

**An-Najah National University**  
**Faculty of Graduate Studies**

**Master Thesis Titled: Effect of Urban Open  
Spaces on Users Behavior. An Najah  
University Campus as a Case Study**

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## **Dedication**

*To my dearest parents for their continuous encouragement, love  
and prays*

*To my beloved sister my “life companion” and brothers*

*To my wonderful friends for their support*

*To all who supported and encouraged me through this journey*

*And finally to my teachers for their continuous guidance and  
advice*

## Acknowledgment

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*I am also grateful to the instructors and teachers who supported in overcoming numerous obstacles I have been facing through my research.*

*I would like to expand my gratitude to my friends for accepting nothing less than excellence from me. Last but not the least, I would like to thank my family: my parents and to my brothers and sister for supporting me spiritually throughout writing this thesis and my life in general.*

## الإقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان

### **Master Thesis Titled: Effect of Urban Open Spaces on Users Behavior. An Najah University Campus as a Case Study**

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#### **Declaration**

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degrees or qualifications.

**Student's Name:**

اسم الطالب:

**Signature**

التوقيع:

**Date**

التاريخ:

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**Abstract**

This thesis aims to contribute to the literature by analyzing open spaces uses, particularly squares in university campuses, and to the relationship between its physical settings and movement patterns. Therefore two questions are answered through the research: How do student's circulation relate to the physical features of an open space? And how does the spatial design of the university campus affect student circulation and interaction?

In order to address these questions, An Najah National University campus was chosen as a case study. The research employed a methodology that combines direct field observations, mobile sensing and space syntax theories, in different open spaces in the university campus, to expose the activity patterns that relates with particular use of design features within the square.

Direct field observation, provided direct experience and understanding of the space. Types and locations of the activities taking place within the space were recorded in order to provide people's activities patterns. Moreover, mobile sensing was used for more accurate results of student's movements and activities.

### XIII

Finally, the campus was modeled as spatial configurations using space syntax methods. It was used to find the relationship between spatial configuration and student activities in the space. Axial line, visibility and isovist analysis were done to the whole campus.

The results of space syntax analysis were compared with the field observation in order to come out with the results and conclusion to this thesis.

Research concluded that the spatial configuration and the physical features of the urban space influence how the space is use and how often. Moreover, the spaces on campus lack the adequate amount of seating and natural elements, and if found were not used efficiently. It also found that the space syntax is a useful method for studying the relation between the spatial setting of the space and the form of use. In addition, visibility is a key element in understanding human preferences and the study showed that students tend to sit on spaces with maximum visibility.

Therefore, the thesis with the proposed methodology will help finding out why some urban spaces work while others don't.

# **Chapter One**

## **Thesis Introduction and Methodology**

### **1.1 Introduction**

### **1.2 Problem Statement**

### **1.3 Study Objectives**

### **1.4 Case Study**

### **1.5 Methodology**

### **1.6 Research tools**

### **1.7 Sources of Data**

### **1.8 Research Structure**

# Chapter One

## Thesis Introduction and Methodology

This chapter is going to provide an introduction to the subject. It will give a brief background; define the problem, focus and objectives. It will show the value of the study and clarify the followed methodology.

### 1.1 Introduction

Researchers have found that students' perception of the campus environment is related to academic accomplishment. Additionally, studies have found that the designed environment of the university can influence the degree of stress students may feel. (McFarland, 2007)

Thus, it becomes important to evaluate and investigate actual use of these open spaces, how and why they are used. Therefore, an opportunity exists to reveal and understand the interrelationship between physical patterns of open spaces and student's activity patterns within such spaces.

The research employs a methodology that combines direct field observations, mobile sensing and space syntax theory, in different open spaces in An Najah University Campus, to expose the activity patterns that relates with particular use of design features within the square.

Therefore, the value of this thesis is in studying the relationship between the activities and the physical settings of urban public spaces through using the proposed methodology. Analyzing this relationship will add insights into and complement the application of urban design theories and practice

which could lead to further studies to improve the existing open spaces design and provide data and guidelines to new campus area design.

## **1.2 Problem Statement**

As the literature review shows, there are few researches related to the relationship between university users' activities and the design of the campus, and mainly the open spaces features within campus. Some used surveys and observation, while others used software programs such as space syntax theory. This research aims to contribute to this literature by analyzing An Najah National University by using mobile sensing to produce activity maps and relate them with space syntax theory. This problem forms the main reason to clarify, evaluate and analyze the relationship between physical patterns and student's activity patterns within open spaces in campuses. . Therefore two questions would be answered through the paper: How do student's movement relate to the physical features of an open space? And how does the spatial design of the university campus affect student movement and interaction?

## **1.3 Study Objectives**

The main goal of this research is to investigate the relation between open spaces design in university campus and the students' circulation and activity. This goal will be achieved through the following objectives:

1. Identifying the design features of open spaces and characteristics that affect the movement patterns.



2. Studying the spatial organization of the university campus.
3. Evaluating open spaces in campus; whether it was efficiently used or not.
4. Producing guidelines to improve the existing open spaces design and provide guidelines to new campus area design.

#### **1.4 The Case Study**

In order to achieve the above stated objectives, An Najah National University New Campus in Nablus City will be used as a case study. Using the suggested methodology, a comparison between different squares and spaces within the campus will be conducted to achieve the results.

#### **1.5 Methodology**

The research is divided into three phases in work plan. Firstly, the literature and theoretical framework. Secondly, the data collection and management. Finally, Data analysis, results, conclusion and recommendations. And the following scientific methodological approaches will be used:

1. Descriptive Approach:

This approach will be used in describing the theoretical background and the literature review. In addition to the study importance and objectives.

2. Data Collection

Direct field observation using activity maps and mobile sensing to record student's movement and location within the selected case

study, in addition to preparing plans and maps of the university campus to be used in space syntax.

3. Analytical Approach:

Data analysis for the activity maps, the movement patterns drawn using mobile software and data from space syntax.

4. Comparative Approach:

The study presents a comparison between the different squares and spaces in the campus with different contexts, design, configuration and organization. This comparison will help in defining the advantages and disadvantages for each space to conclude the most suitable design guidelines for open space design and urban configuration in campuses.

## **1.6 Research tools:**

The research will be based on the following tools for gathering the needed information:

1. Photography:

The need for taking photos for some details will be exigent; “a picture is worth a thousand words”, pictures helps of better understanding the idea and enhance it. Pictures will be needed to show the overall design of the open spaces, landscape features and open space surroundings.

2. Observation:

The observation of students use and movement.

### 3. Mobile Sensing:

It will be used to produce maps that present students locations and movement within campus area. Number of students will be asked to download this app to contribute to this research.

### 4. Space Syntax Theories (DepthmapX software):

Software used to study the relationship between the built environment and physical activity. It would be used to study the spaces spatial configuration, parameters, accessibility, etc.

## **1.7 Sources of Data:**

The data and information in this study will rely on available sources of data, whether written or electronic, as follows:

- Libraries sources: all available references, books, these, articles, etc.
- Electronic & Internet sources.
- Information that will be collected by the researcher herself, to serve the research.

## **1.8 Research Structure**

This study includes the following chapters:

### Chapter 1: Introduction

This chapter gives background of the past studies about the subject of the research. In addition, research objectives are identified, as well as the importance of this study and the methodology used is clarified.

## Chapter 2: Literature Review

The literature review focused on the dimension of the space which influence student use and perception of the spaces within the campus. It included a brief definition of the urban space and its classification. It also discussed the morphological, the perceptual and visual and the social dimension of urban spaces. Finally, It concluded with the framework of the research.

## Chapter 3: Activity Maps and Mobile Sensing

This chapter discusses the activity maps produced from observation. The data collection procedure for conducting the maps and the mobile software used to detect students movements in the university. Finally the data are analyzed and discussed.

## Chapter 4: Space syntax Analysis

The chapter presents brief information about space syntax methodology and analysis. It also provides the reader with some information of the university campus, its land use and configuration. In addition, Depth Map X software is used to analyze the university campus using space syntax techniques. Axial map, Visibility graph and Isovist analysis are presented and discussed.

## Chapter 5: Correlation of space syntax analysis and Observations

This chapter provides comparison of the results from the different methods of analysis used. It present the correlation between the space syntax analysis and the activity maps produced from observation.

## Chapter 6: Conclusion and Recommendation

This chapter gives conclusions regarding open spaces design and configuration and its influence on students' activity. It also puts forward recommendations for university campuses design in general and open spaces and squares in particular.

# **Chapter Two**

## **Urban Space Background**

### **2.1 Defining open spaces**

### **2.2 Classification of urban spaces**

### **2.3 The dimensions of urban spaces**

#### **2.3.1 The morphological dimension**

#### **2.3.2 The perceptual and visual dimension**

#### **2.3.3 The social dimension**

### **2.4 Space syntax background, methods and techniques**

### **2.5 Related work**

### **2.6 Theoretical framework**

### **2.7 Conclusion**

## **Chapter Two**

### **Urban Space Background**

University campuses form a small community and can be treated as small districts of a city. Therefore this chapter will discuss urban spaces in general in the literature. A brief definition is presented; urban spaces classification and the dimensions that influence the use and perception of the space are mentioned. In addition, space syntax theory will be discussed; its elements and methods.

#### **2.1 Defining Public space**

Public space has been defined by different researchers. Carr et al.'s in their definition concentrate on the accessibility of the space, defining public space as “open, publicly accessible places” (Carr, Francis, Rivlin, & Stone, 1992),

Public space is an essential part of the public realm. The physical public realm means the sequence of spaces and settings that support or assists public life and social interaction. It is considered as places of formal and informal public life that have ‘physical’ (i.e. space) and ‘social’ (i.e. activity) dimensions. Carmona et al. in their book defined public space.

“Public space relates to all those parts of the built and natural environment where the public have free access. It encompasses: all the streets, squares and other rights of way, whether predominantly in residential, commercial or community/civic uses; the open spaces and parks; and the “public-

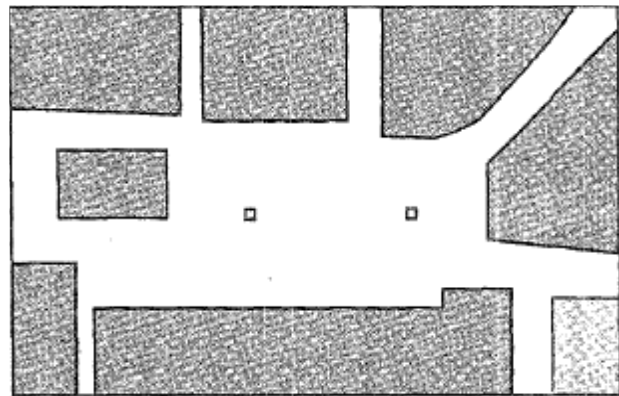
private” spaces where public access is unrestricted”. (Carmona, Heath, Oc, & Tiesdell, 2003)

These spaces are integral contexts that contribute for the society identity. They endorse sense of place, public life and people connection, therefore creating a sense of belongings. (Rasouli, 2013)

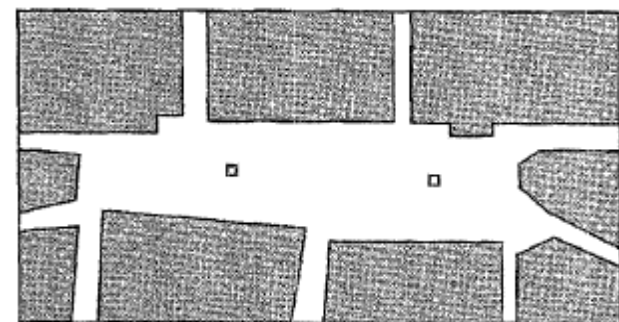
Since in this thesis our concern is the open spaces within university campus areas, our discussion would be on plazas and squares. Urban Plaza: “a mostly hard-surfaced, outdoor public space from which cars are excluded. Its main function is as a place for strolling, sitting, eating, and watching the world go by.” (Cooper & Francis, 1998)

## 2.2 Classification of urban spaces

Although urban spaces come in a variety of different sizes and shapes, there are two main types: 'streets' (roads, paths, avenues, lanes, boulevards, alleys, malls, etc.) and 'squares' (plazas, circuses, piazzas, places, courts, etc.). Streets are 'dynamic' spaces with a sense of movement, while squares are static spaces with less sense of movement. As figure (1) shows,



Ratio approx. 1:3



Ratio approx. 1:5

**Figure 1:** width to length ratio of urban spaces. (Carmona, Heath, Tiesdell, & Oc, 2003)



the Width-to-length ratios help to differentiate between the street and the square. Ratios on plan of greater than 1:3 start to imply dynamic movement as one axis starts to control. The width to length ratio of 1:5 suggests movement along the dominated axis. Ratios more than 1:5 suggests a street while ratios less than 1:3 suggests a square (Carmona, Heath, Oc, & Tiesdell, 2003). Rob krier also classified urban space into streets and squares. He argues that the geometrical characteristics of both are the same, and they are different by the wall that surround them, and by the function and circulation that occur within. (Krier, 1979)

### **2.3 The dimensions of urban space**

It is recognized that configuration of space, distribution of attraction and the physical settings, and social environment all have their importance in users behavior in the space. Thus this section will discuss each dimension its influence on users of the space.

#### **2.3.1 The morphological dimension.**

This dimension focuses on the layout and configuration of urban form and space.

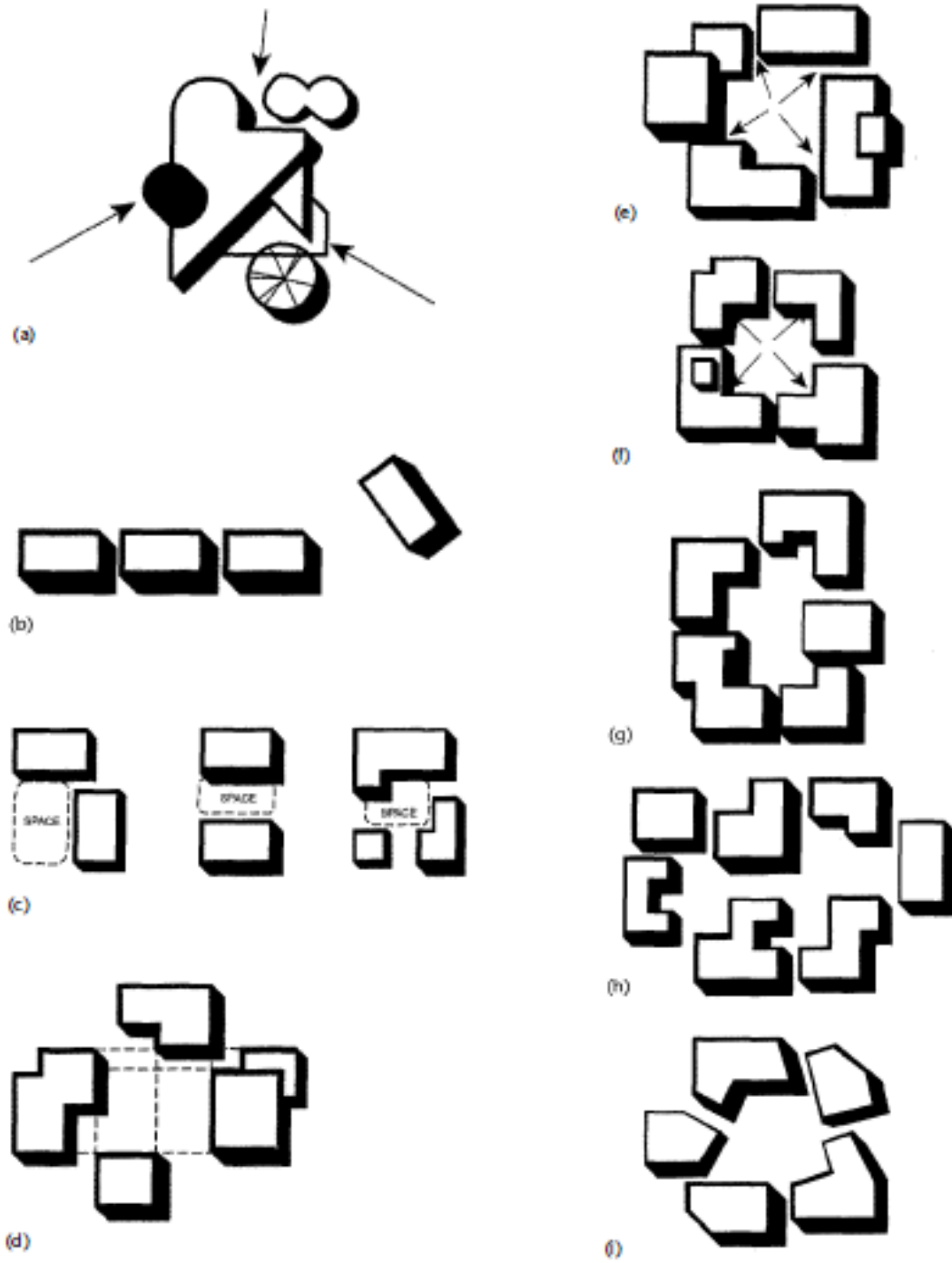
Sitte's (1989), Unwin (1909) and Zucker (1959) highlighted the concept of enclosure as a key factor for a successful urban space. Sitte illustrated that only enclosed spaces could provide the users a sense of well being, comfort and pleasure, thus preferring those spaces over other not enclosed ones. (Compos, 2000)

The amount of enclosure depends partly on the plan arrangement to create a sense of containment. Booth (1983) cited the quality of enclosure through a number of simple diagrams. (Carmona, Heath, Oc, & Tiesdell, 2003)

- a) A single building with a simple form does not define space (Figure 2a).
- b) When buildings are aligned in a long row, the weakest definition of space typically occurs (Figure 2b).
- c) Placing buildings at right angles to one another. (Figure 2c).
- d) Placing the building masses at varying angles to each other, to introduce a degree of variety into the layout. (Figure 2d)
- e) Arranging buildings and blocks around a central space could create a positive sense of enclosure. (Figure 2e).
- f) When the building walls form a right angled rectangle keeping the views within the central space, a stronger sense of enclosure is created (Figure 2f).
- g) If the whole space is visible, it does not invite for further experience. Having a complex perimeter and variations in buildings facades, would result in richer quality of space, with a number of hidden or partially concealed subspaces creating a sense of 'mystery' or 'intrigue' (Figure 2g). Sitte identify the property of "irregularity", which he defines as the interruption of the symmetry of surrounding buildings. He argues that irregularity is important since it can contribute to a 'picturesque' character and create a level of surprise

induced from the disrupted symmetry. Observers are faced with new and unexpected views as they move inside the urban square. (Compos, 2000)

- h) When creating subspaces, there is the fear of creating complex urban space where the subspaces compete the main spaces (Figure 2h).
- i) Another key factor in creating a strong sense of enclosure is the design of openings into the space. Booth (1983) refers to the 'windmill' or 'whirling' square, while Sitte (1889) refers to a 'turbine' plan: here, as the streets do not pass directly through the space, only one street at each corner of the square should be used and if more are needed they must be connected at different angles. This organization strengthens the enclosure of the spaces, and forces pedestrians entering to experience the space, since they are encouraged to walk through - rather than by - it (Figure 2i).



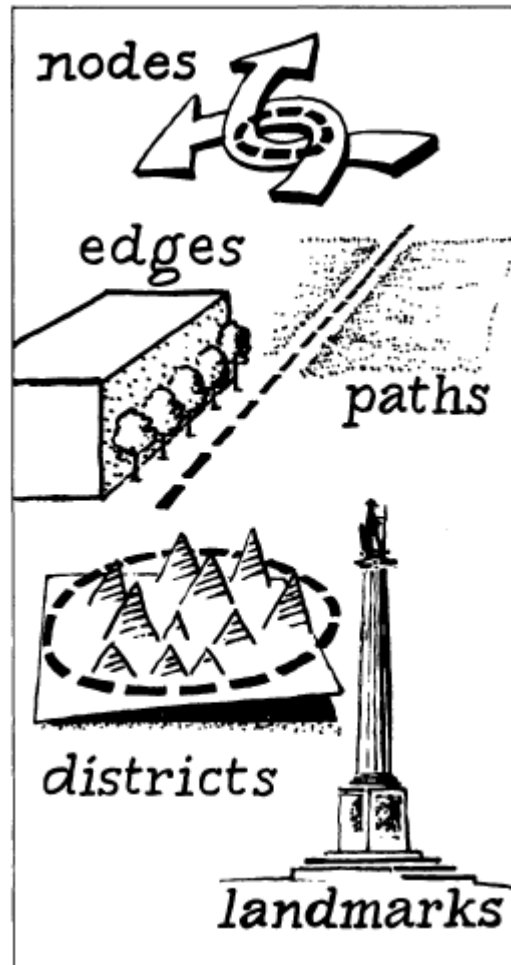
**Figure 2:** Principles of spatial enclosure. (Carmona, Heath, Oc, & Tiesdell, 2003)

### 2.3.2 Perceptual and Visual Dimension

Lynch and Rodwin (1958) believe that physical form of spaces have a significant effects on people's activities happening within them: "A city is the characteristic physical and social unit of civilization. It possesses size, density, grain, outline and pattern as the basic aspects of the city's physical form. The people who live in it shape these properties and are shaped by them". (Rasouli, 2013) In the image of the city, Lynch (1960) explored imageability in terms of physical qualities. He acknowledged five key physical elements – paths, edges, districts, nodes and landmarks – that contribute to configure the image of a city: "districts are structured with nodes, defined by edges, penetrated by paths, and sprinkled with landmarks...elements regularly overlap and pierce one another" (Lynch, 1960)

- Paths: are channels in which the user moves. Paths were often the main elements in people's image with the other elements such as special uses and features along paths.
- Nodes: lynch believed that nodes are point references. They may be intersections, or 'thematic concentrations' of a particular function or physical significance character.
- Landmarks: form the other types of point references. Some landmarks in terms of scale are significant and can be seen from a distance, and others are local. Lynch argued that a landmark's main physical characteristics are "singularity", and "spatial prominence".

- Edges: As linear elements, edges are paths when not used. They may be more or less penetrable boundaries, barrier or lines along which two area are connected and related together.
- Districts: Lynch identifies different areas of the city with particular and identifiable characters which each person is able to distinguish different districts from each other. They can have recognizable boundaries or the melt with the city form.



**Figure 3:** five physical images of Lynch. (Bently, Alcock, Murrain, & McGlynn, 1985)

Kaplan and Kaplan (1982) propose ‘coherence’, ‘legibility’, ‘complexity’ and ‘mystery’ as informal qualities of environments that show people choices for particular physical environment. For instant enjoyment of environments, understanding is supported by environmental ‘coherence’ (to make sense) and ‘complexity’ (‘to encourage involvement’). In the long term, qualities of ‘legibility’ and ‘mystery’ encourage exploration of the environment. See figure (4). (Carmona, Heath, Oc, & Tiesdell, 2003)

	MAKING SENSE	INVOLVEMENT
PRESENT OR IMMEDIATE	<p><b>COHERENCE</b> Environments easy to organise or structure.</p>	<p><b>COMPLEXITY</b> Environments with enough in the present scene to keep one occupied.</p>
FUTURE OR PROMISED	<p><b>LEGIBILITY</b> Environments suggesting they could be explored extensively without getting lost.</p>	<p><b>MYSTERY</b> Environments suggesting that, if they were explored further, new information could be acquired.</p>

**Figure 4:** Kaplan & Kaplan environmental preference framework. (Carmona, Heath, Oc, & Tiesdell, 2003)

### 2.3.3 The social and functional dimension

This section will focus on four researchers findings on the way people use and interact with urban spaces. These are (William H. Whyte, Jan Gehl, Alexander et al. and Bill Hillier)

#### 1) William H. Whyte (1980)

In his book “The Social Life of Small Urban Spaces” studied the social behavior in urban public spaces. According to him in order to achieve a successful urban space, a broad understanding of people activities on space is important. Whyte noted that the following features presented in the most sociable successful space:

- A good location. Whyte concludes that the relationship of a plaza to the street is “far and away the most critical design factor”. He suggests that it must be located on a busy road that is accessible both visually and physically. Whyte found that people tend to prefer places where other people are around. “what attracts people most, it would appear, is other people”

- Places to sit - both integrated in the main design as steps and ledges and other street furniture like benches and seats. “People tend to sit most where there are places to sit.” There must be a variety of choices to sit: sitting up front, in back, to the side, in the sun, in the shade, in groups and alone.
- Movable seats, enabling choice.

In terms of how people used the space, Whyte noticed that most people in public spaces prefer to stay in a corner of the space, for instance, near the steps or walls on the edges instead of the center of large open spaces. “What they rarely choose is the middle of a large place”. People prefer full view, with the rear is covered.

Much of what Whyte observed indicated that pedestrians will sometimes go through a certain degree of physical discomfort to fulfill their basic psychological needs.

## **2) Jan Gehl**

Jan Gehl has written about the patterns of pedestrian life in his book “Life between Buildings”. He divided outdoor activities in public spaces into three categories, as seen in figure (5), each has very different needs on the physical environment: necessary activities, optional activities, and social activities.

- Necessary activities include those that are necessary, for example, going to work, shopping or waiting for a bus or a person. Because these activities are mandatory, their presence is influenced slightly by the physical structure. These activities will occur all year round,



under all climatic or physical conditions, and are more or less independent of the exterior environment.

- Optional activities are those activities that are performed when there is a desire to do so and if time and place that encourage them. They include taking a leisurely walk, standing around observing people, or sitting and sunbathing. These activities happen when the exterior conditions are ideal. These activities are those considered when planning or research because they are dependent on the physical conditions.
- Social activities are the activities that depend on the existence of others in public spaces. Social activities include children playing, greetings and conversations, and finally seeing and hearing other people. These activities are a direct result of people moving about and being in the same spaces.

	Quality of the physical environment	
	Poor	Good
Necessary activities	●	●
Optional activities		
"Resultant activities" (Social activities)	●	●
	●	●
		●
		●

**Figure 5:** classification of activities according to Gehl. (Gehl, 2011)

Gehl's fundamental finding in public space design is that people attract each other: "If given the choice between walking on a deserted or a lively street, most people in most situations will choose the lively street. If the choice is between sitting in a private backyard or in a semiprivate front yard with a view of the street, people will often choose the front of the house where there is more to see'

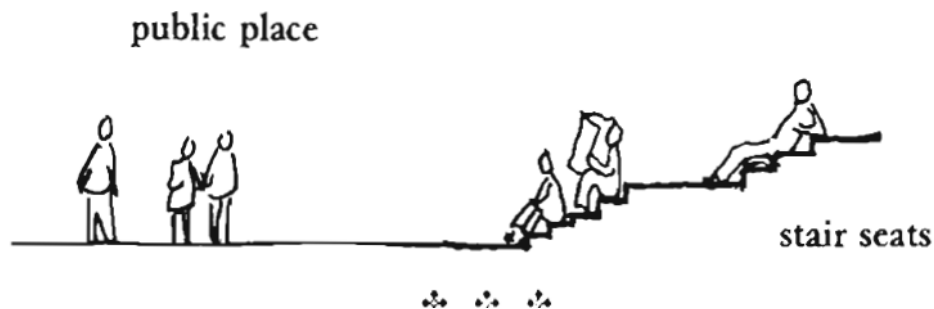
According to Gehl, the edge is the most preferred location for standing or sitting. People first occupy the borders and edges of the public spaces, and when they are fully occupied, do people tend to move to the middle. Gehl calls such a property the "edge effect". This phenomenon exists because people favor sitting in areas facing the pedestrian flow, thus the boundaries of the public space will provide the best views, with wider and richer visual fields. Gehl suggests that most used benches provide a good view of the surrounding activities, while those that have less view are used rarely used. Because human activities are the main magnetism for users of public spaces, he suggests that's shops and other attractors should be placed at the edges along the pedestrian flow routes, in order to improve the success of public spaces.

### **3) Alexander et al.**

In their book "A Pattern Language", they discussed people activities and behavior in spaces. They support the "edge effect" discussed earlier. They stated that because people enjoy looking at the pedestrian flow, the life of public spaces forms naturally around their

edges where people gather. Once they are full, the gradual occupation will naturally turn inwards.

Alexander et al. argues that the design of the edge is the most important element for producing a successful urban space. They stated that “If the edge fails, then the space never becomes lively . . . the space becomes a place to walk through, not a place to stop.”The edge can be treated to enhance the idea of people watching. They could be provided with formal and informal seating places. They also detected that the most inviting spots are those high enough to provide a vantage point, but low enough to be used. See figure (6).



**Figure 6:** the preferable places to sit according to Alexander et al. (Alexander, et al., 1977)

They also declare that a public space 'without a middle is quite likely to stay empty'. They recommend that between “the natural paths which cross a public square . . . choose something to stand roughly in the middle: a fountain, a tree, a statue, a clock-tower with seats, a windmill, a bandstand . . . Leave it exactly where it falls, between the paths; resist the impulse to put it exactly in the middle”.

#### 4) **Bill Hillier**

Hillier in his various researches studied the relationship between the spatial layout and pattern of use. In his theory of natural movement, he stated that the pattern of pedestrian movement in an urban system is primarily generated by the configuration of the urban grid, as the pedestrians likely to follow the shortest and most direct routes. Considering that both forms and density are homogenous and distributed in a grid like structure and given that people are moving from everywhere to everywhere, there will be a strong correlation between the integration values of axial lines of the urban grid and the pedestrian movement. (Hillier, Penn, Hanson, Grajewski, & Xu, 1993)

Hillier also claims that a successful urban square depends on the correct balance between static and moving people. He stated that the “strategic value” which is the sum of the integration values of all axial lines passing through the space, can predict the number of people choosing to stop and make use of the public space. (Compos, 2000)

Regarding preferred locations for static occupancy, it was suggested in the Broadgate study that good locations for unprogrammed use, defined as those uses that do not depend on the existence of specific attractions or facilities in the square, were found to be related to the intersections of integrating lines. They were not on the intersection itself but close to it. It was also concluded that static activities are opposite to movement activities. For people engaged in static activities, when they arrive at the

square by using the linear properties of space, the visual properties become more significant than the linear structure.

This can be measured by looking at the properties of the visually strategic isovist, where stationary people prefer areas with broad extensive isovists. (Hillier, Grajewski, Jones, Jianming, & Greene, 1990) (Compos, 2000)

The next section will discuss space syntax and Hillier theories in details.

## **2.4 Space syntax Background, Methods and Techniques**

Over the past two decades, space syntax has been proposed as a new computational language to describe spatial patterns of modern cities. Syntax principles support the belief that spatial layout or structure has great impact on human social activities. It is a theory proposed by Hillier and colleagues to study the relation between space configuration and social variables. These techniques allows for the representation, description, quantification and interpretation of the spatial configuration of settlements and buildings. (Jiang & Claramunt, 2002)

What space syntax measures is the relation of all segments to all others. It measures the to-movement which is the accessibility, potential, of each street segment with respect to all others. In other words, it measures the location potentials for various urban centers. On the other hand, space syntax measures the through-movement potential. It means that, it measures the streets with the highest potential of movement.

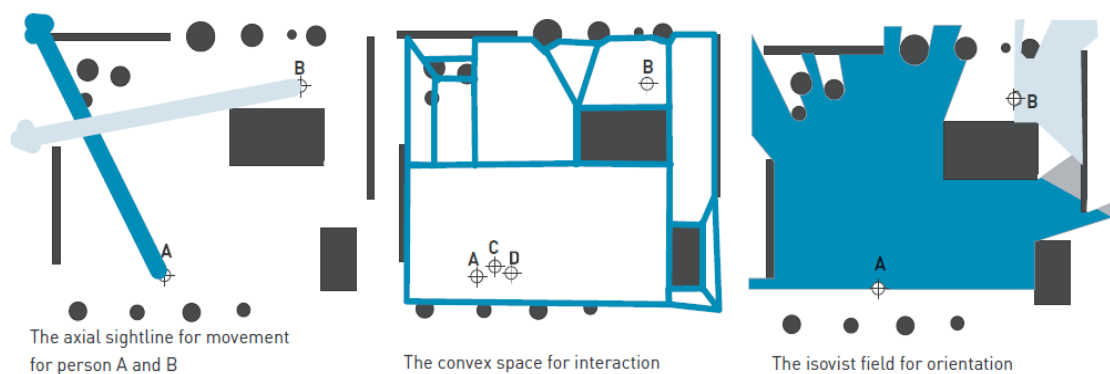
These two types of relational pattern can be represented by different definitions of distance. The metric distance measures the urban network as

a system of shortest paths, while the topological or syntactic distance measures the fewest turn's paths. Finally, the geometrical distance calculates the urban network as a system of least angle change paths. (VAN NES, 2011)

Configuration analysis characterizes the spatial properties of the urban layout with axial lines representing the one-dimensional organization, convex spaces, the two-dimensional organization, and convex isovists, each related to an aspect of how people experience the use of space.

Axial lines are used to represent directions of uninterrupted movement and visibility, so they represent the longest visibility lines in two-dimensional urban spaces. A set of axial lines, that mutually intersect and cover a whole free space, is called an axial map. According to Hillier's initial definition, an axial map constitutes the least number of longest axial lines.

Convex spaces are defined by polygons where no line drawn between any two points in the space goes outside the space. The convex isovist is a spatial description defined as the set of all points visible from within the selected convex space.



**Figure 7:** Example of axial lines, convex spaces and isovist fields. (VAN NES, 2011)

Axial lines are related with movement properties, while convex spaces describe where you are in the system. Hillier illustrates these properties very clearly in *Space is the machine*. (Hillier & Hanson, *The Social Logic of Space*, 1984)

“At the most elementary level, people move in lines... 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 is a mathematical definition of convexity in space... The more complex shape of the third figure defines all points in space, and therefore the potential people, that can be seen by any of the people in the convex space who can also see each other. We call this type of irregular, but well defined, shape a convex isovist” (Hillier B. , *Space is the Machine*, 2004)

Through the structural analysis of an urban environment, urban planners can derive a better understanding of the evolution of urban areas, and gain more insights to help with the design of new urban layouts. Using space syntax principles, human activity patterns in the city can be analyzed, mainly by considering the degree to which urban spaces are integrated and connected. The theory of natural movement asserts that the pattern of pedestrian movement in an urban system is primarily generated by the configuration of the urban grid, as the pedestrians tend to follow the shortest and most direct routes.

Space Syntax has been applied to different types of knowledge-sharing environments such as university campuses, research labs and design studios. These studies above all focus on configurational properties and

suggest that social and informational interaction are influenced by how a space is defined as well as by how that space relates to and is integrated with other spaces. (Heitor, Tomé, Dimas, & Silva, 2007)

### **2.5.1 The One-Dimensional Visibility Analysis**

The axial map is the most important for the space syntax method in urban studies. The street and road network in built environments is represented with the longest and fewest sight lines. (Hillier & Hanson, *The Social Logic of Space*, 1984). In axial representations, depth is identified as the change in direction between one axial line and another. Depth is topological; it means that, it has no geometric value. (Al\_Sayed, Turner, Hillier, Penn, & Iida, 2014). The measure of integration can be used from different levels. Radius-n ( $R_n$ ) or global integration measures the relative depth of each axial line to all other lines of the system. The fewer the direction changes, the higher spatial integration values - the shallowest - in the system. On the contrary, streets with many direction changes to all others have low integration values – the deepest – in the system. (Hillier & Hanson, *The Social Logic of Space*, 1984). In other words, the degree of integration measures the degree of accessibility which is the degree which a line is presented on the fewest changes of direction of each axial line from all the others in the system. (Campos M., 2000)

The local integration analysis emphasizes the various local urban centers. It could be measured with different radiuses, but the most common one is Radius 3 ( $R_3$ ). It is calculated the same as the global integration but when



changing direction three times from an axis. The DepthmapX software calculates this for every axis in the whole built environment. (VAN NES, 2011). Integration is usually indicative to how many people are likely to be in a space, and is thought to correspond to rates of social encounter and retail activities (Hiller, 1996).

Three more main topological measures can explain structural properties of a spatial graph. The measures are used to compute the configurational properties of a layout. Firstly, Connectivity measures the number of immediate neighbors that are directly connected to a space, which is the most local of any syntactic property of a line. Secondly, Control measures the degree to which a space controls access to its immediate neighbors taking into account the number of alternative connections that each of these neighbors has. Control is useful for high-lighting areas where observers can have a large view of the spatial layout. Thirdly, Choice measures movement flows through spaces. (Al\_Sayed, Turner, Hillier, Penn, & Iida, 2014). Spaces that record high global choice are located on the shortest paths from all origins to all destinations. Choice is a powerful measure at forecasting pedestrian and vehicular movement.

In simple words if one compares choice and integration, integration measures how easy is it to access one line to all other lines of the network system, thus indicating the potential of a line for to-movement. In contrast, choice measures the probability for a line to be chosen on paths from one line to another in the network system indicating its potential for through-movement. What is referred here in to-movements people want to

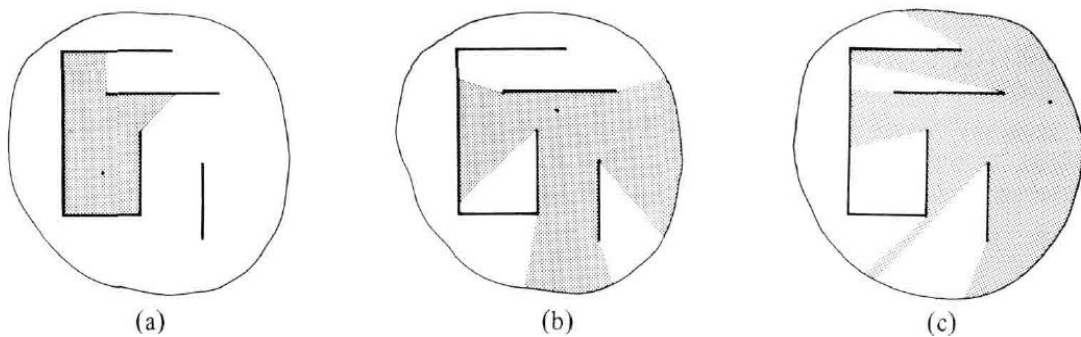
maximize their accessibility to all spaces and in through-movements, the aim is the destination and how to reach it in minimum efforts. (Alobaydi & Rashid, 2015)

Other syntactic measures can be derived from the correlation between the previous measures. Intelligibility for example is a descriptive measure of whole systems which is the correlation coefficient between connectivity and integration. It helps identifying how easy it is for one in a local position to comprehend the global structure. (Hillier B. , Space is the Machine, 2004). The mathematical expression was initially calculated by the degree of linear correlation between connectivity and a global integration value of axial lines (Hillier and Hanson, 1984) graphically illustrated in the "intelligibility scattergram" (Hillier B. , Specifically Architectural Theory, 1993). However, past research has suggested that radius-3 is a better local measure compared to connectivity for the prediction of pedestrian movement. Therefore, the mathematical expression for intelligibility in this thesis is defined as the degree of correlation between local (radius-3) and global (radius-n) integration values of axial lines. Like integration, intelligibility is a very important measure, because in an intelligent system, the information we get in the local parts can give us a clear understanding of the whole system. (Compos, 2000)

### **2.5.2 Two Dimensional analysis**

On a neighbourhood level several tools exist for taking two-dimensional spatial aspects into account. An isovist analysis is one of the methods.

According to Benedikt, an isovist is: “the set of all points visible from a given vantage point in space and with respect to an environment” (Benedikt M. L., 1979). It visualizes the overall view from a particular standing point in a built environment. The view’s borders are defined by walls and free standing objects such as trees, bushes and statues located inside a built environment. When moving around in built environments, the shape and size of the isovist change. (VAN NES, 2011)



**Figure 8:** isovist fields from different points. (Benedikt M. L., 1979)

The isovist analysis are useful for analyzing the degree of visibility of the location of important urban landmarks, and how new urban interventions will increase or decrease existing isovists’ views. In addition, isovists analysis is useful in studies on how trees and vegetation can block the degree of inter-visibility in parks. (Zhai & Baran, 2013). It can identify places of security guards or cameras for a maximum view. (Batty, 2001). It also visualizes the spatial possibilities from where one can get a maximum view of an urban square. (Campos & Golka, Public spaces revisited: a study of the relationship between patterns of stationary activity and visual fields, 2005)

In this paper, geometric measures of Benedikt: area, perimeter, occlusivity, and compactness are used in the analysis. The isovist size measures, such as area and perimeter, approximate the possible amount of information available at the point of isovist (how much and how far one can see) as well as the possible audience size or exposure of a person at the point location. Therefore one would expect that privacy-related path and location choice, and the definition of public and private spaces will pay much attention to the area and perimeter fields. (Benedikt & Davis, 1979) Occlusivity is the proportion of the perimeter on the solid boundary of the environment, while Compactness shows how close the isovists are to a convex space. It ranges from 0 to 1, where 1 is the most compact shape of the circle. Compactness index shows how enclosed the viewer feels in the environment and is affected by the area seen. (Alalhesabi, Hosseini, & Nassabi, 2012)

Another tool for the two dimensional analysis is the visibility graph. (Turner, Doxa, O'Sullivan, & Penn, 2001) Constructed an undirected graph connecting all the inter-visible points in a human-scale grid. The product of this representation is a visibility graph where each point is notated as a node and inter-visibility is the condition for linking one node to the other. (Al\_Sayed, Turner, Hillier, Penn, & Iida, 2014). Clustering coefficient is one of the measures that can be calculated using Depthmap X software. It is derived from the local configurations of each node and calculates the degree to which nodes that are visible from one location are themselves inter-visible. Clustering coefficient is indicative to how much one loses in

terms of visual information when moving from one location to another. (Turner, Doxa, O'Sullivan, & Penn, 2001). In isovist terms this is equivalent to finding the mean area of intersection between the generating isovist and all the isovists visible from it, as a proportion of the area of the generating isovist.

Isovists that are closer to convex hold high clustering coefficient, thus little visual information is lost when moving from one location to another. On the contrary, spiky ones correspond to low clustering coefficient; thus more visual information is lost. Understanding these properties is fundamental. Because movement involves making decisions about destination and the parts of current visual information to leave behind. Thus, the clustering coefficient is potentially related to the decision making process in way-finding and navigation and certainly marks out key decision points within complex configurations. Another measure calculated by the software is control which calculates the area of the current neighborhood with respect to the total area of the immediately adjoining neighborhood. Control is useful for high-lighting areas where observers can have a large view of the spatial layout.

(Turner, Doxa, O'Sullivan, & Penn, 2001)

As research has shown, the degree of visibility of urban spaces affects the way users behave in these spaces. The higher the inter-visibility, the more it generates a mix of people of different social classes, genders, races and ages in public spaces. In addition, the pattern of pedestrian movement in an urban system is primarily generated by the configuration of the urban grid,

as the pedestrians tend to follow the shortest and most direct routes. In the following sections the axial map, visibility graph and isovists fields are analyzed to test these relations.

## **2.5 Related work**

In this research, several literatures were used, mainly papers discussing open space qualities and characteristics, in addition to people's use and perception of these spaces. Papers are divided into two groups. The first group deals with open spaces, their design, how it affects users' interaction within these spaces and how to study this relationship. The second group which consists most of the papers reviewed, deals with campus configuration and student perception of these spaces, which is the main focus of the study.

Campos & Golka Investigates the relationship between visual fields and patterns of stationary activity in several London public spaces. To meet this objective, visibility graph analysis, overlapping point isovists, and convex isovists methodologies were used. Correlation between the static activity patterns and visual fields showed that stationary activity is more likely to happen in relatively segregated spaces offset from the main access points. Also it shows that people selected more secluded areas compared to the exposed ones for informal static activities. (Campos & Golka, 2005)

Koohsariabc et al. briefly introduce the principles of space syntax and describe how space syntax can study the relationship between the built

environment and physical activity research on parks and public open spaces.

The study concludes that the methods and principles of space syntax offer several advantages to researchers studying the spatial properties of urban spaces. Nevertheless, it has some limitations. For example, it doesn't take into account land use and it deals with street configuration. (Koohsariabc, Kaczynskid, McCormack, & Sugiyama, 2014)

The second group deals with university campuses and open spaces within them. Different methodologies had been used. Aydin & Ten paper studied the qualities of a campus plaza, in the Selcuk University located in Konya, Turkey using: survey, observation and photographic methods to examine the benefits of the plaza as an outdoor space. Students were asked about the plaza, its qualities, their purposes and the frequency of plaza use, in addition to analyzing the plaza's quality and the relationship between users perception of space and landscape accessory. The study showed that two main components determining the campus plaza's quality were found: the first is qualities of the physical environment (climatic features, location of plaza, its relation with the surrounding structuring, pedestrian / vehicle relation in terms of accessibility, etc.). The second is user characteristics which are the behavioral and functional quality and the visual quality. Finally the study emphasizes that the presence of high quality outdoor spaces in the campus is important for increasing the users' satisfaction and facilitating optional, social activities outside the class hours. (Aydin & Ter, 2008)

The rest of studies used space syntax theory as a methodology for studying university campuses in addition to surveys, land use and observation. In analyzing socio-spatial construction of universities two aspects of the public life of the university were presented: Firstly, the relationship of the campus with its surrounding was analyzed through the questionnaire conducted with the students and the syntax analysis of the campus including its environment. Secondly, the results of the morphological analysis of the university focusing on the role of spatial configuration of the campus for students' interaction were put together with the observations of outdoor activities and the questionnaire. The syntax and land use analysis of campus showed that the spatial configuration of campus create zones in the campus working as self-sufficient settings and these are integrated with long axial lines, that make the campus car dependent. Also, observation of student life showed that students prefer to go for local restaurants and pubs in the district next to the campus. In the survey, students stated that 'Proximity to their classes and work environment' physical comfort and characteristics' and 'possibility of social interaction' were the reasons for students to prefer specific public spaces in the campus. ( Yaylalı-Yıldız, Çil, Can, & Kılıç-Çalğıcı, 2013). In investigating reasons of isolation in clustered departments from the campus, Nunes compares between the results of spatial analyses of the campus with the results of interviews with the students to understand the influence of spatial configuration for segregation. The study show, although majority of the students evaluated open green places of the



campus positively, they are underutilized in reality. Nunes indicates that this is due to the morphological problems in the planning of the campus that forces the use of vehicles instead of walking. Long distances between the spaces where many activities evolve, large free areas between buildings make, not only the green areas, but also, using open spaces for public activities difficult. ( Nunes, 2007)

Various studies also used comparison to evaluate university campuses and their public space. Kim studies the vitality of central plazas of two campuses, by examining the topological meaning of the plazas in each campus and its characteristics and the role of spatial configuration of these plazas in the movement patterns of students. This study follows the space syntax theory in order to analyze the plazas at the university and to find the relationship between a spatial configuration and a socio-cultural element in a place. In addition, the analyses are compared with the results of a questionnaire of student's movement patterns from their residence to their first class. The study argues that the difference of experienced vitality in the plaza of each campus is derived from the difference in the organization of the spaces. In addition to the plazas' different levels of integration; number of people using the plazas regularly and the different events developing in and around them are defined as the other reasons of difference in spaces' vitality. Although the study analyzes movement patterns of people to measure vitality in the plazas, it does not describe the kind of practices that produces liveliness in these urban squares or what the elements of vitality can be. (Kim, 2009) Another study compares the socio-

spatial analysis of four university campuses in Santiago de Chile in the transmission of knowledge. In Greene & Penn paper, the subject was investigated from three perspectives: spatial structure, observations of patterns of use and movement in the open space and reported social interaction. It presents that the more integrated the academic units, the more interaction between academics students occur, and the higher their frequency of contact with the students and academics of other academic units. (Greene & Penn., 1997)

Finally, Schwander, Kohlert and Aras try to put a benchmarking system for university campuses by comparing the design of two new campuses in the university Hamm Lippstadt.. This article focuses on the spatial configuration of two different campuses of new universities that are built with an interconnected university model with the intention to foster meetings and informal communication of people. The study shows that the two campuses perform very differently in terms of spatial indicators although they are developed on the same design brief. At the macro scale, the study explores to what extent the campus is integrated into the urban fabric and has the potential for exchange with the local economy. At the micro scale it assess, if the internal spatial structure of the campus contributes to the objective of knowledge exchange across departments. For the micro-scale three analysis methods was employed: Topological network analysis, visibility graph analysis and agent analysis. The two different campus concepts result in a different user pattern: A relatively wide courtyard with large landscaping features and distributed entrances in

the case of Hamm results in spread out movement over the entire campus. A compact courtyard with smaller landscaping features and centralized entrances leads to a concentrated movement pattern. However, this study lacks the analysis in the operational phase which could make the result different. (SCHWANDER, KOHLERT, & ARAS, 2012)

These studies address how the spatial organization of a university campus influences the use of open spaces that have the potential to influence different types of interactions among people.

These researches investigate the relation between spaces and changing movement patterns by quantitative methods. In this thesis, besides using space syntax theory, a mobile software app will be used to produce plans and maps for activity and students movements and location, to give more accurate results in addition to the survey and observation.

A rethinking on what kind of public practices are experienced in open spaces which have different physical and spatial characteristics may help us better understand the role of campus layout and its relation to different dimensions of a vivid public life.

## **2.6 Theoretical Framework**

Based on the previous studies, the optional activities will be studied, because according to Gehl these activities are influenced by the physical settings of the space. Those activities are divided into active and passive activities that will be studied later on the thesis.

In terms of the physical and morphological dimension of the space, several criteria will be studied to relate the activities to the different settings. These are the spatial configuration of the campus, the location of the space within campus, its connectivity to the surroundings and the dimension of the space "enclosure or compactness" which will be studied using space syntax. Other qualities are the existence of seating place and landmarks, the treatment of the edges, and the natural elements. Observation and activity maps are used to study these properties. Also, the study aimed to incorporate enclosed spaces and highly open ones with extensive visual connection with the surroundings.

## **2.7 Conclusion**

This chapter discussed the literature review of the connection between urban spaces and users behavior. It included several factors that influence people use of the space and founded the foundation of the research to study these elements. It also discussed the space syntax theories and related work that were the influence of this research. The following chapter will include the observation and activity maps study.

## **Chapter Three**

### **Activity Maps and Mobile Sensing**

#### **3.1 About Observation**

#### **3.2 About the University**

#### **3.3 Campus layout and land use**

#### **3.4 Data Collection Procedure for activity maps**

#### **3.5 Data Collection Procedure for mobile experiment**

#### **3.6 About the five selected spaces**

##### **3.6.1 The white square**

##### **3.6.2 The sciences square**

##### **3.6.3 The fine art square**

##### **3.6.4 The medical colleges' space**

##### **3.6.5 The engineering square**

#### **3.7 Observation Results**

## **Chapter Three**

### **Activity Maps and Mobile Sensing**

In this section, a brief description about the university is presented. Activity maps are discussed. Moreover, the data collection procedures are explained and the observation results are stated and analyzed.

#### **3.1 About Observation**

As the Project for Public Space (PPS, 1999, p.51) advise: “When you observe a space you learn about how it is actually used, rather than how you think it is used.” (Carmona, Heath, Tiesdell, & Oc, 2003)

We observe in order to see how much we can learn about the environment without taking account of people’s intentions. People when asked about destinations, they state why they are going, not how they plan to get there, or what intentions they have in the way to get there . Observations allow regaining something that might be considered as an objective view of human behavior in the built environment. However, in doing observations, some precautions measures should be taken especially when an observer is regarded as a participant in a social study in a specific spatial scene.

Usually, static snapshots are conducted to record the use pattern of spaces within buildings or public spaces in an urban context. The method is useful for comparing static activities (standing, sitting) and movement. By tracking and mapping these activities in time we may outline the patterns of space use in an area and spot the locations where more potential interaction

takes place naturally. In general, snapshots might be comparable to a photograph taken from above showing one moment of activities mapped onto the floor plan.

To conduct snapshots, areas that can be easily observed are predefined and positions at which an observer could maximize visual exposure to the observed field of study and at the same time minimize his/her own visibility to the users. A floor plan is used to note categories and activities (sitting, standing, moving, and interacting) for a period of time over regular intervals during the day. (Al\_Sayed, Turner, Hillier, Penn, & Iida, 2014)

### **3.2 About the University**

An Najah National University was first established in Nablus as a primary school in 1918, and it continued its development until it was chartered as a full-fledged university in 1977. It is now considered the largest in Palestine accommodating more than 22,000 students within the four campuses: The New Campus, the Old Campus, Hisham Hijjawi College of Technology and Khadouri Campus in Tulkarem. It is comprised of 13 faculties distributed in its four campuses. The New Campus is selected as a case study to understand the Physical role of campus for the students' activity.

With a total area of 120 km<sup>2</sup>, the New Campus houses the Faculties of Graduate Studies, Medicine, Science, Law, Fine Arts, Engineering and Information Technology, Optometry, Pharmacy, Nursing, Media and Physical Education. Besides its educational facilities, it is also home to the Prince Turki Bin Abdul Aziz Theatre, the Hikmat Al-Masri Amphitheater,

the Korean-Palestinian IT Institute of Excellence as well as a number of other facilities and laboratories. The New Campus features a library, a media center, a new swimming pool, a sports complex and a mosque. (An Najah University, 2016)

### **3.3 Campus Layout and Land Use**

The New Campus is made up of a range of discrete buildings and building complexes in a relatively open landscape of paths, gardens and carparks. There can be seen a great proportion of corridor spaces articulating court-spaces of different sizes. Three main squares can be from the map of the campus; the largest being the white square, the square between the science and engineering college and the amphitheater. In addition to small open spaces between buildings and colleges.

### **3.4 Data Collection Procedure**

One of the steps in data collection and management procedure of this study is the field data collection. The method used in this methodology approach include direct field observation through photographing and walking through the space creating activity maps, to establish a database of activities related to the physical settings of the University Campus.

Direct observations as a qualitative data collection method are used to record activities and physical aspects of a site without interviewing people and recording responses to questions (Rasouli, M.2013). In addition, direct observations are useful when direct information is wanted and/or when one



is trying to understand the relationship between individuals' activities and the built environment in which they are located.

Prior to the field data collection, an initial observation was conducted to identify areas of activities within the space. On this basis, The University Campus was divided into five main areas, neglecting areas with less activities, and open spaces that are within college's boundaries. The areas are: a) the main square (White Square), b) Science and Engineering square, c) the open area between Fine art and Graduate Study College, d) the open space in front of the medical colleges, and e) the open space in front of the Engineering College. Thus, each session of observation covered every part of these spaces while avoiding overlaps as illustrated in Figure (9).



**Figure 9:** Parts of the University Campus for Field Observation. (GIS map modified by author)

The data collection of the Campus involved several observation sessions on several days in the months of March, April and May 2016. These months was chosen because the weather is warm to neglect weather change. Observation sessions were from 12 to 1 pm during the break time in the Campus, to record different activity types.

All of the areas of the campus were observed during this period. The method for recording peoples' activity within the space includes direct observation by using photography and by walking through the space to create the activity maps. As there are five areas, and the break lasts for an hour, there was an opportunity to scan each area for almost 10 to 15 min.

Walking through each zone with a paper map of the area while taking photos, allows each individual's activity to be recorded on a map. These maps were used as supportive information in the data collection accompanied by required information such as activity type and activity location. Each session of observation and data collection returned a pattern of activity during one day and thus reveals the common location for particular activities that are often chosen by students. Therefore, the activity maps will show the frequency and variety of the activities in each observation session.

Thus, collecting data required defined typologies for each activity as well as for the physical design features. Prior to starting the data collection, typologies were determined for each required data element including activity location and design features. Each observation was classified

according to the activity typology represented in Table 1. The activity classes in this table were based on the literature review of public spaces.

**Table 1: activity types**

Activity Level	Activity Type
<b>Active</b>	Walking around
	Moving from a place to another
<b>Passive</b>	Standing
	Sitting

In terms of passive activities, students tend to sit alone or with a friend. Some students prefer to stand along walkways and talk with a friend or stand along edge walls and watch their surroundings. Active uses range from leisurely walks, with a friend or walking to reach a distance.

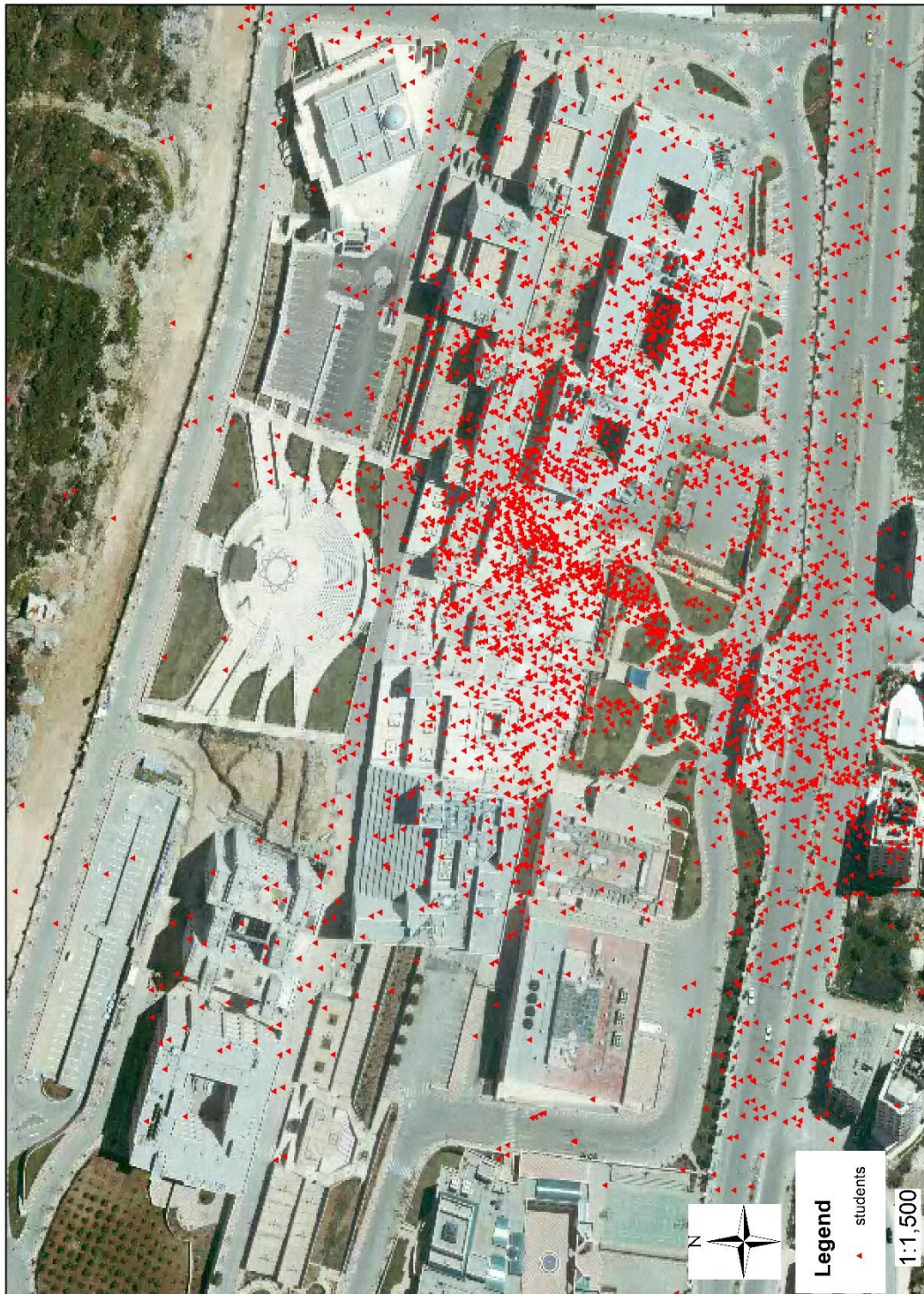
Four main categories were considered for existing physical design features within the space. The spaces within the campus feature two of Lynch's (1960) five physical elements, namely edges and landmarks. The edges are designed as sitting area where students choose to sit on the edges of the walls surrounding the space or the steps of an existing stair. In addition to edges and landmarks, urban furniture such as benches and shades distributed throughout the space were considered key design features. Natural features, specifically grass spaces and some trees, were the field design feature.

### **3.5 Data collection procedure for the mobile experiment**

Dr. Ihab Hijazi produced a software application, which could be used to monitor students' movement within the university campus. Students were asked to download the application on their android system mobiles, and use

it as long as they are at the campus. Data were collected in November 2015 for the whole month period. Then a map was produced using GIS to spot students movements within campus. The total number of students who downloaded the application was 40, which was not sufficient to provide accurate results. However, it helped to give a general view of the campus usage, and the spaces students' use the most. Security issues might reason this; most students did not like the idea of being monitored, even if it is within campus. Figure (10) shows the campus with the dots, which represents students. The map shows that the students gather in the east part of campus, mostly in the white square, while some are in the engineering and sciences square. The reason why the west part has almost no students shown, is that most of the students who downloaded the application were from engineering and sciences colleges, because of the above reason.





**Figure 10:** university campus showing students movement using GIS and mobile application.

### **3.6 About the five selected spaces**

This section discusses the five selected spaces for study, their dimensions, physical features and nature.

#### **3.6.1 The white square**

It is the main square within campus; it has somehow a central position. It is almost 90 meters long in 40 meters wide, surrounded by building from the west and east side by faculties and facilities while the north and south parts are open. As seen from figure (11), it is bounded by the Engineering and the sciences colleges from the east. While the library and Prince Turki Ebn Abd Al aziz theatre lies on the west side. Buildings surrounding the square are two and three stories high, giving a feel of openness and disclosure. The north stairs connected to it leads to the main cafeteria on the first terrace and other terraces that house different facilities such as the student union council.

In terms of its physical features, it has a white stone flooring, some benches and shading devices.





**Figure 11:** The white square.

### 3.6.2 The sciences square

It's on the east side of the campus. It is mainly two connected squares with the same size almost 40 meters by 25 meters. The west square is surrounded by the engineering and the sciences colleges -which are three storeys high-except the paths that leads to it, adding a strong sense of enclosure and privacy. While the north square is bounded by the sciences college from the east and south, leaving the north and west open, and its connected from the west with the main cafeteria. Figure (12) shows the square and its surroundings.

The flooring is covered with brown coursed stones. Moreover, the squares are planted with some palm trees, and a small pond exists on the north square.



**Figure 12:** The sciences square

### **3.6.3 The fine art square**

The fine art square lies on the west part of campus. As figure (13) shows, it is mainly a parking space surrounded by the library from the east and the fine art college from the south. It is connected with the medical colleges through the stairs that leads to different terraces. There are a few trees planted on the sidewalk with a few benches that are distributed there.

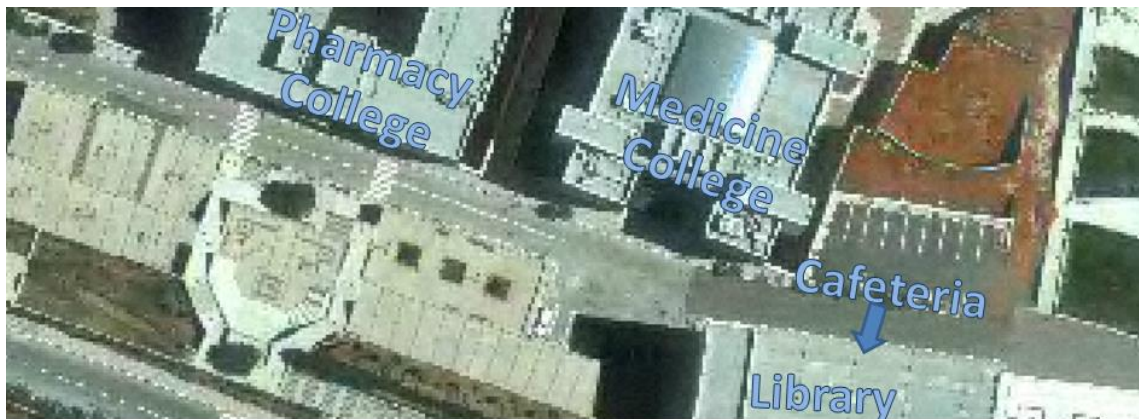




**Figure 13:** the fine art square.

### 3.6.4 The medical colleges space

This space is mainly a street or a path rather than a square, with two parking spaces as shown in figure (14). It is bounded by the medicine and pharmacy colleges from the north and the stairs and terraces from the south. The buildings are four storeys high which gives a strong feeling of enclosure and compactness. In addition a small cafeteria and a mini-market exist. It has some trees planted on the terraces and on the sidewalks of the street. Benches and chairs are almost along the whole path, with one or two on the terraces.



**Figure 14:** the medical college's space.

### 3.6.5 The engineering square

This square is also mainly a parking space with few green areas around. It is bounded by the engineering college from north and a retaining wall from the west. And it is partially closed from the south because of the level differences. Thus it has a medium level of enclosure. There are some benches on the sidewalk with some trees planted in between. Shown in figure (15).

### 3.7 Observation Results

After describing University campus and the spaces studied, this section is based on the data collection described earlier. It includes the observation results, data analysis and findings with particular reference to the



**Figure 15:** Photos of the path in front of the medical colleges.

relationships among people's activity type, use of design features and

activity locations. Particular attention was paid to the use of the design features and activity locations and how design elements affect the activities of the people. Understanding these relationships required determining the common patterns of use, similarities, differences and expectations of use through observation period by analyzing the collected data.

During the three observation sessions of the University Campus there were noticeable mix of students within the open spaces of the campus and variety of activities occurring. There were a large number of students meeting with friends for a coffee, lunch or an after class meeting. Students were out, walking and socializing. Some were sitting while others were enjoying on a leisurely walk. Activities' types and location were recorded on paper activity maps.

Regarding the use of design features, students were sitting on benches where available. Stairs were the second design feature choice that students preferred to use for sitting. Grass spaces were among the other popular sitting areas as well as edges. During all of the observing times, benches, edges and stairs were among the most popular sitting choices.

During the first observation day, Thursday 24th, March 2016, the weather was warm so it offered a nice atmosphere for different activities. Students didn't really sit in shaded areas, on the contrary many were sitting under the sun. With regard to the activity level and activity type, Activities ranged between active to passive activities during the observation time. Some students were sitting and enjoying the nice environment of the space. Others were standing either discussing a subject with friends, or on edges

just watching. There were also a number of students walking around with friends.

The majority of students were in the main square (White Square). Many were sitting on the benches available under the shades; some were setting on the ledges while others were sitting on the stairs steps since the numbers of benches are few. Some students were walking around or standing with friends. In addition, few were standing on the edges watching the surroundings and enjoying the nice weather. Figure (16) shows the students using the space, and the design features used.



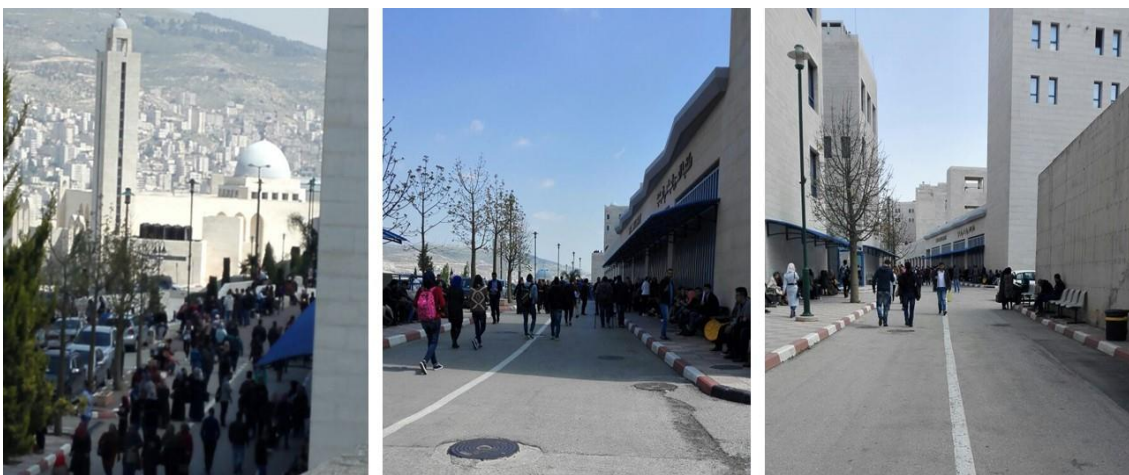
**Figure 16:** photos of students' activities in the White Square

The second busiest space in campus was the path in front of the medical colleges. Students were sitting on the chairs in the two sides of the path under the shades. Some were standing talking with friends. The majority were walking around studying or enjoying time with friends. Figure (17) shows a number of photos of the space.



The square between the Engineering and sciences colleges have moderate number of students using it. Approximately most students were engaged in passive activities during the time of observation. In other words they were mostly sitting and enjoying the nice and calm environment of the space. They were sitting on benches available around the small fountain or water feature available, and on edges of the surrounding walls. Few were walking to reach a distance, not a leisurely walk. Figure (18) shows number of the activities taking place on the area.

The two remaining spaces were not crowded with students as they are parking spaces with few benches and planting areas. Mostly students were sitting on the benches available under the shades of the trees, walls edges and on the green areas available. Some were standing or walking with a friend.





**Figure 17:** Students activities in the square of Engineering and Sciences.

The 21st of April 2016 was assigned to be the second observation day. The



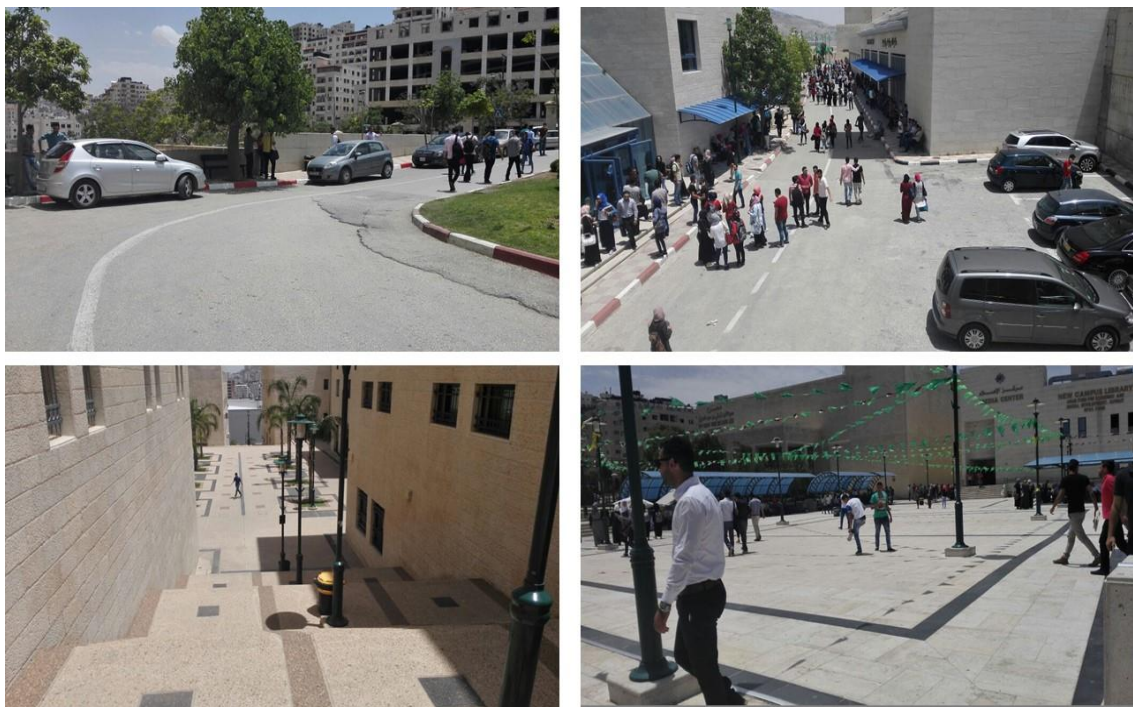
**Figure 18:** Students in the area in front of the Engineering and the Graduate Study colleges.



weather was warmer, therefore the total number of students using the outdoor spaces were less. However activities were almost the same, students were sitting with friends, others were walking, and some were standing watching and enjoying the atmosphere. With less students setting under the direct sun light.

The last day of observation was on Thursday the 26th of May. This session was the least populated day; it could be reasoned by the hot weather and direct sun light. Most of activities were passive including sitting alone or with friends under shades.

Students gathering were mostly in the main white square and the path in front of medical colleges. The square between the Engineering and Science Colleges was almost empty. Other areas occupied a few number of students either sitting on benches under the shades or walking to reach a certain distance. Figure (20) illustrate photos of the areas showing students activities.



**Figure 19:** Students activities on may 26th 2016

According to the collected data, with regard to the time, March 24th was the most populated day, and may 26th was the least. Regarding the areas, the main square and the path of the medical colleges were the most used spaces. Activities ranged from sitting, standing and walking alone or with friends.

The following maps illustrate how activities vary by activity type during the observation sessions and the use of design features (Figure 21-25).

This table summarizes the features and whether they exist or not and the level of use.

**Table 2: Summary of design features**

	White Square	Sciences Square	Engineering Square	Fine art Square	Medical Colleges route
<b>Edges</b>	Exists but are few	stairs are present and edges on the terrace	Few	Yes	No
<b>Seating places</b>	Few benches	Very few	Very few	Very few	yes
<b>Landmarks</b>	No landmark	No	No	No	No
<b>Natural features</b>	No	Some trees and a small fountain	Few trees	Few trees	No



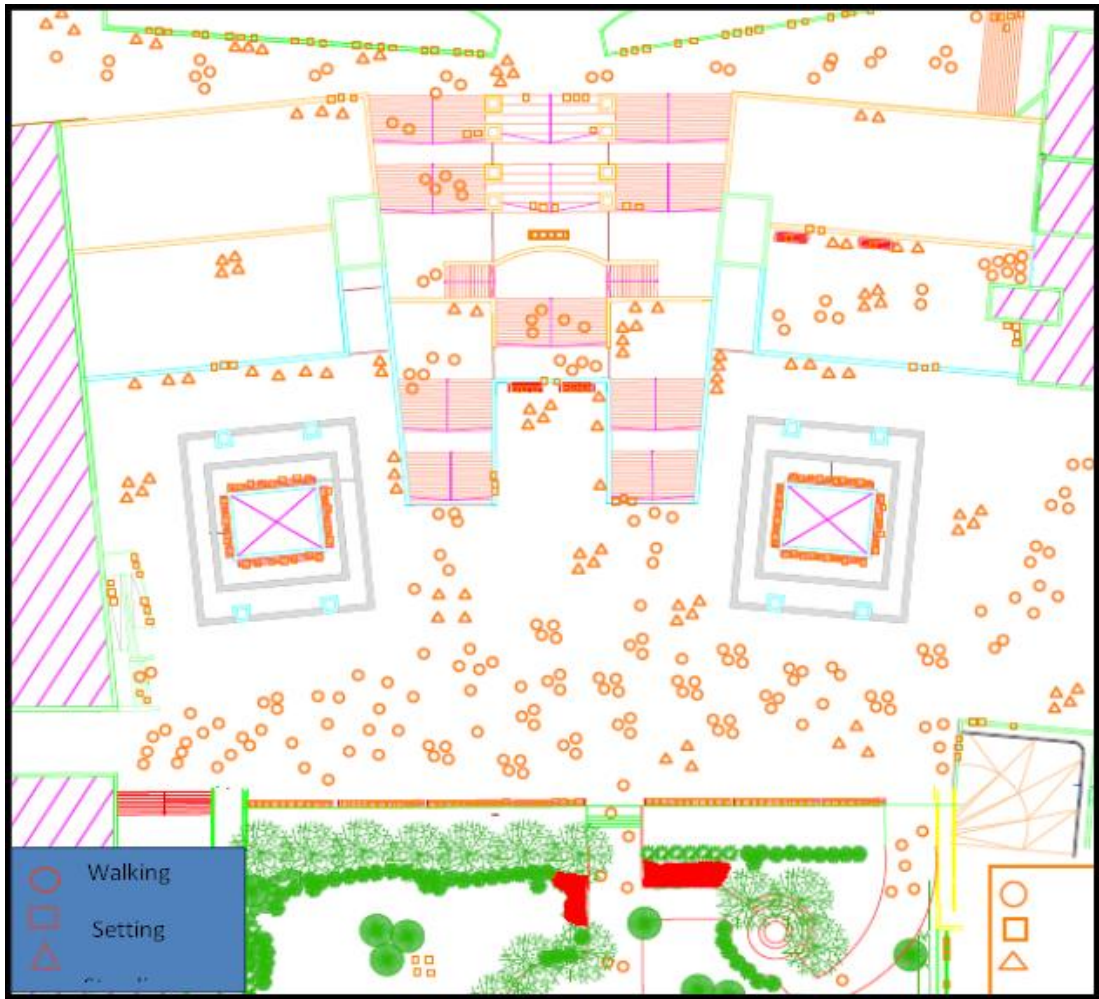


Figure 20: The main (White Square)

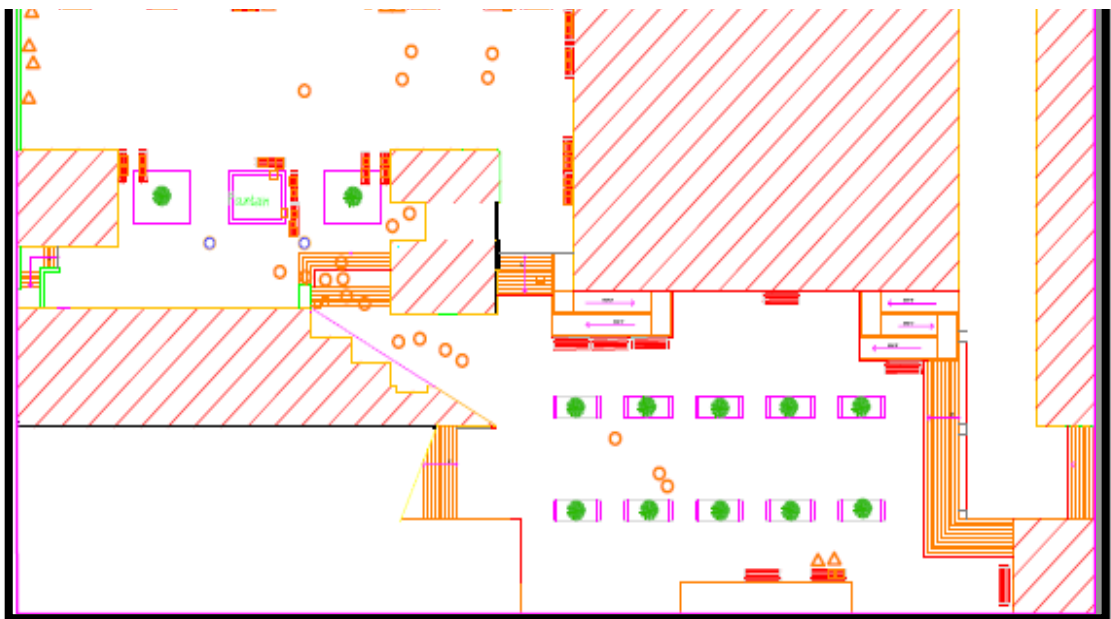


Figure 21: The Sqaue of Engineering and sciences



**Figure 22:** The open space of the medical colleges

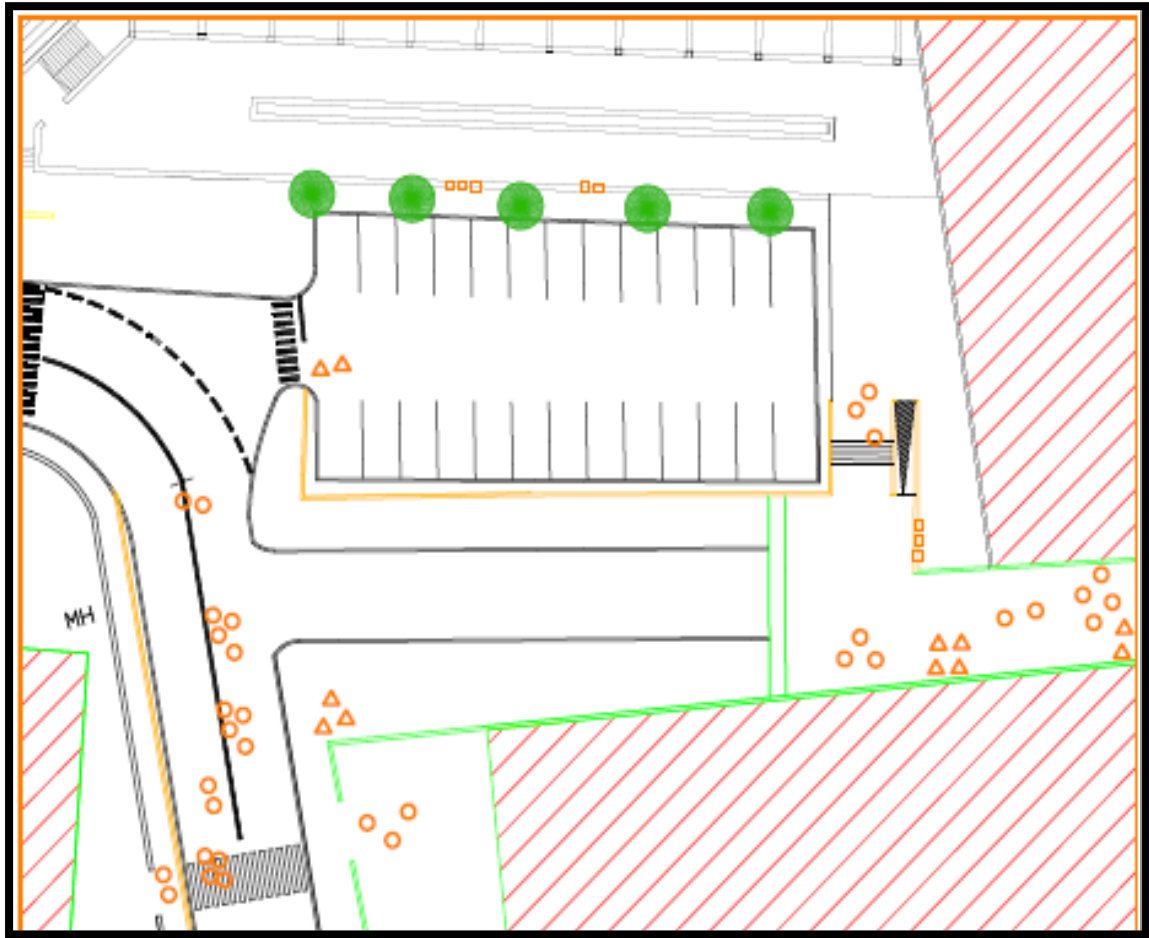
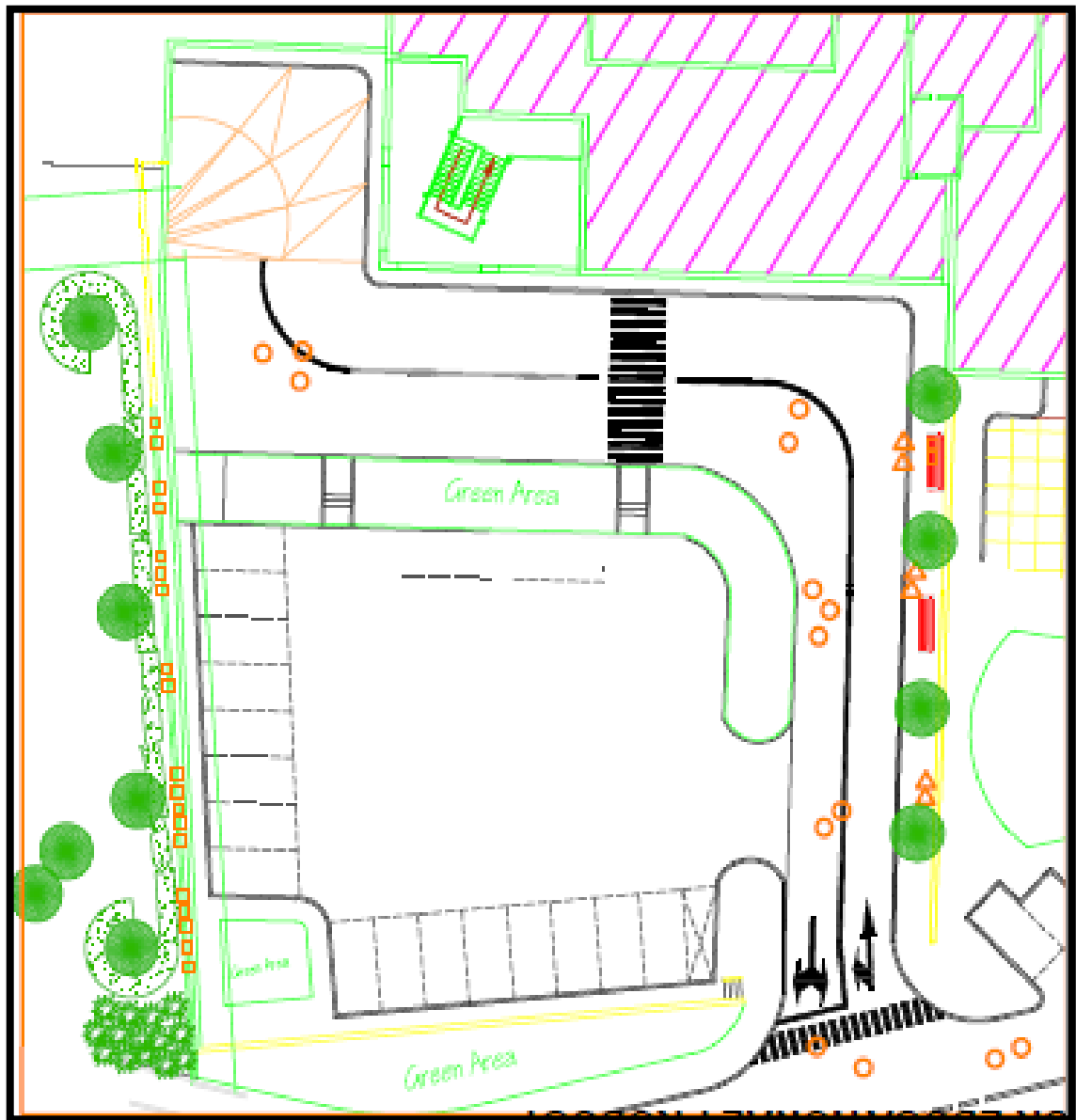


Figure 23: The square in front of the Fine Art college



**Figure 24:** the square in front of the Engineering college

This chapter illustrated the observation results of students' activities and use of the spaces. Mostly spaces lacked the presence of adequate seating, even though students sat on ledges and stairs, more seating would provided more students. Some natural elements existed but are again very few. None of the square has a landmark or something to give uniqueness.

# **Chapter Four**

## **Space Syntax Analysis**

### **4.1 Space Syntax Analysis**

#### **4.1.1 axial line analysis**

#### **4.1.2 strategic value**

#### **4.1.3 visibility graph analysis**

### **4.2 Conclusion**

## Chapter Four

### Space Syntax Analysis

To further enhance the study, 'space syntax' was used, which provides a set of theories, techniques, and measures used for studying the syntactic structure of the networks of physical spaces. In this chapter an analysis of the university campus using depthmapX\* software is presented.






#### 4.1 Space Syntax Analysis

Space syntax analysis of the campus was done according to the method developed within the space syntax theory (Hillier, 1999). It is utilized to understand the spatial organization of the campus and the potential spaces for bringing students together. 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 space within the university campus in term movement. For the purpose of the study, axial line analysis, visibility graph analysis and isovists were constructed using depthmapX software.

- \* more than 20 years ago, calculations of the spatial relationship of the space syntax theory were done manually. Later on, several software programs, such as Axman, Uba Pesh, Orange box, Axwoman, Mindwalk, Webmap at home, and Meanda have improved the possibilities to analyze the complex spatial relationships of the public spaces of whole cities. The Depthmap software is able to illustrate and visualize a built environment's spatial qualities, make

point depth analyses, axial line analyses, visibility analyses and isovists analyses. (VAN NES, 2011)

Throughout the analysis, red would indicate the highest value and blue is the lowest value. This legend would be used for all space syntax analysis provided.

Red		High
Orange		High-medium
Yellow		Medium
Green		Medium-low
Blue		Low

**Figure 25:** Space syntax analysis legend.

#### 4.1.1 Axial Line Analysis

Two types of analysis will be produced. The first one dealing with the whole campus, while the second will exclude the amphitheater; because its only used in case of occasions and as it's an amphitheater it doesn't offer a good environment for movement.

The analysis showed that the mean global integration value of campus is 2.44. Global integration analysis in figure(27) (r-n) shows that the most integrated lines are the axis that connects the medical and pharmacy college with Hikmat Al Masri Amphitheater and with the stairs that lead to the main square (الساحة البيضاء). The next most integrated line is the axis perpendicular to the first which connects the main square with the amphitheater. This means that the potential of movements and the potential of finding most of the students would be in these areas.

The local integration analysis in figure(28) showed almost the same results as the global one, however the focus is not only on the main square, the

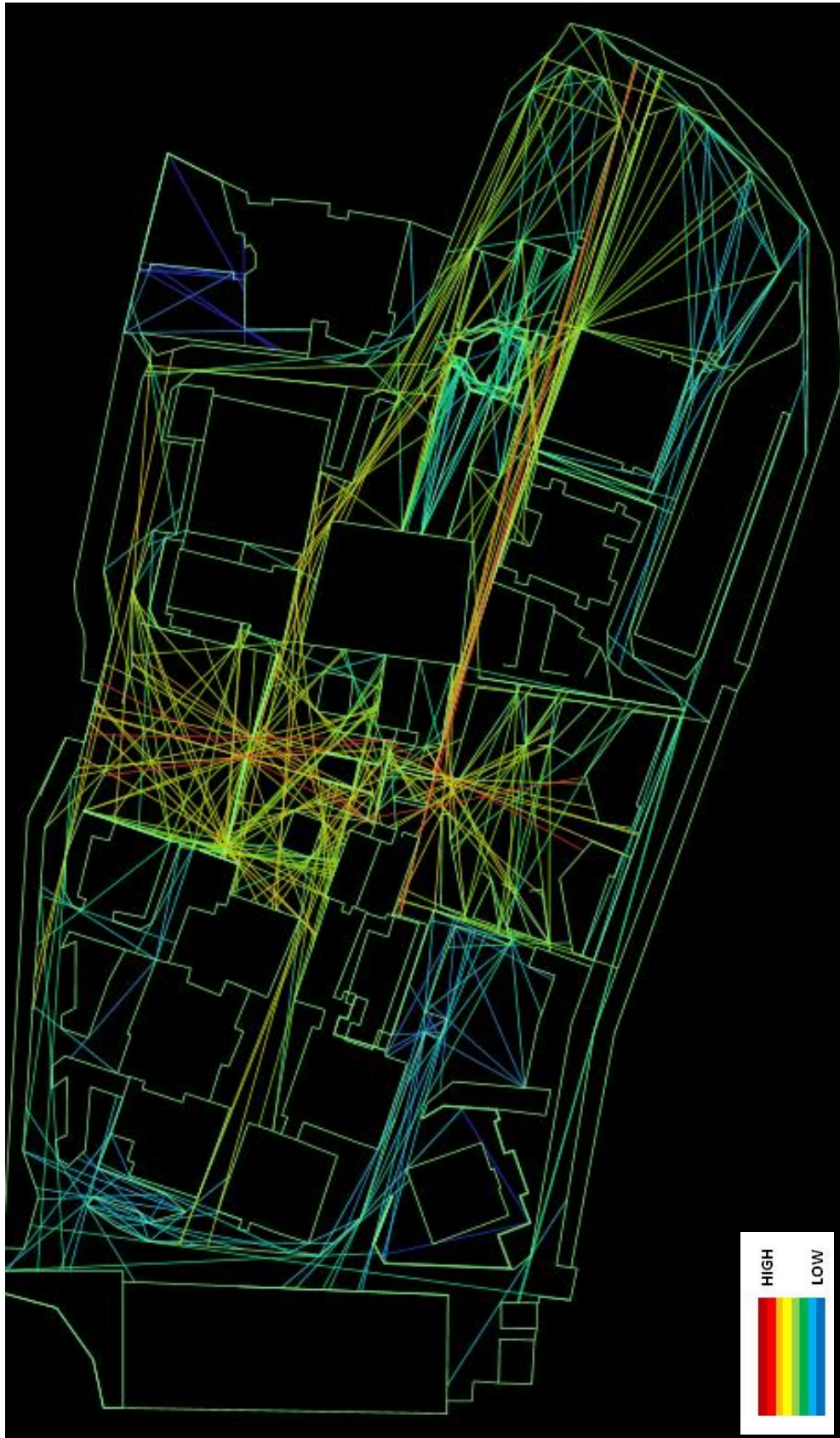
science square and the path that leads to the fine art square have almost the same integration value as the main square.

Connectivity measures accessibility, so the most accessible space in the university is the white square as shown in figure (29). It is easy to reach it from all over the campus, maybe because of its somehow central location.

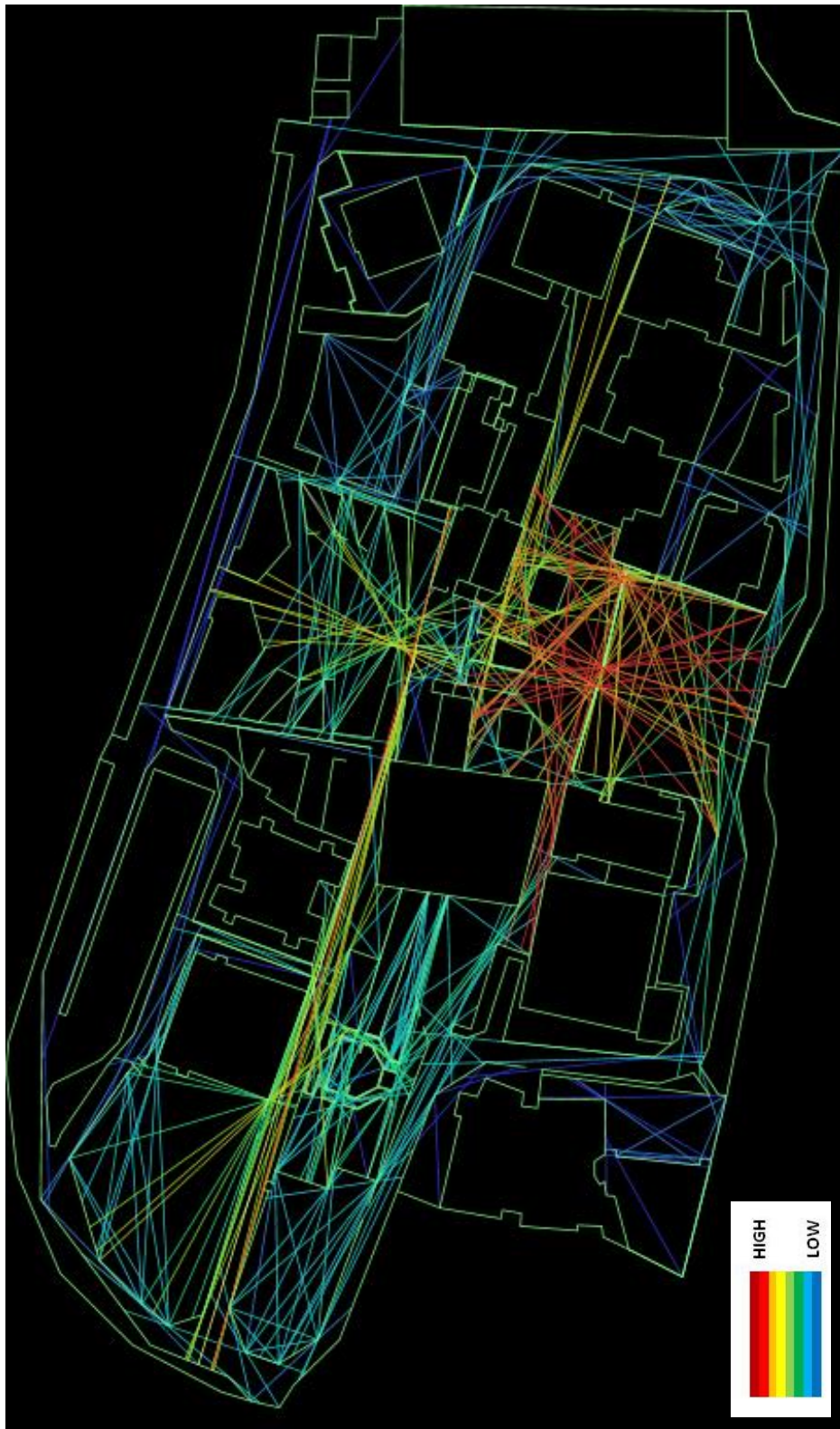
The second most connected space is the path of medical colleges.

The scattagram in figure (30) shows a strong correlation between connectivity and local integration of campus. According to previous studies, Intelligibility is a significant factor which has implications for students' movement to a varying degree. In our example, there is a good relation between local integration and connectivity in the whole campus model, with  $R^2= 0.78$ . That means a clear relation between local and global structure and a strong comprehension of the campus spatial layout.



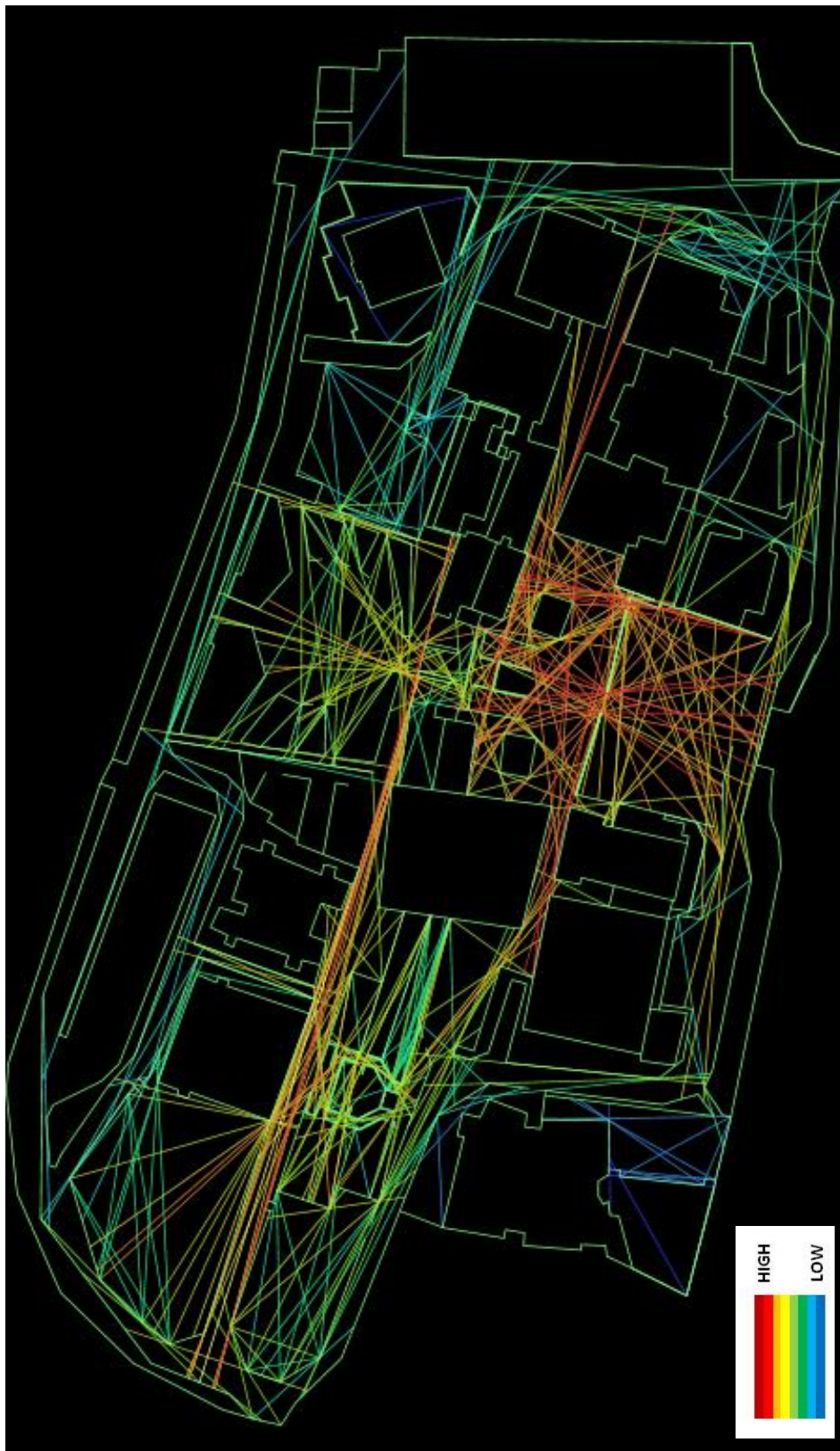


**Figure 26:** the global integration analysis.

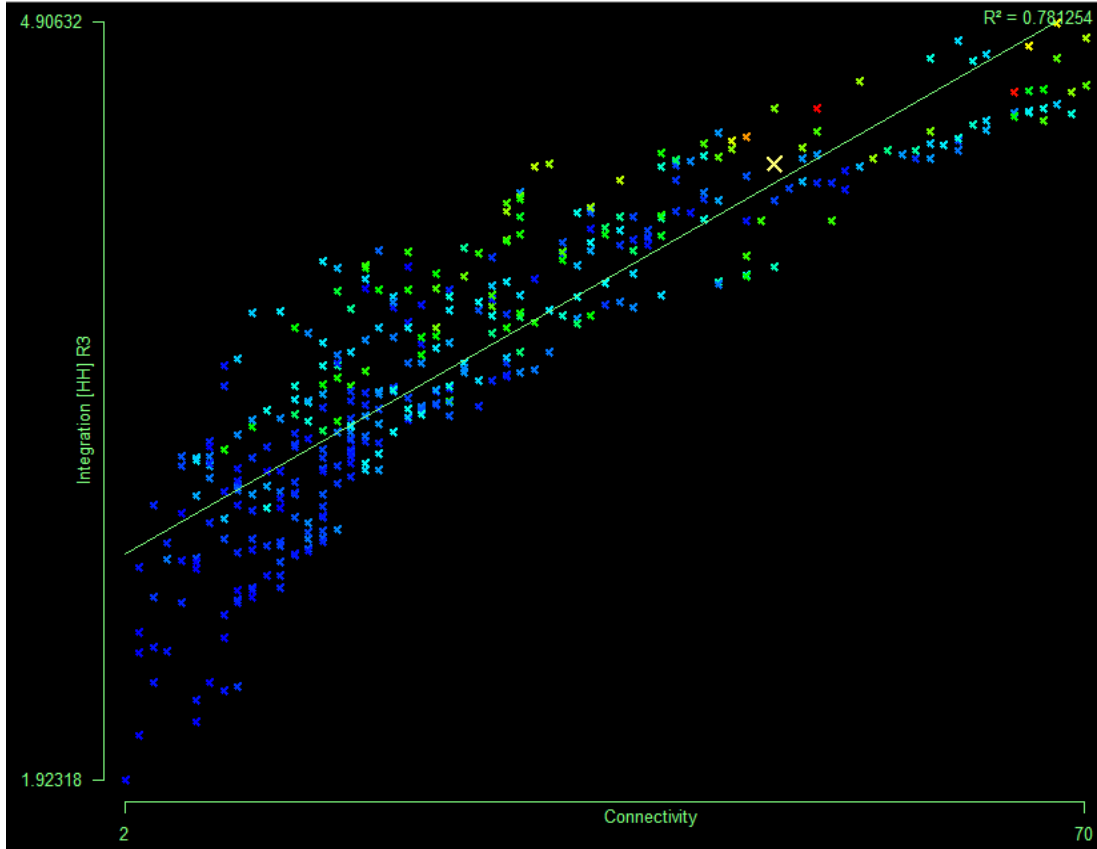


**Figure 27:** the local integration analysis. (R3)



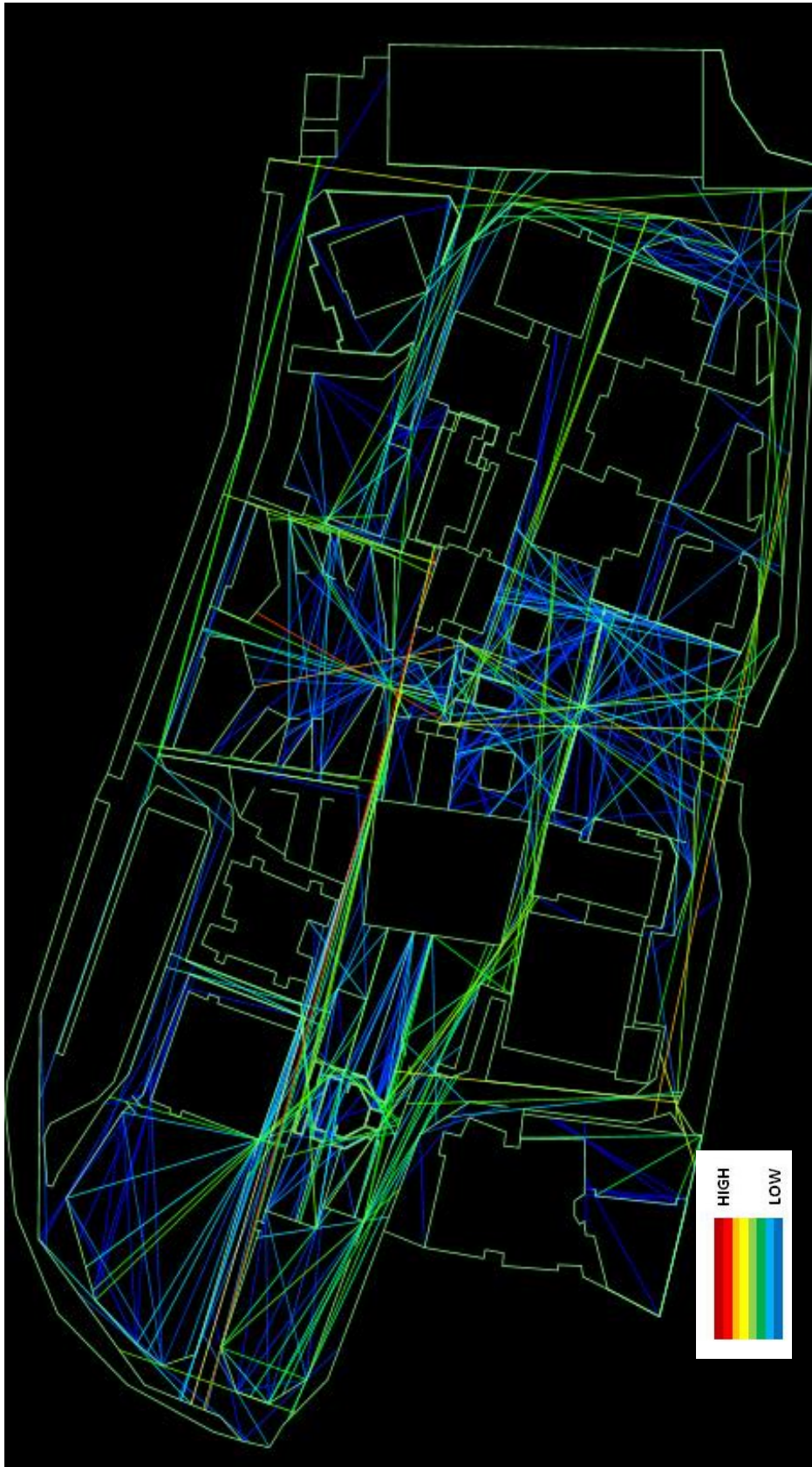


**Figure 28:** connectivity analysis of the campus



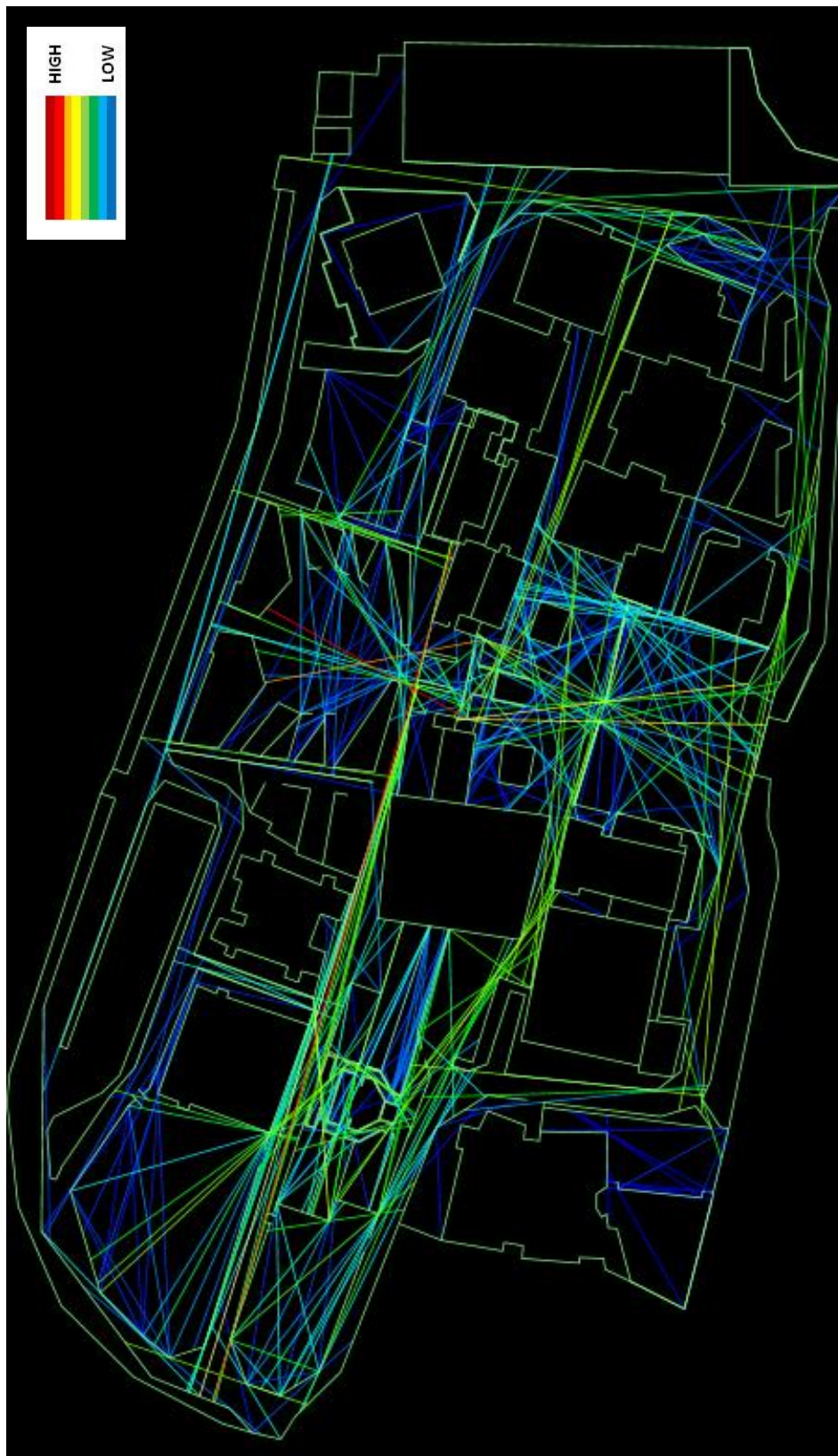
**Figure 29:** scattagram shows the correlation between connectivity and local integration.

Spaces with high global choice are located on the shortest paths from all origins to all destinations. The analysis of choice in figures (31,32) shows that the most likely chosen route for movement from a place to another are the axis in front of the medical colleges, the path in front of the main entrance and the amphitheater. The second most chosen space used as through movement is the white square. The local choice analysis shows almost the same results as the global one.



**Figure 30:** Choice analysis for the campus.



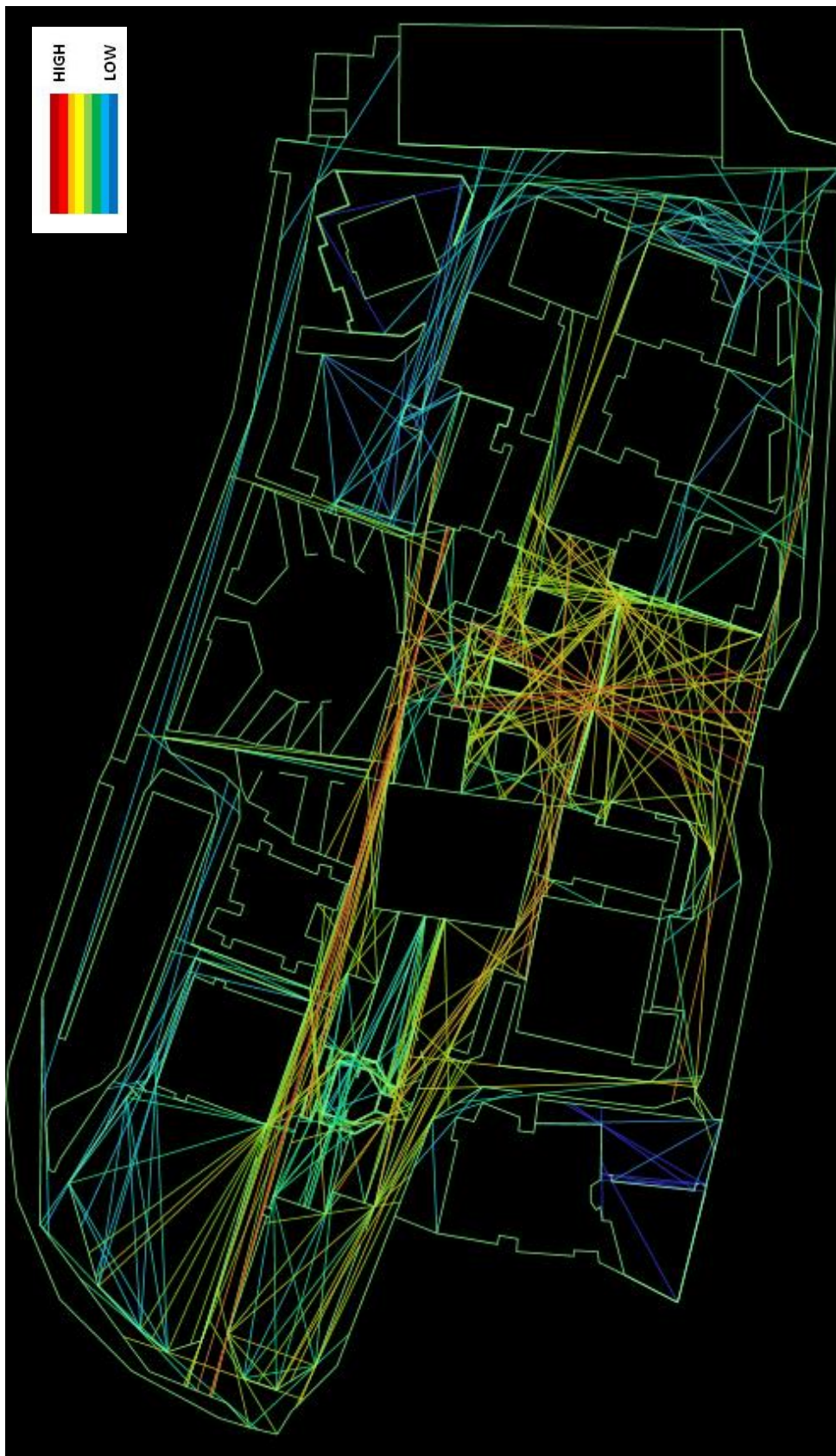


**Figure 31:** choice analysis for R3.

The second axial line analysis will exclude the Hekmat Al Masri Amphitheater. The global integration value is 2.38. Figure (33) shows that the most integrated line lies in the main square (white square) and in the path of medical colleges, which mean it's the busiest space in the university. The next most integrated line is the road at the main entrance of the university. As one can see the integration values didn't have a significant change when excluding the amphitheater for the global integration, while the change occurred in the local integration results. The highest integrated lines are concentrated in the main square, the square between engineering and science colleges and the axis that connects the main square with the fine art college, with an average integration value of 3.62. The next most integrated line is the road in front of the medical colleges. As shown in figure (34).

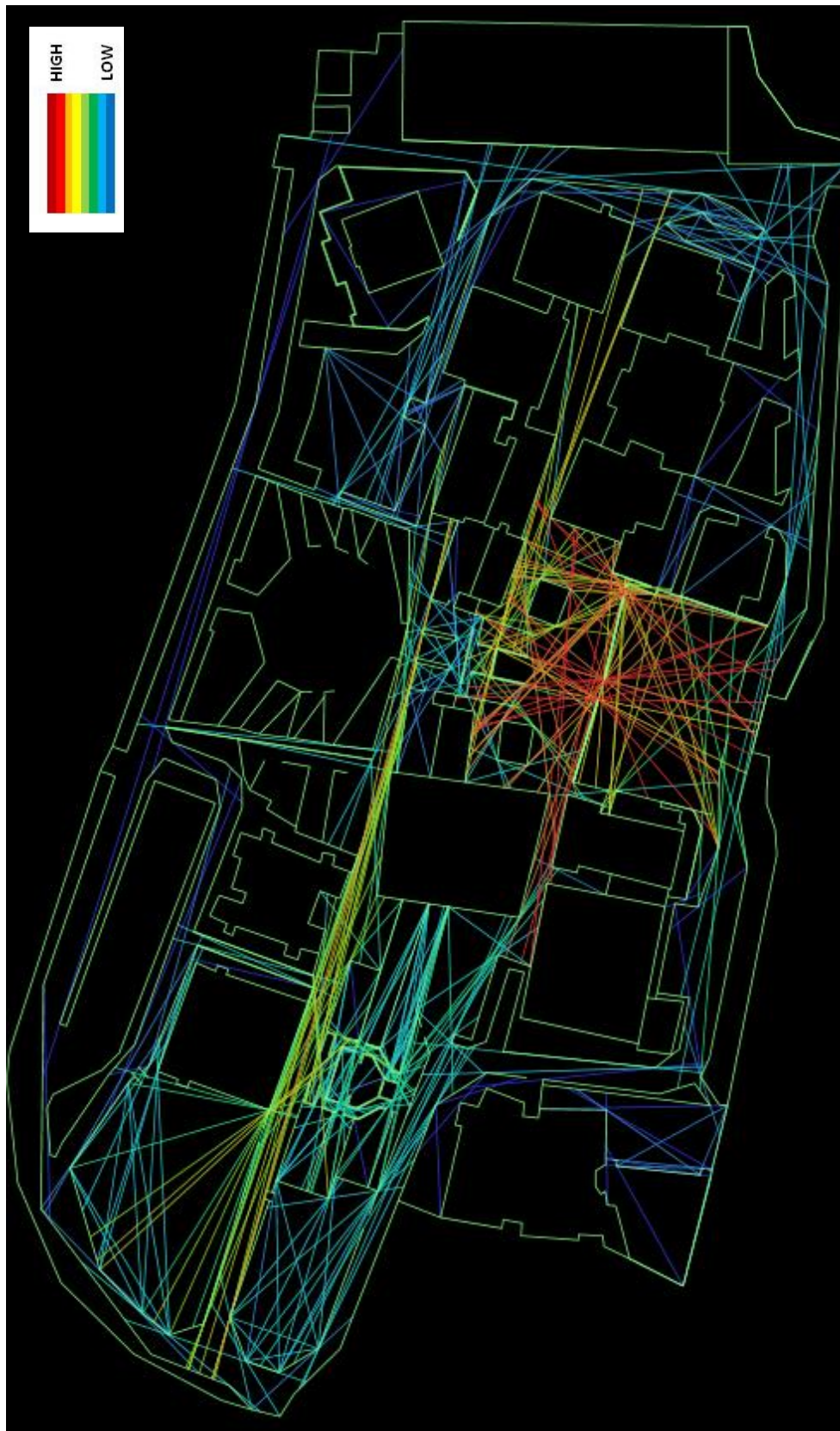
The connectivity analysis illustrate that the most connected lines lies in the main square (white square) , it means that it's the most accessible space within campus. The second most accessible are the road in front of the medical colleges and the science square. See figure (35)

The global choice analysis in figure (36) shows that the most chosen axis is the axis in front of the medical colleges, and the next high chosen axis is the road in front of the main entrance. It means that most students use this axis to reach to their destination within the campus (through-movement). The axis that passes the main square is not really highlighted in the global choice measure as in the local choice with radius 3. It emphasize the results of the global choice measures with more concentration on the axis passing the main square, the science square and the fine art square.

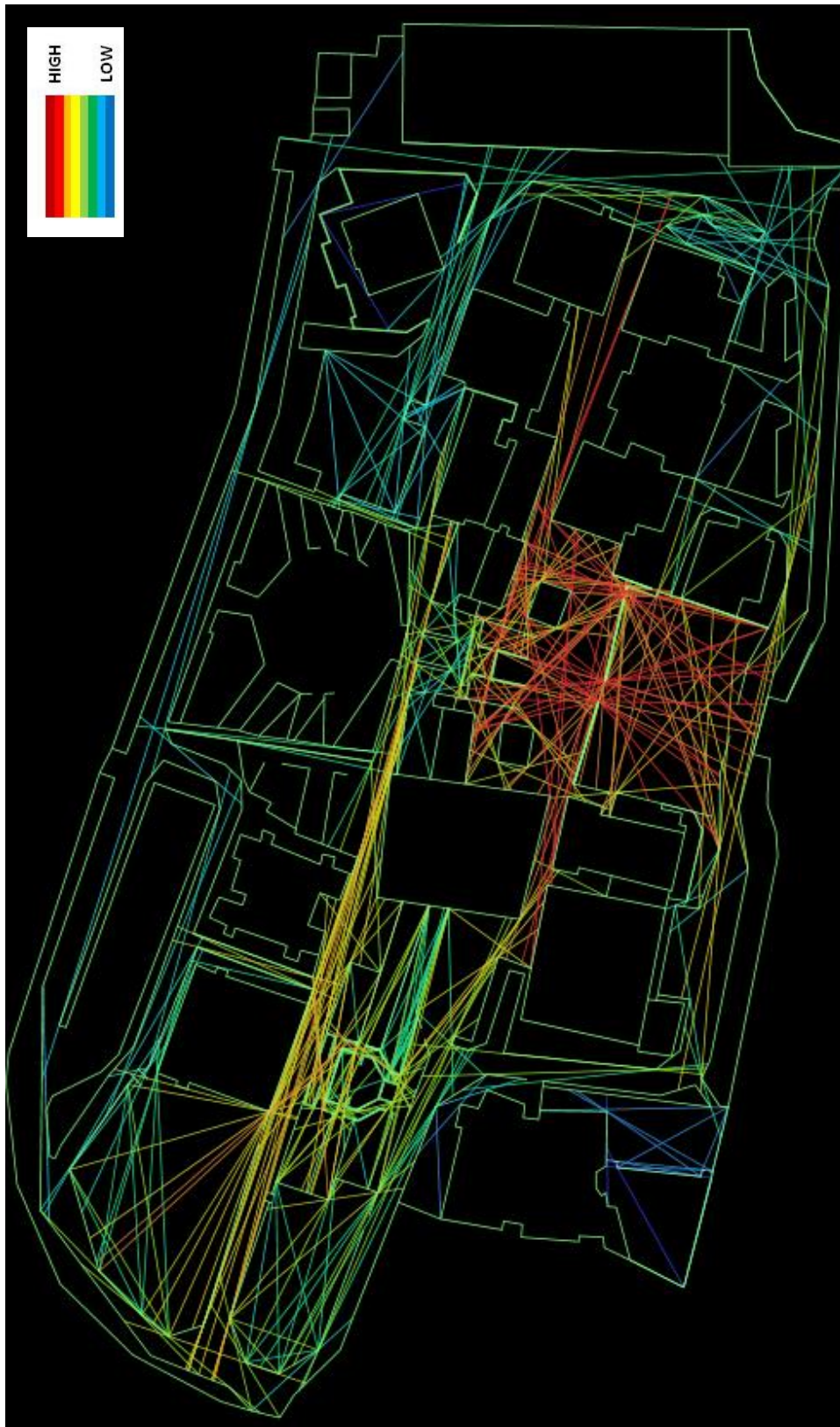


**Figure 32:** the global integration analysis for the campus excluding the amphitheater.





**Figure 33:** the local integration analysis with (R3) excluding the amphitheatre



**Figure 34:** the connectivity analysis excluding the amphitheatre



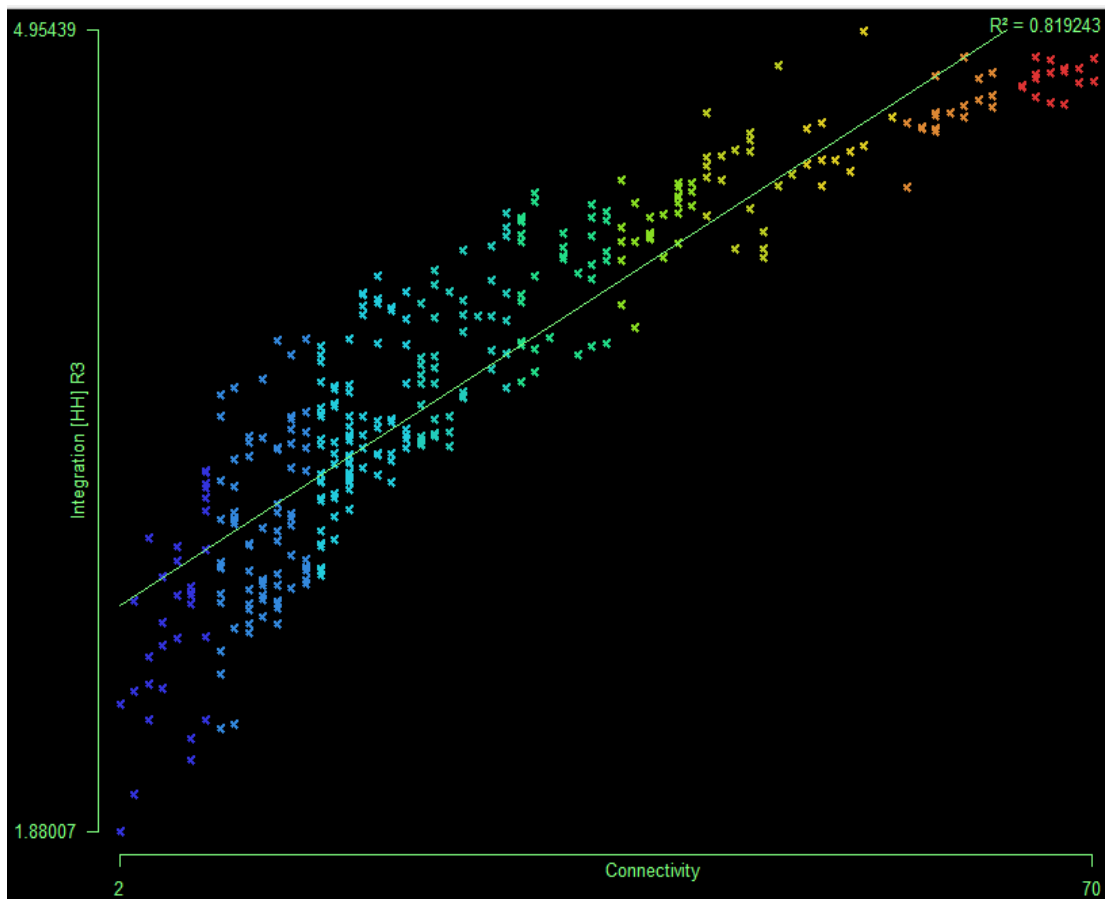


**Figure 35:** global choice analysis excluding the amphitheatre



**Figure 36:** Local Choice analysis with (R3) excluding the amphitheatre

The scattagram in figure (38) shows a strong correlation between connectivity and local integration of campus. In our example, there is a good correlation between local integration and connectivity in the excluded amphitheater model, with  $R^2=0.82$  which is higher than the intelligibility with the previous analysis which included the amphitheatre. It means a clear relation between local and global structure and a strong comprehension of the campus spatial layout. The user can understand the whole from the local parts.



**Figure 37:** scattagram shows the correlation between connectivity and local integration excluding the amphitheatre

**Table 3: Axial line syntax measurements of the whole campus**

	Global integration	Local integration (R3)	Connectivity	Global Choice	Local Choice (R3)	Intelligibility
The whole campus	2.44	3.60	27.16	1070.16	264.85	0.78

**Table 4: Axial line syntax measurements of the campus excluding the amphitheater**

	Global integration	Local integration (R3)	Connectivity	Global Choice	Local Choice (R3)	Intelligibility
The campus excluding the amphitheater	2.38	3.62	26.40	995.37	239.56	0.82

From the values of the tables above, we conclude that there is not much difference in the analysis with the amphitheater or without it, even if the usage is limited in certain occasions. It is highly integrated within the university campus. That might be in purpose; occasions or ceremonies held in this amphitheater are not exclusive to students. So locating it in the intersection between the two most integrated axes will make it easier for guests to reach it. Both analysis shows that the campus is intelligent and the whole can be read from the parts. Axial line analysis also illustrate that the main square has the highest number of lines of sights and movement. Hence, later on this chapter a detailed analysis will be presented to this square.

### 4.1.2 Strategic Value

Since Hillier mentioned that the strategic value which is the sum of the integration line values crossing the urban space indicates how successful the urban space is. They will be analyzed here.



**Figure 38:** axial line integration analysis. (minimal lines)

**Table 5: strategic values for the squares on campus**

	White Square	Engineering Square	Sciences Square	Fine art square	Medical colleges street
Strategic Value	10.57	3.69	2.51	8.04	8.41

The white square has a maximum value which indicate that it is the most used and the busiest space within campus. The street of the medical colleges is next, then comes the fine art square the sciences square and finally the engineering square.



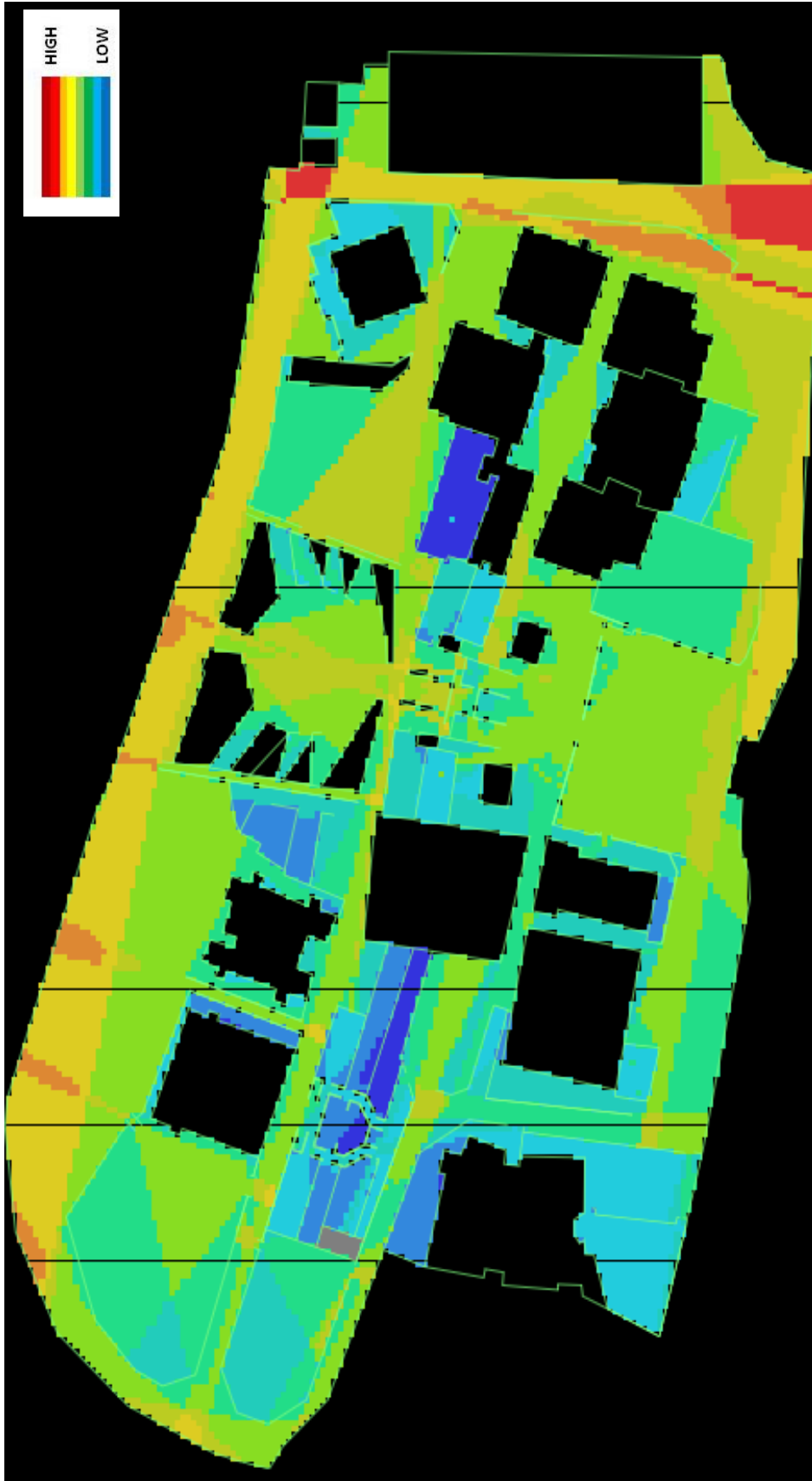
### 4.1.3 Visibility Graph Analysis

To analyze the visual integration of the New Campus, another technique of the Space Syntax theory, the map of visibility, was used. This map was obtained with the help of the software DepthmapX, which calculates the measure of visual integration, control and clustering coefficient. In this software, open spaces are decomposed in cells that have its size determined according to the necessity of analysis. The software calculates relations between each of these cells.

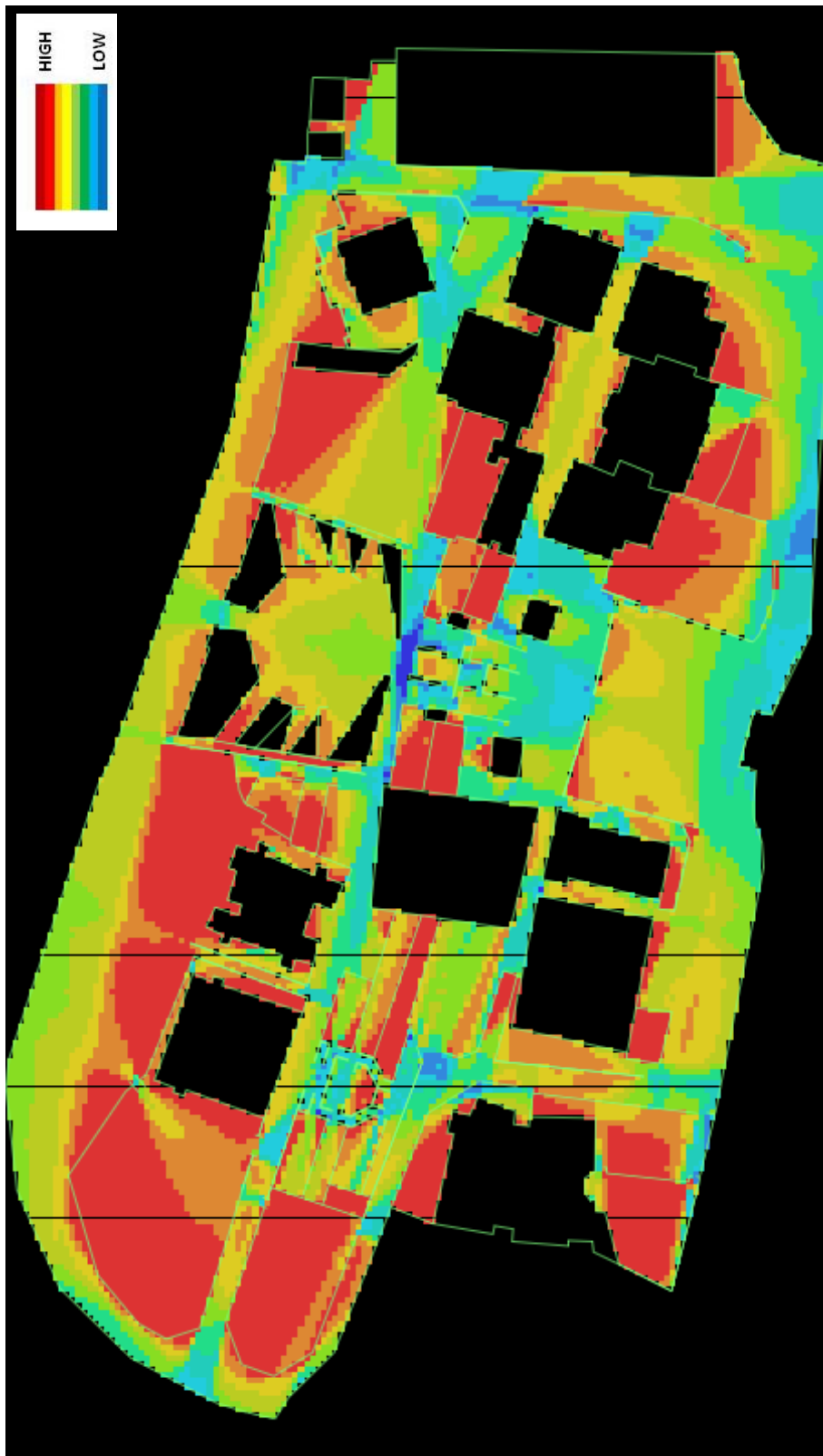
It is obvious from the graph in figure (40) that there are red spots at boundaries of the campus, where the vehicles roads are, representing high visibility, since the area is free of visual barriers. It also shows that the open spaces have moderately high visibility. More important than this, however, is the fact that the visibility map points the same as that the axially map pointed, the fact that the white square, the amphitheater, has the highest visibility as well as the axis connecting the medical colleges with the amphitheater. It is not by chance that the concentration and variety of activities takes place there, not even that the most integrated paths are similar to these areas.

In terms of the clustering coefficient as mentioned earlier, the higher the value the more convex is the space, which means less information is lost when moving from that space. Spaces with low clustering coefficient tend to be places where people stop to make decisions about direction. The main square has the lowest value, due to the multiple choices of direction presented.





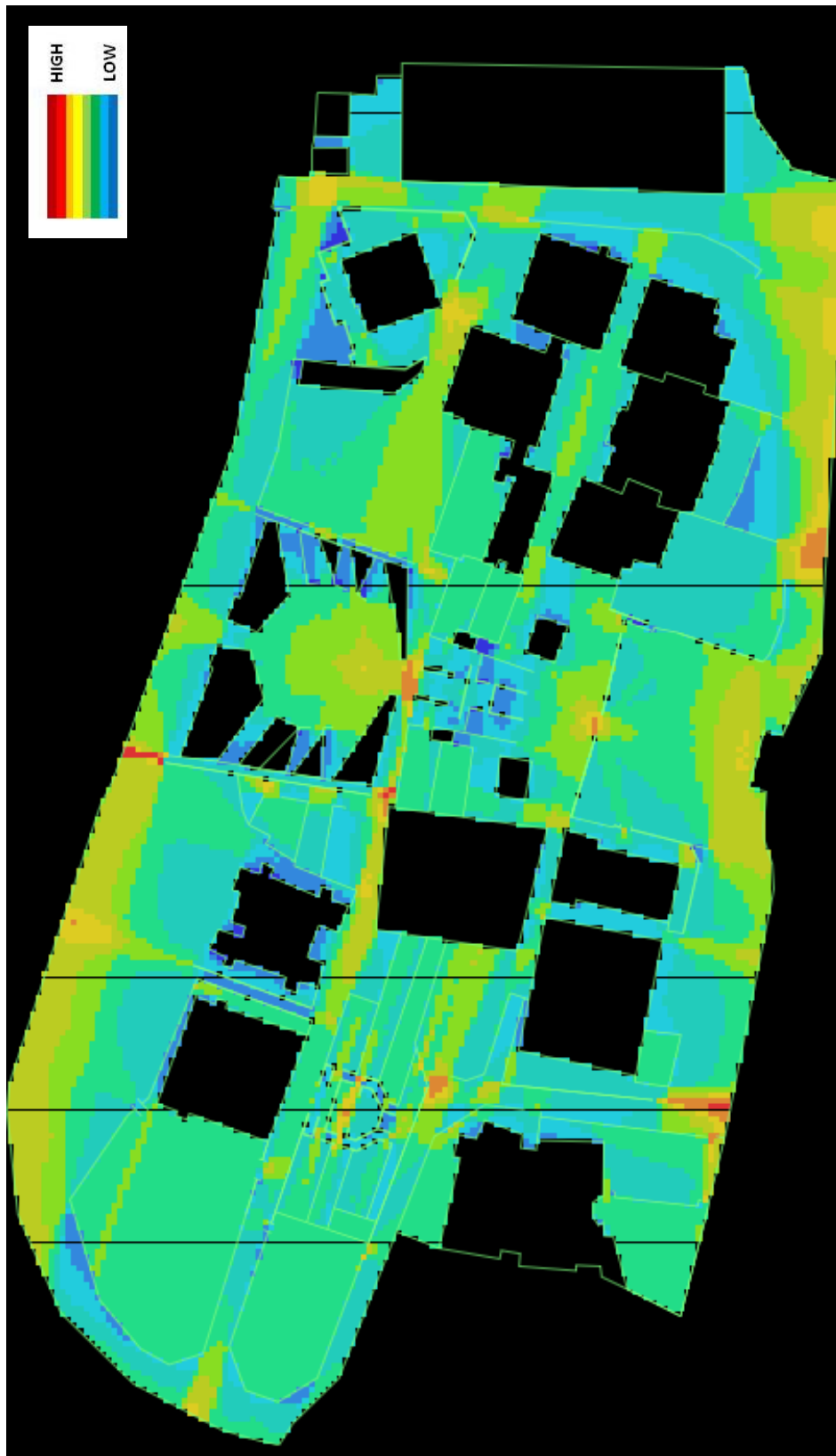
**Figure 39:** visual integration for the campus



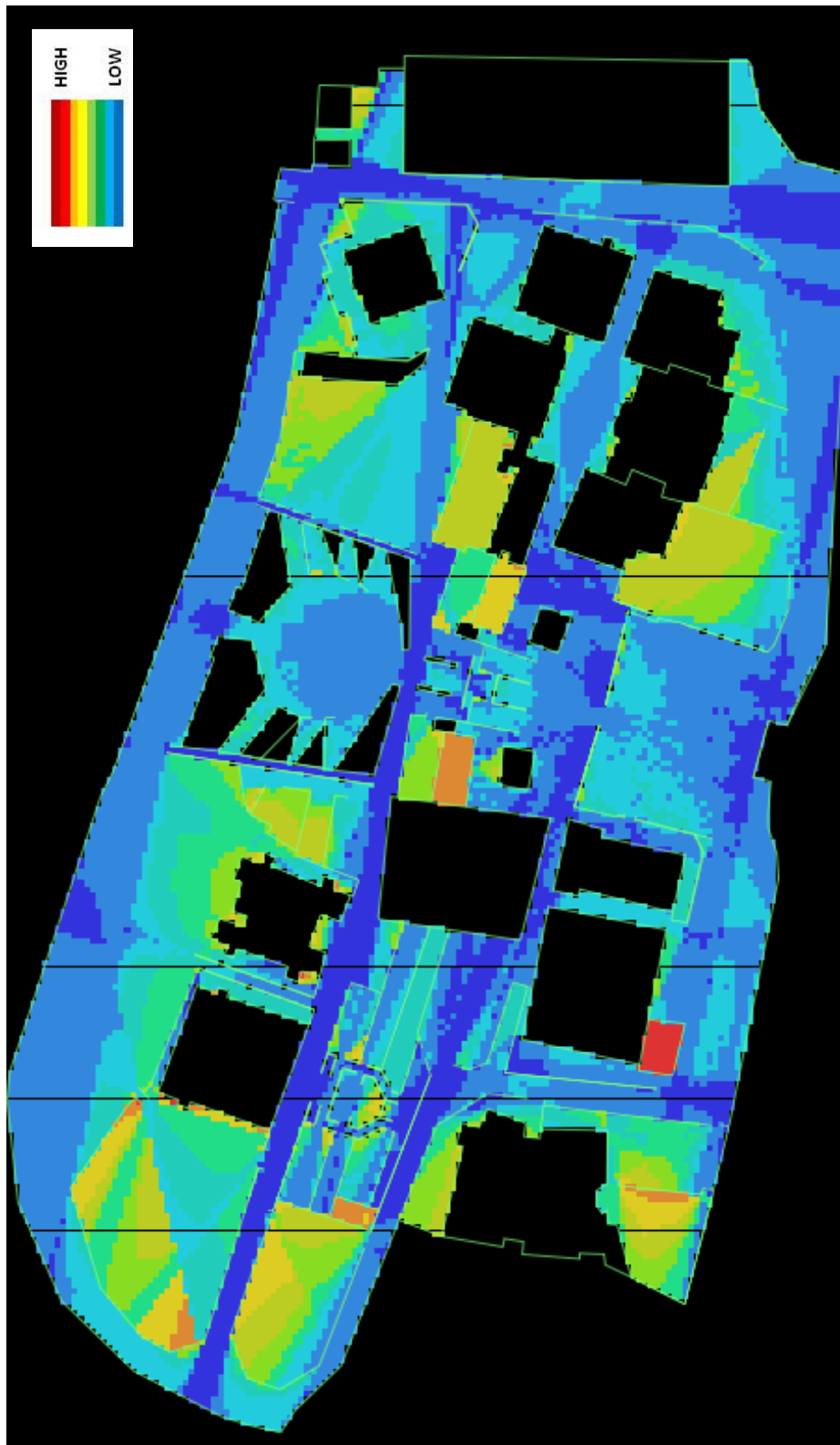
**Figure 40:** Clustering coefficient for the whole campus.

The graph in figure (42) shows the visual control analysis for the campus. It shows a red spot in several locations within the campus area. These locations have the maximum visibility, since a high control value illustrate spaces where the user can have a large view of the whole layout. These spots are around the boundaries where less visual obstruction available. A red spot also is in the entrance of the white square from the south where the main entrance to the university, in addition to the intersection between the medical colleges axis and the amphitheater entrance.

Since people perception of space is influenced by its compactness, an isovist compactness analysis was done for the campus. It shows how enclosed the viewer feels in the environment which is affected by the area seen. As figure (43) the high compactness values are in the west part of the campus where there are areas partially enclosed with walls. All the squares or the studied areas have low compactness values except for the space in front of the engineering college with a compactness value of 0.51.



**Figure 41:** visual control for the campus.



**Figure 42:** isovist compactness analysis for the campus

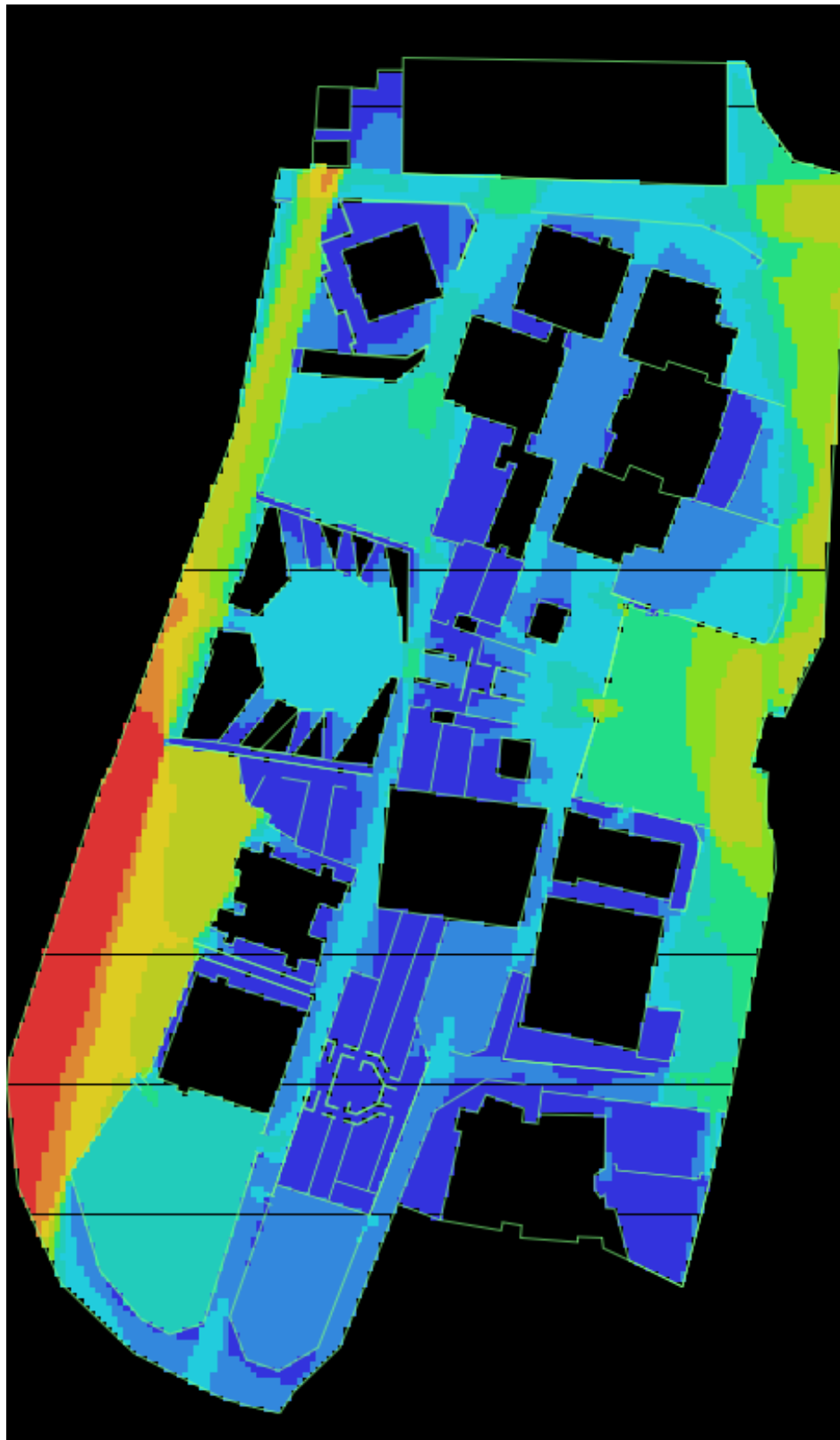
Finally, the isovist area illustrates how much can a user see. The higher the area of the isovist the more visual information is available. Figure (44) present the isovist area analysis for the campus. A high value can be seen at the west north part of the campus and on the entrances to the campus, where the areas have no visual obstruction. The highest area value from the studied spaces is the white square. The axis of the medical colleges comes next; while the other 3 studied spaces has very close values which represent a low isovist area compared to the average value.

The visual analysis above pointed out the same results as the axial line analysis. It suggests that the most used space in the university campus is the white square, because of its high visual integration, control and isovist area values, and low compactness values.

**Table 6: visibility graph and isovist syntax value for the campus**

Average values	Visual integration	Visual Control	Clustering Coefficient	Isovist Compactness	Isovist Area
Whole campus	3.5	1	0.79	0.23	3649.86





**Figure 43:** isovist area analysis for the campus

**Table 7: visibility graph and isovist analysis values for each space.**

	Visual integration	Visual Control	Clustering Coefficient	Isovist Compactness	Isovist Area
White Square	5.17	1.49	0.55	0.10	4532.15
Science- Engineering Square	4.25	1.18	0.79	0.17	2011.35
Fine art Square	3.40	1.32	0.68	0.07	2175.05
Engineering square	3.2	0.87	0.92	0.51	2218.15
Medical Colleges space	5.31	1.41	0.62	0.05	2933.36

## 4.2 Conclusion

This chapter illustrated the space syntax analysis of the campus. It included the axial line, visibility graph and isovist analysis. The next chapter will compare the results of these analysis with the observations from the previous chapter to show the correlation and results of the campus analysis.



## **Chapter Five**

# **Correlation of space syntax analysis and Observations**

### **1.1 Axial map correlations**

### **1.2 Visibility graph and isovist correlation**

#### **5.2.1 The white square**

#### **5.2.2 The sciences square**

#### **5.2.3 The fine art square**

#### **5.2.4 The medical colleges' space**

#### **5.2.5 The engineering square**

### **5.3 Conclusion**

## Chapter Five

### **Correlation between space syntax analysis and Observations**

The relationships between urban space design and students' activity was studied through observations, activity maps, and the space syntax analysis. The following chapter presents a comparison of the space syntax analysis with the data collected from observations and activity maps. It will show similarities, differences and expectations of use within the university campus.

#### **5.1 Axial map correlations**

A minimal axial line analysis will be used here for clearer results. Figure (45) shows the analysis of the global integration for the whole campus excluding the amphitheater.

- 1) It showed that the highest integration value was on the path of the medical colleges which means the highest movement event on campus, which correlates with the actual observation of the campus. Figure (46)
- 2) It also illustrate that the next most integrated space is the white square, which also correlates with the observations and activity maps conducted. See figure (47)
- 3) However, it shows a high integration value in the west part of campus, which is not necessarily true. It might show a high movement index because there are streets and parking spaces there. It might correlate with vehicular movement rather than pedestrians.



**Figure 44:** Global integration analysis. (minimum lines)



**Figure 45:** pictures showing the students on the medical colleges' space.



**Figure 46:** a picture showing the white square.

## 5.2 Visibility Graph and isovist correlation

This section will compare the results of the activity maps produced from the observations and the visibility and isovist analysis done for each of the five selected spaces.

### **5.2.1 The white square**

To explore why within this square 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.

The VGA was limited to the boundary of the public space. The observer is considered to be inside the public space and the urban grid is not part of the analysis.

The behavior map was conducted on March 2015, since the weather was warm and comfortable, in order not to affect the usage results of the space.

The square has been subdivided into four subspaces seen in figure (48) relying on its space layout (the main space A, the terraces B, the stairs C and the space in front of the amphitheater D ). It is composed of several levels connected by stairs.

The first assessment about the behavior mapping of the spatial occupancy of the square shows that stationary people of standing position or sitting in informal space (not setting benches or chairs) represents most of the total number of people students using the square.

The available seating areas are fully occupied, however their number is limited, therefore there are students setting on the ledges in addition to the standing students. Most of standing people occupy the edges of the space, and the left occupy the middle zones.

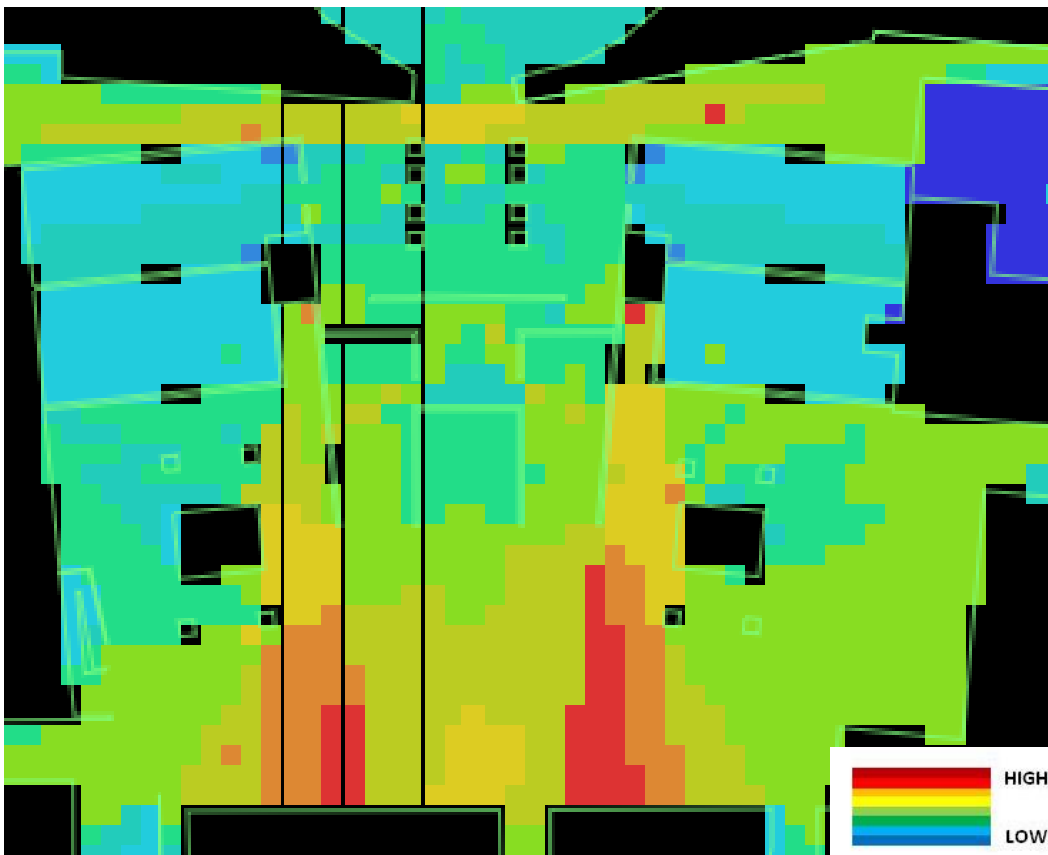
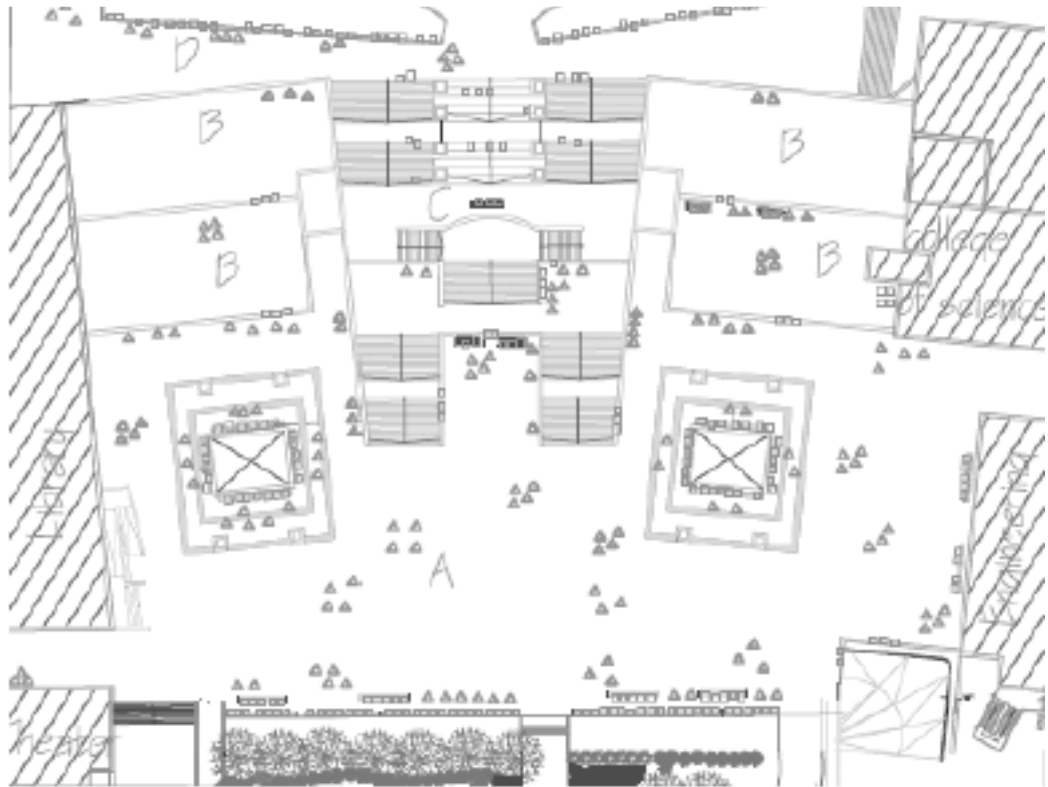
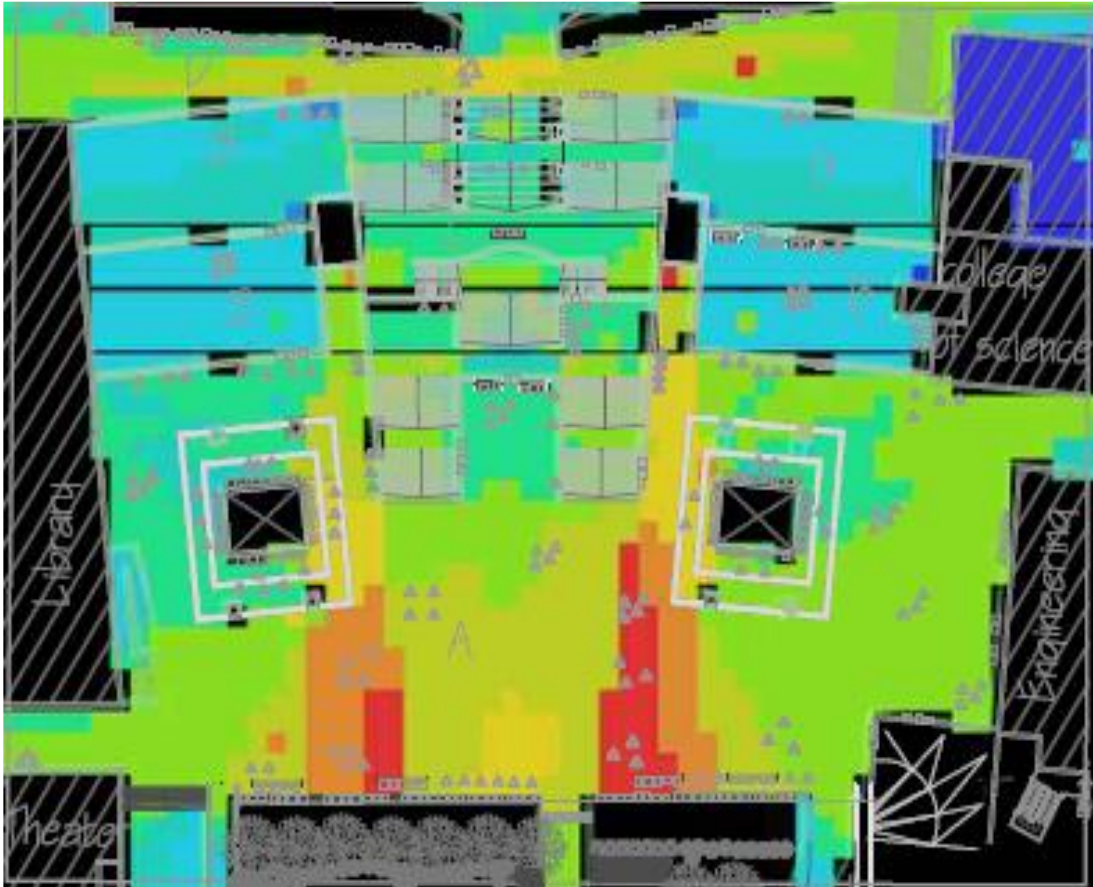


Figure 47: visibility integration of the white square, activity map of the white square

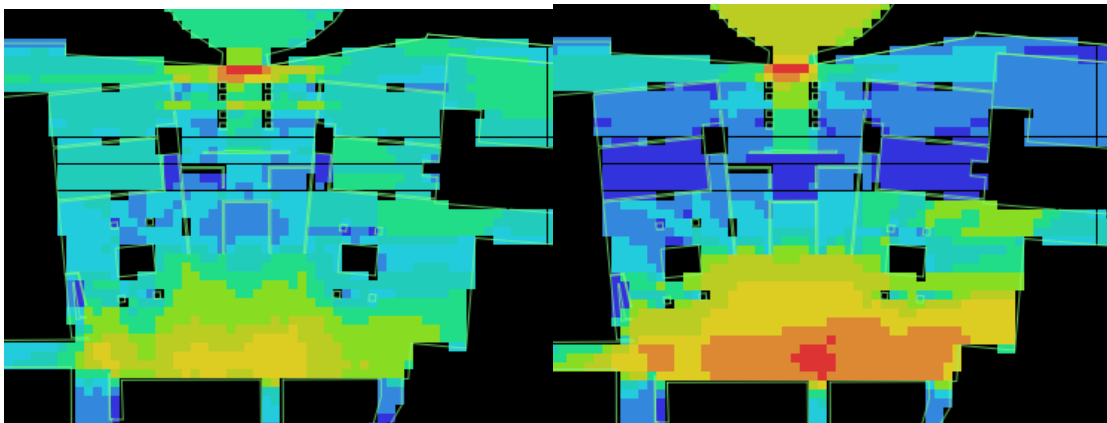
Overlapping the visual graph analysis and behavior mapping of the whole square shown in figure (49) emphasizes that the main space A has the highest integrated zone which correspond to the high number of students in this zone. It has some seating that are distributed, however, despite the limited number of available seats, the high integrated zones are used by stationary people in standing position. Some stationary people in sitting position overlap with a low integrated spaces which correspond to some of sitting places of the square. The terraces B have low occupation number due to their low visibility values and the limited number of seats available, nevertheless we can find some standing students on the edges of the terraces and some people seated on the terraces edges. The same applies to the stairs. Since space D in front of the amphitheater has a high integration value, we can find a lot of students sitting on ledges and standing students, despite the absence of seating areas.

This also corresponds to the isovist area and visual control analysis, as seen in figure (50). The number of students using the space correlates with the high values of isovist areas and control.





**Figure 48:** overlapping the visual integration graph with the observation map



**Figure 49:** visual control for the white square, and isovist area

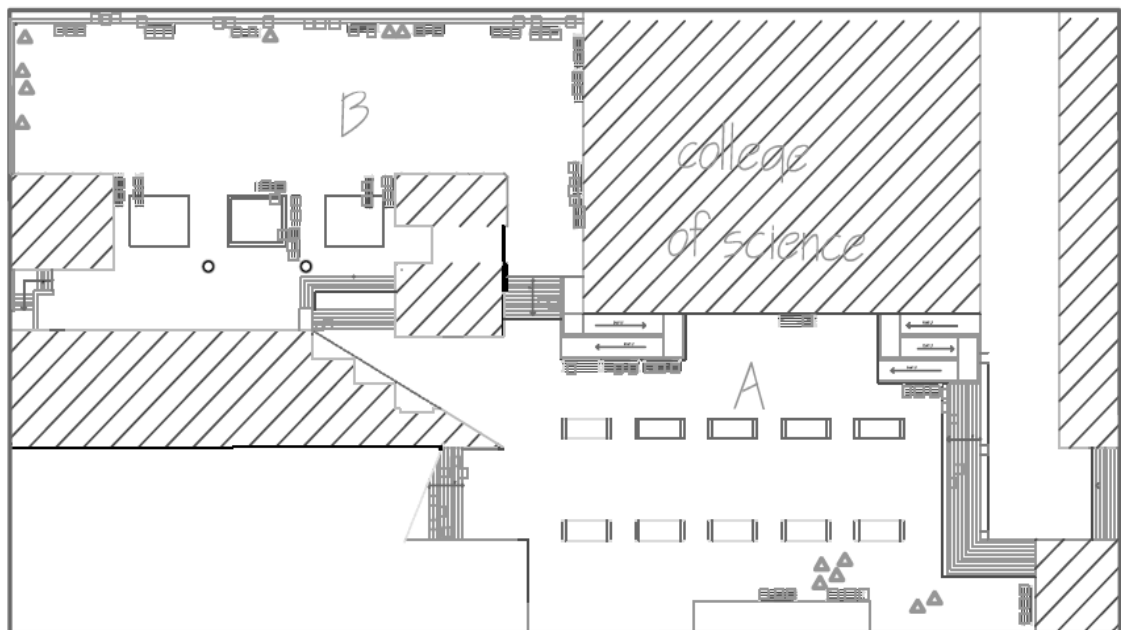


### 5.2.2 The sciences square

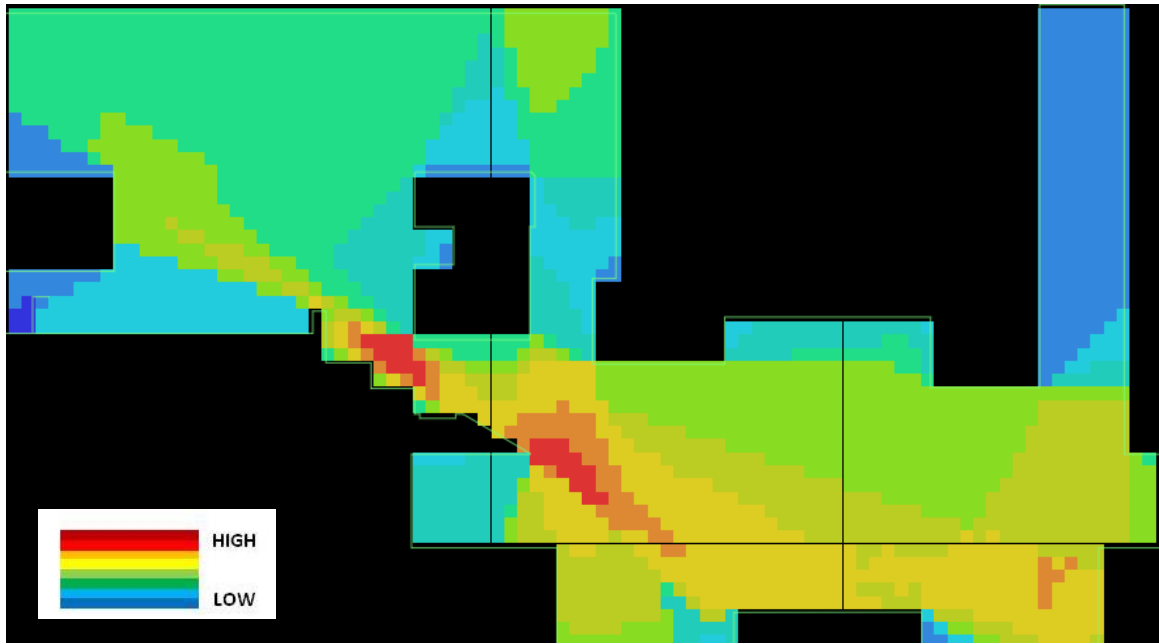
The square has been subdivided into two subspaces relying on its space layout (the south square A, the north square B) as shown in figure (51). They are connected through a path.

The first assessment about the behavior mapping of the spatial occupancy of the square shows that stationary people of standing position are few and students sets on benches and on informal spaces such as stairs and ledges.

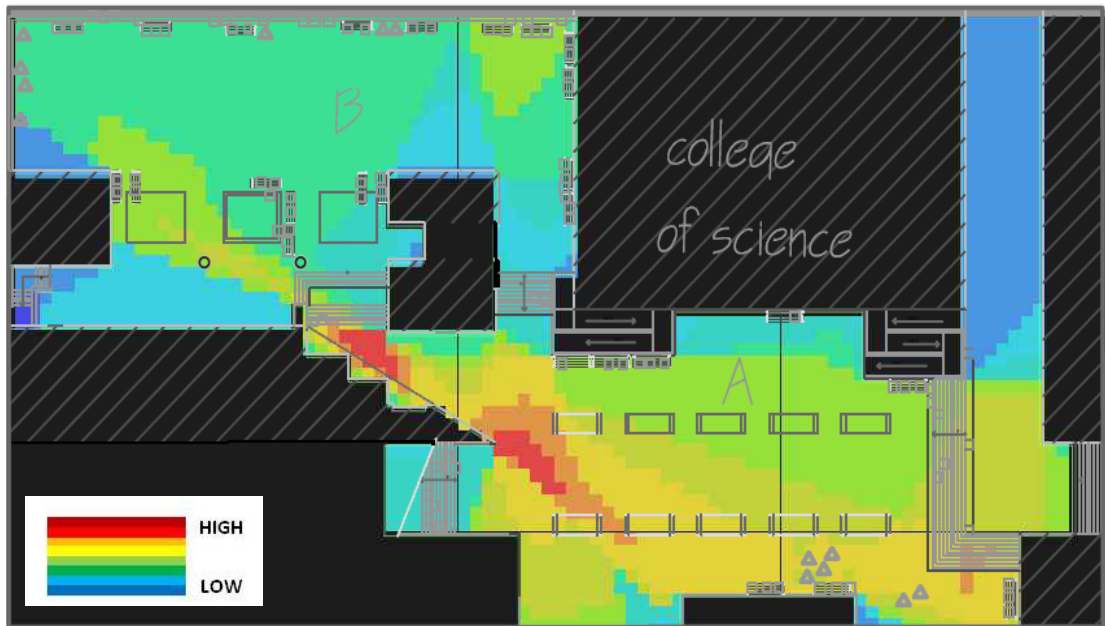
The available seating areas are fully occupied, however their number is limited. Most of the students occupy the edges of the space, and few occupy the middle zone mostly around the pond.



**Figure 50:** activity map of the sciences square



**Figure 51:** visual integration for the sciences square



**Figure 52:** overlapping the visual integration graph with the observation map

Overlapping the visual graph analysis and behavior mapping of the whole square shown in figure (53) emphasizes that the main space A has a higher integrated zone, while the high number of students correspond to zone B which is lower in visibility integration. This might be explained by several assumptions. First, the north square might have higher number of students since it is closer to the main cafeteria. In addition, since it is close to the cafeteria, there is continues movement there, counter to the south square which has low movement. This also correlates with the axial analysis that showed a low integration value for the axis crossing this square. Some stationary students in sitting position overlap with a low integrated spaces which correspond to the pond available in the square, since researches showed that people feel more relaxed around water features. Moreover, some students prefer to sit on more secluded spaces to have more privacy. Generally, students in stationary positions correspond to the isovist area and visual control analysis, as seen in figure (54). The number of students using the space correlates with the high values of isovist areas and control. Since people usually prefer to have more visual control and like to have a full view of the space in order to feel safer.

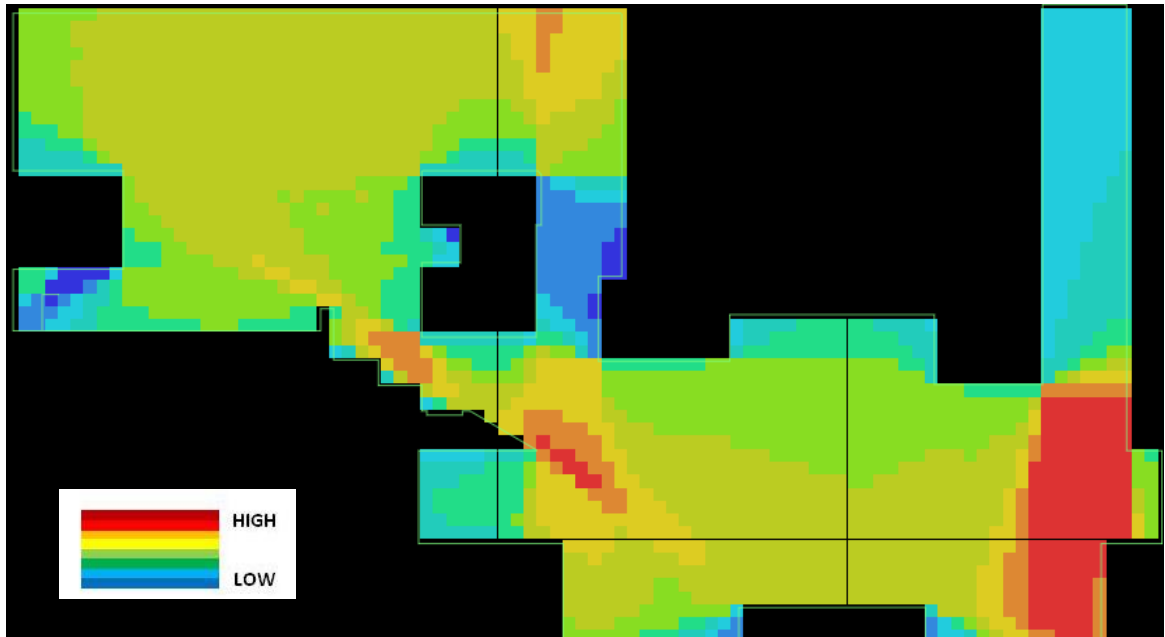


Figure 53: visual control analysis of the sciences square

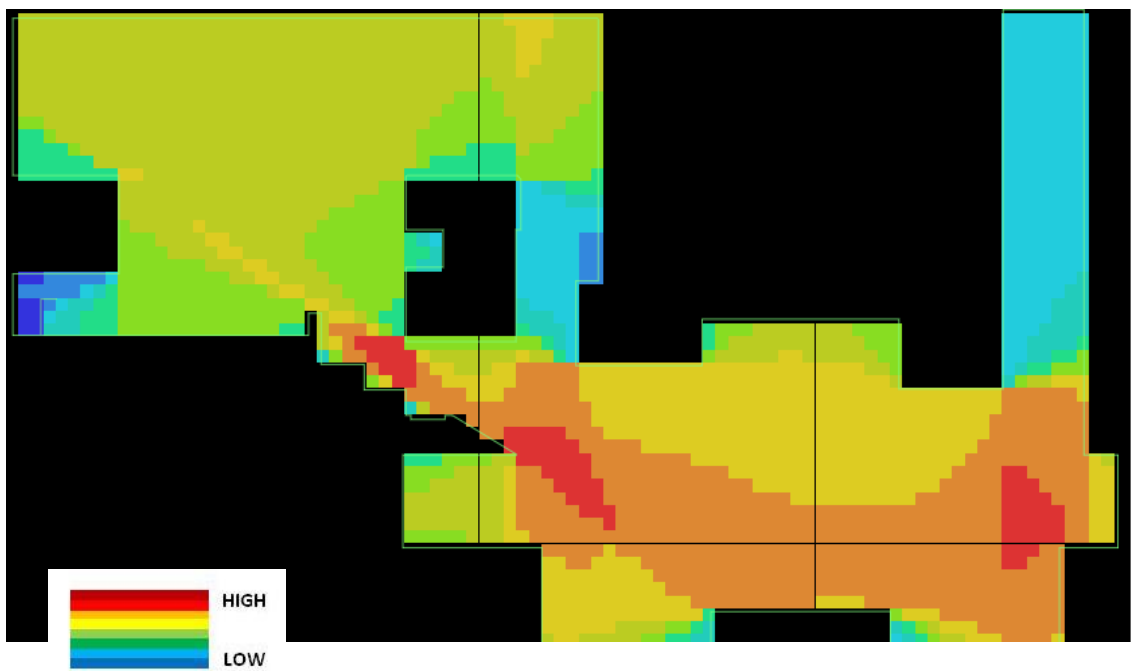


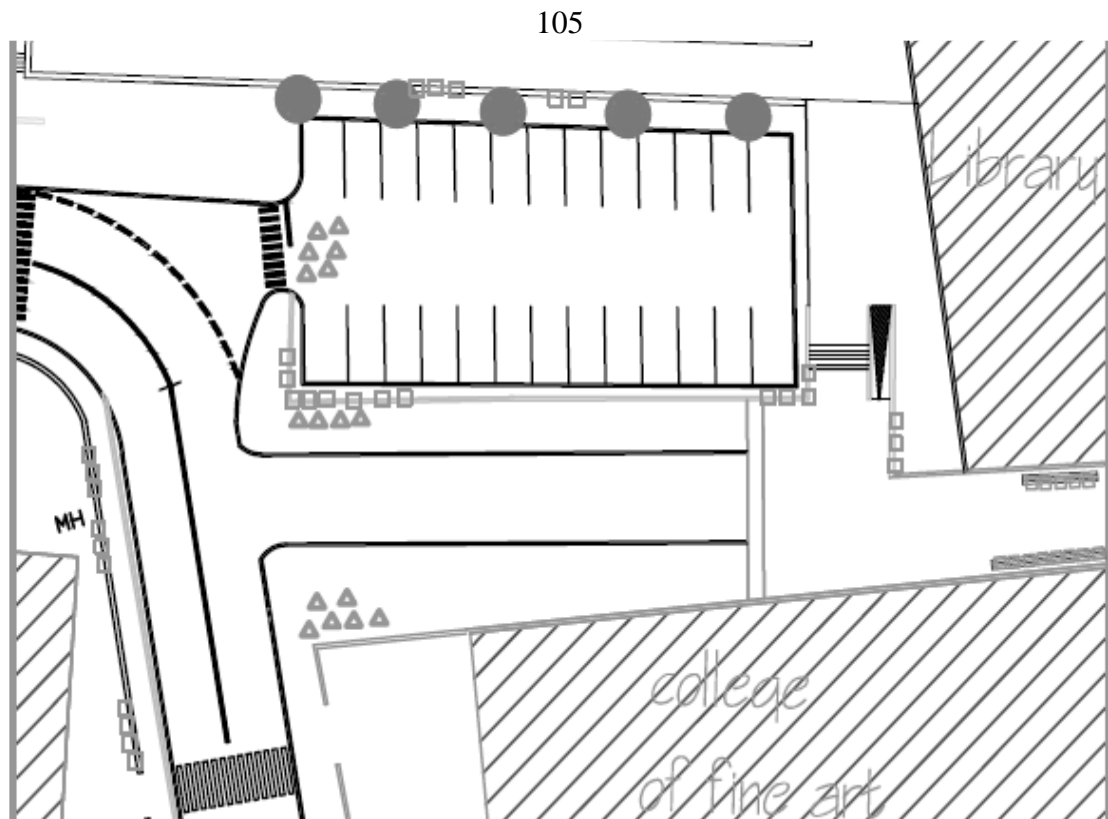
Figure 54: isovist area analysis of the sciences square.

### **5.2.3 The fine art square**

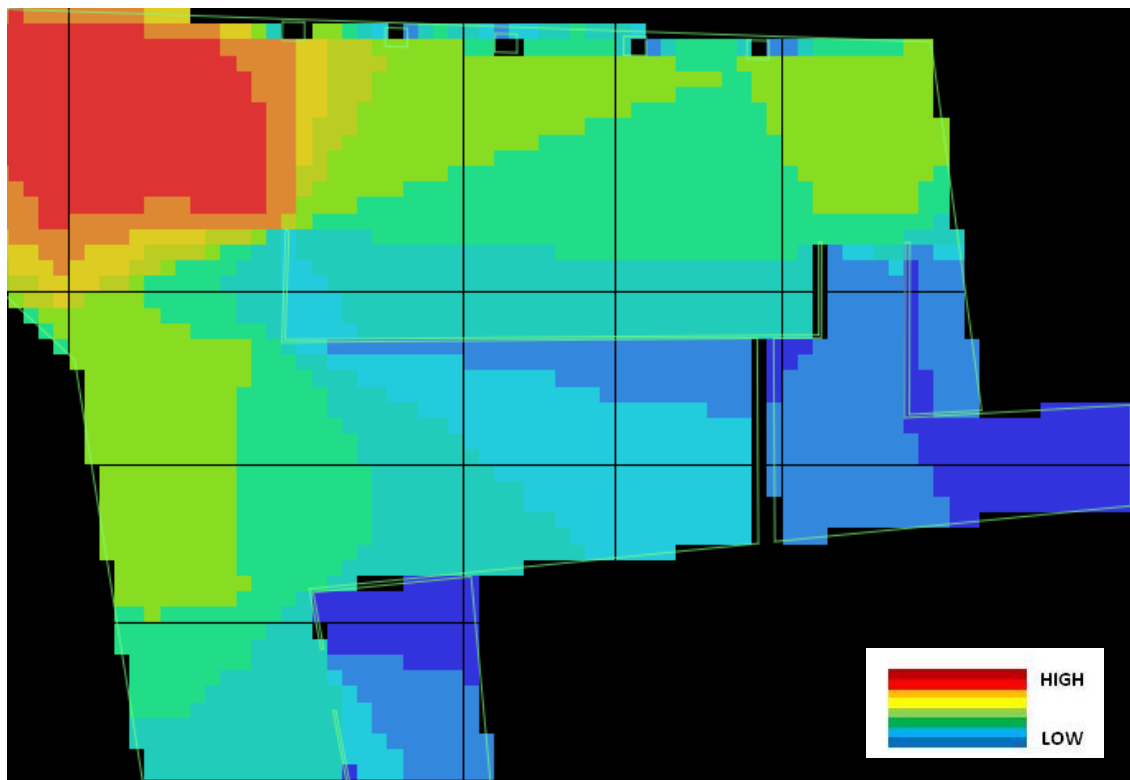
Since this space is mainly a parking space, very few or almost no benches available, except in the path that leads from the white square to it. However you can find several standing and seated students using the space, sitting on ledges around the edges of the space. See figure (56)

Overlapping the visual integration graph with the activity map in figure (58) shows some students with standing position correspond to the high visual integration of value. While most of students using the space correspond to the medium and low integration values, this might be explained by the difference preferences of students. Moreover, students sitting under the trees might seek for privacy or shades from the sun. In addition, although some spaces have low visual integration, they might have a high pattern of movement students. As discussed in the literature chapter, people tend to be where other people are. This explains the high number of sitting students in the path that leads from the white square to this space.

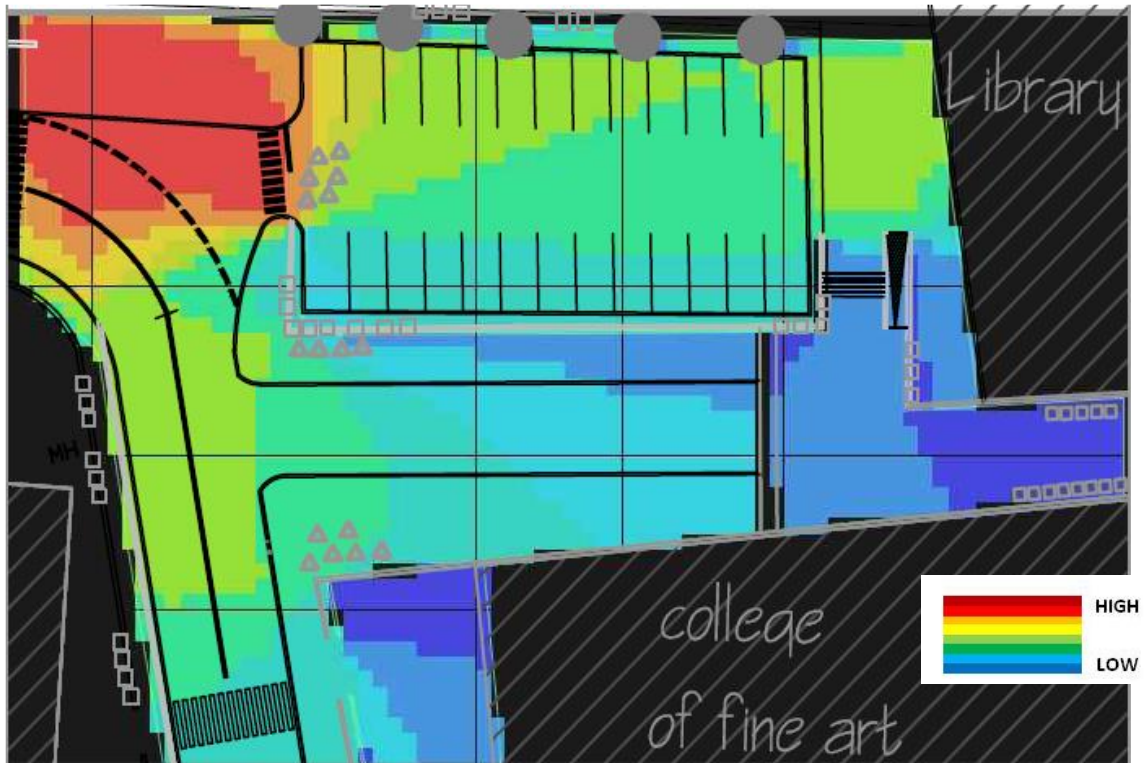
The visual control and isovist analysis might explain the sitting positions of the students on this space. As seen in figure (59), sitting and standing positions correspond with the high values of control and isovist area, where they have a maximum view of the space.



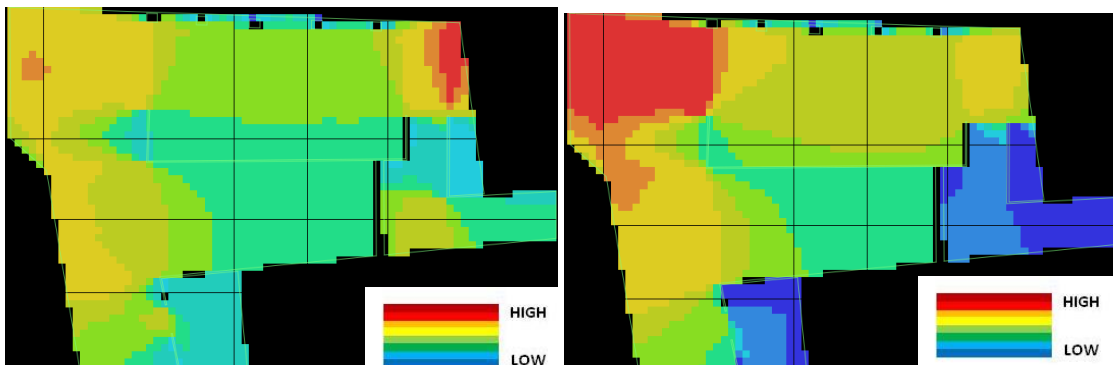
**Figure 55:** activity map of the fine art square.



**Figure 56:** the visual integration for the fine art square



**Figure 57:** overlapping the visual integration with the activity map for the fine art square



**Figure 58:** visual control and isovist area analysis of the fine art square.

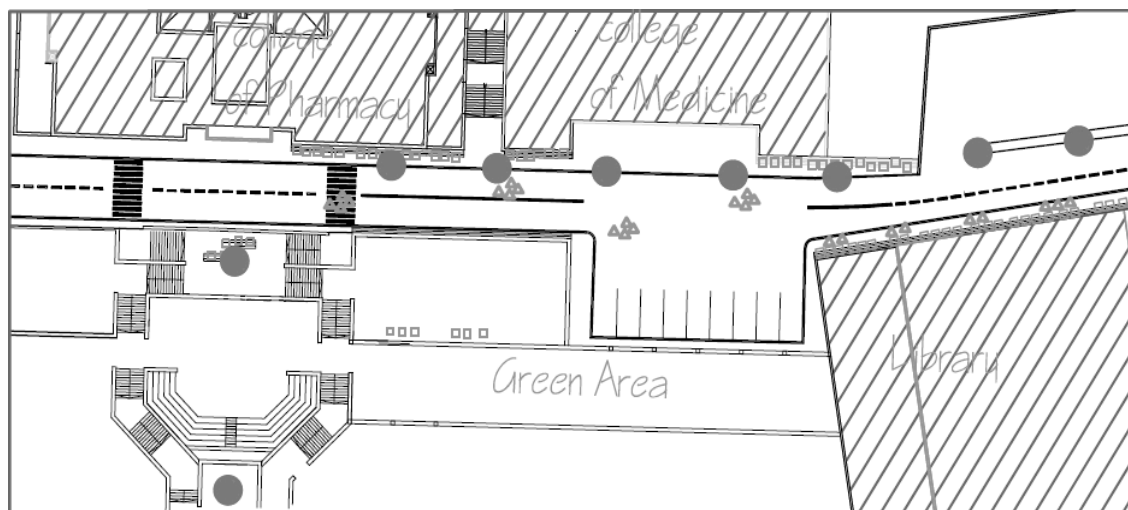
#### 5.2.4 The medical colleges space

The space consists of a street, a parking space and the terraces through the stairs than leads to it from the fine art square. See figure (60)

Students are sitting on the benches and chairs that are available along the sidewalk of the street. Moreover, there is some standing student along the street. The terraces are somehow empty except of few students sitting on benches under the shades of trees.

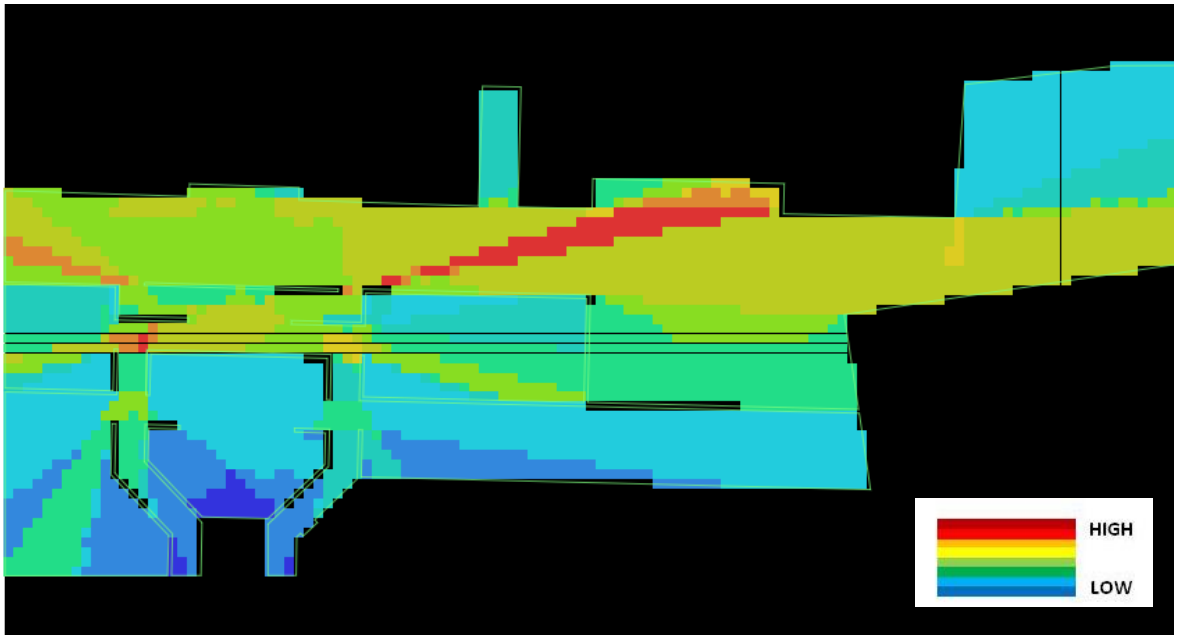
Overlapping the visual integration graph with the activity map in figure (62) shows that most students are seated on area with high visual visibility. Even the few students sitting on the terraces, they correlate with medium visibility integration values.

This also corresponds to the isovist area and visual control analysis, as seen in figure (63). The number of students using the space correlates with the high values of isovist areas and control.

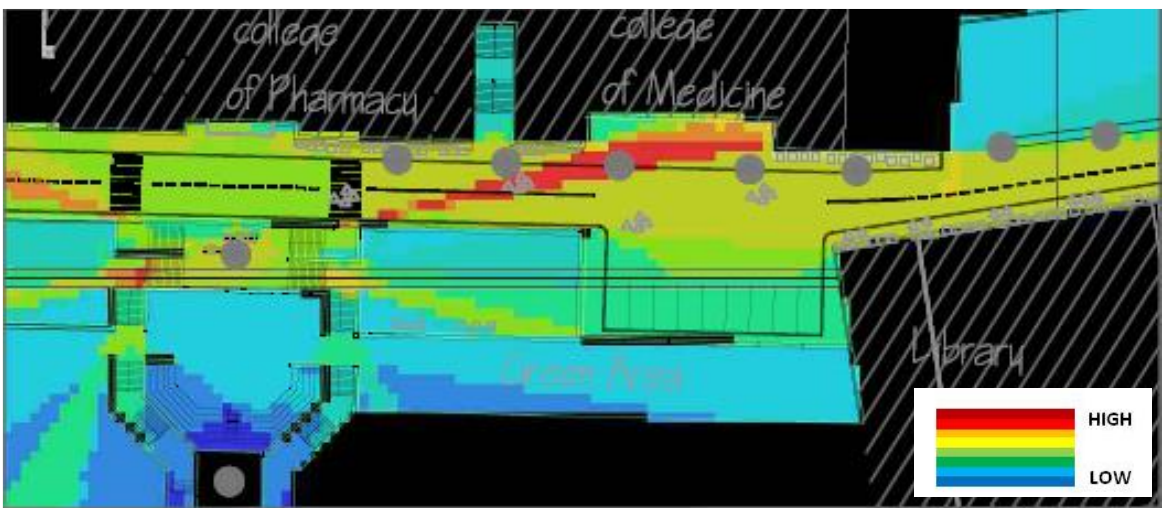


**Figure 59:** activity map of the medical colleges space.

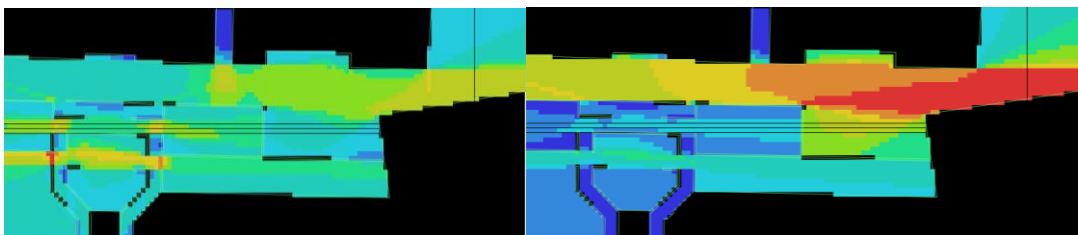




**Figure 60:** the visual integration analysis of medical spaces.



**Figure 61:** overlapping the visual integration with the activity map of the medical colleges.

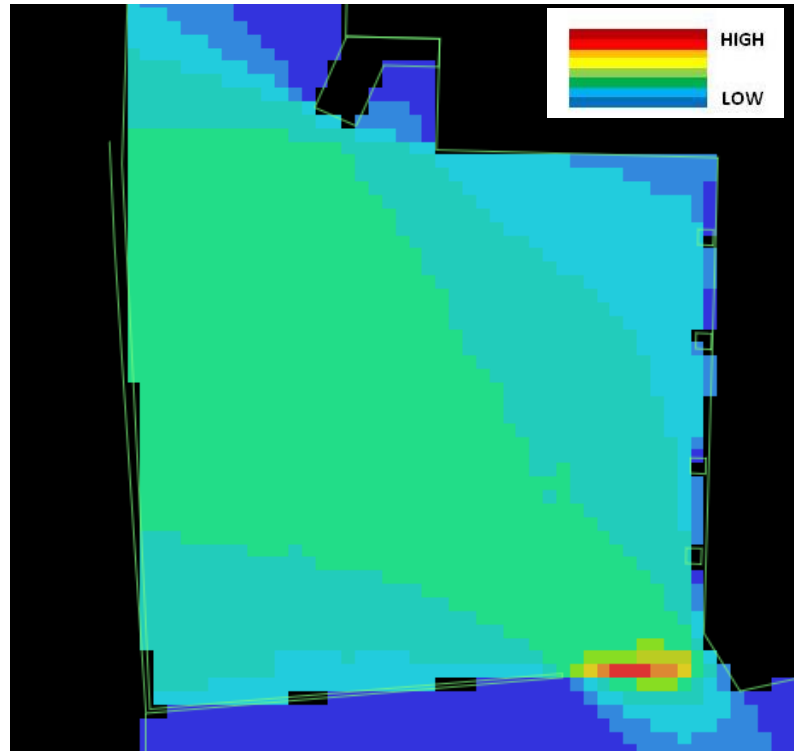


**Figure 62:** visual control and isovist area for the medical space.

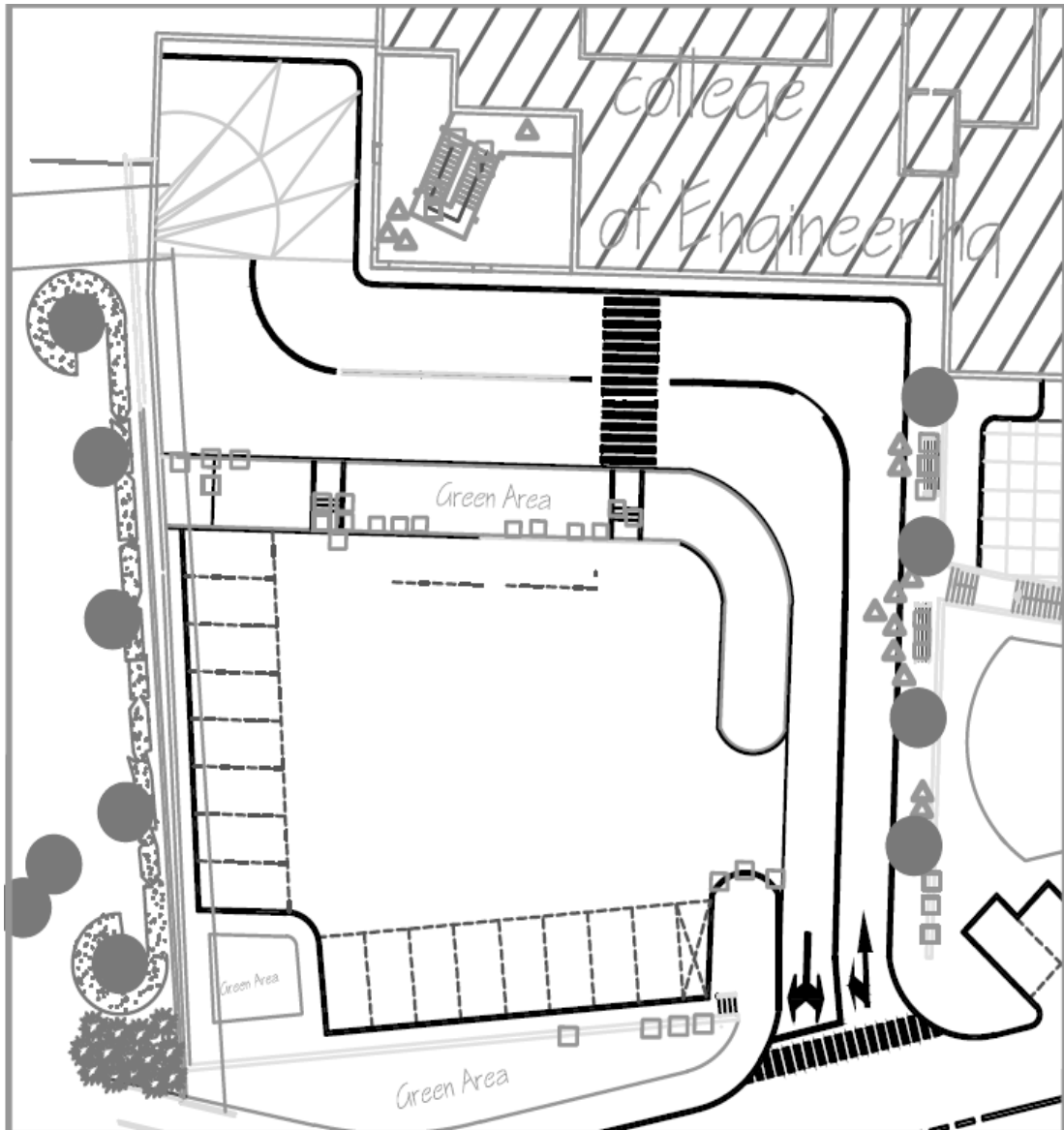
### 5.2.5 The engineering square

The space is a parking space with some green areas and steps. Students are sitting on benches available, on the few steps available, on the sidewalks edges and on the grass of the green areas. While some are sitting on the escape stair of the engineering college. See figure (65)

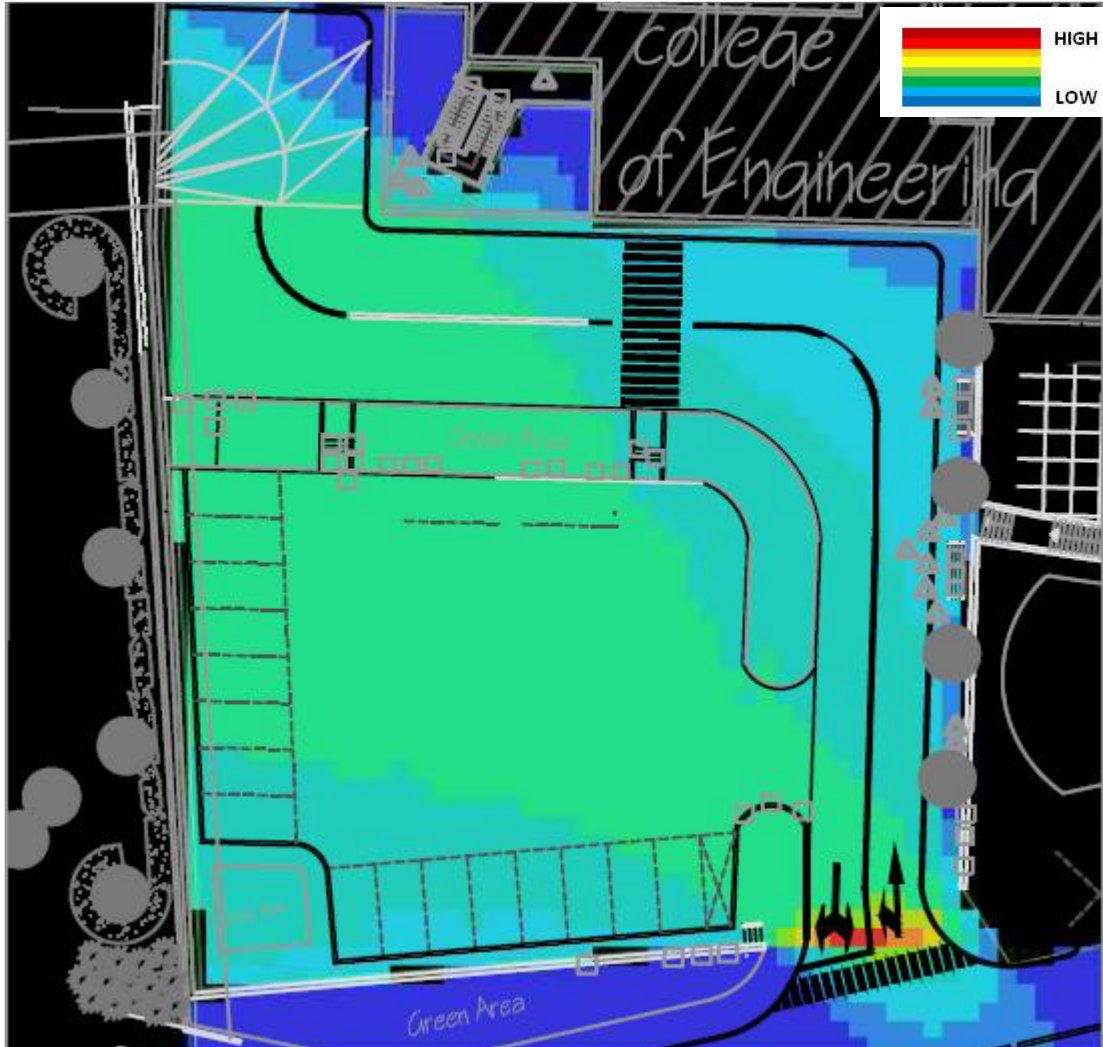
Overlapping the visual integration graph with the activity map in figure (66) shows some observations. Some seated students correspond with the medium value of the visual integration while others who are sitting on benches under the trees are in low visual visibility areas. It might be reasoned with the high isovist area and control shown in figure (67), because of the maximum view available from there. This might explain students sitting on the escape stair as well. In addition students tend to sit where natural elements exists.



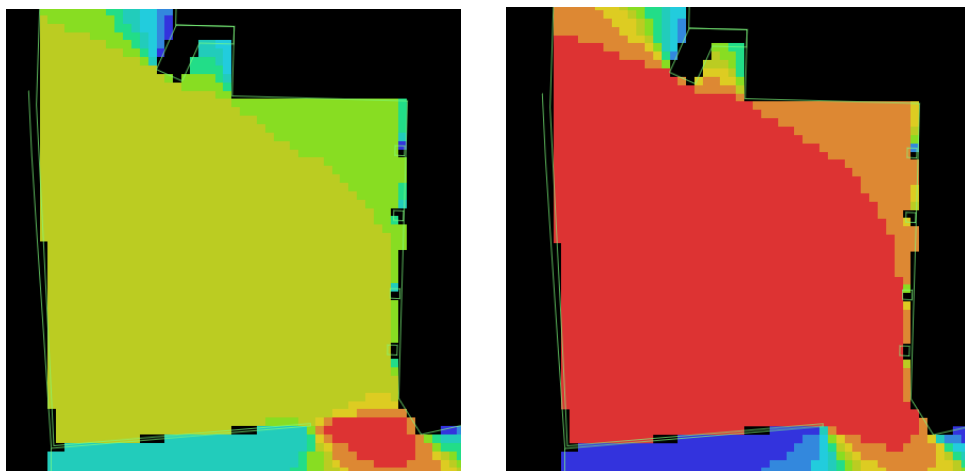
**Figure 63:** visual integration analysis of the engineering square



**Figure 64:** activity map of the engineering square



**Figure 65:** overlapping the visual integration with the activity map of the engineering square



**Figure 66:** visual control and isovist area analysis of the engineering square

### **5.3 Conclusion**

This chapter discussed the correlation between the space syntax analysis done in chapter 4 and the observations from chapter 3. It concluded that students tend to sit mostly on the high visibility areas. Sometimes this is not the case because of reasons such as the availability of seats, the existence of natural elements or the existence of a movement flow. In addition, as illustrated from the literature review chapter, students like to sit on the edges of the space, which most of the time correspond with the high visibility while insuring that their rear is protected so they feel safer.

It also showed that a high flow of movement is correlated with high integration axial lines in the global integration of the whole campus. Except that in some cases it corresponds with vehicular movement rather than pedestrians.

## **Chapter Six**

### **Conclusion and Suggestions**

#### **1.3 Conclusion**

#### **1.4 Suggestions for improvement**

## **Chapter Six**

### **Conclusions and Suggestions**

By analyzing the university campus in details, using observation and space syntax theories, and by spending a great amount of time in the space, the goals of the thesis were realized. This research provided an insight into the spatial configuration of the campus and how it affects the uses of its squares and open spaces.

#### **6.1 Conclusion**

The study is based on the knowledge gained by direct observations, activity maps and using space syntax theory to link between the urban spaces within campus and the students' activities and behavior within them. This knowledge is fundamental in urban design and planning practice. Applying these methods to obtain the actual use of the space and examine potential relationships between the physical features and activities might bring additional insights and criteria for designing and planning process of urban public spaces.

Studying urban open spaces such as squares needs the consideration of the space spatial layout and all its components in order to understand deeply the spatial use.

The research concluded that the spatial configuration has a key impact on how the space is used. The white square since it has a somehow central location within campus and it is connected to several routes and spaces,

was found to be the most used and busiest space on campus, although it is used more as a transitional space, not a destination.

It also showed as Hillier mentioned before, that the strategic value of the integration lines crossing the space has an impact on how used and the successful the space is.

The study also found that the campus lack the amount of adequate seating places, this might explain why the spaces are not really used for static activities. The natural elements presented are not really sufficient and when existed are not well used. The spaces also lack the sense of discovery and 'mystery'. When a person enters the space or the square he can see the whole space. This would create a sense of dullness and reduce the sense of curiosity to discover and walk around the space.

In addition, it was concluded that the visibility is a key element in understanding human preferences. Most static activities occur where visibility is maximizing, but in certain cases like reading or studying this would not be the case.

The combined research method based on available and collected data directly deals with the relationship between activities, uses and the space. Therefore, applying this effective and efficient method resulted in obtaining actual results about existing physical settings and activity relations as well as offering a tool for evaluating the quality of space relative to student's needs.

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 livable spaces.

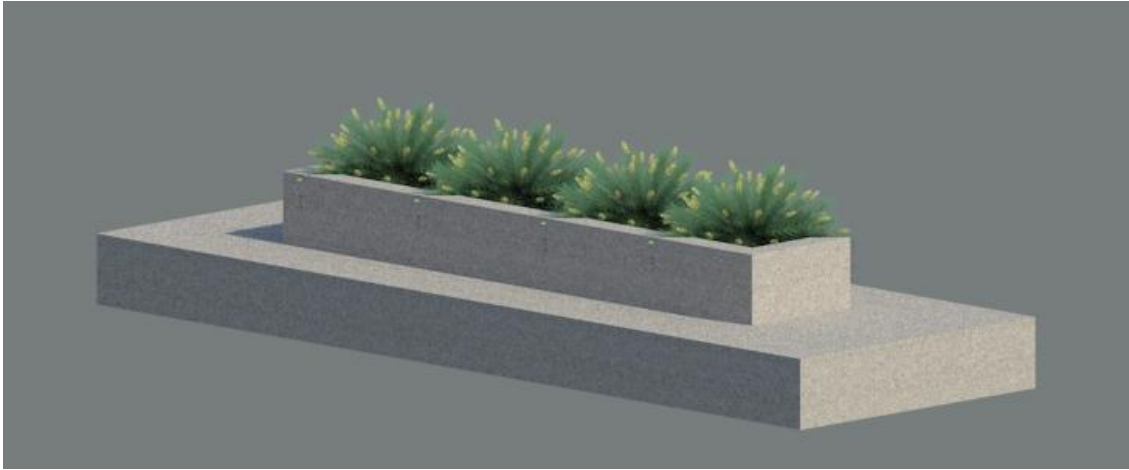


## **6.2 Suggestions for improvements**

One of the solutions is providing movable seats. It can offer a wide variety of choices made by the users. Students can bring those chairs to where they find it comfortable and create their own pleasant environment. Movable chairs also give the preference of facing the sun or setting under the shades and sitting alone or in groups. This could be done on the south east corner of the white square. A small coffee shop, cafeteria or a book shop could be provided, with some tables and movable chairs. This could also be done on the sciences square somewhere nears the east end of the square between the sciences and the physical education college. It is considered an attractor, so it could bring more movement across the square, which would bring more people using the space.

Another solution is placing a landmark in the middle of the square. As Alexander et al. mentioned. It could be a fountain, a large tree or a statue. This could somehow give the square some complexity and gives the user a curiosity to move around and experience the space. A variety of seating could also be introduced surrounding this monument in many different ways. Placing a landmark or a monument will also add to the image of the square and could give the user sense of belonging and character. In addition, this solution might be applied on the sciences square as well. However, since the rest of the spaces are mainly parking areas and street this solution could not be applied.

On the suggestion below, the seating provide an opportunity to set on both sides with the ability to place a natural element whether some small plants flowers or a water element or a small waterfall.



**Figure 67:** seating suggestion

Since the design of the edges is very important and was mentioned repeatedly on the literature, and since most of the space users occupy the edges and prefer it because it provide a maximum visibility to the space with a rear covered. The ledges around the square could be modified. They are more or less one meter high, therefore an additional step could be added which will provide more seating spaces.

These suggestions are examined using space syntax axial line analysis to show how it could alter the integration results.



**Figure 68:** axial line integration analysis of the suggestion.

**Table 8: Strategic value of the squares after the suggestion.**

	White Square	Engineering Square	Sciences Square	Fine art square	Medical colleges street
Strategic Value	14.7	3.69	2.65	8.04	9.96

**Table 9: strategic values for the squares on campus before.**

	White Square	Engineering Square	Sciences Square	Fine art square	Medical colleges street
Strategic Value	10.57	3.69	2.51	8.04	8.41

As we can see from the analysis in figure (72), more lines are intersecting the square. The integration value of the lines crossing the white square is now the highest. Moreover, in spite that the change is only on the white square, the overall strategic value of the whole spaces increased.

Applying the suggestion above to the sciences square as well in figure (73), increased the axial lines crossing the sciences square and also increased its value. Thus this placement will increase movement, and adding an attractor would bring more students using the space.

Finally, more research is needed to be carried out at other campuses in Palestine in order to assess the relationship between spatial layout and interaction and vitality of groups of students.



**Figure 69:** axial line integration analysis for the second suggestion.

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جامعة النجاح الوطنية  
كلية الدراسات العليا

# أثر الفراغ الحضري على سلوك المستخدمين: حالة دراسية جامعة النجاح الوطنية

إعداد  
ندى جمال حسن

إشراف  
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د. ايهاب حجازي

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الهندسة المعمارية  
بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

2017

ب

أثر الفراغ الحضري على سلوك المستخدمين: حالة دراسية جامعة النجاح الوطنية

إعداد

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إشراف

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### الملخص

تهدف هذه الأطروحة للمساهمة في الدراسات العلمية من خلال تحليل استخدام الفراغات الحضرية، لاسيما الساحات في الحرم الجامعي، ودراسة العلاقة بين خصائص الفراغ وأنماط حركة الطلاب. وبالتالي يتم الرد على سؤالين من خلال البحث: ما هي العلاقة بين خصائص الفراغ الحضري الفيزيائية و حركة الطالب؟ وكيف يؤثر التصميم المكاني للحرم الجامعي على حركة الطالب و تفاعله في الفراغ؟

من أجل معالجة هذه المسائل، تم اختيار حرم جامعة النجاح الوطنية كحالة دراسية. استخدمت الدراسة منهج يجمع بين الملاحظة الميدانية و المراقبة المباشرة للساحات، استخدام تطبيقات الهواتف الذكية ونظريات تركيب الفضاء "space syntax"، في الساحات و الفراغات المفتوحة المختلفة في الحرم الجامعي، لتوضيح أنماط الأنشطة التي تتأثر بالتصميم داخل الساحة. الملاحظة الميدانية المباشرة، أعطت خبرة مباشرة و فهم للفراغ. تم تسجيل أنواع ومواقع الأنشطة التي تجري داخل الفراغ. بالإضافة لاستخدام تطبيق الهواتف الذكية للحصول على نتائج أكثر دقة من تحركات وأنشطة الطلاب.

وأخيراً، تم تمثيل التكوين الحضري للحرم الجامعي باستخدام نظريات تركيب الفضاء "space syntax". استخدمت نظريات تركيب الفضاء للعثور على العلاقة بين أنشطة الطلاب في الفراغ و التكوين الحضري للجامعة. وقد أجري تحليل الخط المحوري "axial line"، ومدى الرؤية وتحليل "isovist" لحرم جامعة النجاح الوطنية.

وتمت مقارنة نتائج تحليل نظريات تركيب الفضاء مع المراقبة الميدانية من أجل الخروج بنتائج لهذه الأطروحة.

وخلص البحث إلى أن التكوين المكاني والخصائص الفيزيائية للفراغ تؤثر علي كيفية استخدام الحيز الحضري. بالإضافة إلى أن الساحات في الحرم الجامعي تفتقر إلى وجود كمية كافية من المقاعد والعناصر الطبيعية، وإذا وجدت فإنها لم تستخدم بكفاءة. كما وجدت الدراسة أن نظريات تركيب الفضاء ممكن أن تكون طريقة مفيدة لدراسة العلاقة بين الاستخدام و الإعداد المكاني. وبالإضافة إلى ذلك، مدى الرؤية هي عنصر أساسي في فهم تفضيلات الإنسان، فقد أظهرت الدراسة أن الطلاب يميلون إلى الجلوس في المساحات مع أقصى مساحة من الرؤية. ولذلك، فإن الأطروحة مع المنهجية المقترحة سوف تساعد على معرفة سبب حياة بعض الفراغات الحضرية على حساب الأخرى.