

Wayfinding based Usability of Complex Buildings

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1 ABSTRACT

Usability is a key concept in evaluating the performance of buildings as it puts user experience at the core of its criteria. This measuring tool is crucial in complicated buildings, especially those based on complex circulation systems, where users may be lost. However, modern techniques have proved efficient in performing evaluation for buildings' related aspects whether before the building is constructed or later in the operation stage.

This paper investigates the potential for using way-finding as an indicator of the quality of user experience in hospitals. It correlates -on one end-, way-finding' understandings, and the usability key aspects; effectiveness, efficiency, satisfaction, learn-ability, and security on the other end. It abstracts these correlations to draw a theoretical model that could be used as a framework for further investigations. To validate its theoretical findings, this paper uses a questionnaire to collect information concerning the users' satisfaction with way-finding in hospitals in Alexandria, Egypt. The results show the importance of way-finding as a cornerstone in evaluating user experience in complex buildings and shaping their usability profile accordingly.

Keywords: Hospitals, Wayfinding, Building usability, User experience, Complex buildings

2 INTRODUCTION

Visiting a building for a specific purpose is considered as a travel. An important part of a travel is to know where to go and how to reach there (Hegarty, Montello, Richardson, Ishikawa, & Lovelace, 2006). Kuliga, (2016) described user experience as interactive, dynamic, and cognitive process. Some aspects of Architecture have an impact on this experience such as building functionality, purpose, layout, and structure.

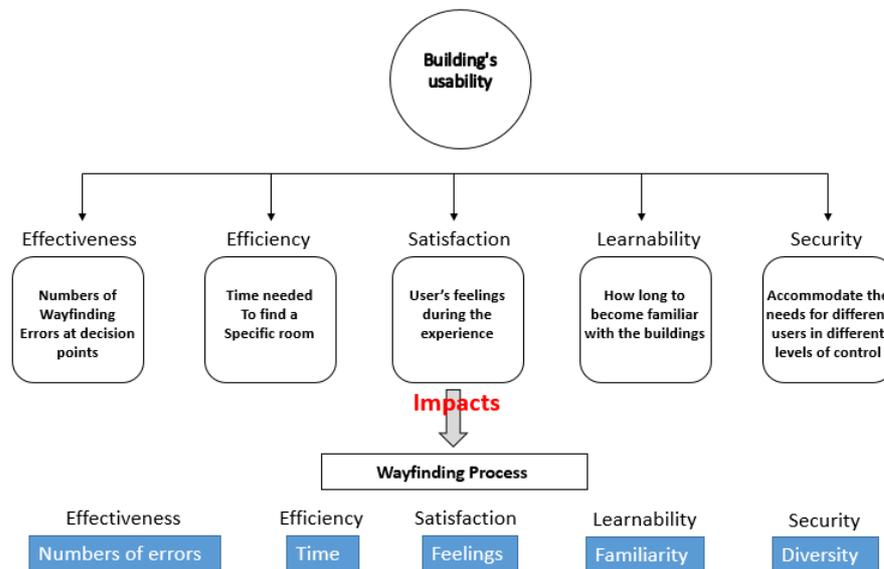


Figure 1: Usability factors (source: Author)

Education, work, and living in all are different purposes of buildings. Depending on how the buildings serve this purpose, buildings grant efficiency, effectiveness, and satisfaction for their users. However, most occupants, architects, constructors, and owners rarely carry out evaluations of how their buildings perform (Blakstad, Hansen, & Knudsen , 2008). Usability is achieved by the interaction of user experience, buildings, design, and management processes (Fenker, 2008). User experience includes perceptual and emotional components over time while usability tends to be focused on effectiveness and efficiency measures of a task

(Nenonen, Rasila, Junnonen, & Kärnä, 2008). It is required that a user can move towards any desired direction without delay or having any difficulties to be a successful journey.

According to Morag Ido et al (2016), it is important to evaluate wayfinding in hospitals to be efficient and suitable for occupants. In hospitals wayfinding is essential because patients are almost under pressure and may have to navigate their way to many places in during their visit. Good wayfinding experience enhance healing since it provides patients with a sense of empowerment and control, in addition to reducing fear, anxiety, and stress. Furthermore, poor wayfinding can cause additional costs through staff interrupting their work, lost time to provide directions, dissatisfaction because of the frustration of users, and lost business. Improving the user-friendly and user centered wayfinding process requires an examination of 'building usability' in different architectural design stages (Kuliga, 2016). Krukar et al. (2016) mentioned that the concept of "building usability" has varied definitions.

Through the usage of hospitals as an example of complex buildings, this article focuses on examining the usability of wayfinding-based wayfinding and how it affects user experience, with as simple note about the new wayfinding technological tools. Furthermore, this research will shed light on the usability definition in buildings and evaluating it by its five factors during the wayfinding process as the following Figure 1 explains. Finally, the results of a questionnaire based on users experiences while visiting hospitals.

3 INCORPORATING WAYFINDING AS A FACTOR INFLUENCING USABILITY

To reach a usable wayfinding design, there are multiple requirements, such as building performance, functionality, security and shelter, spatial legibility, privacy and social interaction, learning opportunities, in addition to aesthetic appeal and delightful experiences (Steele, 1973). As Montello and Raubal (2013) claimed, effective environments might be simple to orient in, result in a suitable level of privacy or sociability, appear engaging without being overly complicated, and enhance feeling of safety.

User-centered wayfinding design guarantee a satisfying architectural experience and provide building users with learning, and reaching their goals effectively and efficiently (Krukar, Dalton, & Hölscher, 2016). A usable wayfinding decreases wayfinding process errors and allows for predictability. It is good for supporting the cognitive processes of wayfinders (Arthur & Passini, 1992/2002).

Way-finders use environmental information, guidelines (for example, verbal or visual) and their cognitive and spatial abilities for the purpose of making wayfinding decisions (Montello D. , 2005). These decisions complexity are distinguished by the given environment structure, the tasks and goals of the way-finder in addition to way-finder own characteristics. Thus, taking environmental factors only into consideration is rather limited (Giannopoulos, et al., 2014).

If the way-finder has adequate information about the structure, according to Passini (1992), a complete plan can be generated. Furthermore, only partial planning (or "sub-tasks" in Passini's terminology) can begin postponing local choices until additional information becomes available. Planning requires cognitively retracing the trip and generating mental ideas of what to expect during the way. An essential factor for studying human wayfinding and the cognitive abilities is the direct observation of human behavior (Hölscher, Meilinger, et al., 2004).

3.1 The concept of wayfinding in the usability factors

ISO 9241-11, 1998 defines usability as 'the extent to which a system can be utilized by specific users to achieve specific goals with efficiency, effectiveness, and satisfaction in a specific context of use'. According to the international usability guidelines, Abran et al. (2003) suggested an 'enhanced usability model' in addition to the established aspects of usability included security and learnability as important measures. Krukar et al. (2016) explained how these usability components (cf. Abran et al., 2013; Table1: left) for evaluations can be expressed in terms of measurements for evaluating building usability (Table1: right). For example, (effectiveness) refers to decisions made during wayfinding that were disappointing. (Efficiency), on the other hand, can be measured in terms of how long it takes to navigate your way around while providing a positive user experience is (satisfaction).

Abran's approach combines a variety of previous usability definitions in the field of human-computer interaction. It indicates that usability is a quality of a product (in this case, a building) which makes it easy to use, safe and stress-free to operate. On the most basic level, usability is about avoiding frustrating the user.

Currently, this concept is implemented in software development projects, as opposed to, this goal has rarely been planned for in architectural projects. As a result, out built environment does not lack of annoying, frustrating, confusing, or mentally tiring spaces (Krukar, Dalton, & Hölscher, 2016).

Usability components	Usability evaluation measures	Building Usability – An example for wayfinding design evaluation
<i>Effectiveness</i>	task accomplishment (success or failure)	number of wayfinding errors made at decision points
<i>Efficiency</i>	resources/constraints (type of errors, time spend for task accomplishment, error recovery)	time needed to find a specific destination
<i>Satisfaction</i>	(un)favourable reviews	architectural experience; emotional and aesthetic evaluation; perceived difficulty and frustration
<i>Learnability</i>	time required to learn how to interact with an environment	time needed to become familiar with a building
<i>Security</i>	controllability/predictability of an interaction, error prevention	degree to which an environment addresses the needs of different user groups with different levels of control; (visual) access between locations

Table 1: Usability concepts and examples for building usability in the context of wayfinding (extended descriptions based on Krukar, Dalton & Hölscher, 2016; and Abran et al., 2003).

4 USING HUMAN-COMPUTER INTERACTION (HCI) METHODS AND CONCEPTS IN ARCHITECTURE

Usability has a general definition that includes all user's experience aspects during the interaction with a product, service, or environment. The CIB W111¹ is interested particularly in 'user experience' in a workplace – covering all aspects of the end-users' while interacting with an organization and its facilities as well as the design and management procedures (of the built environment) (Alexander, 2008)

Krukar et al. (2016) mentioned that one of human-artifact interaction types is human-computer interaction. HCL research is distinguished by analyzing human behavior, cognition processes and tasks that users face. Buildings can also be categorized as artifacts which humans interact with in several ways.

4.1 Usability of human-computer interactions and Building usability in psychological-architectural studies

In this field, usability means taking into account the abilities of users so that they interact and navigate easily without challenges (Krug, 2000). Ritter et al. (2014) said that to evaluate how a certain user can perform specific tasks in a specific contexts is the main purpose of the user feedback during the design-centered process. User feedback clarifies some motivations that drive users' actions. It gives an early analysis of decisions, choices, and the users' constraints during the completion of a task. As a result, user feedback facilitates the examination of potential "patterns of usage" in human-environment interaction, helping researchers to better understand why and how users do what they do when they do it (Ritter, Baxter, & Churchill, 2014). Understanding users, their tasks, and the context the interactions occurs in are some of usability important aspects.

According to Blakstad (2008), qualitative and quantitative measures combination in a mixed method approach in relation to building usage observation, standardized questionnaires, building walkthroughs, and spatial studies can improve post-occupancy evaluation benefits. Evaluations on a cross-sectional basis of particular performance analyses are focusing on "diagnostic" post occupancy evaluation (Preiser, 1995), such as wayfinding. As an example, Hölscher et al. (2006) focused on the decision-making process evaluation of the building users during the wayfinding in relation to the specific building characteristics. The reported challenges according to these researchers, were linked to the complexity of the buildings' spatial design, Signage that is difficult to read, and the individual difficulties of wayfinders while monitoring

¹ International Council for Research and Innovation in Building and Construction (CIB), W111 – Usability of Workplaces

landmarks. They suggested that integrating basic wayfinding ideas into the architectural design phase process as early as possible can help Architects to avoid pricey design faults (Kuliga, 2016).

5 CASE STUDY: GAMAL ABDEL-NASSER HOSPITAL

Wayfinding is considered as a challenge in healthcare facilities as a result of a variety of factors. Hospitals are large complex buildings, unfamiliar environment that may or may not have taken wayfinding into consideration during the early design phase (Devlin, 2014; Mollerup, 2009). Moreover, as hospitals are repaired and expansions are created, spatial challenges frequently develop and/or worsen (Cheng & P´erez-Kriz, 2014; Mollerup, 2009; Rousek & Hallbeck, 2011).

A hospital visit can be a stressful experience; the majority of visitors are not there by choice and are often feeling the pain, discomfort, and-or anxiety, if they require care for themselves or are visiting a sick or injured person (Berger, 2009; Mollerup, 2009). In order to reduce these feeling of discomfort and improve the user experience. Hospitals must set aside funds to improve and simplify navigation within their facilities. Effective wayfinding system utilization helps visitors to locate their destination effectively whether the navigation is in the emergency department or attending an appointment (Cooper, 2010).

5.1 Applied Methodology



Figure 2: A satellite image of the hospital (source: Engineering authority of the hospital)

This hospital was constructed in 1943. There are 15 entrances. The red and green arrows show the entrances in Figure 2. It was selected for the study because of its complexity of functions, buildings' spaces, and number of entrances; another reason was that it has been built and designed as a hospital.

Research aimed at applying the usability concept, as derived from the standard ISO 9241/11, in the field of building design, namely hospitals. The study developed an assessment of effectiveness, efficiency and satisfaction of hospitals in Egypt by conducting a questionnaire for Gamal Abdel Nasser hospital's visitors with the identification of the reasons for the visit, some of the participants are doctors, pharmacists, engineers, other workers, patients, and accompanying patients. There are detailed answers from users on qualitative and quantitative types of questions. The hospital was visited with hard copies of the questionnaire. Every question helps in identifying one of the five usability aspects. 43 responses were collected. The engineers, pharmacists, patients, their escorts, and other workers were asked about their experience in the hospital and if they could easily find their way. One question asked them to explain their experience briefly, the received answers were like: changing the familiar places and departments is very confusing and annoying, too many entrances make the experience harder; and they need to put in a clear signage system to guide the users. Another response was that, as a patient, the security men could not explain the way for me, so I got tired, while others got help from the staff so they could reach their destination.

Questions about errors and wayfinding challenges evaluate the effectiveness, while questions about the time users spend to reach their desired destination evaluate the efficiency. To evaluate the satisfaction, I asked users about their feelings towards the experience. While asking about the familiarity, and assessing the learnability, it is clear more for the hospital's staff. Finally, the security aspect, which is about how a diversity of users can live the experience in the hospital even if they are males or females, they have disabilities or not, they work in the hospital or they are patients or their escorts.

5.2 Results

	No.	%
Q1:Gender		
Male	16	37.2
Female	27	62.8
Q2:What is the reason for your visit to the hospital?		
Patient	4	9.3
Patient escort	17	39.5
I work in the hospital	22	51.2
Q3:If you work in a hospital, what is your job? (n = 22)		
Medical team	11	50.0
Engineering authority	1	4.5
From management	4	18.2
Other - mention it	3	13.6
Nursing team	3	13.6
Q4:Do you face challenges and errors during wayfinding process?		
No- Never	17	39.5
Maybe	3	7.0
Yes sometimes	13	30.2
Yes always	10	23.3
Q5:How long does it take to get to the place you want in the hospital?		
Few minutes	24	55.8
Half an hour	10	23.3
Long time - I arrive very hard	9	20.9
Q6:How do you feel about your experience of visiting the hospital?		
Never satisfied with the experience	6	14.0
Mild feeling	26	60.5
Almost satisfied with the experience	4	9.3
Completely satisfied with the experience	7	16.3
Q7:When visiting the hospital again, do you feel familiar with the place?		
Yes	22	51.2
No	5	11.6
Maybe	16	37.2
Q8: Does having a disability make it difficult for you to find your way?		
I don't have any disabilities	38	88.4
Yes - but my disabilities don't hold me back	3	7.0
Yes - I have a movement disability	2	4.7
Q9:Do signs help you find your way into the hospital?		
Yes	13	30.2
No	9	20.9
Maybe	7	16.3
There are no enough signs in the hospital	14	32.6
Q10:Do you need the help of hospital staff to ask about the way?		
Yes	24	55.8
No	12	27.9
Maybe	7	16.3
Q11:How often do you ask about the road during your experience?		
I do not need to ask	11	25.6
Once	8	18.6
Twice	9	20.9
Three times	6	14.0
More than three times	9	20.9

Table 2: Questionnaire results (Source: Author)

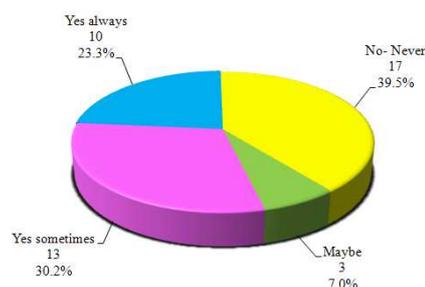


Figure 3: Distribution of the studied samples according to effectiveness Question No.4 about facing challenges

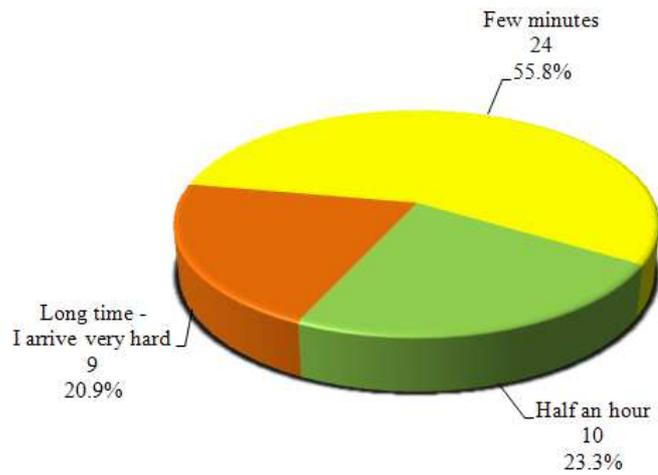


Figure 4: Distribution of the studied samples according to efficiency Question No.5 about the time

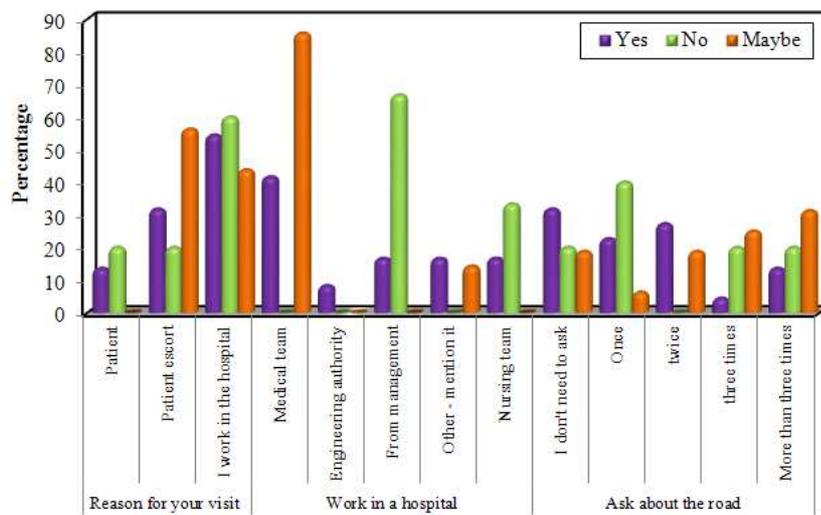


Figure 5: Relation between feeling familiar with the place with different parameters, a relation between Q2, Q3, and Q10 with the Q7

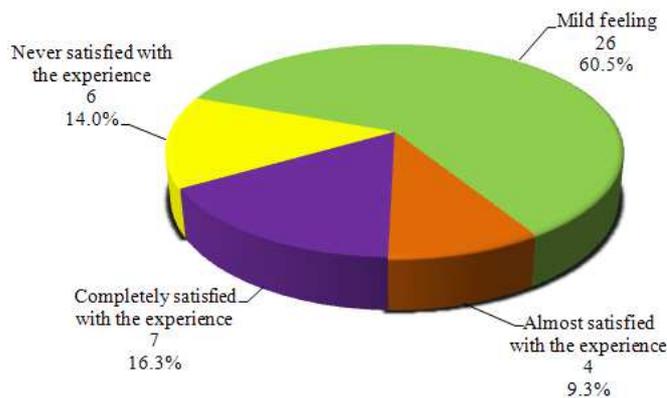


Figure 6: Distribution of the studied samples according to satisfaction Question No.6 about their feelings

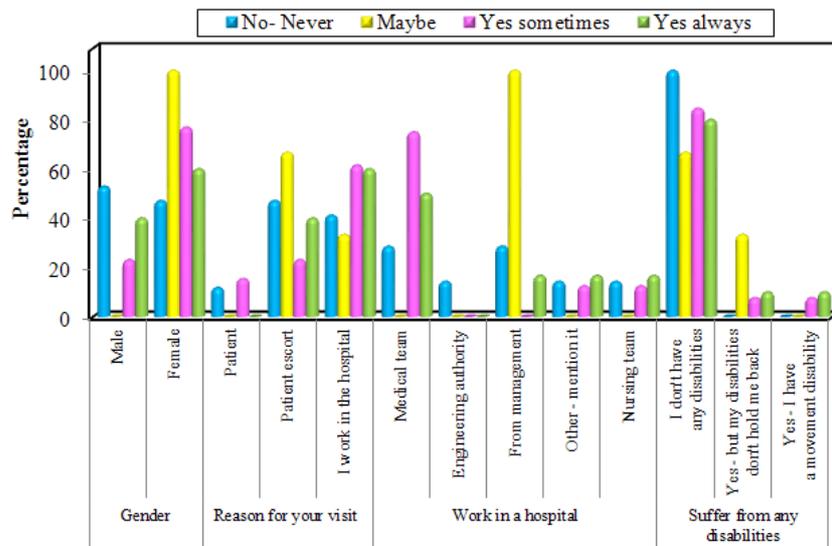


Figure 7: Relation between errors during wayfinding process with different parameters, a relation between Q1, Q2, Q3, and Q8 with Q4

	When visiting the hospital again, do you feel familiar with the place?						MC _p
	Yes (n = 22)		No (n = 5)		Maybe (n = 16)		
	No.	%	No.	%	No.	%	
What is the reason for your visit to the hospital?							
Patient	3	13.6	1	20.0	0	0.0	0.276
Patient escort	7	31.8	1	20.0	9	56.3	
I work in the hospital	12	54.5	3	60.0	7	43.8	
If you work in a hospital, what is your job?							
Medical team	(n = 12)		(n = 3)		(n = 7)		0.129
Engineering authority	5	41.7	0	0.0	6	85.7	
From management	1	8.3	0	0.0	0	0.0	
Other - mention it	2	16.7	2	66.7	0	0.0	
Nursing team	2	16.7	0	0.0	1	14.3	
How often do you ask about the road during your trip to the hospital?							
I don't need to ask	7	31.8	1	20.0	3	18.8	0.267
Once	5	22.7	2	40.0	1	6.3	
twice	6	27.3	0	0.0	3	18.8	
three times	1	4.5	1	20.0	4	25.0	
More than three times	3	13.6	1	20.0	5	31.3	

Table 4: Relation between feeling familiar with the place with different parameters (n = 43) explaining figure 5

This table explains the relation in Figure 5 which link question 2, 3 and 10 with question No.7 to evaluate the learnability aspect of usability. It all comes down to being familiar with the design. Of the 43 respondents, 22 confirmed that they are comfortable returning to the hospital. It makes sense that 12 of them, or 54.5 percent, are employed by hospitals. The majority of them work in the medical field. 31.8 percent of users who feel comfortable in the building do not need to inquire about the road during their wayfinding procedure, whereas 27.3 percent do so twice in order to get where they are going.

Even though they visit the hospital every day, some employees can't sense the familiarity, and 16 out of 43 are unsure. Although the medical professionals provided the majority of responses that they felt were familiar, they also provided 85.7% of the responses that were unsure. In other words, comparing the responses of those who say they feel familiar with those who say no or are unsure will produce results that are nearly comparable regardless of the variety of the reasons for their visits or the number of times they must inquire about their route.

	Do you face challenges and errors during wayfinding process?								MC p
	No- Never (n = 17)		Maybe (n =3)		Yes sometimes (n =13)		Yes always (n =10)		
	No.	%	No.	%	No.	%	No.	%	
Gender									
Male	9	52.9	0	0.0	3	23.1	4	40.0	0.237
Female	8	47.1	3	100.0	10	76.9	6	60.0	
What is the reason for your visit to the hospital?									
Patient	2	11.8	0	0.0	2	15.4	0	0.0	0.656
Patient escort	8	47.1	2	66.7	3	23.1	4	40.0	
I work in the hospital	7	41.2	1	33.3	8	61.5	6	60.0	
If you work in a hospital, what is your job?									
			(n = 7)	(n = 1)	(n = 8)	(n = 6)			
Medical team	2	28.6	0	0.0	6	75.0	3	50.0	0.616
Engineering authority	1	14.3	0	0.0	0	0.0	0	0.0	
From management	2	28.6	1	100.0	0	0.0	1	16.7	
Other - mention it	1	14.3	0	0.0	1	12.5	1	16.7	
Nursing team	1	14.3	0	0.0	1	12.5	1	16.7	
If you suffer from any disabilities, do you face problems because of them while finding the way?									
I don't have any disabilities	17	100.0	2	66.7	11	84.6	8	80.0	0.157
Yes - but my disabilities don't hold me back	0	0.0	1	33.3	1	7.7	1	10.0	
Yes - I have a movement disability	0	0.0	0	0.0	1	7.7	1	10.0	

Table 5: Relation between errors during wayfinding process with different parameters explaining figure 7

This table explains the relation in Figure 7 which link questions 1, 2, 3, and 8 with question No.4 to evaluate the security as an aspect of evaluating the usability. 17 out of 43 said that they are not facing errors or challenges while navigating in the hospital, while 13 are facing them sometimes and 10 are facing them always, so 23 participants out of 43 are facing errors. Most of them are female. Surprisingly, most of the users who are facing challenges and errors are working in the hospital. They find it difficult to navigate more than patients and their escorts. It is surprising too that most of them are from the medical staff. Maybe that is because they are the most frequent users who are asked to navigate all the time. The majority of the participants do not have any disabilities, but most of them are facing wayfinding challenges, with 17.7% of them having movement disabilities, and said yes always and yes sometimes for facing errors in their destination.

6 NEW TECHNOLOGICAL WAYFINDING TOOLS- FUTURE STUDIES RECOMMENDATIONS

This study evaluated a hospital's wayfinding using a conventional approach. However, there are some new technological tools for wayfinding that can help users or be used to evaluate wayfinding. Any technology

that facilitates wayfinding by providing navigational information or corrective feedback while being in movement to keep the user on course may be referred to as wayfinding technology (WFT)(Hunter et al., 2016).

Some examples of advanced functionality that are available today including, touch-screen displays with voice guidance that personalise information for the user based on preferences, past usage, or social feedback. Smartphone popularity in developed nations has made it possible to gain access to GPS-tracking, realistic, virtual three-dimensional (3-D) street views, and reviews of locations from previous users. The next paragraph explains the VR technology including some examples.

These are mostly absent from the virtual environment in current VR systems, but they also present a potential for confusion because the test environment itself is probably going to include competing sensory cues, including displaced sounds or odours. While abstract or "pseudo-real" "mazes" can be used to identify wayfinding strategies (e.g., Lloyd et al. 2009 compared a simplified version of Birmingham, UK with a video game version of Nice, France), they are inherently constrained by the lack of direct comparison with the same real-world environment.



Figure 8: Comparative images of the Real Environment (RE) left, and Virtual Reality Environment (VRE) right, (source: (Ewart & Johnson, 2021)).



Figure 9: The experiment's region and the three paths' decision points are shown on the left side of the diagram. The participants were given the visual map on the right. (Source: Eds, 2014)

The wayfinding post-occupancy evaluation has included mobile applications. As an instance, consider the experiment that was conducted in Zurich to assess outdoor navigation in a street where cars were not permitted. Participants were handed a printed sheet measuring 28 x 28 cm at the beginning of the exercise that described the task. The map shows three different paths that could be taken to get from the starting point (the green point) to the next objective (red point). In order to get there, it was necessary. The three options for routes to the goal were explained on this abstract map, which also included symbols to denote the environment's landmarks (buildings, signs), which helped with wayfinding (Eds et al., 2014)

VR and mobile apps are just examples of the technological wayfinding tools to help users during their journey or to help in wayfinding evaluation.

7 CONCLUSION

One of the aims of building usability is to achieve the satisfaction of users and to meet their needs. As a result, users can consider their experience a successful user experience. This experience relies on other aspects, but in this research, we focused on the wayfinding problems. Taking hospitals as the research case study helped in the determination of the causes of feeling lost in such buildings, which the time factor can make a disaster. That was the main reason for choosing hospitals. Another reason is that people often feel stressed and nervous while visiting hospitals, whether as patients or visitors, which should be taken into consideration. Questionnaire results identified that when there is a lack of a signage system and too many changes in a complex building such as this hospital, that may result in wayfinding errors and people not feeling familiar with the building easily, even if they are part of its staff. People may make errors during their wayfinding, which is a catastrophic situation when you are in a hospital as the minute can cause a difference. The findings indicated that while the efficiency may be high, as half of the participants claimed, the building's effectiveness is not satisfying. Regrettably, they were unable to state they were satisfied with the experience in terms of satisfaction. Learnability and security prove the wayfinding problem in this building and the usability accordingly.

The study establishes a link between wayfinding and usability and demonstrates how to assess it using the five factors of usability, effectiveness, efficiency, satisfaction, learnability, and security. These factors are measured by interviewing users about their experiences with wayfinding. I advise using the latest evaluation tools, such sensors, mobile devices, and virtual reality, to assess existing structures before they are designed. Evaluation can assist in preventing wayfinding issues or reduce them.

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