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Impact of the Degree of Enclosure on the Use of In-between Spaces in Residential Neighbourhoods

The case of Béjaia, Algeria

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Abstract: Culture influences the way people develop and use urban spaces. These are voids between and around buildings intended for public and private use. It consists of many categories of well-defined open spaces, though, some are being categorised as an 'undefined' spaces, referred to in this study as the in-between spaces. This work explores the relationship between people's behaviour and use of such spaces and the spatial configuration in general and the degree of opening and enclosure in particular. Past studies have shown people's preference for open spaces to enclosed ones. In-between spaces in the city of Béjaia, where the case study is located, and most Algerian cities are 'undefined' categories of spaces between streets and buildings. Their unequal use contributes to making them as leftover and disconnected spaces within the urban environment, instead of being spaces for social interactions. Using a mixed method approach, this study attempts to develop a better understanding of the degree of physical enclosure and the use of the in-between spaces using a series of measurable physical indicators to characterise these spaces. The obtained data is compared to the data relating to people' space use obtained from a behaviour mapping. The data shows that people prefer to use the large spaces with a moderate sense of enclosure more than the open spaces or the narrow spaces with a strong sense of enclosure which are used mostly as transitional spaces.

1. INTRODUCTION

The built environment is shaped by man, and it affects his perception and behaviour. It contains in its very form; natural and artificial elements, which should reflect human choices and preferences (Moser and Weiss, 2003). Ittelson (1976) defines the environment according to the individual, the environment is not objective without human presence. Hillier and Hanson (1989) stipulate that "Buildings are important visual symbols of society''; which means that these visual symbols are created in a way to create and

order space in the ability to recognize society. They add that space can only have social significance by virtue of being identified with a particular group of people. In addition, Bada asserts that "A good space is a used space" (Bada and Guney, 2009). A number of researchers studied various aspects of urban spaces such as *life between buildings* (Gehl, 1987) and *shared spaces*, *urban open block* (Portzampark, 2010), which are frequently considered as important factors. On the one hand, such spaces give an indication on how the city is socially sustainable, more liveable, pleasant and attractive for its inhabitants. On the other hand, they can provide evidence of how a given space is well used, well perceived and well experienced and shared by people and consequently, well designed. For these reasons, a number of scholars are interested, nowadays, in the study of the built environment with a view to develop more sustainable cities and to better define and understand people's satisfaction, perception, experience of their everyday life within the city. Hence, the reason behind such need of a practical knowledge on how to order space to promote man-environment interaction is to increase and improve the use of urban space that people encounter in such a way that promotes wellbeing. Hillier and Hanson (1989) add that such knowledge would help to move from the physical arrangement aspect to the social living conditions by means of connections between space properties and social process.

Each physical environment has a specific language between buildings and voids from a culture to another that changes from an era to another. The relationship between them is formed by the shape of buildings and their arrangement together in a way that they create and shape the voids between them and give shape to the open space (Can, 2012). According to a study by Sally (2005), buildings have an impact on public spaces as they determine the spatial enclosure feature of the latter and the way those spaces can be used. Therefore, the intermediate space, in other words, the in-between urban space, between the surrounding environment and the buildings is the negotiation step for/of articulation and hierarchy levels between public, semi-public, semi-private and private spaces. Gehl (1996); Nooraddin (1998) and Can (2012) claimed the relevance of the space between buildings and street by playing an important role in terms of social interaction.

In the Algerian traditional medinas as within the Islamic cities in general, the concepts of public space and in-between spaces do not consist of the same meaning and spatial configuration as in the European and Western communities. In this urban pattern, it is difficult to find a demarcation between public and private space as we know it in today cities. Nooraddin (1998) asserts that instead of boundaries between public and private spaces, there was the in-between space of "Fina", which means spaciousness and roominess, he adds that the 'Fina' territory had various functions, private, public, or both. This term was taken from the old Islamic literature, but it exists in different Islamic cultures as other terms according to the different languages, such as "Afrague" in the Algerian Kabyle villages and "Wast-El-Dar" in the Algerian Kasbahs and Ksours.

Contemporary Algerian cities have lost their specificities, especially after the adoption of Western mass housing estates in response to the crises of housing shortages since independence. This has led to the disappearance of certain types of in-between spaces like those mentioned above. The city has become a series of blocks and voids, where traditional streets and squares are being abolished. These are being replaced by fluid open spaces around the buildings. Their unequal use makes them residual and disconnected from the urban environment, instead of being an interface for social life and shared

spaces for social sustainability. Furthermore, the *in-between* spaces designed between buildings especially within the housing neighbourhoods have missed their main goal as human environment and become leftover spaces. Most of the studies on in-between spaces remain descriptive rather than operational. According to Farida (2013) and Mebirouk, Zeghiche et al. (2005), the models of use and appropriation are affected by the characteristics of society and in-between spaces, but also by their spatial configurations and enclosure, especially, the visual factor, the building arrangements, and the site organization in mass housing that affect their use as asserted by Bendjedidi, Bada et al. (2019). Kaplan (2001) emphasizes the contribution of the environment to the wellbeing of people. Moreover, previous studies in neurophysiology suggest that "enclosure is an important feature of the environment and there is a specific region in the brain responding directly to the environmental enclosure" (Epstein and Kanwisher, 1998; Shi, Gou et al., 2014).

Against this backdrop, the main objective of this paper is to explore how the change in spatial configuration of in-between spaces, especially their degree of enclosure and openness, in urban neighbourhoods can affect their use. The case study, the Naceria neighbourhood in the city of Béjaia, Algeria, provides a variety of in-between space configurations and enclosures. In order to investigate the effect of enclosure degree on the way in-between spaces are used, physical indicators are selected from literature and used to characterise the physical enclosure. To be able to evaluate the use of in-between spaces a behaviour mapping (people counting and activities observations) was used, at the end a comparison of the different outcomes was undertaken.

2. THEORITICAL FRAMEWORK

2.1 In-Between Spaces and Residents' Social Life

In-between spaces have different cultural significations and an important role in terms of social interactions including exchanges and relationships between people in the context of various activities. They are designed as the adjacent spaces, next to, behind, in front of and even above many buildings. According to Gehl (1987, 1996) and Gehl, Kaefer et al. (2006), in-between spaces situated between buildings and streets have some characteristics that encourage interaction, between residents, which cannot take place in the public open space. They add that people tend to occupy the edges of sidewalks especially the places where people could sit and face the pedestrian flow. Once they are full, the occupation gradually goes towards the interior. This means that people prefer areas which offer good visibility but retain some privacy. An edge effect referred to by Gehl (1986), after Bendjedidi, Bada et al. (2019). In-between space is claimed by several authors such as Rummel (1976) and Can (2012), as a place for social interaction since it is the first step where the residents meet and interact with each other. A study of Skjaeveland and Garling (1997) showed four basic spatial requirements for social contact, first the existence and extension of the appropriate space for interaction; second, physical features designed for this purpose such as street furniture; third private-open space, between spaces such as front yards, porches, and verandas, which is the in-between space, and finally, the appearance of the place, and visibility / surveillance.

Therefore, the in-between spaces are the intersections between family and community; their opening and closing degree differ from a community to another and from a culture to another. But the spatial configurations created by the enclosure degree of the in-between spaces shape cities and people interaction. So, it is important to clarify that the physical properties of the in-between spaces, especially their opening and enclosing degree impact the use, wellbeing, and social interaction of people within the city.

2.2 The Importance of the Spatial Enclosure

In accordance with our object of study, this part introduces relevant studies on the spatial enclosure, as a physical feature, which impacts space perception, use and social interaction within the semi-public and the semi-private spaces. According to Hillier (1988) the spatial enclosure expresses the necessity of hierarchy from the public to the private space. Numerous studies on enclosure as a spatial feature have revealed a close relationship between these feature and people's preference, human beings' and even the instinctive need for safety and survival.

According to Shi, Gou et al. (2014), the prospect and refuge theory Appleton (1996), the theories of ecological psychology (Gibson, 1986) and the environmental preference framework (Kaplan and Kaplan, 1989), consider enclosure contributes significantly to feelings of security, safety, and survival. Appleton (1996) argues that people prefer a place (*space*) offering a prospect (*vista*) and an enclosure (*refuge*) at the same time. The same point is argued by Ramanujam (2006), this is based on the ability to see (*vistas*) and at the same time not been seen (*refuge*). This latter, according to Newman (1972), is the kind of spaces that would conduce to a social interaction more than others and create more defensible spaces then others. According to his theory of *defensible space*, the same author argues that building entrances that face a public space can provide surveillance over that space and let residents know if there is a danger in their neighbourhood. In addition to Newman's idea, Van Nes and López (2007) find that the way in which entrances and windows are positioned to each other, influences the probabilities of social control and natural surveillance. In other words, the space that contains a number of access points to buildings is the most secure space and the most monitored by residents compared to the others, as well as the entrances connected to a public space increase their use by residents, and that is called *the degree of constitutedness* by Van Nes and López (2007). Norberg-Schulz and Schulz (1968) suggests that walls being joined together to form a continuous and embracing boundary is essential to create a sense of spatial enclosure. Gibberd (1970) and Spreiregen (1965) claim that spatial enclosure increases if facades of adjacent buildings have more similarities and fewer gaps (voids and access) within the exterior urban spaces. Gehl and Gemzøe (2004) suggest that the size and the shape of urban spaces such as the urban squares influence the intensity of use within them. Ashihara (1981) discusses the relative enclosing effect of different types, sizes, and positions of the surrounding vertical elements.

According to Colonnese and Carpiceci (2020), Maertens (1884) published a work around, where he converts the angle of vision into the relationship between the height of the object and its distance from the viewer, thus the H/D ratio. According to his studies, 1:3 is a comfortable ratio that requires the least effort to adapt the eyes to perceive objects. Furthermore, Spreiregen (1965) has studied this concept of the human field of view and finds that the upper limit of forward field of view (30°) is the

lower limit of creating a sense of spatial enclosure. Stamps III and Smith (2002) examined six physical features of enclosure using pictures showing Parisian street scenes that are picture format, walls, ground, depth, lightness, and the number of open sides. Again Stamps III (2005) has considered the gaps in enclosures and enclosing materials based on simulated rooms and plazas and finds that the size and location of gaps affect the perception of the enclosure, the effect was found much more impressive in small spaces than in large ones. Ching (1996) studied the relationship between the height of vertical planes and the human body.

From this rich literature, physical indicators are defined in order to describe and measure the physical enclosure of the in-between spaces. The selection of physical indicators focuses on those that are easily measurable in reality. Therefore, the indicators of the shape, the surface area, the percentage of opening to the global perimeter of the enclosed space, the number of entrances to the buildings which are oriented towards the enclosed space, the number of openings (access) oriented towards the street, the length to width ratio and the height to width ratio; will be used as variables in this study.

3. CASE STUDY PRESENTATION AND METHOD

3.1 Presentation of the Case Study

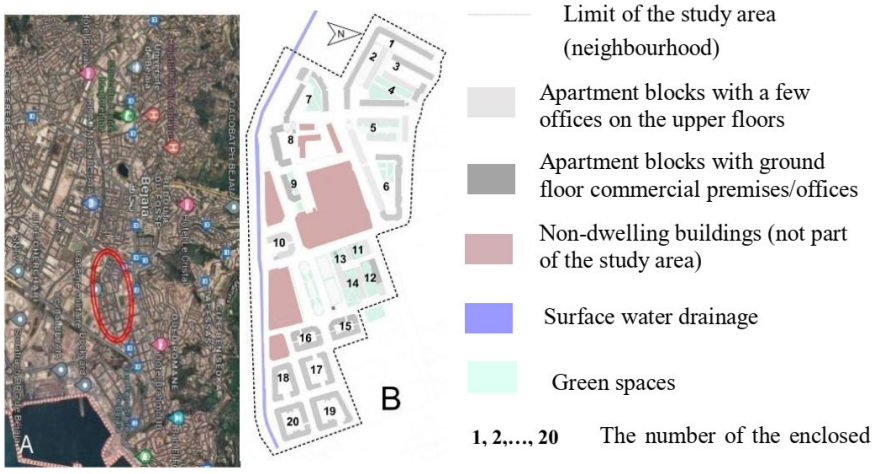

Figure 1. (A): View in Google Maps on the situation of the Naceria neighbourhood in the city of Béjaia, (B): The general plan of the Naceria neighbourhood.
Source: Google Maps and authors

The present study addresses various in-between enclosed spaces in the Naceria neighbourhood situated in the city of Béjaia, a Mediterranean city located in the northeast of Algeria (*Figure 1*). The city has undergone major transformations in its urban fabric, an accumulation of various types of urban forms throughout history ranging from vernacular colonization influenced by several civilizations; namely Phoenician, Roman, Hammadite, Ottoman and Spanish, until the French colonial era and finally post-independence urbanization.

In the early 1970s, the Algerian government implemented a national urban planning strategy to deal with the housing crisis and the expansion of cities due to rapid population growth. This was implemented by creating an urban plan for new urban housing areas, to build the maximum number of

houses in less time. Consequently, these new urban areas adapted from an "international housing model based on the concepts of prefabrication and standardization" (Farida, 2013), produced new types of urban in-between spaces; open, amorphous, and undefined. The parts of the neighbourhood circled in blue colour were constructed as shown in *Figure 2*.

Nationally and internationally, many researchers have shown the failure of these new in-between spaces to meet the needs of social interaction, more specifically the need of residents to meet and interact with each other. Most of these spaces are rarely used and considered as left-over transitional spaces and urban corridors of circulation. This is due to a number of reasons including their spatial configuration, a high degree of openness, a low sense of enclosure, the lack of spatial hierarchy between public and private, the lack of boundaries and connection with surroundings buildings. All of these had a negative impact on their use and the social life of the residents.

Unfortunately, this mass housing policy intended to build large numbers of housing units, yet as cheaply and quickly as possible is still considered by the state as the way forward to deal with the housing crisis. As a result, despite some efforts by architects and urban planners, in-between spaces still present the same failures. Examples of these are indicated by red circles in *Figure 2*.

Twenty in-between spaces are selected in the neighbourhood of Naceria and presented in *Figure 2*. The process of selecting the spaces considered the exterior intermediate spaces between streets and buildings such as interior courtyards and central islands. The spaces are numbered randomly from 1 to 20, where each inner courtyard is considered a single intermediate space.

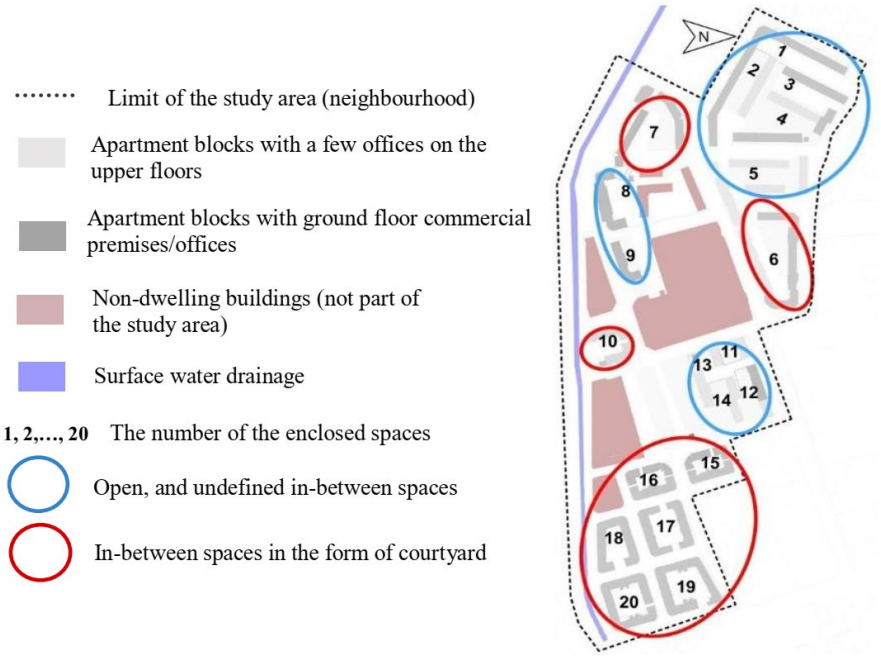

Figure 2. The twenty enclosed spaces selected for the study

3.2 Method

This study attempts to develop a better understanding of the relation between the degree of physical enclosure and the people use within the in-between spaces by using a mixed method. At first, a series of measurable physical enclosure indicators were used, as variables from literature, to characterize the in-between spaces by means of quantitative data. In the

second stage, a behaviour mapping was adopted in order to show the ways people the in-between spaces. In this case both quantitative and qualitative data were obtained. These consist of the number of users, their categories, and the type of activities they are engaged in. The results from the first and second data collection exercises were compared in the third stage of the methodology as shown in the research diagram in *Table 1*.

Table 1. Research diagram

Phase 1 **Quantitative**	**Phase 2** **Quantitative & Qualitative**	**Phase 3** **Comparison**
Establish the degree of physical enclosure through the seven physical indicators	Space usage: Behavior mapping considering the type of activities and the number and categories of users	Results comparison

3.2.1. Physical Enclosure

The objective of this part of the research is the selection of physical enclosure's indicators. The aim is to explore a way to define the enclosure by physical indicators that are measurable in reality. The previous studies have shown the contribution of enclosure to feelings of security, safety, and also survival through the theories of Gibson (1986); Kaplan and Kaplan (1989); the concept of defensible space by Newman (1972), Appleton (1996); Ramanujam (2006) and the degree of "constitutedness" by Van Nes and López (2007). We have also explained the contribution of physical indicators on the creation of the sense of enclosure through the works of Ashihara (1981); Ching (1996); Garling (1969a, 1970b); Gärling (1969b, 1970a); Gehl and Gemzøe (2004); Gibberd (1970); Maertens (1884); Norberg-Schulz and Schulz (1968); Sitte (1979); Spreiregen (1965); Stamps III (2005); Stamps III and Smith (2002); Takei (1969); Thiel (1970); Thiel, Harrison et al. (1986).

Seven physical indicators are chosen in our study in order to describe the physical enclosure of the in-between spaces, including: the shape, the surface area, the percentage of opening to the global perimeter of the enclosed space, the number of entrances to the buildings which are oriented towards the enclosed space, the number of openings (access) oriented towards the street, the length/width ratio, the H/D ratio (average) within each enclosed space.

The surface area and the shape of the spaces were directly selected as two physical indicators according to previous studies (Gehl and Gemzøe, 2004; Stamps III, 2005). Some indicators in our study are generated by extending other physical indicators, such as the percentage of opening to the global perimeter and the perimeter of enclosed space. The length and width of the enclosed space can influence the perception of its enclosure (Maertens, 1884; Shi, 2012; Sitte, 1979; Spreiregen, 1965; Stamps III and Smith, 2002), Meanwhile, in our study, the indicator of the length /to width ratio together with the surface area of the enclosed space are considered to give a better picture of the proportions and the sense of spaces enclosure. According to well established studies dealing with H/D ratio Maertens (1884); Spreiregen (1965), the relationship between the height of the enclosed space boundary (high of buildings) and its distance from the observer should have a strong influence on the physical enclosure. Usually when referring to the H/D ratio, the mean value is considered by default (Maertens, 1884; Sitte, 1979; Spreiregen, 1965). For this, when measuring the H / D ratio in our study we

took the average value. The methods and the assessment of the seven indicators of physical enclosure are listed in *Table 2*. All the indicators are measured in-situ or calculated on the basis of measurements already taken in-situ.

Table 2. The methods of assessing the physical enclosure indicators

Nº	Indicator	Method of assessment
1	Shape of the enclosed space	Visual assessment of drawings and in-situ observation
2	Surface area of the enclosed space	Calculated from drawings
3	The percentage of the total width of openings on the perimeter of the enclosed space	Calculated from drawings
4	The number of openings of the enclosed space (from the streets)	Counted in situ
5	The number of entrances to buildings oriented toward the enclosed space	Counted in situ
6	Length/ width ratio	Calculated from drawings
7	H/D ratio	Calculated from drawings

3.2.2. In-situ Observation: The Use of In-Between Spaces

To understand how the in-between spaces are used by people, in terms of activity pattern and type of users, weather residents or not resident, with presence not presence of children, a behavioural map was done to look for how people experience and move within the in-between spaces case studies, in order to reveal any relationship between the sense of physical enclosure and the way the in-between spaces are used by people. In other words, what attracts or repulse people and residents in term of openness or closeness of the in-between spaces. In general, the use of the in-between spaces in Béjaia city is most affected by the time of day and by the seasons. Consequently, the method of behavioural mapping was carried out for two days, Saturday as a weekday and Friday as a weekend-day, in September 2017, during three times a day, in the morning, the middle of the day and late afternoon, for 10 minutes each time. This period was chosen because it is the time that is conducive to outdoor activities. In order to avoid unexpected and uncertain situations, numerous visits were made before starting the observation.

In order to investigate the use of in-between spaces and to understand people's preferences in terms of space enclosure and activity pattern, an observation process is adopted. It consisted of counting the number of users within the in-between spaces, by considering both moving and stationary people. In the latter category, children playing in small groups were counted separately.

4. RESULTS

The following sections present the data obtained from the application of the chosen research approaches to the case study. The data is presented for both the physical enclosure analysis and the behavioural mapping study.

4.1 Physical Enclosure

The analysis of the twenty in-between spaces through the seven physical enclosure indicators generated numerical data summarized in *Table 3*.

According to the first indicator of geometric shape, the spaces S4, S6 and S7 have a triangular geometric shape while all the rest spaces are rectangular.

The size of the spaces is given through the surface area indicator where we have found spaces S6 and S7 with the highest surfaces 4600 m² and 5200 m² respectively. Then spaces S1, S2, S3, S4, S5, S8, S10, S12, S14, S17, S18, S19 and S20 have a surface area between 2000 m² and 4000m². The smallest spaces are S9, S11, S13, S15 and S16 with a surface that does not exceed 860 m². The percentage (%) of opening to the global perimeter of the space revealed the most opened spaces which are S14, S9 and S13 opened at 43%, 50% and 65% respectively. The less opened spaces are S4, S3, S8, S7, S1, S2, S10, S5 and S12 opened between 13% and 27%. The most closed spaces are S6, S15, S16, S17, S18, S19 and S20 where the opening on the perimeter do not exceed 11%.The enclosed space S11 is completely closed by artificial barriers.

While the high number of openings from street is three 3 accesses which is found in spaces S1, S3, S4, S5, S7, S15 and S16, two 2 accesses are found within the spaces S2, S8, S9, S10, S11, S12, S13, S14, S17 and S20 and only one access from street in the spaces S6, S9 and S19. The enclosed space S11 is completely closed with zero access from the street.

According to Van Nes and López (2007) and Newman (1972), the highest number of entrances to buildings oriented towards the space is important and influences the probabilities of social control and natural surveillance. This was found in the case of space S6 with eleven 11 entrances as a highest number, at the same time spaces S1, S5, S17, S19 and S20 have a moderated number of entrances, between 7 and 8. The spaces S2, S3, S7, S8, S10 S15, S16 and S18 have a low number of entrances between 4 and 6, while a few number of openings to buildings is within the spaces S13, S9, S12, S14 and S7, between 2 and 3. Zero entrance to building in the spaces S4 and S11.

Three space categories can be selected according to the length to width ratio Shi (2012), first, the spaces with a very high length/width ratio, this was found in the spaces S1, S2, S4, S6, S7, S8 and S11, with a ratio value of 5 up to 7.5 here, the difference between the width and the length measures is large. Second, spaces with a less high length/width ratio than the first group, the case of S3, S5, S9, S13, S15, S16 and S18, with a ratio value of 3.2 up to 4.2. Three, spaces with a low length/width ratio, small difference between the width and the length measures found in the spaces S10, S12, S14, S17, S19 and S20, with a ratio value of 1.25 up to 2.

For the last indicator, as long as D value is bigger than H value in a given enclosed space, the ratio H / D is smaller and approaches to zero, which means spaciousness and openness of the enclosed space, (Maertens, 1884; Shi, 2012; Sitte, 1979; Spreiregen, 1965; Stamps III and Smith, 2002), this is the case of spaces S4, S6, S7, S9, S10, S11, S12, S14, S17, S19 and S20 with an H/D ratio value of 0.57 up to 0.93. When the H /D ratio is high the height of the buildings dominates the width of the space in other words the sense of enclosure is high and strong as in the case of spaces S1, S2, S3, S5, S8, S15 , S16 and S18, with an H/D ratio value of 1.07 up to 1.50.

4.2 Results of In-Situ Observations

The results showed in *Figure 3*, and *Figure 4* revealed at one hand, an uneven distribution of users through the in-between spaces studied and at the other hand, two groups of spaces according to the type of activities considered. Firstly, enclosed spaces with localized activities that attract both stationary people for long duration (weather sitting people or children

playing) and people moving through the space (weather in small or large flow) were identified as being spaces S1, S4, S5, S6, S7, S8, S10, S17, S19 and S20 (see *Figure 3* and *Figure 4*). Secondly, transitional enclosed spaces, where people are observed only in movements (weather in small or large flow) were identified as being S2, S3, S9, S11, S12, S13, S14, S15, S16 and S18 (see *Figure 3* and *Figure 4*).

In the *Table 4*, the number of stationary subjects (people) is presented next to the number of children within the first group of enclosed spaces with localized activities. As it can be seen, a first section of these spaces is found with zero number of children and full number of the rest of categories, the case of spaces S1, S4 and S10. The second section of the enclosed spaces with localized activities is found highly used by children then the other categories, the case of S5, S6, S7, S8, S17, S19 and S20.

Table 3. Description of the in-between spaces through the seven physical enclosure indicators

Space	**Shape**	**Surface**	**opening**	**Nº opening**	**Nº entrance**	**l /w**	**H/D**
S1	Rectangle	3,270	20.6	3	8	6.3	1.07
S2	Rectangle	2,375	20.6	2	4	7.5	1.34
S3	Rectangle	2,733	15	3	5	3.6	1.06
S4	Triangle	3,562	13	3	0	5	0.71
S5	Rectangle	2,673	24.6	3	7	4	1.15
S6	Triangle	4,603	6	1	11	6.25	0.72
S7	Triangle	5,200	18	3	3	5	0.57
S8	Rectangle	2,000	17	2	4	6.3	1.08
S9	Rectangle	828	50	2	2	4.2	0.9
S10	Rectangle	1,032	22	2	4	2	0.7
S11	Rectangle	771	0	0	0	6	0.93
S12	Rectangle	1,814	27.5	2	2	1.25	0.8
S13	Rectangle	862	65	2	1	3.2	0.71
S14	Rectangle	2,254	43	2	2	1.3	0.8
S15	Rectangle	756	7	3	6	3.3	1.5
S16	Rectangle	753	8	3	6	3.5	1.5
S17	Rectangle	1,814	11	2	8	2	0.84
S18	Rectangle	1,230	10.5	1	6	3.2	1.2
S19	Rectangle	2,270	5	1	8	1.7	0.88
S20	Rectangle	1,757	4	2	8	1.6	0.82

Note: Surface: Surface area of the enclosed space (m²)
opening: Percentage (%) of opening to the global perimeter of the space
Nº opening: Number of openings of the enclosed space (from the streets)
Nº entrance: number of entrances to the building
l/w: Ratio length /width
H/D: Ratio H/D

Table 4. Number of stationary subjects (all categories including children) in localised spaces

Enclosed space	**S1**	**S4**	**S5**	**S6**	**7S**	**S8**	**S10**	**S17**	**S19**	**S20**
Number of subjects	30	15	15	45	11	18	3	15	19	9
Number of children	0	0	6	19	9	9	0	8	10	5

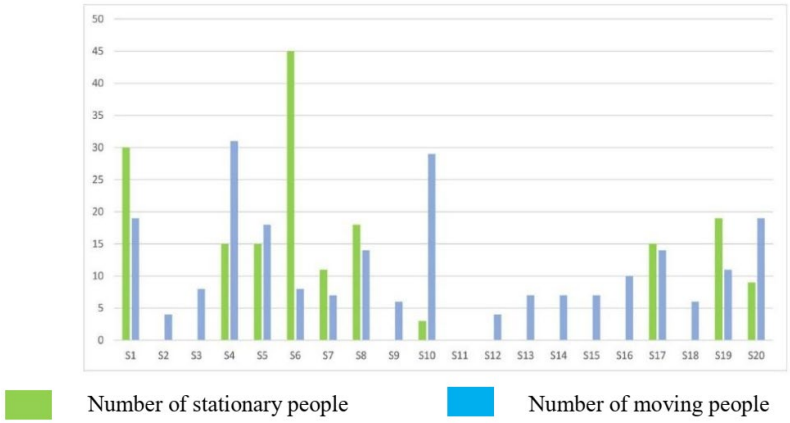

Figure 3. Recorded activity pattern during weekends and weekdays.

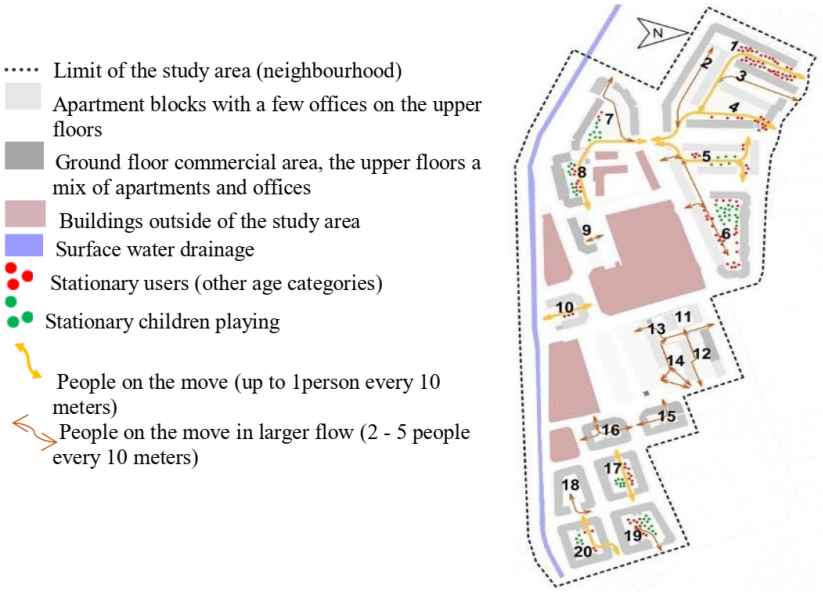

Figure 4. Building entrances directly connected to the enclosed in-between spaces

5. DISCUSSION

The comparison between the physical enclosure characterization results and the data from the behavioural mapping during the observation period for the twenty in-between enclosed spaces shows significant levels of correlation between them. First, there is a strong correlation between the surface area of the in-between enclosed spaces and the type of activities they are holding within them. According to *Table 5* enclosed spaces with large surface areas are most used by both stationary people and people moving through the space compared to the spaces with small surface areas, which are used as transitional spaces most of time. Furthermore, the percentage of opening to the global perimeter of the enclosed spaces and the type of activities seem to go hand in hand. The former is lower in the localized enclosed spaces (those holding both stationary and moving people) but higher in the transitional spaces (those holding people moving through only). This means that people prefer to use the large and less opened spaces for stationary, localized, and long duration activities rather than the small spaces and the very open ones. This result agrees with the findings of a previous study (Bendjedidi, Bada et al., 2019).

Table 5. Relationship between type activity and the two indicators of surface area and ratio length/width of the studied enclosed space

Space	Surface	l/w	Stationary	Moving through
Enclosed spaces with both stationary and moving people				
S1	3,270	6.3	0	40
S4	3,562	5	15	31
S5	2,673	4	15	18
S6	4,603	6.25	45	8
S7	5,200	5	11	7
S8	2,000	6.3	18	14
S10	1,032	2	4	29
S17	1,814	2	15	14
S19	2,270	1.7	19	11
S20	1,757	1.6	9	19
Enclosed spaces with moving people only				
S2	2,375	7.5	0	4
S3	2,733	3.6	0	8
S9	828	4.2	0	6
S11	771	6	0	0
S12	1,814	1.25	0	4
S13	862	3.2	0	7
S14	2,254	1.3	0	7
S15	756	3.3	0	7
S16	753	3.5	0	10
S18	1,230	3.2	0	6

Note: Surface: Surface area of the enclosed space (m²)
l/w: Ratio length /width
Stationary: Number of people who are in the space and staying there
Moving through: Number of people who are moving through/in the space

From another side, some enclosed spaces may have the same number of openings to the street, but different surface areas and different percentage of opening to the global perimeter. For example, a large space like the S4 with 3562 m², three openings on the street and 13% of opening on perimeter cannot be considered as equivalent to the S15 space which has a small surface of 756 m², three openings on the street and a percentage of opening on perimeter of 7%. S15 is more closed-up and smaller than S4. This means that considering the indicator of the number of openings of the spaces on the street, alone, would not help to identify which one of the spaces is the most closed. This is because the number of openings on the street does not provide the percentage of opening to the global perimeter. This result coincides with the work of Shi (2012) and Ashihara (1981).

Next to the surface area indicator, the length/ to width ratio indicator was chosen to know better about the spatial proportions and dimensions of the in-between enclosed spaces *Table 5*. The symmetrical space is when the difference between the length and the width dimensions of a space is low, in other words, the two dimensions are almost equal, this property gives a square space with a balanced length/width ratio like in the case of spaces S10, S17, S19 and S20. These spaces are pleasant and have a moderated sense of physical enclosure. The spaces S1, S2, S3, S5, S8, S12, and S14 have a high length/ to width ratio and a large surface area, with a length dimension which is double or more then the width dimension, they have the shape of a corridor or of a street, with a high sense of physical enclosure compared to the first group. Spaces S9, S11, S13, S15, S16 and S18 have both a high length/ to width ratio and a small surface area, which makes them small, very narrow, and tiny spaces with a strong sense of physical enclosure. Spaces S4, S6 and S7 have an unstable length and width dimensions since their triangular shape but an important length/ to width

ratio, these spaces are spacious with a big surface area, the sense of physical enclosure here is moderated.

Considering the values of the two indicators surface area and length/ to width ratio, contributes to identify the strongest or the weakness of the sense of physical enclosure. But considering both indicators together contribute to better identify the sense of physical enclosure of the in-between spaces rather than considering each indicator separately. This was in somehow discussed in Shi (2012) study on the open spaces in parks. She states that the max and the min axes in themselves may also influence perceived enclosure in open spaces.

Moreover, it is noticeable from *Table 5* that some spaces may have a high surface area and the percentage of opening to the global perimeter but still being used as transitional ones by attracting only people moving through them. Such spaces include S2, S3, S12, and S14. This is likely to be influenced by their very limited number of entrances to buildings oriented toward the enclosed spaces (ranging from 2 to 3). *Figure 5* shows that the group of the localized spaces contain a high number of entrances to buildings oriented toward them and hold more stationary people in general and children in particular. This is the case of spaces S5, S6, S7, S8, S17, S19 and S20, which have a high number of entrances to apartments and no entrances to commercial areas except one or two emergency accesses. The space S4 is used by a small number of stationary people but never used by children, which is due to the total lack of entrances to access the apartments in this space. Space S11 is never used for any stationary or moving activity, which is due to the total absence of entrances to the building oriented towards this space at one hand, at the other hand to it total closeness.

Space S1 contains a high number of entrances to commercial and retail units as well as entrances to apartments, which explains the large number of users engaged in both stationary and moving activities at the same time. The high presence of commercial activities on the ground floor of the blocks surrounding this space attracts many people and visitors (not only residents) from other areas of the neighbourhood, which affects the presence of children. Besides that, *Figure 6* shows a correlation between the numbers of stationary children observed within the group of localized spaces and the physical indicator of the number of entrances to buildings oriented toward the enclosed space. Indeed, the more the enclosed space has a high number of entrances connected with the surrounding buildings, the more it is used by stationary children. Conversely, when the enclosed space has a low number of entrances connected with the surrounding buildings, it is less used by stationary children. Therefore, children prefer to play and stay for long duration within the enclosed spaces that are highly connected with the surrounding buildings. This finding coincides with previous work of Newman (1972) and also with the degree of "constitutedness" studied by Van Nes and López (2007) who found that the way in which entrances and windows are located in relation to the enclosed spaces, influences the probabilities of social control and natural surveillance and that entrances connected to a public space increase their use by residents.

According to *Table 6*, children prefer the enclosed spaces that are not very open to the outside of the space (street). Indeed, they do prefer especially spaces having one or two opening onto the street, the more the enclosed spaces have more than two (2) openings onto streets, the more they became not very occupied by lot of children. This is, somewhat, in agreement with findings of previous studies (Bada and Guney, 2009; Hillier and Hanson, 1989) which reported that the more the space is visible the

more it is occupied by people. Indeed, the more the enclosed spaces are visible and accessible by the parents, from the surrounding apartments the more they are used by their children.

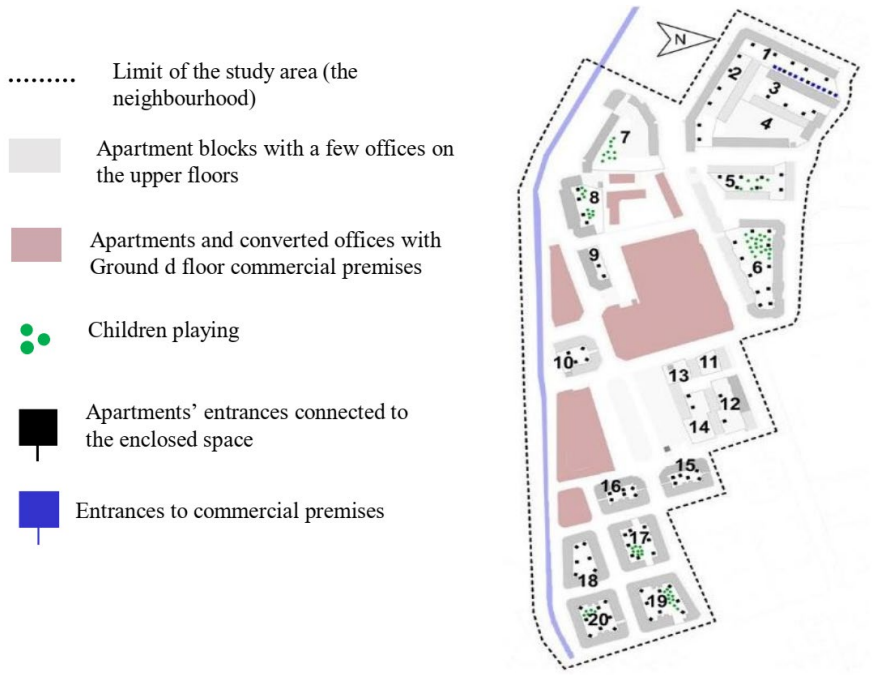

Figure 5. Building entrances directly connected to the enclosed in-between spaces

Table 6. Relationship between opening of a space and number of stationary subjects

The Enclosed Spaces	**S1**	**S4**	**S5**	**S6**	**S7**	**S8**	**S10**	**S17**	**S19**	**S20**
Percentage (%) of opening /to the global perimeter of the enclosed space	20.6	13	25	6	2	17	22	11	5	4
Number of openings from the streets	3	3	3	1	3	2	2	2	1	2
Children staying in the space	0	0	6	19	9	9	1	7	10	5
Stationary People	40	15	9	26	2	9	3	8	9	9

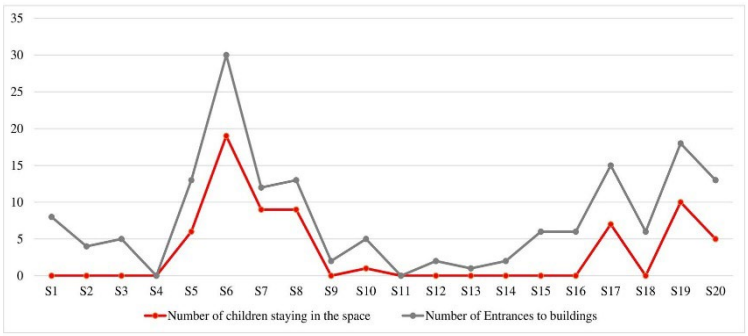

Figure 6. The correlation between the numbers of entrances to buildings oriented toward the enclosed spaces and the number of stationary children

Figure 7 shows that the group of localized spaces with both stationary and moving people, namely the spaces S1, S4, S5, S6, S7, S8, S10, S17, S19 and S20, have an H/D ratio that varies between 0.57 and 1.15. When the angle for which this ratio is the value of its tangent, this finding coincides with the results of Spreiregen (1965) who considers angle 30° degrees as the

smallest angle to create a sense of enclosure. Transitional spaces, namely the enclosed spaces S2, S15, S16 and S19, observed with moving people only, have an H/D ratio that exceeds 1.2 to 1.5. Therefore, the sense of enclosure here is very strong, and people do not find pleasure in having a sit there for a long duration because of the uncomfortable feeling and abused closeness.

Some transitional spaces such as S3, S9, S11, S12, S13, and S14 have an H/D ratio that varies between 0.71 and 1.06, which is equal with the H/D ratio found for the case of the localized spaces with both stationary and moving people. Despite this, these spaces remain transitional and not used for long duration. This is due to their enclosure characteristics already mentioned above, as well as the lack of entrances to buildings and apartments, their small size and surface area and their percentage of opening (either very high or very low).

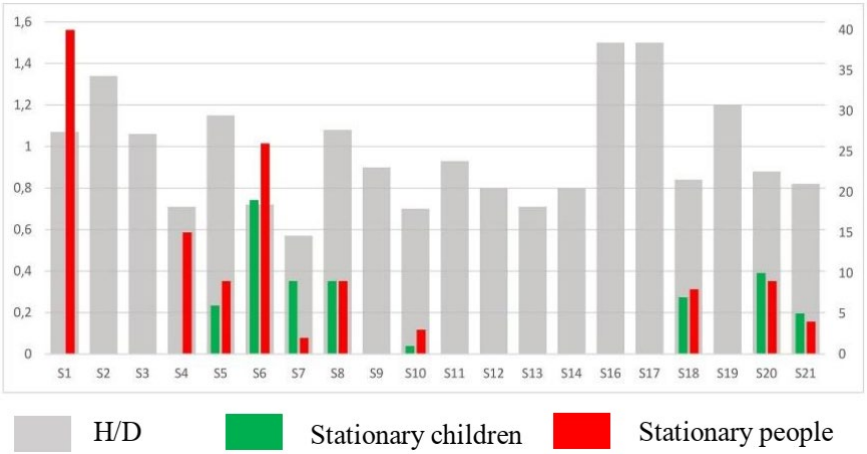

Figure 7. Comparison between the H/D ratio and the number of stationary people (other than children) and stationary children

Figure 8 shows the relation between the flows, which is the number of moving people, and the opening of the enclosed spaces, which is the percentage of the total width of opening on the enclosed space. As it is already mentioned in *Figure 4*, some enclosed spaces were observed with a large flow (from 2 to 5 every 10 meters), while the other enclosed spaces are observed with a small flow (from 0 to 1 every 10 meters).

At first level this is due to the degree of opening of the enclosed spaces, which means that the more enclosed spaces are open the more they are used as transitory spaces and the more the flow is larger. The opening here can be explained by two enclosure physical indicator, at one hand, the number of entrances to buildings oriented toward the enclosed space. Indeed, the flow is larger when the enclosed space has a low number of entrances directly connected to dwellings. In this situation, spaces are not used for stationary activities and become transition corridors. At the other hand, the percentage of the total width of openings on the perimeter of the enclosed space. In this situation, the flow is larger when the enclosed space had a high percentage of opening and vice versa, the flow is small when the enclosed space had a low percentage of opening.

At the second level, it is due to the physical indicator of the number of openings of the enclosed space from the streets. This means that the stronger flows are due to the strong connections with the rest of the city.

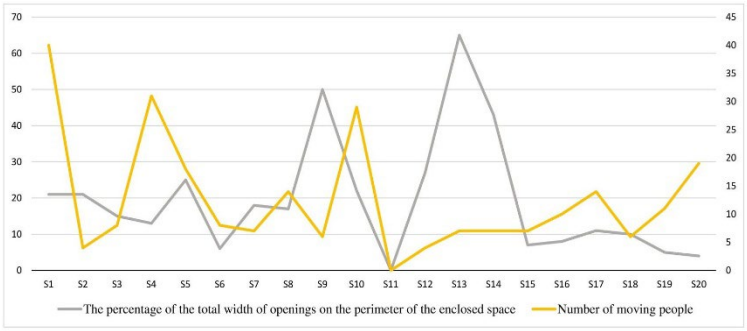

Figure 8. Relation between the flow and the opening of the enclosed spaces

Our work is a new attempt to better understand that relationship between the characteristics of in-between spaces and their use with a view to better design the urban environments and create spaces that are more enjoyable and used by residents. Our results are summarized into four main headings that may explain the use of the in-between spaces, as follows:

1- The size of the in-between enclosed space: the indicators of the geometric shape, the surface area and the length/width ratio are the main three indicator that define the size of a given in-between enclosed space. We have found that large in-between spaces are generally localized spaces, where people prefer to stay for long duration, while spaces that are too narrow and small are transitional and used mainly for movement.

2- The physical opening of the in-between enclosed space: the number of openings from the street and the percentage of openings to the global perimeter are the two main indicators to really identify the physical opening of a given in-between enclosed space. We have found that those spaces that have a percentage of openings that exceed 25% and a number of opening more than 3 openings are too open for users especially residents, therefore they are transitional spaces used in most of the time as transit points. On the other hand, spaces that have a percentage of opening less than 25% and a number of openings that doesn't exceed 2 are localized spaces and preferred by users and residents to stay for long duration for stationary activities especially by children.

3- Entrances to buildings oriented towards the in-between space: in fact, the presence of access be that to commercial premises or to apartments determines the type of activity of the in-between enclosed space, moreover, the type of users. The presence of the entrances to the apartments directly oriented towards the space encourages the feeling of security for the parents and a strong presentation of their children who play for a long duration (time) in the space. While the presence of entrances to commercial premises oriented directly towards the space attracts many users (residents and visitors), a large number of people frequent this type of space but not children. The non-presence of entrances to buildings directly oriented towards the space makes the space transitional and never used for localized and long duration activities or by children.

4- H / D Ratio, already cited in several studies on open space, namely Spreiregen (1965) and Shi (2012), is important in the identification of the physical enclosure of the in-between enclosed spaces. This ratio determines the different viewing angles for the feeling of the enclosure at different degrees. When this ratio is raised beyond 1.2, it

gives a strong feeling of enclosure which contributes to people using such spaces as transitional ones in most of time. When the ratio is between 0.5 and 1.15, a comfortable feeling of enclosure is experienced, leading to the creation of localized spaces for long duration activities.

6. CONCLUSION

The spatial enclosure concept is an important physical feature that architects and urban designers should consider in the design and planning of the residential neighbourhoods, in order to encourage more use of the in-between spaces and contribute to a good social life for residents. Studies dealing with the concept of enclosure and how it impacts the perception and the use of spaces in general and in-between spaces in particular are very few. In addition, most of studies deal with one physical indicator or two at most in order to identify the sense of enclosure. Unlike previous studies, the originality of the present work is manifested in the use of seven physical indicators together in order to identify the physical enclosure and discuss the way each indicator affect the use of the in-between spaces more then or less the other indicators.

According to aim of work, it was found that among the seven physical indicators, the physical enclosure can be defined by four main headings, namely: the size and the physical opening of the in-between space, entrances to buildings oriented towards the in-between space and finally the H / D Ratio. At the other hand, it was found that the use of in-between spaces is really affected by these four headings. Indeed, we have observed that people, especially children, prefer to stay for a long time in large in-between spaces which have an opening percentage of less than 25% and a comfortable feeling of enclosure (when H/D ratio is between 0.5 and 1.15).

This work is not global and can be completed in the future, other interesting directions for future research is in our ambition. As we have identified the physical enclosure through seven physical indicators, in further development, we could consider the perceived enclosure through people's perception in terms of openness and closeness according to their felling within the in-between spaces.

AUTHOR CONTRIBUTIONS

Conceptualization, M.S., B.Y. and B.H.; methodology, M.S., B.Y. and B.H.; field investigation, data analysis, M.S.; Original draft preparation, redrafting and editing, M.S., B.Y. and B.H.; supervision, B.Y. and B.H. All authors have read and agreed to the published version of the manuscript.

ETHICS DECLARATION

The authors declare that they have no conflicts of interest regarding the publication of the paper.

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REFERENCES

Appleton, J. (1996). *The Experience of Landscape.* Wiley Chichester.

Ashihara, Y. (1981). *Exterior Design in Architecture.* Van Nostrand Reinhold Company.

Bada, Y. and Guney, Y. I. (2009). "Visibility and Spatial Use in Urban Plazas: A Case Study from Biskam Algeria". Proceedings of Proceedings of the 7th International Space Syntax Symposium, Stockholm, Sweden, 1-11.

Bendjedidi, S., Bada, Y., et al. (2019). "Urban Plaza Design Process Using Space Syntax Analysis: El-Houria Plaza, Biskra, Algeria". *International Review for Spatial Planning and Sustainable Development*, 7(2), 125-142. doi: https://doi.org/10.14246/irspsda.7.2_125.

Can, I. (2012). "In-between Space and Social Interaction: A Case Study of Three Neighbourhoods in Izmir". University of Nottingham.

Ching, F. D. K. (1996). *Architecture: Form, Space and Order.* (Vol. 20154). John Wiley & Sons.

Colonnese, F. and Carpiceci, M. (2020). "Hermann Maertens' Der Optischemaassstab and the Photography of Architecture". *img journal*, (3), 198-215. doi: https://doi.org/10.6092/issn.2724-2463/12255.

Epstein, R. and Kanwisher, N. (1998). "A Cortical Representation of the Local Visual Environment". *Nature*, 392(6676), 598-601. doi: https://doi.org/10.1038/33402.

Farida, N. (2013). "Effects of Outdoor Shared Spaces on Social Interaction in a Housing Estate in Algeria". *Frontiers of Architectural Research*, 2(4), 457-467. doi: https://doi.org/10.1016/j.foar.2013.09.002.

Garling, T. (1969a). "Studies in Visual Perception of Architectual Spaces and Rooms: Ii. Judgments of Open and Closed Space by Category Rating and Magnitude Estimation". *Scandinavian Journal of Psychology*, 10, 257-268. doi: https://doi.org/10.1111/j.1467-9450.1969.tb00035.x.

Garling, T. (1970b). "Studies in Visual Perception of Architectural Spaces and Rooms: Iv. The Relation of Judged Depth to Judged Size of Space under Different Viewing Conditions". *Scandinavian Journal of Psychology*, 11, 133-145. doi: https://doi.org/10.1111/j.1467-9450.1970.tb00727.x.

Gärling, T. (1969b). "Studies in Visual Perception of Architectural Spaces and Rooms: I. Judgment Scales of Open and Closed Space". *Scandinavian Journal of Psychology*, 10(1), 250-256. doi: https://doi.org/10.1111/j.1467-9450.1969.tb00034.x.

Gärling, T. (1970a). "Studies in Visual Perception of Architectural Spaces and Rooms: Iii. A Relation between Judged Depth and Size of Space". *Scandinavian Journal of Psychology*, 11(1), 124-131. doi: https://doi.org/10.1111/j.1467-9450.1970.tb00726.x.

Gehl, J. (1986). "'Soft Edges" in Residential Streets". *Scandinavian housing and planning research*, 3(2), 89-102. doi: https://doi.org/10.1080/02815738608730092.

Gehl, J. (1987). *Life between Buildings.* (Vol. 23). New York: Van Nostrand Reinhold.

Gehl, J. (1996). "Life between Buildings: Using Public Space, 3rd Edn (Skive: Arkitektens Forlag)".

Gehl, J. and Gemzøe, L. (2004). *Public Spaces-Public Life.* Arkitektens Forlag.

Gehl, J., Kaefer, L. J., et al. (2006). "Close Encounters with Buildings". *Urban design international*, 11(1), 29-47. doi: https://doi.org/10.1057/palgrave.udi.9000162.

Gibberd, F. (1970). *Town Design (6th Ed.).* Architectural Press., London.

Gibson, J. J. (1986). *The Ecological Approach to Visual Perception.* Lawrence Erlbaum Associates, London.

Hillier, B. (1988). "Against Enclosure". *Rehumanizing housing*, 2, 25-21.

Hillier, B. and Hanson, J. (1989). *The Social Logic of Space.* Cambridge university press.

Ittelson, W. H. (1976). "Environment Perception and Contemporary Perceptual Theory". *Environmental psychology: People and their physical settings*, 141-154.

Kaplan, R. (2001). "The Nature of the View from Home: Psychological Benefits". *Environment and behavior*, 33(4), 507-542. doi: https://doi.org/10.1177/00139160121973115.

Kaplan, R. and Kaplan, S. (1989). *The Experience of Nature: A Psychological Perspective.* Cambridge university press.

Maertens, H. (1884). *Der Optische-Maassstab: Oder, Die Theorie Und Praxis Des äesthetischen Sehens in Den Bildenden Künsten.* Ernst Wasmuth.

Mebirouk, H., Zeghiche, A., et al. (2005). "Appropriations De L'espace Public Dans Les Ensembles De Logements Collectifs, Forme D'adaptabilité Ou Contournement De Normes?. Cas Des Zhun D'annaba (Nord-Est Algérien)". *Norois. Environnement, aménagement, société*, (195), 59-77. doi: https://doi.org/10.4000/norois.513.

Moser, G. and Weiss, K. (2003). *Espaces De Vie: Aspects De La Relation Homme-Environnement.* Armand Colin.

Newman, O. (1972). *Defensible Space: People and Design in the Violent City.* ARCHITECTURAL PRESS, London.

Nooraddin, H. (1998). "Al-Fina', in-between Spaces as an Urban Design Concept: Making Public and Private Places Along Streets in Islamic Cities of the Middle East". *Urban design international*, 3(1-2), 65-77. doi: https://doi.org/10.1057/udi.1998.8.

Norberg-Schulz, C. and Schulz, C. N. (1968). *Intentions in Architecture.* MIT press.

Ramanujam, P. (2006). *Prospect-Refuge Theory Revisited: A Search for Safety in Dynamic Public Spaces with a Reference to Design.* The University of Texas at Arlington.

Rummel, R. J. (1976). "Social Behavior and Interaction". *Conflict and War*, 2.

Sally, L. (2005). *Front to Back: A Design Agenda for Urban Housing.* Architectural Press.

Shi, S. (2012). "The Influence of Public Open Space Enclosure on Health: An Environmental, Psychological, and Behavioral Study Based on Public Housing Estates in Hong Kong". *HKU Theses Online*.

Shi, S., Gou, Z., et al. (2014). "How Does Enclosure Influence Environmental Preferences? A Cognitive Study on Urban Public Open Spaces in Hong Kong". *Sustainable Cities and Society*, 13, 148-156. doi: https://doi.org/10.1016/j.scs.2014.04.011.

Sitte, C. (1979). *The Art of Building Cities: City Building According to Its Artistic Fundamentals.* Ravenio Books.

Skjaeveland, O. and Garling, T. (1997). "Effects of Interactional Space on Neighbouring". *Journal of environmental psychology*, 17(3), 181-198. doi: https://doi.org/10.1006/jevp.1997.0054.

Spreiregen, P. D. (1965). *Urban Design, the Architecture of Towns and Cities.* Krieger Publishing Company.

Stamps III, A. E. (2005). "Visual Permeability, Locomotive Permeability, Safety, and Enclosure". *Environment and behavior*, 37(5), 587-619. doi: https://doi.org/10.1177/0013916505276741.

Stamps III, A. E. and Smith, S. (2002). "Environmental Enclosure in Urban Settings". *Environment and behavior*, 34(6), 781-794. doi: https://doi.org/10.1177/001391602237246.

Takei, M. (1969). "Studies on the Method to Measure and Judge the Density of Buildings". *Transactions of Architectural Institute of Japan*, 43-49.

Thiel, P. (1970). "Notes on the Description, Scaling, Notation, and Scoring of Some Perceptual and Cognitive Attributes of the Physical Environment". *Environmental psychology: Man and his physical setting*.

Thiel, P., Harrison, E. D., et al. (1986). "The Perception of Spatial Enclosure as a Function of the Position of Architectural Surfaces". *Environment and behavior*, 18(2), 227-245. doi: https://doi.org/10.1177/0013916586182005.

Van Nes, A. and López, M. J. (2007). "Micro Scale Spatial Relationships in Urban Studies: The Relationship between Private and Public Space and Its Impact on Street Life". Proceedings of Proceedings of the 6th Space Syntax Symposium (6SSS), Istanbul, Turkiye, June 12-15, 2007.