Interactive Indoor Therapeutic Environment for People with Alzheimer's Disease

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Abstract

Alzheimer's disease (AD) changes the relationship of persons suffering from AD and their surrounding environment. To address this interactive therapeutic environment have been proposed to provide protection, support, and rehabilitation services. Although research exists on how interactive therapeutic environments can enhance the quality of life for people with Alzheimer's disease (PWAD), the approach to view PWADs as an end-users for therapeutic environments is often overlooked. This paper provides an overview of definition and principles interactive therapeutic environments, and the role that assistive technology can play in providing for PWAD's daily needs in their rooms in healthcare centers. A quantitative and qualitative study was conducted to elucidate an in-depth understanding of the PWAD's needs-space-assistive technology relationships. Data was acquired through quantitative questionnaire forms, qualitative face-to-face interviews with caregivers and professional experts, as well as shadowing observation of a patient in the early stage of Alzheimer's at an Alzheimer's healthcare center in Vienna, Austria. In general there exists a gap in awareness of available assistive technology that can be used in PWAD's rooms, such that PWAD can feel like home and control their lives individually.

Keywords: Assistive technology, therapeutic environments, interactive architecture, Alzheimer's disease, User experience design concepts.

1. Introduction

The consequence of Alzheimer's disease include spatial disorientation, decline in orienting ability, and a lack of ability to perform daily activities (Alzheimer's Disease and Dementia, 2017; Coughlan, Laczó, Hort, Minihane, & Hornberger, 2018; Kirste et al., 2014). This can be described as problems related to "how-to" (Engineer, Sternberg, & Najafi, 2018) and "where-to."

While recent studies show the importance of a friendly therapeutic environment and its positive impact on PWADs (Fleming, Zeisel, & Bennett, 2020; Jensen & Padilla, 2017), most PWADs who live in long-term healthcare centers experience that such environments are different from the ones in which they used to live (Fleming et al., 2020; Marquardt, Bueter, & Motzek, 2014). Experiences of comfort and security occurs in protective environments where PWADs feel at home and able to self-orient (Wasana de Silva, 2019).

Supporting PWAD's ability to self-orient is fundamental for therapeutic environmental design (Jensen & Padilla, 2017; Marquardt, 2011). PWAD-friendly architectural concepts can support daily routine and self-orientation and enhance PWADs' quality of life. Architects can develop improved solutions by considering the fundamentals of PWAD's needs (Feddersen & Lüdtke, 2014) and applying aspects of the user experience design concept (UX) to enhance the PWADs' therapeutic environment with the aim to ease self-orientation and performing daily activities (Bowes & Dawson, 2019; John Zeisel, 2000; Marquardt et al., 2014; Yates et al., 2019). The UX design concept focuses on understanding users' needs, abilities, and limits (Garrett, 2011).

"Assistive Technology" (AT) has provided supporting solutions that enhance PWADs' therapeutic environments. AT offers the opportunity to enhance PWADs by adapting to individual needs and providing the connection between PWADs and their living environment (Alzheimer's Society, 2018b). This includes, for instance, the use of robotic technology, recorded voice, IPads, interactive projectors (using the kinetic system), or digital calendar alarm clocks with a non-abbreviated day and month alarm clock. This serves to reduce the disorientation in time for PWADs. Moreover, using AT as an assistive tool enhances the PWADs' self-orientation while decreasing the stress that caregivers experience in their work (Dooley & Hinojosa, 2004).

A recent study reported that PWADs may form a cognitive map after repeated movement in a specific environment which serves orientation and navigation (Jheng & Pai, 2009; Pai & Jan, 2020). This study examines in greater depth PWADs' movement and daily routine in their rooms at a long-term healthcare center. The aims include (1) clarifying the relationship between PWADs' needs, surrounding environment and assistive technology as an assistive tool, (2) identifying architectural barriers that prevent PWAD's self-orientation, and (3) exploring the potential role of AT in resolving the identified obstacles. This involves the following questions: What are PWAD's daily routines in their rooms at the healthcare center? What architectural barriers present obstacles to PWAD's self-orientation? How can AT support PWAD's self-orientation in their room? The answers to these questions are expected to inform better designs of a friendly interactive therapeutic environment for PWADs.

2. Methods

2.1 Study Design

A mixed methods study with sequential design (Shiyanbola et al., 2021) was conducted to enable an in-depth understanding of the PWADs space, needs, and potential role of AT (Creswell & Plano Clark, 2018; Palinkas et al., 2015; Ward & Delamont, 2020). This involved quantitative data collection and analysis, followed by qualitative data collection and analysis. The principle for combining quantitative and qualitative data is that neither method is sufficient by itself to examine specifics of circumstances, such as a complex topic of how AD changes a person's interaction with space. While the quantitative data and results comprehensively picture the study problem, the qualitative data and its analysis refined and explained the quantitative results by exploring the participants' views on persistence in more depth (van der Weele & Bredewold, 2021).

This study design, has total of 30 professional experts with daily contact with PWADs participated in the survey, consisted of three steps: (1) quantitative, numeric data is collected and analyzed first, (2) qualitative, text data is collected and analyzed second in the sequence,

which helps elaborate on the quantitative results obtained in the first stage, (3) and a qualitative narrative study using shadowing observation for a resident in his room. In this study, the quantitative questionnaire (n=25) (Picture . 1) (in the German language), elaborated a broad vision of PWADs' health status, needs, and daily activities, highlighting the case study facilities and professional experts' awareness of AT use and purposefully selecting the informants for the second stage. Subsequently, a qualitative face-to-face interviews (n=5) (Picture 2) (in the English language) approach was used to (1) identify the most common barriers fronted by PWADs in their daily life at the center and (2) professional experts' knowledge regarding the AT, tested in the first stage.

Furthermore, the shadowing observation (van der Weele & Bredewold, 2021) explored the architectural barriers PWADs face in their rooms while doing their daily activities. Only one resident was observed due to COVID-19 restrictions. This male patient was 78 years old, in the early stage of AD, and stayed in a single room. He was observed during three time periods on different weekdays from 09:30 am to 12:30 am, from 1:30 pm to 4:15 pm, and from 5:30 pm to 8:00 pm.

The study's priority (Creswell & Plano Clark, 2017; Liamputtong, 2019; Ward & Delamont, 2020) was given to the qualitative approach because it focused on in-depth explanations of the results obtained in the first quantitative stage and involved extensive data collection from multiple sources. The quantitative and qualitative methods were connected when selecting five participants for qualitative case studies and developing the interview protocol based on the results from first phase. The quantitative and qualitative methodologies' results were integrated (Creswell, 2017; Gournelos, 2019) during the discussion of the outcomes of the entire study.

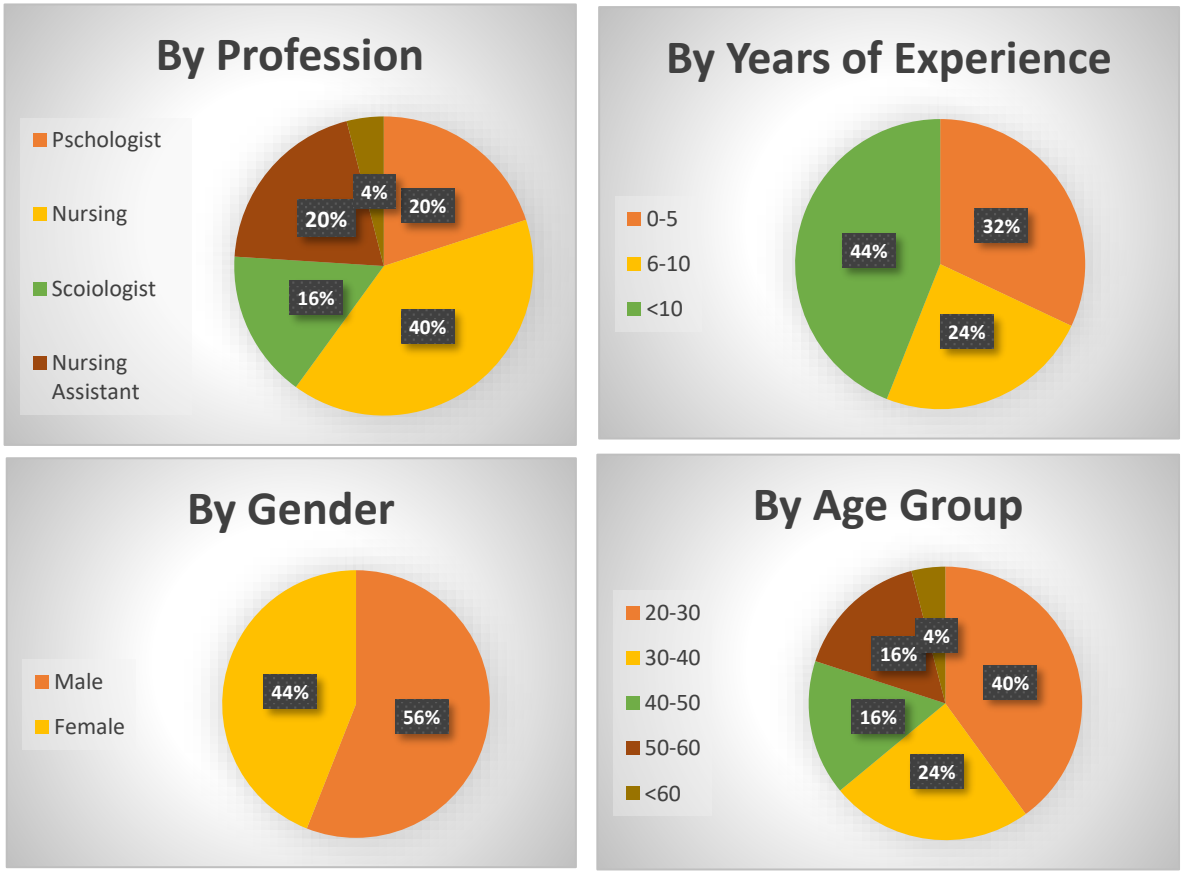
2.2 Data Analysis

NVivo ("QSR International Pty Ltd.," 2020) was used for data analysis for the questionnaire forms and the interviews. The transcript reading, note-making, and listed topics were then used as codes in NVivo. These codes were either exact words or sentences from the transcripts. Codes refer to assistive technology, architectural aspects, values or beliefs, objects, and places. The codes served to gain an improved understanding of PWAD's experiences through professional experts' knowledge and the potential role of integrating interactive architecture into an indoor therapeutic environment for PWAD at healthcare centers. The codes were not used to structure this article. Instead, the subheadings in this article reflect the topics that emerged from the questionnaire and interview responses, focusing on how a person–space–assistive technology relationship challenges PWADs in performing their daily activities.

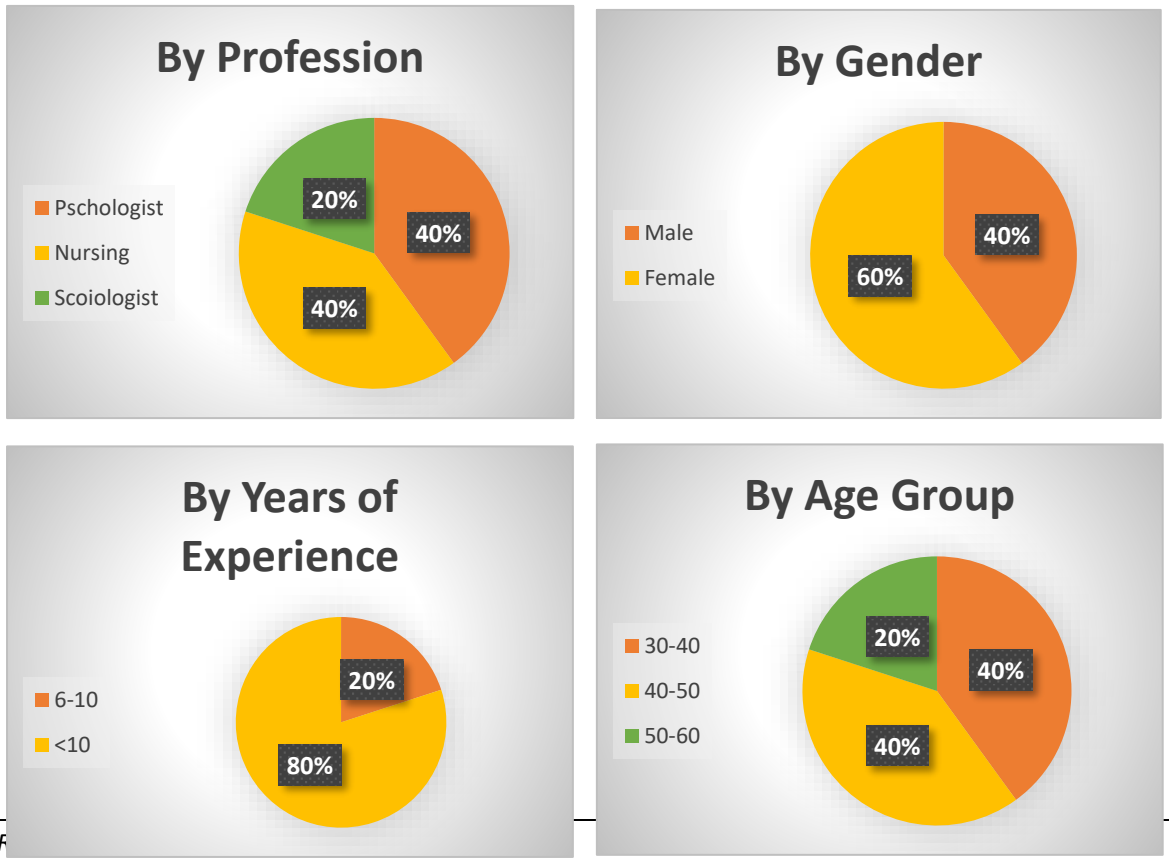
2.3 Ethics

Approval for this study was obtained from the center by signing an informed consent form that explained the study's aims and what participation would entail (Creswell, 2017). Participants approved the use of obtained data. All participants were informed about the study and their rights in written form, and all gave written consent to participate. All data was handled confidentially, and the results were presented in a non-identifiable way at a group level in the present study. In presenting the findings using specific quotations, it was explicitly considered if this could lead to the identification of a participant via deductive disclosure. For this reason, additional details in the direct quotations were removed. Only the researcher can trace the quotations included in this article based on the participant code.

Picture 1: Questionnaire Respondents



Picture 2: Interviews Participants



3. Results

The following themes were identified and are described in the sections below: (1) orientation in space, which entails awareness of the surroundings, activities PWADs can do individually, and PWADs daily needs in their rooms, (2) potential architectural barriers; the resident's room layout and equipment to define the resident's orientation and movement, and (3) assistive technology. The latter involves the following questions: what is AT used for (e.g., rehabilitation, safety, socializing, etc.), and which design concept could help enhance the interactive therapeutic environment?

3.1 PWADs' orientation in space

All the expert participants mentioned "Disorientation" when they were asked to identify the most common barriers encountered by PWADs in their daily life at the center. According to the experts' answers, all PWADs have problems with orientation: "there is no difference in disorientation problem when they are in the early or intermediate stage of Alzheimer's disease" (P5). Due to the participants' answers, disorientation has a different perspective; (1) disorientation in space, for instance, finding their way back to their rooms, (2) disorientation in time, losing the sense of day and night-time, and (3) self-disorientation in PWADs' rooms. According to the interviewees' responses, there are two types of self-disorientation: (1) PWAD needs information on how to do a specific activity, and (2) where to go to do a specific activity. If PWADs can access this information in their rooms, they can act independently, which may increase their self-esteem and quality of life.

Furthermore, the expert participants mentioned different solutions to solve PWADs' disorientation in space; for instance, by hanging a unique sign or element or "putting PWADs' photo on the front door" (P1). In this way, PWADs overcame some of the disorientation difficulties in locating their room. On the other hand, according to the interviewees' answers, there was no apparent solution for solving the PWADs' self-disorientation inside their rooms. PWADs are frequently unable to orientate in their rooms and often cannot act independently.

3.2 Architectural barriers

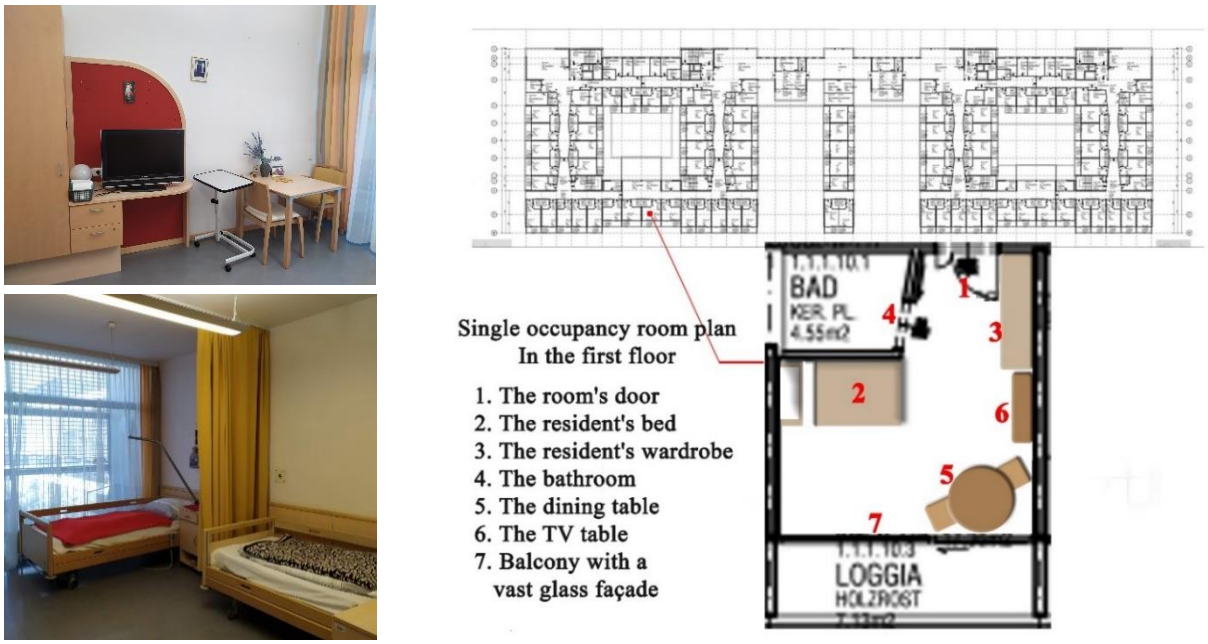
This section outlines the results of the questionnaire, the interview, and the shadowing observation to identify architectural barriers that might prevent PWAD's self-orientation.

Room layout and equipment

The studied long-term healthcare center has single occupancy rooms (one resident per room) is approx. 28m2 and double occupancy rooms (two residents per room) is approx. 39m2. Living in a single or double room, according to the expert participants' answers, "depends on the residents' desire and needs." (P3, P5). Each room has seven main elements: (1) door, (2) bed, (3) wardrobe, (4) bathroom, (5) dining table, (6) TV table, and (7) balcony with large windows (Picture . 3).

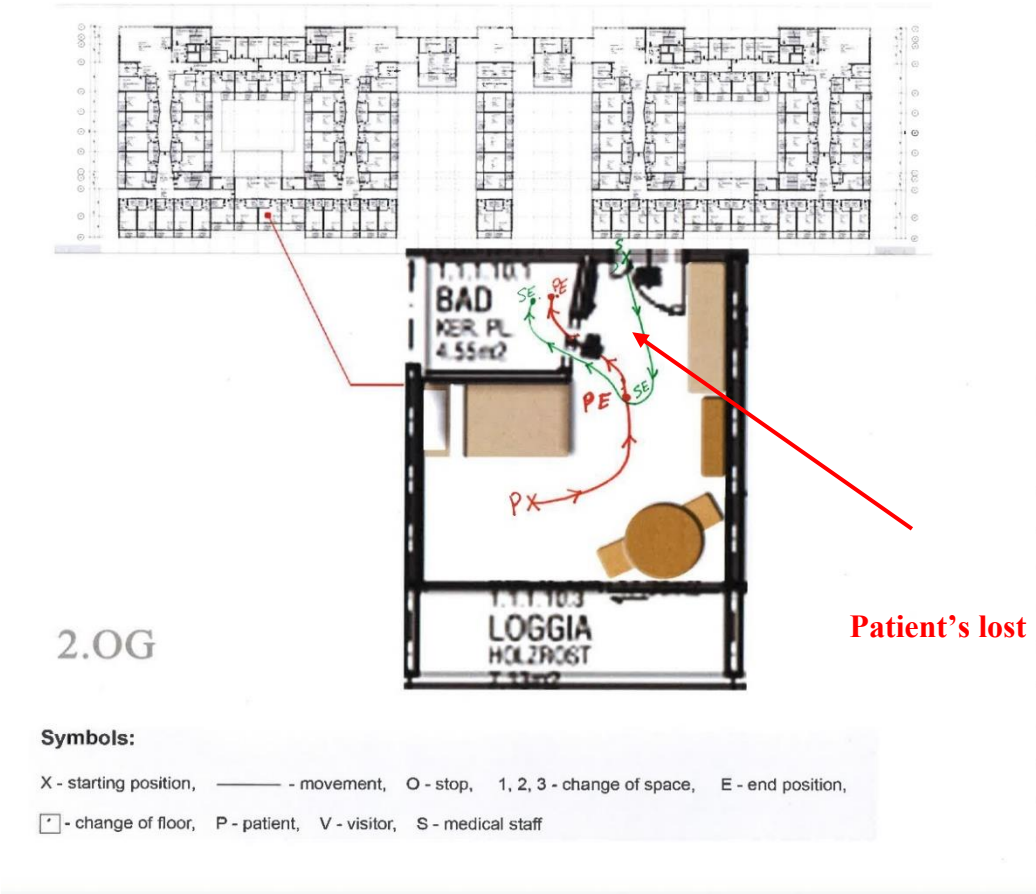
There are three main paths for each resident related to daily fundamental routine: (1) getting out of the bed (element no. 2), (2) toileting (element no. 4), and (3) dressing (element no. 3). The residents need to be oriented in relation to "three paths" (P3): (1) from the bed to the bathroom, (2) from the bathroom to the wardrobe, and (3) from the wardrobe to the room's door. This sequence establishes the "daily routine" (P2,P4) for all residents; this is a complicated sequence for PWADs. According to the

quantitative and qualitative studies, there is no displayed information that would help explain these three routes to PWADs.



Picture 3: Floor plan and images of a typical resident's room in the Alzheimer's center

Furthermore, the shadowing-observation of a resident in his room pointed to additional architectural barriers; the location of the doors in the room acted as an architectural barrier. During the observation time, the resident moved in his wheelchair, heading directly to somewhere inside his room. Then he stopped in confusion, facing three doors in front of him: (1) the room door, (2) the bathroom door, and (3) the wardrobe door (Picture . 4, Picture . 5). When the nurse entered the room, he expressed the wish to wash his hands. The nurse then guided the resident to the bathroom, where he washed his hands without the nurse's help. The resident knew what he wanted but did not know how to get to the bathroom. All three doors are in one corner of the room and face each other without any displayed information, leading to the resident's confusion.



Picture 4: The point where the observed resident became disoriented in his room shown on the room's floor plan

Picture 5: The three doors that made the resident disoriented in the corner of his room: 1. The room's door, 2. The bathroom door, 3. The wardrobe door

3.3 Assistive technology

Although AT could support various purposes, for instance, safety, monitoring, rehabilitation, socializing, etc., according to the experts' answers, AT is mainly used for two purposes: (1) for residents' safety in their rooms, for instance, sensor bar or sensor-carpet, are used to detect the PWADs' movement and (2) for occupational therapy in especial rooms and under caregivers' supervision, for instance, IPad, "Paro-robot."

From the participants' experience, there exists a lack of awareness about available and suitable types of AT. Furthermore, they pointed towards technical problems regarding specific types of AT, for instance, that sensors "do not work" (P3) due to "daylight reflection, or furniture that was accidentally moved in front of it" (P1, P5).

4. Discussion:

As people's cognitive capabilities start to decrease and the memory of recent events disappears, direct sensations remain. As the disease progresses, these become increasingly important (Feddersen & Lüdtke, 2014). When designing architecture for PWAD, designers must take a step back and consider what is fundamental about PWADs' needs and spaces.

In this study, "Disorientation" is the biggest challenge PWADs face. By taking a step back and analyzing PWADs' rooms layout, the following barriers had been found: (1) no clear solutions to help residents' self-orientation inside their rooms, (2) all doors are in one corner, (3) all doors facing each other without any displayed information regarding where these doors lead to, and (4) the AT role in the residents' rooms was only for the residents' safety. In architectural terms, this means rooms without a well-considered spatial arrangement that can be perceived instantaneously are not beneficial. Spaces that turn a corner or are otherwise hard to visualize are unsettling and may cause anxiety (Coughlan et al., 2018; Feddersen & Lüdtke, 2014). On the other hand, making rooms easy to navigate is an essential therapeutic environmental modification that positively impacts PWADs.

Primary research pointed to three main aspects of designing a user-friendly therapeutic environment (Feddersen & Lüdtke, 2014). These include: (1) considering PWADs as end-users, (2) considering what is essential about the environments one lives in, and (3) PWADs' identity, i.e., knowing PWADs hobbies, background, habits, etc. (Van Steenwinkel, van Audenhove, & Heylighen, 2014; Van Steenwinkel, I., Van Audenhove, C., Heylighen, A., 2012; Wasana de Silva, 2019). In addition to the vital aspect of the ten principles reported in the World Alzheimer's Disease International 2020 Report (FLEMING, R., ZEISEL, J. & BENNETT, K, 2020), which emphasize the importance of designing environments allowing PWADs to make decisions and accomplish activities independently. The ten principles are (1) unobtrusively reduced risks; (2) provide a human scale; (3) allow people to see and be seen; (4) reduce unhelpful stimulation; (5) optimize helpful stimulation; (6) support movement and engagement; (7) create a familiar place; (8) provide opportunities to be alone or with others; (9) link to the community; and (10) design in response to vision for a way of life.

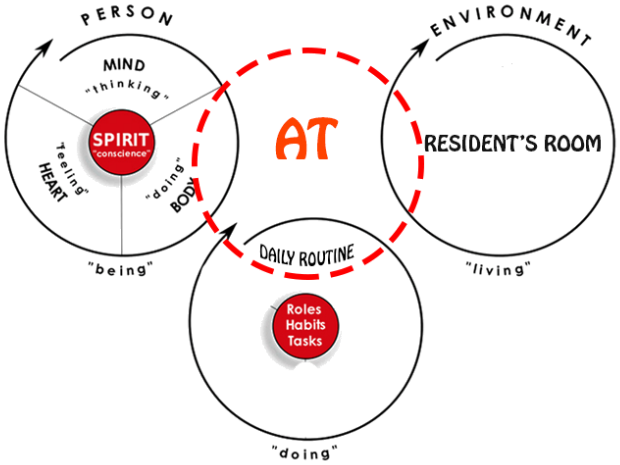
Relying on the aspects mentioned earlier; User Experience Design Concepts (UX) endeavours to function the design principles of the Alzheimer's Disease International 2020 report. UX design concept is capable for designing a friendly therapeutic environment that positively impacts PWADs. UX concentrates on understanding users' needs, abilities, limits, and what they value (Garrett, 2011). UX improves the quality of the user's

interaction with spatial characteristics because the design depends on seven main aspects: (1) helpful, (2) usable, (3) desirable, (4) findable, (5) accessible, (6) credible, and (7) valuable. By applying these primary factors, spatial characteristics can be converted into a sense of space to provide orientation and help PWADs feel safe and comfortable.

By comparing the current layout with the design principles of the Alzheimer's Disease International 2020 report and the UX main aspects, it is evident that the current layout should include most of the UX aspects to create a friendly-therapeutic environment that positively impacts PWADs'. In this context a question emerges as to how to adopt the UX design concept in PWADs' room (in the existing building) to support their self-orientation/ to create a supportive environment for PWADs' daily routine? How could we link salutogenic conditions, daily activities, and design?

There are three possible solutions; firstly; the traditional architectural practices, such as adding signs/ symbols on the doors, secondly; AT; and thirdly; a mix between the traditional architectural methods and the AT. AT is any device or system that enables PWADs to accomplish tasks they would otherwise be unable to perform or improves the ease and safety with which the task can be performed (Alzheimer's Society, 2018a). Although traditional architectural methods are more affordable than AT, AT has dual use; for PWADs' safety and as an assistive tool to achieve a specific activity. AT provides a connection between the PWADs and their surrounding environment to create an interactive therapeutic environment that supports PWADs' self-orientation (Picture . 6) (Smallfield & Heckenlaible, 2017). AT includes a wide variety of devices that, according to their purpose, can be divided into three main groups: (1) supportive technology for helping PWAD to complete tasks, (2) responsive technology for managing risk and raising the alarm, and (3) preventative technology for preventing harm and raising the alarm. Several studies examined the effectiveness of applying the three groups of AT in PWADs therapeutic environments (Duchi et al., 2019; Ienca et al., 2017; Kenfack Ngankam, Pigot, Lorrain, Viens, & Giroux, 2020; Klimova, Valis, & Kuca, 2018).

To improve the architectural legibility and make residents' rooms easy to navigate, the three AT groups can be applied in the PWADs' rooms to solve the residents' self-disorientation problem. This can be done as follows: (1) Supportive AT can display information, showing the route, for instance, to the toilet, wardrobe, or bed, as PWAD should be guided and directed rather than required to choose from several options for self-orientation, (2) Responsive AT can raise the alarm; and (3) Preventative AT can be used when the resident does not follow the displayed information.



Picture 6: Illustrate the role of Assistive Technology in the PWADs' therapeutic environment

5. Conclusions

This study examined the architectural barriers experienced by PWAD when performing their daily activities in their rooms in long-term healthcare centers. In addition, the advantages that can result from applying the UX's seven main aspects to enhance the residents' rooms and equipping the rooms with AT. UX design is the strategy of creating a therapeutic environment that solves a specific user (PWAD) problem while ensuring that the proposed solution is both effortless and satisfying to use. UX design aims to determine what works best for the end-user (PWAD), which means putting the user's (PWAD) needs first and making decisions based on what architects and designers know about them and what PWADs need. UX's main aspects correspond with PWADs' needs and point toward using AT as a connection to develop interactive therapeutic environments that can enhance and support PWADs' self-orientation in their rooms at long-term healthcare centers. Supportive, responsive, and preventative AT can all be used to support PWADs' self-orientation in their rooms. Based on the insights gained in the research described in this paper, this study revealed the following research gaps: (1) a knowledge gap regarding the PWADs' needs in their residence rooms and the room layout and its equipment; (2) a knowledge gap regarding supportive AT in the long-term healthcare center applied in a specific room, not in the residents' rooms, because of: (a) lack of awareness from the caregivers, (b) low budget, as most of the time the companies offer the expensive devices, (c) a need to study each resident individually, which is challenging due to the nursing shortage, and the ethical consideration; (3) a knowledge gap regarding the categorization of AT according to (a) center budget, and (b) what supportive AT helps the residents to enhance their independence in their rooms.

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