Studying the efficiency of spatial organization in a general hospital using space syntax software

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Abstract - Hospital design is a complex process comprised of wide range of services and functional units. On one hand, there are multiple departments working closely with one another and on the other hand, many other working remotely. It is imperative to study the planning of various departments of hospital in terms of intelligibility, way finding, integration etc. since difficulties in complex healthcare settings can cause stress to patients, missed appointments, and distract staff time to giving directions. Springing from the notion that hospitals are small cities, urban design strategies have been employed in healthcare studies to analyse the problems in planning in a better way. Our objective is to educate the readers on having a basic understanding of the space syntax software and how it can be used to generate various maps to facilitate the problems raised in planning and their rectification. This study proposes a comprehensive system of analysis for hospital design through the use of space syntax software, depthmapX. Through this paper, we'll see how concerns like safety/security, way finding in hospital etc. can be solved through the use of this software. This will be a revolutionary study and will make the jobs of architects and healthcare planners easier.

***Key Words*:** space-syntax, depthmapX, Hospital design, Healthcare planning.

1. INTRODUCTION

Hospital designing is system of various functions overlapping each other. With hospital designing becoming complex with advancing time and technology, the scale of hospitals has drastically increased. With the use of software, analysis of planning can be efficiently done with much lesser time and higher accuracy. With this study, we would like to answer a very prominent question amongst us.

"How can space syntax software like depthmapX be used for analysing the spatial organization of hospital design?"

2. UNDERSTANDING SPACE SYNTAX

Space syntax was pioneered in the 1970s by Prof Bill Hillier, Prof Julienne Hanson and colleagues at The Bartlett, University College London. Space syntax is a science-based, human-focused approach that investigates relationships between spatial layout and a range of factors like movement pattern, intelligibility of a space etc. (Space Syntax Limited, n.d.)

Space syntax research is reason based, and more rigorous than most, but it has effectively led to the study of architectural intuition through its creations. In practice, design proceeds by mixing intuition and reason. Space syntax makes the deployment of non-discursive intuition more rational and therefore more discursive. (In, 1990)

It uses theory of space and other quantitative and descriptive tools for analyzing buildings, interior spaces, landscapes, cities, parks etc. It is concerned with the relationship between humans and spaces inhabited by them. It is believed that distinctive characteristics of societies can be studied through their spatial network and human behavior within them. (Dettlaff)

It can be understood in the way, as treating streets, squares, rooms as voids obstructed by walls, fences etc. restraining visual access or pedestrian movement. The idea assumes that most people, most of the time, will take the simplest route to

their destination. That route tends to involve the fewest changes of direction. The more changes of direction, the more complex the system, and therefore the more ineffective or inefficient the network design becomes.

The aim of space syntax research is to develop strategies of description for configuring inhabited spaces in such a way that the underlying social meaning can be enunciated. This is turn can allow for secondary theories or often practical explanations to be developed regarding the effects of spatial configuration on various social or cultural variables. A related theme in space syntax research is to understand configured space itself, particularly its formative process and its social meaning. (Nourian, Rezvani, & Sariyildiz, 2010)

2.1 NEED OF SPACE SYNTAX IN ARCHITECTURAL DESIGN

In architecture, design is a kind of activity that is learned by designing or experiencing and architects discover much about design problem by evaluating their solutions. A comprehensive architectural knowledge helps architects in this process. Critical questions arise at this point: How does an architect evaluate his/her ideas? How does an architect test the spaces that s/he has created? What kind of architectural knowledge leads to this process? Does this knowledge include intuition, feelings, and experiences or does it consist of theory, science and research? Similar to Vitruvius' (1990) definition, architectural experience is a combination of practice and theory. During the design process, the architect must bring intuitive and rational ways of thinking together, in other words mystery and certainty, intuition and science, practice and research. By linking these two ends together, this study aims to focus on the configurational theory of space, namely space syntax, and to explore its contribution to architectural design process.

2.2 TYPES OF SPACE SYNTAX ANALYSIS

2.2.1 VISIBILITY GRAPH

Visibility graph analysis (VGA) in architecture is a method of study of the inter-visibility links within buildings or urban networks. Visibility graph analysis was developed by Turner et al. (2001) from the architectural theory of space syntax, and is applied through the development of a visibility graph within a plan's open space. (Pinelo & Turner)

Analysis of the visibility graph uses different measurements from the theory of small-world networks and centrality in network theory to determine the perceptual qualities of space and its potential use.

2.2.2 VISUAL STEP DEPTH

Step depth illustrates the number of steps (changes of direction) it would take to get from the selected location to any other location in the graph. Selected location has step 0. All locations directly visible from selection have step 1; all locations directly visible from those at step 1, have step 2, and so on throughout. It measures how easily or with least turns one can reach destination. (Pinelo & Turner)

2.2.3 ISOVISTS

A single isovist is the amount of space observable from a given point in space, along with a definition of that point's position. Depth map can generate polygons from a certain position called 'isovists' that represent the possible field of view. (Pinelo & Turner)

3. METHODOLOGY

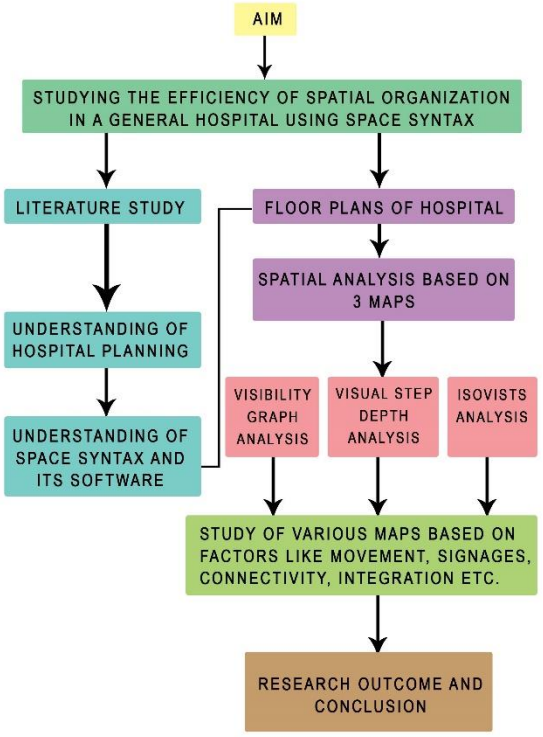

Figure 1: Methodology

4. ANALYSIS

4.1 VISIBILITY GRAPH ANALYSIS

4.1.1 GROUND FLOOR PLAN OF HOSPITAL

Figure 2: Visibility graph analysis of ground floor plan

The areas are coloured according to how many other locations are visible from it. The range runs from blue (for low) through green and yellow to red (many visible locations).

1. The red colour indicates that many locations are visible from that area going from yellow to green to blue depicting least visible area.

2. Most internal rooms are, as expected, blue in colour.

3. The waiting areas of emergency, OPD and other consultation rooms show green colours depicting moderate visibility.

4. Corridor just in front of cafeteria is most visible. This may not be desirable in a hospital setting.

5. The solution could be to shift my entrance to the OPD department in place of cafeteria, making the most of that space since maximum number of spaces are visible from that area.

4.1.2 SURGICAL SUITE

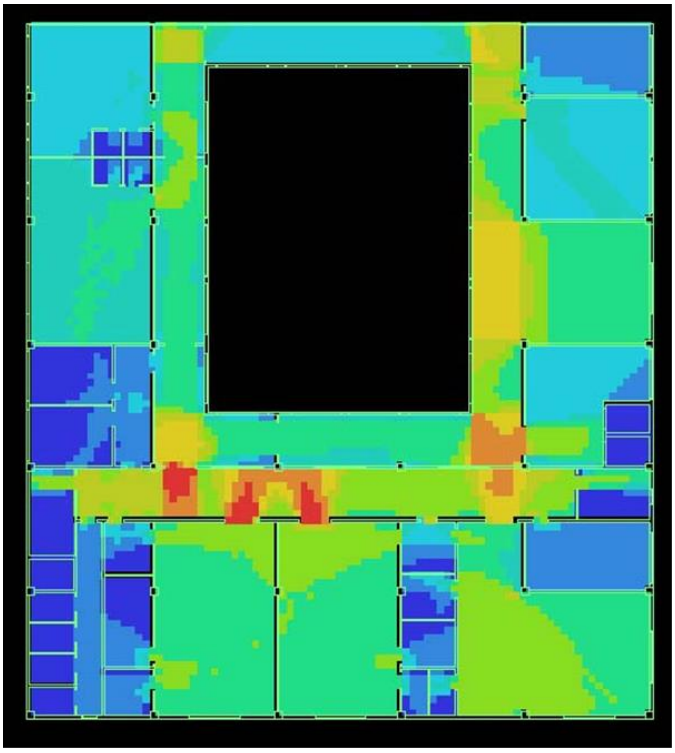

Figure 3: Visibility graph analysis of surgical suite of hospital

1. The area in front of operation theatre has the maximum number of visible points which is desirable.

2. Pre-operative ward and post-operative ward are in the green range depicting moderate visibility.

4.2 VISUAL STEP DEPTH ANALYSIS

4.2.1 GROUND FLOOR PLAN OF HOSPITAL

Figure 4: Visual step depth analysis of ground floor of hospital

Blue areas depict the least number of steps and red indicates the maximum number of steps to reach to the desired point.

1. The diagnostic department in yellow colour depicts that from the main waiting area, it is far off. However, as we have seen in the previous VGA graph, shifting the OPD entrance in place of cafeteria would bring the diagnostic department in close proximity of emergency as well as the OPD department.

4.2.2 SURGICAL SUITE

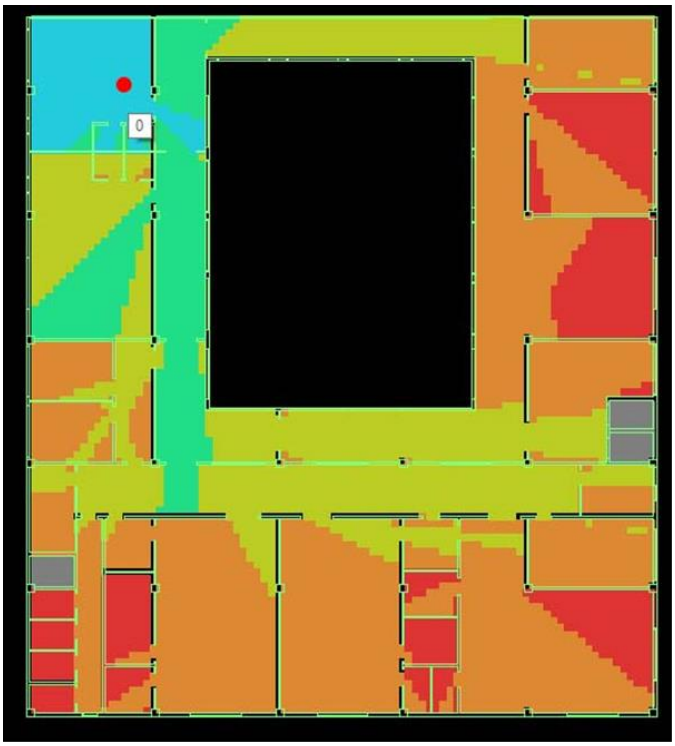

Figure 5: Visual step depth analysis of surgical suite

1. As we move from the pre-operative ward (blue) in colour, we move towards the semi-sterile corridor which is green in colour, to sterile corridor which is yellow in colour and finally to OT represented by orange in colour. This is a good movement pattern for the prevention of nosocomial infection.

4.3 ISOVISTS ANALYSIS

4.3.1 GROUND FLOOR PLAN OF HOSPITAL

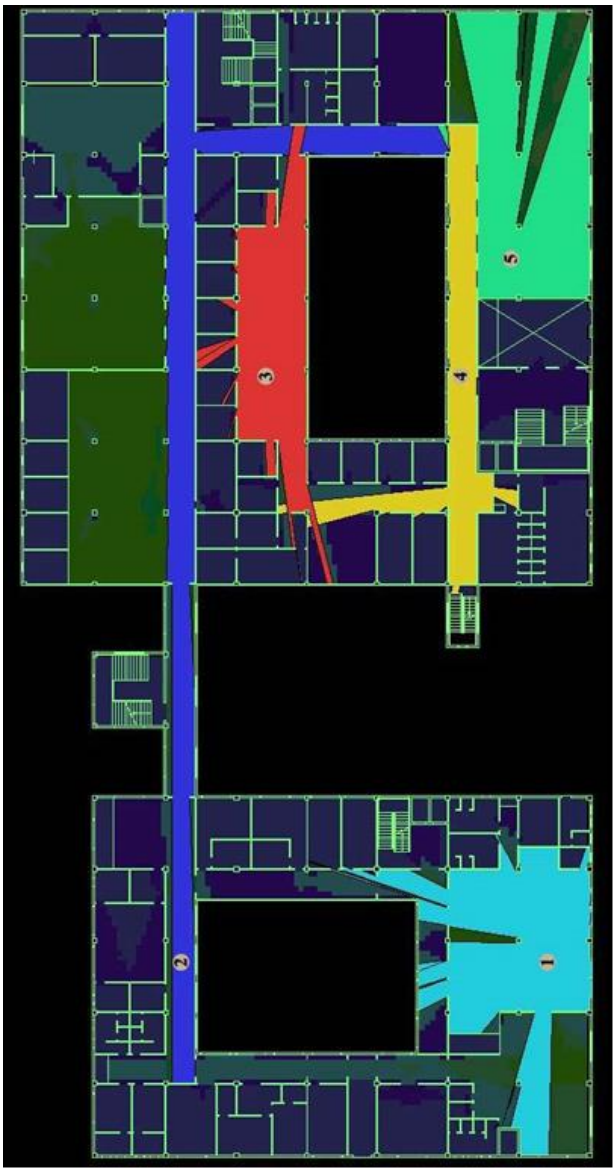

Figure 6: Isovist analysis of ground floor of hospital

1. The graph depicts 5 isovists in 120 degree view from different locations on the ground floor.

2. Zone 1, emergency department; From the main entrance, part of triage, reception and staircase is visible. However, the shift in the door of staircase lobby would be beneficial.

3. If a person is standing in zone 2 at the 'T' junction, OPD consultation rooms are not directly visible, so a signage there is needed.

4. Isovists can be used as a tool for designing of spaces in terms of visibility. Issues like privacy, safety and security, need of signage etc. can be solved through this.

5. CONCLUSION

Based on the graph analysis of these spaces, the following factors can be judged through space syntax:

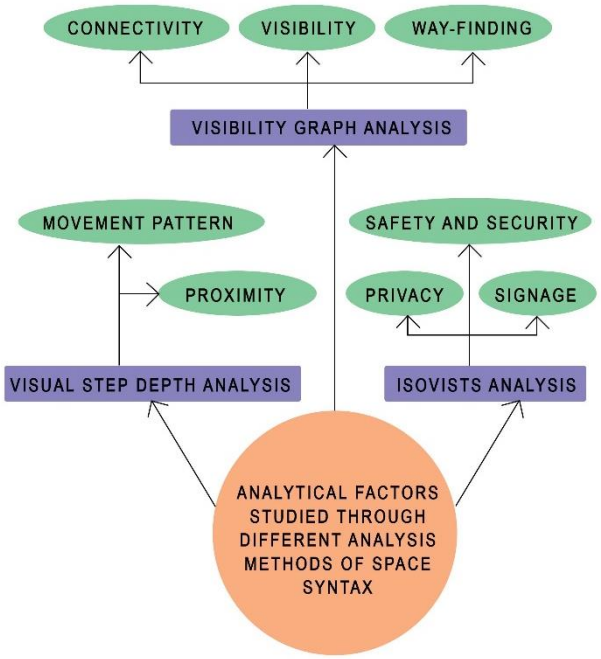

Figure 7: Factors studied through various space syntax tools

Space syntax which is the subject of this study is a scientific or research based approach for understanding and evaluating architectural space. Based on the case studies which are examined in this study, the role of space syntax in architectural design can be summarised as follows:

1. Space syntax provides a language for thinking and communicating about space inside the dialog between architect and built environment. It's more mathematical, and more analytical. This allows discursive non-discursive features of space, and places the space in a broader debate.

2. If design is an activity learned by creating and testing, the syntax of space contributes to this process by providing architects with tools to explore their concepts, to understand the potential consequences of their projects, and to demonstrate how their designs will work.

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APPENDIX

Figure 8: Architectural layout of ground floor plan

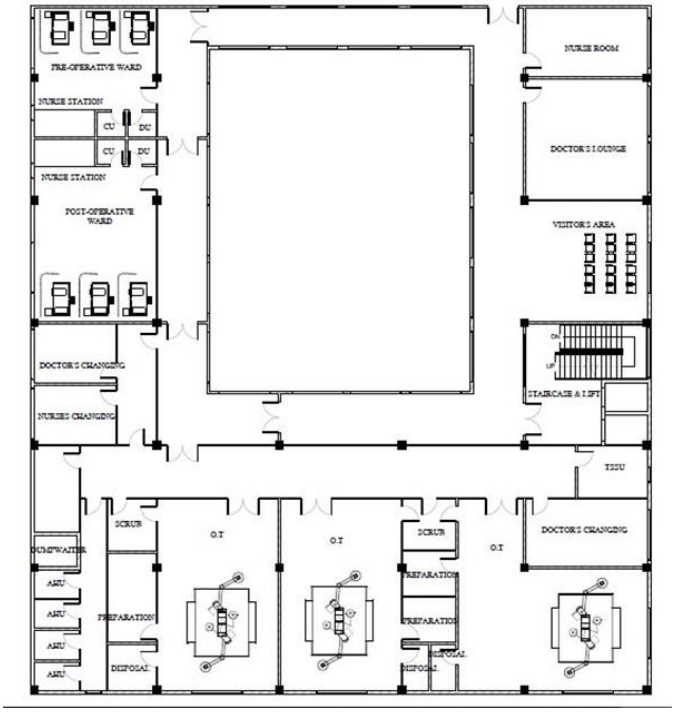

Figure 9: Architectural layout of surgical suite

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