

# Spatial Performance Using the Space Syntax Analysis Method (Case Study: Forensic Installation at Bhayangkara Hospital, Jakarta)

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Article Information	Abstract
<b>Keywords</b> Spatial Planning, Forensic Installation, Space Syntax	Various existing hospitals seek to gain public trust by improving the quality of services that are more effective and quality. Spatial planning is one of the important things that can affect the movement of users so that it has an impact on the work process. This study aims to analyze spatial performance in forensic installations, using the space syntax analysis method. This research was conducted using a case study approach to the development of the Forensic Installation, Bhayangkara Hospital. The analysis was carried out on the operating room unit before and after development. The data were obtained through surveys and observations, then the data were analyzed and explained descriptively. The development of the results of the analysis is to obtain recommendations and information that the composition of the Forensic Installation Bhayangkara Hospital is in accordance with existing standards. The results of this study are expected to be a reference and consideration in improving the quality of work, especially in the field of forensic installation spatial planning, to maximize the level of accessibility in the room so as to maximize effective user movement in the forensic installation room. The author hopes that this research can be used as a reference and review further improvements in further related research.

## INTRODUCTION

The phenomenon of rampant criminal acts such as terrorism, murder, violence, persecution, rape is increasingly troubling all parties. This resulted in many victims who were lightly injured, moderately injured, seriously injured and died. To reveal the cause of the wound and determine the aspects of the injury to the victim and the perpetrator, forensic medicine is needed. Autopsy or post mortem examination, serves as a medical procedure to determine the cause, duration of death, or evaluate the disease process, and trauma that occurred to the victim. Autopsies can be done in two ways, external autopsies and internal autopsies. In autopsies, victims are found in various circumstances, body parts, skeletons, decomposing bodies, or recently deceased. Forensic science explains the identity (who) of the suspect who committed the crime; the type (what) of the crime was committed; the time (when) the incident occurred; location (where/place of the incident); modus operandi (how) the violation occurred; and the motives behind the crime. (Anam. n.d.)

In view of this, an effective and efficient forensic installation design is required, which all depends on the equipment, work flow and personnel. One of the important factors that determine the smooth running of the workers is the preparation of the best spatial layout. Spatial planning is important and inseparable from the physical atmosphere of the surrounding space, because this condition greatly affects employee performance. (Ridwan, Niswaty, & Darwis, 2018). Spatial planning itself is a determination of space requirements and detailed use of this space to create a practical arrangement of physical factors that are considered necessary for the implementation of work. Spatial planning can make work more effective and efficient which can provide comfort for employees who work in forensic installations.

This study will analyze the spatial performance in the forensic installation of Bhayangkara Hospital, using the space syntax analysis method. The results of this study are expected to be taken into consideration and input in helping to optimize work, especially in terms of the comfort and effectiveness of the user's movement. This is what makes the writer interested in observing the spatial performance of the forensic installation at Bhayangkara Hospital, to find out whether the spatial layout of the forensic installation there is efficient and effective.

# LITERATURE REVIEW

## Definition of Hospital

Hospital is a health service institution that provides complete individual health services that provide inpatient, outpatient and emergency services. Hospitals provide several types of services including medical services, medical support services, care services, rehabilitation services, prevention and improvement of health, as a place for education and/or training for medical and medical professionals, as a place for research and development of science and technology in the health sector and to avoid risks. and health problems as intended, so it is necessary to organize a hospital environment in accordance with health requirements.

The hospital consists of a general hospital and a special hospital. General Hospital is a hospital that provides health services in all fields and types of disease. Meanwhile, a special hospital is a hospital that provides primary services in a particular field or type of disease, based on scientific discipline, age group, organ or type of disease. Classification of Special Hospitals is determined based on services, Human Resources, equipment, facilities and infrastructure, as well as administration and management. (Kementrian Kesehatan RI, 2010)

#### Definition of Forensic Installation

The function of the forensic installation is a place to place/temporarily store the corpse before it is taken by the family, a place for bathing/decontaminating the body, a place to dry the body after being washed, autopsy of the body, room for grief and bereavement, anatomical pathology laboratory. (Kementerian Kesehatan RI, 2010)

#### Accessibility In Room Configuration

Configuration is a relationship between objects that integrate with each other in a structure that is formed either naturally or intentionally (Bill Hillier, 1998). There are several important things in the spatial configuration proposed by Darjosanjoto (Darjosanjoto, 2006):

- 1. Syntax that covers the building is a space that is part of the discussion of the entire organization of the building.
- 2. Space configuration is a link between one space and another as a whole (complex).

In the context of the interior space of the building, of course this is related to the interconnected objects in it. This relationship can be realized based on the movement that occurs in the movement of individuals from one space to another that has been previously formed so as to form a network pattern between spaces. network pattern is an important component that affects aspects of space quality in the form of permeability and accessibility (Carmona, Heath, Oc, Tiesdell, & Carmona, 2012). Hillier's theory shows the superiority of spatial configuration that there is a relationship between spatial configuration, motion and environmental attractiveness. The environmental attractiveness can be in the form of land use, density, including well-being and fear. Hillier and Hanson also assume that human relations are not shown in accordance with what is expressed or stated, but buildings that organize them, spatial configurations, especially public relations and private needs related to space and access control. (B. Hillier & Hanson, 1988).

#### Space Syntax

By using references to the ideas of Hillier and Hanson in their book The Social Logic of Space (1984), "space syntax" is a technique or method for displaying, estimating, calculating or measuring a configuration of space and how to analyze and interpret it. (Darjosanjoto, 2006). According to Hillier and Hanson, the purpose of the preparation of the space syntax program is to develop a theoretical understanding of how space works with a strategy of combining computer-based descriptions based on rules regarding spatial patterns with empirical observations of how space patterns are used.

Space syntax is a method for explaining and analyzing the relationship between voids in open space and the relationship formed to existing spatial patterns. According to The social logic of space (Hanson, 1984) space syntax is a technique for visualizing, measuring and also calculating the configuration of space and producing an analysis and providing a definition of the space formed. The theory of space syntax is the relationship between society and the arrangement of space-forming structures in urban theory and the formation of architectural space. An understanding of the theory produces an analytical research basis to produce a study of open space and public space in terms of: spatial space, people's lives, routines of movement, meaning of space, interaction and also

spatial configuration. The theory is related to the relationship between pedestrian movement and the configuration of public spaces (Vujadinovic, 2016).

#### The Concept of Distance in Space Syntax

Space syntax uses the concept of distance called depth which is measured in steps called topological distance or topological distance (Hillier et al: 1987). 1 step 2 depth means the distance between two spaces that are directly connected, 2 step depth means the distance between rooms A and B which must pass 1 piece of space between. In Figure 1, the distance between a - b, b - c and vice versa is each worth 1 step depth while the distance a - c and vice versa is worth 2 step depth because it must pass through space b (1 step depth + 1 step depth = 2 step depth).



Figure 1. Step depth Concept

# Connectivity Concept in Space Syntax

Connectivity is a dimension that measures local properties by calculating the number of spaces that are directly connected to each other in a spatial configuration (Hillier et al: 1993 and Hillier et al: 1987). It is called a local property because information about spatial relationships can be directly observed from the observation space, while spaces that cannot be observed from the observation space will not be taken into account. The number of connected spaces is calculated using the concept of distance called depth. Thus, it is said to be directly connected if it only has a distance of 1 step or 1 step depth.

Connectivity measurements are carried out to find the level of interaction between each room and the adjacent rooms. The main use of the connectivity value is to measure the level of intelligibility by correlating the connectivity value with the integrity value. The calculation of the connectivity value for each room is done by adding up all the rooms that are directly connected to the observation room.



Figure 2. Connectivity value of the illustration room configuration

From the above analysis it is found that the e room has the highest connectivity and the f room has the lowest. Visually, it can be observed in the j-graph in Figure 2 where the e space is in the middle of the configuration so that it tends to have more spatial relationships than the f space which is at the edge of the configuration. Even so, the results of this connectivity analysis are not enough to prove the above allegations. Integrity analysis needs to be done to prove the relative position of each space based on its relative depth.

## The Concept of Integrity in Space Syntax

Integrity is a dimension that measures the global property in the form of the relative position of each space to other spaces in a spatial configuration (Hillier et al: 1987 and Hillier et al: 1993). It is called a global property because the calculation of the integrity value does not only involve spaces that are directly connected, but also other spaces that are not directly connected to the observation room. Integrity is one of the important measurements in space syntax because with this measurement method, an analysis of the configuration of space as a system can be carried out.

The relative position of the space is calculated using the step depth method. From this relative position, it can be seen how far (step depth) a space is from other spaces. Spaces that have a high integrity value (low depth) are considered to have high interactions relative to other spaces in the configuration, or in other words, are well connected to the observation space (Hillier and Hanson: 1984). The more spaces that are directly connected to the observation room, the higher the value of the integrity of the space, on the contrary, the more space between, the lower the value of the integrity of the space.



Figure 3. Observation room with high integrity

In the picture above, room X as an observation room has a relatively higher integrity value than other rooms, because room X is directly connected to many surrounding spaces. From this understanding, the value of integrity can be interpreted as a hypothetical value for the ease for someone to reach a space from every other space.

#### Density and Crowd

There are several opinions that state about density and crowd theoretically. Heimstra (Heimstra, N. W., & McFarling, 1978) states that basically density is a physical concept, while crowding is a psychological concept. Gifford (Gifford, 2012) states that crowding is a person's subjective feeling of the number of individuals (other people) around him. Congestion may be associated with high density, but density is not an absolute requirement for causing congestion. According to Sarwono (Sarwono, 1995), the relationship between density and crowding has two characteristics:

- 1. Crowding is the perception of density which means the number of people in a place. Crowded is related to density, a space that has a limited number of people in it. The more people compared to the area of the space, the denser the conditions in the space.
- 2. Crowding is a perception so it is subjective. Individuals who are used to riding buses with dense passengers, may not feel congested anymore (high density but low crowding). On the other hand, individuals who usually use private vehicles can feel cramped in a half-empty bus (low density but high crowding). So the condition of a person's tightness can also be influenced by habits and cultural factors.

Meanwhile, Altman (Altman, 1975) divides density into social density and spatial density. The difference is, if social density is formed on social conditions that gather in a place with subjective spatial boundaries according to the psychology of each individual. While the density of space is based on the limitations of the physical area of a building space when it accommodates a number of people in it.

# METHODOLOGY

The research method is using a comparative method, which is done by comparing the results of the analysis of spatial and circulation performance using space syntax on the old design and development. This research method also uses a qualitative approach, the analysis is carried out by field observations and interviews will be analyzed descriptively using a literature study and also presented in the form of photos.

The descriptive qualitative method in this study was carried out by direct observation to the field and conducting interviews with related parties. Collecting data and interviews at the forensic installation of Bhayangkara Hospital, the author was accompanied by two forensic technicians who worked there. At the beginning of the conversation, he explained how the flow of activities in the forensic installation while showing the rooms in the forensic installation of Bhayangkara Hospital. Studies and observations based on changes that occur in the object of research in a certain period in accordance with the findings in the field.

#### FINDING AND DISCUSSION

Based on the survey that has been conducted and the literature study obtained, a comparison between the literature study and data obtained from the forensic installation of Bhayangkara Hospital is obtained as follows:

		Old Design				New Design			
No.	Room	Exist	None	Fit	Doesn't Fit	Exist	None	Fit	Doesn't Fit
1.	Admin Room	V	-	V	-	V	-	V	-
2.	Waiting Room	-	V	-	V	V	-	-	V
3.	Funeral Room	V	-	V	-	V	-	-	V
4.	Funeral Room Equipment Warehouse	-	v	-	V	v	-	v	-
5.	Funeral Parlor	V	-	-	V	V	-	-	V
6.	Autopsy Room	V	-	-	V	V	-	V	-
7.	Corpse Room	V	-	V	-	V	-	V	-
8.	Changing Room	V	-	V	-	V	-	V	-
9.	Chief Room	V	-	V	-	V	-	V	-
10.	Tools Room	V	-	-	V	V	-	V	-
11.	Warehouse	V	-	-	V	V	-	V	-
12.	Toilet	V	-	V	-	V	-	V	-

TABLE 1. COMPARISON RESULTS BETWEEN LITERATURE STUDY DATA WITH SURVEY DATA

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Question	Answer
How many employees work in a forensic	18 people (5 people for forensic doctors, 5 people for forensic technicians, 3 people
installation?	for administration, 3 people for ambulance drivers, 2 people for cleaning services).
How is the flow of activities in the forensic	When there is a corpse from a crime scene, it is stored in the corpse's refrigerator,
installation?	after that it is reported first to obtain legal certainty whether an autopsy can be done
	or not. If an autopsy is done, the autopsy process will begin. After completion, a death
	certificate will be made and the process of wrapping the body/cremation and bringing
	it back to the funeral home/buried.
How is the situation of the forensic	There has been an increase in the amount of space for the autopsy room, the corpse
installation?	cooler room, and the investigator room. However, there is a change in the form of the
	corpse transit room.
Do you think that the spatial layout of the	The autopsy room and the body cooler are sufficient. However, the decontamination
forensic installation is sufficient and	room, funeral parlor, and funeral room are too narrow.
according to needs?	
Will there be additional rooms in the hospital	There are plans to enlarge the funeral parlor.
planning in the future?	

# TABLE 2. INTERVIEW RESULT

# Space Syntax Analysis

Based on the illustration images and the results of the calculation of the space configuration based on the concept of integrity in the space syntax analysis method, it can be seen in the following table:

Room	Total Depth (TD)	Mean Depth (MD)	Relative Asymmetry (RA)
1	37	2,85	0,31
2	37	2,85	0,31
3	38	2,92	0,32
4	36	2,77	0,29
5	48	3,69	0,45
6	38	2,92	0,32
7	31	2,38	0,23
8	31	2,38	0,23
9	53	4,08	0,51
10	41	3,15	0,36
11	41	3,15	0,36
12	53	4,08	0,51
13	26	2,00	0,17
14	26	2,00	0,17

TABLE 3. CALCULATIONS OF TD, MD, AND RA (OLD DESIGN)

TABLE 4. CALCULATIONS OF TD, MD, AND RA (NEW DESIGN)

Room	Total Depth (TD)	Mean Depth (MD)	Relative Asymmetry (RA)
Α	95	4,32	0,32
В	95	4,32	0,32
C	95	4,32	0,32
D	76	3,45	0,23
E	63	2,86	0,18
F	97	4,41	0,32
G	118	5,36	0,42
Н	99	4,50	0,33
I	60	2,73	0,16
J	80	3,64	0,25
K	80	3,64	0,25
L	68	3,09	0,20

Room	Total Depth (TD)	Mean Depth (MD)	Relative Asymmetry (RA)
М	81	3,68	0,26
Ν	80	3,64	0,25
0	59	2,68	0,16
Р	80	3,64	0,25
Q	102	4,64	0,35
R	102	4,64	0,35
S	102	4,64	0,35
Т	102	4,64	0,35
U	89	4,05	0,29
V	97	4,41	0,32
W	78	3,55	0,24

Based on the results of the calculation of the total depth (TD), Mean depth (MD), and Relative Asymmetry (RA), then the Real Relative Asymmetry (RRA) calculation is carried out which is used to obtain an operational

image of the integrity value in the spatial configuration. The results of this calculation can be seen in the following table:

L	$\sqrt{\mathbf{L}}$	2L	L(√L)- 2L+1	L-1	L-2	(L-1)(L-2)	GL	
14	3,74	28	23,38	13	12	156	0,300	

TABLE 5. CALCULATIONS OF GL (OLD DESIGN)

TABLE 6. CALCULATIONS OF RRA (OLD DESIGN)

		R	RA		
1	=	1,03	8	=	0,77
2	=	1,03	9	=	1,71
3	=	1,07	10	=	1,20
4	=	0,98	11	=	1,20
5	=	1,50	12	=	1,71
6	=	1,07	13	=	0,56
7	=	0,77	14	=	0,56

Based on the results of the analysis, room 13 and 14 have the same value and have higher integrity and room 9 and 12 have the lowest integrity values. It can be concluded that room 13 has the closest unity to the overall (global) configuration of space compared to other spaces. By interpreting the results of this calculation based on the concept of topological distance, room 13 is the easiest room to reach from all other rooms in the spatial configuration because it has less intermediate space. If it is associated with Hillier's theory, room 13 is a space that can be hypothesized as the space where the most pedestrian movement activities are found.

TABLE 7. CALCULATIONS OF GL (NEW DESIGN)

L	$\sqrt{\mathbf{L}}$	2L	L(√L)- 2L+1	L-1	L-2	(L-1)(L-2)	GL
23	4,80	46	63,30	22	21	462	0,274

RRA								
А	=	1,15	М	=	0,93			
В	=	1,15	Ν	=	0,92			
С	=	1,15	0	=	0,58			
D	=	0,85	Р	=	0,92			
E	=	0,65	Q	=	1,26			
F	=	1,18	R	=	1,26			
G	=	1,52	S	=	1,26			
Н	=	1,22	Т	=	1,26			
Ι	=	0,60	U	=	1,06			
J	=	0,92	V	=	1,18			
Κ	=	0,92	W	=	0,88			
L	=	0.73						

 TABLE 8.

 CALCULATIONS OF RRA (NEW DESIGN)

Based on the results of the analysis, room O has a higher integrity value and G has the lowest integrity value. It can be concluded that room O has the closest unity to the overall (global) configuration of space compared to other spaces. By interpreting the results of this calculation based on the concept of topological distance, room O is the easiest room to reach from all other rooms in the configuration of the space because it has less space between. If it is associated with Hillier's theory, room O is a room that can be hypothesized as the space where the most pedestrian movement activities are found.

To see a comparison of the level of space performance on the plan before and after the development of the Forensic Installation of Bhayangkara Hospital, a scatter diagram analysis is needed that shows the relationship between connectivity and integrity aspects. From the relationship between these two aspects, the value of the integrity aspect will be obtained, namely the clarity of a space in a spatial configuration.

#### TABLE 9. CONNECTIVITY GRAPH & SCATTER DIAGRAMS USING DEPTHMAP SOFTWARE



The configuration of the space after development has two red areas, namely the Autopsy Room 3 and the lobby 2. While the configuration before the development has one red area, namely the Autopsy Room area. The color in the integrity calculation means that the area in red has the highest level of human activity compared to other spaces. While the dark blue color has the meaning of the lowest level of human activity compared to other spaces.

Referring to the results of the R value, namely the intelligibility (clarity of space) the floor plan after development has decreased with the value before R = 0.856614 to R = 0.827328.



Referring to the results of the R value, namely the intelligibility (clarity of space) of the plan after the development has increased with the value before R = 0.682069 to R = 0.809056.

From the results of the analysis above, it can be presented in a table to see comparative data and also the percentage of decreasing or increasing performance.

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Elser	Deserve	A	Analysis	Demonsteres	
Flow	Kooms	Aspect	Old Design	New Design	Percentage
Paramedic	Funeral Room - Weighing Room	Connectivity	29	30	3,45%
Pathway with	- CT Scan Room - Autopsy Room	Integrity	6,31	7	10,89%
autopsy	- Funeral Parlor - Bathroom	Intelligibility	0,856614	0,827328	-3,42%
Paramedic	Engenal Deserver Engenal Destan	Connectivity	27	18	-33,33%
Pathway	Funeral Room - Funeral Parlor -	Integrity	4,84	4,81	-0,75%
without autopsy	Baunoom	Intelligibility	0,682069	0,809056	19%

# TABLE 10. COMPARISON OF SPACE SYNTAX ASPECT CALCULATIONS

In the paramedic pathway with autopsy, in the connectivity aspect there is an increase of 3.45% this is due to the addition of space on the floor plan, thus increasing connectivity between rooms. And in the aspect of integrity there is also an increase of 10.89%. From these two variables, it can be seen that the intelligibility value decreased by -3.42%, indicating that the clarity of space in the configuration of the space has decreased in the plan after development.

In the paramedic pathway without autopsy, in the connectivity aspect there is also a decrease of -33.33% this is due to the large number of rooms that have dead corners that are not directly connected. And in the integrity aspect there is also a decrease of -0.75% this also occurs because of the addition of space so that it increases the distance between spaces. Of the two variables that have a decrease, in the intelligibility assessment there is an increase of 19% indicating that the clarity of space in the configuration of the space increases in the plan after development.

These two space circulation paths, after being analyzed using the Depthmap software, obtained the percentage value of the R ratio, namely the intelligibility syntax (spatial clarity) as an assessment of the level of correlation between the measurement of connectivity aspects and integrity aspects. The percentage increase was found in the Paramedic pathway without autopsy (Funeral Room - Funeral Parlor – Bathroom) by 19%. The percentage decrease was in the Paramedic Pathway with autopsy (Funeral Room - Weighing Room - CT Scan Room - Autopsy Room - Funeral Parlor – Bathroom) by -3.42%.

#### CONCLUSION

From the comparison of the performance improvement value in the room configuration as seen from the Intelligibility value which shows the level of correlation between local scale measurements (connectivity) and global scale measurements (integrity), in the paramedic pathway without autopsy, it shows an improvement condition where by better understanding connectivity at scale. Locally, space users may be able to better understand spatial patterns and find one space to another. Meanwhile, the paramedic pathway with autopsy has a decreased level of space performance because the spatial patterns in the configuration are not well integrated with each other.

When viewed from the assessment parameters in the Depthmap software, there are different values in the room, this is due to spatial factors, circulation that is passed and the distance between different spaces. It can be seen by the decreasing level of integrity in the space configuration after development, this is due to the increasing distance between spaces. So that the ease of users in reaching one space decreases due to the increasing distance. Meanwhile, the connectivity value has increased and decreased which is influenced by the number of rooms connected to other rooms.

The difference in the decrease or increase in the two aspects will be seen from the value of the correlation in the two factors (connectivity and integrity), namely the intelligibility presented in the scatter diagram and looking for the percentage of the increase and decrease in value.

From the results of the analysis, it can be concluded that there is an increase or decrease in the spatial and circulation performance of the forensic installation before and after development, which is seen by using the space syntax method in the aspects of Connectivity, Integrity, and Intelligibility.

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