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Research Article

An experimental research on the impact of spatial configurations of complex hospitals on human wayfinding performances

Asst. Prof. Dr. Esra Aksoy[1*], Prof. Dr. Dicle Aydın[2], Asst. Prof. Dr. Gökhan İskifoğlu[3]

[1]Aydın Adnan Menderes University, Vocational School of Karacasu Memnune İnci, Program of Architectural Restoration, Aydın, Turkey.
esra.aksoy@adu.edu.tr

[2]Necmettin Erbakan University, Faculty of Fine Arts and Architecture, Department of Architecture, Konya, Turkey.
dicleaydin@erbakan.edu.tr

[3]European University of Lefke, Faculty of Education, Department of Basic Education, TRNC.
giskifoglu@eul.edu.tr

*Corresponding Author
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Abstract
This study was carried out to investigate the impact of spatial configurations of a complex hospital plan on individuals' wayfinding performances on the basis of a human cognition theory. 20 participants were sent to two different locations in the hospital (Breast Clinic and X-Ray Clinic). After qualitative data derived from VGA study was analyzed, VGA results were transferred into binominal continuous values for each variable and statistically analyzed by SPSS 24 to come up with quantitative results regarding the wayfinding performances of the participants. As a result, cross-sectional node points were found to be the decision-making points of participants where they mostly stopped to think and lost time and effort. The results also revealed that reference points have strong positive influence on wayfinding performances. This study concludes that wayfinding performances of navigators are supported when there is small gap between the users' existing schemata and new building design. Designing circulation areas in a curvilinear shape allow direct day light to get into the building and that creates wide spectrum of vision rather than vertically designed cross-sectional areas, which create narrower vision of the circulation areas and node points.

Keywords: Cognitive Mapping, Complex Hospital Designs, Space Syntax, Spatial Configurations Wayfinding

Extended Abstract

Introduction: Consideration of the important emphasis the bulk of the literature puts on the context of spatial configuration, human cognition and human-wayfinding lead us to shift our attention on human-wayfinding behavior in complex hospital designs from the same theoretical perspective. There are many reasons for carrying out this research but among many reasons, the first and foremost is that the related literature lacks in explaining how human dimension with its psychological entities are embedded in the field of architecture, and in relation to that, the literature is lacking in the amount of experimental research in explaining how humans are affected by their environment and react accordingly. Designing buildings which keep balance between spatial configurations and human cognition to support wayfinding

practices require excessive knowledge regarding how human possesses and processes knowledge for his/her benefit. This is hugely significant since the extent to which an environment is designed by considering the human dimension, the needs of human wayfinding will be better catered. That is why experiments need to be conducted to understand the psychological contributions to architectural designs. The aim of this research therefore is to gain deeper insight into how people are affected by complex building types and what sort of spatial factors affect their wayfinding behavior in relation to their cognition.

Purpose and scope: This research was designed as a quasi-experimental research supported by qualitative and quantitative research paradigms to bring deeper insight into how individuals find their ways in complex hospital buildings and what factors actually affect the way they navigate through their destinations. Understanding the extent to which users of complex hospital buildings are affected by several exogenous variables required researchers to observe the natural behaviors of participants in their natural settings. For that matter, qualitative aspect of this research becomes crucial. For the quantitative dimension, however; it was tended to fix the standards for the participants of this experiment.

Method: Based on the theoretical framework of the current research, the experiment was designed to gather data from the participants with respect to their wayfinding behaviors and cognitive processes. Participants' navigation strategies were directly observed and data regarding wayfinding behavior was successfully elicited from the verbal reports and live thoughts of navigators. At that point, Arthur and Passini’s (1992) suggestion was followed, which points the importance of collecting data from both researchers' and participants' point of views during an ongoing wayfinding task to get a clearer picture of the actual situation. Such an expectation required an experimental procedure in which some critical variables are in need to be observed and controlled directly (Anastasi & Urbina, 1997). A way of capturing verbal inputs, which involves cognitive processes, was to provide participants with opportunities to think aloud as they navigate through the given destination (Barkaoui, 2011: 53). Therefore, GoPro action camera attached to the heads of each participant enabled us to get clear picture regarding their wayfinding strategies and cognitive processes. The experiment was also designed as mixed method approach including both qualitative and quantitative paradigms. Although this research aimed to gather more qualitative data, qualitative approaches were allowed to infer quantitative data to be further analyzed by some statistical procedures. Direct observation results elicited from participants' verbal reports enabled us to deal with behavioral measures such as time, stops, getting lost, distance, way/shortest way, speed, and pause time. The intention in doing so was causally related to the fact that multilevel hospital buildings with complex plans produce inconsistent routes with numerous death-ends, which in turn, affect the wayfinding performance. In this experiment, in this regard, would give an idea about how navigators interact with such environments and how are their wayfinding performances affected by the design elements and complexity of such structures.

Findings and conclusion: In conclusion, findings under the light of discussions and the contributions of the pioneers of the field concluded that wayfinding performances of navigators are supported when there is a small gap between the user’s existing schemata and new building design; and when main circulation areas were designed in a curvilinear shape getting direct day light through inside the building, which creates wide spectrum of vision, rather than vertically designed cross-sectional areas, which create narrower vision of the circulation areas and node points. Signage system should be free from too much information and the background color should be emphasizing the written directions with concise information.

Based on the results and discussions rendered from the current study, suggestions for the betterment of designs and suggestions for further research are outlined as a form of guideline and are provided below. The most important element in supporting the wayfinding behaviors (performances) of users is to create consistent circulation areas with smooth cross-sectional node points. Node points, where navigators most frequently stop and need more guide from the environment need to be designed in a more memorable manner. Placing artistic elements around these node points support navigators' wayfinding practices and help them activate their already existing schemata. Natural day light coming through inside of a building and lightening the node points and providing navigators with a vision of outside with big enough windows can be considered as an important factor in positively affecting the wayfinding performances of users. While designing a signage system and directory signboards, some important factors which require attention are that a main directory signboard should be situated just in front of the outpatient entries, and should also maintain consistency throughout the spaces in hospitals in terms of texture, color, type size, frame shape, background color and means and additional signboards should be added around node points, especially at cross-sectional corridors where users mostly get confused and stopped for further decision making.

Keywords: Cognitive Mapping, Complex Hospital Designs, Space Syntax, Spatial Configurations Wayfinding

INTRODUCTION

One of the routines of any daily life experience is navigating and orienting via environments to reach a destination for most people. This daily life routine takes places in many different forms such as driving, walking, and moving in a building. Even though this daily event usually occurs with no or minimal problems, people sometimes experience some serious problems in finding their way to reach the desired destinations, which make people feel disappointed or being lost (Arthur & Passini, 1992; Golledge, 1999; Lynch, 1960; Raubal & Egenhofer, 1998: 897). This act refers to the cognitive and behavioral abilities which individuals use to navigate from one location to another (Palmiero & Piccardi, 2017: 2; Ruotolo et al., 2019: 1085). When a person associates him/herself to a wayfinding task, certain cognitive processes occur. According to (Downs & Stea, 2017), this cognitive process is composed of four important stages. The first stage is to locate himself and his/her target destination points. The second phase is to set up an initial route to get to the target location. The third stage includes peculiarities of the first and the second stages. In the final stage, a person makes some decisions about the route taken by means of some evaluations of the decisions he/she made in the first and the second stages as he/she navigates thorough the desired destination. The final stage, which concludes the wayfinding task, is to remember the whole wayfinding process when a person reaches the desired destination. This natural process has been defined by some other scholars in a similar manner but in different number of stages (Carpman & Grant, 2016: 10; Conroy, 2001; Golledge, 1999: 4).

People avoid getting into such buildings alone. They can otherwise miss important meetings which results with loss of effort and opportunities (Carpman & Grant, 2016). Such problematic situations generally happen in hospitals with complex structures (Ulrich et al., 2008: 65). Hospitals are especially unique for some reasons. They are places where people are in hurry to reach their destinations in the shortest time since they might have to catch up with meetings, appointments and hurry on to find their relatives or doctors with whom they need to get on time. Studies indicate that the way buildings were planned and the way spatial areas were configured have enormous impacts on human cognitive maps (Huelat, 2007; Rooke et al., 2009: 5). Studies also exposed that building plans and spatial configurations guide users to be more confident in wayfinding with less lost frequencies (Huelat, 2007; Rooke et al., 2009: 6). Studies also added that there is a significant relationship between well designed buildings and users' compelling harmony to achieve a more successful wayfinding behavior (Brunyé et al., 2019: 5). The architectural setting and logic of the design a building covers are considered to be the key elements of successful wayfinding. Lawson described this phenomenon as “human language of spaces”, and mentioned that such language should be considered as a primary focus of attention and need to be evaluated in depth by architects and researchers from the perspective of human cognition (Lawson, 2007). A group of researchers indicated that wayfinding performances of individuals are quite affected by signage systems that are explicitly available in the environment (Conroy, 2001; Vilar et al., 2012: 1151). Since it is known that people tend to trust the information provided by the signage system. Even though signage system is the first to be considered by way-finders, it does not guarantee good wayfinding in an emergency or when it is urgent to reach a desired destination, especially in complex buildings.

Bringing deeper insight into human-wayfinding behavior requires untying the intriguing relationship between spatial configuration, human cognition, and wayfinding. For that very reason, a considerable body of research has accumulated to unpack the relationships between the so-called variables. For example, a significant group of researchers has put a great emphasis both on the spatial configuration and human cognitive maps, to better understand human wayfinding behavior in relation to human cognition (Downs & Stea, 2017: 16; Kaplan, 1976; Lynch, 1960; Siegel & White, 1975: 12). Cognitive researchers, such as (Downs & Stea, 1977; Kaplan, 1976) claimed that humans first gain cognitive maps of their environments and then store that information and then turn them into a form of structural schemata. Therefore, when a person enters a building or before taking any action to navigate through, he/she first calls information back from these preliminary defined schemata. This clearly underlines the fact that successful human wayfinding is associated with the activation of the already existing schemata of that person by the hand of successful designs and special configurations (Imani & Tabaeian, 2012: 56). It is strongly believed by Hunter that the origin of such behavior roots to a sort of human cognitive exercise, which helps them create information as a tool of wayfinding (Abu-Obeid, 1998: 161; Appleyard, 1970: 113; Gärling & Golledge, 1989: 206; Hunter, 2010; Lynch, 1960; O’Neill, 1991b, 1991a; Passini, 1980: 24; Weisman, 1981: 190).

Many research studies have put effort to understand how human wayfinding behavior functions in real life situations through several experimental studies. For instance, a group of researchers considered human-way finding in conjunction with environmental dimension (Carpman & Grant, 2016; Huelat, 2004; Rooke et al., 2010: 3), while some other group of researchers continued their studies in close relation with human cognition dimension (Golledge, 1999; Haq & Zimring 2003: 137; Hölscher et al., 2005: 823; Raubal, 2001: 366). When recent studies concerning wayfinding were carefully evaluated, it was found out that suggestions for the solutions regarding wayfinding issues were all based on cognitive psychological discipline or environmental psychology (Holst, 2015; Payne et al., 2015: 265; Vogels, 2012; Yang et al., 2018: 22).

RESEARCH FOCUS

Consideration the significant emphasis the bulk of the literature puts on the context of spatial configuration, human cognition and human-wayfinding lead to shift attention on human-wayfinding behavior in complex hospital designs from the same theoretical perspective. There are many reasons for carrying out this research but among many reasons, the first and foremost is that the related literature lacks in explaining how human dimension with its psychological entities are embedded in the field of architecture, and in relation to that, the literature is lacking in the amount of experimental research in explaining how humans are affected by their environment and react accordingly. Designing buildings which keep balance between spatial configurations and human cognition to support wayfinding practices require excessive knowledge regarding how human possesses and processes knowledge for his/her benefit. This is hugely significant since the extent to which an environment is designed by considering the human dimension, the needs of human wayfinding will be better catered. That is why experiments need to be conducted to understand the psychological contributions to architectural designs.

Hospitals are not only crowded places but also the most nerve-driving places, which might possibly create a negative impact on human wayfinding behaviors. For this reason, architectural design features and interior spatial configurations of complex hospital buildings draw attention to their impact on human wayfinding behaviors in relation to human cognition. The aim of this research therefore is to gain deeper insight into how people are affected by complex building types and what sort of spatial factors affect their wayfinding behavior in relation to their cognition.

METHODOLOGY

Research Design

This research was designed in 2017 as a quasi-experimental research supported by qualitative and quantitative research paradigms to bring deeper insight into how individuals find their ways in complex hospital buildings and what factors actually affect the way they navigate through their destinations. Understanding the extent to which users of complex hospital buildings are affected by several exogenous variables required researchers to observe the natural behaviors of participants in their natural settings. For that matter, qualitative aspect of this research becomes crucial. For the quantitative dimension, however; it was tended to fix the standards for the participants of this experiment.

Research questions

To achieve the aim of this study, following research questions have guided the study:

Q1: How do the decision points in the targeted hospital effect the wayfinding behavior of the participants in given wayfinding tasks?

Q2: How do design elements in the defined circulation areas in the targeted hospital affect the wayfinding behavior of the participants in given wayfinding tasks?

Q3: How does signage system in the targeted hospital affect the wayfinding behaviors of the participants in given wayfinding tasks?

Participants

Participants were 20 pre-license students studying in the Aydın Adnan Menderes University between the age range of 18-24 and had no previous experiences of the hospital and were composed of 10 males and 10 females. The reason for choosing young people for this experiment is related to the fact that the difficulties they will experience despite their young ages will expose the actual wayfinding difficulties regarding the building. They have been informed about the research, ethical aspects, and their responsibilities as researcher participants, and they have all accepted to voluntarily contribute to the study by signing participant consent forms. Participants were not allowed to use the elevators and not allowed to ask for directions throughout their wayfinding tasks.

Research Setting

The hospital selected for this research was chosen according to some limitations and perspectives. First, the research team paid attention to concentrate on complex hospital buildings. A complex building design is described as follows: (a) including at least two different plan types in terms of hospital scale and architectural type; (b) having over 300 beds capacity; and (c) composed of multilevel layers. In addition to complexity, the other criterion was the age of the building. This research concentrated on hospitals younger than 10 years old. Outpatient space configuration and position and the willingness of hospitals to support the study were some other factors that was considered in selecting the hospital for the study.

When all the hospitals in the broad area of Aegean region in Turkey were evaluated, the results showed up with one national hospital in Aydin region, which accepted to contribute to this experimental study. The hospital is called Nazilli National Hospital (NNH). The basic premise behind selecting this hospital for this research was to reach more generalizable results of analyses regarding to the spatial configuration and other statistical analyses as well as qualitative responses recorded. Moreover, the managers and hospital head were utmost positive and encouraging in having us to convey this research in their hospital. After the informed consent forms were signed and research policy limitations including codes of conduct, the research team arranged several meetings with some gate keepers in the hospital to get detailed information about the plans and other necessary materials for this research. Invaluable information was collected on the research setting which highly supported this research. For better understanding, thick descriptions regarding the hospital building and its environment were provided in the following section.

Nazilli National Hospital (NNH) with its 73,156 m^2 covered area serving with 481 bed capacities is situated in Nazilli district (connected to the city of Aydin) and consists of the combination of 11 structures. The central core block is surrounded by 10 additional blocks and has nine levels. But three of the nine surrounding blocks have eight levels, four of them have five levels, two of them have six levels and one of them has seven levels. The combination of such a variety of structures with different number of levels turns the building into an even more complex structure. The central core block of the NNH is designed with spiral circulation schema. Other connected blocks; however, are designed by rectangular plan schema.

Experimental Procedures

Based on the theoretical framework of the current research, the experiment was designed to gather data from the participants with respect to their wayfinding behaviors and cognitive processes. Participants' navigation strategies were directly observed and data regarding their wayfinding behavior was successfully elicited from the verbal reports and live thoughts of navigators. At that point, Arthur and Passini’s (1992) suggestion was followed, which emphasizes the importance of collecting data from both researchers' and participants' point of views during an ongoing wayfinding task to get a clearer picture of the actual situation. Such an expectation required an experimental procedure in which some critical variables are in need to be observed and controlled directly (Anastasi & Urbina, 1997). A way of capturing verbal inputs, which involves cognitive processes, was to provide participants with opportunities to think aloud as they navigate through the given destination (Barkaoui, 2011: 53). Therefore, GoPro action camera attached to the heads of each participant enabled us to get clear picture regarding their wayfinding strategies and cognitive processes. The experiment was also designed with a mixed method approach including both qualitative and quantitative paradigms. Although this research aimed to gather more qualitative data, the way the research was employed qualitative approaches allowed to infer quantitative data to be further analyzed by some statistical procedures. Direct observation results elicited from participants' verbal reports enabled us to deal with behavioral measures such as time, stops, getting lost, distance, way/shortest way, speed, and pause time. The intention in doing so was causally related to the fact that multilevel hospital buildings with complex plans produce inconsistent routes with numerous death-ends, which in turn, affect the wayfinding performance. The experiment, in this regard, would give an idea about how navigators interact with such an environment and how their wayfinding performances are affected by design elements and complexity of such structures.

Data Collection and Analyses Procedures

Study 1: Visibility Graph Analysis (VGA)

First, by the help of Depth Map Software, the plans of the hospital building were analyzed on the basis of the space syntax theory in order to find out the most challenging routes for users in terms of connectivity, integration and step-depth. The results for those parameters were shown in illustrations for both base level and level -1 respectively (see Figure 1). Route tasks were determined by researchers' direct observations of the hospital building at different times of a day and the results have been gathered from space syntax analyses.

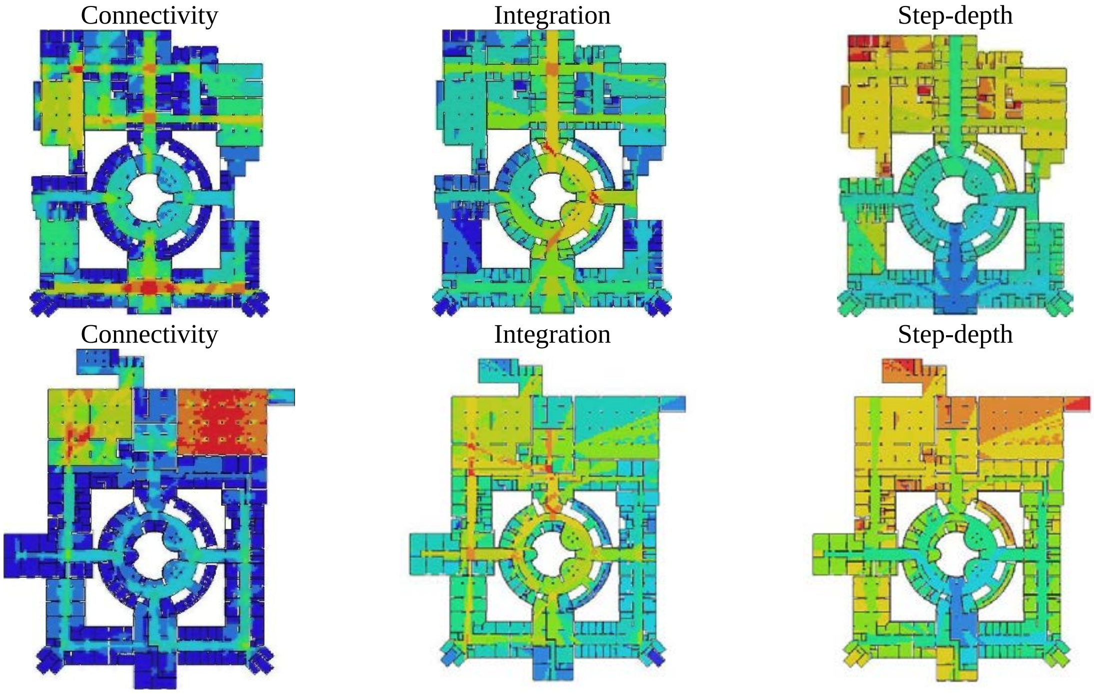
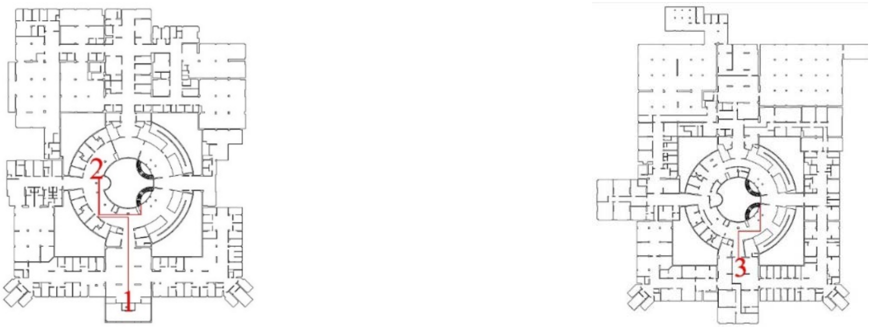


Figure 1. The graphical representation of NNH regarding base level and Level-1 in terms of connectivity, integration and step-depth

This preliminary study guided to determine the zone of proximal analysis within which the distance between actual and potential route tasks were analyzed. Occasionally, such results might have been negotiable unless otherwise experts would have provided opinions on the issue. For that very reason, a group of four experts voluntarily interpreted the observation results and results derived from space syntax analysis to provide their opinions for the optimum route tasks that will be given to participants as directions and destinations. The route task decided for the experiment is shown in the related illustration for NNH.

Base Floor Plan -1 Floor Plan



1: Outpatient Entry 2: Breast Clinic Area 3: X-Ray Area

Figure 2. Specified route-tasks for both Base Floor and Floor-1

The second attempt was to arrange several meetings with participants to give them some valuable information about the research, however; no information was given regarding which hospital they would be enrolled with. Though, they were informed of their roles and responsibilities. According to the given instructions, they were informed that they will be given a specific route task that they need to accomplish.

Participants were also informed that a GoPro camera will be mounted on their heads which will be recording sound and vision at the same time. The most important part of those briefings was that each participant was clearly instructed on their main role of thinking aloud all the time as they navigate through the specified destinations. The route task included two destination points. When they reached the first destination point, they were expected to get an envelope from a research agent. This envelope included information about the second route task that they need to complete. Participants were also requested not to talk to anyone or request help from anyone unless otherwise it is quite necessary and to use stairs instead of elevators.

Study 2: Wayfinding Performance Measures

Passini, highlighted the necessity of investigating the wayfinding processes for better understanding the wayfinding issues (1996: 321). Researchers, considering this view of Passini, developed a strategy to assess the wayfinding processes of navigators (Brösamle & Hölscher, 2007; Hölscher et al., 2006, 2004: 15). They suggested assessing the wayfinding processes through wayfinding measures. Data with respect to those six wayfinding measures were derived from qualitative think aloud speech analysis and GoPro camera recordings. And then they were transferred into quantitative data for calculating performance measures such as time (sec.), stops (n), getting lost (n), distance (meter), distshort (distance/shortest way) (meter) and speed (m/sec). However, for the current research, one more variable was added and it is called stop times (sec.). It was believed that stop times would give better insights into which stopping points make navigators loose more time for their decision-making process and to find out the characteristics of these areas and their relation to navigators' cognition in terms of those areas' spatial configurations.

In addition to all, those specified performance measures helped us to better understand the most complicated areas; the factors causing complexity; the routes participants got lost most and why they were lost in these routes; the amount of unnecessary paths taken by the participants in contrast to the shortest path; the environmental factors that guided participants most as they have navigated through; the areas where participants had to ask for directions; which key elements helped them to make correct decisions and take the correct routes; the effects of the circulation areas' installation on the participants' navigation manner; how the signage systems are affecting participants' wayfinding behaviors; and the influence of environmental factors (e.g. color, lightening, artistic elements and etc.) on participants' wayfinding behaviors.

Statistical Procedures

The qualitative data obtained from the GoPro action camera and the data regarding to hospital plans derived from Depth Map in terms of connectivity, integration and step-depth were processed as nominal values to be further analyzed by necessary statistical calculations. In addition, as representative documentation of participants' performance measurers, additional data from those defined seven performance measures with respect to the hospital are coded as continuous variables and passed into the SPSS 24 statistical analysis software. All statistical analyses covered Space Syntax Variables and wayfinding behavior performance variables and interpretations were based on the results derived from cross-sectional probability analyses such as Pearson Correlation Coefficient levels with their significances, regression analyses and t-tests. It should be said at this point that before proceeding with any of these parametric tests, necessary assumptions were tested as a priority and reported in the results section of this article.

RESULTS OF ANALYSIS

Results Regarding to Study 1: VGA Analyses

As a result of the VGA analyses, the first finding emerged was that participants, as they were approaching to their first defined destination of breast clinic from the entry, tried to find a directory signboard, but they could not find the directory signboard located at the entry. Repeatedly watched VGA records revealed that the directory signboard showing the places of various clinic areas was located in the wind protector apron area in the entry and participants could not see them since they looked it after they have passed the apron area.

Although the main corridors were so crowded during the experiment day, participants seemed to be moving smoothly and seemed to be relaxed as they navigate. Main corridors being designed wide enough (min. 450 cm wide) helped participants to easily move along with the corridors towards their destinations. Because clinic areas were located around the spiral structure of the core center point of the hospital, participants found their destinations with less effort. Another factor was the direct day light entry into the building which helped with vision and affected participants' navigation positively. When the GoPro recordings were carefully watched, it was realized that the clinical areas in the node points of corridors happened to be more visible and were found easily by the participants. Participants also did not happen to ask for any help from other individuals for direction (Figure 3).

Figure 3. Outpatient breast clinical area

For the second route task, which directed participants from breast clinic to x-ray area located at the floor -1, the first attempt of all participants was to look for a directory signboard. It was found from the think aloud practice and voice recordings of some participants that they had previous experiences regarding where x-ray areas are generally located in hospitals, so they directly approached toward the stairs. The stairs designed in a spiral form and situated at the center core point of the hospital were so visible that participants found the area in question without any hesitation (Figure 4).

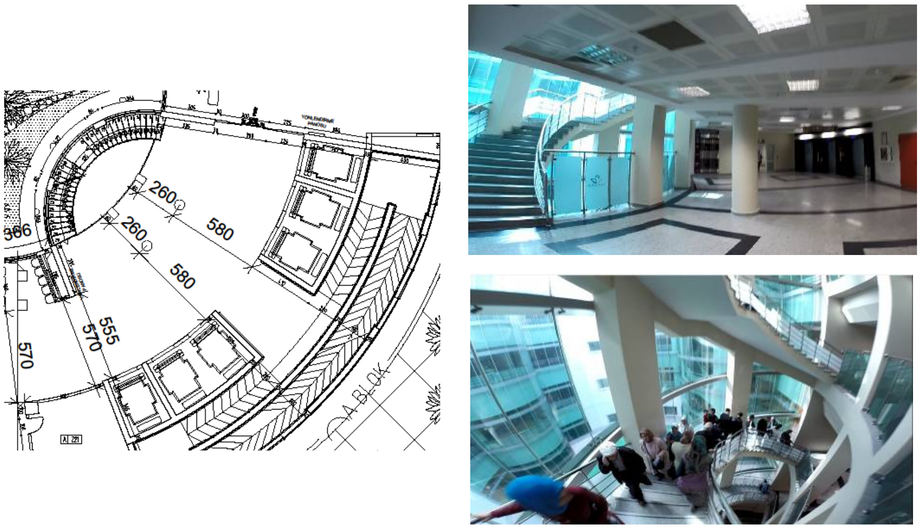


Figure 4. The spiral positioning and design of central core block of the NNH

Some other participants found the directory signboard, which was directing users to go straight but they misinterpreted the go straight sign (↑) and they approached towards upstairs, which made them loose time and effort.

From the recordings it was clear that natural daylight coming through the main circulation area of the floor -1 helped participants remember the area. The node points of circulation areas and long corridor areas were found to be the main areas where participants stopped to think. Participants were mostly nervous when they have arrived to narrow corridors which do not get direct day light (Figure 5). Because some corridors did not have any design elements in their node points, navigators happened to visit same corridors and stopped at same points for several times. Another important finding was that the corridor walls were painted to the same color and there was no artistic element around or on the walls to make users remember and distinguish areas from one another. Likewise, participants had troubles in finding their ways and they got confused so they could not find the stairs to floor -1 in the second mission. When participants were in their way back to the starting point they have come across a peddler and they considered the peddler as a reference point.

Figure 5. The corridor and circulation area of X-Ray Clinic

Following the participants' completions of their missions, they have been individually interviewed and have been asked for the most important factor that they have experienced and helped them find their ways just after they have completed their missions. All the participants responded to this question as "the direct daylight coming through inside the building and the views of outside of the building". For the second question related to the factor that made them have trouble in their wayfinding tasks, all of them responded as "'the situation of the walls". They said that 'the corridor walls are identical everywhere in the hospital which made them to get confused of their location and affected their navigation negatively'. They also added that the informative explanations on the signboards were so crowded that they could not read clearly and created confusion. This result was consistent with the GoPro recordings and most of the participants complained about the excessive information put on each signboard in the hospital. One other factor, which made participants think the signboards were incomprehensible, related to the shiny background color of the signboards that reflected daylight and reduced the readability. Here, it was noticed that an important irony between the advantage (wayfinding) and disadvantage (readability of the signboards) caused by the direct day light. Furthermore, this ironic situation was mentioned by some of the participants during their route task missions.

Results Regarding to Study 2: Wayfinding Performance Measures

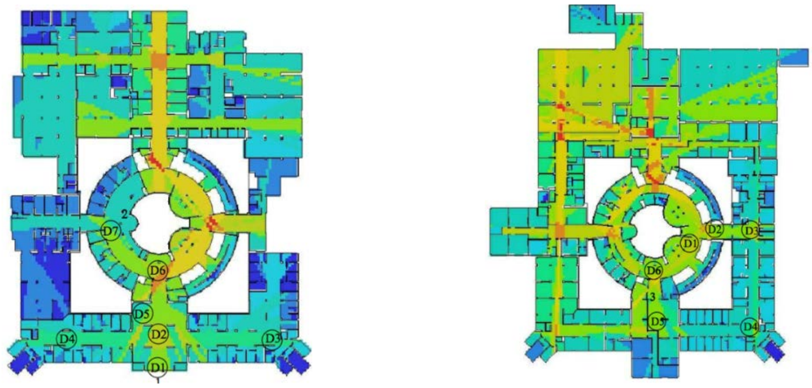
The first set of findings with reference to the wayfinding performances of the participants were related to time (the total duration of route task), stops (how many times participants stopped to think or to make decisions), stop times (time spent during each stop), lost (how many times participants deviated from the actual route), distance (the length used to reach the destination), distshort (the distance between actual and optimum routes) and speed (distance divided by time). The mean values and standard deviations brought out from 20 participants on the back of the given tasks analogous to the defined wayfinding performance measures are shown in the related table (see Table 1) below.

Table 1. Descriptive statistics regarding participants' performance parameters

	N	Minimum	Maximum	Mean	Std. Deviation
Base Floor Time (seconds)	20	35	248	95,50	48,329
Floor -1 Time (seconds)	20	54	627	305,65	172,042
Base Floor Stops (n)	20	1	6	1,75	1,293
Floor -1 Stops (n)	20	1	12	4,90	2,864
Base Floor Stop Times (seconds)	20	2	31	5,20	6,518
Floor -1 Stop Times (seconds)	20	2	59	22,05	15,517
Base Floor Lost (n)	20	0	3	0,35	,813
Floor -1 Lost (n)	20	0	10	3,05	3,316
Base Floor Distance (meter)	20	66,99	292,07	85,8380	51,48912
Floor -1 Distance (meter)	20	86,42	496,75	242,6845	137,55983
Base floor Distshort (meter)	20	1,00	4,35	1,2805	,76644
Floor -1 Distshort (meter)	20	1,00	5,74	2,8040	1,59008
Base Floor Speed (meter/seconds)	20	27,01	191,40	92,1150	40,00815
Floor -1 Speed (meter/seconds	20	19,33	176,07	80,5555	30,25933

Results derived from VGA observation analyses in terms of the stopping points and the characteristic profiles of those points in terms of integrity were visualized for better understanding (Figure 6 for base level). By evaluating Table 1, it can be seen that the standard deviations related to means of each variable were low and the means are consistently high. The means and standard deviations for the second route task concerning the level -1 are shown in the related table (see Table 1). As a result of observations, it was realized that participants most frequently stopped at the node points situated at the beginning of corridor areas. For better visualization of this result, a plan of the hospital covering the results of wayfinding performances were prepared in relation to the integration feature of level -1 (Figure 6 for level -1).

Floor Map for Base Level | Floor Map for Level -1



D1: First Stop Point; D2: Second Stop Point; D3: Third Stop Point; and etc. | D1: First Stop Point; D2: Second Stop Point; D3: Third Stop Point; and etc.

Figure 6. The representative image of the relationship between the degree of integration and stopping frequencies of participants

To analyze the spatial configurations of maps of base level and floor -1 and their spatial interrelationships, Depth-map software was used. The analysis of space syntax included connectivity, integration, step-depth, and intelligibility characteristics. As a result of analyses regarding to the base level of hospital, the calculated mean values with respect to space syntax parameters are respectively 267.44 for connectivity, 2.66 for integration and 4.26 for step-depth (Table 2).

Further investigation showed that the color scale in the plans reduced from red to blue as space depth got lower values. When those parameters were evaluated together with VGA findings, it was found that wayfinding performances of participants were positively affected in the areas where connectivity and integration values are found to be high and step-depth values are found to be low (Figure 6). As it can be seen in Figure 6, the highest connectivity values were recorded at the cross-section node points of corridors. When the general structure of the hospital plan was treated, the highest values regarding integration facet was found to be the node points just as it was in the case of connectivity facet. On the other hand, it is noticeable that the integration values are getting lower and step-depth values are getting higher as approaching to the end points of corridor areas. Naturally, step-depth values, which are in contrast relationship with integration, are getting lower in the areas were integration values are increasing.

As a result of the correlation and regression analyses including connectivity and integration variables, established as predictive variables, helped to predict the intelligibility of the hospital area. The regression result for the base level revealed the total explained variance as R^2=0.23. Therefore, it is understood that the intelligibility of the base level of the NNH is low since the calculations have only explained 23% of the total variance. The results derived from integration graphic and observation results, which showed the points where users benefit for navigation, were compared to graphical side marks and both graphics were shown on the plan (Figure 6). According to those analyses, the places where participants have stopped, matched with the places where integration values were found to be high. For the floor -1, mean values calculated for space syntax parameters are 303.63, 3.099 and 4.87 respectively for connectivity, integration, and step-depth (Table 2). When those numbers are evaluated, it is obvious that findings regarding to integration and step-depth are quite like those of base level of the NNH (Table 2).

Table 2. Base and -1. VGA values of floors

VGA values	Minimum	Maximum	Average	Std. Deviation
Base floor connectivity	3	834	267.443	29.51
Base floor integration	1.613	4.45124	2.65694	1.03
Base floor step depth	0	8	4.25774	1.78
Floor -1 connectivity	3	1072	303.63	33.4
Floor -1 integration	1.613	4.87225	3.09937	1.10
Floor -1 step depth	0	7	4.2429	1.57

For connectivity, the plan generally showed up with blue color and main circulation areas were shown to be even in lighter colors. The best area, in terms of connectivity and integration, was found to be the physical rehabilitation center in comparison to other areas of the building (Figure 4).

Intelligibility value for the floor -1 was calculated to be R2=0.11. Since the explained variance ratio is 11%, it can be indicated that the intelligibility facet is as low as the base level of the NNH.

The relationship between spatial configuration variables and wayfinding performance parameters were explored for both base floor and floor -1 by calculating the Pearson Moments Correlation Co-efficiency. The results of analysis yielded low and negative correlation loads and showed no statistically significant correlations between variables.

It is found out that the higher the connectivity values are, the higher the wayfinding performance measures of time, pause time, getting lost time, distance and extra road taken become. Participants mostly stopped at the circulation areas where integration values found to be high. On the other hand, increment in the integration values, which is in negative correlation with depth values, make the same wayfinding performance measures decrease in values. The correlation co-efficiencies between step depth and wayfinding performances ranged between r=0.01 and r=0.26 (Table 3).

Table 3. Correlation coefficients between performance parameters and space syntax parameters regarding base level

Wayfinding Performance		Connectivity	Integration	Step depth
	Pearson Correlation	-,288	-,052	,142
Time	Sig. (2-tailed)	,218	,828	,551
	N	20	20	20
	Pearson Correlation	,102	,243	-,259
Stops	Sig. (2-tailed)	,669	,301	,270
	N	20	20	20
	Pearson Correlation	-,057	,131	-,225
Stop Times	Sig. (2-tailed)	,810	,583	,341
	N	20	20	20
	Pearson Correlation	-,215	-,001	,019
Lost	Sig. (2-tailed)	,362	,998	,937
	N	20	20	20
	Pearson Correlation	-,174	-,068	,147
Distance	Sig. (2-tailed)	,464	,776	,538
	N	20	20	20
	Pearson Correlation	-,174	-,068	,146
Distshort	Sig. (2-tailed)	,464	,776	,539
	N	20	20	20
	Pearson Correlation	,291	,140	-,125
Speed	Sig. (2-tailed)	,213	,555	,598
	N	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

For floor level -1, like in the case of base level, there were little non-significant and negative relationships between connectivity integration and wayfinding behavior performances of participants. The relationship between step-depth wayfinding performances was found to be either negative or truly little correlation co-efficiency with very little loadings (Table 4). Like findings for base floor, the circulation areas with high integration values, which are also considered as node points, were the areas where participants stopped for thinking and decision making.

Table 4. Correlation coefficients between performance parameters and space syntax parameters regarding -1 level

Wayfinding Performance		Connectivity	Integration	Step depth
Time	Pearson Correlation	-,090	-,054	,332
	Sig. (2-tailed)	,707	,822	,153
	N	20	20	20
Stops	Pearson Correlation	-,133	,193	,166
	Sig. (2-tailed)	,576	,416	,485
	N	20	20	20
Stop Times	Pearson Correlation	-,325	,210	,100
	Sig. (2-tailed)	,163	,375	,673
	N	20	20	20
Lost	Pearson Correlation	-,265	,130	,253
	Sig. (2-tailed)	,259	,585	,281
	N	20	20	20
Distance	Pearson Correlation	-,143	-,053	,372
	Sig. (2-tailed)	,548	,826	,106
	N	20	20	20
Distshort	Pearson Correlation	-,143	-,053	,372
	Sig. (2-tailed)	,548	,825	,106
	N	20	20	20
Speed	Pearson Correlation	-,031	,010	,030
	Sig. (2-tailed)	,897	,967	,899
	N	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION AND CONCLUSIONS

The interaction and communication between human and spaces help people design spaces and consequently lead spaces affect human behavior (Zheng, 2012: 442). Architects create buildings, design environments, and give their souls to those buildings. And the designed environments tend to manage human behavior. In other words, the way the buildings are designed, the way the environments have been shaped, the way the buildings are connected to the outside world and the way the surface structures of buildings have been characterized, have significant positive or negative influences on the behaviors of people with respect to the interactional actions they have encountered with. In this regard, the connection quality between spatial configurations of buildings and human behavior are associated with the design quality of buildings (Dalton et al., 2019; Ulrich et al., 2019: 2). Therefore, this study, which attempted to figure out the effects of complex hospital buildings on human wayfinding performances by considering the psychological cognitive perspective, revealed that individuals tend to use their already existing schemata and try to connect it with the structure of the new environment to make sense out of it. If the gap between existing schemata and new building structure is big, individuals experience more trouble in finding their ways comfortably regarding to insufficient cognitive mapping required for effective navigation. This finding of this study is consistent with numerous research (Carpman & Grant, 2016; Huelat, 2007; Rooke et al., 2009: 15).

Other key points open to discussion are the reference points and the number of stimulating sources of information. Participants who deviated from their correct routes complained about the amount of information written on signboards. In addition, it was noticed from the recorded journeys that those participants were also affected by some unnecessary stimulating sources of information such as electronic boards situated nearby the actual signboards. Huelat (2007) supported this finding by indicating that unnecessary use of information causes confusion and negatively affects the wayfinding performances of users. Signboards and directories should play the role of a bridge between preliminary defined node points and main destination areas, and function in the way of directing users to another node point (Carpman, 1991: 104; Haq & Zimring, 2003: 135). Ruddle and Peruch (2004: 301) supported that a hospital building which is architecturally well designed with poorly designed signage system does not have any positive effect on human wayfinding behaviors. Reference points, on the other hand, have strong influence on wayfinding performances. It was found out from the recordings that all the participants noticed the peddler and used it as a reference point and an important guide element in their turns. Reference points and adding artistic elements around the node points also helped navigability in advance (Garip, 2003; Pati et al., 2015: 45). Likewise, the peddler played the same role in this experiment. Therefore, in order to denote circulation areas and node points with unnecessary information, designers should pay more attention on denoting those areas with more art elements which support memorization and establishing more comprehensible output from their cognitive maps (Denis, 2017).

In conclusion, when rendered up the qualitative and quantitative findings under the light of discussions and the contributions of the pioneers of the field, it can be concluded that wayfinding performances of navigators are supported when there is a small gap between the users' existing schemata and new building designs; and when main circulation areas were designed in a curvilinear shape getting direct day light through inside the building, which creates wide spectrum of vision, rather than vertically designed cross-sectional areas, which create narrower vision of the circulation areas and node points. Signage system should be free from excessive information and the background color should be emphasizing the written directions with concise information.

IMPLICATIONS FOR DESIGNERS

Based on the results and discussions rendered from the current study, suggestions for the betterment of designs and suggestions for further researches are outlined as a form of guideline as provided below:

- The most important element in supporting the wayfinding behaviors (performances) of users is to create consistent circulation areas with smooth cross-sectional node points.
- Crossing points of corridors are important in wayfinding because these points are found to be the decision-making points. For this reason, node points, where navigators most frequently stop and need more guide from the environment need to be designed in a more memorable manner.
- Placing artistic elements around these node points support navigators' wayfinding practices and help them activate their already existing schemata.
- Natural day light coming through inside of a building and lightening the node points and providing navigators with a vision of outside with big enough windows can be considered as an important factor in positively affecting the wayfinding performances of users.
- In order to reach a desired destination, navigators should use a direct path with less steps instead of passing by another connecting route, which will reduce step-depth and create a more comfortable pathway.
- In order to design main circulation areas with narrow connecting points to other areas in a hospital building, designers should go for wide spaces connecting main circulation areas to other areas in a building, because; having wider vision on a both horizontal and vertical spectrum will enable navigators to store specific information regarding an environment.
- While designing signage systems and directory signboards, special attention should be paid to these factors: the main directory signboard should be situated just in front of the outpatient entries, and throughout the spaces in hospitals in terms of texture, color, type size, frame shape, background color and means consistency should be maintained. Furthermore, additional signboards should be added around node points, especially at cross-sectional corridors where users mostly get confused and stopped for further decision making.

Authors' Contributions

The authors contributed equally to the study.

Competing Interests

There is no potential conflict of interest.

Ethics Committee Declaration

This article has been completed by all the authors upon their agreements. We as the authors of this article declare that this manuscript has not been sent to any other outlet for consideration of publication and that research has been carried out under the necessary ethical considerations. Authors, in this regard, declare that there is no conflict of interest and that no funding was received from any institutions. No ethical comity agreement decision was necessary for this study.

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Author’s Biography

Esra Aksoy is an Interior Architect and Environmental Designer. She works as a lecturer at Aydın Adnan Menderes University, Karacasu Memnune İnci Vocational School, Department of Architecture and Urban and Regional Planning. She received his undergraduate degree from Selçuk University Faculty of Fine Arts, Department of Interior Architecture and Environmental Design in 2007, and her master's degree in 2010 and doctorate degree in 2018 from Selçuk University, Institute of Science and Technology, Department of Architecture. Basic research topics; health structures, wayfinding, spatial perception and cultural heritage.

Dicle Aydın is an architect. She works as a lecturer at Necmettin Erbakan University, Faculty of Fine Arts and Architecture, Department of Architecture, Department of Building Science. She received his bachelor's degree in 1992 from Selçuk University Faculty of Engineering and Architecture Department of Architecture, her master's degree in 1996 and her doctorate degree in 2001 from Selçuk University Science Institute Architecture Department. Basic research topics; architectural programming and design, health buildings, refunctioning in old buildings and rural architecture.

Gökhan İskifoğlu is a psychometrician who holds a PhD degree in the field of measurement and evaluation and research instruments. He concentrated on experimenting the applicability of research instruments across different cultural groups, Structural Equation Modeling, and experimental research in the field of education. His major study areas are Measurement and Evaluation - Curriculum and Instruction.