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Mismatch between Anthropometry Characteristics of Nigerian Occupational Bus Drivers and the In-Vehicle Measurement

Fajobi Moses O[1]*, Onawumi Ayodele S.1.[2], Mfon Udoh M. O[2] & Awoyemi Elijah A[3]

[1,2]Department of Mechanical Engineering, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso. Oyo State. Nigeria.
[2]Department of Mechanical Engineering, Covenant University, P.M.B. 1023, Ota, Ogun State, Nigeria.
[3]Department of Works and Maintenance, Osun State University, Osogbo, Osun State, Nigeria.
mofajobi54@lautech.edu.ng

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Abstract- The characterization of interfacing elements of in-vehicle and driver's anthropometric variables of a randomly selected operators with sample size of 161 subjects of commercial buses in the study area were considered in this work. Participatory ergonomic intervention approach was employed in data mining, opinion gathering and subsequent analysis. Related variables between the two systems were compared to establish fitness as well as the level to which human operator were accommodated in the vehicle dimension. A few cases of misfit were recorded based on drivers' opinion and the measurements taken. Work related musculoskeletal disorder experienced by the users under study were traceable to inappropriate design variable of the in-vehicle elements.

Keywords: Anthropometry, Workstation, Bus Driver, Ergonomics, Musculoskeletal Disorders

1. Introduction

The movement of goods and services plays significant role in everyday life bustle with varying means of transportation resulting from vivid research and development activities. Common technological systems in use are usually operated by human being whose capabilities and limitation are rarely considered at the development stage of the means of transportation especially in the face of international trading of automobile industry. Work related musculoskeletal disorder reported by drivers of automobile continue to create design challenges receiving attention of ergonomists and automobile in-vehicle developers [1] [2]. Although the risk exposure of both driver and passengers of automobiles are seemingly of the same level, the vigilance level required for save control of the system place higher demand on the driver [3]. Some of the occupational risks experienced by the users includes fatigue, health damages by noise, vibration, toxic and irritable effects by atmospheric pollution, injury or death in case of fatal accidents. Significant mismatch of in-vehicle design variables and the anthropometric characteristics demand of taxi cab drivers in Nigeria was found to be responsible for reported disorder and other uncomfortable conditions [4] [5] [6]. Much of the challenges, trauma, and disorders complained by operator of automobiles in Nigeria were more of absence of effective legislation and absence of enforcement of existing rules and regulations in automotive industry. Ongoing efforts to mitigate persistence musculoskeletal and psychological trauma imposed by imported technological systems are yet to yield reasonable result due to technically missing link [7]. The combined work design and ergonomics approach, especially for the redesign of faulty physical environment do not only increase the production output but also the user's safety and comfort for effective and efficient performance [8].

Anthropometry: is the art and science of measurement the physical geometry, mass properties, and strength capabilities of the human body [9] [10] [11]. It is concerned with the scientific study of human subjects for the development of standards and evolving of specific demands associated particularly with manufactured goods and services to enhance product usability and ergonomics suitability for the user population [12] [13]. Anthropometric data bank for citizen of varying age group have been developed in most developed countries and used in area of product design and manufacture. However, anthropometric dimensions and other various factors such as gender, age, race, nutritional status, physiological build and nature of work were found to vary widely across every region, state and country [14]. This suggests significance differences in anthropometric data of populace/subject from among countries and the misfit of products imported from place with organised database (UK, USA, Japan. Germany. China etc.) into developing countries like Nigeria, Ghana, Cameroon etc. where required body dimensions were not considered in product development [4]. In the case of automobile industry, a number of drivers' workstation were reported to cause discomforts due poor design and inadequate adjustability as well as lack of application of ergonomic principles in the design of some in-vehicle components. Reliable anthropometric data for a targeted population becomes necessary when designing for that population otherwise the product may not be suitable for the users [15].

The challenges associated with the applications ergonomic principles become obvious due to significance of the variations in human capabilities and the unavailability of updated user's anthropometric database. These have posed enormous task for ergonomists and designers of products and components peculiar [16] [17] [18].

Anthropometric data application in man-machine system and similar facilities design can be stressful due to number of design parameters involved [19] [20], this problem has recently been made much easier giving some developed design principles like design for adjustable range, design for average sizes (50th percentile) and design for extremities (5th/95th percentiles).

This study seeks to identify research and development gaps and areas of mismatch between driver and technological systems characteristics. Driver's posture is also important to vehicle design process, man-machine system as well as the static and dynamic anthropometric demands of the operator [21] [22]. Other variables that could be used to determine ergonomic suitability of driver in the workstation are; seating comfort, postural composition and body flexibility. These can also be used to estimate the driver's resilience and endurance level at work [23] [24].

To have a better understanding of the causal factors of musculoskeletal disorder and discomfort to the driver while at workstation, the relationship between the operator's seat, steering column and wheel and pedals in the workstation must be clearly understood [25].

These have a great influence on posture of the operator. Previous researches have it that sitting position enhances the comfort and effectiveness of bus drivers. The posture is however limited to 30 minutes in constrained location and/or fixed position.

2. Materials and Methods

Sampling Technique

Two commonly used model of passenger vehicles namely Toyota Hiace and Mazda identified through preliminary survey at the study area were considered for further study. With the use of participatory ergonomic intervention approach, opinion of 161 randomly selected bus operators from six prominent motor park units were used for ergonomic evaluation and anthropometric characterization study. Three trained enumerators were involved in the procedure for collection of fifteen relevant anthropometric measurements for each of the subjects who volunteered to the rigour of the procedure adopted by [26].

Bus Operators Anthropometric Characterization Procedures: The procedure for taking subject's anthropometric measurement used by [4] was adopted in this study with the assistance of three trained enumerators. Body variables considered were Shoulder-Height-Sitting, Shoulder-Elbow-Length, Shoulder-Breadth, Sitting-Height-Normal, Sitting-Height-Erect, Buttock-Knee-Length, Buttock-Popliteal-Length, Thigh-Clearance-Height, Popliteal-Height-Sitting, Thumb-Tip-Reach-Sitting, Anterior-Arm-Reach, Stature, Hip-Breadth and Maximum-Body-Breadth.

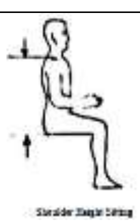
The instrument employed in the measurement include Stadiometer, Vernier-Callipers, measuring Tape, Anthropometric-Seat, and Bathroom-Weighing-Scale, clipboard, Data collection form pencil with cleaner and digital camera. The average values of the triplicated measurements were calculated and considered for further analysis.

A 2D model of each of the anthropometric dimension of a seated operator were divided into three groups for easy identification as follows:

i. Sagittal Plane (Vertical Dimensions)
ii. Sagittal Plane (Horizontal Dimensions) and
iii. Frontal Plane.

Driver's Seat and Workstation Characteristics: Twenty-three physical characteristics of driver seat and other workstation parameters were considered for the study. The considered physical dimensions of the driver and the workstation were characterised with measurements which include: Seat height, Seat depth, Backrest seat plane height, Backrest height, Distance from edge of seat to application of force point, Lumber support height, Lumber support depth Lumber support extension, Rounded front edge width, Armrest clearance, Backrest width (Lumber level), Backrest width (Thoracic level), Horizontal lumber concavity (Radius), Horizontal Thoracic concavity(Radius), Headrest length, Headrest width, Armrest surface length, Armrest surface breadth, Backrest angle and Seat plane angle. Data collected were processed in Microsoft Excel Spreadsheet 2010 version and imported into SPSS 17.0 for further analysis. Descriptive statistics which included; mean, standard deviation, range and percentiles (5th, 50th and 95th percentiles) were determined. Results obtained from both characterizations were compared with each other and these formed the bases upon which bus design specifications were developed and the anthropometric database created.

Table 1: Anthropometric Description of Seated Vehicle Operator from Vertical View of the Sagittal Plane

Model	**Description**	**In-vehicle applications**
	**Shoulder Height (Sitting) (SHS):** The vertical distance from the sitting surface to the uppermost point on the lateral edge of the shoulder (acromiale).	Backrest height, Door Height, Headrest adjustable range, Seat belt design

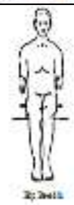
	**Shoulder – Elbow Length (SL):** The vertical distance from the uppermost point on the lateral edge of the shoulder (acromiale) to the bottom of the elbow (alecranon).	Armrest height Armrest depth Armrest clearance, Side gear control knob. Door opening lever location Side door armrest buttons
	**Sitting Height Normal:** The vertical distance from the sitting surface to the uppermost point of the head (subject sits relaxed)	Vehicle roof-seat plane distance, Seat plane vatical adjustment range,
	**Sitting Height Erect:** The vertical distance from the sitting surface to the uppermost point of the head (subject sits erect)	Backrest-seat plane height, Headrest height, Vehicle roof-seat plane distance, Seat plane vatical adjustment range,
	**Popliteal Height Sitting (PHS):** The vertical distance between the floor and to the thigh immediately behind the knee.	Seat plane height Seat plane vatical adjustment range, Seat depth
	**Thigh Clearance Height (TCH):** The vertical distance from the sitting surface to the top of thigh at its intersection with the abdomen.	Seat plane-steering wheel distance Seat depth adjustment range

	**Stature/Standing Height:** The vertical distance between the centre of the head and the sole of the feet was measured.	Seat stretch and pedal room design

Table 2: Anthropometric Description of Seated Vehicle Operator from Horizontal View of the Sagittal Plane

Model	Description	In-vehicle Applications
	**Buttock – Knee Length (BNL):** The horizontal distance from the most posterior point on the buttocks to the most anterior point on the knee.	Seat plane depth Backrest-dashboard distance Pedal room design Knee-dashboard clearance
	**Buttock – Popliteal Length:** The horizontal distance from the most posterior point on the buttocks to the most interior point on the knee (i.e., back of the kneel)	Seat depth Seat plane contour
	**Anterior Arm Reach, Sitting (AAR):** The horizontal distance from the back of the shoulder (greatest bulge of trapezium) to the tip of the extended middle finger.	Seat Backrest- windscreen distance, In-vehicle work space evilop.
	**Thumb – Tip Reach, Sitting (TRS):** The horizontal distance from the back of the shoulder (greatest bulge of trapezium) to the tip of the extended thumb.	Dashboard buttons-driver distance, Seat Backrest- windscreen distance, In-vehicle work space evilop. Door opening lever location Side door buttons Armrest surface length

Table 3: Anthropometric Description of Seated Vehicle Operator from Front View of the Sagittal Plane

Model	Description	In-vehicle Application
	**Shoulder Breadth (SB):** The maximum horizontal distance across the deltoid (triangular muscle on the human shoulder) muscles.	Backrest width (Thoracic level) Backrest contour design
	**Hip Breadth (Sitting) (HB):** The maximum horizontal distance across the hips.	Backrest width (Lumber level) Pedal room width
	**Maximum Body Breadth (MBB):** The maximum horizontal distance between the lateral surfaces of the elbows.	

3. Results and Discussion

In-Vehicle's Variable and Anthropometric Characteristics: Age group of the studied subjects ranges between 18 to 60 years. Table 4 shows the summary of the descriptive and percentiles statistics of the anthropometric characteristics. Table 5 shows the results of the in-vehicle geometrical characterization. Table 6 shows individual characteristics of the in-vehicle geometry against the pertinent anthropometric dimension(s).

Driver's door (Height and Width): Data obtained from the design reveals that existing door variables (door height) of the buses (135.7cm by 99.5cm) does not adequately meet the operators' requirements as indicated in the percentile statistics of the drivers. The suggests a redesign using design recommendation dimension of average door height and width of 140.0cm by 99.5cm respectively for the extreme 95th percentile.

Ground-to-driver's door height: Interactions and personal observations revealed that the existing ground-to-driver's door height might not be adequate as it is too high (70.4cm) especially for the short drivers. This makes the drivers uncomfortable while ingress and egress his workstation. Therefore, as suggested by Brooks, 1979, ground-to-driver's door height be lowered to an average of 34.8cm and stair steps would be necessary. The existing handrail should be designed to ergonomically conform to the driver's fingers shape in order to generally reduce the problems (like sliding of the hand against the handrail) faced by the drivers while entering as well as exiting through the driver's doors.

Seat: As defined by SAE 2013 (Motor Vehicle Seating System), motor vehicle seat system is a structure engineered to seat the driver and/or passengers, including all pads, upholstery, decorative metal trim parts and seat adjusters or supporting components. For better performance of the drivers at workstations, the seat should be designed putting into consideration, the following design specifications for each of the variables;

Seat widths: From Table 3 the seat width is seen to be satisfactory for the 95th percentile of the drivers as compared with the hip breadth as an anthropometric dimension. Since it is suitable for the 5th percentile of the drivers, it is therefore recommended that the average seat width for the bus should be maintained as existing 49.8cm.

Seat length: Over 50% of the studied drivers might find the average seat length in the existing design as measured (55.6cm) uncomfortable. So it is suggested that the average seat length in the existing design should be reduced to about 17.8% of the present dimension i.e., 45.7cm, so as to comfortably accommodate at least 5th percentile range, i.e., 95% of the drivers.

Seat adjustments: Upper, middle and lower; back pains, knee joints pain, elbows pains, chest pain, neck pain amongst others were identified as major musculoskeletal disorders experienced by drivers [4]. Consequently, these forms of disorders can be reduced to the barest minimal if all the necessary adjustments ranges and devices are in place and functional. These adjustments include; seat fore/aft adjustment, seat height adjustment and seat back angle adjustment (tilting).

Seat heights: Although through interview, none of the drivers said the seat height were too high but many agreed that the seat height was too low, therefore, it is suggested that the average seat height should remain as 45.1 and seat adjustment be included to accommodate users in the extreme percentiles. Therefore, the seat height adjustments should be 7.2cm for total upward and downward adjustment. This will enable drivers in the 5th percentile to adjust the seat to their comfort.

Table 4: Anthropometric Data of Ogbomoso Bus Operators (n = 161)

Anthropometric Variables	Mean	Std. Dev	Range	Percentile		
				5th	50th	95th
Shoulder Height Sitting	57.54	2.55	9.7	53.9	57.3	61.5
Shoulder-Elbow Length	37.26	2.26	7.7	34.0	37.0	40.8
Shoulder Breadth	45.42	3.25	10.6	40.4	45.1	50.1
Sitting height normal	79.32	4.31	16.8	72.7	79.3	85.0
Sitting height erect	83.36	6.65	27.4	75.0	83.2	93.6
Buttock-Knee Length	58.89	2.88	13.6	55.0	59.0	63.1
Buttock-Popliteal Length	48.97	2.57	10.5	45.7	48.6	53.2
Thigh Clearance Height	14.06	1.38	4.49	12.1	13.9	16.1
Popliteal Height Sitting	49.39	2.02	6.79	46.3	49.3	52.3

Thumb-Tip Reach Sitting	81.44	3.53	12.7	76.7	80.9	87.2
Anterior-Arm Reach	89.19	3.99	15.3	83.7	89.2	95.4
Stature	176.12	6.17	21.8	167.6	175.6	185.9
Hip Breadth	37.95	3.62	15.7	32.8	37.9	42.7
Maximum Body Breadth	46.1	3.2	11.2	41.0	46.2	50.8
Weight	74.05	6.70	31.5	61.7	73.6	85.1

All dimensions were measured in centimetres (cm) except weight which is in kilogram (kg)

Table 5: In- Vehicle Design Data

Design Parameters	Mean Dimension	
	Toyota Hiace	Mazda
Seat height	45.1	45.4
Seat width	49.8	50.2
Seat length	55.6	55.6
Back-rest length	53.3	53.5
Back-rest width	47.7	48.1
Dashboard-backrest length	75.1	75.3
Steering-wheel external diameter	44.7	44.7
Steering-wheel thickness Minimum	38.1	38.1
Steering-wheel thickness Maximum	44.7	44.7
Thigh clearance (steering wheel-seat height)	22.6	22.7
Driver's door height	135.7	135.9
Driver's door width	99.5	99.6
Ground-to-driver's door height	70.4	70.3
Elbow clearance	N/A	N/A
Seat-pedal length	34.4	34.4
Rounded front edge width	8.7	8.7
Headrest length	23.8	23.7
Headrest width	12.7	12.6
Headrest breadth	27.8	27.9
Armrest surface length	N/A	N/A
Armrest surface breadth	N/A	N/A
Seat Adjustment Minimum	87.7	88.3
Seat Adjustment Maximum	101.6	101.6

All variables were measured in centimetres (cm)

Seat fore/aft adjustment: Buses with fixed adjustments give drivers problems as the level of inconvenience and discomfort increases. During the study, it was noted by critical look at the seats that, most of the seats had fore/aft seat adjusters, but just few were functional. In fact most seats were found permanently welded to the driver's workstation thereby not giving room for maneuvering to suit driver's postural comfort. It was also gathered at one of the motor park units visited that over 70% of the buses used by the motorists were brought into the country right handed, possibly due to less cost of procurement. To comply with the use of road act of Nigerian government these buses were converted into a left handed drive. But with this they could only to convert the steering column and dash boards alone and not the seats. Hence they manipulate workstation thereby making the seat not adjustable for the driver but the passenger who sits at the front. It is of paramount importance to note that with these findings, discrepancies in the design variables and that of the anthropometric dimensions of the drivers becomes intensified. Hence it becomes more pronounced that the buses were not pre-designed for Nigerians i.e., anthropometric data of Nigerians were not incorporated into the existing bus design. In general, the seat adjustments of the buses across the studied motor park units were not adequate even those that seem to be functional could not be adjusted in their full length of 13.5cm. Therefore, as it is suggested by [27], that a driver's seat should have a seat adjuster to be maintained at an average of 18.4cm for total fore/aft adjustment for Molue buses, also 13.5cm for Toyota Hiace and Mazda buses.

Backrest adjustments: Observations from the buses measured showed that a very limited number among the buses had adjustable backrest, though by looking closely at the seats, it was revealed that most of the seats had damaged backrest adjusters. It is therefore suggested that the driver's seat backrest should adjust backward (Tilt) to 35 degrees from the vertical to accommodate user to who may lean against the backrest as suggested by [25].

Other design considerations include the inclusion of armrests that is adjustable in height and width, to accommodate various body dimensions on the seats as desired by the drivers, to reduce some musculoskeletal problems, relating to hand and back pains. In addition, introduction of removable seat cushions will go a long way in reducing soiling, odour retention and wear; the seats are subjected to, due to the fact that diverse drivers use the same workstation. Also to increase driver's satisfaction and comfort in his workstation, seats should be designed to have a perfect seat depth and well comfortable seat to fit the user.

Backrest width: To ensure that the backrest width covers the shoulder breadth, the average backrest width should be increased by 5.87% of the present dimension, thereby making it 50.5cm so as to accommodate 95% of the drivers.

Backrest length: For the backrest length at least to be at the shoulder height for comfort of 95% of the drivers, the average backrest length should be increased to about 5.87% of the present dimension (47.7cm) to make it 50.5cm. Seats with air actuated lumbar and back side bolster support backrest will be desirable by the bus drivers and as suggested by [28] for bus operators, to reduce some musculoskeletal disorders, relating to back pains. Also adjustable headrest (up/down and forward/backward adjustments) will be necessary as suggested [28] and desired by the surveyed drivers. Although there are headrests in the existing design yet most were found to be designed alongside (merged) with the backrest and not separately. Incorporation of this in the future design would help in curtailing some musculoskeletal problems, relating to neck and back pains while it enhances the comfort of the drivers.

Dashboard-backrest length: Driving task is an activity that requires maximum concentration by the driver as various judgments need to be made at every point in time. However, while he does these, there is need for the driver to interact with various in-vehicle components. For ease of reach for various controls on the dashboard, control lever/knobs and side/rear mirrors, it is necessary the design for control reach is within the maximum arm reach so as not to pose discomfort on the driver. On this note, it is suggested that the dashboard-backrest length is increased by 11.45% of the present dimension to become 83.7cm. This will allow the workstation to accommodate 95% of the drivers. The proposed design specification for bus is shown in Table 4.

Anthropometric Comparison of Ogbomoso Bus Drivers with Lagos Molue Bus and Ibadan Taxicab Drivers

The comparison of major anthropometric dimensions of Ogbomoso bus operators with those of Lagos Molue bus drivers and Ibadan taxicab drivers of the same region, south western urban centres of Nigeria, reveals that there are variations in most of the dimensions for; Shoulder Breadth, hip breadth, Thumb-Tip Reach Sitting/Anterior Arm Reach and Stature which stands at (166.8, 173.3, 179.7) for Lagos drivers, (161.3, 172.0, 182.76) for Ibadan drivers and (167.6, 175.6, 185.9) for Ogbomoso drivers for 5th, 50th and 95th percentiles respectively, Table 5. It may be due to nutrition and body build. This shows the distinct nature of the anthropometry of the urban centres and the dynamism. Although the anthropometric data of Ibadan were not obtained from bus operators but it is stipulated that driving is a free for all kind of work in Ibadan, it is possible that majority of these drivers also at one-time drive buses. Therefore, buses to be designed for the Ogbomoso bus drivers at south western Nigeria, need to be modified with suitable adjustment in body dimensions affected.

The mean values of some major anthropometric data (body dimensions) of Ogbomoso in south western Nigeria were also compared with mean values of passengers in buses as indicated in Table 6. Analysis of variance (ANOVA) performed on the mean values revealed at 95% confidence level that there was no significant difference ($p > 0.01$). The comparison reveals that the Ogbomoso bus operators are variably smaller than the passengers in bus of Ogun south western Nigeria in all structural body dimensions where data were available except in stature where they have 176.12 as against 174.8. The variation may be attributed to the discrepancies in physiological factors and body build up. The lower body dimensions may lead to uncomfortable postures adopted while driving buses posing fatigue on drivers and possibly inefficiency.

Table 7 presents the comparison of sitting height to stature ratio of Ogbomoso (south west) bus operator in Nigeria with different ethnic groups across Nigeria. Result from this comparison shows almost similar ratio of sitting height to stature among different ethnic groups which is in line with survey carried out on anthropometric data of Indian workers [29]. Consequently, this comparison is in accordance with [30-34] who also stipulated that there is a high probability that whatever the mean stature of a sample, any given body dimension of length will be very nearly a constant proportion of the stature. Therefore, if the stature is known, any dimension that is not available in the sample can be obtained by proportion [35].

Table 6: Driver's workstation design variables fitted with related anthropometric variables

Design Variables	Mean Dimension	Anthropometric Variable	Mean	SD	5th	50th	95th
Seat height	45.1	Popliteal height sitting	49.39	2.02	46.3	49.3	52.3
Seat width	49.8	Hip breadth sitting	37.95	3.62	32.8	37.9	42.7
Seat length	55.6	Buttock-popliteal length	48.97	2.57	45.7	48.6	53.2
Back-rest length	53.3	Shoulder height, sitting	57.54	2.55	53.9	57.3	61.5
Back-rest width	47.7	Shoulder breadth	45.42	3.25	40.4	45.1	50.1
Dashboard-backrest length	75.1	a. Anterior arm reach sitting b. Thumb –tip reach sitting c. Buttock-Knee length	89.19 81.44 58.89	3.99 3.53 2.88	83.7 76.7 55.0	89.2 80.9 59.0	95.4 87.2 63.1
Steering-wheel external diameter	44.7	Anterior arm reach sitting	89.19	3.99	83.7	89.2	95.4
Steering-wheel thickness	6.6	Na	na	na	na	na	na
Thigh clearance (steering wheel-seat height)	22.6	Thigh height sitting	14.06	1.38	12.1	13.9	16.1

Driver's door height	135.7	Stature	176.12	6.17	167.6	175.6	185.9
Driver's door width	99.5	Max. body breadth	46.1	3.2	41.0	46.2	50.8
Ground-to-driver's door height	70.4	Stature	176.12	6.17	167.6	175.6	185.9
Elbow clearance	Na	Na	na	na	na	na	na
Seat-pedal length	34.4	Popliteal height sitting	49.39	2.02	46.3	49.3	52.3
Rounded front edge seat width	8.7	Popliteal height sitting	49.39	2.02	46.3	49.3	52.3
Headrest length	23.8	Sitting height Normal	79.32	4.31	72.7	79.3	85.0
		Sitting height Erect	83.36	6.65	75.0	83.2	93.6
Headrest width	12.7	Sitting height Normal	79.32	4.31	72.7	79.3	85.0
		Sitting height Erect	83.36	6.65	75.0	83.2	93.6
Headrest breadth	27.8	Sitting height Normal	79.32	4.31	72.7	79.3	85.0
		Sitting height Erect	83.36	6.65	75.0	83.2	93.6
Armrest surface length	Na	Na	na	na	na	na	na
Armrest surface breadth	Na	Na	na	na	na	na	na
Seat Adjustment	13.1	Buttock-Knee length	58.89	2.88	55.0	59.0	63.1

All variables were measured in centimetres (cm), SD denotes Standard Deviation

Table 7: Proposed In-vehicle design specifications

	Design variable	**Proposed design variable (cm)**
A.	Seat height	45.1
B.	Seat width	49.8
C.	Seat length	45.7*
D.	Back-rest length	50.5*
E.	Back-rest width	50.5*
F.	Dashboard-backrest length	83.7*
G.	Steering-wheel external radius	44.7
H.	Steering-wheel thickness	6.6 (with padding)
I.	Thigh clearance (steering wheel-seat height)	22.6

J.	Driver's door height	140*
K.	Driver's door width	99.5
L.	Ground-to-driver's door height	34.8*
M.	Elbow clearance	Suggested
N.	Seat-pedal length	34.4
O.	Seat fore/aft adjustment (Forward and Backward)	13.5
P.	Seat adjustment (Upward and Downward)	7.2*

* Not Present

Table 8: Comparison of Mean Sitting Height to Mean Stature Ratio with other studies on anthropometry

Study	Mean Ratio	Source
Ogbomoso (South Western Nigeria)	0.4733	Present study (2015)
Ibadan (South Western Nigeria)	0.4839	Onawumi 2008
Igbo (South Eastern Nigeria)	0.5122	Onuoha 2012
Doko (North Central Nigeria)	0.4661	Jonathan and Shehu 2012
Kutigi (North Central Nigeria)	0.4926	Jonathan and Shehu 2012

All variables were measured in centimetres (cm)

4. Conclusions and Recommendation

Stakeholders in the automotive industry has yet relent in search for a system that meet up with the recent challenges of user's population requirements, established technical standards, and other basic specifications for research uses. The basis for achieving these has been found to be through a comprehensive Participatory Ergonomic Intervention (PEI) approach.

However, in ensuring an ergonomically suitable products and physical equipment, anthropometry becomes an inevitable tool to define the population of the potential users. Mainly because the human body occupies a central position in the design of man machine interface and the system at large. Also, this study has opened up the need to conduct a national anthropometry survey for user population in Nigeria. Such data can be used to configure the vehicle, driver's workstation layout and in-vehicle interface for the purpose of enhancing functional effectiveness, human comfort and ergonomic suitability. Consequently, integrating the limitations of the potential users in relation to such's demographics and other physical characteristics enhances the driver's comfort. Although as a matter of research and development a number of studies have been carried out on driver fatigue and low back disorders however the needs for overall assessment of driver's workplace, the extent to which the existing bus design is found to be ergonomically suitable and its user friendliness are inevitable, hence the conception of this work.

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