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Investigation of the Suitability of Tricycles with the Riders in a Nigerian Tertiary Institution

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Abstract

Inappropriate tricycle designs can cause serious health and safety risks for riders. This study examined tricycles at a Nigerian tertiary institution to assess their compatibility with riders. Ten anthropometric measurements were taken from 100 tricycle riders, along with eleven relevant dimensions of the riding space from two tricycle brands (TVS and Bajaj), at a tertiary institution in Southwest Nigeria. The anthropometric data of the riders were analysed, and the dimensions of the two brands were assessed to determine their suitability for the riders' anthropometry. The results showed that Seat Height (SH) has a high match of 92% for TVS and 87% for Bajaj. Additionally, Seat Width (SW), Seat Length (SL), Backrest Height (BH), and Backrest Width (BW) all exceed a 90% high match. However, the comparison between Foot Breadth (FB) and Pedal Width (PW) revealed a 100% low match for both brands. The findings suggest that the current tricycle designs do not perfectly match the anthropometrics of riders in the tertiary institutions. Therefore, future designs should incorporate the anthropometric characteristics of the dominant rider age group in Nigerian tertiary institutions.

Keywords
Ergonomics, Tricycles, Anthropometric data, Suitability, Tricycle Riders.

1. Introduction
Over the years, Nigeria has faced numerous challenges in the transportation sector, especially within intra-city transportation and public tertiary institutions (Usman and Egbinola, 2025). These challenges include high operational and maintenance costs, fuel availability, fuel prices, poor road networks, and inaccessibility (Okeagu, 2024; Atela *et al.*, 2021). To address these issues, the use of motorcycles and tricycles has become widespread, with a greater focus on tricycles due to their ease of manoeuvring on poor road networks, short distances, and fuel efficiency (Ishak *et al.*, 2023). The benefits of tricycles have led to a rise in their adoption over the past five years, as many people now regard them as affordable, safer, and more secure for short trips along less-trafficked roads. In fact, many streets, estates, and tertiary institutions in Nigeria now prefer tricycles for public transportation within their areas.

Students, academic staff, non-academic staff, and vendors in Nigeria's tertiary institutions require a means of transportation to get to their classes and other locations within the school premises (Otu and Agugua, 2020). Over the years, tertiary institutions in the country have adopted various means of transportation, such as motorcycles, buses, cabs, and tricycles. However, the use of tricycles or "Keke" as they are popularly called has increased because they are a safer and easier option for on-campus transportation than motorcycles (Olaiya *et al.*, 2024). Also, they have the capacity to transport more passengers at a time, are more stable, and are protected from harsh weather conditions. It has a well-regulated travelling speed, and as such, the university authorities are confident that speed limits within the university environment can be effectively managed with tricycles.

The widespread use of tricycles for transportation in Nigerian tertiary institutions has generated more employment opportunities (Ibrahim, 2018; Olaiya *et al*., 2024). This means of transportation is now in high demand among students for daily intra-campus movement and nearby travel. To meet this daily transportation need within the university, tricycle riders spend considerable time on their vehicles, navigating different routes, which results in many repetitive tasks each day. The nature of the riders' job requires them to maintain a specific working posture throughout their working period. This includes prolonged sitting postures, which can lead to musculoskeletal disorders (MSDs). To assume and sustain these postures comfortably, the parameters of the tricycle that interact with the rider's body must meet specific ergonomic standards for this type of work. Therefore, it is essential to evaluate the suitability of the tricycle for the riders in line with the ergonomic principle of fitting the job to the person. This has become the primary focus of this study.

Although tricycles used for commercial transportation in Nigeria are assembled in Nigeria, they are designed and manufactured by Asian-based companies with different physical characteristics from those of Nigerians. Thus, their designs may not have captured the entire anthropometric dimensions of the Nigerian users. Additionally, the absence of a well-established ergonomic standard based on Nigerian anthropometric data, combined with Nigeria's multicultural nature, may pose another challenge in achieving a unified design (Adebimpe *et al*., 2024). According to Onawumi and Lucas (2012), this lack of organised and comprehensive anthropometric data is the major challenge of developing countries, including Nigeria. With this in view, it is then important to evaluate the suitability of tricycles for the Nigerian riders using the standard ergonomic principles.

Numerous efforts have been made regarding the ergonomics of tricycles. Dorado *et al.* (2015) applied different ergonomic assessments to evaluate the factors that contribute to the discomfort of passengers. Also, Uba *et al.* (2018), Adeyemi and Yusuf (2019), Jaiyesimi *et al.* (2018), Osoja and Olasokan (2019) considered the ergonomics of tricycles and other automotive vehicles for commercial transportation. The outcome of this research revealed that the Nigerian users' comfort has not been well accounted for in the design of these vehicles. Their reports revealed different cases of musculoskeletal disorders as a result of the incompatibility between tricycles and the anthropometrics of users and roads in Nigeria (Jaiyesimi *et al.*, 2018; Oluwakoya, 2024). Gumasing and Liao (2021), in their efforts, identified some of these factors contributing to the discomfort level of passengers in riding the tricycle and came up with an ergonomic design of a motorised tricycle as a standard blueprint in the Philippines. Musa (2024) made efforts to optimise the workstations of a tricycle for rider comfort by incorporating ergonomic solutions. Ibrahim *et al*. (2024) worked on the optimisation of the tricycle seats and discovered the prevalence of discomfort to riders' wrists, neck, and shoulders because of the current workstation. This was followed by a proposal on the need for optimisation of leg space, introduction of a headrest, and enhancing seat comfort.

Although previous work has furthered research in this area, many of these works have investigated the issues of comfort of the passengers and riders, but have not fully captured some parameters that are considered pertinent to tricycle operations. Thus, this study aims to assess the suitability or otherwise of commuting tricycles in a tertiary institution for the riders based on their anthropometric data.

2. Methodology

2.1 Sample and Study Design

This study considered the tricycle riders stationed at the main park of a public university in South-Western Nigeria. The tricycle transportation system is operated as a commercial business by individuals under the regulations of the university. The riders are responsible for the intra-campus transportation of students, staff and visitors at a regulated fee. A preliminary study revealed the ages of the riders to be between 20 and 60 years, and they operate as an organised group within the university community. The group was visited, briefed and engaged in research. A total of 100 willing male tricycle riders, who represent more than 55% of the active tricycle operators within the university, were randomly selected. This sample aligns with the prevailing gender distribution among the riders in the park.

Structured questionnaires were administered to the willing participants to obtain information regarding bio data, work-related data, brand of tricycles, work experience, and work-related pains. Questions regarding riders' comforts were on tricycle seats, backrests, handlebars, pedals, and the exit system. Also, eleven tricycle parameters that are relevant to operating a tricycle were identified and measured. The measurements formed the basis for determining the level of match between the tricycles' design and the corresponding anthropometrics of the riders.

2.2 Data Collection Procedure

The parameters of tricycles that were considered relevant for ease of operation and operators' comfort were identified through an observational study of the riding operation, literature, and manufacturers' guides. The identified relevant tricycle parameters and the corresponding anthropometric data are explained as follows;

1. **Seat height (SH):** This is the vertical distance from the base of the tricycle's seat to the floor of the tricycle. The anthropometric data of users that corresponds to this is the popliteal height (PH), as it affects the angle at the knee joint when the rider is driving.

2. **Seat width (SW):** This is the horizontal distance from one end of the tricycle's seat to the other end. The corresponding anthropometric data measured in users with respect to seat width is the hip breadth (HB).

3. **Seat length (SL):** This is measured as the horizontal distance from one end of the seat to the other. For the ergonomic evaluation, the corresponding anthropometric data measured is the buttock to popliteal length (BPL), as this body part has direct contact with the seat.

4. **Backrest width (BW):** This is the distance from one end of the backrest to the other. The shoulder breadth (SB) of the user is measured as the corresponding anthropometric data for this tricycle parameter.

5. **Backrest length (BL):** This is the vertical distance from the top of the backrest to its bottom. The corresponding users' anthropometric data is the shoulder sitting height (SSH) because it determines the necessary backrest height to provide adequate support to the upper body.

6. **Exit width (EW):** This is the horizontal distance from one end of an exit access to the other end. The corresponding anthropometric data measured in users is the maximum body breadth (MBB) to ensure that the user can easily and safely exit the tricycle without any obstructions.

7. **Handlebar width (HW):** This refers to the distance between the two ends of the handlebar. The corresponding anthropometric data is the elbow-to-elbow breadth (EEB), as this influences the rider's comfort and stability.

8. **Handlebar height (HH):** This is the vertical distance between the handlebars to the ground of the tricycle. The corresponding anthropometric data measured is the Sitting knee height (SKH) because the design of the handlebar height should be designed in a way that allows a rider to maintain a comfortable and upright posture while riding.

9. **Handlebar reach (HR):** This is measured as the horizontal distance from the centre of the handlebar to the backrest. The corresponding anthropometric data measured in users is the functional thumb tip reach (FTR).

10. **Pedal width (PW):** This is the horizontal distance between the ends of the pedal. The corresponding anthropometric data measured in the user is the foot breadth (FB) because it can impact how comfortable and effective the rider is when operating the pedal.

11. **Headroom (H):** This is the vertical distance or space between a tricycle user's head and the roof of the tricycle. The corresponding anthropometric data of the operator is the sitting height erect (SHE), as it determines the amount of space that a person would require to comfortably sit in the tricycle without their head hitting the roof.

2.3 Anthropometric Data of Tricycle Riders

The data collection process employed the service of three well-trained personnel alongside the researchers to measure the dimensions of the tricycles and the corresponding riders' anthropometrics. The measurements were achieved using a set of tools, including a tape measure, weighing scale, record sheet, anthropometer and structured questionnaire.

During the measurement period, the riders wore minimal clothing and were barefoot to minimise errors. The measurements for standing and sitting positions were taken on a level, non-compressible and horizontal platform. Standard procedures for anthropometric measurements were followed. For instance, during stature measurement, the measured subjects were positioned to look straight ahead with their heels together, relaxed upper body, and at normal breathing. Measurements at sitting positions were done with an erect torso, relaxed shoulders, supported feet, and thighs parallel to each other.

The relevant tricycle parameters and the corresponding anthropometric data were measured as shown in Table 1, with Figure 1 illustrating the pictorial representations of the measured anthropometric data.

Table 1.Tricycle parameters and corresponding anthropometric details

S/N	Tricycle parameters	Corresponding anthropometric details
1	Seat height	Popliteal height (PH)
2	Seat length	Buttock-popliteal length (BPL)
3	Seat width	Hip breadth (HB)
4	Headroom	Sitting height erect (SHE)
5	Backrest width	Shoulder breadth (SB)
6	Backrest length	Sitting shoulder height (SSH)
7	Handlebar width	Elbow-elbow length (EEL)
8	Handlebar reach	Functional thumb tip reach (FTR)
9	Handlebar height	Sitting knee height (SKH)
10	Exit width	Elbow-elbow length (EEL)
11	Pedal width	Foot breadth (FB)

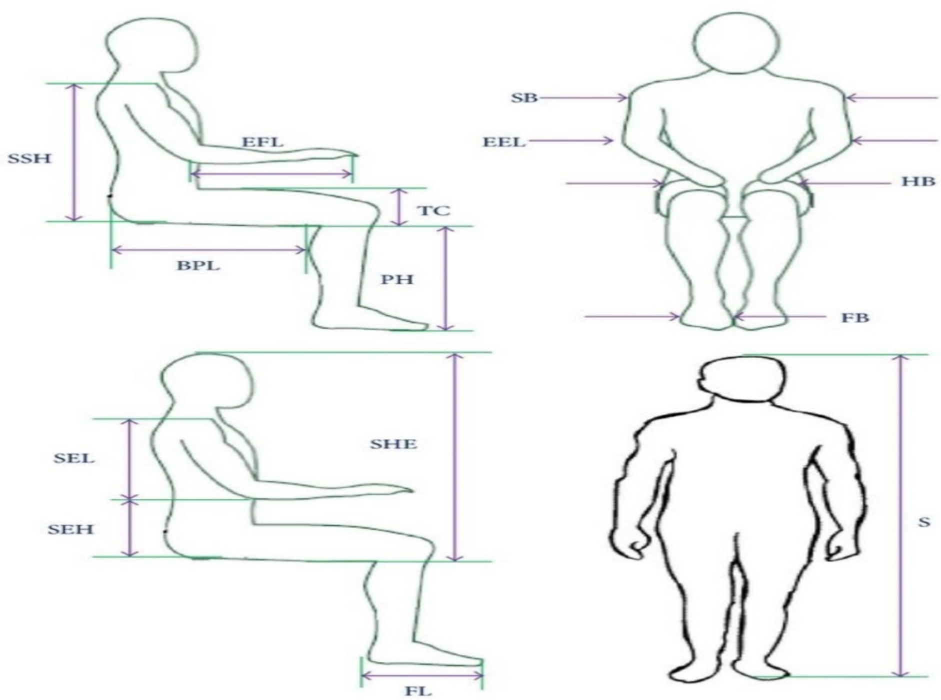

Figure 1. Identified corresponding anthropometric data
Source: Adeyemi and Yusuf (2019)

2.4 Assessment of the Tricycle Suitability

The suitability of the tricycles was evaluated by determining the level of match with the rider. This was done by comparing the riders' relevant anthropometric data with the existing tricycle dimensions. For the evaluation, relevant equations based on ergonomic principles were employed to determine the range within which the tricycle parameters were considered suitable for the riders. The relevant ergonomic principles that were considered in the assessment of the tricycles with riders are presented in Table 2. The collected anthropometric data of the riders were analysed using statistical methods such as the mean, variance, standard deviation, and percentile. The results from the analysis were incorporated into equations appropriately to form a benchmark design that was compared with the rider's body parameters.

After applying the standard equations, the existing tricycle parameters were compared with users' body anthropometrics, and three categories for match level were defined. The three categories are Match, High match and Low match. The "Match" level occurs when the anthropometric measure falls within the design limits. A "High match" level is achieved when the minimum limit of the parameter exceeds the anthropometric measure. Users whose anthropometric details fall under the "High match" region may still find the related parameter usable after adjusting their position. A "Low match" level is when the maximum limit of the design parameter is lower than the anthropometric measure. Users within this range may experience discomfort when using the related parameter.

Table 2. Equations for assessing the suitability of a tricycle for the rider

S/N	Tricycle design parameter	Anthropometric Data	Recommended Standard
1	Seat width (SW)	Hip breadth (HB)	$1.10HB \leq SW \leq 1.30HB$ 95th Percentile of HB, SW should be between a minimum of 110% and a maximum of 130%.
2	Seat height (SH)	Sitting popliteal height (SPH)	$(SPH+3)Cos\ 30° \leq SH \leq (SPH+3)Cos\ 5°$ SPH should be higher than SH.
3	Seat Depth (SD)	Buttock to popliteal length (BPL)	$0.80BPL \leq SD \leq 0.95BPL$ 5th Percentile of the BPL and the BP: should be higher than SD.
4	Backrest width (BW)	Shoulder breadth at sitting (SB)	$BW \leq SB + 0.2SB$ 95th Percentile of SB
5	Backrest Height (BH)	Shoulder sitting height (SSH)	$0.6055H \leq BL \leq 0.8055H$ Between 60% and 80% of SSH.
6	Pedal width (PW)	Foot breadth (FB)	$PW \geq FB$ 95th Percentile of FB
7	Handlebar reach (HR)	Functional thumb tip reach (FTT)	$HR \leq FTT$ 5th Percentile of FTT
8	Handlebar width (HW)	Shoulder breadth (SB)	$HW \leq SB + 5CM$ 50th Percentile of SB
9	Handlebar height (HH)	Sitting Knee height (SKH)	$HH \geq SKH + 5CM$ 95th Percentile of SKH
10	Exit way (EW)	Elbow to elbow length (EEL)	$EW \geq EEL + 0.2EEL$ 95th Percentile of EEL
11	Headroom (H)	Sitting height erect (SHE)	$H \geq SHE + 5CM$ 95th Percentile of SHE

Sources: Guitierrez and Morgado, 2001; Molenbroek *et al.,* 2003; Milanese and Grimmer, 2004; Gouvali and Boudolos, 2006; Gouvali and Boudolos, 2006; Oyewole *et al.,* 2010

3. Results and Discussion

The percentage analysis of the questionnaire shows that 40% of the riders were between 26 and 35 years old, 38% were between 36 and 45 years old, 15% were aged 46 to 55, and the remaining 7% were between 18 and 25. This indicates that over 70% of the riders were between the ages of 26 and 45, which is considered the active and energetic working age group. The popular brands of tricycles used in the study area were TVS and Bajaj, with TVS being the most used, accounting for 88%, while only 12% of Bajaj tricycles were used.

Experience levels of the riders in tricycle transportation were considered when evaluating response quality. The analysis shows that a larger percentage of riders, about 48%, had between 3-5 years of experience in riding commercial tricycles; 17% of the riders have been riding tricycles for 6-10 years; 16% have over 10 years, and 19% had less than 2 years of experience. This suggests that the subjects possess better knowledge of their job and are more capable of providing an adequate response.

Analysis of the daily operation of the riders reveals that 39% of the riders made more than 41 trips per day, 29% made between 21-30 trips, 20% made between 31-40 trips per day, 6% made 11-20 trips, while the remaining 6% made less than 10 trips per day. These indicate that a larger percentage of the riders work full-time, with only 6% being part-time tricycle riders. This corroborates the fact that tricycle operation for commercial transportation is now regarded as a full-time job in Nigeria, with many riders viewing a Tertiary institution as a suitable place for their riding business. Putting this number of trips into time context, it was observed that a larger percentage of the riders worked more than 9 hours a day. 53%, 37% and 10% work between 9 to 12 hours, 5-8 hours and above 12 hours per day, respectively. This violates the standard 8 hours per day and not more than 48 hours a week of the International Labour Organisation (Syed, 2024).

The working culture of the tricycle riders is not healthy and good for a long-term job, as they spend many hours sitting down. Also, they have minimal rest within these busy schedules. For instance, analysis of the frequency of breaks taken by the riders between trips and their duration shows a lack of sufficient rest. The statistical analysis shows that 43% of the riders take about 3 breaks, 37% take between 4-6 breaks, 12% take between 7-9 breaks, while the remaining 8% take more than 15 breaks daily during their working hours. However, the frequency of the breaks did not justify the deserved relaxation time. The analysis of the total time spent during the break indicates that many took about 20 minutes per break. Meanwhile, it was observed that the breaks and the durations are mostly situational rather than being intentional. This is because the organised group of tricycle riders adopted a First Come First Served (FCFS) queuing system, so upon arrival, riders join the queue and wait for their turn.

The analysis of responses from tricycle riders about their experiences with the tricycle parameters is presented in Table 3. 76% of riders strongly agreed that their tricycle seats were uncomfortable, indicating that most found the seats unsuitable. The poor fitness of the seat includes the lack of conformity to body shape, with 54% strongly agreeing to poor fit. Riders also reported poor posture due to the seat's design. 66% strongly agreed that the seat position negatively affects their working posture. Overall, seat comfort was very low for both brands of tricycles, as 90% of riders complained that their seats lacked sufficient cushioning. This is a critical issue that manufacturers must address in future designs to improve comfort and posture support.

The backrest designs for the two brands of tricycles were reported to be uncomfortable, with 65% and 23% of the riders strongly agreeing and agreeing, respectively, to the discomfort being caused by it. The backrest has been observed to contribute to a negative posture effect among the riders and lacks adequate upper back support during riding operations. This may exacerbate discomfort and contribute to upper-body strain.

Though the responses of riders about the height of the handlebars indicate a satisfactory level of suitability for the considered tricycle brands, there were some concerns regarding the ease of reach and control and the position strain. Responses regarding strains because of the handlebars of the tricycles indicate a mixed reaction, as some found it comfortable, while some reported strain. In the case of the pedal and throttle reach, they were found to be generally acceptable by the riders.

Table 4 shows the analysis of the collected anthropometric data of the riders. The mean of sitting popliteal height (SPH), hip breadth (HB), buttocks-popliteal length (BPL), Shoulder breadth (SB), Sitting height erect (SHE), Elbow-elbow length (EEL), Sitting knee height (SKH), Functional thumb tip reach (FTR), Foot breadth (FB), Sitting shoulder height (SSH) are 46.6 cm, 41.2 cm, 47.1 cm, 47.1 cm, 79.6 cm, 53.6 cm, 54.8 cm, 60.1 cm, 17.9 cm, 54.9 cm with standard deviation 2.2 cm, 3.6 cm, 2.6 cm, 2.1 cm, 2.3 cm, 6.7 cm, 2.2 cm, 2.5 cm, 1.3 cm, and 3.2 cm, respectively.

From the analysis, the standard deviation of the anthropometric data of the tricycle riders ranges from ±1.3 and ±6.7. The foot breadth (FB) has the lowest standard deviation, which suggests that the samples are close to the mean. The 5th, 50th, 95th, and 99th percentiles for SPH are 43.7, 50.5, 50.5 and 53.6, respectively. This implies that 5% of the population of the tricycle riders in the study area has a sitting popliteal height that is less than 43.7 cm, while more than 5% have a sitting popliteal height that is more than 50.5 cm (Table 3- Table 4).

Table 3. Analysis of tricycle riders' responses on the comfort of the relevant tricycle designs

S/N	**Questions**	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1	The seat of the tricycle is uncomfortable	76%	10%	4%	7%	3%
2	The seat does not fit my body shape and size well	54%	2%	18%	14%	16%
3	The seat does not affect my posture while riding	_	_	20%	14%	66%
4	The seat puts too much pressure on my backside	47%	34%	_	19%	_
5	The seat lacks sufficient cushioning	90%	8%	2%	_	_
6	The backrest is uncomfortable	65%	23%	_	12%	_
7	The backrest does not interfere with my ability to operate the tricycle	45%	10%	3%	15%	27%
8	The backrest affects my posture negatively while riding	63%	12%	5%	13%	7%
9	The backrest causes discomfort in my neck and shoulders	75%	10%	_	5%	10%
10	The backrest does not provide enough support for my upper back	50%	10%	4%	23%	13%
11	The handlebar height is suitable for me	67%	12%	_	6%	5%
12	The handlebar position does not strain my arms and shoulders	45%	23%	2%	17%	13%
13	The handlebar is easy to reach and operates all controls	34%	23%	1%	22%	20%
14	The pedal is easy to reach with my foot	56%	12%	3%	9%	20%
15	The throttle is designed in a way that prevents foot slippage	34%	10%	1%	50%	5%
16	The tricycle is easy to alight and board.	45%	3%	4%	43%	5%

Table 4. Descriptive statistics of riders' anthropometric data (n=100).
Dimensions are in Centimeters

Anthropometric Dimension	SPH	HB	BPL	SB	SHE	EEL	SKH	FTR	FB	SSH
Mean	46.6	41.2	47.1	47.1	79.6	53.6	54.8	60.1	17.9	54.9
Std. Deviation	2.2	3.6	2.6	2.1	2.3	6.7	2.2	2.5	1.3	3.2
Minimum	43.1	36.0	41.2	41.2	72.0	40.0	51	53.0	14.0	48
Maximum	53.7	48.7	51.4	51.3	84.5	61.8	60.8	65.9	20.5	63
5th Percentile	43.7	36.2	43.1	43.0	76.1	40.6	51.4	56.5	7.9	48.5

50^{th} Percentile	43.7	41.0	47.2	47.4	80.0	56.0	54.9	60.1	8.8	55.1
95^{th} Percentile	50.5	48.2	50.5	50.0	82.5	61.3	59.3	65.0	9.8	59.5
99^{th} Percentile	53.6	48.2	51.0	51.2	84.0	61.7	60.6	65.7	10.5	62.1

Table 5 shows the measured values of the tricycle parameters under consideration. The results indicate clear discrepancies between the parameters of the two tricycle brands used in the study area. This suggests that there is no strict standard that has been followed in the design of tricycles in Nigeria, and as a result, less consideration might have been given to the body dimensions of many of the Nigerian tricycle riders. The discrepancies between the two brands, which range from 0.5 cm to 9.0 cm, depending on the parameters, are an indication of a lack of uniform design among manufacturers targeting the same users.

In Table 6, the level of match between the riders' anthropometrics and the relevant parameters of the tricycle is presented. The parameters include backrest width, handlebar height, handlebar reach, exit width, and pedal width. The data in this study indicate a substantial level of high and low match between the anthropometric dimensions of tricycle riders and the tricycle parameters. From the table, Seat height matches 8% of TVS riders and 5% of Bajaj users, while the seat length matched only 8% of TVS tricycle riders and 4% of Bajaj tricycle riders. The backrest width matched only 4% of Bajaj tricycle riders. The exit width matches 15% of users who ride the TVS tricycles, and only 9% of Bajaj riders. The handlebar height matches 5% of users of the TVS tricycle, and 0% for the Bajaj tricycle. The handlebar reach matches only 19% of users of the TVS tricycle, and 1% of Bajaj tricycle users. Other results are either at high match or low match, which indicates that riders may have to make some body adjustments or compromise the appropriate riding posture during operation.

Table 5. Measured Tricycle parameters

S/N	Tricycle parameter	TVS Measured value (cm)	Bajaj measured value (cm)
1	Seat height	43.0	49.0
2	Seat width	69.0	64.5
3	Seat length	42.0	43.0
4	Backrest width	52.0	43.0
5	Backrest Height	34.5	35.0
6	Exit width	72.0	67.0
7	Handlebar width	61.0	63.0
8	Handlebar height	64.0	68.0
9	Handlebar reach	60.5	57.5
10	Pedal width	6.0	5.0
11	Headroom	96.0	101.0

Table 6. Percentage Match for Tricycle Riders

	MATCH (%)	HIGH MATCH (%)	LOW MATCH (%)
		Bajaj	
Dimensions			
SH	5	87	8
SW	_	100	_
SL	4	92	4
BH	4	92	4
BW	_	100	_
EW	9	40	51
HW	_	100	_
HH	_	100	_
HR	1	91	8
PW	_	_	100

H	_	100	_
TVS			
SH	8	92	_
SW	_	100	_
SL	8	92	_
BH	1	99	_
BW	_	100	_
EW	15	85	_
HW	_	100	_
HH	5	91	4
HR	19	35	46
PW	_	_	100
H	_	100	_

5. Conclusion

In this study, the ergonomic suitability of tricycles was investigated using tricycle riders in a tertiary institution in Southwest Nigeria as a case study. Relevant tricycle parameters for the study and the corresponding anthropometric details of users were identified by exploring several literature sources, manufacturers' guides, and specification guidelines. This includes seat height, seat width, seat length, headroom, backrest width, and backrest length. Also, relevant anthropometric data for operating tricycles, such as popliteal height, hip breadth, buttock-popliteal length, and sitting height of the riders within the study area, were analysed. Relevant ergonomic equations were generated to determine the level of match between the relevant tricycle parameters and the anthropometry of the riders. The result of the analysis shows that only a few of the tricycle parameters were found to perfectly match the riders' anthropometric. Parameters such as seat, cushion thickness, backrest, and pedal of both tricycle brands were found to be unsuitable and require some improvements.

In addition, the study revealed that tricycle riders lack basic understanding about work and corresponding relaxation, as analysis indicates that their frequency and duration of breaks did not merit the productive hours of operating the tricycles. Therefore, it is recommended that designers and manufacturers make necessary adjustments to improve the tricycle design parameters, such as the seat, the backrest, and the pedals. Also, education on work procedure and deserving rest targeted at the tricycle riders should be developed to help solve the work-related pains and issues of elongated riding hours.

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