

Duhok University Campus Traffic

Space Syntax (Theory & Method) as Evaluation Tool.

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Abstract

Continuous urban expansion of the University of Duhok has involved the increase in the number of buildings, streets and parking with increase the number of staff, employees and students alike. This expansion has reflected on the traffic movement in the streets and corridors paths of the university, which eventually led to the emergence of the problem of traffic congestion and its negative impacts during the rush hours. The overlapping between the axes of movement both of pedestrians and vehicles occurs as a result of the lack of consideration the spatial configuration design of the street network of the University and its space expansion.

In this study, a novel method was developed to analyse the streets networks of the University of Duhok, in terms of its spatial urban designs and the functional structures based on Space Syntax Approach using the depth map as an analytical tool. In our new methodology, the researchers investigated the syntactic properties of movements axes based on two parameters: integration and choice in order to: identify the most crowded street path which has a connection with more than one road; interpret the functional structure of the University. Plenty of the tests to the architectural hypotheses were conducted to analyse the causes of traffic congestion and the absorptive flaws in the spatial configuration of the network streets of the University of Duhok.

The results revealed that the compact paths and crowded streets are escalated because they connected to the main road with several entrances in the most congested road axes. It is concluded that the redirection of the connection entrances of roads with streets through changing their spatial connection points and the functional structure can lead to mitigate the severity of traffic congestion. A distinctive specialty of the proposed approach has its applicability to help in reducing the congestion in the University of Duhok and to verify the feasible solutions to avoid the problems of the traffic congestion in the future.

Keywords: Space syntax, spatial configuration, axial map analysis, Duhok University Campus, Traffic congestion.

I-INTRODUCTION

Over the years, space syntax analysis has contributed to a greater understanding of the spatial configuration of street and road networks, and how these kinds of configuration affect movement flows, the location of economic activities, and the numerical levels of street life an alternative type of analysis is to use a methodology known as space syntax. Space syntax is a set of techniques for representing the street networks to analyze the underlying patterns and structures, which influence movement of people and land use. Street permeability is not only related to street characteristics, but also to the spatial configuration of the street network. A street network is analyzed as a network of choices, and then represented in maps and graphs that describe the relative connectivity and Integration of those streets.

II-UNIVERSITY OF DUHOK: HISTORIC EVALUATION AND URBAN MORFOLOGY

The University of Duhok (UOD) was established on October 31st, 1992, with two colleges and 149 students. The first colleges established at the University of Duhok were the College of Medicine and the College of Agriculture. Initially, the College of Medicine had 48 students, while the College of Agriculture had 166. During the first two years, embargoes imposed by the UN on Iraq and by the Iraqi Central Government on the Kurdistan Region contributed to the slow-paced growth of the University of Duhok and the poor economic conditions in Kurdistan. Today, the University has expanded to contain 17 colleges; The University of Duhok was founded following a resolution by the Parliament of the Kurdistan Region to address the increasing demand for higher education in the region. It is a fast-growing institution in the Duhok. It is situated on the international highway between Iraq and Turkey. It plays a vital role in developing the community by instigating socioeconomic, cultural, scientific as well as educational progress in the Kurdistan Region of Iraq⁽¹⁾. (Figure 1)



Figure 1: Duhok University Site, Aerial View

III-SPACE SYNTAX METHODOLOGY

Space Syntax's procedure is based on the representation and quantification of environmental characteristics of the environment with the aim to use them as independent variables for a statistical analysis of observed behavioral patterns such as routes and flows⁽²⁾.

According to Space Syntax, the total urban space network, defined by the natural form of the urban tissue of every settlement or city, can be considered as a single and continuous spatial system⁽³⁾. This system can be divided into components, followed by the analysis as connectivity and integration of those spaces.

The most widely used Space Syntax analysis method is integration. Integration method uses shortest path algorithms in order to measure the number of turns one would have to make when located at a street segment to reach other street segments in the network. In case where the amount of turns required for reaching all segments in the graph is analyzed, the analysis is said to measure integration at radius n (global integration). It is not necessary to apply the integration analysis to the whole network, it can also be applied and analyzed in local scale. If the integration is measured at radius 3 for instance, only three turns are counted departing from each street segment. The Space Syntax integration value represents the degree of integration of the initial segment in the system. A higher value indicates more connectivity to the network while a lower one shows segregation⁽⁴⁾. The results of the analysis are presented in colored axial maps, in which each axis has a differentiation in color depending on its integration value, ranging from red (high values) to purple (low values).

A schematic approach of space syntax analysis relies on the concept of graphs. An informal definition of the graph suitable for this analysis could be the following: a graph is a finite set of dots called vertices (or nodes) connected by links called edges (or arcs). In the case of the axial map, the streets play the role of the vertices of the graph while their interconnections correspond to the edges. The integration measures are well – established topological parameters⁽⁵⁾.

Space Syntax can compare to transport models, though it was pointed out that they are based on different representation

systems: transport models are characterized by node-link representation, whereas Space Syntax is based on a graphic representation of the environment highlighting the morphologic structure of an urban area (axial map) as a starting point to describe spatial configuration⁽⁶⁾.

IV-DEPTHMAP SOFTWARE AS AN ANALYSING TOOL

DepthMap is primarily a computer program to perform visibility analysis of architectural and urban systems. It takes input in the form of a plan of the system, and is able to construct a map of 'visually integrated' locations within it. In addition, the most recent version of DepthMap now supplies a range of configurational analyses, which come under the umbrella term of 'space syntax'. Space syntax analyses examine the relationships between components of space; each analysis starts with a representation of the spatial components, then makes a graph of these components, and finally analyses this graph using, for the most part, conventional graph theoretical measures. The analyses available within DepthMap include the original visibility analysis, generation and analysis of axial maps as well as segment analysis.⁽⁷⁾

V-RESEARCH, PROBLEM, OBJECTIVE, METHOD

This research addresses the problem of expansion in University of Duhok has reflected on the traffic movement in the streets and corridors paths of the university, which eventually led to the emergence of the problem of traffic congestion and its negative impacts during the rush hours.

Also, the overlapping between the axes of movement both of pedestrians and vehicles occurs as a result of the lack of consideration the spatial configuration design of the street network of the University and its space expansion.

The aim of this research is to invest the spatial configuration of the Duhok University campus as impact factor to analysis the streets and nodes by using the space syntax theory as method and tool to solve the problem of the traffic congestion. Method that used by this research to analyze the streets networks of the Duhok University, in terms of its spatial urban designs and the functional structures based on Space Syntax Approach using the depth map as an analytical tool. (Figure 2), (Figure 3)



Figure 2: Duhok University Site, Traffic Intersection

VI-RESEARCH METHODOLOGY

In methodology of this research, is investigated the syntactic properties of movements axes based on parameters: Connectivity, integration and choice in order to: identify the most crowded street path which has a connection with more than one road; interpret the functional structure of the University. Plenty of the tests to the architectural hypotheses were conducted to analyse the causes of traffic congestion and the absorptive flaws in the spatial configuration of the network streets of the University of Duhok.

Space Syntax methodology adopted by this research is to assess and develop the spatial configuration of university campus by using space syntax theory as a method and DepthMap software program as a tool.

VII-SPACE SYNTAX ANALYSIS: DUHOK UNIVERSITY CAMPUS SYNTACTIC PROPERTIES ANALYSIS:

DepthMap as application program created by Alsadir Turner in 1998 in university of London to analyze the Visibility Graph analysis(VGA) in architectural and urban space and its input from a plan.

For campus of the University, the streets network as (DXF.) format drawings imported into DepthMap to generate all axial lines map in one click covers all the campus system, after that the lines reduced to a fewest line- map.

Thus, the VGA analysis starts to calculate the related syntactic properties. (Figure 4)

VIII-MESURMENT OF SYNTACTICAL PROPERTIES: INTEGRATION, CHOICE, INTELLIGIBILITY:

According to space syntax theory, and to Hillier (1987) and his colleagues found the syntactic properties- integration (To Movement) refers to how many lines up to number -n step from each line (8). Also, Klarqvisit (1999) defined the integration is a static global measure. It describes the average depth of a space to all other spaces in the system.

The spaces of a system can be ranked from the most integrated to the most segregated.

While the Connectivity is “measures the number of immediate neighbors that are directly connected to a space. This is a static local measure.”(9), for Hillier Connectivity is a property of the line that can be seen from the line, whereas global integration couldn't be seen from the line, (10).

And for Global choice “is a dynamic global measure of the “flow” through a space. A space has a strong choice value when many of the shortest paths, connecting all spaces to all spaces of a system, passes through it” (11)

While Hillier found it refers to how likely to pass through all shortest line from one space to another (12).

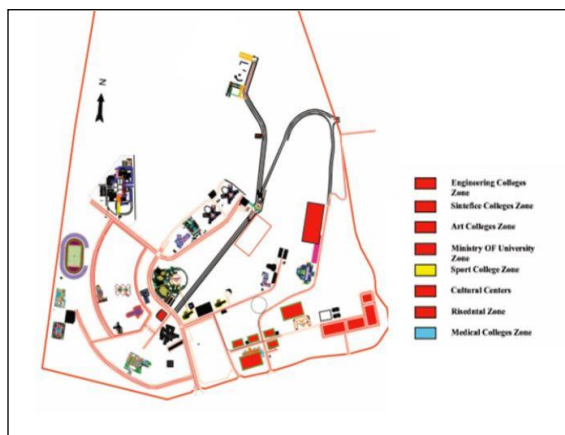


Figure 3: Duhok University Site, Buildings Zoning

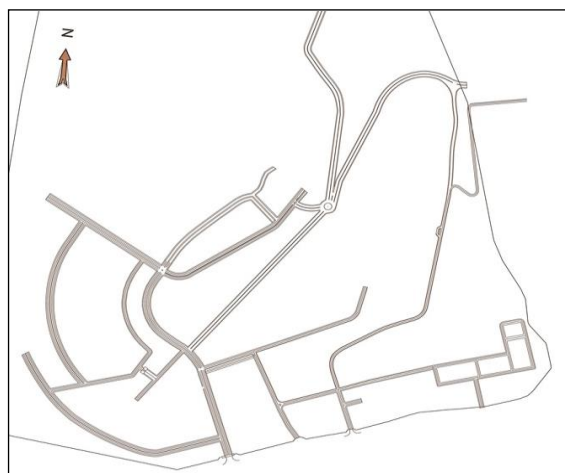


Figure 4: Duhok University Campus, Geometrical Plan

Each axial line covered the system in axial map in the university campus has its syntactic properties different from other lines.

For intelligible measurement regarding to Hillier a good systems, the integration core relate to all other areas, this is mean whenever you are in the system you are never away from a high integration line, and it is an indicator how the urban spaces structured, so define as the degree to which what

can be seen and experienced locally in the system allows a large scale system to be learnt without conscious efforts. It is measure the relationship between the connectivity of space to the global integration. ⁽¹³⁾

Thus, for the campus system the result shows unintelligible spatial layout because the scatter diffused and that mean is poor and not a perfect correlation for the campus system. (Figure 5) (Figure 6).

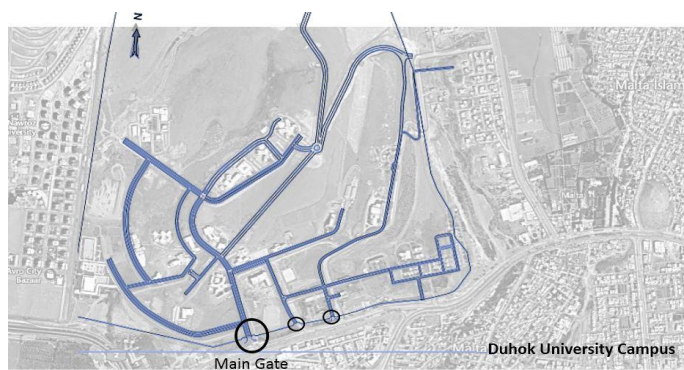


Figure 6: Duhok University Site, Main & secondary Gates

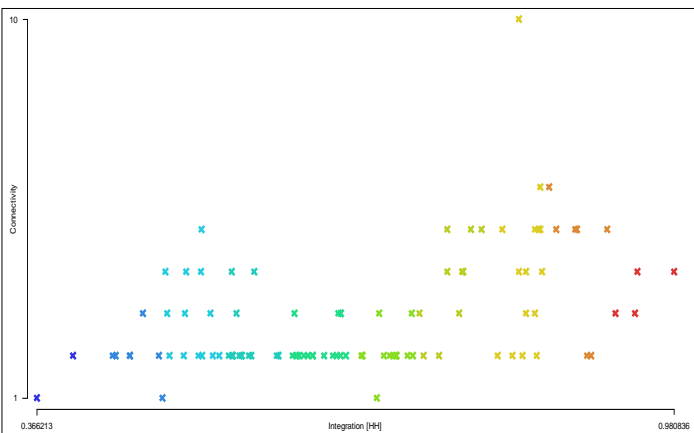


Figure 5 Scatter Diagram, Unintelligible Spatial System

Links the main segments in the campus represent the integration core of the system (Hub with spokes) that consist of the longest integrated lines in the central area of the campus system and surrounding by the low level of integration values gradation to the ends of the campus to the more segregated lines. (Figure 7a), (Figure 7b)

Thus, the average of Global integration (n) appears (0.67) with max (0.9) and min (0.36). (Figure 8a) (Figure 8b) (Table 2)

IX-SYNTACTIC PROPERTIES ANALYSIS: DUHOK UNIVERSITY CAMPUS DISCUSSION AND RESULTS

According to Hillier and the researcher came behind him, there are a strong relationship between the spatial integration in the axial map and observed human movement flows in urban areas. The space syntax and the syntactic properties- integration related to the spatial behaviors, observed that the more integrated lines are the grater traffic⁽¹⁵⁾. Hence, for the VGA analysis of the Duhok university campus and specify for the highest values of integration and choice means the most congested areas or the most crowded streets in the university campus and vice versa, But this is not desirable to achieve the research objective.

According to axial lines map that covered the system in total (105) lines with the Fewest- line map (minimal) with maximum line length (684m), that located in the central area of the university campus closed to the main gate of the university, while the shortest line with (1.0m) with (188m) represents the average of line length. (Table 1)

Regarding to the axial map analysis, observed that the largest lines and the most line intersected are connected to the other lines, and nearest to the main entrance located in the midpoint of the campus.

The result of syntactic properties –integration analysis show the more integrated lines are faced the main gate and

Line Length		
Values		
Value	Attribute	Selection
Average	188.216	No Value
Minimum	1.01342	No Value
Maximum	684.733	No Value
Std Dev	139.104	No Value
Count	105	0
< 69.385365	17	No Value
69.385365 to 137...	30	No Value

Table 1: Line length Values

For the Global Choice the average is (0.12) with the max (0.53) and min (0). (Table 3)

The highest choice value located in the midpoint of the system nearest the main gate of the university.

In the urban space for both syntactic properties integration + Choice the same axial line or street has the highest value. (Figure 9) (Table 4)

Integration [HH]		
Values		
Value	Attribute	Selection
Average	0.675919	0.88585
Minimum	0.366213	0.88585
Maximum	0.980836	0.88585
Std Dev	0.144876	0
Count	102	1
< 0.427675	2	0
0.427675 to 0.48...	7	0

Table 2: Integration H-H Values



Figure 7a: Axial lines map, Integration core

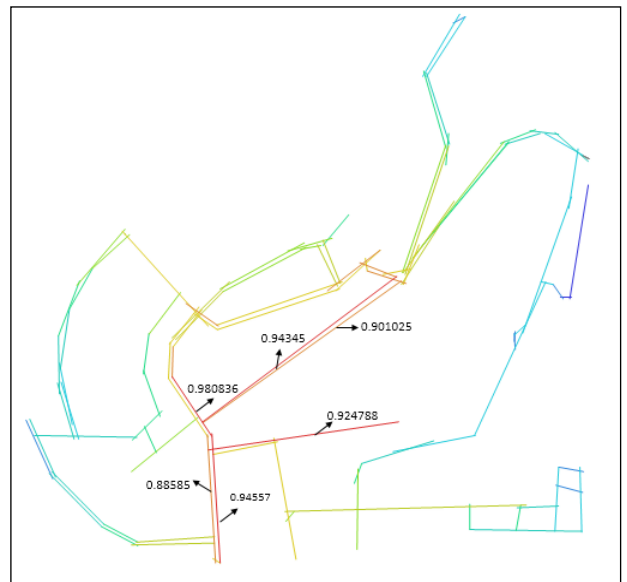


Figure 7b: Axial lines map, Integration core values



Figure 8a: Axial map- All lines, integration H-H

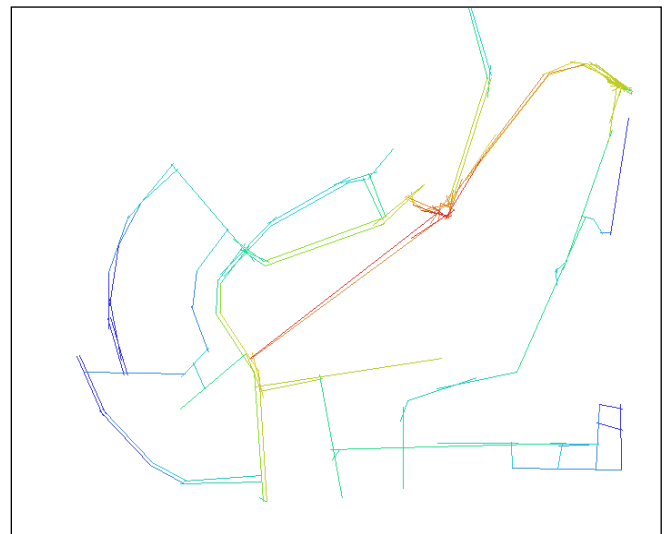


Figure 8b: Axial map- fewest line, integration H-H

Syntactic property	Average	Maximum	Minimum
Integration (n)	0.67	0.98	0.36
Choice (n)	0.12	0.53	0
Connectivity	2.87	10	1

Table 3: Axil map analysis, Syntactic properties

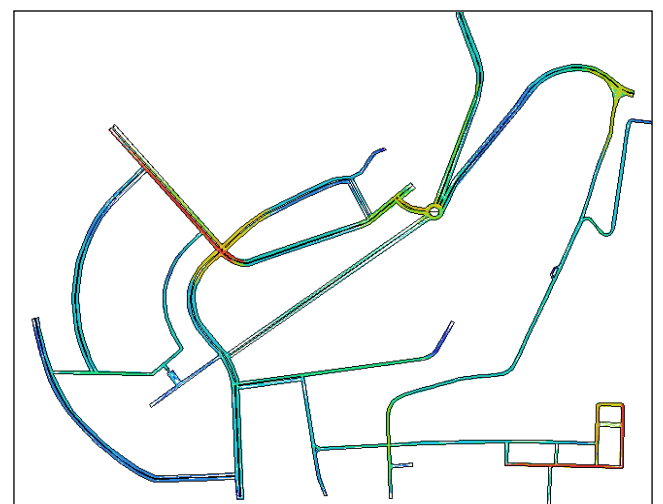


Figure 9: Axial map, Connectivity

Choice [Norm]		
Values		
Value	Attribute	Selection
Average	0.125703	0.533861
Minimum	0	0.533861
Maximum	0.533861	0.533861
Std Dev	0.130976	0
Count	105	1
< 0.053386	40	0
0.053386 to 0.10...	20	0

Table 4: Choice Values

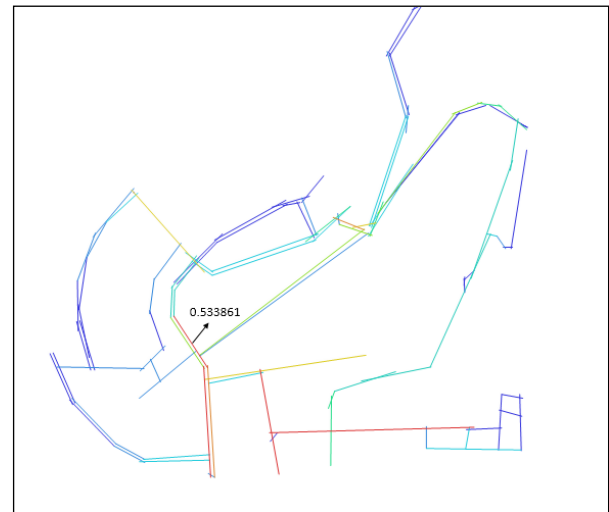


Figure 10: Axial map, Global Choice

X-CONCLUSION:

Space syntax analysis for Duhok university Campus shows the more integrated lines (high integration and choice value) located in the midpoint of the central area linked other spaces, nearest to the main entrance toward the most segregated lines to the end of the campus system. In addition the study provide various findings about visibility Graph analysis (VGA) analysis, Connectivity, Integration, Choice. This analysis shows that the most density and strength flows of pedestrian and vehicles occurred in the strong spatial configuration that connected to all other spaces in the system.

Hence, the estimation of which street has traffic congestion become clearer after the spatial analyzed and their syntactic properties calculated.

Thus, revealed that the compact paths and crowded streets are escalated because they connected to the main road with several entrances in the most congested road axes.

It is concluded that the redirection of the connection entrances of roads with streets through changing their spatial connection points and the functional structure can lead to mitigate the severity of traffic congestion. A distinctive specialty of the proposed approach has its applicability to help in reducing the congestion in the University of Duhok and to verify the feasible solutions to avoid the problems of the traffic congestion in the future.

REFERENCE:

- 1 - www.UOD.Ac
- 2 - Penn, A. *Space Syntax and Spatial Cognition. Or why the axial line?* *Environment & Behavior*, 35, 30-65. 2003.
- 3 - Hillier, B., & Hanson, J., *the Social logic of space.* Cambridge: Cambridge University Pres. 1984.
- 4 - Hillier, B., & Hanson, J., Grajewski, T., & Xu, J. *Natural movement: or, configuration and attraction in urban pedestrian movement.* *Environment and Planning B: Planning and Design*, 20(1), 29-66. 1993.
- 5 - Hillier, B., *The hidden geometry of the deformed grids: or, why space syntax works, when it looks as though it shouldn't* *Environment and Planning B: Planning and Design*, 26 169-191. 1999
- 6 - Nenci, A.M. & Troffa, R. *Integration space syntax in wayfinding analysis.* In: C. Holcher, R. onroy Dalton & A. Turner (Eds.) *Space syntax and spatial cognition.* (pp. 181-184). Bremen: Universitat Bremen. 2007.
- 7 - Turner, A., *\Depthmap 4 | A Researcher's Handbook*", Bartlett School of Graduate Studies, UCL, London. 2004, - <http://www.vr.ucl.ac.uk/depthmap/depthmap4>.
- 8 - Hillier et al, *the Social logic of space.* Cambridge: Cambridge University Pres. 1987.
- 9 - Klarqvist.B. (1993). *A Space Syntax Glossary.* NORDISK ARKITEKTUR FOR SKNING.
- 10 - Hillier, B., Hanson, J., 1984, *The Social Logical Space*, London, Cambridge.
- 11 - Klarqvist.B. (1993). *A Space Syntax Glossary.* NORDISK ARKITEKTUR FOR SKNING.
- 12 - Hillier et al, *the Social logic of space.* Cambridge: Cambridge University Pres. 1987.
- 13 - Hillier B., Penn, A., Hanson, J., Grajewski, T., and Xu, J., 1993, "Natural Movement: Or, Configuration and Attraction in Urban Pedestrian Movement", *Environment and Planning B: Planning and Design*, 20, pp. 29-66