Spatial and behavior analysis for improving the Siantan Hilir health center into a Type-D Hospital

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Abstract. The public awareness increasingly for the importance of quality and safety of services in health services such as hospitals or health centers. The Siantan Hilir Health Center has classified as complete facilities comparing to other health centers in Pontianak City. From this condition, it is necessary to formulate studies and strategies for improving facilities that refer to the Minister of Health Regulation. This study aims to: 1) as a basis for a feasibility study to improve the status of the Siantan Hilir Health Center into a Type-D Hospital in Pontianak; 2) as a basis for planners to accommodate planned functions; 3) as a basis for effective and efficient circulation planning relate functions in the environment. The research method used the descriptive qualitative approach for describing the current situation to identify the existing conditions of the Siantan Hilir Public Health Care. Space syntax analysis is used to find out the intelligibility of space in the Siantan Hilir Health Center space layout, as seen from the connectivity, integrity, and mean depth of space and behavior mapping. The results are the analysis of spatial layout configuration and the performance of building user behavior to improve the Siantan Hilir Public Health Care into a Type-D Hospital.

1. Introduction

North Pontianak Subdistrict is the only sub-district in Pontianak City that does not have a hospital, so there are demands from the community for the area to have a hospital. The mandate of Law Number 44 of 2009 regarding hospitals in article 6 [1], regarding the responsibility of the government and local governments, states that it is the responsibility of the central government (ministry of health) and local (district / provincial health offices) to provide, guarantee to finance, fostering, supervising and providing protection to hospitals to be able to provide health services professionally and responsibly to the community. The Siantan Hilir Public Health Center in North Pontianak is a health center that has fairly complete facilities compared to another health center in Pontianak, so the city government wants to upgrade the facilities at the Siantan Hilir public health center into a Type-D hospital. The process of improving facilities from public health services to hospitals starts from a feasibility study and behavioral studies, especially in the configuration of the space in the existing building.

In spatial analysis and configuration, the main problem is those psychological aspects including behavior that not raised in the study, this is an important aspect of creating activities that give rise to various directions of spatial configuration [2]. In his dissertation, Sarraf stated that the public space environment meets the foreground network through an overlapping space which simultaneously
overlaps with other environments [3]. The spatial pervasiveness of such overlapping spaces makes the co-presence of individuals from different environments more likely to occur in it [3]. However, in behavior patterns analysis is that given the current need for privacy in the spatial organization of modern buildings, privacy has not been widely recognized as a behavioral pattern that may influence the spatial configuration of living space [4]. In other research suggested “psychological efficiency” and “physical efficiency” as the two components for determining the efficiency of any spatial layout [5]. Psychological efficiency refers to the extent to which the built space invites its users to enter and explore it, and physical efficiency shows the ease of movement and accessibility in the built space [6]. Furthermore, it is necessary to define the form of space to analyze spatial problems, and it has two meanings. First, the composition of humans in space and the relationships between humans in it [7]. Next, the spatial configuration is the relationship between space and another as a whole, and syntax defining as a space that includes in the discussion of the entire building structure [8].

This research aims as a basis for a feasibility study to improve the status of the Siantan Hilir Health Center into a Type-D Hospital. Next, as the basis for effective and efficient and circulation planning that relates functions. Also, as an overview to upgrade the Public Health Center into a Type-D Hospital according to the Minister of Health Regulation No.56 of 2014 and 2012. The novelty of this research is about a study that helps the planner to accommodate planned functions of the building and used by decision-makers, especially the City Government as a basis for consideration to determine policies for improving the status of public health care in general.

2. Research methods
A qualitative descriptive approach used for this research and aims to describe the current situation to identify the existing conditions of the Siantan Hilir Public Health Care, which then identifying the problem, then from the symptoms of the problem the analysis using behavior attributes and space syntax method made. This research conducting a behavior analysis through Behavior Mapping. The first stage is to analyze qualitatively by using behavioral attributes. The second stage is simulating the space syntax which is described in a measured using the depth map software.

2.1. Existing data
The Siantan Hilir Public Health Care was founded in 1971 and has an area of approximately 787 Ha / m², with eight areas according to its use which includes residential 613 ha / m², plantation 67 ha / m², graveyard 2 ha/m², yard 7 ha/m², office 10 ha/m², and the public infrastructure 88 ha/m². The location is on Jl. Khatulistiwa No. 151, Siantan Hilir. The average travel time for the community to health care is ± 10 minutes to 30 minutes. The existing plan for Siantan Hilir Health Care describes in the Figure 1.

Figure 1. The Siantan Hilir health care center existing floor plan.
The existing plan of the Siantan Hilir public health care dividing into 2 entrances. The first is on right in front of the building, while the second entrance is to the Emergency Unit which places to the left of the building. The building zone centralizing where the services area is in the middle of the building and there is an inner court in it. The examination room and polyclinic are on the right side. On the left for the delivery room. Next, service areas such as kitchen and laundry are at the back. The puerperium room and the mortuary also located in this area. On the second floor, there are the maternal room, baby room, and the management unit of the health care center. Access to the building itself consists of the main staircase and a ramp in the middle of the building. There is an emergency staircase placed in the back area of the building, at the right corner. Most of the waiting rooms are located in the entrance and along the corridor.

2.2. Behavior mapping
Behavioral studies carrying out by observing behavior and it mapping, it is also adding the interview [9]. Behavior mapping illustrated in the form of sketches or diagrams about an area where humans perform various activities, their own goal is to describe the behavior on the map, identify the type and frequency of the behavior, and show the relationship between user behavior with specific spaces [10]. This research was conducted for 4 days, on Monday, Wednesday, Friday, and weekends. The observation time at 08.00-10.00 am, 12.00-02.00 pm, and 03.00-05.00 pm. Especially on weekends, observations made until 08.00 pm.

2.3. Space syntax
The Space Syntax organize in developing theories regarding the configuration of space. Space syntax use for understanding space in the form of a configuration, especially about the process of its formation and the social meaning that conveys [11]. In other research states that the main idea of space syntax is that the use and understanding of space functioning are influenced by the relationships between spaces (of a city or within a building) [12]. Space syntax is based on space affecting the behavior that unfolds there. The simulation uses a depth map analysis tool, this application is the official space syntax (open source) platform developed by the Space Syntax Laboratory at Barlett School-UCL. The space syntax step has 3 stages, namely connectivity, integrity, and intelligibility. The results of this analysis are then overlaying with the existing building plan.

3. Analysis and results
Each floor in this building has been grouped based on the level of privacy, namely the public and semi-public zones placed on the front of the 1st floor. The service zone at the rear, the private and semiprivate zones are at the rear of the 1st floor. However, in this zoning, the circulation between the service and the public not separated and caused the patients pass through service rooms (kitchen and laundry). In the table below shows behavior mapping from visitors in every floor in a week.
Table 1. Behavior mapping-place centered mapping.

|                | Week 1 | Week 2 |
|----------------|--------|--------|
|                | Monday | Wednesday | Friday | Monday | Wednesday | Friday |
| 1st Floor      | ![Image](image1.png) | ![Image](image2.png) | ![Image](image3.png) | ![Image](image4.png) | ![Image](image5.png) | ![Image](image6.png) |
| 2nd Floor      | ![Image](image7.png) | ![Image](image8.png) | ![Image](image9.png) | ![Image](image10.png) | ![Image](image11.png) | ![Image](image12.png) |

From the results of the Table 1, it concluded that the use of space on the 1st floor of the Siantan Hilir health care center building is maximal, while for the second floor it is less than optimal. 08.00-10.00 AM is the time when the number of patients/visitors is very crowded both on the 1st and 2nd floor. Visitors concentrated on the right side, the polyclinic. When the time is noon and above there is mass reduction after 05.00 pm. On the other hand, the contradiction occurred in the emergency room and delivery room. In the image below describing dividing zone between the morning poly and 24-hour poly.

![Image](image13.png)

Figure 2. Visitor density based on visiting/working time on 1st and 2nd floor.

From the Figure 2 and the context of the space on the 1st floor, it looks like privacy creates good zoning between the polyclinic with the emergency and the delivery room. However, in the polyclinic zone, it does not function optimally, this is indicated by the mixture of registration, waiting, and payment rooms. On the existing plan, the children's polyclinic and immunization rooms are placed on the 2nd floor, while the Maternal and Child Health room placed on the 1st floor, it makes the movement of mothers who bring toddlers and children to consult on pediatric longer. Poor zoning also found in the canteen on the 1st floor. The canteen can only access by visitors who enter the health care center. Its location at the end of the hallway on the right side of the building and not visible from the waiting room for the medicine queue. On the 2nd floor, privacy is good enough. The separation between the adult room and the children's room also the baby room is good enough. However, the paediatrician room and the immunization room are separated by a corridor, this is not effective.
because in general, the paediatrician will carry out immunization measures immediately after examining the child.

Circulation between spaces fixed at the edge of the space thus creating a circular corridor. From this conception, the division of spaces on each floor adjusts the shape of the circulation. Here the zoning errors were found for both space and circulation access. For circulation access such as emergency stairs, placed in the back most area on the right, this would be dangerous. After all, it cannot be accessed from the left side area quickly because it is quite hidden and far from the back/emergency door. On the 2nd floor, the territory of the TB room for TB patients close to the baby room. TB is a type of disease that is contagious or easily infected. Placing an examination room for TB sufferers near the nursery will be very dangerous because new-born babies are very vulnerable to infections from outside. It can see in Figure 3 below that shows TB poly near with the baby room.

![Figure 3. TB room and baby room territory on the 2nd floor.](image)

The next analysis continues with space syntax analysis of the visitors and employees' movement of the Siantan Hilir Health Center. Observation of the flow of building users is useful for determining which spaces have the potential to change and maintained. From the results of movement analysis continue with depth map simulating software to determine the circulation between spaces. In the depth map software, agent analysis used to determine the density of movement in the corridor circulation and between spaces. The visitor’s movement mapping can be seen in the left picture of figure 4.

![Figure 4. User movements in existing conditions (a), simulation of agent analysis (b).](image)
From the agent analysis simulation, it illustrated that the corridor around the inner court on the 1st floor has good density. The color gradation in this area is yellowish green, this means the corridor value is moderate in density and crowding. Meanwhile, the corridor in the front area close to the waiting room for drug collection showing yellow to orange, this shows the potential for high density and crowding. This influence by the gathering of service areas in one place and the access very close to the entrance. On the 2nd floor, the flow of visitor movement looks dominant in the front area of the children's clinic indicated by reddish-yellow color gradation. This is because the achievement of the depth of space value is 1 comparing to other depths, it means easily accessible from any circulation. Crowding and density in this area are potentially quite high because of the number of building users gathering in the area. The corridor in front of the paediatric patient room and front of the TB clinic has a low to medium grade color, showing blue greenish it meaning the privacy is more maintained.

Next, the analysis continues by using a visual graphic analysis (VGA) simulation, it found that the connectivity on the 1st floor was higher than the 2nd floor because the accessibility of the 1st floor was easier to reach. The spatial distribution between the 24-hour poly and the morning poly was quite clear, while on the second floor the connectivity lower than the 1st floor and only occurs in the area in front of the stairs. Space zoning on the 2nd floor categorized lacking due to its relatively low achievement value, even though it has a fairly high integrity value. This comparison shown in the image below. Comparison of connectivity and integrity between 1st floor and 2nd floor can be seen from the Figure 5.

![Figure 5](image)

**Figure 5.** Comparison of connectivity (a) and integrity (b) between 1st and 2nd floor.

For integrity, the 2nd floor shows high value in each room, this is because the integrity value of the corridor on the 2nd floor is lower than the first floor. Integrity on the 1st floor quite good because it could use as an alternative recommendation for the placement of entrance or exit. If the integrity value on the top floor higher than from the security perspective is not good, meaning reaching spatial from outside is too easy. In the picture below presenting the comparison of intelligibility between 1st and 2nd floor and parameter comparison number.

![Figure 6](image)

**Figure 6.** Comparison of the intelligibility value between 1st floor and 2nd floor.

From the Figure 6 could be see that the results of the correlation between connectivity and integrity on the 1st floor have an intelligibility value of $R = 0.638$. When viewed from the parameters for
achieving the effective value of space table above, the spatial configuration on the 1st floor of the Siantan Hilir Community Health Center categorized as "fair" in terms of ease of achievement and spatial relationship, while the results of the correlation on the 2nd floor produce an intelligibility value of R = 0.48 which categorized as "less" in terms of ease of achievement and spatial relationship.

4. Conclusion
From the results of the analysis, it concluded that the zoning on the 1st floor is very good between the morning and 24-hour polyclinic and that access to entry is very clear. The room configuration on the 1st floor needs attention to its zoning because it has a depth level of up to 5 levels, which means that getting to that space needs a long time. Arranging the emergency stair needs attention again.

Recommendations that applied to the existing conditions of the Siantan Hilir Health Care Center include: a) Adding lift facilities to the building, and preferably using space for ramps not taking a lot of space; b) Access to emergency stairs that could easily reach by visitors by providing clear signs, and preferably close to the exit; c) Maximizing the living space used as a space with close zoning; d) Moving the TB poly room near to exit to prevent the spread of infectious diseases; e) Children's poly room, immunization room, and MCH should be close together for controlling easier; f) The lactation room should put on in an area that is easily accessible from the morning clinic and 24-hour clinic and preferably close to the toilet due to the high need for water for baby hygiene; g) Canteen access should be accessible from outside the building.

Acknowledgments
The authors gratefully acknowledge to colleagues and part who have supported this paper. Gratitude also acknowledges to Technic Consultant Service of Borneo Co., Public Health Office of Pontianak City, and Asia Raya Studio for their support and to all those who cannot write one by one.

References
[1] Anonym 2009 Laws of The Republic Indonesia No. 44 Year 2009 About Hospital (Indonesia)
[2] Wardhana M 2007 Logic of Space Configuration and Aspects of Space Psychology for Elderly J. Eng. Plan. 4 1–16
[3] Sarraf M 2015 Spatiality of Multiculturalism (KTH Royal Institute of Technology)
[4] Alitajer S and Molavi Nojoumi G 2016 Privacy at home: Analysis of behavioral patterns in the spatial configuration of traditional and modern houses in the city of Hamedan based on the notion of space syntax Front. Archit. Res.
[5] Mustafa F A and Hassan A S 2013 Mosque layout design: An analytical study of mosque layouts in the early Ottoman period Front. Archit. Res.
[6] Asif N, Utaberta N, Sabil A Bin and Ismail S 2018 Reflection of cultural practices on syntactical values: An introduction to the application of space syntax to vernacular Malay architecture Front. Archit. Res.
[7] Hillier, B. and J H 1984 “Buildings and their genotypes.” In The social logic of space (New York: Cambridge University Press)
[8] Darjosanjoto E 2006 Computerized Phenomenology in Exploration of Kampong House Architecture Maj. Iptek 17
[9] Zeisel J 1981 Inquiry by Design, Tools for Environment – Behavior Research (Cambridge: Cambridge University Press)
[10] Siregar, Aldo Wicaksano , Jenny Ernawati T H 2017 Perancangan Balai Latihan Kerja Industri Dengan Pendekatan Pola Pergerakan Pengguna (Universitas Brawijaya)
[11] Hillier B 2007 Space is the Machine: A Configurational Theory of Architecture (London)
[12] Zerouati W and Bellal T 2019 Evaluating the impact of mass housings’ in-between spaces’ spatial configuration on users’ social interaction Front. Archit. Res.