S.O. Ismaila, O.G. Akanbi, N.O. Adekunle, O.R. Adetunji, S.I. Kuye*

AN ERGONOMICS ASSESSMENT OF PASSENGER SEATS IN BUSES IN SOUTH WESTERN NIGERIA

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SUMMARY: The objective of the study was to survey and obtain the anthropometric data of users of passenger buses and examine the possible mismatch between their relevant dimensions and the seats they sit on when in these buses.

Two hundred passengers participated in the study with ages ranging from 20 years to 55 years. Eleven anthropometric measurements were taken. Also, the dimensions of the locally fabricated seats in 30 Toyota Hiace buses were measured. The means, standard deviations, fifth, fiftieth and ninety fifth percentiles were calculated. Moreover, the passengers' body dimensions and seat dimensions were compared.

The results showed a degree of mismatch between the passengers' bodily dimensions and the seat dimensions. It was thus concluded that the anthropometric data of the Nigerian passengers was not employed in the manufacture of the seats in the buses. This may be an indication that seats in the buses and passengers' anthropometric dimensions are at variant nationwide.

Key words: *anthropometry, ergonomics, buses, seats*

INTRODUCTION

The ownership of cars in the developing countries is low compared to the developed countries. In fact, Hilling *(1996)* observed that access to personal means of transportation, frequency of trips and choice of mode are closely related to income levels.

In Nigeria, commercial transport operators depend largely on imported fairly used buses popularly called 'Tokunbo' which in most cases do not come with passenger seats or when they do they are modified to accommodate more passengers to maximize their profits. Therefore, local manufacturers usually design or redesign the seats to suit the expectations of their customers without due consideration for the comfort and safety of the passengers.

The question of the correct design of passenger seats with emphasis on comfort as regards the Nigerian people arises due to the fact that required anthropometric measurements are few and the local manufacturers assume that manufacture of seats is an art rather than science.

Jeong and Park *(1990)*, and Bridger *(1995)* noted that physical dimensions of furniture, equipment, clothing and workspaces are specified

*Salami Olasunkanmi Ismaila, Ph.D., Department of Mechanical Engineering, University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria (ismailasalami@yahoo.com), Olusegun Gabriel Akanbi, Ph.D., Department of Industrial and Production Engineering, University of Ibadan, Ibadan, Nigeria, Nurudeen Olatunde Adekunle, B.Eng., Olaide Rasaq Adetunji, B.Eng., Sidikat Ibiyemi Kuye, B.Eng., Department of Mechanical Engineering, University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria.

using anthropometric data to achieve proper ergonomic design. Thus the use of anthropometric data in design may constitute improvement in the health and comfort of the users *(Barroso et al, 2005)*. Similarly, Xiao et al *(2005)* noted that anthropometric data is needed for ergonomically correct design of safe and efficient workplaces, equipment and tools.

Necessary as the anthropometric data is, the data for Nigerian population is scant. The few reported anthropometric data includes the work of Okunribido *(2000)* which surveyed the hand anthropometry of female rural workers. Similarly, Oguntona and Kuku *(2000)* reported some anthropometric data (height, weight, upper arm, hip and waist circumferences) of the elderly in South Western Nigeria. Also, Igboanugo et al *(2002)* reported the anthropometric data of Nigerian adult working class to serve as a data base for designers working for domestic and industrial population. Ayodeji et al *(2008)* also gathered anthropometric data of Nigerian paraplegics while Ismaila *(2008)* obtained the anthropometric data of the foot of Nigerian University students. For proper ergonomic design of passenger seats, anthropometric data for Nigerian users of these seats is necessary and seems not reported.

The main aim of this study is to gather anthropometric data necessary for the design of passenger seats as well as to compare the data with that of the passenger seats presently in use. Three main methods of obtaining anthropometric dimensions have been reported: the tailor's method, traditional anthropometry and, very recently, 3-D surface anthropometry.

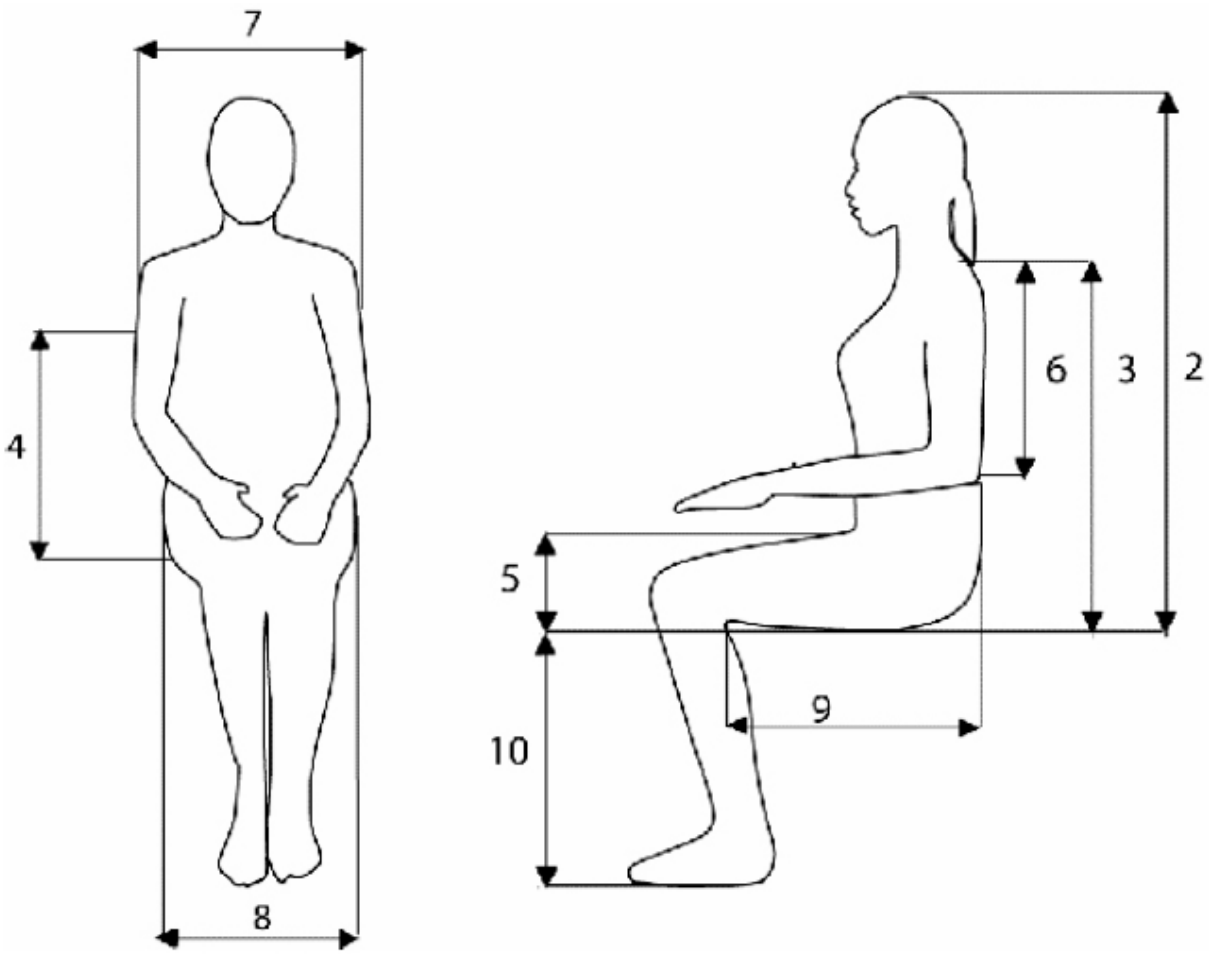
Robinette et al *(1999)* used 3-D surface anthropometry and the method was said to provide data that allowed for effective design of better fitting clothes, protective equipment, better seats and workstation design. However, apart from the fact that 3-D surface anthropometry methodology is presently not available in Nigeria, it is not flexible and is very costly *(Deros et al, 2009)* necessitating the use of traditional anthropometry.

MATERIALS AND METHODS

A survey was conducted and data on existing randomly selected locally manufactured seats was collected from 30 randomly selected Toyota Hiace buses (commonly used mini buses). The data covered the seat height, seat depth, seat breadth and back rest height.

Also, relevant anthropometric data (as shown in Figure 1); *(Molenbroek et al, 2009)* of 200 randomly selected users of the passenger seats was collected. The age of the subjects ranged between 20 and 50 years (mean of 37.9 years). All the measurements were taken in Ibadan Metropolis which is a cosmopolitan city where all major ethnic tribes in Nigeria are represented. The survey was carried out over a period of 12 weeks. The data collected was analyzed using descriptive statistics such as means, standard deviations, fifth, fiftieth and ninety-fifth percentiles using Excel Microsoft Package.

The data obtained for the passengers was compared with the relevant dimensions of the seats using Independent Samples T-test (2-tailed) and Chi-Square at 95 percent level of confidence.



2. Sitting height (SH)
3. Sitting to shoulder height (SSH)
4. Lowest point scapula to sitting
5. Thigh clearance height (TCH)
6. Shoulder-elbow length
7. Biacromial breadth or shoulder breadth (BB)
8. Hip breadth seated (HB)
9. Popliteal depth or buttocks to popliteal length (BPL)
10. Popliteal height (PH)

2. Visina sjedenja
3. Visina od mjesta sjedenja do ramena
4. Najniža točka skapule
5. Razmak donje i gornje razine bedra
6. Duljina od ramena do lakta
7. Širina ramena
8. Širina bokova pri sjedenju
9. Poplitealna dubina
10. Poplitealna visina

Figure 1. Anthropometric dimensions measured
Slika 1. Izmjerene antropometrijske mjere

RESULTS AND DISCUSSION

The summary of the anthropometric dimensions of the passengers in terms of means, standard deviations, fifth, fiftieth, and ninety fifth percentiles are presented in Table 1 while those of the seat dimensions are presented in Table 2. Table 3 shows the T-test analysis and the results of the chi-square analysis are presented in Table 4.

Table 1. Anthropometric data of passengers in cm

Tablica 1. Antropometrijski podaci u cm

	Mean	Standard Deviation	5th Percentile	50th Percentile	95th Percentile
Height	174.8	9.7	158.8	172.5	190.8
PH	42.8	3.8	36.6	41.4	49.0
SH	84.9	4.9	76.9	83.5	93.0
Knee Height	56.9	3.1	51.2	54.4	61.5
Elbow –Elbow Breadth	48.8	9.3	33.7	46.0	64.0
Eye Sitting Height	76.2	5.5	67.2	74.5	85.2
Buttocks Knee Length	63.0	2.8	58.4	62.1	67.7
BPL	52.6	5.0	44.4	51.1	60.8
TCH	14.4	1.5	11.9	14.1	16.9
HB	37.7	5.3	29.0	36.4	46.4
BB	47.6	8.6	33.5	46.1	61.8

Table 2. Dimensions of existing seats

Tablica 2. Dimenzije postojećih sjedala

	Mean	Standard Deviation	5th Percentile	50th Percentile	95th Percentile
Seat Height	39.4	1.6	36.8	39.3	42.0
Seat Depth	40.0	3.3	34.6	39.3	45.4
Seat Breadth	36.8	1.2	34.8	36.8	39.8
Back Rest Height	40.8	1.4	38.0	40.5	42.6

Table 3. T-test analysis of seat dimensions and passengers' anthropometric data

Tablica 3. Analiza T-testa dimenzija sjedala i antropometrijskih podataka

Anthropometric Data			Seat Dimension					
	Mean	Std. Dev.		Mean	Std. Dev.	Diff.	Criterion	Decision
PH	42.8	3.8	Seat Height	39.4	1.6	3.4	±0.76	Reject
BPL	52.6	5.0	Seat Depth	40.0	3.3	12.6	±1.4	Reject
HB	37.7	5.3	Seat Width	36.8	1.2	0.9	±0.85	Reject

Table 4. Chi-Square test analysis of seat dimensions and passengers' anthropometric data

Tablica 4. Analiza chi-square testa dimenzija sjedala i antropometrijskih podataka

Anthropometric Data				Seat Dimension						
	5th %tile	50th %tile	95th %tile		5th %tile	50th %tile	95th %tile	χ^2	Degree of Freedom	Decision
PH	36.6	41.4	49.0	Seat Height	36.8	39.3	42.0	1.11	5.99	Accept
BPL	44.4	51.1	60.8	Seat Depth	34.6	39.3	45.4	8.79	5.99	Reject
HB	29.0	36.4	46.4	Seat Width	34.8	36.8	38.8	2.42	5.99	Accept

From Table 3 it can be inferred that significant differences exist between the means of Popliteal Height (PH) and Seat Height; Buttocks to Popliteal Length and Seat Depth; Hip Breadth and Seat Width. Thus, there is the likelihood of discomfort experienced by the passengers that use the seats due to this mismatch. This fact was corroborated by the results of the chi-square goodness-of-fit statistics which rejected any relationship between Buttocks to Popliteal Length and Seat Depth. Parcells et al *(1999)* suggest that a chair whose seat height is >95% or <88% of Popliteal Height is a mismatch for the user. This suggests that the seat height should be between 39.3 cm and 36.4 cm (using the mean value of 41.4 cm) as compared to between 36.8 cm and 42 cm which makes the seats too high. Too high seats do not allow the feet to reach the floor which makes the passengers uncomfortable *(Kroemer, 1971)* and may result in low-back pain if the posture is prolonged *(Chaffin and Anderson, 1991)*. Similarly, the seat depth should be between 48.5 cm and 40.9 cm as Parcells et al *(1999)* stated that a mismatch exists between Buttock-Popliteal Length and seat depth when the seat depth is >95% or <80% of the Buttock Popliteal Length. The existing seat depth was between 45.4 cm and 34.6 cm which means that the seats are shallow and may cause the user not only to have the sensation of falling off the front of the chair but may also result in the lack of support of the lower thighs *(Panero and Zeinik, 1979)*. Moreover, as recommended by Molenbroek et al *(2003)*, the seat width should be equivalent to 99 percentile value plus 15% which puts the seat width at 53.4 cm. This mismatch, as noted by Ashby *(1978)*, may mean that the seats may not be suitable for the user as the anthropometric data for the target population was necessary when designing for that population.

CONCLUSION

The current study shows a mismatch between the dimensions of locally manufactured seats and the anthropometric data of passengers in Ibadan, South Western Nigeria. This suggests that anthropometric data of the Nigerians was not employed in the manufacture of the seats. This study may be an indication that bus seats and passengers' anthropometric dimensions are at variance nationwide.

The study provides anthropometric data that may be used by local bus seat manufacturers for the design and fabrication of these seats to suit the Nigerian population.

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ERGONOMSKA OCJENA AUTOBUSNIH SJEDALA U JUGOZAPADNOJ NIGERIJI

SAŽETAK: Cilj ovoga rada bio je doći do antropometrijskih podataka o korisnicima putničkih autobusa i ispitati moguću neprilagođenost sjedala antropometrijskim mjerama. U istraživanju je sudjelovalo 200 ispitanika između 20 i 55 godina starosti. Provedeno je jedanaest antropometrijskih mjerenja, a izmjerene su i dimenzije sjedala u 30 Toyotinih autobusa koji se koriste u javnome prijevozu. Izračunate su srednje vrijednosti, standardne devijacije, te peti, pedeseti i devedesetpeti percentil. Uspoređene su tjelesne mjere putnika i dimenzije sjedala. Rezultati pokazuju određenu neprilagođenost dimenzija sjedala tjelesnim mjerama. Zaključak je da se pri izradi autobusnih sjedala nisu koristili antropometrijskim podacima za tu populaciju. Iz ovoga se može zaključiti da se u cijeloj zemlji antropometrijski podaci nisu koristili pri izradi autobusnih sjedala.

Ključne riječi: *antropometrija, ergonomija, autobusi, sjedala*

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