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A Study of Way-finding According to Universal Design Concept: Case Study of Faculty of Architecture, King Mongkut's Institute of Technology Ladkrabang

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Abstract

Nowadays, Way-finding is the most important system in highly complex environments. The purpose of the research is to study Way-finding of Faculty of Architecture, King Mongkut's Institute of Technology Ladkrabang (KMITL.). This study aims to 1) Study the behavior and requirements of the Way-finding system of users in the Faculty of Architecture, KMITL. 2) Study the guideline concept of Way-finding for universal design. 3) Suggest the suitable guideline concept of Way-finding for the Faculty of Architecture, KMITL.

The design of the Way-finding system should be considered in all groups of users. Accordingly, to find the suitable concept of Way-finding of the faculty of Architecture, KMITL. This research uses the concept of universal design concept (Steinfeld and Maisel, 2012, para. 2). The concept affects the behavior and demand of all groups of users, students, including internal users, outsiders and 3 groups of persons with disability.

This study is qualitative research by taking the experiences of research participants. It leads to the benefit for the development of a Way-finding system in the faculty, KMITL. Moreover, the result of the study of Way-finding for universal design concept, a case study

of the Faculty of Architecture, KMITL., found that five groups of research participants have similar problems in the Way-finding system of the faculty. However, wheelchair users and people with visual disabilities suggest that the faculty should improve access and use of facilities for the disabled person rather than develop a Way-finding system. Moreover, the result shows that 6 groups of research participants mention the problem of the signal system except for people with visual disabilities who solely use other facilities such as Braille blocks, curb stone, speed bump, and bridge.

Keyword: ***Way-finding, Signage, Physical Environment, Universal Design***

1. Introduction

Because architectural environments are more complicated, people need to have maps or symbols to guide people to destinations. In these stressful environments, effective way-finding systems will help to create feelings of safety. According to the literature review, floor-plan configurations and signage/way-finding aids from Weisman's theory (Phaholthep, 2017, p. 81) were physical environments with significant influence in way-finding. Therefore, physical environments were the main factors used in this study.

Currently, the Faculty of Architecture, KMITL, found problems in accessing buildings caused by insufficient signage or way-finding aids, causing users to be confused and causing user needs to not be meet, particularly the needs of disabled persons such as students who use wheelchairs. Boonvong and Niamsap (2000, p. 19) stated three types of disabilities had direct effects on public building designs consisting of physical and mobility disabilities, hearing or interpretation disabilities and visual disabilities. In addition,

according to the findings from a survey conducted by the National Statistical Office in 1996 found people with these three types of disabilities combined to make up 73.2 percent of all persons with disabilities. Therefore, the researcher has a concept to improve the Faculty of Architecture, KMITL, to facilitate access by three types of disabled persons and universal design needed to be used as a guideline for designing the way-finding system in this study.

2. Objectives

1.Study the behavior and requirements of the Way-finding system of users in the Faculty of Architecture, KMITL.

2. Study the guideline concept of Way-finding for universal design.

3. Suggest the suitable guideline concept of Way-finding for the Faculty of Architecture, KMITL.

3.Theories and Literature

3.1 Physical Environment Affecting to Way-finding

Phaholthep) 2017, p. 81 (mention Weisman's theory that there are 4factors of physical environment affecting to way-finding are: 1) Floor-Plan Configuration2) Visual Access 3) Signage/Way-finding Aids 4)Space Differentiation.

3.2 Physical Environment

The one thing that humans learn and remember from the physical environment has a relationship with each other as a system called Conceptual System that occurs within the mind instead of what appears outside. Because the conceptual system in the human mind is complex. Therefore, the approach to the conceptual study of the physical environment was discussed. Then analyze the important parts of the structure of the conceptual system into 3parts as

follows: 1) Imaginary is the perceived mentally from the physical environment perceived through vision. 2) Distance and boundary are the relationship of the position of the imaginary elements with emphasis on distance and boundaries. 3) Meaning is the part that helps to understand what is present in the image. how to use and causing any feelings or attitudes. Therefore, meaning in here including the functional meaning and the emotional meaning.In which distances or boundaries and meanings are hidden in the imagination, these 3 important parts are related to each other. May create a clearer conceptual system.)Horayangkul,Setvorakitand Klinmalai,2013, p. 92)

In Kevin Lynch's study, there are three key components of a city's conception, known as the "Image": 1) Identity means the things that make up a city and have unity 2) Instruction means the physical relationship of things to each other. 3) Meaning is important for understanding the meaning of things. It can be a functional meaning or it could be an emotional meaning.)Horayangkul,Setvorakitand Klinmalai,2013, p. 94)

Horayangkul,Setvorakitand Klinmalai)2013, p.94-96)mention Kevin Lynch's theory that Kevin Lynch emphasizes the importance of organization in the physical environment. in order to understand and be able to cause "Imageability". Anything that produces a clear imagery must have unique and structural qualities.There are 5 **components of urban imagery: 1) Paths 2) Edges 3) Districts 4) Nodes5) Landmark. Therefore "** 5**components of urban imagery" became an important part of the study of the shape of the city. It is something to consider in urban planning. And had a great influence on the subsequent study of the city's mentality.**

3.3 Way-finding

Way-finding is human perception and familiarity with the built environment. There are 7important things to consider about navigation: 1) "Visual Guidance System" uses visual navigation systems such as colors, badges, to ensure that users can use those interior spaces. 2) "Architecture Element and Interior" such as using floor tiles, changing wall colors to help find paths. and creating space differences by alternating certain elements, such as choice of color or placement. Counter/waiting seat It will help the seeker to guess the area 3) Signposts should be installed in areas where the user can decide, such as entrances, lobby, elevators, corridors, intersection corridors, etc. 4) Choose a vision symbol that is suitable for a large group of people, such as children, the elderly and people with vision problems. (Universal Design concept.)5) "Legibility" The graphics used must be able to communicate. It is aimed at the desired point and visible at a reasonable distance. 6) Graphic design must be designed and placed in a consistent place along the way. (Directional signs of the road traffic system, signs on the superhighway giving clear directions, given at regular intervals) 7) Avoid overuse of the vision system. Be specific and show only the essential information. Also, the sign should not be installed too much before the location where the user will make the decision of the route. Because if the label is in the previous position too much or filled with too many signposts It will make it uninteresting to read and meaningless.)Phaholthep, 2017, p.81-82(

Differences in style translate into differences in strategy. Since more men than women fall into the map navigator style, they often rely on global reference points that assist them in building conceptual models of built environments. Women tend to strongly

rely on cues from the immediate built environment, such as landmarks or information given to them about which routes to take. Think traditional cardinal directions (North, South, East, West) as opposed to "over by the fountain with the ducks" — both points of reference can get you where you want to go, but men and women choose one over the other. Along the same vein, studies show that women are better able to recall specific landmarks in their environment than are men. For a deeper understanding of wayfinding and how architectural signage can improve communication, check out this whitepaper titled Pathways to Success with Wayfinding Signage.) Liz Kelly ,2012, para .3(

When it comes to what's known as the sense of direction, studies have suggested differences in confidence levels between the genders. Confidence level directly correlates into how much anxiety a person experiences in navigating complex structures and campuses. On the whole, men report feeling more confident than women about their sense of direction, which strongly comes into play when they're faced with having to find their way around an environment that's new to them.) Liz Kelly ,2012, para.4(

3.5 Signage

Signage is part of the way-finding system or graphic directional system to enable the masses travel to places as needed. In the preparation of tools to reach the destination. The environmental graphic designers have narrowed down the meaning. It creates tools to give directions, identify locations and give instructions, providing organized and concrete information, which provide information in orderly and concrete that consider of the use follow a standard called the Signage System. A good signage system

must consider the environment to make it effective in use.)Julmatcha, 2004, p.10)

The main functions of the badge are divided into 4 types according to their use as follows:

1) Directional is a basic type of sign, from map signs to road signs.

2) Identifying is a sign indicating the name and location of a place or thing, such as a city sign, a room sign, and a fire extinguisher sign.

3).Informational is a sign to tell information about giving details. It is considered as a decorative part of the venue, including exhibition information boards and announcements.

4) Restrictive or Prohibitive is a sign to tell restrictions, prohibitions, such as rules, regulations, no smoking signs. until the restricted area sign.) Kobsuknirun, 2015, p. 19(

3.6 Universal Design

The 7 Principles of Universal Design are well known in the universal design world. They've been used as a guide for many years by design professionals. The IDeA Center at the University at Buffalo has taken these principles and made them more practical. The 8 Goals of Universal Design help practitioners apply UD and measure outcomes. They cover functional, social and emotional dimensions. Briefly, the 8 Goals are:1) Body fit 2) Comfort 3) Awareness4) Understanding 5) Wellness6) Social integration 7) Personalization 8) Cultural Appropriateness)Steinfeld and Maisel, 2012, para. 2(

3.7 Literature Review

The literature review, it was found that Thai literature such as "The Creative Enviromental Graphic Designfor Yannawa Riverfront"byImsamang and Disakul Na Ayudhya)2019(, interested in studying and researching signs that are part of the Wayfinding

system over the direct way search system. And "The Design Guidelines for Floor-Plan Conguration to Increase Waynding PerformanceIn National Museums" by Moorapun (2013) focuses on floor planning. which the literature related to the design of the search system in accordance with the principles of Universal Design will be found in foreign literature more than Thai literature such as"Gender Differences in Wayfinding Strategies and Anxiety About Wayfinding: A Cross-Cultural Comparison" byCarol A. Lawton and Janos Kallai) 2002)and"Gender and Age Differences in Using Indoor Maps for Wayfinding in Real Environments"byChengshun Wang, Yufen Chen,Shulei Zheng and Hua Liao)2019(, a study of gender and age affecting path-finding ability. In addition, the research "Wayfinding in University Settings: A Case Study of the Wayfinding Design Process at Carleton University" by Kehinde Oyelola (2014) is the literature most relevant to this research. Research is qualitative research and uses different data collection methods. In particular, the study explores the approach to university campuses by examining and analyzing different perspectives of real users. Carleton University in Ottawa a place to explore. This place consists of a complex spatial structure. Multicultural End Users and the strategic goal of being an accessible and inclusive institution.

Therefore, Floor-Plan Configurationand Signage/Way-finding Aids from Weisman' theory)2017, p. 81(are interesting factors to study. Kevin Lynch mentions a well-organized environment to create a clear image. In this research, the five components of urban imagery by Kevin Lynch (Horayangkul, Setvorakit and Klinmalai, 2013, p. 94-96) were used in the analysis of "Floor-Plan Configuration". and using the principle of classification of symbols

according to their uses, 4 types (Kobsuknirun, 2015, p. 19) were used in the analysis of "Signage/Way-finding Aids".

4. Research Methodology

The research was a systematic research on the way-finding system of the Faculty of Architecture, KMITL, with the aim of producing recommendations on design improvement methods according to the concept of universal design. Qualitative research methods were employed through surveys and observation of the behaviors and needs of the users of the internal search system of the Faculty of Architecture of KMITL in addition to data collection from focused-group discussions involving research participants and actual user experience, followed by analysis and processing for the development of design guidelines.

4.1 Location of Study

The Faculty of Architecture, King Mongkut's Institute of Technology Ladkrabang

4.2 Key Informants

For the sample groups in this study, the sample receiving open-ended interview forms consisted of 31 subjects consisting of 8 outside people, 19 students, and 4 internal staff members, while the for the qualitative portion of the research through focused-group discussions consisted of 28 research participants consisting of 17 outside people, 7 students, and 4 internal staff members. The key informants were divided into two groups as follows:

1. Outside People – These consisted of the primary users of the way-finding system of the Faculty of Architecture of KMITL at first use, namely users of footpaths, users of vehicles, and three categories of disabled persons, namely persons with physical and movement impairments, people with visual impairments, and people

with hearing or communication impairments; they consisted of users of wheelchairs, blind persons and persons with blurred vision, and deaf persons.

2. Students-internal staff members of the Faculty of Architecture of KMITL – These consisted of the secondary users of the way-finding system of the Faculty of Architecture of KMITL, namely students, professors, staff, and a person with physical and movement impairments, namely one wheelchair-bound student.

4.3 Research Instrumentation

1. The instruments for recording the survey of the physical environment and user behaviors:

- Survey equipment consisted of GoPro cameras, photo cameras, and notebooks.

- Equipment used to demonstrate hypothetical roles consisted of wheelchairs, tinted glasses,fully-opaque glasses, white walking sticks, and ear plugs.

2. An open-ended interview form was used to conduct interviews online.

3. A focused-group interviews were recorded by a form with supplementation by an audio recorder.

4.4 Data Collection Procedures

1. A preliminary survey of the area was surveyed, followed by the photographing of the various physical environment of the Faculty of Architecture of KMITL for a thorough and systematic study. The researcher spent two days to conduct the preliminary survey, namely 11 December 2019 and 1 November 2020 from 1:00 to 4:00 pm, for a total of 6 hours (3 hours per day).

2. The open-ended interview form was distributed online to students, internal staff members, and outside people to obtain

information about the problems on the first use of the way-finding systems of the Faculty of Architecture of KMITL and information about user behaviors. The purpose was to seek preliminary guidelines on the improvements and development of tools for focused-group discussions on 8-11 May 2020. In total, 31 people returned their forms, namely 19 students, 4 internal staff members, and 8 outside people.

3. A survey of the area was conducted by the researcher, by which the researcher created hypothetical roles for the research participants by dividing them into 7 groups consisting of students, internal staff members, outside people on footpaths, vehicle users, and 3 groups of disabled persons consisting of wheelchair users, blind persons and persons with visual impairment, and deaf persons. Simultaneously, the researcher prepared the instrument for recording the survey of physical environment and user behaviors to develop understanding about the problems encountered and to select the best paths for all 7 groups participating in the research, with the actual survey conducted at a later stage. One day was spent for making records of the area and hypothetical roles of the research participants, namely 22 July 2020 from 1:00 to 4:00 pm, or 3 hours total.

4. The behaviors of the research participants who used the way-finding system of the Faculty of Architecture of KMITL were observed with the instruments for recording the survey of physical environment and user behaviors, and focused-group discussions were held and recorded to collect in-depth data from actual users and to reflect upon the different problems and needs of the 7 groups of research participants consisting of 28 people, namely 7 students, 4 internal staff members, 3 outside people on footpaths, 3 outside

people in vehicles, and disabled persons from 3 categories, namely 5 wheelchair users, 3 blind-visually impaired persons, and 3 deaf persons. This stage took 7 days on 26-28 October 2020 and on 6, 16, 18, and 25 November 2020.

5. Research Findings

5.1 Data from the Study into the Physical Environment of the Faculty of Architecture of KMITL

The researcher conducted the preliminary survey and took photographs of the different parts of the physical environment of the Faculty of Architecture of KMITL and subjected floor-plan configuration factors and signage/way-finding aids that influenced way-finding to analysis of the way-finding system as shown in Table 1 below.

Table 1 – Data from Area Survey by Analysis of Floor-Plan Configuration and Signage/Way-Finding Aids

Survey Data	Survey Photographs
1. Floor-Plan Configuration **1.1 Paths** **1) Footpaths and some intersections are small and narrow.** **2) Footpaths have rough surfaces with different levels, which create risk for falls.** **3) Footpaths have obstructions at intervals and trees that block traffic visibility.** **4) Footpaths are unsafe and deserted as there are no users in the evening hours.** **5) It is unknown whether the roads of the Faculty of Architecture of**	   **Figure for Item1** **Figure for Item 2** **Figure for Item 3**   

KMITL are one-way or two-way roads, as there are no arrows or signage to indicate directions on the roads, thus hindering decision-making. **6) The traffic pathways still do not comply with the principle of universal design.**	**Figure for Item 4 Figure for Item 5 Figure for Item 6**
1.2 (Edges) **1) Footpaths and roads are clearly designated by lines, but lanes are not marked at entrances and exits for vehicles at the Faculty of Architecture of KMITL.** **2) The edges are old and deteriorated.** **3) Edges are missing or disconnected.** **4) Edges still do not conform to the principle of universal design.**	   **Figure for Item 1 Figure for Item 2 Figure for Item 3**

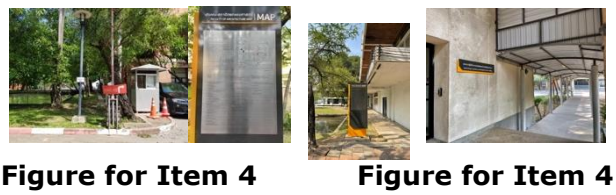
Table 1 (Continued)

ข้อมูลจากการสำรวจ	ภาพจากการสำรวจ
1.3 Zones **1) There are no clear zoning practices. Buildings were only constructed in succession without consideration to their functions. Although zones became clearly established after 1 November 2020, it is impossible to identify which zone someone is located in on the pathways.** **2) The zones or unique usage characteristics of each building do**	 **Figure for Item 1**

not appear distinct, or it is unclear which building is used for what purpose. **3) It is impossible to spot facilities ahead from a distance.** **4) Although parking zones are more organized, motorcycles are not parked in an orderly fashion. Moreover, there are very few handicap parking spaces.**	 **Figure for Item 2** **Figure for Item 3** **Figure for Item 4**
1.4 Nodes **1) The intersections inside the Faculty of Architecture of KMITL is chaotic and hazardous for users. In particular, there are not enough concave mirrors, warning lights, and zebra crossings for disabled persons.** **2) The footpath intersections inside the Faculty of Architecture of KMITL lack adequate signage, thus making it inconvenient to access and utilize areas.** **3) Intersections still do not conform to the principle of universal design.**	 **Figure for Item 1** **Figure for Item 1** **Figure for Item 2**  **Figure for Item 2** **Figure for Item 3** **Figure for Item 3**
1.5 Landmarks **1) There are not as many architectural structures as previously believed. In addition, some architectural structures are old and dilapidated.** **2) The appearance of the buildings inside the Faculty of Architecture of KMITL is poor and buildings are not easy to access by paths. For example, trees obstruct buildings, so they are**	 **Figure for Item 1** **Figure for Item 2** **Figure for Item 3**

difficult to see from afar. **3) There are clear landmarks such as the "flying saucer" building.**	
2. Signage/Way-Finding Aids such as Directional Signs, Identifying Signs, Informational Signs, and Restrictive or Prohibitive Signs **1) Signs are inadequate for use in every type, especially at interactions.**	 **Figure for Item 1** **Figure for Item 2**

Table 1 (Continued)

ข้อมูลจากการสำรวจ	ภาพจากการสำรวจ
2) The visibility of signs is poor for every type, and signs are inappropriately positioned. **3) Directional signs are deteriorated and were not properly designed. In addition, information shown on the signs are unclear and cannot provide information on where someone is located within the Faculty of Architecture of KMITL. Moreover, they are provided only for vehicle paths and not for footpaths, thus causing users to require a significant of time to develop understanding.** **4) Some directional signs are small and lack proper design. Although after 1 November 2020 signs were**	 **Figure for Item 2** **Figure for Item 3** **Figure for Item 3**  **Figure for Item 4** **Figure for Item 4**

designed, modified, and added for each intersection to appear more attractive and distinctive and to clearly identify locations or facilities, the material (steel) chosen for use in displaying information about the faculty is inadequate, as the texts are too small, and the information is placed too closely together. **5) Identifying signs clearly identify building names, but the signs are small and not distinctive.**	**Figure for Item 5**

Source: Researcher (2020).

The above survey data show that the floor plan configuration of the Faculty of Architecture of KMITL consists of a horizontal distribution and buildings and layout, thereby presenting physical environment problems in all 5 categories, namely paths, edges, zones, nodes, and landmarks, which hinder way-finding. In particular, signage/way-finding aids are not available in sufficient numbers to adequately meet usage requirements, and the way-finding system of the Faculty of Architecture of KMITL still do not conform to the principle of universal design.

5.2 Data from the Study of the Physical Environment of the Faculty of Architecture of KMITL by Using Hypothetical Roles

The researcher surveyed the area by utilizing hypothetical roles with the 7 groups of research participants to develop understanding about the problems encountered and to select the most convenient paths for the research participants. Paths were selected based on open-ended interviews of students and internal staff members, which provided the information that the areas inside the Faculty of Architecture of KMITL which are frequently used are the central learning building, the cafeteria, area under the 4-story

building, and the dean's building. Thus, this research selected the main facility as the library located around the 1st floor of the central learning building and for the destinations for each group to be locations to be visited for the first time by the research participants. The paths used differed as appropriate, and the details are shown in

Table 2 as follows:

Table 2 – Data from Area Survey Using Hypothetical Roles was the 7Groups of Research Participants

Group	Type of User	Start Point	Goal	Nearest Distance (Metre)		Walking Time (Min)	
1	Student	Library	Operation Building(Research and Interior Design)	230		3	
2	internal staff member	Library	Operation Building 1 (Communication Design)	265		3	
3	Users of footpath	front of faculty	Library	355		4	
4	Users of vehicle	front of faculty	Library	600 (Front of Faculty to Car Park(	150 (Car Park to Library(	2.00 (Front of Faculty to Car Park(	2.20 (Car Park to Library(
5	Users of wheelchair	Building in the middle	Library	220		5.00	

		of water			
6	**Blindperson**	**Building in the middle of water**	**Library**	**220**	**10.00**
7	**Deafperson**	**Building in the middle of water**	**Library**	**220**	**2.40**

Source: Researcher (2020).

5.3 Data from the Observation of the Behaviors of the Research Participants

The researcher surveyed the area by observing the behaviors of the research participants who used the way-finding system of the Faculty of Architecture of KMITL across all 7 groups at the paths designated for them from the utilization of the hypothetical roles for the research participants. It was found that, 3 wheelchair users out of 5 and all 3 blind or visually-impaired were unable to personally explore the area. Thus, the researcher provided guidance, since the environment of the faculty was not facilitative of way-finding. To summarize the mean travel time in surveying areas through observation of the behaviors of the research participants who used the way-finding system of the Faculty of Architecture of KMITL, 22 out of 28 people visited the areas and searched for their designated buildings without the researcher's guidance, of whom 11 were females, with mean time required at 5.45 minutes, and 11 were males with mean time required at 5.22 minutes. Furthermore, a total of 14 out of 22 research participants asked other students

and staff members for directions; of these participants, 8 were females, while 6 were males. Thus, it was learned that men were more confident about way-finding than women. However, due to the small number of research participants, it was not possible to calculate a precise mean time value. Nevertheless, the results from the observation of the behaviors of the research participants are shown in Table 3 as follows:

Table 3 – Data from the Mean Time of the 6 Research Participants who Visited the Building Search Site

Group	Type of User	Length of Time The Researcher Surveyed	Female		Male	
			Total Number of People	Average Time)Min(	Total Number of People	Average Time)Min(
1	Student	3.00	4	6.16	3	4.28
2	internal staff member	3.00	2	3.13	2	3.35
3	Users of footpath	4.00	1	4.30	2	5.5
4	Users of vehicle	4.20	1	9.00	2	8.8
5	Users of wheelchair	5.00	1	4.00	1	3.30
6	Deafperson	2.40	2	7.10	1	7.00

Source: Researcher (2020).

5.4 Data from Focused-Group Discussions with the Research Participants

After the observation of the behaviors of the research participants in all 7 groups, the researcher turned the floor-plan configuration and signage/way-finding aid factors influencing way-finding into topics for focused-group discussions with the 7 groups

of research participants concerning the problems and solutions for the way-finding system of the Faculty of Architecture of KMITL as shown in Table 4 as follows:

Table 4 – Data from Focused-Group Discussions with the 7 Groups of Research Participants

Group	Problems Encountered	Recommendations from Participants
1-7	1. Floor-plan Configuration 1.1 Paths - Missing footpaths. - Diverse/disconnected footpaths.	- Design footpaths to be more accessible and abundant with signage or colors that are consistent with the characteristics of the Faculty of Architecture by creating long footpaths to reach destinations, painting along footpaths, creating clear footprints/wave/cartoon markings on foot paths for directional guidance or attaching stickers in the shape of footprints along footpaths.
3, 5 and 7	- Footpaths are deserted and not safe in the evenings.	- Install lights along paths similarly to what is done at airports to enhance safety during evening hours.
4	- Absence of road or lane names.	- Install signs bearing the names of roads or lanes at the entrances of each lane.

Group	Problems Encountered	Recommendations from Participants
4	- Unable to identify whether roads are one-way or two-way due to absence of directional signage on roads.	- Vehicle roads should be made to be one-way roads. - Arrows should be affixed to road surfaces to enhance driver understanding and safety.
1-7	- Paths still do not conform to the principle of universal design.	- Systematically and clearly design traffic paths by dividing paths into primary and secondary paths.

		- Construct correct braille blocks for blind persons. Moreover, blind persons can identify locations based on contact with rock surfaces and counting speedbumps/bridges. **- Design patterns and paint coatings to be suitable for persons with visual impairments.**
1, 2, 3, 5, 6 and 7	**- Footpaths have rough and uneven surfaces.**	**- Replace footpath materials to make them uniform and connect paths to each other. Concrete materials are superior to metals, due to the greater slipperiness of metals.**
3, 5, 7	**- Some footpaths and intersections are small and narrow.**	**- Broaden footpaths (reduce road width and expand footpaths).**
1, 2, 5and 6	**- Footpaths are hot and not covered by awnings.** **- Footpaths have obstructions such as trees and electrical posts.**	**- Construct roofs to permit visibility of footpaths from afar and to provide protection from the sun and rain.**
5	**- Footpaths are not conducive to access and use of various facilities.**	**- Construct paths, slopes, and parking paths for wheelchair users. Additionally, existing sloops for wheelchair users that should be renovated include the integrated building, the building surrounded by water, and the cafeteria.**
1, 2, 3, 4 and 7	**1.2 Edges** **- Clearly separate footpaths and roads with edges, although the research participants were uninterested in this.** **- Edges are missing and deteriorated.**	**- Separate footpaths and vehicle roads by using paints that provide greater visibility (white-red/yellow) or plant trees to separate each area to ensure safety.** **- Design edges to be consistent with safety practices by increasing the height of footpath edges to allow blind persons**

		to touch them by hand, increasing clear fencing in hazardous areas (around the fish pond in front of the dean's building) and installing posts to prevent motorcycles from entering footpaths (open ground in front of the central learning building).
5,6 and 7	**- Edges still do not conform to the principle of universal design.**	**- Construct railings for disabled and elderly persons.** **- Design railings for blind persons by providing directions by braille on the railings.**
Group	**Problems Encountered**	**Recommendations from Participants**
1-7	**1.3 Zones** **- The zones or usage characteristics of each building are non-distinct.**	**- Construct signs or symbols that can be understood by outsiders by paining buildings to match the map signs or create directional signs that divide zones from north to south or left to right wings with 2 zones, namely, Zone A and Zone B.**
4, 5 and 7	**- Facilities ahead cannot be spotted from a distance.**	**- Design large zone signage to permit visibility from afar.**
5	**- There are few parking zones for disabled persons.**	**- Add parking zones for wheelchair users.**
1, 2, 3, 4, 5 and 7	**- There are no clear zoning practices, as new buildings are constructed in succession without consideration to usage, thus a long time is required to search for paths.**	**- Divide zones by using various symbols or by dividing buildings by color by cultivating a variety of colorful flowers or providing bright and colorful signage as appropriate.** **- Create boundaries/atmospheres for zones such as by installing ATMs at the commercial area.** **- Design the environment in a manner that allows blind persons to understand and be communicated with such as by**

		installing speedbumps on the ground and bridges crossing over zones.
4, 5and 6	**1.4 Nodes** **- Roads are not safe for pedestrians to cross.** **- Intersections are busy and dangerous for users.**	**- Warning signs should be clearly added to danger areas such as unfenced fishponds. Furthermore, intersections should have mirrors or light/audio warning signals.**
2	**- No landmarks are found at intersections that can be used in communications with others.**	**- Nodes or intersections should be connected to landmarks.** **- Intersections should have landmarks designed as artwork that can be used as references or boost the identity of the Faculty of Architecture, KMITL.** **- Intersections should have clearly identifying symbols, colors or objects.**
1, 2and 4	**- Insufficient resting places**	**- Add seats at intersections to let people know these are meeting places.**
5, 6 and 7	**- Intersections do not have universal design**	**- Directional signs or posts should be designed to have directional arrow buttons to provide audio directions for the blind.** **- Braille blocks should be built at crosswalks.**
1, 2, 4, 5, 6 and 7	**1.5 Landmarks** **- No landmarks are found at major sites to identify intersections.** **- Landmark access paths are difficult.** **- Buildings have poor visibility.**	**- Select landmark points that are clearly visible.** **- Design buildings or existing sculptures to be more attractive by using different colors and materials.**

Group	Problems Encountered	Recommendations from Participants
3, 4,	**- Landmarks are unknown.**	**- Select landmark points that are clearly**

5, 6 and 7		**visible.**
1, 2 ,3 and 4	**- Fewer architectural works were found than expected.**	**- Landmark designs are an artistic work that can be used as a reference or to promote identity of the Faculty of Architecture, KMITL, by creating large colorful sculptures of animals or the faculty symbol (beehive).**
7	**- Landmark areas are dangerous for the blind because most of the landmarks are at the feet of stairs, bridges and fountains.**	**- Landmark design should give consideration to safety because this area supports every type of person. In particular, the area at the feet of stairs, bridges and fountains may be dangerous for the blind or people walking with a cane may fall from bridges.**
1-6	**2. Signage/Way-finding Aids Such as Directional Signs, Identifying Signs, Informative Signs and Restrictive or Prohibitive Signs** **- Every type of sign is sufficient for use.** **- Visibility of every sign type is poor and signs are placed inappropriate positions with difficult access in some cases.** **- Directional signs lack clear design and information with only vehicle routes. No information on footpaths can be found.** **- Some directional signs are small and deficient in design. Directional sign materials are**	**- The number of signs should be increased to be sufficient for use, particularly at intersections.** **- Signs should be clearly placed at paths, zones or important points with visual access and visibility on main paths.** **- Directional and information signs should be enlarged to stand out more.** **- Signs should be designed to be attractive, have the same identity and simple to understand. For example, vehicle directional signs should have clear directions. Sign colors should be painted to be connected to buildings, symbol designs and building colors.** **- Directional signs should be placed to show a layout of the Faculty of Architecture, KMITL, at the first point of entry to the Faculty, paths, zones and intersections.**

	inappropriate and have small letters with too much information packed together. **- Information signs are small and do not stand out.**	**- Information on directional signs should be more detailed and clear. More information on footpaths, building characteristics and current location should be provided, particularly at intersections.** **- Technology should be used to design touch screen systems for directional signs.** **- Building names should be designated to create a universal signage system such as systems for Buildings A, B and C or Buildings 1, 2 and 3.**
กลุ่มที่ **1-7**	**Additional Recommendations Concerning Universal Design** **- Signs do not cover universal design.** **- Signs are important for the deaf, particularly at intersections.**	**- Signs should be designed with visual access for wheelchair users.** **- Warning lights should be used for the deaf rather than audio signals.**

Group	Problems Encountered	Recommendations from Participants
	- The blind and visually-impaired do not use signage systems.	**- Raised maps and Braille characters should be added to directional signs.** **- Directional signs or posts should be designed to have buttons with audio directions for the blind.** **- Information on signs should be in two languages consisting of the English and Thai languages.** **- A universal way-finding system application for the Faculty of Architecture, KMITL, should be designed such as the CREW App for the blind.** **- Brochures should be designed and**

		handed out at the front entrance. Brochures should contain information about paths in the Faculty of Architecture, KMITL. **- Users should participate in every step of design.**

Source: Researcher (2020).

6. Discussion of the Findings, Conclusion and Recommendations

6.1 Discussion of the Findings

Based on the study of the way-finding system of the Faculty of Architecture, KMITL, and the concept of universal design, the researcher discusses the findings based on research objectives on the following three topics:

6.1.1 Behaviors and Needs of Users of the Way-finding System in the Faculty of Architecture, KMITL According to field observations of the participants' behaviors when using the way-finding system of the Faculty of Architecture, KMITL, to search for designated buildings, women spend more time looking for paths than men on average (Table 4.7) and women are more likely to ask for directions from students and internal staff than men. Thus, men are more confident about finding paths than women. This is consistent with the theory of Liz Kelly (2012, Paragraph 4), which states that women are more anxious about finding paths than men because the gender difference affects confidence when walking in a new environment. Furthermore, three out of five wheelchair users and all of the blind and visually-impaired were found to be unable to enter the survey area in person and had to be guided by the researcher, because the environment in the Faculty does not facilitate way-finding and does not have a universal design. The

behaviors and needs of users of the way-finding system in the Faculty of Architecture, KMITL are as follows:

- In the area of floor-plan configurations, the participants in five groups consisting of students, internal staff, outside pedestrians, outside drivers and the deaf were found to have similar problems in using the area. However, two other groups of participants consisting of wheelchair users and the blind and visually-impaired stated that building access should be improved and amenities for disabled persons should be used rather than developing way-finding aids because disabled persons cannot access and use an area if way-finding aids are good and environments do not facilitate access.

- Signage/way-finding aids were a factor with significant mentions of problems from six groups of participants consisting of students, internal staff, outside pedestrians, outside drivers, wheelchair users and the deaf, in particular, because signage is the core of path recognition. Signage should be placed at intersections. The deaf use sign language to communicate, causing barriers in way-finding. This differs from the blind and visually-impaired, who do not use signage, but use other way-finding aids such as Braille blocks, curb stones, speed bumps or bridges.

6.1.2 Guidelines for Designing a Way-finding System Consistent with the Universal Design Principle

According to the study, the 7 way-finding system design principles of Jarunya Pahontep (2017, Page 81-82) on "Key Considerations About Way-finding Systems" were consistent with the 8 universal design principles of Steinfeld and Maisel (2012, Paragraph 2) according to the following details in Table 5:

Table 5 – Data from Guidelines for Designing a Way-finding System Consistent with the Universal Design Principle

Way-finding)Phaholthep, 2017(	Universal Design)Steinfeld and Maisel, 2012(							
	BodyFit	Comfort	Awareness	Understanding	Wellness	Social Integration	Personalization	Cultural Appropriateness
1.Visual Navigation	☐	☐		☐				
2. Create Different Area from Architecture and Interior Design Elements	☐	☐	☐		☐		☐	
3. Guide signs should be installed in the area where the user decides	☐	☐	☐					

4. Choose a visual mark that is appropriate for a large group of people		☐	☐				☐	
5. Graphics must be able to communicate directly at the desired point and visible at a reasonable distance		☐	☐				☐	
6. Graphic design must be designed and installed		☐	☐		☐			

consistentntly along the way								
7. Avoid using too many vision systems	☐				☐			

Source: Researcher (2021).

6.1.3 Guidelines on Designing a Way-finding System in a Case Study of the Faculty of Architecture, KMITL

According to data from preliminary area surveys, the Faculty of Architecture, KMITL, has dispersed buildings and horizontal building floor plans. Furthermore, in focus groups with the participants regarding problems and problem-solving guidelines for the way-finding system in the Faculty of Architecture, KMITL, floor-plan configurations and signage/way-finding aids were analyzed as physical environments with effects on way-finding in Weisman's theory (Jarunya Pahontep, 2017, Page 81) (Table 4). By using the 7 way-finding system designing principles of Jarunya Pahontep (2017, Page 81-82) to accompany consideration of recommendations from the participants and the 8 universal design concepts of Steinfeld and Maisel (2012, Paragraph 2) to solve problems of way-finding systems in order to meet the behaviors and needs of every user group, the researcher was able to summarize details of way-finding system designing guidelines in a case study of the Faculty of Architecture, KMITL, in Table 6 as follows:

Table 6 – Data from Guidelines on Designing a Way-finding System in a Case Study

of the Faculty of Architecture, KMITL

Solution	Design Principles of 7 Way-finding							Universal Design
	1	2	3	4	5	6	7	
1. Floor Plan Configuration **1.1 Paths** **- Path materials should be changed to be smooth and not slippery or rough.**	☐	☐						**Comfort, Awareness and Wellness**
- Footpaths should be modified to cover universal design by modifying and building slopes for wheelchair users along with creating Braille block paths for the blind.	☐	☐						**Body Fit, Comfort, Awareness and Wellness**
- Footpaths should be created through education buildings to connect with the Prof. PrasomRangsiroj Auditorium.		☐						**Body Fit, Comfort, Awareness and Wellness**
- Footpaths at sidewalks in front of the Faculty of Architecture, KMITL, should be modified and roofs should be built.	☐	☐						**Body Fit, Comfort, Awareness and Wellness**
- Lights should be installed at footpaths in Zones B and C.	☐							**Comfort,Awareness and Wellness**
- Directional symbols should be designed on footpaths in the shape of symbols or colors consistent with the Faculty of Architecture, KMITL.	☐		☐	☐	☐	☐		**Comfort, Awareness, Understandingand Personalization**

Table 6 (Continued)

Solution	Design Principles of 7 Way-finding							Universal Design
	1	2	3	4	5	6	7	
- Roads should be divided and directional arrows should be painted on road surfaces/vehicle traffic routes.	☐		☐	☐	☐	☐		Body Fit, Comfort, Awareness, Understanding and Wellness
1.2 Edges - Curb stones should be used as the main directional symbol and Braille blocks should be used as the secondary directional symbol for the blind and the visually-impaired.	☐	☐						Body Fit, Comfort, Awarenessand Wellness
- More stainless steel posts for motorcycles should be installed at missing points.	☐	☐						Comfort, Awareness and Wellness
- Guardrails should be built in dangerous areas using signage models consistent with the Faculty of Architecture, KMITL.	☐	☐						Body Fit, Comfort, Awareness, Wellness and Personalization,
- Braille characters should be used to identify routes on rails before reaching danger points.	☐	☐	☐		☐			Comfort, Awareness, Understanding and Wellness
- Sidewalks should be clearly painted and sidewalk materials should be changed to be different from roads.	☐	☐						Awareness, Understanding and Wellness
1.3 Zones - Zones in the Faculty of Architecture, KMITL, should be divided by painting and designing wall graphics in each	☐	☐			☐			Awareness, Understanding and Personalization

zone to be consistent with the Faculty of Architecture, KMITL.								
1.4 Nodes **- Tables-chairs to be added at intersections and tables-chairs should have modular design (footpaths).**	☐	☐						**Body Fit, Comfort, Awareness, Social Integration and Cultural Appropriateness**
- Warning signs should be added clearly in danger areas (vehicle traffic routes).(	☐		☐	☐				**Comfort, Awareness, Understanding and Wellness**
1.5 Landmarks **- Landmarks should be installed in Zones A-D at 1-2 points per zone.**	☐	☐	☐		☐			**Comfort and Awareness**
- Buildings or existing furniture should be painted or decorated to be consistent with the Faculty of Architecture, KMITL.	☐	☐			☐			**Awareness and Personalization**

Table 6 (Continued)

Solution	**Design Principles of 7 Way-finding**							**Universal Design**
	1	**2**	**3**	**4**	**5**	**6**	**7**	
- Sculptures should be created to identify zones and give character to the Faculty and existing sculptures created by fine arts students should be placed as landmarks.	☐	☐			☐			**Awareness, Personalization and Cultural Appropriateness**
2. Signage/Way-finding Aids **- Signage should have the same identity and should be designed to be consistent with the institution overall**	☐			☐	☐			**Awareness and Personalization**

and applicable to every faculty.								
- Every sign type should have visual access and size accessible to every type of user.	☐			☐	☐			**Body Fit, Comfort and Awareness**
- Every sign type should be increased to be sufficient for use.	☐		☐		☐	☐		**Comfort, Awareness and Wellness**
- Every sign type should be positioned to be clearly visible on main paths.	☐		☐		☐	☐		**Body Fit, Comfort, Awareness and Wellness**
- Signage materials should not be reflective metal materials.		☐		☐				**Comfort**
- Signage should provide clear directional information.	☐				☐		☐	**Comfort, Awareness and Understanding**
- Letters on signs should be complete characters and contrast between color pairs of letters and base colors should be effective.				☐				**Comfort and Awareness**
- The first information shown on way-find signs should be information showing where the reader is in the Faculty.					☐		☐	**Comfort, Awareness and Understanding**
- Information on way-finding signs shown on charts of the Faculty of Architecture, KMITL, should have information identifying footpaths, building characteristics and current location.					☐		☐	**Comfort, Awareness and Understanding**
- Buttons with audio directional information should be designed for blind persons in addition to raised maps, Braille characters. Furthermore, QR codes should be added and linked				☐	☐			**Comfort, Awareness and Understanding**

to maps on the website of the Faculty of Architecture, KMITL.								

Source: Researcher (2021).

And the researcher has seven recommendations outside designing principles and guidelines for the way-finding system consistent with the principle of universal design with consideration given to people of every group as shown in the details in Table 7 as follows:

Table 7 – Data from the Recommendations Outside Designing Principles

Solution	Universal Design
1. Footpaths in the Faculty of Architecture, KMITL, should be modified to avoid routes blocked by trees.	**Body Fit, Comfort and Wellness**
2.Vehicle traffic routes in front of Studio 1 and the cafeteria should be converted into footpaths.	**Body Fit, Comfort and Wellness**
3.Zones should be divided by vehicle traffic roiutes by adding Zone D in the lower area of the chart.	**Comfort, Awareness and Understanding**
4.Building names in each zone should be changed to be universal.	**Comfort, Awareness, Understanding and Personalization**

Source: Researcher (2021).

6.2 Recommendations for Implementation of the Findings

This study was aimed at investigating modification of the way-finding system of the Faculty of Architecture, KMITL, based on the concept of universal design to support diverse users including students, internal staff, outside pedestrians, outside drivers and three types of disabled persons consisting of wheelchair users, blind or visually impaired and persons with hearing impairments. The findings were obtained from real users. Guidelines from designing the way-finding system in a case study of the Faculty of

Architecture, KMITL (Item 6.1.3) will provide baseline data that can be applied as guidelines in designing way-finding systems in universities or education facilities with similar contexts to enable equal user access to buildings.

6.3 Recommendations for Future Studies

A part from considering the abovementioned models, this study explored only floor-plan configurations and signage/way-finding aids with effects on way-finding. According to the study, visual access and space differentiation should be considered in designing the way-finding system. Any person who will conduct research concerning universal design should include disabled persons because this will obtain data from the group with needs, and cause amenities to be found as necessary for disabled persons.

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