The configuration of window placement and spatial arrangement based on patient’s seeing capacity

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Abstract. A window plays a role in connecting the outer and inner space that supports the connection between humans and the natural elements in the building. The presence and absence of windows, the type of view from the windows and the application of window's technology become the main issue right now in designing an inpatient ward, but it becomes irrelevant if it does not link to the experience of seeing patients. This study reveals the degree of relation of the configuration of the windows placement, seeing's capacity of patients and the arrangement of space. Exploration of the relation is done through five alternative configurations, to provide different patterns that produce a degree of relationship. Relation levels are presented through calculation of image region analyser MATLAB. The results of this study provide several alternative patterns of configuration with different levels of relationships that can be used as a basis for consideration in designing space in the hospital.

Keywords: Window Placement, Spatial Arrangement, Seeing Capacity

1. Introduction

A window as an architectural element plays a role in connecting the outer space and inner space as a practical approach, in emphasising the connection between humans and the natural elements in buildings [1] [2]. Human and natural elements are a major concern in the application of building design for sustainability. Specific discussion about natural elements in influencing recovery of the patient involved the role of windows that provided the sights of a window view as a positive distraction for patients [3] [4] [5]. The presence and absence of a window, as well as the type of scenery of the windows, and the application of window technology are the recent central issue in designing an inpatient ward in supporting recovery based on the relation of human and the natural environment [6] [7] [8].

But the window area that perceived in the visual range of the patient becomes essential, that no matter how good the scenery and application of technology and the presence of windows in space, but if the patient did not perceive the window area in the patient's visual range then the window will have no role as an instrument that provides the scenery.
The ignorance of the potential surface in the inpatient ward in providing an area of a window was seen by the design hospital today in a spatial arrangement that decreases the possibility of window placement. This research was discovering a specific area as the best potential of a surface to provide the possible range of window placement based on the visual range of the patient that effect by the space arrangement. The question is how far the window placement play a role in a configuration of spatial arrangement in patient's seeing capacity?

A Windows placement in the variant of space arrangement describes a pattern of a relation among elements called configuration [9]. The principle of the configuration is a meeting of the nature of the physical function of space being seen by the patients and the patient seeing capacity in experiencing space. A window has a nature of providing visual information that enables the patient to perceive the window in seeing activities through the character of the window elements that reflected and distributed light. Seeing capacity has a nature in perceiving physical elements through a light that reflected by the element. [10] The sensitive area in perceiving lights in seeing capacity is the foveal area which is 300 to recognise a form of the physical elements and 2100 as the peripheral area of visual range to fill the context of the visual sphere. [11]

Configuration is a relation between something that has a dependent nature in the whole. In principle, the configuration of each physical element lies between the other physical elements, and the relationship between them occurs through several natural laws, namely gravity, proximity, direction (in front, behind, above or below) and light reflection. The natural laws of configuration become the basis of logic to allows objects to enter in the eye and knowing the position of the elements. Those principles of this nature connect the body and the physical space [12].

A variant of configuration occurs when the nature of the relation has a modification and change the conditions of each one to the other. The modification of spatial arrangement automatically provides a different probability of window placement in the potential surface of inpatient ward that creates a pattern difference level of relation. Therefore a space in process design can be defined as the product of the configuration of seeing experience in experiencing space through the modification window placement and space arrangement.

2. Simulation’s alternative as a method of exploring the relation of windows placement and spatial arrangement: Capturing and calculating image in recording the seeing experience of patient

In representing the modification of window placement and spatial arrangement based on the seeing capacity of a patient this research using alternative methods of simulation through the application of 2d cad and 3d Rhino (Figure 1) [13] [14]. Through fife alternative (A1-A5) of the configuration of window placement and spatial arrangement based on seeing capacity reveal differences of relation level. The Changes of space configuration opens the opportunity for the alternative of window placement in one in one area that is connected to the outer space. The first alternative (A1) is the configuration of the original design that has been built and applied to the hospital and the second alternative until the fifth alternative (A2-A5) is a design with a configuration that applies the modification from the original design.

![Figure 1. 3d Simulation Model of first alternative in Rhinoceros. Source: Author (2018)](image1)

![Figure 2. Five position of the alternative of window’s placement. Source: Author (2018)](image2)
The second alternative (A2) is a configuration by moving mirroring horizontally a space in inpatient ward layout that creates a parallel orientation of the eye position of the patient. The third until the fifth alternative (A3-A5) has a modification in moving space with a mirroring vertically, therefore occur the position possibility of window placement variant (Figure 2).

The seeing capacity was explore using camera view in 3d simulation model in capturing view through the combination of vertical (135°), and horizontal (210°) visual ranges based on the foveal view in 30° in recognise shape (Figure 3). The results of capturing images are the combination of vertical and horizontal visual ranges produces a coordinate system as a mapping of the patient's visual sphere (Figure 7). Each data record a scene that represents a view in 30° total images capturing view produces 104 scenes on one alternative configuration (Figure 4). Five alternatives produce 52 scenes. Every scene has a collection of a region that represents a visual element perceived in visual range. To determine the level of relation, each region in a scene was calculated using MATLAB “Calculate Region Properties Using Image Region Analyzer”.

Matlab calculates a part of the entire window area that is captured by the seeing capacities in a visual range of 30° (Figure 5). Through Matlab calculation, it can be seen the difference in the percentage of the window area in the five alternatives of window’s placement based on the space configuration. Matlab calculate the total percentage of window area that occupies the patient’s visual sphere, (Figure 8) by dividing the window area to the total area of each region in all scenes of the patient’s visual sphere (Figure 6).

3. Result
3.1 The First and second alternative of the configuration of window’s placement and spatial arrangement
The first alternative has a window area 0.17% in patient's visual sphere which is divided into sub-coordinates at 2 points, i.e. 1 (2,1) 0.08% and 1 (3,1) 0.09% with a distance of the viewpoint is 4544
mm. The position of the window area in patient's visual sphere defines that window placement was in the area of peripheral view and not in the focus view of the patient. Not merely in the peripheral view and not in the focus view of patient 0.17% was insignificant in patient's seeing capacity. It was a result of the configuration of the window placement in the patient's seeing capacity that was covered by the position of the spatial arrangement in the inpatient ward. At the second alternative, the window area in patient's visual sphere is 0.32% which is divided into sub-coordinates at 2 points, i.e. 2 (1,1) 0.27% and 2 (2,1) 0.06% with a distance of the viewpoint is 4291 mm. The second alternative shows the percentage of window area higher than the percentage of the second alternative but 0.32% is still insignificant in patient's seeing capacity, even though the window placement has direct access of the patient's point of view.

3.2 The third until fifth alternative of the configuration of window’s placement and spatial arrangement

The window area in patient visual sphere of third alternative 0.81% which is divided into sub-coordinates at 6 points i.e 3 (2,1) 0.05%, 3 (3,1) 0.52%, 3 (4,1) 0.08%, 3 (2,2) 0.01%, 3 (3,2) 0.08%, and 3 (4,2) 0.07%. The distance of the viewpoint at the third alternative is 2808 mm. The fourth alternative window area in patient visual sphere is 0.65% which is divided into sub-coordinates at 6 points i.e 4 (1,1) 0.1%, 4 (2,1) 0.16%, 4 (3,1) 0.15%, 4 (1,2) 0.04%, 4 (2,2) 0.16%, and 4 (3,2) 0.04% with a distance of the viewpoint is 2534 mm. The Fifth alternative window area in patient visual sphere is 1.21% 0.66%, 5 (2,1) 0.15%, and 5 (3,1) 0.01% with a distance of the viewpoint is 2363 mm. The fifth alternative indicates the magnitude of the openings with the highest percentage of the other alternatives, followed by the smallest distance number indicating closest to the position of the patient's point of view. The third, fourth, and fifth alternative display the position of the window area in patient's visual sphere was in the patient's peripheral view and the percentage of the window area in patient's visual sphere was insignificant.
3.3 Summary of the five configurations between window’s placement and space arrangement in patient’s visual range.

The five alternatives reveal different levels of relation through different percentages of window areas in patient's visual sphere that affected by space arrangement in the inpatient ward. The percentage of window area in patient's visual sphere in each alternative tends to be inversely proportional to the number of distance from the position of the patient's point of view. The higher the percentage of the window placement in the patient's seeing capacity, the higher distance of the window placement from the eye position of the patient.

First alternative (A1) has a window area in patient visual sphere in 0.17%, (A2) 0.32% (A3) 0.81%, (A4) 0.65%, and (A5) 1.21%. The first alternative (A1) with a distance of 4544 mm as the farthest distance has the smallest percentage of window area in the patient's visual sphere. The fifth alternative (A5) 2363 mm as the nearest distance has the highest percentage. The distance differences in alternatives (A1), (A2), (A3), (A4) and (A5) occur due to the application of modifications of window variant of the patient's point of view position. The application of windows placement that only one side of the patient's room causes the variant of the window area that always produces patterns on the patient's peripheral area.

4. Discussion

Why does the first alternative (A1) as the original design has the smallest percentage of the window area in patient's visual sphere in contributing to strengthening the relation between the window placement, spatial arrangement and the seeing capacity of the patient? The spatial arrangement in inpatient ward of the first alternative (A1) becomes the interrupter in the relation between the window and the point of view of the patient because of the position was within the visual range of the patient and between the patient's point of view and the window. The spatial arrangement which does not provide the possibility of the window's placement in seeing the capacity of the patient shows a lack of consideration of the relation between patient seeing experience in experiencing patient healing environment.

Why is the alternative of the configuration in (A1), (A2), (A3), (A4) and (A5) tends to be inverse proportional between the distance of the window placement and the percentage of window area in patient's visual sphere? The farther distance, the fewer scenes of the visual range has captured the window area, and the nearer distance, the more scenes of visual range capturing the window area in patient's visual range. Those alternatives configurations reveal that distance factors are essential in uncovering the size of the window area which captured within the patient's visual range.
The results of this study reveal the relation that occurs between the physical elements of healing environment of a patient and the seeing experience of the patient in experiencing space. A relation level was explored through a variant of the configuration of the window placement and spatial arrangement in patient's seeing capacity.

5. Conclusion
This study emphasises the experience of seeing patients as the missing link in the relation of human recovery and healing environment that involves the natural view through windows. Debates in designing hospitals by presenting windows, defining natural elements as in window view, and applying the latest technology for windows are irrelevant if the window placement is beyond the capacity to see patients. The discussion of window placement and capacity-based space arrangements to see the patient was a bridge to fill the gap is considered to create a better design by building relationships between physical elements of space and patients.

Subsequent research can be focused on more complex variants in the range of distance and in the complexity of the magnitude of the area. The magnitude of the distance which determined by the magnitude of the visual element area can produce a clear principle in revealing the magnitude of the element of the exact elemental dimension in reality in the seeing perspective. This research leads to further research to reveal the different perception in the different distance of visual elements in a point of view as a recommendation base of a design process.

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