Study on Information Perception and Communication of P Type Bus Stop Signs for the Elderly

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ABSTRACT

With the coming of an aging society, the elderly's perception of information communication in their lives is gradually becoming more valued. This study treated the elderly as subjects to investigate the information communication of P type bus stop signs in Taiwan. First, observations (of nine elderly people) and interviews (with ten elderly people) were conducted. Using the information from the interviews, Verbal protocol analysis was performed to analyze the elderly's views on information communication efficacy and demand for bus stop signs. Finally, this study improved the design of P type bus stop signs to enhance the quality of bus transportation systems, provide the elderly with a more human transportation environment, and increase their quality of life.

Keywords: *Elder Citizens, Information communication,, P type bus stop, Participant observation method, Verbal protocol analysis, Information design*

1. Introduction

With improved and progressive medical health and living standards, the average life span is extended. According to the definition provided by the United Nations, any country whose proportion of elderly population is more than 7% of the overall population is becoming a so-called ageing society, and any country whose proportion of elderly population is more than 14% is an "ageing society." In recent years, "population aging" has become a common phenomenon in developed countries [1], for example, in 2008 Japan, Italy, and Monaco became "super-aging societies," and 34 other countries became "aging societies [2]." Due to such extended average life span of citizens, future age structures of populations are transforming to aging populations. In 1996, the proportion of the elderly population over the age of 65 in Taiwan was 7.0%, and has increased to 10.6% to date [3]. It is estimated that the proportion of elderly population in the overall population will reach 29.2% by 2036, and Taiwan will become a nation of a "super-aging society [4]." Thus, with the coming of an aging society, the government should take corresponding measures regarding issues concerned with health care, economic safety, housing, communications, and transportation to enable the elderly to maintain a life of dignity and independence. With increased age, both the physiological and psychological functions of the elderly will gradually degenerate; therefore, their lifestyles and transportation demands are different from those of other age groups. For example, they attach more importance to medical care and leisure activities, their life scope decreases, their daily trips are simple and regular, and they mainly travel to destinations by bus, MRT, and walking. These are the fundamentals of the activities of the elderly.

The major physical degeneration affecting the elderly's ability to read bus stop signs is visual degeneration, as color recognition ability significantly decreases with increased age, words they see become vague, and they tend to experience eye-fatigue [5]. In terms of psychological functions, reduced cognitive ability, such as declined memory function, comprehension ability, and inattention, affects the elderly's information extraction ability when looking at bus stop signs. In order to help the elderly avoid transportation obstacles [6], in the design aspect of bus stop sign information, the elderly should be provided with sufficient and clear bus information, and design methods of conceptualization, symbolization, and systematization should be applied in order to reduce the elderly's sense of insecurity and distrust[7]. Methods of perceptual engineering should be used to transform the elderly's perceptions and image expectations into physical design elements [8~10]. In this study, participant observations, questionnaire survey, and verbal protocol analysis were used to understand the needs of the elderly [11~14] in order to further improve the current P type bus stop signs according to their needs.

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There are various types of bus stop signs. In addition to improvements in design pattern, the main function of bus stop signs is to effectively convey bus information to passengers, including the information of bus station name, bus number, route map, timetable, etc. This study investigated the information communication of bus stop signs, upon the aspect of software and from the perspective of the elderly, in order to understand the needs and obstacles concerning information extraction for the elderly when taking buses from the perspective of design, and investigates the information communication efficacy of bus stop signs and the demands of the elderly. It was intended that an effective and convenient bus information system can be established, and the principles for designing bus stop sign information can be summarized and provided as reference to future bus stop sign information design.

1. Investigation on Image/Letter Recognition of P Type Bus Stop Signs

2.1 The Elderly's Recognition of P Type Bus Stop Signs

The perspectives of human factor engineering and cognitive psychology suggest that a three-phase series model of perception, recognition and action can be applied to the information processing of any system. External stimuli cannot enter the system until it enters the perception phase. The information is conveyed by the perception phase to the cognition phase, where it is analyzed, compared, judged and processed to make an adequate decision. The decision is then conveyed to the action phase for execution [6]. Owing to the aging of the peripheral nervous system, signal transduction functions also gradually decline. Therefore, when external stimuli are transmitted to the brain, the time required for the brain to give orders to the motor nerves will increase, resulting in the prolonged search time of the elderly [15]. In terms of the information extraction of objects at a transport station, the elderly are also affected by environmental factors. Consequently, it is necessary to attach special importance to environmental information, as well as wrong interpretations caused by viewing distance, differences in sight range, and visual deterioration [16].

The function of a bus stop sign is to provide and convey information about the bus station and bus routes. As bus stop signs are the main resource used by the elderly to obtain information, the design of such information facilities should take convenient and efficient accessibility for users into consideration. Lin (2006), in a study on the information aspect of bus stop signs for the use of the elderly, indicated that the elderly are mainly perplexed by five factors, in the following order: the letters of signs at the bus stations are too small and vague (23.2%), the route map is incomprehensible (9.9%), there is a lack of a timetable and route map on the bus stop signs (9.7%), bus stop signs are too old and the bus information is vague (8.7%), they can find the bus station, but they still have no idea in which direction to take the bus (6.7%), the timetable is incomprehensible (6.7%), and after asking people around them, they still cannot understand the timetable and route map (1.0%) [17]. This study further investigated P type bus stop signs based on letter recognition and image symbol recognition.

2.1.1 Letter recognition

Letters are intended for communication and information conveyance. Letters can be mainly divided into fonts and font sizes. Chinese fonts include a large number of strokes. The use of different fonts results in different readability [15]. For the readability of fonts, round lightface and medium boldface Chinese letters are more identifiable [18]. The visual recognizability of boldface letters is higher than that of DFKai-SB [19]. In terms of visual searching, Wang and Hou indicated that the accuracy searching boldface fonts is higher, and that the search time is shorter as well. Under poor reading conditions, the readability of boldface fonts is higher; therefore, boldface fonts can be used in headings or for labeling [20]. In terms of font size, the average font size of Chinese letters on bus stop signs should be at least 30, and a font size over 35 is more readable. The average font size of Arabic numerals should be at least 24, and a font size over 28 is more readable [21]. Font size is correlated to viewing distance and viewing angle. An experiment on the proper viewing distance of information objects for normal vision found that, if a subject reads the information object at a distance of 3.4 meters, the altitude of the fonts should be at least 11.5 centimeters. To enable the general public to clearly identify the location of bus stop signs, it is necessary to enable the general public to successfully identify bus stop signs when walking in public spaces. In Japan, ECOMO, in a study on transportation facilities for passengers, indicated that the viewing angle decreases with an increase in walking speed. The faster one walks, the smaller the viewing angle will be. Therefore, the notability and location of bus stop signs are relatively important.

2.1.2 Image symbol recognition

There are various image-related terms, including English terms such as pictogram, pictograph, picture, isotype, sign, images, icon, and trademark, [22] etc. Image symbols are the tools used to identify, guide, and inform a person about certain information in more complicated architectural facilities. They are a visual design, where letters, images and color combinations are used to achieve the functions of identification, instruction, explanation, and warning. The use of images to convey the meaning of letters enables users to apprehend meaning by viewing images, without requiring an explanation to be given or memorized. Images of information objects can assist illiterate people and the elderly, as well as foreign travellers who do not understand the written language of a nation [23]. At present, the images on bus stop signs include route images and station points. Symbols and images are used in station points to represent specific information, such as the MRT station symbol, one-way bus stops, and two-way buss stop. A route image is the abstract map of a real environment. The information structure is geographic; points (symbols) and lines are used to present images of the bus route.

Image symbols are the non-verbal and non-text visual combination of images with symbolic meanings to convey information. Based on the above, the image symbols of bus stop signs should be simple and explicit, replacing complicated text descriptions. The application of image design to the conveyance of text information enables users to immediately identify information by looking at images. The Taichung City government began planning an MRT system in 2009. It imitated the Taipei MRT system by using colors to distinguish routes. It also drew network diagrams and used seven bright colors to denote different routes to facilitate the reading comprehension of passengers (Figure 1).

All route maps originate from the metro system designed in London England, by Harry Beck in 1933, and they play important roles in transportation. He used three forms: vertical lines, horizontal lines, and 45 degree angles, to transform complicated and twisted routes into a simple and comprehensible version, and he used colors to distinguish different routes and directions. His route map design was characterized by an enlarged proportion of the central area, enabling a complicated network to become clear (Figure 2 and Figure 3). The route map was drawn in a simple style to enable passengers to immediately understand the direction of travel. It became the milestone for the information design of public transportation.

2.2 Investigation on the Bus Stop Signs of Various Countries

Bus stop signs are designed differently in various countries, and they vary with the differences in road traffic conditions and habits of various countries. The route maps for buses in Beijing, China and Taiwan (Figure 4 and Figure 7) are provided on the bus stop signs. However, timetables are provided on bus stop signs in Japan instead (Figure 5). Bus stop signs in Beijing and Japan are both H type, while those in Taiwan are mainly P type. Different types of bus stop signs have their own pros and cons. More information can be presented on H type bus stop signs; however, they occupy more space. On the contrary, P type bus stop signs occupy less space, but less information can be provided on them. The purpose of this study was to improve the design of current P type bus stop signs in Taiwan.

2.3 Research Method

The main purpose of this study was to investigate the efficacy of information communication of bus stop signs, and the subjects were the elderly. "Participant observation" was used to understand the obstacles concerning current P type bus stop signs, as perceived by the elderly, which were used as factors for conducting interviews in the second study stage, as shown in Figure 6. Moreover, these factors were used to conduct "structured interviews" in the second stage to obtain the elderly's opinions on the information design of current P type bus stop signs. In the second study stage, "verbal protocol analysis" was used to arrange the interview contents, the results of which were regarded as principles for P type bus stop sign information design improvements. It was intended that appropriate information design of bus stop signs can be offered to provide services for elderly passengers.

3. Investigation on the Elderly's Perceptions of Bus Stop Signs

3.1 Results of Participant Observation Method and Interviews

Preliminary participant observation was used to select 9 senior citizens to conduct observations and interviews in order to fully understand how the elderly read bus stop signs. This study chose the

Welcome Mart Supermarket Bus Station as the study site, as shown in Figure 7, in order to observe how the elderly take buses. Simple interviews were conducted after the observations to obtain information on the elderly's perceptions of the information communication efficacy and their demands for current P type bus stop signs (Figure 8). After the interviews, the elderly's opinions on the information contents and types of current bus stop signs were summarized and classified in order to obtain the information design factors of bus stop signs to facilitate the interviews of the next stage.

Figure 7 Actual situation of Welcome mart supermarket – P type bus stop sign

The main purpose of participant observation was to summarize the information design factors of bus stop signs as the fundamentals of the subsequent in-depth investigation regarding the information design of bus stop signs. Therefore, the Q&As with the observation subjects were summarized into two factors for investigation, namely, "defects of interactive design of bus stop signs" and "information communication efficacy and demands for bus stop signs".

1. Investigation on the Defects of Interactive Designs of Bus Stop Signs from the Perspective of the Elderly

    The results of the preliminary Q&A indicated that due to the influence of experiences, most elderly were satisfied with the current information aspect of bus stop signs. However, after in-depth interviews were conducted, most indicated obstacles regarding bus stop signs they had encountered. For example, the bus stop signs were installed too high, the letters on the bus stop signs were too small, the information on the bus stop signs was unclear, and there were no waiting seats. The elderly also indicated that too many information communication items were included on the bus stop signs. In terms of the layout design, the elderly generally suggested that the layout of bus stop signs was too disordered and there was no unified planning. However, due to the accumulation of bus-taking experiences, most had become familiar with the information contents of bus stop signs. As a whole, the information designs of current bus stop signs have room for improvement. For example, the information presentation and viewing distance of current bus stop signs failed to take the viewing angle of the public into consideration, and thus, bus stop signs are too high to be read by the public.

2. Information Communication Efficacy and Demand for Bus Stop Signs

    (1) Demand for Information of Bus Stop Signs

    The information conveyed by current bus stop signs is complicated, and in order to understand the elderly's demands for bus stop sign information and information communication efficacy, this study conducted interviews with the elderly based on the information items on bus stop signs. The interview results revealed that "bus stop location map" (88.8%) and "route image and symbol" (88.8%) were in the highest demand, while "bus helpline" (55.5%) was in the lowest demand. However, more than half of the elderly indicated that they needed the "bus helpline." In contrast, the elderly passengers suggested that the "bus helpline" was dispensable. It could be inferred that most of the subjects had taken buses and understood the bus route information, thus, bus route information was quite important to them. It was advised that information items should be divided based on their level of importance, for example, the items should be divided into "bus stop location map," "route images and symbols," and the secondary information of "bus helpline" and "bus route information" to provide elderly passengers with the most appropriate bus information and services meeting their needs.

    (2) Information Communication Efficacy of Bus Stop Signs

    The information item of the lowest information communication efficacy was "route image and symbol." This study found that, as more information, such as station names along the route, road names, and traffic signs need to be conveyed in the current "route images and symbols," the presentation of too much information causes the layout to

become disordered, thus, increasing the burden on the elderly when reading bus stop signs. The number of letters in the station names along the route on current route maps is inconsistent, thus, the spacing and line-width are disordered, resulting in frequent eye movements when reading bus stop signs, instilling a feeling of confusion in the elderly. Most subjects indicated that they used their experience to compensate the defect. To summarize the above, where ever possible, the same font should be used in the letters of bus stop signs. Simple, rather than complicated information should be presented on route maps, and in regard to complicated routes, different colors can be used to increase recognizability. Moreover, space or auxiliary clues can be added to station names along the route in order to control visual distance and range when reading, enabling the elderly to effectively read bus route images.

The information contents and patterns of bus stop signs significantly affected the elderly's extraction of bus stop sign information. According to the results of the observation, this study divided the information of bus stop signs into two major categories, as follows:

a. Category 1: Information Communication

The factors of Category 1 included "bus helpline" and "bus route information," "bus stop location map," and "route image and symbol." This category included the major information items of bus stop signs, such as the investigation on the simplification of route maps and abstract information presentation comprehensible to the elderly. In order to understand how the elderly perceived information communication efficacy of other information items, this study categorized these four factors into the aspect of information communication of bus stop signs in order to further investigate the elderly's perceived information communication efficacy of each information item on bus stop signs in the next stage, which would be beneficial to the study regarding the information design of bus stop signs for the elderly.

b. Category 2: Human Factors

Category 2 was the aspect of human factors, which included "viewing angle," "eye level," and "time efficiency" of characteristic of information extraction and information searching of the elderly. The focus was on the interaction between the elderly and the bus stop signs in the environment. A study was conducted on the design factors in the next stage to enable the elderly to feel more comfortable and effectively use the information of bus stop signs upon reading.

3.2 Results of Structured Interviews and Verbal Protocol Analysis

3.2.1 Verbal protocol analysis

Structured interviews were conducted to further analyze the information obtained in the former interviews, as based on participant observation. The interviews were conducted in order to more exactly understand the opinions of the elderly. Therefore, ten different senior citizens were interviewed, as shown in Table 1. The information obtained from the former interviews was used to develop questions and assist the author in choosing the direction of the interviews. The outline of questions is shown in Appendix 1.

The elderly were asked the specified questions above to obtain their opinions on information communication efficacy and demands for various information items of bus stop signs. The entire interview lasted 20 to 30 minutes, and the interview contents were recorded for conversion to text data for analysis. Verbal protocol analysis was used to establish the encoding system for all the information obtained from the interviews in this stage; where the information design factors of bus stop signs obtained from "participant observation" were used. The system was used to analyze the obstacles concerning information design of bus stop signs, as encountered by the elderly. Procedures, such as "phrasing," "encoding of the detailed items," and "encoding processes" were conducted in order to obtain the encoded data, which enabled the conduct of systematized analysis during research procedures. In addition, the obstacles concerning information design of bus stop signs encountered by the elderly were summarized to design new samples. The research procedures are explained, as follows:

1. Principle and Process of Phrasing
   The major principle for phrasing was to use verbal replies to interview questions as the unit. After the oral information of the interviews were converted into text (verbatim transcription), phrasing was performed. Moreover, regarding the analysis on the phrasing of verbal units, each punctuated sentence was encoded into a number to

facilitate subsequent documentation, and these numbers were used to give examples. For example, the punctuated sentences of Subject 1 were encoded into 1_01, 1_02, 1_03, etc., while those of Subject 2 were encoded into 2_01, 2_02, etc., as shown in Table 2**.** After phrasing and encoding were completed, verbal information was included into the information design factors of bus stop signs. The encoding framework and detailed items are defined in the next stage.

2. Definitions and Explanations of the Detailed Items of Encoding

The information design factors of bus stop signs, obtained as based on participant observation, were encoded for investigating the information communication of bus stop signs. The information design factors of bus stop signs included five categories, as follows:

(1) [identification's ability, Id]: Bus Stop Location Map

It refers to the necessity to possess identifiability of bus stop signs, namely, the bus stop name, bus number, letters in Chinese, and Arabic numerals, as well as the elderly's visual perceptions of bus stops signs, such as:

Bus stop sign is the primary target, and the letters should be as big as possible. It is better that I can see it before I reach there. (Subject 1; number of encoded punctuated sentence: 1_09)

The simpler, the better. There are three colors on the white background of the bus stop sign. (Subject 5; number of encoded punctuated sentence: 5_09)

(2) [readability, Re]: Bus Helpline and Bus Route Information

It refers to the easy-to-read and easy-to-understand letters and sentences of bus stop signs, such as the probability to use and need for bus information and bus helpline, as well as the font size, font, descriptions, blank space, etc.

I cannot read the letters without putting on my glasses. The font size is too small to read, and I have to come closer to the bus stop signs in order to read it. (Subject 4; number of punctuated sentence: 4_03).

There are two-way and one-way routes. I completely understand the two-section route, bus operating hours, and headways. (Subject 7; number of punctuated sentence: 7_06).

(3) [image recognition, Ri]: Route Images and Symbols

It refers to the route images and symbols. The interviewed elderly subjects were asked if the abstract route map was more comprehensible, and how the recognizability and information communication efficacy of symbolic images were for them. For example:

I usually do not look at the symbols and images because I only want to find the letters of route. As long as I find the location of bus stop sign, I will not look at the explanations about the symbols.

It is more difficult to understand the bus sub-line on the route map. The presence of bus sub-lines of some buses make it more complicated to read the bus stop signs. (Subject 1; number of punctuated sentence: 1_19).

(4) [viewing distance, Vd]: Viewing Angle and Eye Level

It refers to whether the viewing angle for the bus stop signs met the eye level of the elderly reading bus stop signs. For example:

The bus stop sign is too high. It makes the elderly uncomfortable to raise up heads to look at it, and it should be adjusted to an appropriate distance. (Subject 3; number of punctuated sentence: 3_12).

Some bus stop signs are erected densely and the reader will be kept out of sight. (Subject 5; number of punctuated sentence: 5_02).

(5) [the ability in vision searching, Vr]: Characteristic of Information Extraction and Time Efficiency

It refers to the elderly characteristics of information extraction and time efficiency when searching for information when reading bus stop signs. For example:

One may feel that it is uneasy to find the route map when in a hurry because it is disorderly designed. (Subject 1; number of punctuated sentence: 1_22).

I will look at the bus number at the top of bus stop sign, followed by the larger letter below, and the route map, to see if my destination is there. (Subject 6; number of punctuated sentence: 6_13).

This study divided information design factors of bus stop signs into two categories, Category 1- information communication factors (C1) and Category 2- human factors (C2). Therefore, the framework of the encoding and the corresponding categories are summarized, as in Table 3, as the encoding system.

3. Encoding Process

A total of five items were included in the

encoding framework. The information communication factors included identification ability, readability, and image recognition, while human factors included viewing distance and visual searching ability. During the encoding, after the verbal information was punctuated according to the phrasing principle, the subjects' verbal descriptions were encoded. The same punctuated sentence might include more than 2 codes, which codes may belong to the same category or include two categories, as shown in Table 4.

3.2.2 Results of verbal protocol analysis

The verbal information of a total of 10 subjects was obtained in this study, and the information was encoded and analyzed based on the encoding system established in this study. A total of 203 punctuated sentences were obtained. The information processing of the number of punctuated sentences in the verbal protocol analysis could help summarize the elderly's countermeasures for five information designs of bus stop signs, as shown in Table 5. The table revealed that the number of punctuated sentences (61 in total; 30%) of "image recognition" in the elderly was larger than those of the other four items, namely, "identification ability" (46; 22.7%), "readability" (37; 18.3%), "visual searching ability" (35; 17.2%), and "viewing distance" (24; 11.8%).

3.3 Improvement in the Design of P Type Bus Stop Signs

Verbal protocol analysis was used to analyze the information obtained from interviews in order to understand the obstacles concerning P type bus stop signs encountered by the elderly. The encoding process helped to better understand the level of influence, and after these obstacles were summarized, the design of P type bus stop signs could be improved. In this study, Adobe Illustrator CS3 was used to re-design the bus stop signs.

4. Analysis on the Obstacles Concerning P Type Bus Stop Signs and Design Improvement

4.1 Analysis on the Obstacles of P Type Bus Stop Signs

4.1.1 Image recognition

The factors of "image recognition" affecting information design included letters, colors, and images. Image recognition was most frequently mentioned by the elderly, according to the number of punctuated sentences. However, image recognition mainly included route image and symbol, and such bus information, which played a major role in the layout of bus stop signs. Most of the elderly could understand the symbolic meanings of route images; however, in terms of the functionality of route images, if they took bus from an unfamiliar place, they needed to look at the route map. Moreover, they had to look at it from the starting station, followed by the names of other stations, suggesting that the route map was beneficial to passengers and enabled passengers to develop the simple geographical location, surrounding environment, and distance in their mind.

Route map included letters, plots, and lines. In terms of current layout, letters might be arranged in either a vertical or a horizontal order, which confused the elderly's search of station information. Regarding the lines, they would be confused with the presence of turning lines or images, and thus, failed to obtain the required information. They indicated that differences in the text information of "sub-lines," "two-section ticket," and "buffer section" rendered the information too complicated to be understood. Moreover, some elderly subjects advised that there should not be any line on the route map, and only orderly arranged letters should be presented. In terms of the explanatory table for symbols, most elderly indicated that they did not notice it. As for route images, most of the elderly suggested that MRT stations were transfer stations. Therefore, the "MRT image" should be highlighted, as most frequently looked for the arrow pattern of "starting station" and the main "Taipei Station," suggesting that their recognizability should be increased.

4.1.2 Identification ability

The main factor of the information item "identification ability" was bus number, including three factors, letter, color, and layout. The elderly regarded bus stop signs as the symbol of bus stop locations, as well as the primary target on the street when they were walking to the bus stop, and suggested that they could obtain the information they needed from bus stop signs. During the interviews, almost all indicated that their primary behavior was to identify and look for "bus number," such as the numbers "262 and 309," and suggested that the size of bus numbers could be enlarged, as the letters of the largest size on the current bus stop signs are "station names," such as "Welcome Mart

Supermarket and Xingya Junior High School." The elderly said, "The passengers who are going to get off the bus will look for station name. However, the passengers who are going to get on it will look for bus number." Therefore, the priority for taking a bus was to locate the correct bus number, and not the station name, as most passengers know the station name when taking buses, suggesting that there was a conflict between the most identifiable information of bus stop signs and users. As a result, it was advised that the bus information of "bus number" should be highlighted to increase identifiability.

In terms of color identification, red, yellow, white, and black are mainly used in current bus stop signs in Taipei City. The elderly indicated the yellow and red were significantly identifiable. Regarding the use of letters, they indicated that black letters are clearer than red letters. Moreover, they suggested that the most eye-catching combination was black letters on a yellow background. As a whole, they hoped simple colors should be mainly used; however, it would be preferable if different colors could be used to increase identifiability.

4.1.3 Readability

The main factor of information item readability was letters, including font size, font, and letter/image configuration. In terms of readability, some elderly subjects indicated that the letters were too complicated and vague to understand, and they perceived obstacles in the amount of time it took for them to look at bus stop signs. Further interviews revealed that the main causes of obstacles in reading were the poor readability of route images, followed by font size. The elderly all indicated that they had presbyopia and usually felt fatigue when reading bus stop signs. Moreover, without putting on glasses, they could not read the letters on bus stop signs as the letters were too small, and even when wearing glasses, the letters remained small and vague. Furthermore, as the number of strokes in Chinese letters was larger, the use of different fonts would affect the reading ability of the elderly. A total of three Chinese fonts are used in current bus stop signs. In terms of design, it was advised to use boldface or round fonts to reduce the elderly's time spent on searching information. Regarding text layout, horizontal, vertical, and italic letters are used in current bus stop signs; however, the line-width and layout are not unified, resulting in overcrowded information contents on bus stop signs. It was advised to simplify the text layout and rendering it compliant with the reading habits of Taiwanese in order to increase readability.

4.1.4 Viewing distance

The main factors of information item "viewing distance" were eye level and viewing angle. View distance referred to whether the viewing angle of bus stop signs met the eye level of elderly readers. All elderly subjects indicated in the interviews that the current bus stop signs were erected too high, forcing them to raise their heads to look at the information at such a height. In addition, the font size of bus stop signs were too small, forcing them to spend more time searching for bus information, which caused their eyes, neck, and cervical vertebra to feel tender, painful, and uncomfortable. Because the elderly were forced to lift their heads to look at bus stop sign information, the increased viewing angle resulted in experiencing obstacles and deviations in reading bus stop sign information. Therefore, in addition to making the height the bus stop signs meet the average height of Taiwanese, the font of the text information of bus stop signs should also be taken into consideration. Furthermore, as there is limited space for major stations with numerous passengers in Taipei City, bus stop signs were densely erected, which would interfere with the sightline of passengers when looking at bus stop signs. It was advised that there should be appropriate distance between each bus stop sign.

4.1.5 Visual searching ability

The main factors of the information item "visual searching ability" were time efficiency and the elderly's characteristic behaviors during information extraction. The elderly were mainly cautious and did not intend to exhibit rapid response. When they were searching complicated or strange information, they mainly gazed at it without overlapping until they scanned the entire information area. If the information of bus stop signs was too complicated, the elderly were forced to spend more time visually searching in order to identify target information, and during the interviews, they indicated that they tended to encounter more obstacles when in an unfamiliar locations, commonly resulting in missing the bus while trying to read bus stop sign information. Moreover, when they were in a hurry, they suggested that bus stop sign information was too complicated for them to quickly determine the bus information required, thus, the time efficiency to extract information was low. Under such a circumstance, the elderly preferred to ask other passengers waiting for buses in order to obtain bus information.

In order to effectively convey required bus

information to the elderly; it is necessary to attach particular importance to their visual searching ability when encountering complicated or disordered information. The interviews revealed that most would look for bus stop sign information in a fixed order. As shown in Figure 9, they would look for the "bus number," then the "route map" below, the station name, followed by the terminal and starting stations of the entire route map. The obtained information regarding bus stop sign information extraction characteristics advises increased consistency of route maps, highlighted bus numbers, starting stations, and terminal stations in the design.

4.2 Results of Design Improvement

The information design countermeasures are summarized according to the results of analyses on collected relevant literature and encoded data, and are provided as reference for the design of a new type of bus stop signs, as shown in Figure 10.

1. Route map: route maps are the main information abstract of actual environments, including "point elements: dots and landmarks" and "line element: paths." Because the elderly's perceptions of route maps varied with their experiences, organized landmarks or dots should be used in the "point elements" of route map design as identifiable reference points to the elderly. In the design of a new type of bus stop signs in this study, landmarks in Taipei, such as "Taipei Station," "Welcome Mart Supermarket," and "MRT stations" were chosen as the fixed characteristic element of route maps, as well as identifiable reference points. The fixed characteristic elements were changed from Taipei Station to 台北車站 , Welcome Mart Supermarket to 頂好市場 , and MRT Ximen Station to 捷運西門車站. It is intended that such highlighted fixed characteristic elements could increase the elderly's ability to search route map information. In terms of the design of "line elements," the route map was simplified with vertical lines, horizontal lines, and oblique lines at an angle of 45 degrees, which clearly presented complicated information.

2. Bus number: bus number is the first information item noticed by the elderly. Therefore, in addition to enlarging the font size of numbers, strong or bright colors should be used to increase visibility, and the ratio of brightness contrast should be 5:1. Moreover, bus numbers should be placed at the most eye-catching

position of the layout to enable the elderly to identify it from a distance.

3. Letters: the letters used in the old type of bus stop signs were not unified, with boldface, DFKai-SB, and clerical fonts used. In the new type of bus stop signs, only boldface and round fonts were used to present the text information of bus stop signs in order to reduce the elderly's time spent on searching information. In terms of letters on route maps, the font sizes of the old type of route map were not consistent, resulting in an overcrowded layout, causing difficulties for the elderly in searching information. To overcome this difficulty, the line-width of the new type of bus stop signs was maintained and the letters on route maps were simplified and unified to increase readability.

4. Eye level and viewing angle: one of the newly designed bus stop signs meets the eye level of the elderly, and was designed according to the average height and correct viewing angle of the elderly, in order to reduce the obstacles and deviation in reading information. In order to preserve human behaviors of the old type of bus stop signs, the height of another newly designed bus stop sign was the same as that of the old sign design, as it was hoped that the elderly's existing perceptions would not change with the information of new bus stop signs. Although the information contents of the bus stop sign was changed, the height was not changed.

5. Time efficiency and characteristic of information extraction: because buses frequently travel between bus stop signs, it is necessary to effectively extract the required bus information when reading bus stop signs. Therefore, the same information on the layout should be grouped together, and the proportions of information should be adjusted according to the level of importance to reduce the time spent on visual searching. Moreover, when facing complicated and substantial new information, the elderly would make decisions intuitively according to their previous perceptions. To comply with such a property, similar layouts and color schemes were applied to the design of the new type of bus stop signs to enable the elderly to more rapidly adapt themselves to information contents.

5. Conclusions

The gradual increase of an aging population not only represents the aging of the population structure in society, but also changes in lifestyles, social values, and welfare resource allocation of people in Taiwan. The proportion of the elderly taking buses will increase with the coming of the aging society, and with increased age, the elderly will experience physical degenerations, such as decreased visual functions and action abilities. Moreover, they also experience anxiety, impatience, stubbornness, conservation, and reduced perceptual time psychologically, which directly affect their emotions when taking buses.

This study intended to investigate the status of information communication of bus stop signs, as seen from the common perspectives of the elderly. As the mobility smoothness and action abilities of the elderly are poorer than those of other age groups they tend to be ignored in rapid bus transportation environments, this study intended to investigate the information communication efficacy of current bus stop signs. According to the investigation, current defects can be improved by using design methods to compensate for the physical and psychological deficiencies experienced by the elderly. Therefore, this study amended the current defects and proposed a new design project in the hope that the elderly can be effectively provided with comprehensible information when taking buses.

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Appendix

(1)   Which kind of public transportation do you most frequently use when going out in a city? Why?

(2)   How often do you take bus?

(3)   What kinds of obstacles do you encounter when waiting for a bus?

(4)   How do feel about the information communication efficacy and demands for bus stop signs?

How do you feel about the information communication efficacy and demands for the "bus helpline?"

How do you feel about the information communication efficacy and demands for "bus route information?"

How do you feel about the information communication efficacy and demands for "bus stop location map?"

How do you feel about the information communication efficacy and demand for "route images and symbols?"

(5)   Are you satisfied with the current bus stop signs? Why?

(6)   What is your opinion on the ideal information content and pattern of bus stop signs?

Figure 1 Taichung City MRT bus network map

Figure 2 Pre-innovation version of London Metro Map in 1932

Figure 3 London Metro Map (from the left to the right) 1st innovation version in 1933; latest version in 2009

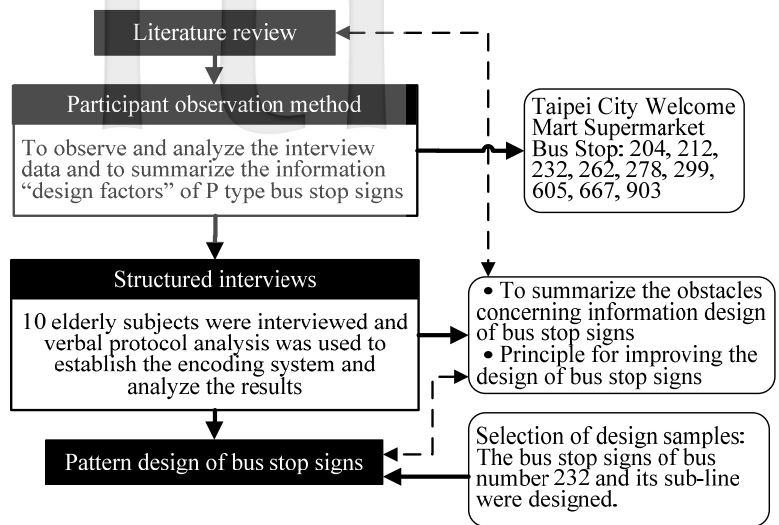Figure 4 Beijing, China   Figure 5 Japan
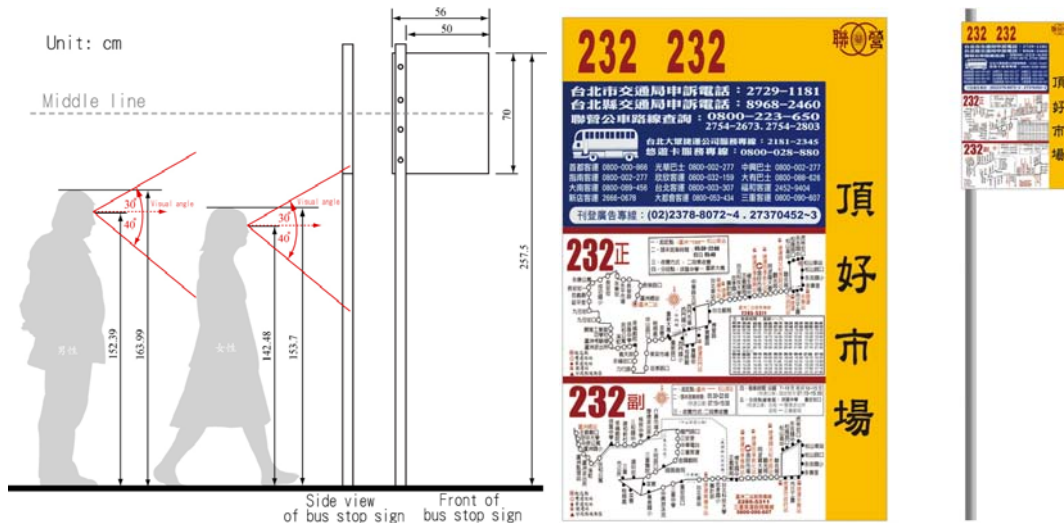
Figure 6 Study flow chart

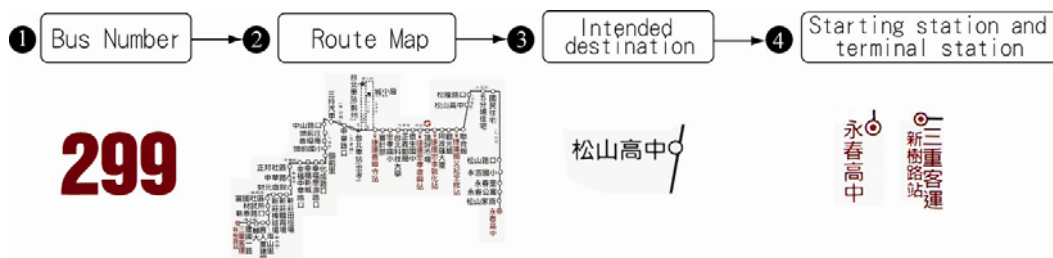Figure 8 Current pattern of P type bus stop sign

Figure 9 The elderly's order of visual searching for bus stop sign information
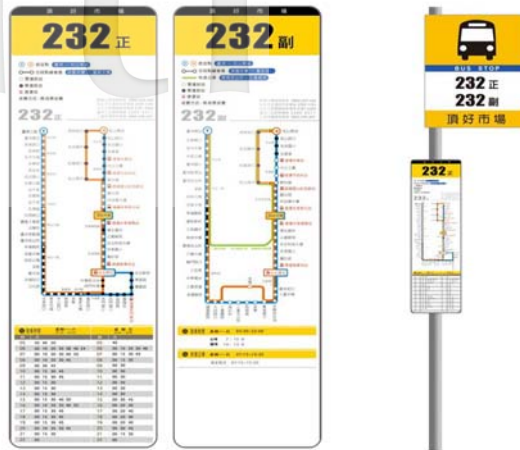
Figure 10 Information design of the new type of bus stop sign

Table 1 Basic information of the subjects

Subjects	Gender	Age	Level of education	Frequency of bus taking
N1	Male	73	Elementary school	4 times a week
N2	Female	65	Junior high school	5 times a week
N3	Female	67	Vocational college	Seldom
N4	Female	81	Elementary school	Seldom
N5	Male	74	Vocational college	Twice a week
N6	Male	70	Vocational high school/high school	Uncertain
N7	Female	82	Vocational high school/high school	Seldom
N8	Female	72	Junior high school	Occasionally
N9	Female	77	Illiteracy	Everyday
N10	Female	68	Vocational high school/high school	Occasionally

Table 2 Encoding of the punctuated sentences of subject 1

Time	Encoding of the punctuated sentences	Verbal information
15:26	1_01	Bus stop signs are installed at fixed locations, and I can find the buses at the bus stops.
	1_02	I still look for buses through bus stop signs.
	1_03	There are too many bus stops and sometimes the bus passed through before I find it.
	1_04	The letters are too small and I have to come closer to the bus stop signs.
	1_….	…………………………………………………………………

Table 3 Encoding system for information communication of bus stop signs

Categories	Codes	Classification	Factors
C1	Id	Identification ability	Bus stop location
	Re	Readability	Bus helpline and route information
	Ri	Image recognition	Route images and symbols
C2	Vd	Viewing distance	Visual angle and eye level
	Vr	Ability in visual searching	Characteristic of information extraction and time efficiency

Table 4 Examples of encoding

Number of punctuated sentences	Verbal descriptions	Codes				
		C1			C2	
		Id	Re	Ri	Vd	Vr
1_01	I have to look at the bus stop sign to make sure where to take the bus.	■				
1_02	I have to put on my glasses because I have presbyopia.		■			■
1_03	I usually take a regular bus number to a fixed location. It is harder me to read other bus stop signs.		■			■

Table 5 Comparison on the total number of punctuated sentences of five information items

Categories	Items	Number of punctuated sentences	Percentage number of punctuated sentences
Information communication	Identification ability	46	22.7%
	Readability	37	18.3%
	Image recognition	61	30.0%
Human factors	Viewing distance	24	11.8%
	Visual searching ability	35	17.2%

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