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Tours and Maps Operations as Movement Mechanism in Indoor Wayfinding

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Abstract. This paper addresses the issue of wayfinding and human movement in a complex building. It focuses on the operations people perform to enable themselves to move from one place to another during the process of searching for a destination in a building. The wayfinding operations build upon the concept of *tours* and *maps* proposed by de Certeau (1984). This paper analyses how the *tours* and the *maps* operations were employed and distributed in a wayfinding journey within a building, with these operations enabling visitors to reach a certain destination in the building. The *tours* and *maps* operations were revealed by looking into the wayfinding narrative based on observations of participants executing wayfinding tasks. The results of the study indicate that the length of a wayfinding journey conforms to the number of operations performed. Both *tours* and *maps* operations had the same role in regulating the movements in the wayfinding journeys. While the *tours* operations regulated how people moved from place to place, the *maps* operations supported their movements by giving information from the surrounding environment. Understanding movement mechanisms by exploring operations in a wayfinding journey could contribute to the development of digital navigation systems for indoor wayfinding.

Keywords: Complex building; Journey; Movement; Operation; Wayfinding

1. Introduction

Finding a way through a public building can be quite a challenge, especially for a new visitor who is not familiar with the environment. Public buildings have become complex environments with many building masses and rooms connected by complex networks of corridors (Passini, 1992). People search and reach a destination by moving from one place to another in a building (Ingold, 2011). The difficulty in finding a destination may also mean problems with moving through places and relating them together within a building. These problems can result in loss of time, money, or even life caused by missed flights, delays of medical service, or being trapped in an emergency situation. Understanding wayfinding mechanisms is essential to developing wayfinding systems that support an efficient movement for locating the desired destination.

Wayfinding has been widely discussed as a complex cognitive process (Golledge, 1999; Spiers & Maguire, 2008; Jamshidi & Pati, 2020). In short, wayfinding is simply a matter of moving from one place to another in a building or other, larger environment. It is based on a perception-action approach that involves continually adjusted movement according to an ongoing perceptual process (Ingold, 2011; Heft, 2013); however, there is a

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lack discussion on how people move during the search. Meanwhile, the development of digital technology for indoor wayfinding and navigation does not follow the rapid development of digital outdoor navigation. The Global Positioning System (GPS) that has been used for digital outdoor navigation cannot work properly and accurately in buildings (Karimi, 2015). Some infrastructures are being developed to assist navigation in buildings, but these are still focused on the use of positioning technology based in space (Gu et al., 2009; Deak et al., 2012) rather than the movement mechanism being the basis of wayfinding. The wayfinding movement mechanism ought to be explored for the development of future digital indoor wayfinding systems.

This paper will discuss the movement aspect of wayfinding by revealing the way of operations involved during wayfinding. Operation refers to a schema of actions that describe how people do something (de Certeau, 1984). In this study, the spatial operations in a wayfinding journey will be analyzed through the *tours* and *maps* approach (de Certeau, 1984). In particular, this study attempts to analyze the role of the two operations types, the *tours* and the *maps*, within a sequence of a wayfinding journey in a hospital building. Some studies in hospital and healthcare facilities have revealed the role of spatial configuration in hospital performance (Johanes & Atmodiwirjo, 2015; Sengke et al., 2020; Yatmo et al., 2018, 2021), including issues with wayfinding (Pati et al., 2015; Carpman et al., 2016; Johanes & Yatmo, 2018). This current study demonstrates how the movement of visitors can take place in a particular spatial configuration of a hospital.

2. *Tours* and *Maps* as Operations in Wayfinding Movement Mechanism

Wayfinding is "*the movement of a person from one location on the earth's surface to another*" (Downs & Stea, 1977, p. 124), involving a relational act between body and space. As an action in space, wayfinding involves locomotion or moving from one location to another (Montello & Sas, 2006). Wayfinding involves purposive movements to search and reach the desired destination through a certain route. However, wayfinding movements carried out by a subject in a new and unfamiliar environment can be explorative without any prior travel plans (Zacharias, 2001; Xia et al., 2008).

To see how movement is involved in the process of searching, wayfinding should be elaborated into operations. The term operation refers to what de Certeau (1984) calls a "*way of doing,*" which shows how a person applies "*spatial tactics*" according to the surrounding environment. The operation involves "*schemata of actions*" or patterns of actions performed by users in utilizing the spatial conditions and situations of an environment to achieve his/her goals. Operations also involve space reappropriation in multiforms and fragments that are relative to the situation and details (de Certeau, 1984). Details of operation include every visible gesture of subjects and every action generated by various triggers that show how a subject explores visual cues from his surroundings, moving his body toward any boundaries and according to any rules, and how any surrounding object can trigger a subject to move (Yatmo et al., 2017; Pilegaard, 2021). Looking at operations shows how a spatial configuration performs in the everyday environment (Atmodiwirjo et al., 2019) and the interactional relation between human body, sensory and object in space when experiencing a designed environment (Austin, 2018; Stafford, 2019).

Tours and *maps* is an approach proposed by Michele de Certeau (1984) to see how space is actualized and place is identified. This approach sees a spatial journey as consisting of two elements: the element of tours or actions that makes up the journey and the element of maps as a *citation* that marks out the journey (de Certeau, 1984, p. 120). The *tours* are made up of the operation of *"going"* or "*prescription of movement,*"

which describes how people move through space (Guano, 2003). The *maps* explain '*seeing*' or "*the plane projection of totalizing observation*" that shows "*the knowledge of order of places*" (de Certeau, 1984, p. 119). Maps here are not understood only as the product of "*seeing*" but also the action of "*seeing*" as an operation that generates the product, which brings what is invisible into visibility (Lozanovska, 2002). As wayfinding essentially constitutes a journey, the *tours and maps* approach is used in this study to elaborate operations involved in the journey.

3. Methods

This study used a mixed research method to explore the operations of how people move when they search for a destination in a building. This study observed wayfinding movement operations of participants in a general hospital setting (Figure 1). Ten adult participants involved in this study consisted of six females and four males aged 20-50 years. These participants came from volunteers with various backgrounds and were purposefully chosen to meet the requirements of the study: they were unfamiliar with the setting and had no serious visual or physical problems.

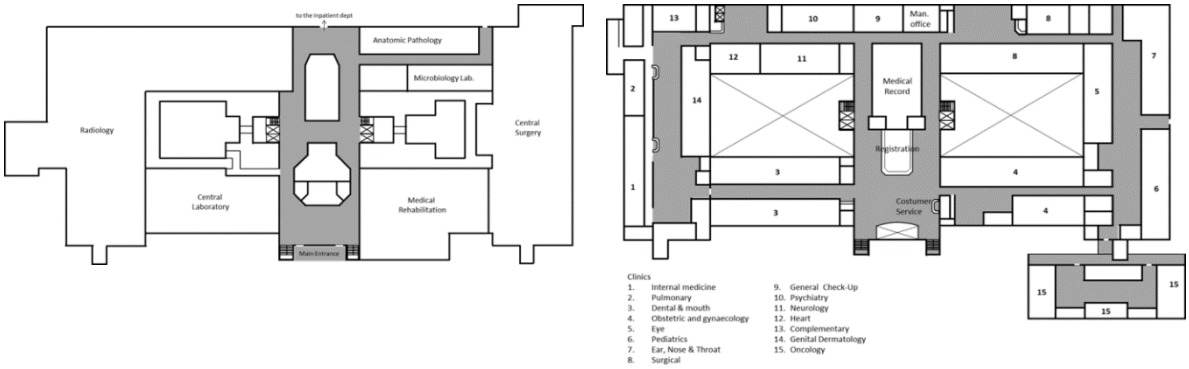

Figure 1 The layout of the setting: The main entrance is on the first floor (left), while the outpatient entrance is on the second floor (right).

The study analyzed the wayfinding journey narratives of the participants executing their wayfinding tasks. Every participant was given wayfinding tasks that imitated the wayfinding experience of a new patient/visitor of the outpatient department.

Table 1 Participant's wayfinding task

Task code	Description	Origin	Destination
Task A	To find the outpatient department area	The main entrance (1st floor)	The outpatient department lobby (2nd floor)
Task B	To find the customer service counter	The outpatient department lobby (2nd floor)	The customer service counter (2nd floor)
Task C	To find the registration counter	The customer service counter (2nd floor)	The registration counter (2nd floor)
Task D	To find a particular clinic	The registration counter (2nd floor)	The clinic (2nd floor)

In each task, the participants were only given the name of the destination without any information on location. They had to use any sources of information in their environment

to locate the destination, but they were not allowed to ask other people. All participants began the first task from the main entrance on the first floor of the building and had to find the four destinations located on the second floor. Thus each participant performed four different wayfinding journeys that started from a particular origin and ended up at one particular destination. The tasks were performed through a walking-with observation, where the researcher accompanied the participant's walk and recorded the process. The audio-visual documentation of the observations was then translated into the narratives describing all the actions performed by the participants. The narratives reveal the ways of operation within the spatial-temporal context and involve both the general and more detailed aspects of events (Atmodiwirjo et al., 2019).

Each narrative was analyzed through *tours and maps* to reveal the operations involved in the journey. *Tours* captured the expressions that described all actions taken resulting in a shift in position or changes in the condition of the subject's movement. *Maps* identified all visual actions taken, involving the movement of the eyes, neck, and limbs, to perceive and obtain visuospatial information. The results were then discussed to discover how the way of operations regulated wayfinding movement through different patterns of actions that might indicate a relation to the surrounding spatial context. The operations revealed were also analyzed quantitatively to find out the distribution of tours and maps operations within each journey, indicating the role of each type in the journey.

4. Results and Discussion

4.1. The Tours and Maps Operations in a Wayfinding Journey

This study tried to reveal the wayfinding operations by looking at the texts of the wayfinding journey narration of participants. Each narrative showed how participants reached a requested destination from a particular point of origin. The following paragraph gives an example of part of the wayfinding execution narration of a participant who had to find a polyclinic.

Subject P04 stood on the terrace of the main hospital entrance, facing the main entrance door. She looked at the door THEN walked towards it and entered the 1st-floor lobby through the door. AFTER entering the lobby, she immediately turned left and walked forward. WHEN he walked and turned her head to the right, she saw a lit-up standing sign in the middle of the lobby. She THEN turned right AND walked slowly towards the sign WHILE looking at it. She stopped in front of the sign and AFTER reading it, got the information that the polyclinic was on the second floor. ….

This example of narration tells the beginning of the journey that describes how a participant learned the destination's location. The narrations tell us the sequential actions that were performed by participants, which were operations that showed how each participant utilized the spatial conditions and situations to find a way to the destination. There were a total of 40 wayfinding execution narrations from four tasks conducted by 10 participants. The narrations tell us the sequential actions that were performed by participants, which were operations that showed how each participant utilized the spatial conditions and situations to find a way to the destination.

There were two kinds of operations that were revealed from these narratives. The first was *tours* operations that consisted of movement actions, such as '*walked forward', 'walked towards',* or '*turned left*'. We called these types *tours operations*. This study reveals that *tours* operation refers to the movement action that regulates the displacement of the subject from place to place. We identified five different types of *tours* operations that were performed based on the purpose of the movement: *shifting* to change positions between points, horizontally or vertically; *responding* to respond to visible objects, be they static

objects or moving entities in space found during wayfinding journey; *maneuvering* to change the movement direction; *controlling* to regulate the walks by keeping in movement and to control the walking speed; and *breaking* to interrupt the movement for a while or to terminate the journey.

Table 2 Types of *tours* operations

Code	Types Of *Tours* Operations	Operation Details	Examples Of Actions
T1	*Shifting*	A movement in order to change positions horizontally between points on the same floor or vertically between points on different floors	*Walking forward* *Stepping to the left/right* *Walking up*
T2	*Responding*	A movement to respond to visible objects, be they static objects or moving entities.	*Walking toward* *Approaching* *Walking into/out* *Walking down* *Following*
T3	*Maneuvering*	A movement to change direction triggered by a position of a destination object, a spatial configuration or a decision to walk to another direction.	*Turning right/left* *Turning back* *Turning around*
T4	*Controlling*	A movement to regulate the walks both to keep one in movement and to control the speed of movement.	*keep walking* *Slowing down* *Walking faster*
T5	*Breaking*	Interrupting for a while or terminating the movement.	*Pausing* *Stopping*

The second types of operations were *maps operations* that consisted of the subject's visual actions such as *'looked at the door*', *turned her head to the right* or '*saw a hanging sign*'. The *maps* operations are related to the acquiring of environmental information. In this study, *maps* operations referred to every visual gesture carried out by the subject to search and perceive the visual information. These operations are part of the process of 'reading' the surrounding environment and gaining information from it that involves a movement of one's eyes, head or body to get a visual view. There are four types of *maps* operations identified in this study, namely: *searching, seeing, observing* and *obtaining-information*. *Searching* involves the eye, head or rotational body movement aiming at finding a cue from the surrounding environment. *Seeing* involves the use of visual senses to see an object that can be considered a cue. *Observing* is an action of taking a closer look at a seen cue to obtain any information about it. Whereas *obtaining information* is an operation when the subject is getting any information from a cue that can suggest him/her perform a further action or enable him/her to conclude a position. These maps operations conform to the idea that wayfinding involves seeing mechanisms while someone is moving from place to place (Sengke & Mustikawati, 2019).

Table 3 Types of *maps* operations

Code	Type Of *Maps* Operations	Operation Details	Example Of Mechanisms
M1	*Searching*	The eye, head or rotational body movement to a certain direction to look for a cue from the surrounding environment	*Look ahead/forward/up/to the right-left* *turn the head to the right-left* *raise the head up* *turn the body to the right-left / around*
M2	*Seeing*	The movement of visual senses to see an object that can be considered a cue	*face (something)* *see (something)*
M3	*Observing*	An act of watching an object/condition carefully to obtain information from it.	*Observe* *Read* *Look at/towards*
M4	*Obtaining information*	A condition when the subject is getting information from a cue that can suggest him/her to perform a further action, or enable him/her to conclude a position.	*Decide to (further action)* *Declare/state/Identify/conclude that (a position)* *Thought/ assume that (a position)* *Find/get information about (a position)*

4.2. Performing Operations in Wayfinding

This study showed that different numbers of operations were performed in each journey of wayfinding execution. Table 4 shows the total *tours* and *maps* operations performed by participants in each wayfinding journey.

Table 4 The total operations in each wayfinding journey

Wayfinding Journey	Task & Movement Description	*Tours* Operations		*Maps* Operations		Total *Tours* and *Maps* Operations
		Total	**Average**	**Total**	**Average**	
Journey 1	Task A: Movement search between two different floors	218	21.8	228	22.8	446
Journey 2	Task B: Movement search in the same area on the same floor	122	12.2	99	9.9	221
Journey 3	Task C: Movement search in the same area on the same floor	40	4.0	29	2.9	69
Journey 4	Task D: Movement search between different area on the same floor	181	18.1	152	15.2	333

Journey 1 was the execution of Task A. This was a movement search from the main entrance to the outpatient area that involved mobility between floors. This journey had the largest number of operations performed by participants. It had a total of 446 operations that were carried out by participants, consisting of a total of 218 *tours* operations and 228 *maps* operations. The second largest number of operations was in Journey 4 from the registration area to a particular clinic that involved mobility between different areas on the same floor. In this journey, 333 operations were performed by the participants, consisting of 181 *tours* operations and 152 *maps* operations. In Journey 2, there were a total of 221 operations with 122 *tours* operations and 99 *maps* operations performed by the participants. This was a journey of searching a customer service counter in the lobby of the outpatient area. Journey 3 was the short journey to search a registration counter from the customer service counter, which was located across from the point of origin. This journey only involved a total of 69 operations, consisting of 40 *tours* operations and 29 *maps* operations. This result indicates that the number of operations corresponded to the length of the journey: the longer the journey, the more movements that were involved, and the more operations that needed to be performed.

This study indicated that although there were differences in the number of operations performed, the distribution of *tours* and *maps* operations within every journey was almost equal, suggesting the equal roles of both types of operations in wayfinding movement mechanisms. The *tours* operations played an important role in regulating the movement of subjects from place to place. These operations directed where the subject went to and controlled when the subject should move or stop the walks. On the other hand, the *maps* operations had a significant role in providing the subject with spatial information. This information was required to determine which tour operation would be applied.

This study also pointed out that in the same journey, different participants could apply different operations during wayfinding with various numbers of operations performed, as illustrated in Figure 1. Moreover, each participant could carry out different numbers of these operations in the same journey. This might happen since each participant could take a different route to reach the same destination and experience different events.

In Journey 1 (Figure 1a), while seven participants took less than 50 operations to finish the journey, the other three participants had more operations. Two participants (P05 and P09) had to do a lot more operations than others. They missed information when they applied the operation of *searching* at the beginning of the journey that made them move in the wrong direction. More tour operations had to be applied for *maneuvering* by *turning back* to move to the starting point. This incident indicated that map operation is crucial in determining the right direction of movement. When someone takes the wrong route, the mechanism of moving back to the origin might be applied to solve the problem.

There were also participants who did more operations than others in journey 2 (Figure 1b). A participant (P01) misidentified another object as the destination point and the mechanism of re-searching the destination had to be applied by performing a *searching* operation and moving in another direction. This mechanism was applied several times until she found the destination. The other participant (P07) did a lot more operations since he went toward direction away from the actual destination location. He actually passed the destination point but did not see it. In this case, the map operation of *seeing* was seen to be key for an effective search.

The least operations were carried out in journey 3 (Figure 1c). This was the shortest journey from the customer service counter to the registration counter, which was

opposite to each other. The destination could be seen from the origin point, allowing participants to *see* and *obtain information* to identify the destination easily. They could find the destination through just some short *searching* operations, and reach it by doing a *maneuvering* and *responding* movement.

Journey 4 (Figure 1d) was also quite a challenge for some participants, as indicated by more operations. A participant (P04) did a *searching back* mechanism after having doubt about the route she took. In the middle of the journey, she could not find any information to ensure that she had taken the right route. She turned back and went to the point where she last obtained information. This *searching back* mechanism made her do more tour operations, while the *searching* operation allowed her find out the right direction to take.

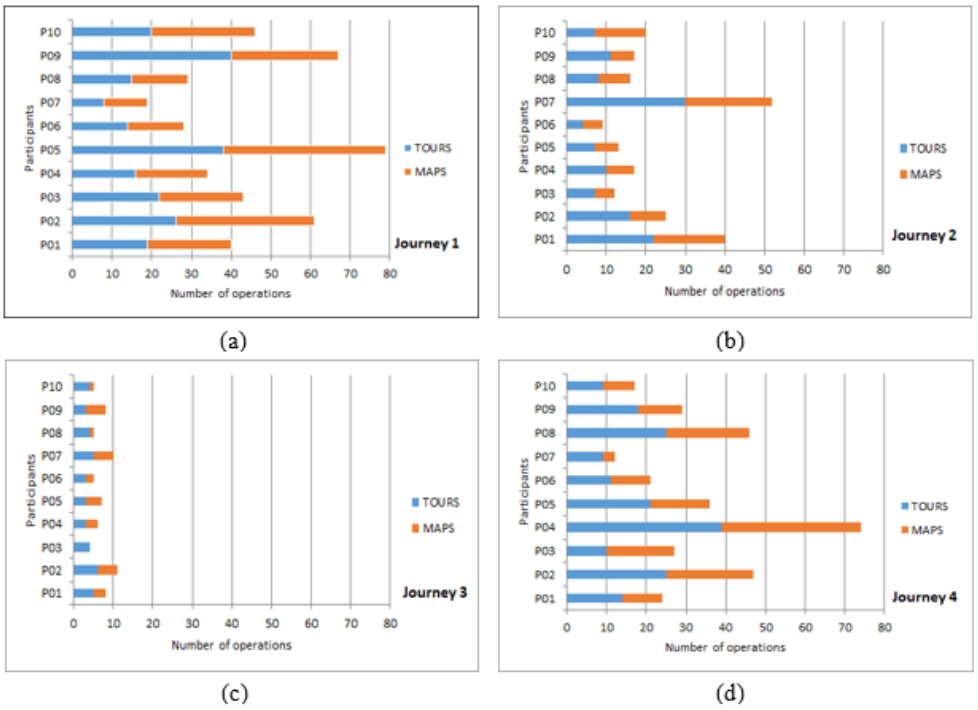

Figure 2 Operations in participants' wayfinding journey

The above illustration indicated that any difficulty encountered while someone was finding his/her way to a destination would result in more operations carried out and thus more movements to take. In this study, the difficulties that participants faced were taking the wrong route, being unsure about the route taken, or having difficulty in identifying the destination. Performing more operations means more effort is required to find a particular location, which can result in wayfinding inefficiency with regard to distance and time.

5. Conclusions

This study has demonstrated how the mechanism of movement can be discovered by looking at the operations performed during wayfinding. It shows that operations during wayfinding can be revealed by looking at the narratives of wayfinding journeys, which shows how a wayfinding journey is composed of *tours* and *maps* operations. The result indicates that the *tours* operations regulate all the movements involved during wayfinding, while the *maps* operations regulate how visual senses work to read the surrounding environment and provide information for connecting all the movements.

Both operations work together as the movement mechanism during the search for the destination in a building.

Different subjects might perform different wayfinding operations, demonstrating that each operation is related to the situation and condition around the subject. The different operations would take the subject through different routes with different wayfinding and spatial experiences. However, a pattern of operations might be performed in a situation and condition related to a particular spatial configuration. These patterns have not been discussed in this paper and might be investigated in further studies.

This study offers a way of understanding movement mechanisms by exploring operations in a wayfinding journey. The findings of the study demonstrate a mechanism that may contribute to the future development of digital indoor wayfinding systems.

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References

Atmodiwirjo, P., Johanes, M., Yatmo, Y.A., 2019. Mapping Stories: Representing Urban Everyday Narratives and Operations. *Urban Design International*, Volume 24(4), pp. 225–240

Austin, T., 2018. Some Distinctive Features of Narrative Environments. *Interiority*, Volume 1(2), pp. 153-172

Carpman, J.R., Grant, M.A., Kirchen, E.M., 2016. *Design That Cares: Planning Health Facilities for Patients and Visitors (Third edition)*. San Fransisco: Jossey-Bass

De Certeau, M., 1984. *The Practice of Everyday Life (Nachdr.)*. Berkeley: Univ. of California Press

Deak, G., Curran, K., Condell, J., 2012. A Survey of Active and Passive Indoor Localisation Systems. *Computer Communications*, Volume 35(16), pp. 1939–1954

Downs, R.M., Stea, D., 1977. *Maps in Minds: Reflections on Cognitive Mapping*. New York: Harper & Row

Golledge, R.G. (Ed.), 1999. *Wayfinding Behavior: Cognitive Mapping and Other Spatial Processes*. Baltimore: Johns Hopkins University Press

Gu, Y., Lo, A., Niemegeers, I., 2009. A Survey of Indoor Positioning Systems for Wireless Personal Networks. *IEEE Communications Surveys & Tutorials*, Volume 11(1), pp. 13–32

Guano, E., 2003. A Stroll Through la Boca: The Politics and Poetics of Spatial Experience in a Buenos Aires Neighborhood. *Space and Culture*, Volume 6(4), pp. 356–376

Heft, H., 2013. Wayfinding, Navigation, and Environmental Cognition from A Naturalist's Stance. *In:* Handbook of Spatial Cognition, D. Waller & L. Nadel (Eds.), American Psychological Association, Washington, USA, pp. 265–294

Ingold, T., 2011. *The Perception of The Environment: Essays on Livelihood, Dwelling and Skill*. London: Routledge

Jamshidi, S., Pati, D., 2020. A Narrative Review of Theories of Wayfinding within The Interior Environment. *HERD: Health Environments Research & Design Journal*, Volume 14(1), pp. 290-303

Johanes, M., Atmodiwirjo, P., 2015. Visibility Analysis of Hospital Inpatient Ward. *International Journal of Technology*, Volume 6(3), pp. 400-409

Johanes, M., Yatmo, Y. A., 2018. Application of Visibility Analysis and Visualisation in Hospital Wayfinding Sign Design. *DIMENSI (Journal of Architecture and Built Environment)*, Volume 45(1), pp. 1-8

Karimi, H. A. (Ed.)., 2015. *Indoor Wayfinding and Navigation*. CRC Press, Taylor & Francis Group

Lozanovska, M., 2002. Architectural Frontier/Spatial Story: The Problematic of Representing the Everyday. *Space and Culture*, Volume 5(2), pp. 140–151

Montello, D., Sas, C., 2006. Human Factors of Wayfinding in Navigation. *In:* International Encyclopedia of Ergonomics and Human Factors, Second Edition—3 Volume Set, W. Karwowski (Ed.), CRC Press

Passini, R., 1992. *Wayfinding in Architecture*. New York: Van Nostrand Reinhold.

Pati, D., Harvey, T. E., Willis, D. A., & Pati, S., 2015. Identifying Elements of the Health Care Environment That Contribute to Wayfinding. *HERD: Health Environments Research & Design Journal*, Volume 8(3), pp. 44–67

Pilegaard, A., 2021. Between Inhabited Interiors and Interiors on Display: Exploring Spatial Boundaries at Rosenborg Castle. *Interiority*, Volume 4(2), pp. 139-158

Sengke, M. M. C., Atmodiwirjo, P., Yatmo, Y. A., Johanes, M., 2020. Design Consideration for Window Placement to Provide the View within the Patient's Visual Range. *Journal of Design and Built Environment*, Volume 20(1), pp.13-23

Sengke, M. M., Mustikawati, T., 2019. The Visual Mechanisms of Seeing in Experiencing the Interior. *Interiority*, Volume 2(2), pp. 213-229.

Spiers, H. J., Maguire, E. A., 2008. The Dynamic Nature of Cognition During Wayfinding. *Journal of Environmental Psychology*, Volume 28(3), pp. 232–249

Stafford, L., 2019. Contested Interiority: Sense of Outsideness/Insideness Conveyed through Everyday Interactions with University Campus Doors. *Interiority*, Volume 2(1), pp. 25-41

Xia, J., Arrowsmith, C., Jackson, M., Cartwright, W., 2008. The Wayfinding Process Relationships between Decision-Making and Landmark Utility. *Tourism Management*, Volume 29(3), pp. 445–457

Yatmo, Y.A., Atmodiwirjo, P., Paramita, K. D., 2017. Topological Reading of Movement Connectivity in Sensory Integration Space for Autistic Children. *Space and Culture*, Volume 20(1), pp. 24–41

Yatmo, Y.A., Harahap, M.M.Y., Atmodiwirjo, P., 2021. Modular Isolation Units for Patients with Mild-to-Moderate Conditions in Response to Hospital Surges Resulting from the COVID-19 Pandemic. *International Journal of Technology*, Volume 12(1), pp. 43-53

Yatmo, Y.A., Putra, N., Harahap, M.M.Y., Saginatari, D.P., 2018. Evaluation of Spatial Layout in Health Care Waiting Areas based on Simulation of Droplet Movement Trace. *International Journal of Technology*, Volume 9(5), pp. 888-897

Zacharias, J., 2001. Path Choice and Visual Stimuli: Signs of Human Activity and Architecture. *Journal of Environmental Psychology*, Volume 21(4), pp. 341–352