A STUDY OF ERGONOMIC CITY TRANSPORT UTILITIES BY ANTHROPOMETRIC APPROACH

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Abstract - The technology which has been developed is to fulfill human needs, so human should be spoiled. However, this doesn't make human feel safe, comfortable, healthy and facilitated, meaning that in the designing, decision making and development process, there are orientation deviation. Public Transportation in Makassar should be made by considering ergonomic aspect, however this isn't the case. Problems of public transportation include boarding and alighting access, hangar, seat layout which don't fit the users of the vehicles. The purpose of the study was to study ergonomic public transport utilities by anthropometric approach to analyze body parts not compatible with vehicle utilities. Data collection method was measuring passenger's body dimension to be analyzed by ergonomic anthropometric approach. Based on the research result, the ergonomic size of public transport utilities by anthropometric approach for hangar is 104,78 cm, height of first step 24,76 cm, second step 49,53 cm, stair width 24,25 cm, seat width 36,21 cm, seat height 44,45 cm and backrest height 27,08 cm. Height of hangar was adjusted with the height of elbow when standing, so users can easily reach hangar. The height of the first step was adjusted with height of knee where half of the height of user's knee when stepping onto the stairs was used. Stair width was adjusted with length of foot. Seat width was adjusted with distance from buttock to stomach to make sitting comfortable and seat height was adjusted with the height of popliteal to the floor. Backrest height was adjusted with the backside of the body to prevent it from hitting hard objects.

Keyword: utility vehicles, anthropometry, ergonomics

1. INTRODUCTION

In the production process, before company makes a decision to produce a product, product is designed first. Designing is performed to know the product. Public Transportation in Makassar should be made by considering ergonomic aspect, however this isn't the case. Consideration to human values is put after economic goal. So, human values are often not referred to in the designing process.

The problem in this study was public transportation in Makassar. The first problem was the public transport utilities of 140 vehicles. Most vehicles don't have facilities which should be in public transport, including boarding and alighting access, such as the height of the first step being 32 - 48 cm, the height of the second step 52 - 73 cm, door width 65 - 72 cm and width of the first step 16 - 24 cm. Hangar is place to hold when a passenger board a vehicle. The distance between the hangar and the road is 100 - 205 cm. Seat layout includes seat height 25 - 35 cm, length of the first seat 185 - 233 cm, length of the second seat 120 - 160 cm, height of backrest 20 - 36 cm.

Passengers have difficulty with the size of boarding access. The distance between the road and the stair is quite far so smaller passengers and women in skirts have difficulty boarding. Limited human capability,

door hangar not suitable with passenger's arm reach, seat height not suitable with passenger's body made riding not comfortable. The research purposes were 1. To study ergonomic public transport utilities by anthropometric approach., 2. To analyze body parts which don't fit vehicle utilities.

Ergonomics in Transportation Infrastructure

Ergonomic design for transportation infrastructures is described next. Although, the field most often involved in designing transportation infrastructures is Civil Engineering, designing transportation infrastructures is also related to ergonomic study. For example, highway. The radius and slope of corners, angles of hills, demarcation lines, etc. influence the comfort and security of road users. Because the distance and viewpoint of human sight is limited, road geometric design which doesn't consider human limitations often causes accidents. Pedestrian facilities should be designed well for human's security and comfort, not only to complement and accessorize streets. Generally, pedestrians are only given a very small and inadequate portion, so they have to walk slowly on the roadside with no sidewalk in fear, uncomfortable because the road isn't smooth and there are puddles when it rains. (Ngudi Tjahjono).

2. RESEARCH METHOD

The study was conducted in Makassar. Makassar was selected because the city has a large number of public transport, which is 4113 vehicles from 17 routes. However, the vehicle utilities aren't optimum, particularly in public transport there is no uniformity in vehicle facilities. Research population and sample were public transport users; on vehicle utilities they were students, college students, civil servants, private employees, and public passengers.

Research design

Data collection done directly to the comfort and security in public vehicles especially in the access up and down, was household, wide domestic workers, was in rows and was hangar doors.

After data, then continued with the trial statistics

- The trial uniformity data said uniform when data is between border controls and the borders As Under control by using a confidence level of 95 percent and high precision 5 percent.
- Adequacy Test data, it would be useful to know enough data or not with conditions $N' < N$, with a confidence level of 95 percent and high precision 5 percent.
- 5th percentile test-th, 50-year and 95-years old, it would be useful to get the dimension body in accordance with the value ergonomics.

In this research, the population is the object or, to determine the number of samples or used similarities bernoulli's principle:

$$N \geq \frac{\left(Z_{\alpha/2} \right)^2 p \cdot q}{e^2} \quad (1)$$

the upper control limit (UCL), lower control limits (LCL), using a 95% confidence level and 5 % level of accurac. can be seen in the following table.

$$BKA = \bar{X} + 2\sigma_x \quad \text{And} \quad BKA = \bar{X} - 2\sigma_x \quad (2)$$

Data just when $N' < N$, using the formula :

$$N' = \left[\frac{K / S \sqrt{N \sum X_i^2 - (\sum X_i)^2}}{\sum X_i} \right]^2 \quad (3)$$

A Test trialth percentile with wield normal distribution and the count th percentile (Stevenson (Disambiguation), 1989), (nurmianto, 1991) with the formula:

$$5\text{th percentile th} = \bar{X} - 1.65 \sigma_x \quad (4)$$

$$50\text{th percentile th} = \bar{X} \quad (5)$$

$$95\text{th percentile th} = \bar{X} + 1.65 \sigma_x \quad (6)$$

3. RESULTS AND DISCUSSION

3.1 Results of research

For the size of public transport used to carry passengers to their destination, there was no uniformity in vehicle utilities among 140 vehicles from 10 routes in Makassar.

Table.1. Sizes of Public Transport Utilities

No.	Vehicle Utility	Smallest Size (cm)	Biggest Size (cm)
1.	Boarding and alighting access		
	- First step	32	48
	- Second step	52	73
	- Door width	65	72
	- Stair width	16	24
2	Hangar	100	205
3	Seat layout		
	- Seat height	25	35
	- Length of first seat	185	233
	- Length of second seat	120	160
	- Backrest height	20	36

The body dimensions of 150 public transport user respondents were measured. 48 body dimensions were measured in each respondent. Based on the result, body dimensions which influence public transport utilities are: elbow to floor, half of knee height, foot length, popliteal height, backrest height, buttock to stomach.

Data uniformity test as a control calculated the mean, upper control limit (UCL), lower control limit (LCL), with 95 % confidence level and 5 % accuracy level. It's presented in the following table:

Table. 2. The result of uniformity anthropometric

No.	Dimension body	N	$\bar{X}$	UCL	LCL	Note
1	Elbow to Floor	150	101,22	105,55	96,90	uniform
2	Half of knee height	150	47,50	49,97	45,03	uniform
3	Foot length	150	23,50	24,41	22,59	uniform
4	Buttock to stomach	150	31,59	37,21	25,97	uniform
5	Popliteal height	150	41,06	45,18	36,94	uniform
6	Backrest height	150	26,35	30,59	22,12	uniform

95 % confidence level and 5 % accuracy level with data adequacy requirement $N' < N$. It can be seen in the following table

Table 3. Results of anthropometry adequacy test

No.	Dimension The body	N	N'	Note
1	Elbow to Floor	150	10,92	Sufficiently
2	Half of knee height	150	16,20	Sufficiently
3	Foot length	150	9,26	Sufficiently
4	Buttock to stomach	150	13,64	Sufficiently
5	Popliteal height	150	59,96	Sufficiently
6	Backrest height	150	12,42	Sufficiently

The result of data adequacy test on the six body dimensions of 150 showed that all N' are below 150, meaning data was adequate.

Table 4. Results of anthropometry percentile test

No.	Dimension body	The promotes ergonomic comfort, Anthropometric (cm)		
		5 % - ile	50%-ile	95%-ile
1	Elbow to Floor	97,66	101,22	104,78
2	Half of knee height	22,74	23,75	24,74
3	Foot length	22,75	23,75	24,25
4	Buttock to stomach	26,97	31,59	36,21
5	Popliteal height	37,67	41,06	44,45
6	Backrest height	22,87	26,87	29,84

The results of anthropometry percentile test used as a reference in designing public transport utilities in Makassar were:

1. Hangar size. The body dimension used was elbow to floor.
- Percentile used 95 % = 104,78 cm.
2. Height of first step. The body dimension used was half of knee height
- Percentile used 95 % = 23,75 cm
3. Width of first step. The body dimension used was foot length
- Percentile used % = 24,25 cm
- Seat width. The body dimension used was buttock to stomach. Percentile used 95 % = 36,21 cm
4. Seat height. The body dimension used was popliteal height to floor. Percentile used 95 % = 44,45 cm
5. Backrest height. The body dimension used was back height
- Percentile used 95 % = 27,08 cm.

Figure 1. (a) boarding and alighting access , (b) seat layout

3.2 Discussion

The research result showed that ergonomic public transport utility size with anthropometric approach for the hangar section is 104,78 cm, meaning public transport users can reach hangar to help them board vehicle. Height of first step is 23,75 cm which can be used by all passengers and stair width is 24,25 cm which is adjusted with foot length so passengers won't slip when boarding the vehicle. Seat width is 36,21 cm which makes sitting easier and seat height is 44,45 cm so knees won't be bent and backrest height is 27,08 cm.

Height of hangar was adjusted with the height of elbow when standing, so users can easily reach hangar. The height of the first step was adjusted with height of knee where half of the height of user's knee when stepping onto the stairs was used. Stair width was adjusted with length of foot. Seat width was adjusted with distance from buttock to stomach to make sitting comfortable and seat height was adjusted with the height of popliteal to the floor. Backrest height was adjusted with the backside of the body to prevent it from hitting hard objects.

4. CONCLUSION

1. Ergonomic public transport utility sizes by anthropometric approach are: for hangar 104,78 cm, height of the first step 23,75 cm, and stair width 24,25 cm. Seat width is 36,21 cm, seat height 44,45 cm and backrest height 27,08 cm.
2. Height of hangar was adjusted with the height of elbow when standing, so users can easily reach hangar. The height of the first step was adjusted with height of knee where half of the height of user's knee when stepping onto the stairs was used. Stair width was adjusted with length of foot. Seat width was adjusted with distance from buttock to stomach to make sitting comfortable and seat height was adjusted with the height of popliteal to the floor. Backrest height was adjusted with the backside of the body to prevent it from hitting hard objects.

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