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Evidence-Based Research on Barriers and Physical Limitations in Hospital Public Zones Regarding the Universal Design Approach

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Abstract

The hospital is a public building which has the primary duty to provide services to everyone. So far, it is necessary to take into consideration the principle of Universal Design (UD) in responding to the behavior of users, particularly, persons with disabilities. This research focused on 2 main issues, (1) the physical features of the public areas for measurement and collection regarding to the style, size and location of facilities, and whether they meet the requirement and/or appropriate for people with disabilities, and (2) behavior of users with disabilities in accessing spaces and service facilities in the hospital public zones, focusing on the involvement between activities, behaviors and problems which occur. This research used empirical method to assess and evaluate the physical features by the process of Post Occupancy Evaluation, (POE), using 2 evaluation methods, 1) survey/observation (Cognitive walkthrough) and 2) scenario access audit methods. In detail, the survey/observation focused on the obstacles within a physical environment that affect space and service activities regarding people with different types of disabilities. Identifying the obstructions in public functions and health care facilities was implemented by a group of design specialists. On the other hand, the scenario access audit process was operated by determining the level of accessibility and the real patient flow of patients with disabilities on-sites and spaces in public zones. Therefore, this research speculated on all problems and came up with the design guidelines to improve the physical features of public zones in responding to the usability of the service facilities under the UD approach.

Keywords: Evidence-based research, physical feature, users' behavior, disabilities, Universal Design, Hospital

1. Introduction

The 21st Century has ushered in a new paradigm for universal design which no longer merely has singular or practical uses, such as catering to people with disabilities, but offers much beyond that, considering such concepts as autonomy, self-organization, ecology, sustainability, adaptation, and potential for continuous improvement. These concepts apply not only to social service facilities but to all types of operations related to design, including products, interiors, architecture, urban setting, traffic, even communication and information technologies (Preiser & Ostroff, 2001). Karen Kroll said in 2005 that "the impact of buildings on people came not from an architect or a researcher studying workplace performance, but from a politician" (Kroll, 2005), suggesting the importance of considering the human community as a whole when conceptualizing design. Eventually, the Seven Principles of Universal Design were established by the Center for Universal Design in 1997, which offered a complete and thorough paradigm for how to benefit humanity through design. And if there is any one facility type that this new paradigm should be applied to, it is healthcare facilities (Preiser, n.d.).

Universal Design (UD) is a design concept intending to provide benefits equally for everyone and inclusively for all physical limitations, genders, ages and so on. Although the concept of UD was influenced considerably by the modern family and modern social structure, those with special needs were often at the forefront of the designers' minds. But, the idea of UD is not generated from a feeling of pity or sympathy; the non-dependent person is also considered, and the consideration for how "normal" people go about their everyday lives is a powerful influence on the design trend, particularly housing design. Indeed, it encompasses a variety of lifestyles and living trends in modern society, so in essence, the UD concept is fundamentally based on human usability rather than

accessibility, usable in all aspects of design, but also considering the prevention of problems that may arise for anyone, with or without special needs, and allowing for later modifications if any problems should occur later.

In today's society, the role of a healthcare organization does not just mean only the quality of hospital treatment, but it also must consider people's health rights and security. People must have a Right to Health (an economic, social and cultural right). Matters such as a self-determination, access to information, privacy, solidarity, doctors-patient relations, and relevant person-doctor-patient relations (WHO, 2008). Accordingly, the basic rights and social needs must be addressed, such as ease-of-access, and to give priority to all people inclusively (Setola, Borgianni, Martinez, & Tobari, 2013). Right to health and quality of life are the core of human and social rights, and the foundation for the structure of a good society should be based on that. Therefore, social links – such as family, school, working environment, social and personal life environment – in which and through everybody becomes a person and is able to express him/herself as such (Longo, 2012), should be considered when designing a building; how buildings are structured is an integral part of this foundation.

The rational process of architectural design begins with these questions – 1) what is the main purpose and what will be the main uses and functions of this building, and, 2) who is this building going to be designed for? Therefore, the usability of space is essential in design, based on the user's activities, needs and behavior (Sahachaiseri, 2012).

A hospital is a type of building that consists of a wide variety of utilities, making its design very complicated. It is created to fulfill public requirement (Murphy, 2012). Thus, its essential nature means that good design is very important. To complicate matters, the planning of healthcare facilities, whether for a small or large complex, always requires more elaborations and sensibilities because the facilities within the hospital are continuously in need of change and upgrade as technology advances and the world changes, in general. Users of these facilities often have the right to make a decision where to go for healthcare, and they may choose the most easily accessible and most comfortable environment (Preiser, Verderber, & Battisto, 2009). The positive effects of physical environment design indeed influences well-being, promotes healing, and even plays a role in relieving patient pain and stress and reducing medical errors, infections and falls (Preiser et al., 2009). Recently in various studies, very clear results showed the important role of design and architecture in therapy treatment and well-being (Ulrich et al., 2008). There is increasing awareness of this fact, however, those who wield administrative power thus far are sometimes reluctant to make important changes. Thus, some improvements in healthcare environment design are still not being developed. The quality of treatment alone is being measured and improved with standard criteria for assessment and evaluation, but important extra factors are often ignored.

The researcher is contributing to the project named "Evidence-Based Research on Barriers and Physical Limitations in Public Zones Regarding the Universal Design Approach: The Case of Naresuan University (NU) Hospital", which consists of a process of empirical study on structural features and environmental design, mainly focusing on the level of accessibility of people with disabilities regarding the service functions and facilities within the public zone of the hospital.

2. The Research Objectives

1. Studying the physical environments and function accessibilities of the hospital's public areas for people with disabilities.

2. Analyzing the obstacles which cause a level of inaccessibility in the hospital's public areas for people with disabilities.

3. Making design guidelines and suggestions for the design process in building design and overall environment design in the hospital's public areas concerning people with disabilities.

3. The Methods

This article focused on the behavioral and the functional accessibility issues of people with disabilities, considering in the public zones of NU Hospital. The operation processes are described as follows:

3.1 Step 1 - It is divided into two parts: the first part was to identify the concept of UD theory as well as criteria standards as defined for the basic facilities for disabled persons in accordance with the rules of 'The ministerial regulations regarding facilities for the disabled and elderly of Thailand 2005'(Department of Empowerment of Persons with Disabilities, 2012) ; the second part was to study and review building and environment design theories, including the way-showing and wayfinding systems, environment design for directional guidance, the design process for the healthcare facility to meet behavioral needs and provide satisfaction to patients and occupiers, and the techniques and processes of building environment evaluation so as to provide appropriate physical facilities with an emphasis on the issues related to people with disabilities.

3.2 Step 2 - A preliminary survey about the flow of access to service functions and physical features of the public area which consists of the parking lots, the main entrance to the building, the triage counter, the public relations (PR) counter, the out-patient department (OPD), the emergency room (ER), the exam diagnostic rooms, the cashier counters, the pharmacy, the elevators and elevator halls, the public corridors and halls, the bathrooms, etcetera. This study determined details and limitations of the location and size of these particular spaces, and addressed the flow of activities and how service functions are affected.

3.3 Step 3 - Applying the information from the survey to determine the problems regarding the limitation of mobility in general, and problems for the hearing and visually impaired. This experimental study considered problems in building design for the deaf, blind, low-vision, wheelchair-bound, crippled, and those in need of canes and walkers.

3.4 Step 4 - From the results of Step 3, the researcher created tools and methods for implementation and evaluation regarding the physical environment, both inside and outside the hospital. The operation began with a group of people with disabilities participating in and completing simulation tasks in settings which represented the regular patient flow settings of NU Hospital. This process was used to determine spaces and facilities that did not meet the requirements of people with physical disability, and how exactly these spaces and facilities failed. All of the corrected results were recoded, identified, analyzed and then classified, determining the problems group by group, and isolating the problems by the level of frequency. This was done mathematically with the basic statistics formula (T-Test), which adduced a percentage system.

3.5 Step 5 - From the scenario access audit reports in Step 4, the researcher analyzed and summarized the obstacles caused by the physical limitations of disabilities regarding access to the public facilities of hospital. In addition, the summary of obstacles was reviewed in cooperation with interior design theories. Finally, design guidelines were suggested, and how they can be implemented, so that people with disabilities can best utilize hospital public zones.

4. The Research Results

The researcher summarized and divided the research results into 2 issues: 1) a preliminary survey regarding the physical features in the hospital public areas as they pertain to how and how well they function, and, 2) an access audit and evaluation process resulting from the participation of people with different types of disabilities in simulation tasks at Naresuan Hospital public areas in situ. Details are as follows:

4.1 Summary of results from a preliminary survey of the hospital public areas; regarding how well they function, following the formal process of Post Occupancy Evaluation (POE) (Preiser et al., 1988). This method focused on assessing and evaluating physical functions of hospital public areas as they pertain to people with disabilities. The results highlighted the problems and obstacles of physical environments regarding spaces, activities and service facilities for people with disabilities. Areas looked into included a gamut of navigation paths, such as hospital corridors, and how well they connect different areas of the hospital for people with disabilities, and how they were associated with each other in general within the realm of people with disabilities. This is described as follows:

4.1.1 The exploration map illustrates the walking and vehicle routes approaching the entrance to the hospital building.

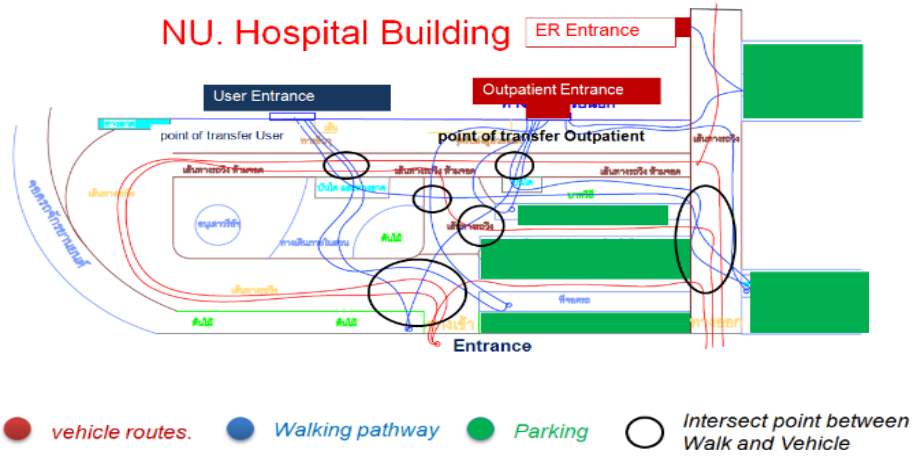

Figure 1. The exploration map of the vehicle ways and walkways according to the actual situation of NU Hospital

4.1.2 The location map consists of as follows: Triage counter, Public Relations counter, National Health Security office, Outpatient Department (various specialists), Exam Diagnostic rooms (X-Ray, Lab), ER, Cashier, Pharmacy.

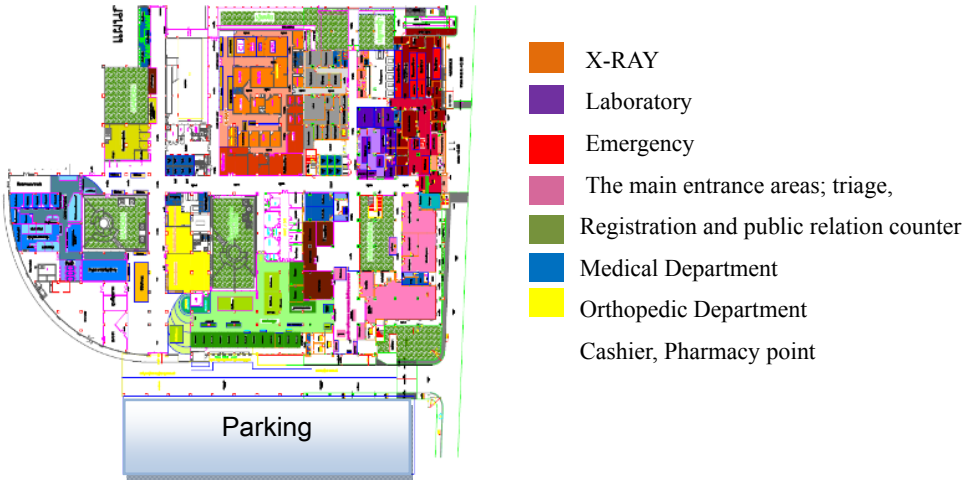

Figure 2. The location map featuring each service facility according to the actual situation of the 1st floor at NU Hospital

4.1.3 Exploration of various facilities, specifically for people with disabilities, with paying attention to signage, ramps, elevators, and furnitures such as waiting-room chairs, counters, and etcetera.

Figure 3. Images of facilities at NU Hospital - a service counter, an indoor ramp, and a parking space for disabled people

The survey found that obstructive crowd density occurred in various critical areas, both inside and outside the hospital, such as the car parking areas, passenger drop-off areas, the OPD main entrance point, the triage counter, the public relations/registration counter, the entrance to the medical department, the entrance hall and corridor within the blood test laboratory, the orthopedic department and several other departments, the walkways in front of cashier, and the pharmacy. The high number of people caused a great obstruction to flow routes at various critical points. This affected the flow of patient trolleys, wheelchairs and persons with disabilities who were on foot, and impeded accessing and finding the way to other service facilities and to other areas of the hospital. The main problems at NU Hospital are finding destinations with relative ease, and obstructions caused by the density of people along various pathways and at service facilities throughout the hospital.

4.2 Summarizing the results from the scenario access audit process (Phaholthep, Sawadsri, & Skates, 2016). This research relied on empirical study, namely, the participation of a number of people with disabilities experiencing real situations with service facilities within NU Hospital, and experiencing real situations within the hospital in general. Specifically, this study intends to identify, investigate, and diagnose the sources of obstruction problems which affect activities, and how people with an assortment of disabilities are affected in the public areas of NU Hospital. Physical features, locations, spaces, furnishing styles, building environments, the signage system, and the connections between each function and each area within the hospital, were looked into. The people with different types of disabilities who participate this access audit process comprised 5 males and 6 females. One of them is elderly. Of the 11 participants; one is deaf, four have visual limitations - two are completely blind and the other two are visually impaired - four are wheelchair user, one is crippled, and the last one is congenitally armless.

Each participant took part in simulated situations, accessing various service functions within the hospital. Each of them was assigned different tasks and required to perform an activity individually, imagining that they were a

real outpatient coming to the hospital and seeking medical treatment. Participants performed these tasks individually due to the individual nature of their disability, and the unique way they assessed the hospital conditions, such as appropriate and inappropriate space, environment, service facilities, and any obstructions or other impediments that may affect their specific disability. This process was employed not only to seek out the problems with building design and service functions but also to find out what's good about building design and service functions as they were applied to people with disabilities. These operations were performed in the following areas by each participant; the car parking area, the main entrance, the triage counter, the registration and public relations counter, the medical department, the emergency department, the exam diagnosis room, the X-ray room and laboratory, the cashier counter, the pharmacy area, the connective corridors, the halls inside the building, and other facilities such as elevators and bathrooms. It was vital to keep the scenario as close to the reality as possible. Each participant being a part of scenario access audit was observed and recorded on video camera by the camera-person from a certain distance without any assistance unless it needed. The camera-person always kept a certain distance from participants, and does not assist them in their tasks unless assistance needed. The results can be summarized as follows:

4.2.1 Car parking area and the building entrance: Problems found

- The signage showing where to park is not clear.

- There is no sign or signal leading in the parking lot for people with disabilities to guide them to disable parking spaces.

- There is no footpath or an obvious non-vehicle passageway, making it dangerous for people as they have to share the passageway with vehicles.

4.2.2 Hospital main entrance: Problems found

- Temporary drop-off at the building entrances has no signage (or signage that is not clear enough)

- The distance between the drop-off point – where people get out of the vehicle - and flowing vehicle traffic, is very slight, which can cause serious harm if someone to someone getting out of a vehicle.

- The pathway around the building entrances, and the Outpatient Department (OPD) main entrance, has no cues (such as tactile paving) to help navigate the visually handicapped, and there are objects, such as chairs, that obstruct the passageways. There are other obstructions as well in the general building-entrance area. Especially for the visually impaired, there is a lack of cues to guide people to where they need to go.

- Intersections and the main entrance doors should have a warning sign, both visually and auditory, and warning devices should be installed at other important points for blind and visually-impaired persons.

- Walking passages into the building were often blocked by wheelchairs or patient trolleys, causing difficulty in accessing the entrance.

-The OPD signage was installed at a position that is not perceptible to the eye.

4.2.3 Triage Counter for new patients: Problems found

- The location of the triage counter is located right next to the entrance door, which is good. This makes access easier for persons with disabilities. However, there is always a congestion in this area during peak time of the morning. There is often a great density of people waiting in this area. Consequently, this can cause a difficulty for everyone.

– not only for people with disabilities, but for able-bodied people as well - regarding smooth access to the building, then figuring out one's position or situation relative to one's surroundings, and even can affect smooth navigation to one's destination within the hospital.

- The sign or nameplate of the triage counter is located only inside the building. It is difficult or even impossible to see from the outside. For people with disabilities such as the wheelchair bound or the visually impaired, especially when crowd density occurs, the triage counter area was almost inaccessible.

- Although counter height level is appropriate for both able-bodied people and people with disabilities, but there is no space underneath, needed for easy access for those who approach the counter with wheelchair. Thus, a wheelchair user who wishes to use the counter for writing or other functions experienced some difficulties.

4.2.4 Public Relations area: Problems found

- The observation and simulation exercises found a density of crowd at this area, especially in the morning. Regular queues of people at the PR counter caused congestion as the queue extended across the hall and

obstructed the main passage to various important hospital departments. This congestion creates an obstruction to all users, especially for wheelchairs, patient trolleys, and people with disabilities. Because of the congestion in this area, many people moving through the area cut across the queue, causing a chaotic situation, and even jumping the queue cutting in front of anyone, even people with disabilities. This situation become even worse for the visually impaired or the blind, who cannot realize their surroundings well or even at all, mainly because of the fore mentioned obstructions.

- The public relations area has no audio signal to indicate the position of this service facility.

- The counter is too high, which causes a difficulty for wheelchair users to communicate with staff.

- The waiting area (which includes benches and chairs) impinges on the main passage to the other departments. Consequently, the visually impaired as well as wheelchair users have great difficulty passing through, or attempting to access other services.

4.2.5 Focusing on hospital department issues, the researcher selected only the departments that experiences the highest density of crowd as well as the highest level of problems in service facilities. These departments included the Medical and the orthopedic departments.

Medical department: Problems found

− As the department entrance is located very close to the PR and the triage counter, the crowd of people waiting in queue for registration, especially at the peak period, always overflows and blocks the front of the entrance. Thus, the wheelchair bound and the blind often always find the difficulty to see or enter this department.

− Registration and primary physical examination (Wellness check) counters inside the department are located so close to the entrance, and impinges on the inner walkway. During peak periods crowd congestion frequently obstructs the passages within this department.

− Around the area where people wait for their appointment cards, the circulation of pedestrians congests the area between the waiting seats and the appointment counter, thus it is difficult for the wheelchair bound and the blind to access this function easily.

− The signs or nameplates which guide people to the service facility points within this department are not clear. The fonts on several of them are too small, and some are located at a level too low to view sitting in a chair or a wheelchair. They are often blocked because of the combined density of crowds and equipment.

− There are no signs, symbols, audio signals or tactical tiles to guide the way to each service facility.

− The public address (PA) system is often inaudible due to noise, which is a problem during peak periods. This poses a problem especially for the hearing impaired, but sometimes PA announcements can't even be understand by those without any hearing difficulties. As a visual signboard is not present in this department, people are reliant on hearing messages given through the loudspeakers.

− Although the wide corridor of this department is good for wheelchairs, because it lacks tactile paving (Braille blocks) its wideness makes it difficult to estimate the direction and surroundings for the visually impaired or the blind.

Department of Orthopedics: Problems found

- There is no tactile paving (Braille blocks) nor audio signaling to help the visually impaired and the blind navigate, and to help them be aware of their environment.

- There is often a high density of patients congested in front of the department entrance, waiting for their treatment. Thus, the visually impaired and the blind find it difficult to get to the registration counter because the entrance is impeded.

- There is no audio signal or other specific equipment to help blind people get to the registration counter.

- Congestion often occurs at the entrance hall, causing difficulty for people with disabilities to pass through the entrance to the Department of Orthopedics, especially the wheelchair bound and the visually impaired.

- The positioning and location of the furniture within this department is not ideal. For example, the wellness checks counter is located so close to the registration counter that patient/nurse interaction has to be done in a crowded space, in the same area where people are registering. It can be chaotic. Further, the registration counter and waiting benches are located too close to each other. This causes the walkway to the treatment room to be too narrow. As orthopedic patients often come to this department using walkers or canes, or are in wheelchairs, the narrow walkway, the overlapping space that both nurses and patients plus registering patients use, and the overall

density of crowds, cause difficulty for orthopedic patients to access the facilities within this department.

- The height and design of registration and appointment counter is obviously too high and unsuitable design for a person in wheelchair to communicate with the staff or use the countertop in writing purposes.

4.2.6 Out Patient Department (OPD) Cashier: Problems found

- Most participants are able to access to OPD cashier easily because it is located at the main corridor of this hospital, making it clearly visible.

- Wheelchair-bound persons require more effort to find the cashier because the section nameplate is not installed at the appropriate location for them to see it clearly.

- There are no cues to navigate the blind to the OPD cashier, thus blind persons cannot find this section themselves. (In the simulation exercise, staff have to lead them to the OPD cashier.)

- The height of the payment window is too high for wheelchair-bound persons, causing communication difficulty for participant and cashier staff.

- During the peak period, so many people stand in queue to access this service that the queue goes across the main corridor, where many people are passing through. There is such chaos and confusion sometimes that at times people with disabilities are overtaken in the queue.

-There are no symbols or audio signals for the hearing impaired or deaf.

4.2.7 OPD Pharmacy - two activities are performed at this stage: 1) submitting the payment slip, and then, 2) receiving the medicine: Problems found.

- Most of the participants are unable to find the OPD pharmacy because there is no clear sign or nameplate to present the location of this facility.

- This facility is located along a main passageway, where a lot of people pass through for various purposes. During the peak period, the queue goes across the passageway, creating inconvenience and obstruction for both those in queue and those passing through on the passageway. This situation frequently causes the blind and wheelchair bound to be overtaken in queues, and in general makes it difficult for them to reach the pharmacy counter.

- The pharmacy counters used for submitting payment and receiving medications are too high for wheelchair-bound persons. It is inconvenient for them when trying to communicate with the pharmacist so as to receive their medication.

- Since the main passageway impinges on the waiting area and on the pharmacy counter, the wheelchair bound, the blind, and in fact everyone, are frequently obstructed by the crowds of people who walk through this area.

- There should be waiting seats for people with disabilities near the calling area so they can access messages clearly. This is especially applicable for the deaf and elderly who are unable to hear or see from a distance.

4.2.8 Intersections, walkways, corridors and halls on the 1st floor of NU Hospital: Problems found.

- All participants experienced similar problems with patient flow. Since most of service facilities within this hospital are located along the main passageway, the density of crowds impeding the passageway, especially around each department, was a regular problem. In addition, the positioning and location of furniture and equipment sometimes exacerbated the problem of impeded user flow. The said situation really affects people with disabilities the most because of their mobility and physical limitations.

- Chairs or benches at the waiting area of each department are often located across the walkway.

- There is no tactile paving (Braille blocks) or other navigation equipment to help the blind in finding direction.

- In some areas furniture is installed too close to the passageway. For example, at the waiting area of the public relations counter, the corridor is blocked by some chairs. (During the simulation exercises, the blind got confused with direction because of this obstruction.)

- Signage along corridors and by service departments guiding people to find, approach, and enter service departments should be more visible.

- Signage should come at appropriate points while users are enroute from the main entrance to their department destinations.

- Signage located at walkway intersections, though its purpose is to help user flow, actually obstructs user flow at the same time because some people stop and spend time in the middle of the walkways reading the signage.

- The position of some the signage is too high for a wheelchair user to see easily.

- The wider walkway is an advantage for wheelchair movement, but on the other hand, the blind find it difficult to keep direction or estimate their surroundings on wider walkways.

4.2.9 Elevators: Problems found

- The audible signal in the elevators is only in English, thus most of participants cannot access this function fully because they cannot understand English. This is especially problematic for blind users.

- In terms of size, the elevator has enough space for wheelchairs to rotate within the cell. Although the height of control buttons - including the open-close button and the floor buttons - are located within the reach of wheelchair-bound persons, the emergency button is located too high for wheelchair-bound persons to reach.

- Braille letter are available on the control buttons so the blind can use this function conveniently.

- There are no specific signals, especially outside the elevator, to help the blind in finding the location of the elevator-calling button, the elevator doors, and there are no signals to inform the blind which elevator is coming, and when. And, as was recorded from the simulated exercises, the blind cannot get into the elevator before the door automatically closes. Therefore, the staff has to help them to get into the elevator.

4.2.10 Lavatories: Problems found

- Participants are able to access the toilet stalls for the disabled with ease. However, as the toilets for the disabled at NU Hospital are located along a busy passageway, the participants have to be careful of people crossing back and forth while they - particularly the blind and wheelchair bound - are going in and out of the toilet stalls.

- In the toilet stalls for the disabled, the participants have no privacy when using this facility because its wall is made of translucent glass and is attached to the main corridor, which has lot of people passing through.

From the results of the participant's exercises in simulated situations, and the analysis regarding obstructions caused by the physical limitations of the users with disabilities in the public areas of NU Hospital: The most obvious problem is related to the wayfinding system, as the participants often get lost or spend too much time finding their destination. This type of problem may be caused by - the inappropriate signage system, environmental design, and the design of entrances of and approaches to each department, which are not well marked and not visible enough. Furthermore, the overall interior design of the hospital is insufficient for users with disabilities in these ways: Insufficient guiding mechanisms for directing the visually impaired or the blind; the main circulation passage from the car parking area to each department within the hospital is unsafe or not conceived and developed well enough in various aspects; and, some equipment and apparatuses within each department is inaccessible or not conveniently accessible for different types of disabilities. The researcher summarized all the results recorded from the simulated exercises in combination with keeping in mind observations, theories and knowledge of multidisciplinary design, including the building environment design, wayfinding-wayshowing, interior design for healthcare facilities, and the criteria of facilities designed for universal usability. Subsequently, the researcher concluded all the studies and suggested design guidelines to increase the level of convenience, benefit and satisfaction, especially regarding disabled users, and in general to create a more suitable physical environment in public areas of NU Hospital. The simulation features of redesign guidelines are present in the following illustrations.

4.2.11 Hospital Approach: Approaching the hospital towards the inner hospital area.

Figure 4. Current condition

Figure 5. Simulation feature
(Bunyasakseri & Phaholthep, 2014)

Example; The vehicle route that approaches the emergency room (ER) from outside the hospital should have an obvious sign to promote the location of department. High-intensity color painted on the road, plus the addition of a large-size

nameplate, would help to make the ER more accessible and visible. Even saving a few seconds for someone in an emergency situation could save a life, and increased accessibility and visibility may help vehicles get to the ER door a little faster.

4.2.12 Car parking area in front of the hospital entrance

Figure 6. Current condition

Figure 7. Simulation feature
(Bunyasakseri & Phaholthep, 2014)

Example; of the new improved parking lot, with consideration for people with disabilities, and the elderly. Handicapped parking spaces should be located at the nearest parking lot area to the main entrance of the hospital, and each handicapped parking space should provide extra room for wheelchair users, including room enough for them to get in and out of their vehicles (blue label in the picture). In addition, there should be an appropriately-wide ramp to the building entrance, plus safety rails. The material surface should be painted with a vivid color to accommodate the visually impaired.

4.2.13 Passage to the building.

Figure 8. Current condition

Figure 9. Guideline feature simulation
(Bunyasakseri & Phaholthep, 2014)

Example; The illustration shows improvement of space in front of the hospital entrance. This area is also used as a drop-off point. For safety reasons, the design suggestion is to install a safety rail to provide separation between pedestrians and vehicles, and to add a speed bump on the traffic surface. As well, all of the new equipment should be vividly painted with warning colors. In addition, the nameplate and banner of the main entrance could be improved by enlarging its size and adjusting its position, making it easy to be seen from a distance.

4.2.13 (Continue).

Figure 10. Current condition

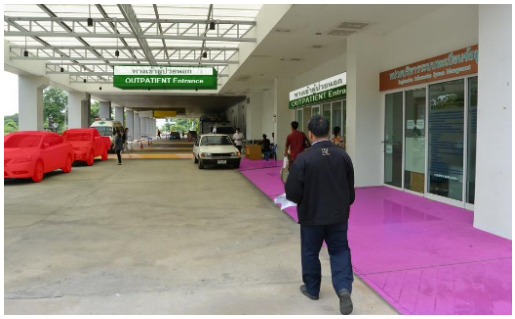

Figure 11. Guideline feature simulation (Bunyasakseri & Phaholthep, 2014)

Example; These illustrations present a guideline to improving the OPD entrance. Firstly, the footpath should be clearly separated from the road and painted with any vivid color. Secondly, the OPD entrance sign should be enlarged and clearly readable from both the footpath and the road. Thirdly, the cars are colored red in the simulation picture to signify that they should be removed (Figure 11). Allowing vehicles to park in this area may cause congestion and even chaos. Parking here should be forbidden because of a high number of people and vehicles at peak periods.

4.2.14 Service facility points such as Blood Test Lab and OPD Pharmacy.

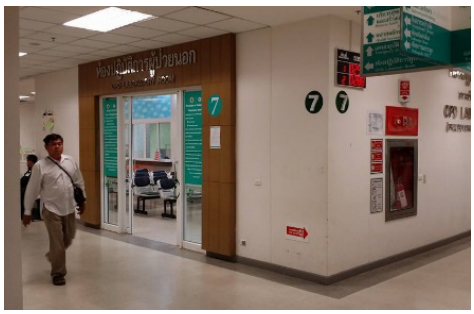

Figure 12. The current condition of the intersection in front of the entrance to the blood test lab

Figure13. Guideline feature simulation of the intersection in front of the entrance to the blood test lab (Bunyasakseri & Phaholthep, 2014)

Example; The blood test lab would be improved by introducing a new service counter facing the main corridor for easy access and visibility, and improved service. The counter itself should have two levels to accommodate more types of physical conditions. The instruction board should be enlarged and reinstalled next to the counter. This would make it much easier for people to notice, and to read. The signage at the middle of the intersection should be reordered.

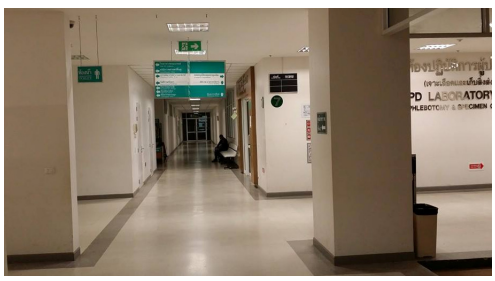

Figure 14. The current condition of the corridor intersection in front of the entrance to the blood test lab

Figure 15. Guideline feature simulation of the corridor intersection in front of the entrance to the blood test lab (Bunyasakseri & Phaholthep, 2014)

Example; The illustration demonstrates that the signage at the corridor intersection, which is supposed to guide people to various service points, should not be put exactly at the middle of the intersection, and should not contain too much information. These misapplications cause blockage on the corridor from people who are constantly stopping at this point to attempt to gather information about where to go next. The signage should be located before the intersection, its font should

be more readable - with sufficient contrast between the lettering and the background - and there should be less with succinct information on the signage. More information could appear later on further signage, after the users have moved along to the next navigation point. These changes would surely result in less crowding and less confusion. Beyond that, to further increase the level of performance by the wayfinding system, color classification may be used to improve visibility and recognition. The signs, banners, nameplates and lobby/facade of each important department could be classified by color all over the hospital, such as an emergency department could be painted red, the specialist departments green, blue signs could signify lavatories, and on and on. An information board could be installed on the building columns support poles around this area, not only for providing information but to serve as a recognizable visibility landmark, from both close up and from far away. Regarding the matter of floor materials, colored tactile paving (Braille blocks) could be applied systematically along the corridors to help the visually impaired or the blind with navigation. These specific-color floor tiles would improve the wayfinding system for general usage as well.

4.2.14 OPD Pharmacy (Continue).

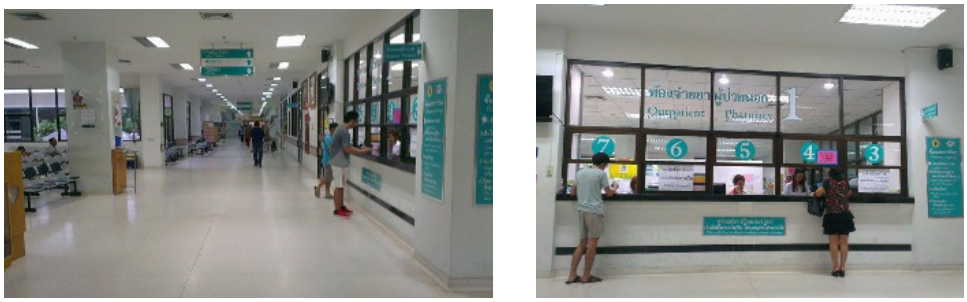

Figure 16. The current condition of the pharmacy located along the main passage

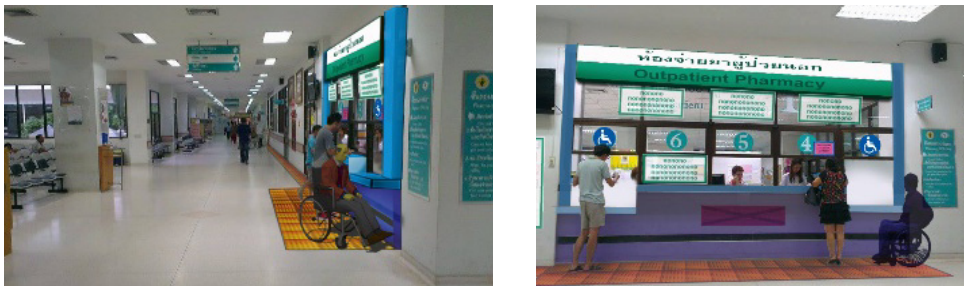

Figure 17. Guideline feature simulation of the pharmacy (Bunyasakseri & Phaholthep, 2014)

Example; The pictures demonstrate how the simulation features can improve the use of space at the pharmacy, especially for making the area more accessible and convenient for people with disabilities. Simulation features include tactile paving along the walkway to the pharmacy counter to help the blind and visually impaired find their way, and more vivid colors at the pharmacy counter and/or a redesign of the department nameplate or banner to facilitate recognition and navigation as well. Moreover, a lower counter for use by persons with certain disabilities, or the elderly, could be introduced, possibly set off to the side in order to prevent congestion.

4.2.15 Corridor halls and intersections within the building

Figure 18. The current condition of the corridor intersection in front of the entrance to the Orthopedic Surgery department

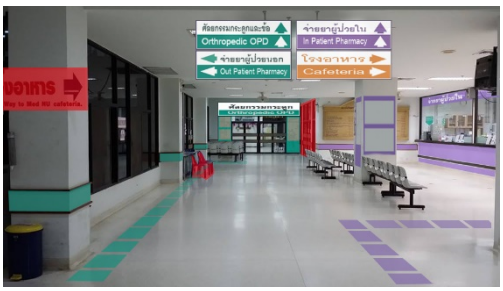

Figure 19. Guideline feature simulation of the corridor intersection in front of the entrance to the Orthopedic Surgery department (Bunyasakseri & Phaholthep, 2014)

Example; The improvement guideline illustration is a simulation of the actual corridor intersection and walkway leading to the entrance to the Orthopedic Surgery department. The signs have been installed in a location that is easily seen from the pathway. The pathway is coming from the elevator hall, so the location of the nameplates should be before or after the intersection. In addition, the signs of each department should use different colors for easy access and recognition, the details about that having been mentioned earlier. Moreover, each department should be vividly decorated to create a noticeable atmosphere, easy to notice and to see even from a distance. Each department and service facility could be marked by different colors, and color coordinated with the signage and guiding floor tiles. This will definitely improve user wayfinding, and provide an overall atmosphere improvement within the hospital. Please keep in mind that there should not be too much information posted, or too many signs and other markers scattered about, as this can cause confusion, and ultimately cause signage and navigation system failure. Moreover, not only the application of specific floor tile materials to increase navigation for all physical abilities is important, but the location and positioning of furniture should also be carefully considered, and set up at the appropriate places. There should be no obstructions to pathways, for example, especially to the blind and visually impaired. Non-public entrances and non-public areas should be very clearly marked to prevent confusion and unwanted visitors.

Figure 20.The current condition of the main corridor and the cashier counter

Figure 21.Guideline feature simulation of the main corridor and the cashier counter (Bunyasakseri & Phaholthep, 2014)

Example; The design guideline simulates the feature of navigated Braille blocks which are installed at the rim of both sides of the pathway to avoid the pedestrian traffic flow in the middle. As the Braille blocks are applied in two colors - green and orange – they not only benefit the blind and visually-impaired, but also help other users in finding their destinations; the orange blocks guide users towards all points from the inner building to the cashier counter, while the blue blocks serves as a navigation tool for users who are going to any point from the building entrance to specific departments inside the hospital building.

4.2.16 Elevator Hall and Corridor

Figure 22. Current condition of the Elevator Hall and Corridor of NU Hospital's new building

Figure 23. Guideline feature simulation of the Elevator Hall and Corridor of NU Hospital's new building (Bunyasakseri & Phaholthep, 2014)

Example; The elevator hall is located along the main corridor. At that location users who have just exited from the elevator regularly have to make a decision about where to go next. As the current design of the elevator hall is quite monotonic, and because the elevators are located in a busy flowing area – especially at peak times – along the main corridor, and in fact contribute to that since people are constantly entering and exiting the elevators, there is often chaos and congestion in the elevator area. The suggestion to reduce the problem from the said causes is to make the elevator area boldly stand out

relative to its surrounding area. This can be done redesigned by applying color to walls and floor tiles, as is shown in Figure 23, to give users an immediate sense of where to go and what to do, and a warning sign in front of the elevators for guiding people with disabilities, and offering immediate and easier noticing, recognition, direction, and access to all others. In addition, paving materials should be a tactile type that can guide the blind and visually impaired to find the elevators easily. Further, on the top of each elevator exterior should be both a visual and audio signal to indicate each elevator's position and direction of travel. This would offer a great improvement in usability not only for people with disabilities, but as well as general users. The best location to install the signage so as to improve the signage system is just opposite the elevators. At this location there would be an improved wayfinding system, information regarding overall directions within each floor of this hospital, and possibly a circulation and configuration floor plan. Moreover, the colors classification system as mentioned earlier should be applied to the signage and wayfinding system. This would create a smoother and faster traffic flow as people would understand what to do and where to go quicker. Finally, please note that these changes should take into account all the potential physical conditions of users. For example, text font, size and color should be readable from wheelchair height, and readable enough to be read by the visually impaired.

5. Discussions

From the research study, the most obvious problem with accessing the facilities within NU Hospital is regarding wayfinding, and the density of crowds is a regular problem as well, sometimes causing the congestion or blocking of passageways, causing difficulty for people with physical disabilities and functional limitation to navigate. An inanimate obstacle in passageways, such as furniture or hospital equipment, was not found to be an issue. To stress, too many people crowding around passageways was found to be a primary problem. If this problem continues unchecked, people with all kinds of disabilities could be affected regarding finding/accessing the facilities, such as the deaf, blind, elderly, and wheelchair-bound. Further, in order to solve or reduce the problems in accessing the service facilities within the public area of this hospital, accordingly, improvements should be considered regarding the disabled parking area. More wheelchair ramps to the building are needed, patient drop-off can be improved as can features and locations of signage, signal and symbols; and, appropriation of service facility points should be addressed, in terms of features and location, for people with disabilities. For instance, the treatment and exam diagnostic departments, pharmacy and other departments should have bold and clear entrance signage and façades featuring department nameplates/symbols, an appropriately designed counter and other furniture, specific floor tiles for visually-impaired people, and navigable features and signage along the corridors/halls and around elevators. Therefore, the researcher has suggested the improvements mentioned above, and created a set of design guidelines featuring simulation illustrations which are based on the literature review from (Preiser et al., 2009). Hopefully, this will bring improvement to NU Hospital. This research study has demonstrated that building designers must take into account the usability for their intended groups of people, taking into account the gamut of physical conditions. The researcher believes that building designs cannot be successful unless the designer carefully considers the complete range of all users. Every user has an effect on every other user, so building designs have to take everyone into account. For example, if passageways are congested by able-bodied people, this suggests that a design change is needed not just keeping in mind the disabled, but keeping everyone in mind.

6. Suggestions

The redesign guideline and suggestions for the public zone of NU Hospital is an improvement guideline created from the process of an empirical study. The observation of this operation has determined that the needs and behaviors of the participants (11 persons with different types of disabilities) are evidentially different from general people. Finally, please note that all the simulation features illustrated in the redesign guideline of this study do not focus on aesthetics, but rather on the improvement of functions relative to the usability of people with disabilities. The aesthetics of healthcare facility design is important, and definitely requires further study.

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