ISSN: 2449 – 0539
BAYERO JOURNAL OF ENGINEERING AND TECHNOLOGY (BJET) VOL.16 No.3, AUGUST, 2021 PP 60 - 64

AN INVESTIGATION INTO ERGONOMICS OF TRICYCLE SEAT

Ibrahim Abdullahi Rafukka

Department of Mechanical Engineering, Bayero University, PMB 3011, Kano, Nigeria

Corresponding Author Email: ibrahimrafukka@yahoo.com

ABSTRACT

In this work, the ergonomic of tricycle seats used in Nigeria was studied with a view of determining its conformity with anthropometric data of the users. Data of 100 male and 88 female tricycle riders was collected for three dimensions namely: popliteal height, buttock-popliteal length and seating height. Corresponding seat dimensions of tricycle; seat height, seat length and backrest height were also determined from TVS samba model of tricycle. Statistical analysis using SPSS was carried out to obtain descriptive statistical parameters. Various percentiles of user's anthropometry were compared with corresponding seat dimensions. It was found that there was significant difference between the anthropometric data and the seat dimensions for most of the parameters compared for all percentiles. The observed mismatch results in discomfort and health risk to the tricycle users. Backrest height is 40% below the standard seat dimension and 34% lower than 50th percentile user which could lead to whiplash injuries. It is recommended that the Seat length, back rest height and seat height be adjusted by 23cm, 27cm and 12cm respectively to fit 95% of the users. Sitting height of driver needs little adjustment to fit 50% of drivers. It is therefore imperative for designers of commercial motor tricycles seats to take proper considerations of ergonomic principles and the anthropometric data of users in order to reduce discomfort, improve safety and eliminate fatigue to the tricycle users.

Keywords: Anthropometry; comfort; ergonomics; percentiles; seat; tricycle.

1. INTRODUCTION

Tricycle has been the major public transport system in most cities and villages of developing countries. This has become necessary due to unavailability of buses and trains coupled with the natures of the terrain and road networks in ancient cities. Tricycle is considered cheep and simple mobility that can be used in the congested and intricate areas due to its small size and structure coupled with its advantage of dropping off passenger at any point (Dorado, Fabros, & Rupisan, 2015). In Nigeria however, tricycle has been popular means of transportation in many cities replacing taxicab and motor bikes. Commuting in Kano state is very much a part of lifestyle as people on a daily basis go out for their business adventures.

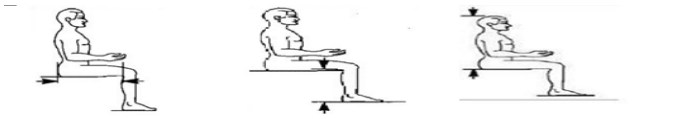
Studying the ergonomics of passengers and drivers of public transport system has been given attention in recent years because of the health and comfort issues associated with it. Literature survey shows works on investigating the mismatch between the passenger and the seat for taxicabs (Samuel, Fajobi, & Oluwatobi, 2016; Onawumi, 2020). Other studies were on comparing the anthropometric data of bus passengers with seat design variable with the aim of adjusting the seat dimension to fit the bus users (Ajayeoba & Adekoya, 2012; Ismaila, Akanbi, Adekunle, Adetunji, & Kuye, 2010; Moses, Ayodele, M, & Elijah, 2019). These studies revealed that the seat of taxicab and bus does not fit the anthropometry of Nigerians and they recommended the adjustment in the

seat dimensions to match the Nigerian riders. Despite the large volume of tricycle in Nigeria and the complaints by the users on discomfort experienced when riding it, little attention was given in studying tricycle ergonomics (Hezekiah & Taofeek, 2019).

There has been higher number of complaints from passengers and drivers on experiencing discomfort and even accidents while using tricycle. Discussing with some tricycle users in Kano confirmed to me that they are not satisfied with the tricycle seat and they complained about neck and knee pain especially when used tricycle for long time. Canvassing with a number of drivers who use tricycles as a means of transportation daily, they complained of the musculoskeletal disorders, back pains and rheumatic pains. This is confirmed by Hezekiah & Taofeek, (2019) who found that the tricycle users in southeast and south western Nigeria experienced discomfort and neck, knee and lower back pain when they used it. When anthropometric measurement is considered in design it helps to achieve comfort and reduce Musculoskeletal disorders (Taifa & Desai, 2017). The design and development of the motorized tricycle seats appears to have been made without considerations to ergonomic principles and the fact that the anthropometry of Nigerians were not taken in to account in the design. The aim of this study is to generate anthropometric database of tricycle users in Kano metropolis and determine the differences between the dimensions of existing tricycles seats with the anthropometric data of Kano users and also to provide some design specifications of motor tricycle seats to be used for maximum comfort and safety.

2. MATERIALS AND METHODS

This research was conducted in the Kano metropolis. Anthropometric data of Kano adults aged 18 to 50 who rides tricycle was used as sample. Total of 188 samples comprising of 100 male (53.2%), and 88 female (46.8%) were measured. Flexible tape with accuracy of 0.1 mm was used to measure the various body dimensions used in the work. It was used because it permits one to measure around curves or corners. Subject was asked for consent before conducting the measurement. Measurements were made in accordance to ISO7250 standard. Body dimensions selected in this study are Popliteal-buttock length, Popliteal-height and seating height as shown in Figure 1 a, b and c respectively. Table 1 shows the serial number and description of the selected body dimensions as contained in the standard. Data collected were processed in Microsoft Excel Spreadsheet and imported into SPSS 16.0 for analysis.



a Buttock-popliteal length b Knee height c Sitting height

Figure 1

Table1 Selected body dimension for tricycle seat design

S/No. according to ISO7250	Body dimension	Description
4.2.1	Sitting height (erect)	Vertical distance from a horizontal sitting surface to the highest point of the head (vertex)
4.4.6	Buttock-popliteal length (seat depth)	Horizontal distance from the hollow of the knee to the rearmost point of the buttock
4.2.12	Lower leg length (popliteal height)	Vertical distance from the foot-rest surface to the lower surface of the thigh immediately behind the knee, bent at right angle

The anthropometric data was inputted in SPSS software for analysis to calculate the mean, standard deviation and percentiles of the three body dimensions.

TVS samba tricycle which is 76% of the total population of tricycle used in Kano was used in this research work. It is mainly used in Kano because it's cheaper to maintain and consumed little amount of fuel. Physical measurement of tricycle seat was carried out using a meter rule for length and a vernier bevel protractor for seat angle of the tricycle. The variables measured include: Seat height, seat length and backrest height. Five samples of such seats from different tricycles were measured and average was taken and used for comparison with users' anthropometry.

3. RESULTS AND DISCUSSIONS

Table 2 showed the results obtained from the analysis conducted in the SPSS software for male and female subject. It can be envisaged that the seat dimension does not fit well with the anthropometry of male and female subject in most of the parameters compared. Seat length is not adequate for 50th and 95th percentile passenger which makes the sitting uncomfortable and might cause thigh pain when used for long time. It however, fits the anthropometry of 5th percentile female.

Seat backrest height is 25% and 35% shorter than sitting height of 50th percentile male and female respectively. It is also greatly lower than all percentiles for male and female passengers. This indicates that passenger neck and head cannot rest on the seat which might cause whiplash injury when emergency brakes are applied. It is therefore imperative to increase the backrest length to fit well with the tricycle users.

Seat height does not seems to be satisfactory for 50th percentile male and female as it is 22% to 24% different from the popliteal height, thus passenger thigh cannot lay on the seat which causes fatigue and discomfort to passengers. Seat height is shorter than the popliteal height

Table 2 Descriptive statistics of passenger anthropometric data

			Male					Female				
Design Variable	**Mean dimension (cm)**	**Anthropometric variable**	**Mean**	**SD**	**5th**	**50th**	**95th**	**Mean**	**SD**	**5th**	**50th**	**95th**
Seat length	40	Buttock-popliteal length	50.4	5.2	43	50	62	46.3	3.6	39.8	46.3	53.6
Back rest height	45	Sitting height	51.0	5.5	62	68	74	67.9	3.1	54	62	73.0
Seat height	38	Popliteal height	68.4	4.4	42	49	62	39.2	3.6	39.2	46.3	53.6
Seat-backrest angle	90											

for male 5th percentile male and 95th male and female but it fits well with popliteal height of 5th percentiles female as presented in Table 2. This means the seat is only comfortable for 5% female tricycle users.

Table 3 presents the comparison of driver anthropometry with driver seat dimensions. It is clear that the Buttock-popliteal length is 40% longer than the seat length for 50th percentile driver which means greater part of the driver thigh is not supported by the seat which causes discomfort and pain especially when used for long time. The back rest height is shorter than the driver's sitting height for all percentiles. This can also cause whiplash injuries in the event of sudden brakes or impact. Popliteal height conform ergonomically to the seat height of a 50th percentile driver, hence it is comfortable for an average driver. It is however shorter than the popliteal height of 95th percentiles driver which might cause discomfort and thigh pain for prolong riding. 5th percentile popliteal height is shorter than the drivers sitting height as such tricycle is not convenient for children and small male drivers.

The seat angle was measured as 90^0 as shown in Table 3. It does not fit with the recommendation of proper sitting angle of 95^0-120^0 (Reed, 2000). Thus, sitting for prolong time affect the lumbar and spinal gradually resulting to wrest pains. It should therefore be adjusted to 95-120 degrees for comfort and safety.

Table 3 Tricycle dimensions in comparison with driver anthropometric data

			Male Anthropometry (cm)				
Design Variable	**Mean dimension (cm)**	**Anthropometric variable**	**Mean**	**SD**	**5th**	**50th**	**95th**
Seat length	30	Buttock-popliteal	50.4	5.2	43	50	62
Back rest height	48	Sitting height	51.0	5.5	62	68	74
Seat height	50	Popliteal height	68.4	4.4	42	49	62
Seat-backrest angle	90^0						

Buttock-popliteal length obtained from present study is higher than what is obtained by Ajayeoba & Adekoya, (2012) in western Nigeria and Dorado et al., (2015) in Philippines as shown in Table 4. Popliteal height is in par with data of western Nigeria and about 5cm higher than Philippines population.

Table 4 Comparison of anthropometric data of Kano people and other studies

Anthropometric variable	Data of Western Nigeria (Ajayeoba & Adekoya, 2012)	Data of Philippines (Dorado et al., 2015)	Present study (Northern Nigeria)
Buttock-popliteal length(cm)	47.6	46	50
Popliteal height (cm)	49.8	44.2	49

5

Table 5 compares the data measured from tricycle seat with recommended standard for tricycle seat. It is seen that tricycle dimensions are does not satisfy the recommended values. Backrest height and seat angle is grossly lower than the recommended value and are therefore needed to fit both the recommended standard and the users anthropometry.

Table 5 Comparison of tricycle data with recommended standard

Tricycle variables	Average measured	Recommended standard
Seat height (cm)	38	40-50
Backrest height (cm)	45	75
Seat length (cm)	40	38.1
Seat angle	90°	102°

Table 6 is hereby recommended to accommodate 95% of tricycle users comfortably.

Table 6 Proposed design specification

Design variable	Proposed specifications	
	Passenger seat	Driver seat
Seat height	62	62
Seat length	63	63
Backrest height	75	75
Seat angle	102°	102°

4. CONCLUSIONS

Ergonomic assessment of commonly used tricycle in the Kano, carried out by comparing the various percentiles of users suggests possible improvements in the design of seats for more comfort and safety. The prominent among the variable considered is backrest height which is greatly lower than even the 5th percentiles of the driver and passengers which might cause whiplash injuries on impact or sudden brakes. Seat height of tricycle studied is designed only to fit 5% of female passenger which makes it not comfortable for average and large users. The driver seat evaluated shows the need for adjustment in the tricycle operator's seat as ineffective seating posture can influence the interaction of the driver with control button and the pedals. Deviation of seat dimensions from standard and anthropometry makes the users susceptible to pains and discomfort. Design for adjustability could help in mitigating ergonomics problems of tricycle. Application of ergonomics in design of technological systems is a key to obtaining safe, comfortable and user friendly systems. Government should establish ergonomic standards that fit Nigerian anthropometry for public transport systems. Imported tricycles should meet Nigerians ergonomic requirements.

5. REFERENCES

Ajayeoba, A. O., & Adekoya, L. O. (2012). Evaluation of the ergonomic suitability of passenger seats in molue buses in Nigeria. *Journal of Mechanical Engineering*, *1*(2), 4–11.

Dorado, N. J. L., Fabros, P. D. C., & Rupisan, C. A. N. (2015). An Ergonomic Analysis of Tricycle Sidecars in Quezon City. *Procedia Manufacturing*, *3*(Ahfe), 2816–2823. http://doi.org/10.1016/j.promfg.2015.07.757

Hezekiah, A., & Taofeek, Y. (2019). Tricycles for Nigerian Public Transport Unit: Assessment of Ergonomics Design Considerations. *Jurnal Kejuruteraan*, *31*(1), 57–63. http://doi.org/10.17576/jkukm-2019-31(1)-

07

Ismaila, S. O., Akanbi, O. G., Adekunle, N. O., Adetunji, O. R., & Kuye, S. I. (2010). An ergonomics assessment of passenger seats in buses in South Western Nigeria. *Sigurnost*, *52*(4), 329–334.

Moses, F., Ayodele, O., M, M. U., & Elijah, A. (2019). Mismatch between Anthropometry Characteristics of Nigerian Occupational Bus Drivers and the In-Vehicle Measurement. *Covenant Journal of Engineering Technology (CJET)*, *3*(1), 20–37. http://doi.org/10.20370/5y5f-7733

Onawumi, A. S. (2012). Ergonomic Assessment of Driver's Seat of Taxicab used in Nigeria. *International Journal of Industrial Engineering & Technology (IJIET)*, *Vol. 2*(January 2012), 1–16.

Reed, M. P. (2000). *Survey of auto seat design recommendations for improved comfort*.

Samuel, A., Fajobi, A. O., & Oluwatobi, M. (2016). Ergonomic Assessment And Driving Experience of Taxicab Operators In Nigeria. *Journal of Research in Mechanical Engineering*, *Vol.2*(January), 0–6.

Taifa, I. W., & Desai, D. A. (2017). Anthropometric measurements for ergonomic design of students' furniture in India. *Engineering Science and Technology, an International Journal*, *20*(1), 232–239. http://doi.org/10.1016/j.jestch.2016.08.004