ERGONOMICS ASSESSMENT AND IMPROVEMENT OF TRICYCLE RIDER'S SEAT

Musa Adekunle Ibrahim[1]*, Ihe Goodness[2], Musa Ayomide Idris[3], Adesusi Olanrewaju Moses[4]

[1&2]Department of Mechanical Engineering, Olabisi Onabanjo University, Ago Iwoye, Nigeria
[3]Department of Mechanical Engineering, Bells University of Technology, Ota, Nigeria
[4]Department of Mechanical Engineering, Igbinedion University, Okada, Nigeria
*Corresponding author email: musa.adekunle@oouagoiwoye.edu.ng

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Abstract: This research aimed to enhance the comfort and safety of tricycle riders by optimizing the ergonomic design of their seats. The study employed a mixed-methods approach, incorporating anthropometric measurements, questionnaire surveys, and seat pressure mapping for a comprehensive evaluation. Anthropometric measurements, including seated height, elbow to fingertip, buttock to knee length, hand dimensions, and others, were gathered to understand the diverse body sizes among riders. The collected data underwent analysis using SPSS software, revealing a mean sitting height of 81.53 cm, knee height of 50.24 cm, and hand length of 19.33 cm. Results indicated that 43.3% of riders found the seats convenient, while 56.7% considered them inconvenient. Similarly, 56.7% perceived the tricycle steering as too rigid, contrasting with 43.3% finding it flexible. Notably, all riders were comfortable with the side mirror positions. However, 53.3% found the distance between the knee and the tricycle body frame inconvenient. Regarding tyre replacement, 76.7% replaced tricycle tyres annually, while 23.3% did so every six months. The study identified a prevalent issue of inadequate lumbar support and cushioning in current seats, leading to reported discomfort and fatigue during prolonged rides. Insights from this research contributed to the development of tricycle seats prioritizing rider comfort, aiming for safer and more enjoyable tricycle experiences.

Keywords: tricycle, anthropometric, seat, design, comfort, rider

Introduction

Tricycles hold significance within the transportation domain as they effectively tackle the obstacles associated with private cars in various countries, such as negotiating tight and limited roadways and coping with a growing population (Toanchina, 2019). The presence of tricycles significantly impacts transportation, accessibility, safety, and even serves as a form of artistic expression (Noorsasetya and Harsanto, 2019).Nonetheless, extended periods of sitting present a range of challenges for tricycle riders. One issue involves the potential for injuries due to improper seated positions. Sitting in a way that causes knees to extend beyond the tricycle's body can lead to collisions with objects, resulting in harm (Salawu and Kolade, 2019). Another concern is the discomfort and muscle fatigue experienced (Shafiei et al., 2015). However, Lothe (2020), noted that elderly women passengers in India who ride as pillion riders on motorcycles while seated sideways face challenges concerning ergonomic factors and the organization of seating. The comfort and safety of tricycle riders are directly influenced by the design of their seats. There is a requirement to enhance the current motorcycle seat design to effectively tackle these concerns and lower the susceptibility to musculoskeletal disorders (Lothe, 2020). This study centers on assessing the ergonomic aspects of tricycle seats and suggests design improvements aimed at enhancing the overall riding satisfaction.

The concept of ergonomic vehicle design involves creating vehicles that prioritize the well-being, safety, and effectiveness of both drivers and passengers (Santos D, 2023; Bubb et al., 2021; Kumar et al., 2020; Majumder and Chowdhury, 2019). Ergonomics, the study of designing products and systems for optimal human interaction, is a critical consideration in vehicle design. Tricycle riders, particularly those involved in business operations, devote prolonged hours on the road, underscoring the significance of a thoughtfully designed seat. Inadequately designed tricycle seating can lead to rider discomfort and potential harm. It may cause instability, difficulties in steering, increased vibrations, fatigue, and can even play a role in the development of persistent musculoskeletal issues (Barchek et al., 2016; Suvac and Ganea-chrstu 2019; Albert et al., 2020).

In this study, assessment of the existing tricycle seat designs was performed to determined ways to make the workstation better. While assessing the tricycle, it was discovered that majority of the riders has problem of seat and knee problem. In view of this, authors aimed at investigating the comfort and safety of tricycle riders in billed to improve and recommend the ergonomic design of their seats. This research also delves into the ergonomics of tricycle seats through a comprehensive evaluation of the existing seat and rider.

Materials and Method

I. Participants

A diverse group of tricycle riders was recruited and investigated in this study. The participants included both male and female riders from various age groups and backgrounds, ensuring a representative sample of the target population. The study was conducted in Ifo Local Government Area, Ogun State, Southwestern Nigeria, and involved 125 (male and female) tricycle riders.

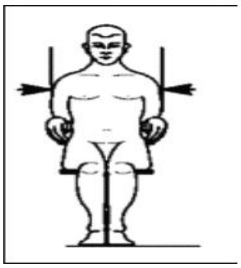
II. Anthropometric Measurements

Anthropometric measurements were taken to gather data of the physical dimensions of the participants. Body dimensions measurement such as height in a seated position,

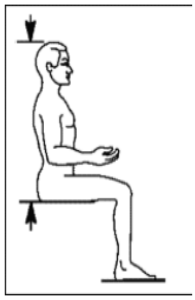
elbow to fingertip, and buttock to knee length, hand length, buttock to popliteal length, hand width, knee Height, shoulder width, popliteal height, hip width, and shoulder to elbow height were performed and recorded to understand the range of body sizes within the rider population.

a) Buttock-to-popliteal length

b) Popliteal Height



c) Shoulder Width



d) Height in a seated position

Fig 1: Anthropometric Measurements

The figure 1 shows few of the anthropometric measurements taken from the research participants.

III. Questionnaire Surveys

Participants were asked to complete a questionnaire that focused on their riding habits, comfort levels, and discomfort points related to the tricycle seat. The survey also included questions about any existing musculoskeletal issues that might be exacerbated by prolonged sitting.

IV. Seat Pressure Mapping

Seat pressure mapping technology was utilized to assess pressure distribution across the tricycle seat during different riding conditions. This involved placing pressure sensors on the seat and recording data while participants rode under various scenarios, including short and long rides.

An observational study was carried out on the rider's seats. Physical measurement of fourteen (14) variables related to seat, access and exit were carried out on thirty (30) sampled TVS king brand of Tricycles.

Tricycle data measured

Seat Width, Seat to Compartment, Seat Length, Compartment Width ,Width of space where to kept money, length of compartment, Seat Height, Door Height , Sitting Height , Door Width, Floor Length, Tilt (lower) of the tricycle in degree, Floor Width ,Tilt (upper) of the tricycle in degree

V. Proposed Design Recommendations

Based on the findings from the evaluation, design recommendations were formulated to address the identified ergonomic shortcomings. These recommendations encompassed seat contouring, lumbar support mechanisms, cushioning materials, and adjustability features.

VI. Data Analysis

The information collected from anthropometric measurements, surveys, and seat pressure mapping was subjected to analysis using SPSS software, version 21 and Microsoft excel (2010) for descriptive statistics and percentiles. This analytical process aimed to uncover discomfort patterns and pressure points. Through this assessment, valuable information was obtained regarding potential areas where the current seat might lack ergonomic suitability.

Results and Discussion

This section presents the quantitative outcomes from the study, analyzing data obtained from the anthropometric and subjective measurements. Out of 130 riders involved in this study, only 125 (83.3%) riders completed the exercise of measurements. Participants confirmed their use of tricycles for transportation for a minimum of three years. The data on body measurements among tricycle riders showed a wide variety. This gives rise to the need for seat designs that can fit different body sizes and shapes to ensure everyone is comfortable and well-supported.

Table 1 shows the average mean value, 5^{th} percentile, 95^{th} percentile of the participant's anthropometric measurement respectively.

Table 1: Anthropometric Data of Tricycle Rider

Anthropometric Measurement (cm)	Mean	5th Percentile	Median	95th Percentile	Std. Dev.
Sitting Height	81.53	69.00	78.00	88.40	3.20
Buttock to Knee Length	50.12	40.00	50.00	59.00	3.30
Buttock to Popliteal Length	42.11	32.00	42.00	50.00	3.22
Knee Height	50.24	37.60	50.00	54.00	3.19
Popliteal Height	47.11	29.86	40.25	49.00	3.25
Shoulder to Elbow Length	31.53	25.72	30.00	38.20	2.40
Elbow-Finger tip Length	42.51	30.51	41.00	45.10	2.58
Shoulder Breadth	40.33	30.74	39.40	42.35	3.88
Hip Breadth	33.87	26.50	30.00	40.20	4.30
Hand Length	19.33	14.00	17.00	19.54	1.30
Handbreadth(metacarpal)	10.08	8.00	9.00	10.40	0.75

Table 1 shows the average mean value of the sitting height as 81.53 (±3.20) cm, knee height of 50.24 (±3.19) cm and 19.33 (±1.30) cm of hand length. Similarly, the result shows that the participants have 47.11 (±3.25) cm, 40.33 (±3.88) cm and 33.87 (±4.30) cm of popliteal height, shoulder breadth and hip breadth respectively.

Table 2: Subjective measurement from Tricycle Riders

Questions	Options	Frequency	Percentage
Is the rider's seat convenient?	Yes	13	43.3%
	No	17	56.7%
Is the steering too rigid or flexible?	Rigid	17	56.7%
	Flexible	13	43.3%
Are you comfortable with the position of the side mirrors?	Yes	30	100%
	No		
Are you comfortable with the distance between your knee to the body frame of the tricycle while riding?	Yes	14	46.7%
	No	16	53.3%
How frequent do you change the tyres?	1 Year	23	76.7%
	Six month	7	23.3%
Would you suggest removing the manual start option?	Yes	0	
	No	30	100%
Would you suggest an improvement on the manual start option?	Yes	30	100%
	No	0	
Are you comfortable with the position of the handbrake?	Yes	28	93.3%
	No	2	6.7%
Do you carry beyond the no of passengers required?	Yes	30	100%
	No	0	
Are you comfortable with the position of hand gear?	Yes	30	100%
	No		

Table 2 shows the result of the subjective measurements (Questionnaires) administered to the riders. The result showed that a considerable number of riders felt uncomfortable, especially in their lower back and buttocks, during long rides. Majority of the rider mentioned that the current seats does not provide enough support for their lower back and weren't cushioned well, which made them feel stressed and tired (Table 2).

Table 2 further presents the following findings regarding the riders' responses: Over forty three (43.3%) of the riders indicated that the seat is convenient, while 56.7% found it inconvenient. Similarly, 56.7% of the riders reported that the steering is rigid, while 43.3% mentioned that it is flexible. All of the riders (100%) indicated that they are comfortable with the position of the side mirrors. However, 46.7% of the riders reported being comfortable with the distance between the knee and the body frame of the tricycle workstation, while 53.3% found it inconvenient. Regarding tyre replacement, 76.7% of the riders indicated replacing the tricycle tires yearly, while 23.3% reported replacing them every six months. All of the riders (100%) indicated that the manual start option should not be removed, and 100% of them also suggested improvements to the manual start option. over ninety three percent (93.3%) of the riders expressed comfort with the position of the handbrake, while 6.7% were not comfortable with its position. All of the riders (100%) admitted to carrying more passengers than the required number. Additionally, all of the riders (100%) reported being comfortable with the position of the hand gear.

Table 3: Tricycle Physical Measurement

	Tricycle variables	Average measured (cm)	Recommendation (cm)
i.	Seat width	75.61	76.70
ii.	Seat length	35.42	36.51
iii.	Seat height	21.73	22.84
iv.	Sitting height	84.80	85.20
v.	Floor length	56.83	57.72
vi.	Floor width	75.62	76.51
vii.	Seat to Compartment	13.83	14.95
viii.	Width compartment	14.21	15.30
ix.	Length compartment	41.77	42.58
x.	Door height	90.62	92.59
xi.	Door width	41.71	43.92
xii.	Width of space where to save money	18.95	19.00
xiii.	Tilt (upper) in degrees	11.00	12.11
xiv.	Tilt (lower) in degrees	9.00	10.20

Table 3 shows the physical measurement of the tricycle such as seat width, seat length etc. The Seat pressure mapping data confirmed the areas of discomfort reported by participants. High-pressure zones were consistent with the regions where discomfort was commonly experienced. This data further emphasized the importance of distributing pressure evenly across the seat surface to prevent discomfort and pressure-related issues.

Table 3 further shows the measurement of tricycle seat width, seat length and height of floor to seat as 75.61cm, 35.42cm and 21.73cm respectively. Similarly, sitting height, floor length and floor width of the tricycle was measured as 84.80cm, 56.83cm and 75.62cm respectively.

The seat to compartment, width compartment, and length compartment of the tricycle was measured as 13.83cm, 14.21cm and 41.77cm respectively. Moreso, the height of door and width of door was measured as 90.62cm and 41.71cm respectively.

Table 3 also shows the recommended dimension based on the obtained measurement of the anthropometric dimension of the riders.

Bringing together the body measurements, survey responses, and seat pressure mapping findings, it became clear that the current tricycle seat design didn't effectively prioritize rider comfort and ergonomics. The main issues identified were the absence of proper lower back support and insufficient cushioning. This study shows a similarly trend in Barchek et al., (2016) and Suvac and Ganea-chrstu (2019) studies based on the development of persistent musculoskeletal issues.

The results of this study highlighted how vital it was to think about rider comfort when designing tricycle seats. Extended rides without proper support also result in discomfort, tiredness, and possible health problems.

Conclusion

This study identified critical shortcomings in the ergonomic design of tricycle seats, notably in lumbar support and cushioning, leading to discomfort and fatigue during

prolonged rides. The findings, derived from anthropometric measurements, surveys, and seat pressure mapping, underscore the need for a re-evaluation of seat design aspects such as cushion materials, lumbar support mechanisms, and adjustability.

Recommendations stemming from this research suggest implementing improved seat designs that prioritize rider comfort and well-being. This may involve incorporating better lumbar support, utilizing advanced cushion materials, and enhancing adjustability features to accommodate a diverse range of body sizes within the rider population. Furthermore, addressing concerns raised by riders regarding the rigidity of tricycle steering and the distance between the knee and the body frame should be considered in future design modifications.

By prioritizing these ergonomic improvements, tricycle manufacturers can enhance the overall safety and enjoyment of tricycle experiences for riders. Ultimately, this study contributes valuable insights that can guide the development of tricycle seats that not only meet ergonomic standards but also contribute to a more enjoyable and safer riding experience.

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