

Space Syntax for Evaluating Attractivity and Visit Frequency

A Comparative Study of Two Public Squares of Downtown Setif (Algeria)

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ABSTRACT

The current study uses the Space Syntax innovative method for determining the causes of the attractivity and visit frequency gap between two open public spaces of downtown Setif (Algeria): Sahat El Istiklal square and Masjid Ibn Badis square. A design drawn from a map coming from the National Institute of Cartography and Teledetection (Algeria) is chosen for the configurative analysis carried out by Space Syntax through the DepthMap software. Visibility Graph Analysis (VGA) superimposed with the pedestrian real flow permits the visual integration of the analysis of each square. The analysis revealed relevant gaps in the syntactic measure values obtained for each square emphasizing their positive aspects and specific problems. Space Syntax allows the extension of the initial discussion about public squares in urban environments and to work out causality relationships between spatial configuration and human behavior.

Keywords-Space Syntax; special configuration; public square; attractivity; visit frequency

I. INTRODUCTION

Public squares reflect the identity and culture of a city and are parts of its image and prestige. There is a growing demand to increase the entertainment, conviviality, and social interaction of city residents since the laws No. 2006-06 of 20 February 2006 were promulgated, and the amelioration of the the quality of the urban living environment became a priority for the Algerian State [1]. This social aspect is not a priority for the local authorities, which focus more on the development advantages. So, starting from the principle that public squares are optimally central sociability places we considered the case study of two squares of downtown Setif: Sahat El Istiklal and Masjid Ibn Badis squares, which have a gap of attractivity and visit frequency.

The current studies about the urban open space widely focus on the qualitative aspect and few studies concern the quantitative perspective. Thus, a Space Syntax-based study intends to quantitatively determine the essential causes of the inequality of attractivity and visit frequency between the two squares. In this way, we consider the accessibility to a place and the visibility degrees of its design as the indices determining social interactions and hence attractivity and visit frequency. A clear comprehension of the relationship between

the spatial configuration and popularity of a place is a must for better designs [2].

Previous researches focused on the social logic specific to the space, which impacts human behavior, using accessibility and visibility notions [3]. Authors in [4] define spatial configuration as the simultaneous relationship set existing between the parts and which design the whole, concluding that the spatial shape must be seen as a factor which contributes to the formation of the integration and segregation models in cities. Accessibility is the movement potentiality from one place to another or from a point to another. The event is perceived in the form of time, distance, and cost [5, 6]. Space Syntax theory presents three interaction forms between persons and space to observe movement, interactions with people, and watching the function of a visual field [7]. Moreover, while the visual potentialities are biological or technical, the choice modalities of what is seen or unseen depend on the social dimension [8].

For quantitatively apprehending the attractivity and visit frequency gap between the two considered urban squares, configurative analysis was carried out by Space Syntax through the DepthMap software. It carries out axial integration studies (global ($r=n$) and local ($r=3$)) for describing visual move axes

and the Visibility Graph Analysis (VGA) for the evaluation of the integration and visual permeability levels. The results of the current research may contribute to innovative proposals for better designs in the development and planning of the urban open spaces.

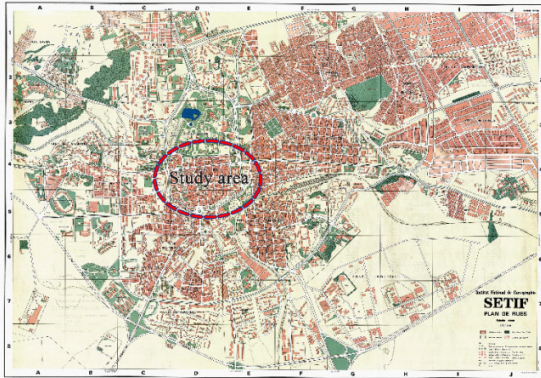


Fig. 1. The location of the study area in the city of Setif (original image © The National Institute of Cartography and Remote Sensing).

II. METHODOLOGY

A. Context and Case Study

Downtown Setif is an ex-nihilo creation of the French army [9]. Setif is an eastern city located at 300km from Algiers and at a height of 1100m in the Algerian highlands. Two central historical places, in a distance of 265m, are the object of the current study.



Fig. 2. Location of Sahal El Istiklal and Masjid Ibn Badis in downtown Setif. (Image © 2022 Maxar Technology, Google Earth, processed by the authors).

Sahal El Istiklal square (Figure 3A–C) is the first big historical square of downtown Setif, created in 1845 at the western entry of the city. It is distinguished by its location at the intersection of two big historical axes structuring the ancient downtown. Its shape results from the enlargement of 8 May 1945 Street constituting a 70m sided square, whose center contains a fountain monument surrounded by 4 high trees shading its space. Its framework contains Al Atik mosque, two

hotels, an administrative building, and other housing buildings with a commercial ground floor (cafeterias, restaurants and shops...) and in the upper floor some flats and professional spaces (physicians, lawyers, architects, etc.). After the works due to the tramway crossing in 2018, the square became a space reserved to pedestrians and so preventing the access to vehicles. The ground floor is paved with concrete elements and abounds in unified urban furniture with many public benches, flowers trays, and huge umbrellas.

The Ibn Badis mosque square (Figure 3B–D) is a historical square of the city, erected far from the big traffic, reinforcing its quiet space pattern [10]. It is located in the eastern side of Ben Boulaid Street, it is 22m wide and is used as a jewelry and craft commerce point. It is the result of the removal of two urban meshes, which replaced two blocks in the European district [11]. This gives a large space in the form of a rectangle whose length and width are 135 and 62m, respectively. This square is framed by communal schools and housing buildings with a ground floor limited to some small retail shops (shoes, one café, and two groceries) and some professionals at the upper floor. After the Independence, during the period 1962-1970, this square has known important modifications: The church became a mosque, the square space has been enclosed and finished as a garden, and a simple stele has replaced the memorial decorating the middle of the square. The urban furniture is almost absent in the square, except some benches and street lamps inside its garden.

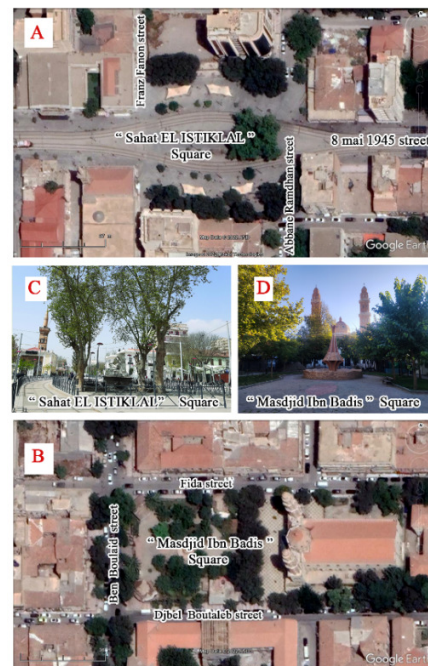


Fig. 3. A, C: The Sahal El Istiklal square, B, D: The Ibn Badis mosque square, (images A, B © 2022 Maxar Technology, Google Earth, processed by the authors).

A. Analysis Method

As said above, public squares in urban environments are the study object of this research. The analysis of the attractivity

and the visit frequency in the considered urban punctualities of downtown Setif is based on Space Syntax as a method and theory developed by the Space Syntax Laboratory (SSL) in the seventies. Space Syntax can be summed up as a reflection on the rules and the principles of the urban organization and is based on the elements of configuration aspects, which compound the space as social behavior influencers while focusing on the questions linked to the persons' movement. In order to quantitatively explore the correlation between the spatial configuration and a social variable and using the tools given by Space Syntax, we focused on the fundamental variable of the number of persons crossing the square (pedestrian flow) considered as the real factor of attractivity and visit frequency. The person movement is figured from the axial map describing the mobility system of a given space. Through its decomposition in axes we can draw the traffic movement of open spaces of urban meshes [12]. A sketch drawn from the map given by the National Institute of Cartography and Teledetection (Algeria) is chosen for the syntactic study because it contains the whole historical downtown of Setif (urban colonial nucleus) and its two central historical squares as study topics. Its design will be completed by satellite photos from Google Earth which show the current places' state. Concerning the design of each square used for the visual analysis, it is reconstituted from the above design and from the surveys carried out on the field. A contour in dotted blue line drawn on the surrounding walls prints of the ancient city indicates the limits of the study area.

The study limit of the visual integration of each square is represented by the square space, the peripheral buildings, and its accessing streets. The design of each square will be drawn with Autocad. The global map of the whole study area and the partial maps of the public squares will be changed in DXF format then reproduced by the DepthMap software. After the evaluation of the syntactic properties and the calculation of the measures of the global ($r=n$) and local ($r=3$) integration plus the visual integration. DepthMap automatically assigns a series of colors with different shades: blue for the low values, yellow and green for the medium values, and red for the high values.

The axial map of the pedestrian traffic follows the pedestrians' walking which access the squares while the axial lines apply the rule of the longest and the less numerous. In the used method, the pedestrian flows systems are compounded of more or less accessible roads, which are then interpreted in function of their depth. The more accessible axes are qualified as less deep and integrated while the less accessible as deep and segregated. In theory, the most integrated lines are supposed to have a maximal flow of persons and so a greater attractivity and visit frequency. A space is considered as integrated if it tends to bring to it the other system spaces [13]. The axial map of the pedestrian traffic allowed us to compare the two squares with the medium value of the integration of all the axial elements of the global and local integration and the intelligibility of the urban system of the historical center could determine the role of each square in the urban system. In parallel, the values of the visual integration superimposed to the in situ observation (pedestrian real flow) allow us to compare the two squares and to explain the gap of the attractivity and visit frequency values.

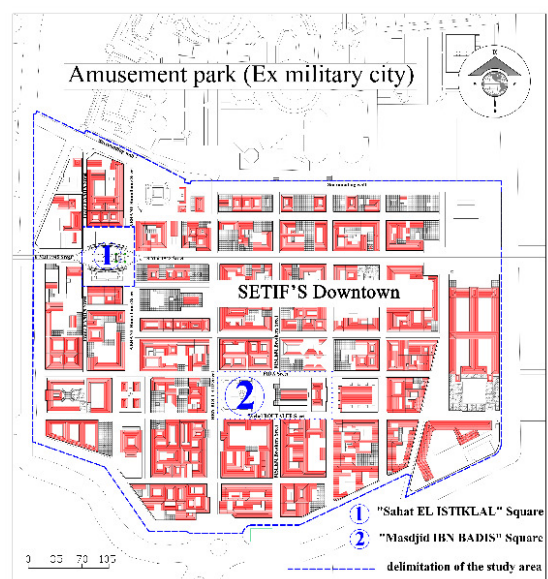


Fig. 4. Plan delimiting the study area and the two study squares. (Original image © The National Institute of Cartography and Remote Sensing. Processed by the authors).

B. Field Investigation: Counting and Following up the Pedestrian Real Flow

We are interested in the transit functions and the pedestrian follow up in order to measure the attractivity and the visit frequency of the considered squares. The pedestrian real flow has been counted from the numerical data and the statistical surveys. The used method is based on manual counting, which is preferable to the automatic counting [14]. It consists in counting and following up of the pedestrian flow carried out on each public square in the same time. This method can be based on the Geographical Information System (GIS) for exploring researches in the urban development fields [15]. The counting and following up were carried out by Architecture Master students. They worked as operators and were pre-trained about the counting program objectives, the data collection process, and the way of using the collect form and the follow up plans. Each operator had a chronometer and prepared investigation forms, containing all the information about the counting places and the pedestrians (hour, date, observator, direction, gender and age). Moreover, a detailed sketch of the square was given to help situate the pedestrian flow. This was necessary for the accuracy of the results during the data interpretation.

Standing at the access of the streets serving each square, one or two operators-in function of the importance of the way - carried out the counting of the persons entering the square and reported on the form the visually surveyed data. Persons leaving the square were not counted. Then, a sample of persons, determined from the counting results was followed from their entrance to the square until leaving it. The field visits and the counting development were carried out during the period between May and June 2020. For each counting the interval was not more than five minutes and ran during the working days of the week (Sunday and Monday) and the weekends (Friday and Saturday). The timing periods corresponded to rush hours: from 7.30 to 8.30 AM and 5.30 to

6.30 PM and between 8 to 9 PM. The counting results appear in Table I. The plans of the moves are exhibited by lines of different thicknesses and colors on plans containing all the ways converging to the square, which can be taken by pedestrians.

III. RESULT ANALYSIS, AND DISCUSSION

A. Results, Analysis, and Discussion of the Axial Map

The axial integration map of Figure 5 obtained from the pedestrian flow shows a color difference of the axial lines of the most integrated to the system public square, which appears in dominant red color and the most segregated square in axial line mainly in blue tones. It also shows the analysis results of the global integration (HH) at the radius n and the local integration at radius 3, for the description of the move axes which intend to explore the most localized organizations like central public squares in the city. This axial map showcases the evident inequality in the integration values of the pedestrian traffic which crosses each square. So, Sahat El Istiklal square presents the highest local and global integration values (from 1.75889 to 6.05969) with maximum red colors lines. At the opposite, Ibn Badis mosque square presents a predominance of less high axial lines (from 2.48420 to 4.04988) with a blue tone primacy. It is relevant to notice in the urban system of the historical center the pertinence of important streets as integration axes of the pedestrian traffic serving each square. So, the map in Figure 5 shows that Abane Ramdane Street and 8 May 1945 Street which intersect in Sahat El Istiklal square, present the highest integration values (5.91332 and 6.06208) while Ben Boulaid Street adjacent to the western side of the Ibn Badis mosque square displays the less high integration value (4.20904). The streets' layout near each square influences the animation and their syntactic values. So we can deduce that the environment may have more effect on the square congestion than the square design itself.

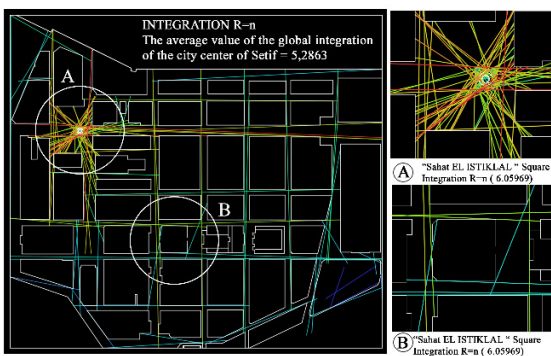


Fig. 5. Results of the axial pedestrian map analysis.

So, 8 May 1945 street being a highly integrated move axe, strongly impacts the peripheral sides of the square, especially the emergence of connection places, and the attractivity of the commercial areas located in the building ground floors framing the square, which then become multiplicator spaces of attractivity and frequent visit. The fountain monument site, with its high trees shading its space at the axes intersection, presents the highest integration value. Thus, this is a highly

integrated connection space and an attractivity element giving Sahat El Istiklal square a good animation and a good user's frequent visit and permitting great mobility and a better access from its western entry. On the other hand, the wall enclosing the garden in the middle of the Ibn Badis mosque square, constitutes a barrier and a repulsive element for the pedestrians, preventing any movement.

If we put in correlation the global spatial integration and the connectivity of the map axes of the historic center urban network under a dispersion diagram form, we obtain an intelligibility value of $R^2=0,893$. This very high second degree measure shows that these two squares belong to a very intelligible urban system and defines the integration level of each square [17]. This can be demonstrated by the visibility of the historic center urban system and by the role of each square in terms of attractivity and frequent visit.

TABLE I. VALUES OF VISUAL INTEGRATION

Values of visual integration	Sahat El Istiklal	Masjid Ibn Badis
Minimum	5.18850	5.6545
Average	21.8004	11.1485
Maximum	36.8479	18.4607

TABLE II. COUNTS OF THE PERSONS COMING FROM THE STREETS SERVING THE SQUARE EVERY 5 MINUTES

	Sahat El Istiklal	Masjid Ibn Badis
Street 1	328	108
Street 2	281	46
Street 3	29	58
Street 4	53	28
Street 5	14	64
Street 6	8	45
Total	713	349
Observation	Very animated	Segregated

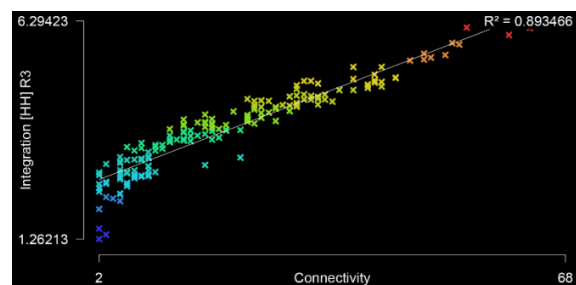


Fig. 6. Intelligibility diagram of the historic center of Setif City.

B. Results, Analysis, and Discussion of the Visual Integration

This part of the study deals with the square analysis compared to its own space. The Visibility Graph Analysis (VGA) maps present a chromatic differentiation of the visibility spaces from the most visually integrated spaces -in red- to the most visually segregated spaces, in blue. It shows the results of the visual integration analysis (HH) for the evaluation of the integration levels indicating the places with more or less big visual eventuality. The observation of the pedestrian flow concerned a sample of 500 persons coming from the streets of surrounding neighborhoods and entering the

square. The results of the visual integration of the syntactic study in Table II are compared to those of the counting and followed by the real move of the persons in the square. From the results of the pedestrian counting, it appears that greater pedestrian number passes from Sahat El Istiklal square, which makes it a very animated and visited space compared to the Ibn Badis mosque square. Ibn Badis mosque square was at first a church and had been designed as a quiet place. The counting results of Table II are in congruence with the visual integration values of Table I. The results of the comparison between the diagrams of the pedestrians real movement and the visual integration plus the square spatial configuration, show that the visual integration values are related with both the pedestrian movement and the spatial configuration as analyzed by the Space Syntax method (Figures 7, 8). Actually, the fact that Sahat El Istiklal square has been designed to be at the exact place of the enlargement of the most integrated axe of the urban system (8 May 1945 Street), enhances its attractivity and fluidity. The fountain monument and the dominant building (the mosque) as attractive elements are located at the eastern and western entry of the square. So, they permit good animation, balancing of the syntactic values of the walk in the middle of the square and all along its perimeter with an expressive reduction of the values around the fountain. These attractive elements of the square are positioned in the visibility axe of the most integrated move. The maximal values of the visual integration in Table I confirm that Sahat El Istiklal square offers good visibility and permits to clearly distinguish the borders of the peripheral convex buildings facilitating the interaction. In the visual integration map, the fountain monument erected on a stone pedestal and surrounded by four trees shading its space is considered as a barrier to the square visibility and has very low visual integration values (from 5.572 to 1.4654). Concerning Ibn Badis mosque square, due to its location adjacent to the eastern side of the Ben Boulaid Street, it cannot capture the pedestrian flow coming from this axe and presents low visual integration values. The building dominating the square was originally designed to be located in the visibility axes of the person movement and represented one of the most beautiful urban paintings decorating Setif City [18]. The central area of Sahat El Istiklal square concentrates the highest visual integration value (36.8479), gradually regressing as we approach the periphery of the buildings surrounding the square (Figure 7). The central area is the most visible area from which we can visually dominate the rest of the square, which makes it the most potential animated and visited space. On the other hand, for Ibn Badis mosque square, the buildings located in the square perimeter display low visual integration (9.09819), due to the construction of the garden enclosure wall. It contains a great number of high trees all around the square center constituting a physical barrier preventing continuity in visual integration. Moreover, in spite of the low visibility dominating this square, some parts inside the garden or at the mosque entry present moderately high integration values, and other parts situated at the intersection of the streets leading to the square present high values, which could imply a real possibility of animation. In the urban system of the historic center, each square is identified by its diversity and its functions which give vitality to urban life [19]. So the commercial frame gives Sahat El Istiklal square a role of very

animated and visited space, while the Ibn Badis mosque square is limited to some modest shops and is a very little attractive and less visited space. These in situ observation results are in correlation with the counting values of the pedestrian move (Table II).

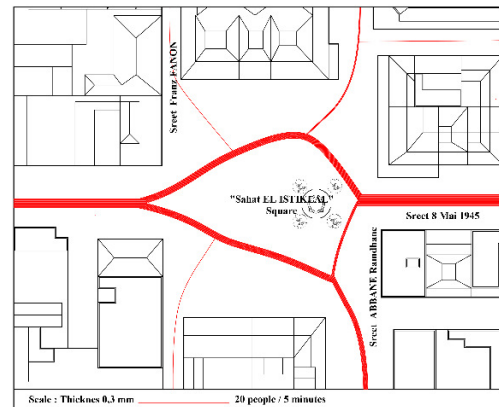
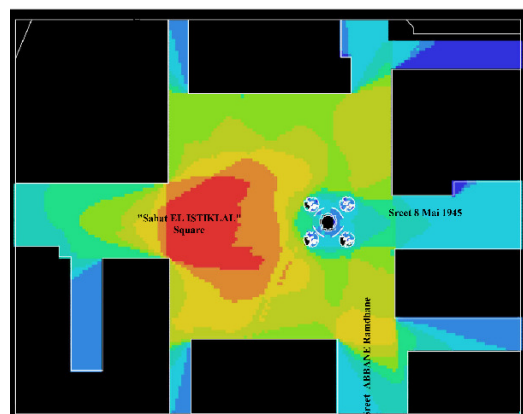


Diagram of a pedestrian pathway for 500people



Visual integration of the SAHAT EL ISTIKLAL square

Fig. 7. Juxtaposition of the pedestrian movement scheme and the visual integration plan in Sahat El Istiklal square.

IV. CONCLUSION

The spatial arrangement of downtown Setif City has a rectangular shape laying out ways on which the public squares are distributed. The methodology used for the comparative study of the two central squares, as spatial models through the Space Syntax method, focused on the study of supposed persons' flows as a necessary factor for real attractivity and visit frequency estimation. This permits to quantitatively estimate the attractivity and visit frequency differences for a future development of the squares. Other researches in the Space Syntax field, in different urban contexts, proved that the spatial integration level is a revelator of the pedestrian urban mobility. The inequalities in attractivity and visit frequency perceived in each square are the consequence of the configuration and the urban role originally devoted to each one.

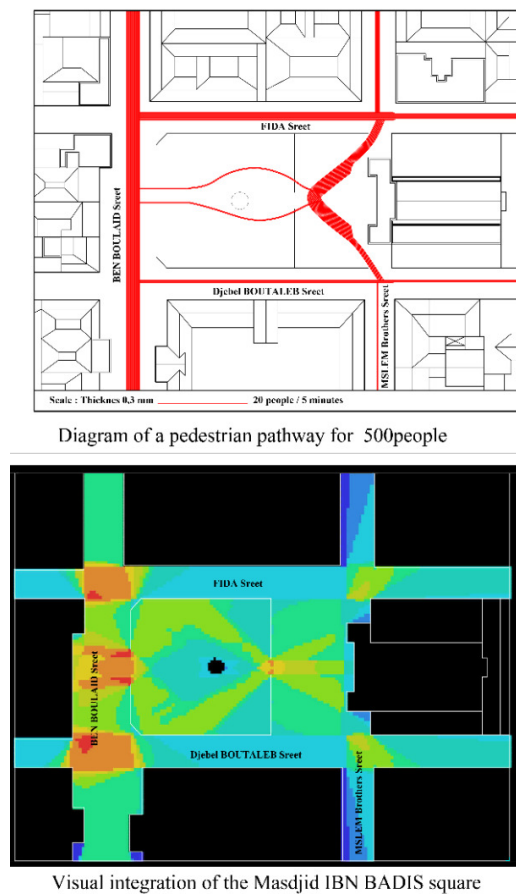


Fig. 8. Juxtaposition of the pedestrian movement scheme and the visual integration plan in Masjdj Ibn Badis square.

So, Sahat El Istiklal square is destined to become the most animated and visited urban space of the city due to its design, location, and the number of shops surrounding its space. It has been designed in order to be the anchor link of the two most animated historical and commercial axes of the city. The syntactic measures confirm that the two axes, Abane Ramdane Street and 8 May 1945 Street are very integrated in the axial integration $r=n$ of the global system. Thus, the square is highly visually and globally integrated and its attractiveness and visiting space are perfectly adapted to the pedestrians' mobility. Concerning Ibn Badis mosque square, even though it is situated in the eastern side of Ben Boulaïd Street, it cannot catch its animated flow. This square has been created only for serving its dominant building (Sainte Monique, church now Ibn Badis mosque). Actually, it was intended to be used as a quiet space, situated apart from the great traffic and with a limited number of surrounding shops. The syntactic results prove that this square owns the lowest visual and global integration values. Its few attractive spaces seem more adapted to a mechanical traffic.

This animation and frequent visit gap does not absolutely constitute a factor proving the success of the first square compared to the second one. Actually, each one finds its originality in the social economic and political role assigned in the urban system of the center of Setif City. The obtained

results show that the connection to Sahat El Istiklal square is essentially assured by the square size, the peripheral buildings, the dominant building (the mosque), the monument and the urban context, which fully participate to its attractiveness. Concerning the connection to Ibn Badis mosque square, it is more assured by the indoor spaces of the dominant equipment and the schools surrounding the square. This square remains segregated and less visited, especially in the night when the stores and schools are closed.

The development of downtown Setif goes through the increase of the global and visual integration values of the squares in the urban global context. Space Syntax, through DepthMap software, allowed us to demonstrate the attractiveness and traffic inequalities. It allowed to extend the debate initiated about public squares in urban environments and to lay down causality relationships between spatial configuration and human behavior in order to contribute to the elaboration of innovating recommendations.

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