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ERGONOMIC BUS STAIRCASE DESIGN FOR ELDERLY

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Abstract

Bus staircase design is very important for the users to board and descend from the bus. This is because there is a bus stairs design does not user-friendly and sometimes the design of the stairs are too narrow, high gradient and no hand rail. This can cause minor accidents happen to senior citizens. This study was performed to propose a design of the bus stairs that ergonomic for the elderly as well as all users. The total numbers of 15 observations is being carried out and our focus is to find elderly that climb bus staircase. The observations were take place at Kuala Lumpur city and each of observations need to be followed by answering a few questions provided in order to complete the observations process. The data then being analyze and incorporated with anthropometric data to find the suitable dimension of staircase in order to design for a new staircase for elderly. This study also to create awareness of the need for ergonomic design among the bus manufacturers in Malaysia so that they can provide better service and ergonomics design to convince elderly that their safety is assured when boarding and descending bus.

Keywords: staircase, elderly, design, ergonomics, boarding, descending

1. Introduction

Public transport modes can enable the elderly to partake in everyday life, hence improving their social inclusion and the population of many societies consists increasingly of more elderly than young people.

Accessible design of public transport modes becomes more crucial in order to meet the needs of all passengers and provide comfortable journeys.

There are over 800 falls on buses every day in the UK by people over 65 years [1] with falls from stairs and steps and falls on the same level being reported as the most common types of falls [2]

Fear of falling is an equivalent problem to falls as it can affect a person's quality of life and health. In the UK, 53% of the total cost of falls is related to falls on or from stairs or steps and 30% to falls on the same level for those over 60 years old [3]. Older passengers, especially women, are less stable than younger passengers and climbing the stairs on the other hand is more demanding as it requires more body capabilities for the centre of mass to be transferred vertically from one step to another [4]. Older people and women achieve lower speeds than younger people and men while climbing the stairs. Furthermore, people with smaller step length, lower grip strength and shorter unipedal stance have more difficulties climbing the stairs.

	55-59	60-64	65-69	70-74	75-79	>80	Amount total = 1356	Percentage %
Bus	203	142	121	56	40	29	591	43.58
Taxi	155	99	77	54	36	24	445	32.82
Intercity Train	5	5	4	2	4	-	20	1.47
KTM Commuter	7	6	6	3	-	-	22	1.62
LRT	14	18	7	3	-	-	42	3.1
Monorail	5	5	3	1	-	-	14	1.03
Minibus	35	15	15	1	5	1	72	5.31
Own transport	238	137	94	50	34	9	562	41.45

Table 1.1 Modal choice for urban travel by age in Kuala Lumpur. [5]

2. Objective

a) The study will focus on identifying limitations in the current city busses staircase design for the elderly in Kuala Lumpur.
b) Proposing staircase design and solutions for the elderly to overcome the limitations.

3. Methodology

To serve our research purpose, an observation method is used in our research. Fifteen samples of elderly peoples entered the bus are recorded and measured. The location of our observation is at Kotaraya, Kuala Lumpur.

No.	Observation	Female		Male	
		Yes	No	Yes	No
1	Does the elderly entered the bus quickly?		/		/
2	Does the elderly stop before they take a step on climbing	/		/	
3	Does the elderly needed help to enter the bus		/		/
4	Does the elderly hold to both side rails of the bus when step into the bus?	/			/
5	Does the elderly hold to one of the side rails of the bus when step into the bus?		/	/	
6	Does the elderly steps into the bus directly from the side ramp?	/		/	

Table 3.1: Observation's checklist

All observations came out with an observation's checklist as shown in table 4.1. So that each observation done properly and hit the objectives.

From the observation, we list down all the findings and select the critical problem and overcome the problems by incorporating with standard design dimensions for public transport by DPTAC and UNPD Malaysia. Also incorporating with anthropometric data taken from Rosnah M.Y et al.(2009) "Anthropometry Dimensions of Older Malaysian: Comparison of Age, Gender and Ethnicity".

Item	Ideal Specification	Transitional Specification
Maximum first step height	250mm	325mm
Maximum height for subsequent steps	200mm	225mm
Maximum number of steps (total)	3	3
Maximum ground to floor height	650mm	775mm
Minimum depth of steps	300mm (280mm on vehicles less than 2.5m wide)	
Step risers	Vertival. Smooth, flat, colour contrast on nose	
Minimum ceiling height at door	1.8m above first step	
Entrance width between handrails	Min. 700mm, max 850mm (single stream) Min 530mm, max 850mm (for wider doorways with central handrail) Handrails to start within 100mm from outside edge of first step.	

Table 3.2: Ideal and transitional specification for bus entrances (no wheelchair access) [11]

Each proposed design will be use the standard dimension provided by DPTAC. Then, a comparison between the old design and proposed design can be made either the old design is following the correct design in order to fit with elderly dimensions.

4. Results and Discussion

4.1 Observation Findings

From the samples, two things are similar in the effort of elderly entering the bus:

a) Difficulties in climbing the staircase
a) Need handrail to support

Figure 4.1 Elder people climbed bus staircase.

Stair	Range of Limit	Standards Malaysia stair built on the recommended values suggested by British Standard and Department of Occupational Safety and Health Malaysia
Pitch angle	≤ 42°	29°
Riser	100mm - 220mm	155mm
Going/Tread Depth	220mm-350mm	280mm
Follow the formula 2R (riser) + G going) = 550mm-700mm		2(155) + 280 = 590mm

Table 4.1 Guidance of British Standard on staircase geometry and Standard Malaysia staircase Source: [7]

From Table 4.1, the suggested value for pitch angle, riser and tread depth are 29°, 155mm, 280mm respectively. By comparing data taken from other two bus services, can be shown in figure 1.

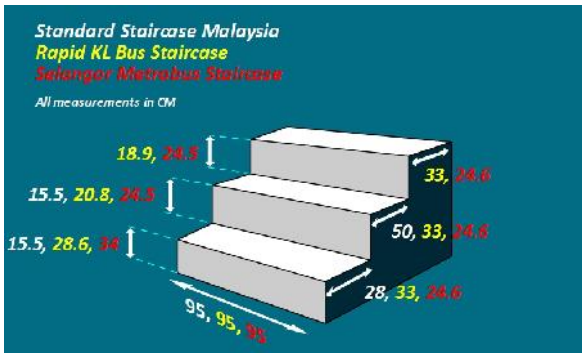

Figure 4.2: Measured Data from 2 bus services

4.2 Propose Design

a) Bus Entrance

For bus entrance, a satisfactory design of steps, steps height and width that comply to anthropometric data or standard dimensions is designed.

b) Handrails

Handrail is installed each side of stairs with contrast colour (Bright Yellow) to give better sight for elderly. The diameter and height of hand rail also must comply to anthropometric data to provide ergonomic design that fit elderly.

The height of handrail is designed based on anthropometric data of male's elbow height while standing as shown in table 4.2, with 97.1 mean.

Dimensions, (cm)	Male, N=129		Female, N=101	
	Mean	Std.Dev.	Mean	Std.Dev.
9.Elbow Height, Standing	97.1	5.8	89.2	4.4

Table 4.2 Anthropometry data [8]

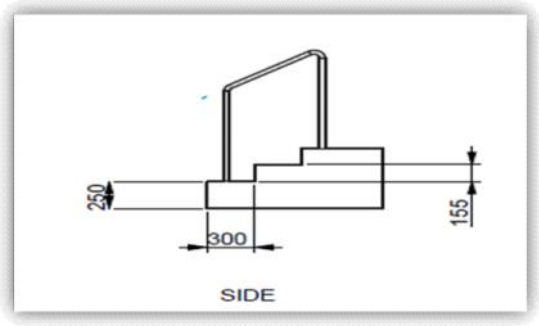

Figure 4.3 Proposed step riser's dimension.

The step riser 250 mm design according to consideration from DPTAC [6].
Subsequent step height 155 mm design according to consideration from DPTAC [6].
Steps depth 300 mm design according to consideration from DPTAC [6].

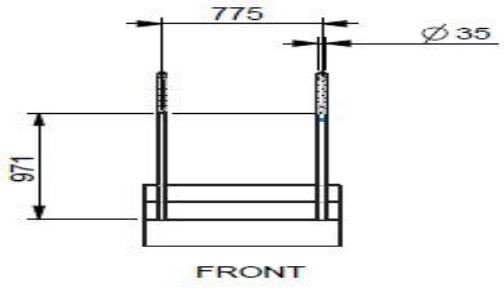

Figure 4.4 Proposed handrail's dimension.

Handrail height 971 mm design according to anthropometric data of elbow height, standing male. Data taken from Rosnah M.Y et [8] "Anthropometry Dimensions of Older Malaysian: Comparison of Age, Gender and Ethnicity"

Handrail width 775 mm design according to consideration from DPTAC [6].
Handrail diameter 35 mm design according to consideration from DPTAC [6].

4.3 Additional Propose Design

Low-floor bus Design

A low-floor bus is a bus that has no steps between one or more entrances and part or all of the passenger cabin. Being low floor improves the accessibility of the bus for the public, particularly the elderly as shown in figure 5.5.

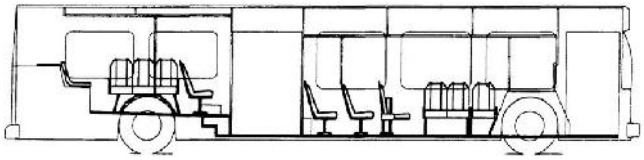

Figure 5.5 Low-floor bus design

Advantages of this design, it can help in term of ease of boarding for the elderly and also reduce falls occurring among elderly while entering and exiting the bus.
But, it is costly and more suitable to be executed as a long term solution to the public busses design in Malaysia which caters to the elderly needs.

5. Conclusion

By comparing two city bus staircases with Malaysian standards some mismatches are found. Difficulty of the elderly while climbing the staircase was observed. To facilitate use of the elderly and incompliance with the Malaysian standards, new designs were proposed.

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