

PRODUCT DESIGN SPECIFICATION (PDS) DEVELOPMENT FOR DEVELOPING AN ASSISTIVE WALKING DEVICE FOR ELDERLY

Yap Mei Shy¹, Mohd Shahrizal Dolah^{1*}, Shahrul Azman Shahbudin¹, Ahmad Rizal Abdul Rahman¹,
Mohd Rizal Hussain² and Saiful Hasley Ramly¹

¹Department of Industrial Design, Faculty of Design and Architecture,
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

²Malaysian Research Institute on Ageing (Myageing),
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

*Corresponding author:
shahrizal@upm.edu.my

ABSTRACT

Ageing is an issue occur globally. Malaysia is one of the countries which is slowly stepping into the ageing nation. As the number of elderlies increased, the fall risk prevalence has become as one of the major issues among the elderly. An Elderly tend to experience higher fall risk and more severe injury cause compare to other age group since some of the fall factors are age-related. Therefore, the purpose of this study is to analyze the public perception, behavior on the use of walking aids and to develop product design specification (PDS) for developing an assistive walking device with better user experience and efficiency to reduce fall risk among elderly. Mix-methods were used to carry out this study consist of observation and questionnaire. 100 respondents were involved in this study that was focusing care center in Klang Valley Malaysia. Majority of the respondents agreed that the existing walker causes unpleasant user experience due to improper walker sizing and ergonomic issues. PDS will be proposed in developing an assistive walking device to enhance the effectiveness of the device in reducing elderly fall risk. The outcome of the PDS will contribute to walker users, people with disabilities, senior citizen, elderly caretaker and guidance for product designer.

Keywords: Ageing, Fall risk, Walking aid, Elderly, Product Design Specification (PDS)

1. INTRODUCTION

Malaysia has also been one of the countries that is going to face the “silver tsunami”. Malaysia is stepping into the ageing nation as the statistics of ageing population in the country has been rising in a stable pace. The increasing statistics of the ageing population in the country since a few years back then, are giving a hint that Malaysia is in high potential to turn into an ageing nation status.

Since the 1970s, the numbers of elderlies who aged 65 and beyond that has shown a stable increasing sign and it is foresaw that, the number of ageing population will be 3 times higher than the number of the existing ageing population now by the year of 2040. According to the statistics of population in 1970, there are only about 3.3% who aged 65 years old and more, while 44.5% of the population was under 14 years old. However, the scenario has changed. The number of children population not even occupied a quarter of the total population with the percentage of 24.1% in the year of 2017. On the other hand, the ageing population had increased to 6.2% which is more likely to be double of the statistics in 1970s. It is predicted to have almost balanced portion of the youngsters (18.6%) and the senior citizens (14.5%) by 2040, which mean there will be 3 elderlies in every 20 population. The declining Total Fertility Rate (TRT) and improving life expectancy of the population in Malaysia are more likely to be the factors that contribute to this issue (Department of Statistics Malaysia, 2017).

The Silver Tsunami (also known as Grey Tsunami, Gray Tsunami, Silver Wave, Gray Wave, or Grey Wave) is a metaphor used to describe population aging.

As human aged, the senior citizens tend to have poorer physical abilities as their cells, bones, muscles, and joints are functioning weaker than before. The living environment is no longer user friendly for them in term of mobility. These are more likely to be the major factors that cause the high fall risk among the senior citizens in Malaysia. According to World Health Organization (2017), there are approximately 28-35% of the people aged of 65 and over fall each year increasing to 32-42% for those over 70 years of age. There are some mobility challenges faced by the senior citizens especially for those who suffer from some diseases. In order to reduce the fall risk among the senior citizens, walking aids are needed. Therefore, proper assistive walker must be designed.

2. LITERATURE REVIEW

2.1 Ageing

According to Chung & Mansur (2018), Malaysia is now preparing itself to be an ageing when 7% out of the total population in the country reached the age of 65 years old and even older by the year of 2030. According to Chew Mei Fun (2017) (Women, Family and Community Development Deputy Minister), the population of the young and those who aged 60 and above may share the equal portion, which each group will occupy up to 20% of the country total population by the year of 2045 (The Elderly to Outnumber, 2017).

Thus, Department of Statistics Malaysia (2017) stated that, the senior citizens in Malaysia are going to achieve up to 6.0 million of the population by 2040. There is a change in the scenario as compared to now and back to the year of 1970s. Back in 1970, there is only 3.3% of the total population in the country was 65 and above, and a large portion of the population was younger than 14 years old at that time. However, the portion of the senior citizens are growing larger nowadays. There are 2.10 Million (6.5%) out of the total population aged 65+ in 2018 compare to 2.00 million (6.3%) in 2017 which shows almost double of the size of the elderlies in 1970 (Mahidin, 2018).

The increment of the senior population is the result from the extended life expectancy and a lower birth rate as compared to the birth rate in 1970. As the number of elderly increases, an injury such as fall risk among elderly will be one of the correlated issues that will be rose as well. Therefore, there should be a concern in putting more effort in reducing the fall risk among the elderlies. In order to overcome this issue, an action should be taken as the early preparations to take care of them.

2.2 Fall Factors

Many researches agreed that the main factors that contributed to elderly fall issue are related to age factors. Bird et al. (2011) stated that, fall rates are expected to rise as the population growing older, and leads to an increment in accidental injury and injury-related deaths, and increases to the burden on health care systems. As the population ages, the cognitive function and the physical abilities tend to turn downhill. Therefore, the elderly may suffer for higher fall risk and more severe injuries as compared to the other age group.

The chances to experience fall increase with age-related biological change, several number of the people who aged 80 and above will trigger substantial increase of fall and fall injury at a warning level. 131% over the last 3 decades on the incidence if some fall injuries, for example fractures and spinal cord injury. The numbers of injuries are expected to be 100% higher in the year of 2030 if there are not preventive measures are taken in immediate future (WHO, 2007).

According to Lord, Metz, and Sherrington (2006) found that, environmental obstacles play a part in falls to a better extent in older energetic people as compared to older frail people. For elderlies with fair balance may face greatest risk to deal with the household environmental obstacles, whereas those elderlies who are weak in balancing are more likely to have less exposure to the obstacles, while those with excellent mobility are more able withstand the obstacles.

2.3 Walking Aid

Walking aid or walker (figure 1) is a device that is commonly used among the elderly to increase their stability. Luz, Bush and Shen (2015) mentioned that, senior citizen who experience fall at their home, majority of them do not have a walking aid. They revealed that, those who do not have their walking aid tend to experience more severe injuries. The research result shows a positive relationship between the use of the walking aid and fall prevention.



Figure 1: Walking aid / walker

According to Liu and Du (2016), most senior citizen dependence on the assistive walking aid for mobility purpose, as the person spend more time using it every day. The elderly may try to avoid or even reduce more and more activities without the use of assistive walking device. This may result in the increase of the fear of fall among the elderly and indirectly increase the risk of falling.

Walker users have 7 times higher possibility to fall and injure themselves as compared to the walking stick users (Stevens et al, 2009). However, through observation researcher found that walking aid does help in reducing falling rate, but it may cause the user to fall when the user chose the wrong device for his or her body condition.

2.4 Ergonomics

The ergonomics value within the walking aid is very important in providing a good user experience to the users. Improper device height may causes fall. Majority of walker users obtained a rolling walker without consulting medical professional. Some of them even purchase the walker without receiving instruction or demonstration from the professionals (Liu, 2009).

Wrong sizing of the walker may cause the users to have forward-leaning posture and this is more likely to be the factor of walker-related fall (Liu et al., 2009). Thus, research done by Foley, et al. (2010) revealed that, the continual use of walker may cause arthritis, tendonitis, and carpal tunnel syndrome as it increases the stress to the user's upper extremity joints. Their research found that improper sizing of the walker chosen can lead users to injuries or even fall.

3. METHODOLOGY

Mix-methods approach was used in this study. Primary data consists of the use of the observation method and questionnaire and secondary data were collected from related articles and journals.

3.1. Observation

Direct observation technique was used in this research. According to Dolah (2018) stated that "Seeing" and "listening" are the keys to observation. A filed study has been carried out to observe the elderly's behavior while doing their daily routine. Four elderly care centers were selected for observation. The care centers were in Selangor.

- a. Kuan Ai Pusat Warga Mas Penyayang (Seri Kembangan)
- b. Wan Hing Home Care, Seri Kembangan (Bukit Serdang home care center)
- c. Pusat jagaan Al-Fikrah Malaysia (Sungai Sekamat Kajang)
- d. Pusat jagaan Siti Nor Aini (Kajang)

3.2 Questionnaire

A set of questionnaires has been developed by referring to the earlier observation as mentioned in 3.1. The questionnaires were distributed to 100 respondents who aged 60 and above within Serdang and Hulu Langat area. The questionnaire will be distributed to the residents in the selected area only.

3.3 Contextual research

There are some journals, articles and newspaper with related content to this research. Therefore, the information obtained from secondary data has been cited into this research as one of the references to carry out the study.

4. FINDING AND ANALYSIS

Data analysis will include the data obtained through observation and questionnaire. The table below has shown the result which answer by 100 respondents in the measurement of mean value.

4.1 Observation

A field study was conducted at four care centers to observe the senior citizen behavior and their daily activities. There are some similarities found while in the observation. The similarities are concluded as below:

1. The elderlies with better physical condition spend more time on walking around than those who is mobility inactive;
2. Most of the elderlies need assistance while stepping over threshold or small staircase;
3. Majority of the walking aid users have a lean forward posture.

There are two commons walking aid used by the senior citizen in Malaysia. The characteristics, strengths and weaknesses of each of the walking aid has been analyzed in this research. The weaknesses of the walk aid: 1) do not offer sit-to-stand function, 2) weak performance for outdoor usage, and 3) not stable on bumpy ground surface.

4.2 Questionnaire Survey

A set of questionnaires has been designed by using the information obtained from the observation as mention in 4.1. The questionnaire is targeting the people who aged 50 and above as these people are the potential user. It consists of 5 sections which putting concerns on the respondent profiles, user behaviors, user awareness and perception, user experiences on walking aid and design consideration.

A total of 100 respondents (figure 2) were involved in this survey, and the results from each of these sections will help in understanding the target user more effectively. All the data have been gathered and tabulate into tables. The results are as follow:

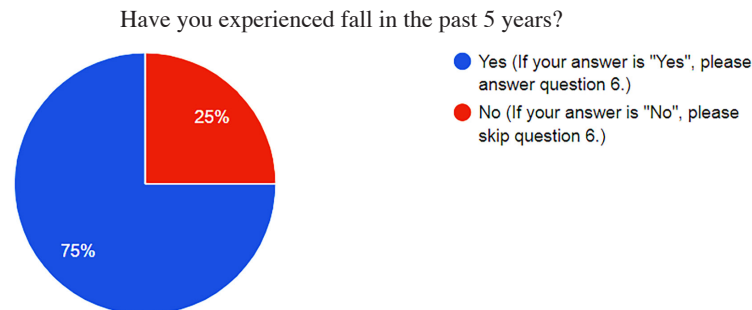


Figure 2: Respondent's fall experience

Figure 2 shows that, 75 respondents (75%) out of the total number of the participants have fall experienced in the past 5 years. 25 respondents (25%) of the total participants did not fall in the range of time mentioned in the question. The result in question reflects the scenario of high fall risk among the silver age population as there are 3 quarters of them admitted to experience fall in the past 5 years.

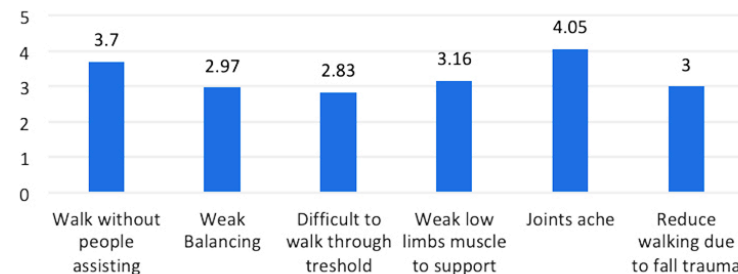


Figure 3: Mean value of user's physical abilities and behavior

Figure 3 reviewed the user's physical abilities and their behavior. Most of the respondents agree that they can walk without anyone assisting them as the mean value for the statement has achieved 3.7.

The respondents may be able to walk on their own, yet there are somehow some issues bothering them while they are walking. Their self-rating balancing ability is only in an average value of 2.97, which reflecting many of the respondents may not have excellent balancing control of their body. Other than that, some of the elderlies feel challenging to step over the threshold as the value for this statement is 2.83.

These may be the results from weak low limbs muscle support (3.16) and achy joints (4.05) as the mean values obtained for these 2 statements are respectively higher than the average. Analysis also revealed that, they try to reduce the walking opportunities as they have trauma resulted from previous fall. They are afraid to experience fall again so they rather prevent walking opportunity, and this results in the achievement of the value of 3.

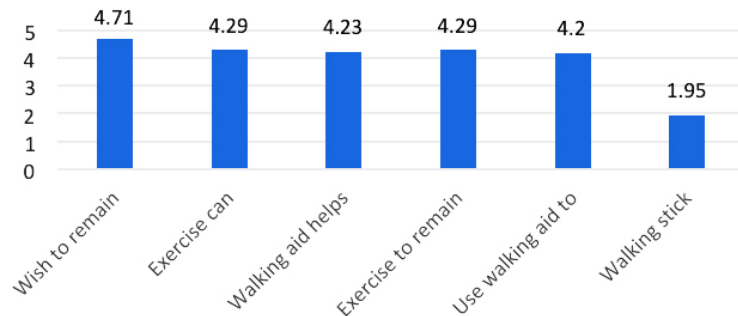


Figure 4: Mean value on user's awareness and perception on the use of walking aid in fall prevention

Refer to figure 4, majority of the respondents in this survey would like to remain mobility independent as the mean value for the statement has reached 4.71. The feedbacks from the participants are very positive as the mean values obtained for the statements in this section are respectively high. The values for statement 2 (4.29) and statement 3 (4.23) reflects on a high level of awareness on the importance of exercise and the use of walking aid in fall prevention. Also, the respondents show positive attitude on the will to exercise and use walking aid to maintain their mobility active level as the value for statement 4 (4.29) and statement 5 (4.2) are higher than the average rate. Majority of the respondents stated that walking stick is not as effective as the use of walker in preventing fall according to the mean value (1.95) obtained in the last statement.

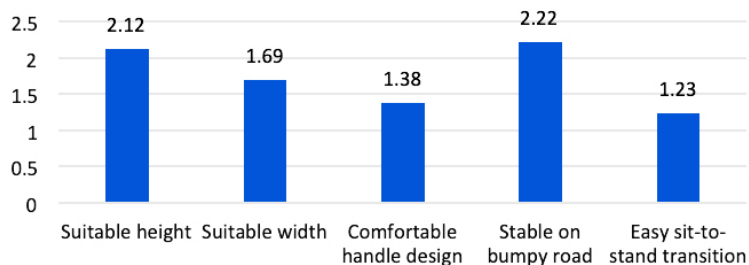


Figure 5: Mean value on user's experience on the existing commercialized walking aid

The overall user experience on the existing commercialized walking aid seems unsatisfying according to the results obtained in figure 5. Majority of the respondents agree that the walker in the existing market do not provide the sit-to-stand transition function to the users. It's a challenge for the elderlies to stand up from sitting posture. Therefore, they would like to have that as an additional function on the walking aid to help them to stand up without much struggling. Thus, the respondents are unsatisfied with the handle design on the existing walking aid too. Some of them mentioned that the walking aid handle causes unpleasant user experience especially after using it for a longer period.

This may be the reason why the respondents are rating the handle design with a low mean value of 1.38. The values for statement 1 (2.12) and statement 2 (1.69) reflects on the uncomfortable walking aid sizing use by the respondents. The width of the walking aid may be bothering the respondents as most of the walking aid cannot do adjustment on the width. Furthermore, the respondents also show their dissatisfaction on their walker's outdoor performance. They agree that their walking aid was less stable on bumpy ground and the impact received from the ground may cause them to lose balance.

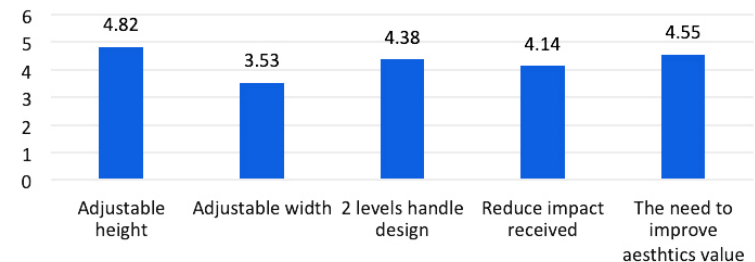


Figure 6: Mean value on user's preferences on the walking aid design

Questions in figure 6 were designed to determine the product design specification (PDS) for the walking aid. The new walking aid design shall be height and width adjustable as the mean values for both statements are higher than the average, which are 4.82 and 3.53. Most of the respondents (mean value of 4.55) agree that the appearance of the walking aid design shall be improved, as some of the senior citizen may refuse to use a walking aid because they think it make them look weak and old. The mean value for statement number 3 achieved 4.38 which reflects on the need to have 2 levels handle design by the respondents. A lower level handle will be added into the design to facilitate the elderlies to stand up from the sitting posture.

The respondents also would like to have a new walking aid design that can reduce the impact receive from the ground especially for outdoor usage as the mean value for this statement has achieved 4.14 which mean this is one of the important criteria to be take into considerations as well.

4.3 Product Design Specification (PDS)

All the data obtained in this research will be analyzed and concluded into a series of product design specifications. These specifications will play the role as the guideline for the researcher to develop a new walking aid design. There are 5 factors of the product design specifications (PDS) concluded from the user preferences section in the questionnaire as listed in table 1.

Table 1: Product design specification

No.	Factors	Product Design Specification
1	Adjustable Height	The height of the assistive walking device is preferred to be adjustable as the users may have different physical appearance. Adjustable height can cater the best user experience to the users according to their height. It keeps them with the correct and comfortable posture as the device is set to follow their body height needs. Researcher believes that flexible device height adjustment can reduce the falling possibilities among the elderlies very effectively, as it helps to avoid the practice of lean forward posture while using the walking aid. Therefore, this specification will be tackled in developing the walking aid design since it can help in reducing the elderlies fall rate
2	Adjustable Width	<p>According to the feedbacks of the respondents in the survey, the respondents are preferred to not only have adjustable height function but also to have adjustable width function in the walking aid design as well. The users can improve the walking aid user experience by setting the walking aid width according to their body sizes.</p> <p>Majority of the walking aid in the market cannot be adjusted in width and it may create unpleasant user experience to the users who are obese or underweight. Their body size may not be included within the average size coverage. Therefore, some of them may feel uncomfortable while using their walking aid.</p>
3	Two Levels Handle Design	The elderlies always having a hard time to do the transition from sitting to standing posture or in reverse, from standing to sitting posture. Therefore, it is considerable to design a walking aid with 2 levels handle design which including a lower level of horizontal bar that can be hold on to help the users to stand up easier from sitting posture. However, the higher level of handle functions as the handle for the users to hold onto while they are walking with the walking aid.

No.	Factors	Product Design Specification
4	Reduce Impact Received	Majority of the existing walking aids in the market do not perform well for outdoor purpose. The walking aids are very stiff. Therefore, the impact received from the bumpy ground will transmit to the users directly through the contact at the handle. The impact can be reduced by increasing the walking aid wheels size and improving the flexibility of the wheel material.
5	Aesthetics	The aesthetics value of the walking aid needs to be improved as many of the respondents agreed that the appearance of the existing walking aids make them feel bored, weak and old. Some of the elderlies even refused to use walking aid because of the bad impressions of the walking aid appearance. Therefore, a more stylish and fashionable the appearance of the walking aid may improve their wills to use walking aid for fall prevention purpose

5. CONCLUSION

In conclusion, most of the falling issue and fall related injuries are preventable. There are a few effective ways to reduce fall rate among the elderlies and the use of walking aid is one of the most effective ways to achieve the objective. Walking aid can help in improving the user experience on the walking aid and reduce the fall rate with some of the design characteristics applied for example 2 levels handle design and bigger front wheels design. This study has proposed PDS factors for stakeholder in developing an assistive walking device for elderly. Using PDS, will help to increase value added in the walking aid design and eliminate the poor perception of the elderly.

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