of space is key to good functioning; visual access is a decisive factor in public spaces use (Montello, 2007). This tells us about the deep integration between the physical features of open spaces in mass housing and the way inhabitants occupy them, hence the visibility is an important factor that must be taken into consideration in the mass housing layout design, but in a way that takes into account the needs of all age groups; "Visual thinking in particular becomes a very important mode of thought that may change people's view of their environment in order to improve it" (Meziani, Ghazal, & Hajjdiab, 2015).

The outcome of this investigation is neither complete nor exhaustive. Although our interest in this research is on the impact of visibility produced by the spatial configuration on spatial use, numerous factors may also influence the use of these spaces. Other interesting directions for future research could consider the building height or the effect of the visibility from each building surrounding the open space, moreover study people's use of space which may be coupled by other measures that address people's perception in terms of their relations with space (e.g. territoriality) as a factor more important than physical ones in building a positive relationship with a territory, thus to maximize the use and the quality of these spaces.

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