

## EXPERIENCING URBAN SPACES: ISOVISTS PROPERTIES AND SPATIAL USE OF PLAZAS

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### ABSTRACT

This paper starts from the assumption that a good space is a used space and that people's behavior, movement and use, is primarily correlated to the potential of both the spatial structure and the visual fields created by the spatial configuration: visibility. The success is attributable to "...how well the spatial configuration fits real pattern of human behavior" (Hillier 2004). The use of space is governed by two considerations: Its attractiveness, in term movement, how easy for people to move in; as *to-movement and through-movement* space, and the conduciveness of its visual properties to people's activities. The correlation between the spatial use and isovists proprieties of space is the focus of this paper that is divided into two parts. The first, a comparative study of four plazas, considering the concept of natural movement about the "accessible destination" and space intelligibility, is carried out to look for the correlation of the number of static people (sitting and standing position) and syntactic and isovist properties of each plaza within the urban layout embedding all of them, the city center district of Biskra. In the second, taking only one plaza, to explore why within it some parts are busy and preferred by people to others; considering only stationary activities of sitting and standing positions. In order to grasp this deeply, believing that a space may have many sub-settings, the plaza has been subdivided into many subspaces to look for links between visibility and spatial use.

To achieve this goal the paper relies on overlapping two methods ; behavior mapping, by people counting and spatial use mapping, and space syntax methods initiated by Bill Hillier and visibility graph analysis by using Depthmap, a software developed by Alasdair Turner at UCL.

**KEY WORDS:** Isovists, space Syntax, spatial experience, behavior, configuration, Plazas

### 1 INTRODUCTION

How people and why they use the layout of the environment in a certain way is the interface of many fields of research such as environmental psychology, environmental sociology, architecture and environmental design; it is an interdisciplinary topic. This implies an understanding on one hand, the individual, involving perception, cognition and behavior, and on the other the physical properties of the environment (natural and built). However, more emphasis is put on the implication of visual perception because "...through perceiving that individuals experience world and come discover its properties" (Moore and Marans, 1987). The emergence of Gibson's ecological approach of the optic array concept, stressed on the interrelatedness of perception and movement. He consequently developed his theory with the notion affordance.

In human behavioral studies the individual behavior is a function of motivation, the affordances of the environment and the individual past experience (Lang, 1987). Two main concepts emerged one links behavior to cultural considerations (proxemics) and the other the physical environment that directs somehow the individual behavior

(behavior setting) (Baker, 1968).

Meanwhile, in environmental design the physical determinism approach believes that "changes in the geographic environment and "built form" will result in changes in behavior.

So this is well concluded by Lewin's formula  $B = f(p, E)$  where P is the person and E is the physical influences of the environment and p and E comprise the life space (Kaplan 1987). A better understanding of this formula would help" to create more human buildings and spaces and to improve their use" (Canter, 1977)

### 2 URBAN SPACES USE

Urban space is the "void" between buildings for movement and for outdoor activities such as streets, plazas ad parks; to take in public life in the city. It is considered as the armature of the city and has been the center of different theories of urbanism and city planning through history. The modern concept overturned all the heritage of urban spaces, nonetheless a rationalist trend tends to revive the urban spaces (streets and squares) heritage as the sole spaces for

public life in the city. Nowadays the concept of sustainability, driven by environment quality, public health and people well-being, strengthen more emphasis on the quality of public life through a set of recommendations and laws to improve public spaces as the “armature” of the city life.

The quality and the success of urban spaces such as public plazas is generally investigated either by looking for how comfortable are these spaces in term of ambience characteristics such as thermal and acoustic comfort, i.e. more sensory oriented approach, or by questioning and examining the spatial properties that are considered as qualitative such as enclosure (Sitte, 1945), good proportion (Alexander, 1977) and the landscape features like fountains and benches. As mentioned by Campos (2005), earlier studies failed to link people’s behavior and space use to spatial properties of the spaces such as their morphology and visibility properties.

How is used by people has been the interest of many fields. Edward T Hall interested on how different cultures use space and physical environment, he invented the term *proxemics*. In the meantime William Whyte studied, by observing urban plazas in N. York city, to understand why some plazas were underutilized while others are crowded. He suggests guidelines for the design of successful plazas and concludes that plaza use is correlated mostly with the amount of sittable space and its proximity to street life (Groat and Wang, 2002).

Gehl (1987) in looking into the usage of urban spaces classifies outdoor activities into three categories dependant on different conditions of the physical environment: *necessary activities*; activities less dependant on exterior environment (customary activities), *optional activities*; activities dependant on exterior physical condition; they occur when exterior conditions are favorable ( weather and space quality), and *social activities*; stimulated by other people presence – inherent to two previous activities.

Alexander, in his part, in investigating the pattern of occupancy of public spaces, points out their occupancy ensues around their borders and edges that people prefer (fig.1). Once they are full, the occupation goes gradually inwards; which is termed by Gehl as “edge effect”. Alexander argued that people ovoid spaces that either too exposed or enclosed. Nevertheless, Hillier emphasizes that the good locations for unprogrammed static use do not depend on the provision of specific attractions or facilities, but may be associated to “the visual properties of space experienced by the stationary person” (Hillier, B et al, 1990).



Figure 1: The edge effect in space occupation (Alexander 1977)

Investigating the relationship between visual fields and patterns of stationary activities in several London public squares Campos (2005) showed, by using space syntax method, that people seem to avoid very exposed spaces and prefer areas that provide good views but by keeping some level of privacy for unprogrammed activity. And she argued that the gradual occupation of public spaces is a local spatial property inversely related to the increasing degree of visual connections between these spaces and the surrounding urban environment rather than following the edge effect.

The individual’s behavior is influenced by his perception that is, too, influenced by the cultural factors and physical factors of space. However, space has a great impact on the individual’s behavior. It may present some affordances that conduce to certain activities. But the visual properties of the environment are the major determinant of the pattern of activities and of people’s behavior.

Observation of people interaction with space and coupling it to visibility analysis of the environment might be the best tool to comprehend people’s behavior and needs to improve architecture and urban design quality.

### 3 VISUAL PERCEPTION, VISIBILITY AND URBAN SPACE

Since the first human establishment, ‘visibility’ has been of a great importance to space and buildings layout. In the renaissance, Alberti introduced the perspective into urban design. St Peter’s square designed, by Bernini, as interconnecting spaces , axis (paths) and building to create an interplay of movement and perception ; optical illusion . Visual consideration implemented by Michelangelo in the redesign of The Campidoglio, the capitol hill (Moughtin, 1996). Camillo Sitte, in an analytical way, illustrated the quality squares of the medieval and renaissance city which by their geometry and configuration offer a good visual experience and perception of spaces and buildings. In a more cognitive aspect Lynch in his study of the perception of urban structure, introduced the concept of “imageability”: how people perceive and recognize their cities through strategic visual spots (nodes). Dealing with the representation of the individual experience and use of space, Thiel (1962) proposed a sequence notation of architecture, whereby the details of the experience can be recorded for paths as they progress through buildings or an urban environment. However Cullen (1962) stressed the role of movement in environmental perception appreciation by introducing the concept of “serial views”, and how space is perceived by the user of urban spaces.

In his studies of evaluative image of the environment Nasar (2000), who relied on works of environmental psychology, argued that the environment as experienced has dynamic rather than static qualities consisting of the changing visual field.

In environment aesthetics, Kaplan and Kaplan, environmental psychologists, associated environment properties such as mystery, which implies changing vistas, to individual preference.

Gibson's ecological approach, optic array concept, is the seed of a more realistic interpretation of person-environment relations. He stressed the importance of movement in the visual perception and that any movement of the perceiver in the environment, the visual field goes through sequences of changes; among these changes the interplay between optical occlusion and disocclusion.

Visibility and visual perception are of a great importance on how we behave, appreciate and experience the environment and could be determinant factors designing urban spaces. Experiencing a space is experiencing the visual fields generated by the arrangement of buildings and urban components. This will impact on the aesthetic appraisal and on people's behavior. So the understanding of visibility and people perception is not only a key to analytical purposes, but also a tool to producing more livable spaces. Since experiencing space involves motion, space is more dynamic than static; is a succession of subspaces involving changing visual fields (Thiel, 1970). Space syntax theory and isovists method emerged to analyze space and the perceived space using visibility as a tool to comprehend person-space relationship.

#### 4 SPACE AND SPACE SYNTAX

Space syntax is a series of techniques to analyse spatial configurations. It is developed by Bill Hillier to tackle the problem of non development of the sense of community in the United Kingdom in the 1960s and 1970s. The book "the social logic of space" (Hillier and Hanson, 1984) represents the starting point of space syntax theory. The main task was to find tools to analyse the interaction between housing layouts and people behavior. Since then space syntax has been developed and used as a method to undertake many aspects of man/space relationship on both architectural space and urban space.

Space syntax theory considers space as a unit dependant and a part of a whole (all other spaces) and that its properties depend of its linkability to the whole called configuration "... A set of relationships among things all of which interdependent in an overall structure of some kind." (Hillier, 1996)

Hillier argues that the functioning and the use of o these spaces is related to their isovist properties and that human space is no limited to the properties of individual spaces, but relates to the interrelation and interconnection between the many spaces that make up the Whole spatial layout (hillier, 2004)

Hillier recapitulate man's interaction with space as "People move in lines, and tend to approximate lines in complex routes. Then if an individual stops to talk to a group of people, the group will collectively define a space in which

all the people the first person can see can see each other, and this in mathematical definition of convexity in space" (fig.2) (Hillier, 2005).

Space syntax started with describing and spatial configuration and forms by means of simple relational graphs consisting of paths and nodes. Space syntax analysis consists of two basic conceptions: convex space, or convex polygon, is a polygon in which all the points are inter-visible; any line drawn between any pair of points is within that polygon, and axial space or axial lines, is the longest line which links convex polygons, it's a straight line; a line of sight and of movement.

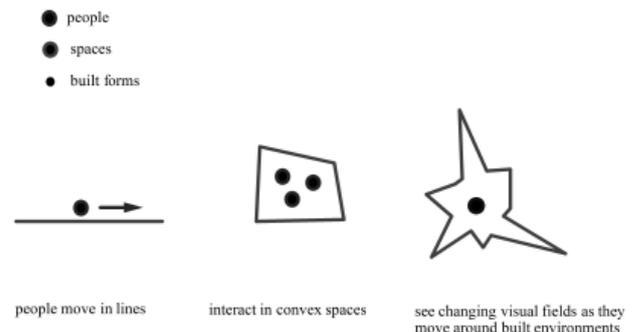


Figure 2: People interaction with space (Hillier, 2005)....

The spatial properties of analyzed space are quantified through a series of measures – derived from space syntax software programs. Two major measures are considered important and constitute the basis of the space syntax theory: a local measure; connectivity and a global measure; integration. Connectivity indicates the relationship of space to the surrounding space, to how many is connected; the higher connectivity value the more accessible is the line or the space. And Integration, which is a global measure describes the way in which each small-scale space is overall linked to all other small-scale (Bafna, 2003). The higher the integration value of a space or a line, the lower the number of connection needed to reach that line or space.

In studying the impact of the configuration of urban space on pedestrian movement, independently from other attraction theory parameters, Hillier suggests the concept of natural movement. Human movement is affected by the streets network implying the space to be a destination, *to-movement*, or to pass by, *through movement*, that will affect its usage. Consequently movement is influenced by the intelligibility of the whole network that which "...means the degree to which what we can see from the spaces that make up the system-that is how many other spaces are connected to- is a good guide to what we cannot see, that is integration of each space to the system as a whole." (Hillier, 1996). It term of measure it is the correlation between integration and connectivity.

The application of space syntax method has been used to cover a myriad of issues that deal with the impact of spatial on human activities and behaviors in urban environments; pedestrian navigation, criminality space attractiveness and space use.

Conroy Dalton (2003), in studying people navigation in space found, by using visibility graph analysis, that people pauses during movement are pauses do not occur in a random manner but coincide with junction that offer more visual information; where the isovists are and where the observer takes spatial decisions. While, Hillier found a strong correlation between integration value and people movement in a study of the city of London. (Hillier, 1992)

## 5 ISOVISTS AND VGA (VISIBILITY GRAPH ANALYSIS)

Researches on space representation and quantification as perceived and experienced by the moving individual started with the work of Philip Thiel by introducing the sequence notation as a tool to describe the environment using a set of symbols. Looking for a precise way to represent space as experienced by the perceiver, Benedikt introduced isovists. An isovist is "the set of all points visible from a given vantage point in space and with respect to an environment" (1979, page 47). A construction of a two-dimensional shape (a polygon) that embraces all the visible points from a particular vantage point. From this polygon a set of measurements of the isovists properties could be extracted to quantify the spatial environment such as area, perimeter, and circularity that might, according to Benedikt could be of use in the study of behavior and perception.

Turner saw some limitation in Benedikt's isovist method in considering only local properties of space and omitting the visual relationship between current location and the whole spatial environment and internal visual relationships between locations with the isovists (Turner, 2001).

Hence, concerned with how to quantify space and what perception of space might be, Turner suggests that more than one isovist is needed, arguing that the way an individual experiences and uses (motion) a space is related to an interplay of isovists. From this point, Turner developed a software package (Depthmap) capable of performing *Visibility Graph Analysis* (VGA). VGA entails a grid onto a space, and uses it to measure the relative mutual visibility among all the cells of the grid and consequently provides all spatial properties through a 2D analyses. Myriad of measures could be calculates either syntactic or isovist 'integration, connectivity, perimeter, area and so on.

The spatial properties of any analyzed space are defined on two levels of measurements: local properties such as connectivity, clustering coefficient (CC) and visual control (VC) and global properties such as integration, isovist maximum radial (MR) and Relativised Entropy (RE) values.

Campos (1999, 2005) has used overlapping points isovists as a tool for understanding preferable location of static people in public spaces in 12 squares the city of London and found that the static occupancy of public spaces is a function of their spatial configuration and their local interconnectivity in the urban fabric where they are embedded. The result showed also that the informal use of

space is a function of the number and the degree of integration values of axial lines passing through the public spaces. Moreover, in studying six squares in London, she found that the number of static people for all cases showed a preference for locations with low levels of exposure, 40% for medium levels and 10% for high levels. (

Papargyropoulo (2006) in a comparative study of two parks; regent's park, London and Pedion Areos Athens, found that the most integrated spaces are more used by organized activities performed by large groups. However, other activities such eating, reading and relaxing (stationary activities) go on more visually secluded spaces. Moreover, it is found that the accessibility to the parks is not influenced by the visual properties of the entrances themselves but much more by the relation of the park with its surroundings ; how deep are the isovists from the surroundings(through the entrances) . Wiener and Franz (2005) in experiencing space study, showed significant correlations between some isovists measures and some spatial behavior. Using a virtual reality, subjects were asked to navigate to the positions that maximize the visible area (isovist area), found that this is strongly correlated to with jaggedness, clustering coefficient (jaggedness defined as the ratio between the isovist's square and its area, which indicates the number of vistas into the adjacent spaces).

## 6 CASE STUDY PRESENTATION

Biskra is an oasis city located in the southeastern part of Algeria. It is known by its hot and arid weather. The urban structure of the city is a compilation of principally three main different urban fabrics; the colonial fabric with its gridiron characteristic, the irregular and dense fabric as extension of old nucleus of the city and the 'loose' and amorphous modern fabric of the post-independence urban development. The main open spaces for instance plazas and public gardens that encompass public life are situated within the city center which is sited mainly within the gridiron fabric and expanding to the limit with the irregular and dense one. Most of the plazas were initially created as "left over" spaces or as a result of coming together of the two geometrically different urban fabrics, which were then redesigned to be public spaces (El Houria, Dalaa and Zwaka plazas as case study). It should also be noted that the plazas of the gridiron fabric such as one of the cases in this paper, Larbi Ben Mhidi plaza, were designed as public spaces in the first urban planning scheme of the city during the colonial period.

The selection of plazas to be investigated, El Houria Plaza, Zwaka Plaza, Dalaa Plaza and Larbi Ben Mhidi Plaza was guided by the following consideration: situation, Size, morphology of the space and the configuration of the plaza, in other words the type of how they are linked to the surrounding.

El Houria plaza is the one to undergo the investigation into the correlation between the visual propriety and the spatial use. Its selection has been dictated by its good situation, by its frequent usage and by the affordance of few services

(cafe, shops and so on) that may not alter the objective of the experience. Two main busy streets go parallel on two opposite sides of the plaza. The plaza layout is mainly characterized by its two-level space, the higher part limited by El Emir Abdelkader boulevard the most liveable space of the city and the street and the lower part that is limited by a busy street that links to a popular market. The difference between the two levels is about 1.20 meter-high, and the connection is assured by a series of stairs. However this presents no visual obstruction within the plaza. The space layout is characterized by a linear fountain along a central pathway, a memorial wall and well defined spaces by built sitting areas. Surrounding land uses include cafes, few shops and a state building. In the present study all the features contained within this plaza do not obstruct views at eye-level for pedestrians such as seats, fountains, trees and so on are not considered.

fountains, sitting places and mixed-use of boutique and cafes.

Zwaka Plaza is situated within mostly residential area, Hakim Saadane, one of the major street of the city, passes through the plaza and constitute the major link to the rest of the city. The layout of the plaza is basically a green space crossed a by a pattern of pathways with a fountain, sitting places, and little service activities.

Larbi Ben Mhidi Plaza is situated within the gridiron fabric near a covered market. It is linked to its surrounding by 8 streets and its layout is mainly covered with a bunch of trees in its core that give it a garden like plaza. The mixed-use activities of the plaza consist of boutiques, cafes, and a bank make it a very liveable place.

## 7 IN SITU OBSERVATION

The observation consisted of stationary people counting. Each plaza was divided into sub-zones; and one observer is assigned to each sub-zone.

Surveys were done on two days; a weekday and a weekend, in August 2008 in the late afternoon from 7pm to 8pm. This observation time was chosen where the weather is conducive to outdoor activities in order to avoid the impact of the climatic factors which may alter completely the use of the squares mainly and as well as the goal of the investigation. Taking as reference Hillier findings that weather does affect static behavior, although does little on natural movement (Hillier et al, 1992). All the plazas were observed at the same time. So the observation consisted of reporting and counting people in stationary activities; not moving. Nevertheless, static people are being sorted into two categories of those sitting in the formal sitting places and those in standing position or sitting in informal places such as on the trees borders, the flower walls and so on. The type of activity people are engaged in is not relevant the present study. To make the observation and people counting easier and more accurate plazas have been subdivided into zones with detailed layout plans; an observer for each zone.

In this paper only the total number of all static people is considered for the three plazas: Dalaa, Larbi Ben Mhidi, and Zwaka. Meanwhile for El Houria plaza that is the space to be deeply investigated, all the survey details will be considered.

First assessment of the data collected (fig 4), about the amount of use of each plaza considering only the number of static people during the period from 7 pm to 8 pm (after working hour), shows that EL Houria and Dalaa plazas are the most used and preferred for this period of time. Meanwhile both Larbi Ben Mhidi and Zwaka plaza are underused. Here it should be mentioned that these results are neither conclusive nor exhaustive and object of on going work. However they could give some clues about the plaza uses, albeit limited for a certain period of the time, and help promote questions regarding the relationship between visibility and spatial use of urban plazas.

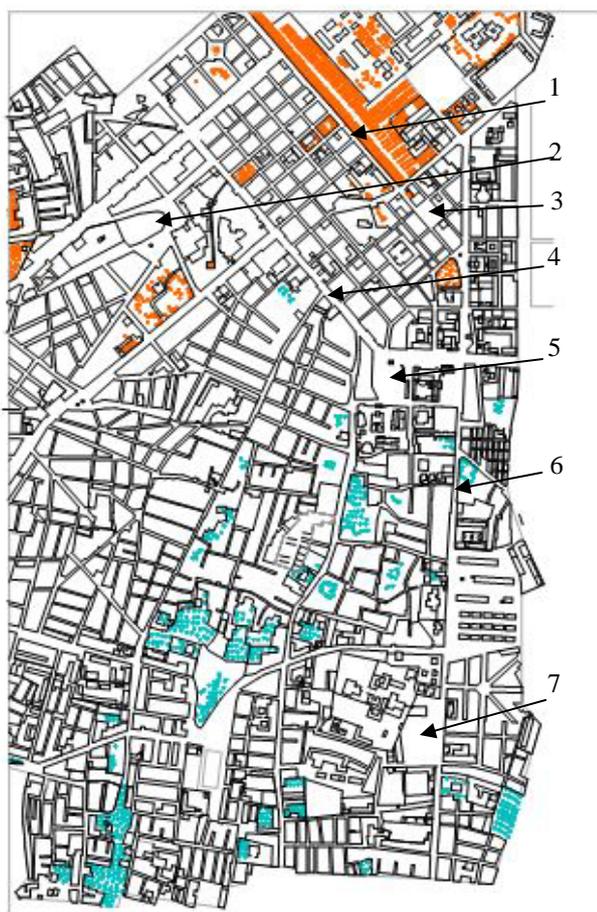


Figure 3: Plan of the city center district, embedding the four plazas

- (1) La République street, (2) Dalaa Plaza, (3) Larbi ben Mhidi plaza, (4) Emir Abdelkhader Boulevard, (5) El Houria Plaza, (6) Hakim Saadan street, (7) Zwaka Plaza,

Dalaa Plaza is typically characterized by its irregular shape resulting of the presence of a rocky hill within the built area. The plaza is linked to the surrounding by numerous streets. Its layout is regarded the presence of some

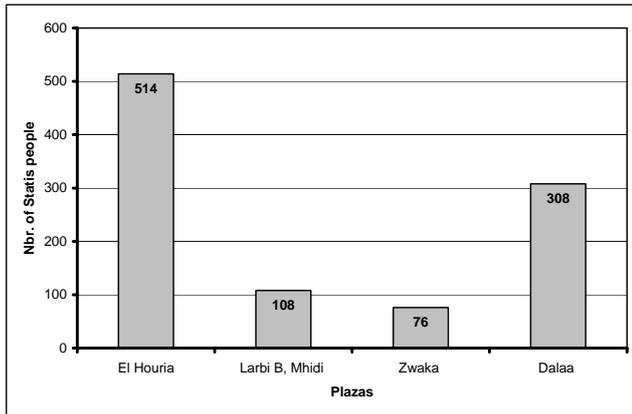


Figure 4: Summarises the number of static people for both categories sitting and standing position according to time period for the four plazas.

### 8 SPATIAL SYNTAX ANALYSIS OF THE PLAZAS

Space syntax theory and theory of natural movement correlate between space configuration, space intelligibility and people behavior (movement and use); configuration of street network shapes people movement and that the position of street in the overall grid affects to-and-through-movement (Hillier 2005). As the network of streets is the means to get to the plazas, the goal is to see the accessibility and attractiveness of the location of each plaza within this network (city center district) in term movement.

Therefore two sets of measures are considered. First, measures relevant to spatial properties of each plaza are examined. On one hand, two global measures: integration

and relativized entropy that indicates how ordered the a system is from a location, and on the other, two local measures connectivity and visual control which indicates the degree of choice each space represents for its neighbors to move to. Second, considering the **visual access concept**, that is the degree to which different places and features can be seen and also the location from which people in particular environment can see particular places and features (Montello, 2007), point isovists were taken from the most integrated streets that surround (or junctions that lead to) the plazas to see to what degree is their overall layout is visible.

The measures are taken on two level one considering a plan of the city center district including all the four plazas and then separately taking each plaza within a surrounding of 250 meter radius of its center (dimensions are taken arbitrarily).

Spatial syntax analysis has been carried out on the four plazas using Depthmap 07 software program (Turner). A plan of the city center district including the four plazas has been used for spatial syntax measurements (Table 1). The visual integration (HH) map (Fig.5) highlights the high value of two streets (dark color), El Emir Abdelkader boulevard passes by El houria plaza and closer to Dalaa plaza and Hakim Saadan street passes by Zwaka plaza and closer to Larbi Ben Mhidi plaza (la Republique street connects Hakim Saadan street to this palza). El Houria Plaza is remarkably integrated within the system. The axial map (fig.6) shows also how many integrated lines (of sight and movement) cross this plaza contrary to Dalaa plaza with is crossed with less crossing lines.

Table 1: Showing some syntax and isovist measurements of the plazas within the perimeter of the city center district.

Plazas \ Sytx Vals	Visual Integr. (HH)	Connectivity.	Visual control	Relativized entropy
Dalaa	0.55	0.22	0.42	0.17
Larbi Ben Mhidi	0.68	0.13	0.40	0.15
El houria	0.78	0.33	0.41	0.13
Zouaka	0.62	0.38	0.38	0.10

Table 2: showing some syntax and isovist measurements of the plazas within the perimeter of 250 meter radius of their center

Plazas \ Syntax measrt.	Visual Integration (HH)	Connectivity	Visual control	Relativized entropy	intelligibility
Dalaa	0.67	0.41	0.48	0.17	0.52
Larbi Ben Mhidi	0.57	0.34	0.45	0.20	0.23
El houria	0.69	0.63	0.53	0.10	0.83
Zouaka	0.63	0.68	0.38	0.07	0.73

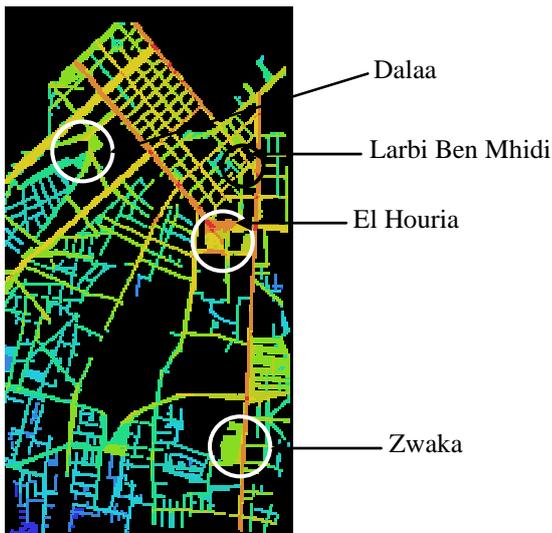


Figure 5: Visual integration (HH) of the city center embedding the four plazas

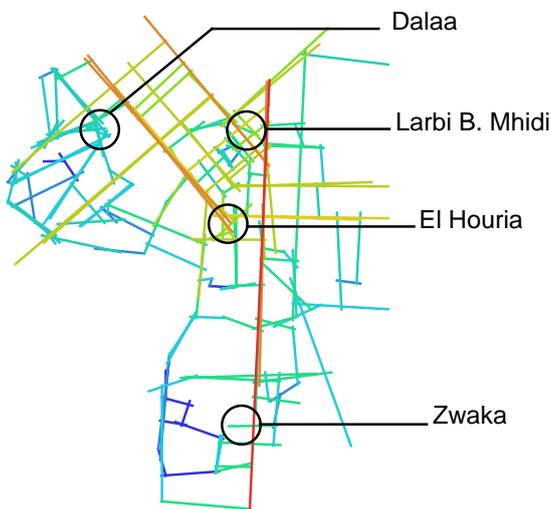


Figure 6: Axial map (fewest lines) of the city center District

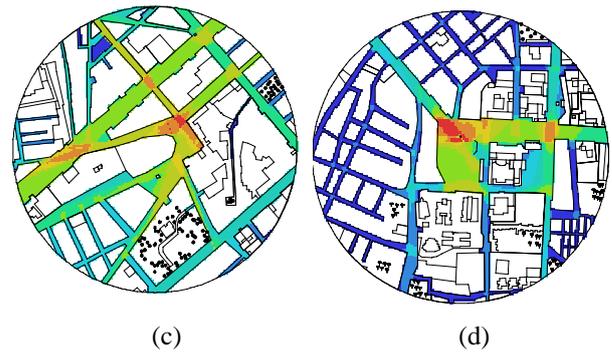
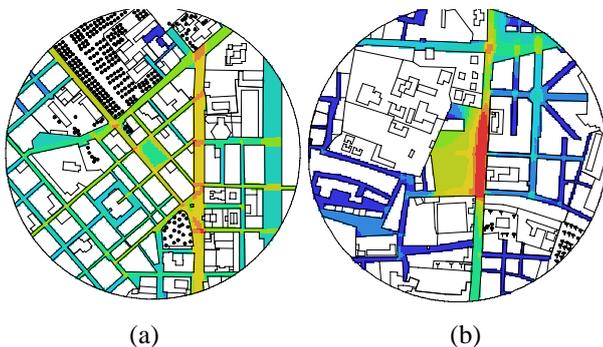


Figure 7: Visual integration (HH) within a perimeter of 250-meter radius

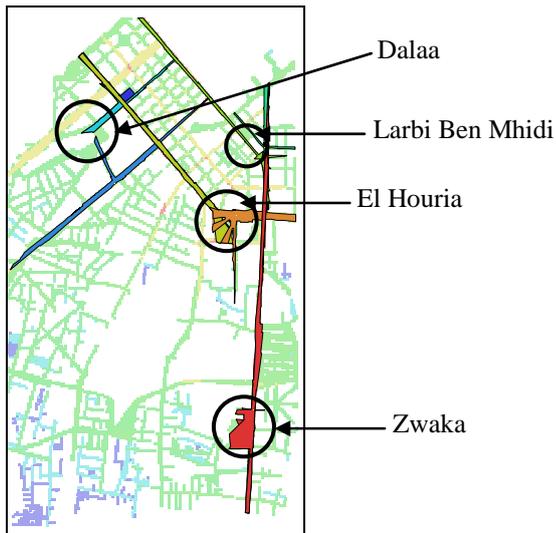
(a) Larbi ben Mhidi plaza, (b) Zwaka Plaza, (c) daliaa Plaza, and (d) El Houria Plaza (the darker the color the more integrated)

A comparative interpretation of the different measures reveal that in term of integration value that El Houria plaza is the best integrated within the system with a value of (0.78) and the least integrated is Daliaa plaza. However, in the local measure, connectivity both El houria and Zwaka plaza have the higher connectivity value.

Overlapping these measures with the occupancy values shows that the most integrated plaza, El Houria, with the highest visual integration (HH)) value (0.78) correspond with the highest number of static people. So there is a correlation between the integration value and the number of static people using the plazas. However, integration measures of Daliaa plaza show two different values: very low value when considering the city center district perimeter and a relatively high value when considering the surrounding area at a perimeter of 250-meter radius (fig.7).

Intelligibility measures sort El Houria Plaza as the most intelligible space with a value of 0.78 that might explain somehow its relatively high usage. However, the value of Zwaka plaza of 0,73, which is very close to that of El Houria Plaza, does not correlate with the number of static people using it. Differently, Larbi Ben Mhidi plaza showed the least intelligibility value and low usage of space, which is a paradox to character this plaza that is known a very liveable place during the morning and early afternoon hours, this, might be, due land use surroundings consisting of a market and banks.

In terms of the visual access measures, i.e. the shapes of isovists that correspond to the potential view of an observer and taken from the most integrated streets leading to plazas are examined. The analysis shows that El Houria presents the higher degree of visual access: a large isovist that means more visual information is available of the plaza for people moving on the most integrated streets, El Emir Abdelkader. However, for Daliaa and Larbi Ben Mhidi, the isovists are “linear”, less visual information is available (the measure of jaggedness or circularity could be as the indicator of the convexity of the isovist is not considered in this paper) (fig.8).



**Figure 8:** Isovists with a vantage point from the most integrated streets that lead to each plaza showing the visual access.

## 9 EL HOURIA PLAZA SPATIAL USE

This plaza has been selected to undergo this analysis according to its importance (stated above).

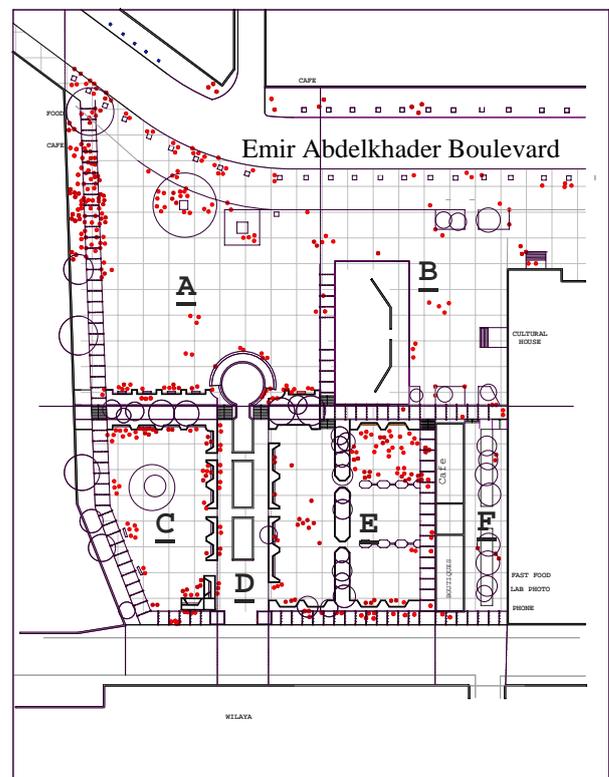
To explore why within this plaza some parts are busy and preferred by people to others, an investigation is carried out to see if there is a relationship between stationary activities (sitting and standing positions) and the syntactic and isovist properties of space. In order to grasp this deeply, believing that a space may have many sub-settings, the plaza has been subdivided into many subspaces that are analyzed to look for links between visibility and spatial use.

The plaza has been subdivided into six subspaces (A, B, C, D, E, F) relying on its space layout (fig.9). It is composed of two levels connected by stairs. The difference between the two levels is about 1.20 meter. Within these two zones created by level differences there are subspaces that are defined by the layout of the plaza furniture such as sitting benches, vegetation pods, and the memorial wall. The upper level is subdivided into two subspaces (A, B) by the presence of a memorial wall, while the lower space is subdivided into four subspaces (C, D, E, F) by the built-in sitting benches and the row of the boutiques. The subspaces (E) embraces the main movement axis of the plaza with a linear fountain.

The first assessment about the behavior mapping of the spatial occupancy of the plaza shows the space occupancy of the higher zone that connects to a major street is slightly higher than the lower zone of the plaza. However, if we

consider stationary people of standing position or sitting in informal space (no sitting furniture) represents 43% of the total number of people using the plaza; moreover if omitting people sitting in the cafes this rate would be 62%. Most of standing people (3/4 of all standing) occupy the edge of the higher zone of the plaza, along EL Emir Abdelkader boulevard and the left (1/4) occupy the lower zone along the street leading the a popular market. This would indicate that people choice and preference of their locations is no tied to the availability of sitting areas. The effect edge is noticeable on the map for both the plaza as a whole space and the subspaces created by the plaza layout.

For the subspaces providing sitting places, it seems that the subspaces (C) and (A) are the preferred by people for sitting, meanwhile, however the subspace (D) that is considered as the main axis of movement that links the zones of the plaza and the space (E) showed very weak occupancy rate (table.3).



**Figure 9:** Two-day aggregate data of number of all static people within the subspaces A,B,C,D,E and F of El Houria plaza (people represented by dots)

**Table 3: Shows the number people of each type of static position according to subspaces of the plaza.**

Plaza name		Static activity type subspaces	Sitting-Formal Sitting Places Nbr. of people	Sitting in terrace Café Nbr. of eople	Standing and sitting in informal spaces Nbr. of people	Total number of all static people
El Houria Plaza	Higher Space	A With sitting places	45	97	103	245
		B No sitting places	00	00	60	60
	Lower space	C With sitting places	57	00	13	70
		D With sitting places	16	00	00	16
		E With sitting places	18	58	38	114
		F No sitting places	00	00	09	09
			136	155	223	514

**Table 4: Syntactic and isovists measurements of El Houria Plaza**

	Integration HH	Visual control	connectivity	Nbr of people
Subspace: A	0.78	0.60	0.76	148
Subspace: B	0.66	0.54	0.61	60
Subspace: C	0.57	0.41	0.54	70
Subspace: D	0.65	0.44	0.57	16
Subspace: E	0.69	0.49	0.68	56
Subspace: F	0.54	0.42	0.28	09

**10 VISIBILITY GRAPH ANALYSIS AND BEHAVIOUR MAPPING**

Overlapping the visual graph analysis and behavior mapping of all the whole plaza emphasizes that the most integrated zones (VI = 0.92) are used by stationary people in standing position or informally sitting (these zones provide no sitting furniture) (fig.10).

And that stationary people in sitting position overlap with a low integrated spaces (VI= 0.56) which correspond to some of sitting places of the plaza layout.

Results on table (4) show that for the subspaces A, B and E there is a correlation of the integration value and number of all static people; the higher integration value the higher the number of people. For subspaces A and B, stationary people in standing position or sitting in informal spaces, which represent more than four times those sitting in sitting spaces, are found around the intersection of the two longest sight lines (fig 11). However, exception is for the subspace C that has a low integration value and a high number of people, moreover this subspace is secluded from the main sight lines and corresponds to the lowest visual control value (0.41). It must be mentioned here that sitting positions represent around 80% of all stationary people in this subspace (C), it is considered as a secluded area that may match the result of compos and Papargyropoulo that sitting activity takes place more in visually secluded spaces

Nevertheless, these sitting spaces do provide a certain control of the view of their surroundings. As can be seen

from the Figure 12, the isovist taken from the center of the busiest subspace C for sitting position covers only visual field within the plaza, while the isovist taken from the busiest subspace A for standing position, given in Figure 13, provides visual fields covering all the plaza space and even extending to the surroundings.

Thus in order to re-verify this and to look into the assumption that people avoid movement spaces for stationary activities such as sitting and relaxing, agent test has been carried by using Depthmap. It consists of releasing a number of agents (a human-like movement with around 170° field of view) (Turner 2003) within El Houria Plaza at a 150-meter radius to track their movement trajectories. The results (fig.14) show that the busiest sitting spaces (subspaces A and C) correspond to the least space used (few traces) by the agents or not used at all. Thus these sitting spaces are away from people natural movement (that it is believed to be guided by the spatial configuration) and consequently provide a seclusion aspect. However, the sitting spaces, the subspace E and D overlap partially by the agents’ trajectories. This might interpret why these subspaces (E and D), despite their affordance of sitting areas, are not as much used as the other sitting subspaces; by being too much visually exposed.

Comparatively, the spaces used by standing people overlap with the ‘medium’ density of agents trajectories.

These results are part of an ongoing research to be completed and compared to in situ observation of people’s movement.

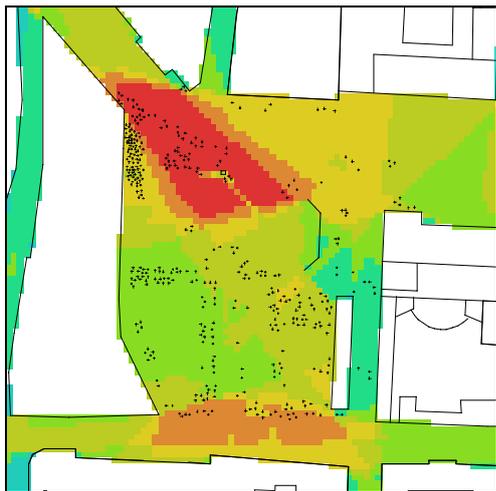


Figure 10: Visibility graph analysis overlapped with two-day aggregate stationary people behavior mapping, El Houria Plaza. Standing zones overlap with the most integrated spaces of the plaza (the darkest color)



Figure 13: Isovist from the busiest space for stationary activities for standing positions or sitting informally; a "spiky" isovist, views towards covering plaza and the surrounding.



Figure 11: Axial Map (few lines the locations of activities According to the longestlines).

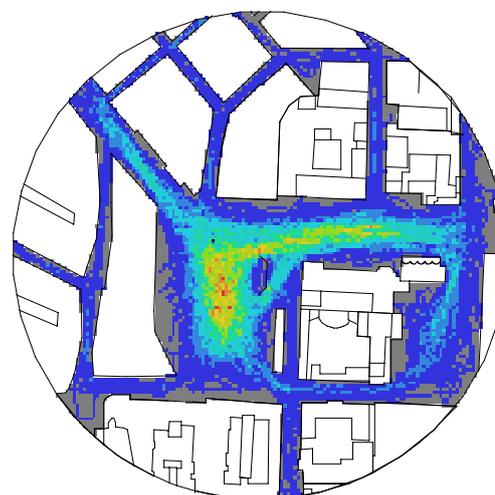


Figure 14: A test of the behavior of the agents showing their traces within El Houria Plaza and its surrounding



Figure 12: Isovist from the busiest sitting space; Large isovist provide local views.

## 11 DISCUSSION

Concerning the comparative study between the four plazas about attractiveness, in term of movement, (integration). Measures of Dalaa plaza show a noticeable variance between integration and connectivity measures taken within the perimeter of the city center district; low values (tabe 1) and those taken within a perimeter of 250-meter radius. So it is more integrated within its surrounding (fig 7c) than within the whole district. This could be explained by the important number of lines (despite their low integration values) crossing the plaza, shown on the axial map (fig 6). This may be explained that the plaza is as locally *through-movement* space.

The study of El Houria Plaza use, subdividing the stationary activities in two categories sitting (using the available sitting places) and standing or sitting informally (using other than the sitting places) show that the preferences or the choice for the locations is not the same,

the former is for more secluded spaces (low integration value) and the later for more exposed spaces (high integration value). The busiest space in the plaza, mostly by stationary people in standing position, is remarkably around the axial lines intersections point of the longest sight lines to from (not crossing the plaza). This finding does not validate the results that the use of plazas depends on the amount of sitting spaces provided. People may accept some discomfort (standing or sitting in informal spaces) for the sake of visibility matters.

As approach of the partition the plaza into subspaces that reposed mainly on the plaza layout gave more detailed results but the rules defining the subdivision, raised by many researchers, still to be investigated. Because the behavior map, in this paper, shows that the space occupied by people is amorphous and does not correspond to the orthogonal layout of the plaza.

## 12 CONCLUSION

Studying urban open spaces such as plazas might need the implication and the consideration of the space layout and all its components, and land topography, in order to understand deeply the spatial use. It should be remembered that some minute details that might be insignificant in representation could completely change the spatial properties of space versus the perceived space and thus a subdivision of a space examined into sub-spaces may be the appropriate approach. The belief that a good space is a used space leads to investigate what makes some spaces crowded and preferred by people than others in looking on the person-environment relationship, and to emphasize the visual "affordance" of spaces and the spatial properties needed for a particular pattern of activity. To conclude, the understanding of visibility and people's perception is not only a key to analytical purposes, but also a tool to producing more liveable spaces.

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