DEVELOPMENT OF PREDICTIVE MODELS FOR SOME ANTHROPOMETRIC DIMENSIONS OF NIGERIAN OCCUPATIONAL BUS OPERATORS

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ABSTRACT
Movement of commodities, material and men from one place to another using various automated means remains a major activity of mankind. The operation of the transportation systems placed much demand on operators' capabilities and limitations in relation to human body dimensions. A stratified sample size of 160 drivers were randomly selected among the operators of commercial buses in six (6) selected motor parks within the study area were considered and anthropometric variables relating to seated drivers' workplace were collected using developed and calibrated anthropometric seat, stadiometer, vernier-calipers, tape rule and bathroom weighing scale. The collected data were analysed using STATA 11.0 and Microsoft excel 2010.Descriptive statistics which included; mean, standard deviation, range and percentiles (5th, 50th and 95th percentiles) were determined. The database developed were used to describe the drivers' anthropometry. Design-Expert 6.0.8 version was used in modelling the anthropometric equations. Models were developed for buttock popliteal length, anterior arm reach and thigh clearance height from data collected for statures, weight and popliteal height sitting. The resulting models exhibited quadratic property with coefficient of determination (R^2) ranging between 0.88 and 0.94. These model provide significantly efficient and effective tool for predicting the studied anthropometric dimensions Automotive industries whose market is in Nigeria and other similar manufacturing companies would find this models useful in both design and manufacture of goods.

KEYWORDS: Anthropometric variables, Response Surface Methodology, Modelling, Automobile industry.

1.0 Introduction

Automobile remains undoubtedly a unique invention of human kind devised to ease the problem encountered in conveying material, machine, men and commodities from one place to another. Driver of this technological system plays an important role in its operation as the human operator interacts with different components of the workplace by way of actuating necessary controls at definite point in time. The comfort of the driver needs to be given due consideration because of the systematic controlling and manoeuvrability activities involved (Mohamad *et al*., 2010).Anthropometric data is a collection of the dimensions of human body and are useful for apparel sizing, forensics, physical anthropology and ergonomic design of the workplace (Chou and Hsiao, 2005). Lucas and Onawumi, (2013) however observed that poor design and mismatches between operator's anthropometric characteristics and in-vehicle requirements of automobiles imported into Nigeria are some of the major risk factors that the operators are exposed to. Ismaila *et al,* (2010) and Agrawal *et al,*(2010) reiterated that anthropometric data for the targeted population is imperative to ensure an ergonomically suitable product and workplace. Since anthropometric dimensions across and between nations as well as within family vary considerably, incorporating anthropometry in design brings about improvement in performance, well-being, comfort, health status and optimum safety of the human operator of any automobile and this has been accorded acknowledgement across the world (Zhizhong *et al,* 2007, Franz *et al*, 2011, Vink and Hallbeck 2012; Darses and Wolf, 2006, Barroso *et al,* 2005 and Panagiotopoulou *et al*, 2004). Although, ideal workplace will not only be compatible with the expected user but also the system performance requirements, the comfort and reliability (Harry, 2000,Ajayeoba, 2005).It is very important that ergonomics is considered right at the product design stage, though with time possibilities of making reasonable changes may be inevitable but made possible with ease (Mohamad *et al*., 2010, Onawumi and Lucas, 2012). The activities involved in gathering anthropometric data could be resourceful and it ranged from the required equipment, apparatus, funds, workforce, time and cost of procurement, (Chao and Wang, 2010). Hence, predicting other anthropometric variables making use of the few known variables for the purpose of design and ergonomic configuration of human operator's workplace within the vehicle would therefore be cheaper and less time consuming. Often times, most designers get approximate anthropometric variables for designing products from standing height(Ismaila *et al,* 2014 and Kothiyal and Tettey, 2001).The approaches employed in determining specific anthropometric variables have been identified by Chao and Wang(2010) have been the focus of some research effort such as determination of standing height and/or weight using a predetermined factor or multiplier, developed into a predictive software, and the use of linear regression models (Asafa *et al.*, 2010, Ismaila *et al* 2014). Oladapo and Akanbi(2015) reiterated that most of the linear anthropometric models make use of standing height and/or weight to estimate body dimensions with some which resulted in unsatisfactory prediction for an anthropometric variable with low correlation (r) as well as low coefficient of determination (R^2). Literature have shown that low coefficient of determination depicts that the model is under fitted (Oladapo and Akanbi, 2015) and this suggests that the pertinent variable(s) is/are not included in the model. Popliteal height and standing height were some of the main anthropometric dimensions found to provide effective prediction of other dimensions in the design of driver's seat. (Asafa *et al.*, 2010) and the determination of seat height (Tuttle, 2004). In this work Response Surface Methodology (RSM) was adopted in the design of experimental combinations of factors which consequently lead to the development of some predictive anthropometric models for a set of difficult-to-measure anthropometric dimensions from the easy-to-measure dimensions.

2.0 Materials and Methods

2.1 Samples

Two commonly used public transportation vehicle models (Toyota Hiace and Mazda) identified through a preliminary survey were selected for the study. A stratified sample size of 160 drivers were randomly selected among the operators of public buses in six (6) functional motor park units within the study area for exploratory study using the Participatory Ergonomic Intervention (PEI) approach. Six anthropometric variables (stature (ST), popliteal-height-sitting (PHS), buttock-popliteal-length (BPL), anterior arm reach sitting (AAR)and thigh clearance sitting (TCH)) and weight (W) were collected using developed and calibrated stadiometer, Vernier-callipers, tape rule, anthropometric seat, and bathroom weighing scale. To ensure consistency, flat wooden piece was used as foot rest to accommodate subjects of different heights and a perpendicular wooden angle to fix the elbow at 90^0 as required for the measurements. The harvested data were analysed using STATA 11.0 and Microsoft excel sheet 2010 and the descriptive statistics which included; mean, standard deviation, range and percentiles (5th, 50th and 95th percentiles) were determined. These were consequently used in creating an anthropometric database used to describe the drivers' anthropometry shown in Table 1.Design-Expert 6.0.8version was also used in the modelling of some anthropometric variable.

2.2 Procedures for Anthropometric Measurements

Drivers' usual working posture is sitting and this has been found to enhance comfort and performance especially when one was not in a constrained location and/or fixed in the same position for more than 30 minutes. A highly reliable anthropometric data for a targeted population becomes necessary when designing for that population otherwise the product may not be suitable for the users (Onawumi *et al* 2016).The procedure for taking anthropometric measurement of subjects is quite technical and it requires the use of two or more trained enumerator and reliable anthropometric equipment. All measurements were taken with subjects putting on simple, light clothing and barefooted to nearest centimetres (cm) otherwise weight which was measured and recorded in kilograms (kg). A 2D diagrammatic model of each of the anthropometric description of a seated operator were divided into three groups for easy identification are presented as follows (Lucas and Onawumi, 2013)

i. Sagittal Plane – Vertical Dimensions,
ii. Sagittal Plane – Horizontal Dimensions and
iii. Frontal Plane.

2.2.1 Sagittal Plane – Horizontal Dimensions

This represents the position and movement of the human body in a two dimensional plane (horizontal component) as seen by an observer of the seated subject in the side view. The following are the related body parameters

Anterior Arm Reach: The subject sits erect on the anthropometric seat with his right/left arm and hand extended forward horizontally to their maximum perpendicular length. The Anthropometer was used to measure the horizontal distance from the back of the shoulder (greatest bulge of trapezium) to the tip of the extended middle finger. (Figure 1a)

Buttock – Popliteal Length: The subject sits erect on the anthropometric seat having adjusted the chair to allow his knees to be at right angle. Then Anthropometer was used to measure the horizontal distance from the most posterior point on the buttocks to the most interior point on the knee (Figure 1b).

2.2.2 Sagittal Plane – Vertical Dimensions

This represents the position and movement of the human body in a two dimensional plane (vertical plane) as seen by an observer of the seated subject from the side view. The following are the related body dimensions:

Thigh Clearance Height (TCH): Thigh Clearance Height: The subject sits erect on the anthropometric seat having adjusted the chair to allow his knees to make a right angle. The vertical distance from the sitting surface to the top of thigh at its intersection with the abdomen is measured using the Anthropometer. (Figure 1c)

Popliteal Height Sitting (PHS): The subject sits erect on the anthropometric seat having adjusted the chair to allow his knees to be at right angle and the bottom of his thigh and the back of his knees barely touching the surface. The anthropometer was used to measure the vertical distance from the floor to the thigh immediately behind the knee. (Figure 1d)

Standing Height/Stature: The subject stands with his shoes removed, his heels together and the weight evenly distributed between both feet. The subject stands erect with the Frankfort plane (line pass horizontally form the ear canal to the lowest point of the eye orbit) of his head parallel to the floor, the shoulder and arms relaxed and enough pressure is exerted to compress the hair. The measurement was then taken at the maximum point of quiet respiration. The stadiometer was then used to take the measurement from the ground (the footplate) by sliding the pointer (headpiece) to contact the scalp (Figure 1e).

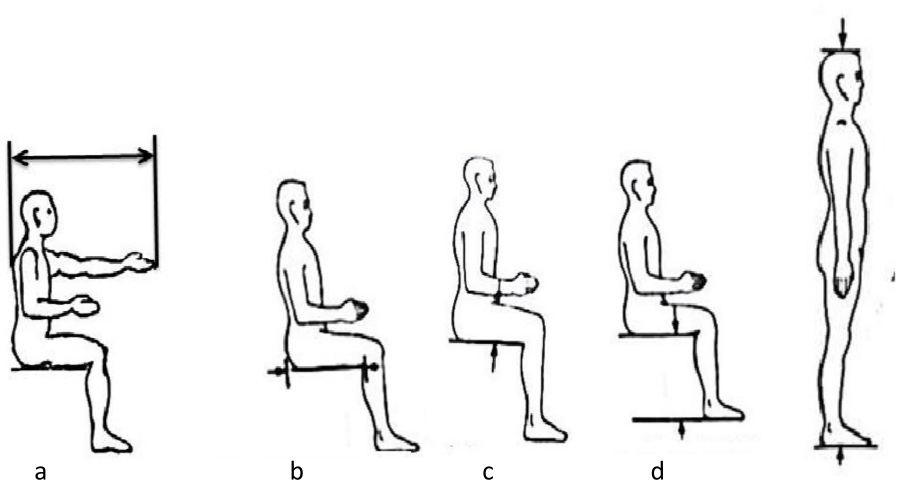


Figure 1: Description of measured anthropometric variables

a. Anterior Arm Reach Sitting, b. Buttock Popliteal Length
c. Thigh Clearance Height, d. Popliteal Height Sitting
e, Stature

Weight: The weights of the subjects were taken to the nearest half kilogram. The subject stands on the centre of the platform (weighing scale) looking straight ahead. The heels are together and the weight evenly distributed on both feet while measurement is being taken.

The measurement was done thrice and the mean values were used as representing the true values of individual anthropometric dimension.

2.3 Prediction of Anthropometric Dimensions

The dimensions were divided into two; dependent and independent variables. The dependent (responses) variables considered were buttock-popliteal-length, anterior-arm-reach-sitting and thigh clearance height because they are; not easy to accurately measured and pertinent to in-vehicle deign configuration. The independent (factors) variables were the dimensions considered peculiar to the configuration of the driver's workplace. This is because they are easy-to-measure and these are Stature, Popliteal Height and Weight (Agha, *et al.,* 2012; Parcells, *et al.,* 1999). Each response variable had second order polynomial response surface model fitted to it. Multiple regression analysis was used to model the data and analysis of variance, ANOVA for each response was examined to test for statistical significance. The statistical analysis of the data and three dimensional plotting were performed using Design-Expert 6.0.8version. The adequacy of regression model was checked by lack-of fit test, R^2, AdjR^2, Pre R^2, Adeq Precision and F-test (Oladapo and Akanbi, 2015). The significance of F value was judged at 95% confidence level. The regression coefficients were then used to make statistical calculations to generate three-dimensional plots from the regression models.

3.0 RESULTS AND DISCUSSIONS

The summary of raw anthropometric data of Ogbomoso bus operators collected from the field which includes the descriptive statistics; mean, standard deviation, range and the (5th, 50th and 95th) percentiles are presented in Table 1.

Table 1: Anthropometric Data of Ogbomoso Bus Operators (n = 160)

Anthropometric Variables	Mean	Std. Dev	Range	Percentile		
				5th	50th	95th
Buttock-Popliteal Length	48.97	2.57	10.5	45.7	48.6	53.2
Anterior-Arm Reach	89.19	3.99	15.3	83.7	89.2	95.4
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
Stature	176.12	6.17	21.8	167.6	175.6	185.9
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)

3.1 Data Analyses and Presentation of Models for All Response Variables

Response 1: Buttock-Popliteal Length

In order to describe the variation of this response, BPL with independent variables and to test for its adequacy, the design programme suggested a quadratic model. The Model F-value of 125.4674 means the model is significant (Table 2). There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise (Oladapo and Akanbi, 2015).

Table 2: ANOVA for response surface quadratic model (Buttock-Popliteal Length)

Source	Sum of Squares	DF	Mean Square	F Value	Prob >F	
Model	38.636	9	4.292889	125.4674	<0.0001	significant
A	13.25797	1	13.25797	387.488	<0.0001	
B	4.10335	1	4.10335	119.9278	<0.0001	
C	1.619812	1	1.619812	47.34192	<0.0001	
A2	5.13973	1	5.13973	150.2178	<0.0001	
B2	1.009785	1	1.009785	29.51277	<0.0001	
C2	0.025969	1	0.025969	0.758977	0.3850	
AB	2.672898	1	2.672898	78.12023	<0.0001	
AC	9.829589	1	9.829589	287.2874	<0.0001	
BC	4.225877	1	4.225877	123.5088	<0.0001	
Residual	5.166492	151	0.034215			
Cor Total	43.80249	160				

Values of "Prob > F" less than 0.0500 indicate model terms are significant. In this case A, B, C, A^2, B^2, AB, AC, BC are significant model terms. Values greater than 0.1000 indicate the model terms are not significant. However, the non-appearance of "Lack of Fit F-value" implies that the model perfectly (100%) fit relative to the pure error.

Table 3 presents the model estimation result, the "Pred R-Squared" of 0.8522 is in reasonable agreement with the "Adj R-Squared" of 0.8750. "Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 67.995 indicates an adequate signal. This model can be used to navigate the design space (Aremu *et al.,* 2014; Montgomery 1997).

Other responses were further analysed following the same proceses and the results are as presented in Table 4.

Table 3: Model estimation result

Std. Dev.	0.184973	R-Squared	0.88205
Mean	49.0624	Adj R-Squared	0.87502
C.V.	0.377017	Pred R-Squared	0.852191
PRESS	6.474407	Adeq Precision	67.99473

3.2: Model equations for occupational bus operators in Nigeria

All the model equations are given in terms of coded factors and for all the equations, A = Status, B = Weight, C = Popliteal height sitting and *E = Exponential function*

Response 1: Buttock popliteal length

The model equation is given as:

$$Buttock\ Popliteal\ length = +22.09841 - 1.25553 * A + 0.26375 * B + 5.11324 * C + 6.04355E - 003 * A^2 - 1.34445E - 003 * B^2 - 3.86109E - 003 * C^2 + 3.17901E - 003 * A * B - 0.021601 * A * C - 0.013216 * B * C$$

Table 4: Design data for occupational bus operators in Nigeria

Study Methodology: Response Surface			Experiments: 160		
			Blocks:	no block	
Initial Design:	Historical Data				
Design Model:	Quadratic		Unit:	cm	
Response	Name	Minimum	Maximum	Trans	Model
1	BPL	42.8	53.3	None	Quadratic
2	AAR	81.2	96.5	None	Quadratic
3	TCH	11.8	16.3	None	Quadratic

Response 2: Anterior arm reach

The model equation is given as:

$$Anterior\ arm\ reach = -164.94188 + 0.71077 * A - 1.90359 * B + 10.01607 * C + 2.87325E-003 * A^2 + 7.60646E-003 * B^2 - 0.058503 * C^2 - 1.33912E-003 * A * B - 0.030664 * A * C + 0.019442 * B * C$$

Response 3: Thigh Clearance Height

The model equation is given as:

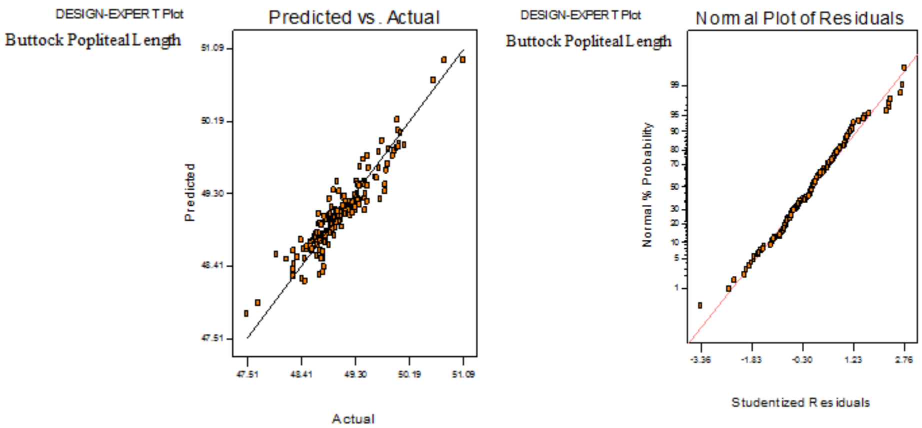
$$Thigh\ clearance\ height = +171.89616 - 9.80188E-003 * A - 0.32572 * B - 5.89673 * C - 6.69443E-004 * A^2 + 1.16369E-003 * B^2 + 0.059137 * C^2 + 2.05165E-003 * A * B + 2.31815E-003 * A * C - 4.87733E-003 * B * C$$

3.3: Diagnostic Tests

Diagnostic tests were conducted making reference to normal plots of residuals and predicted vs actual Plots to show how precisely the responses aremodelled and to show how reliable the models are. Since all the points line up nicely and the deviation of points of the responses from normality is insignificant, then the model is a very good one (Aremu *et al.,* 2014; Montgomery, 2001).For instance, buttock popliteal length as seen in Figures 2a &2b, the earlier stated conditions were met and these confirms the models developed are adequate and reliable.

3.4 Analyses of Response Surface Plots for Nigerian occupational bus operators

This is aimed at having a clearer visualization of the variations among the responses with reference to the independent variables. And for this purpose, series of interaction graphs and 3D response surfaces were drawn from Design Expert 6.0.8 version. According to Abhilasha *et. al., (2009),*the 3D response surface plot is a graphical representation of the regression equations. This was plotted to show the interactions among the variables. Each response surface plotted for responses generated at the different combinations of two factors at a time while maintaining the other variable constant. The convex response surfaces suggested that there are well-defined optimal variables Figures 3 - 5. If the surfaces are rather symmetrical and flat near the optimum, the optimized values may not vary widely from the single variable conditions (Salam *et. al., 2014)*. Figure 3 -5 shows the representation of response surface plot and the interactive effects of combining the factors (stature/weight, stature/popliteal height and weight/popliteal height) on individual responses.



(a) (b)

Figure 2: a. Predicted vs Actual Plot andb. Normal Plot of Residuals for buttock popliteal length

3.4.1: Stature and Weight

Response 1: Buttock popliteal length (BPL)

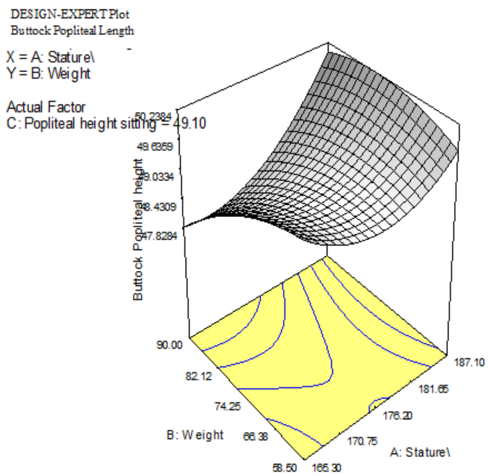
Figure 3a shows the interactive effect of stature and weight on the response BPL. At a low value of weight (58.50kg), buttock popliteal length decreases from 49.53 to 48.81 as stature increases from 165.30 to 176.1. Also buttock popliteal length increases from 48.81 to 49.53 as the stature increases from 176.1 to 187.10. This implies that buttock popliteal length decreases as the stature increases and subsequently the two increases simultaneously. At a high value of popliteal height sitting (90.00kg), the relationship between the stature and buttock popliteal length was observed to be directly proportional because buttock popliteal length increases from 47.82 to 49.10, as stature increases from 165.30 to 187.10.

Response 2: Anterior Arm Reach (AAR)

Figure 3b shows the interactive effect of stature and weight on the response AAR. At a low value of weight (58.50kg), there exist a proportional relationship between the AAR and stature as AAR increases from 90.11 to 93. 37, stature increases from 165.30 to 187.10. Similarly, at a high value of weight (90.00kg), AAR increases from 88.91 to 90.73 while the stature increased from 165.30 to 187.10. This depicts a direct proportional relationship.

Response 3: Thigh Clearance Height (TCH)

Figure 3c shows the interactive effect of stature and weight on the response TCH. At a low value of weight (58.50kg), TCH decreases from 14.48 to 14.03 while stature increases from 165.30 to 187.10. This suggests an inversely proportional relationship between the TCH and stature. On the contrary, at a high value of weight (90.00kg), TCH increases from 12.86 to 13.97 while the stature increased from 165.30 to 187.10. This depicts a direct proportional relationship.



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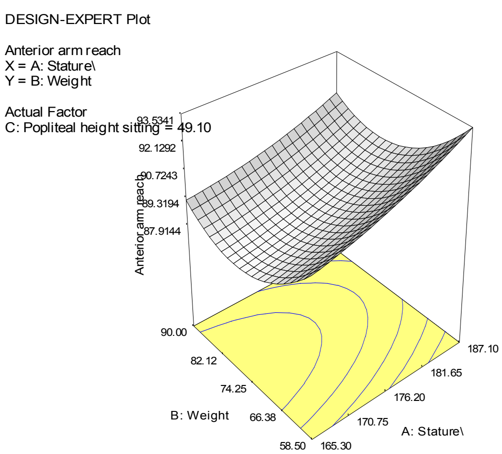

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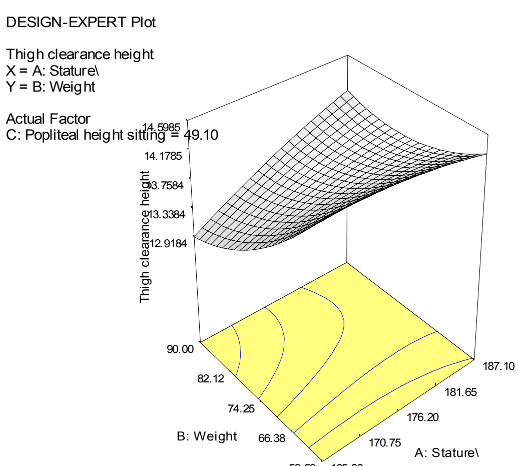


(c)

Figure 3: Stature and Weight Response Surface Interactive Plots of a. PBL, b. AAR, c, TCH

3.4.2: Stature and Popliteal Height Sitting

Response 1: Buttock popliteal length (BPL)

Figure 4a shows the interactive effect of stature and popliteal height on the response BPL. At a low value of Popliteal Sitting Height (45.70cm), the BPL increased from 48.45 to 50.87 while stature also increased from 165.30 to 187.10. This shows a proportional relationship. At a high value of Popliteal Sitting Height (52.50cm), the BPL decreased from 44.48 to 48.48. Also, BPL increased from 48.28 to 48.91 as the stature increased from 178.2 to 187.10. The relationship was inversely proportionate at the beginning and later directly proportional.

Response 2: Anterior Arm Reach (AAR)

Figure 4b shows the interactive effect of stature and popliteal height on the response AAR. At a low value of Popliteal Sitting Height (45.70cm), the BPL increased from 84.97 to 89.67 as stature increased from 165.30 to 187.10. This shows that BPL is directly proportional to stature. Also at a high value of popliteal Sitting Height (52.50cm), the BPL was found to be approximately linear proportional to stature as the BPL slightly increased from 89.51 to 89.54 while the stature increased from 178.2 to 187.10.

Response 3: Thigh Clearance Height (TCH)

Figure 4c shows the interactive effect of stature and popliteal height on the response TCH. At low (45.70cm) and high (52.50cm) values of Popliteal Sitting Height, TCH increases directly proportional as stature, as TCH increased from 14.21 to 14.69 for the former and 13.86 to 14.49 for the later while the stature for both was maintained at 165.30 to 187.10.

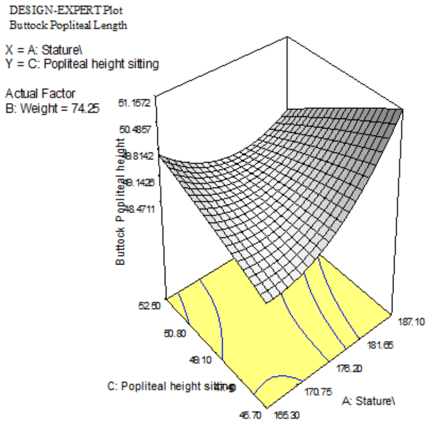
3.4.3 Weight and Popliteal Height Sitting

Response 1: Buttock popliteal length (BPL)

Figure 5a shows the interactive effect of weight and popliteal height on the response BPL. At a low value of Popliteal Sitting Height (45.70cm), BPL increases from 48.31 to 48.93 and weight increased from 58.50 to 80.89. This shows a level of direct proportionality between the factor and the response. Furthermore, the BPL went linear between 80.89 to 87.36 positions of stature. Also, an inverse proportionality relationship was observed, as the BPL decreased from 48.93 to 48.03 and the weight increased from 87.36 to 90.00. At a high value of Popliteal Sitting Height (52.50cm), the BPL increased from 47.45 to 53.69 as weight increased from 58.50 to 90.00. This exhibits a direct proportionality relationship.

Response 2: Anterior Arm Reach (AAR)

Figure 5b shows the interactive effect of weight and popliteal height on the response AAR. At a low value of Popliteal Sitting Height (45.70cm), the AAR decreased from 91.01 to 86.63 and later from increased 86.63 to 86.98 while the weight was maintained at fixed range of 58.50 to 90.00. These show that there exist an inversely proportional relationship and thereafter a direct proportionality. At a high value of Popliteal Sitting Height (52.50cm), the AAR decreased from 91.03 to 89.24 and later from increased 89.24 to 91.45 while the weight was maintained at fixed range of 58.50 to 90.00. These show that there exist an inversely proportional relationship and thereafter a direct proportionality.



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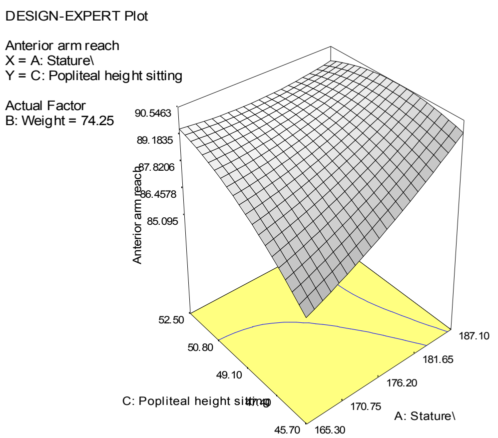

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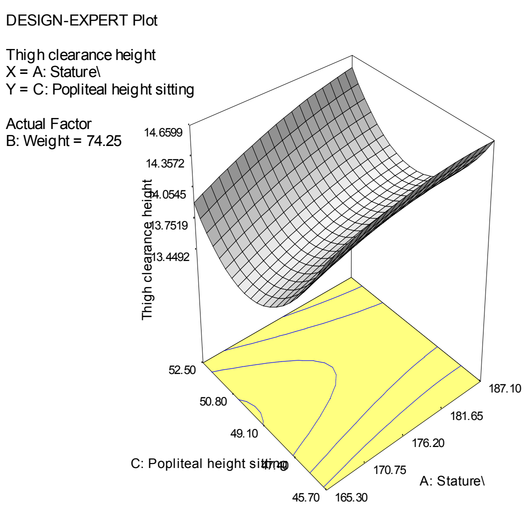
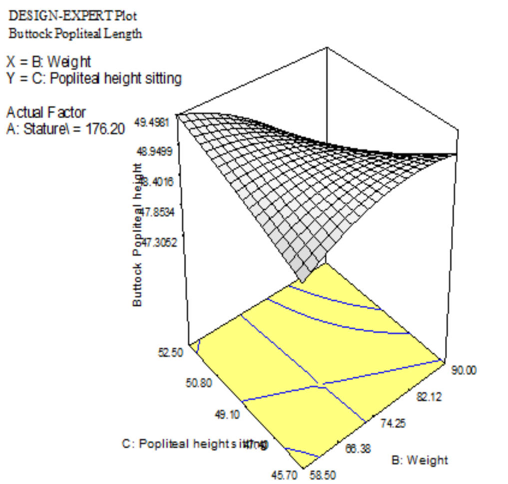


(c)

Figure 4: Stature and Popliteal Height Sitting Response Surface Interactive Plotsof
a. PBL, b. AAR, c, TCH

Response 3: Thigh Clearance Height (TCH)

Figure 5c shows the interactive effect of weight and popliteal height on the response TCH. At low (45.70cm) and high (52.50cm) values of Popliteal Sitting Height, TCH increases directly proportional as weight, as TCH decreased from 15.21 to 13.83 for the former and 15.09 to 14.54 for the later while the weight for both was maintained at 58.50 to 90.00.



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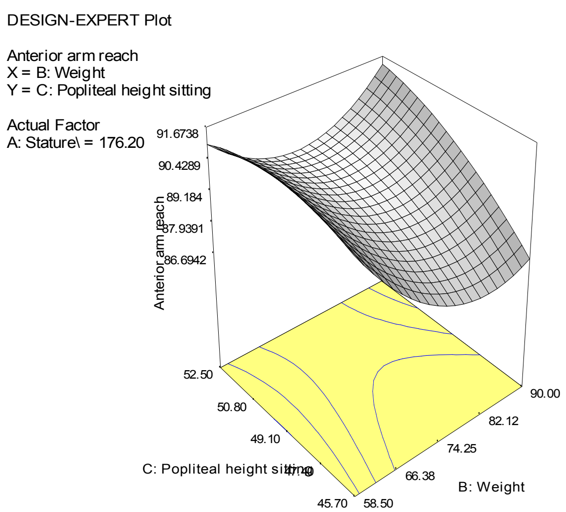

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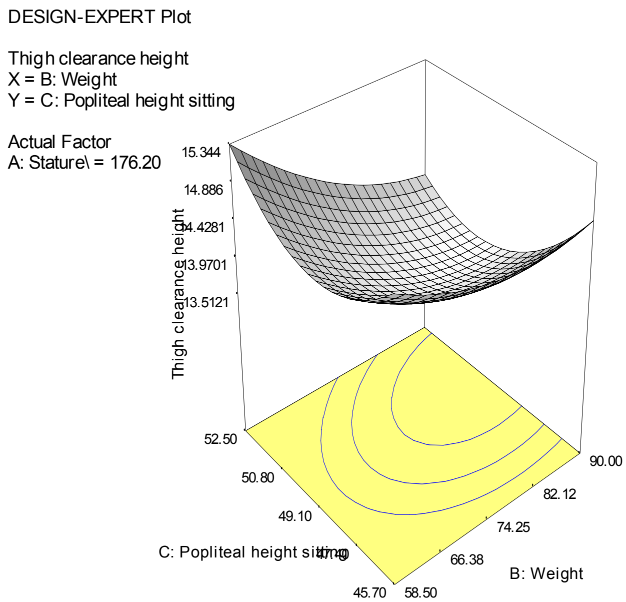

(c)

Figure 5: Weight and Popliteal Height Sitting and Response Surface Interactive Plotsof a. PBL, b. AAR, c, TCH

3.5: Efficiencies of the Models

The most common performance measures for the efficiency of predictive models are co-efficient of determination (R^2) and co-efficient of variation (C.V) (Agha, et al., 2012). High value of R^2 and low value of C.V are desirable (Oladapo and Akanbi, 2015). In this study, three models were developed and the adjusted co-efficient of determination (R^2) is greater than 0.85 in all. In general, all the models showed good predictive ability (efficiency) as can be observed in Table 5. Not less than 75% of the models have adjusted R^2 value of over 90% and non-of the models have adjusted R^2 value that is less than 85%. This confirmed the validity of the models. Furthermore, according to a high coefficient of variation (C.V) demonstrates that variation in the mean value is large and does not sufficiently generate an acceptable response model (Liyana-Pathirana and Shahidi, 2005). Therefore, CV < 10% has been suggested suitable in predicting the response surface models. Hence CV ≤ 6.56% for all the models implied that the models exhibited very high predictive ability and very efficient.

Table 5: Model Estimation Result

Response	BPL	AAR	TCH
R-Square	0.88205	0.96269	0.935624
Adj R-Squared	0.87502	0.960466	0.931787
Pred R-Squared	0.852191	0.953642	0.919456
Adeq Precision	67.99473	109.9555	98.09248
Std. Dev.	0.184973	0.248795	0.09226
Mean	49.0624	89.09744	14.05289
C.V	0.377017	0.27924	0.656517
PRESS	6.474407	11.61347	1.608084

3.6 Models Description

Using ergonomic principles, the common anthropometric measurements considered in the design of driver's workstation are popliteal height for seat height, buttock-popliteal length for seat depth and thigh clearance height for vertical distance from the steering wheel to the seat top level. This study has developed three mathematical models considered necessary for estimating the pertinent the design of driver's workstation. While the relationships among standing height and length dimensions have usually been assumed linear, the present study confirmed that all the developed models. According to Ismaila et al., (2014), it can be very expensive in developing countries like Nigeria to obtain anthropometric data when needed, and as such, measuring few ease-to-measure anthropometric variables to determine others would be helpful and affordable. Although economic reason is important but, at the same time, adequacy and effectiveness of the predictive models cannot be compromised. The current study took these three factors; economic reason, adequacy and effectiveness into consideration and in view of the high predictive ability of the models, using them in estimating other ones are justifiable.

4.0 CONCLUSION

Anthropometric data obtained from occupational bus operators of Nigeria have been modeled using RSM and resulting models potentially found good applications in the predictions of the studed anthropometric variables needed in the design and manufacture of drivers workplace and in-vehicles elements.The haculian task and cost associated with large population human body dimension can reduced significantly with the instrumentality of reliable models such as those developed in this work. This study has proposed three mathematical models that can be used to estimate various anthropometric dimensions necessary for the design of workstation compatible to drivers in Nigeria and the automobile industry would find in these models reliable, economical, effective and efficient prediction tools.

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