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Analyzing Passenger Comfort in Modern Jeepneys: Measuring Compatibility with the Anthropometric Measurements of Metro Manila Commuters

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Abstract

In the Philippines, jeepneys are a key mode of transportation, accounting for 40% of public motorized trips. Launched in 2017, the Public Utility Vehicle Modernization Program (PUVMP) proposed modern jeepneys to address air pollution, enhance passenger safety, and alleviate traffic congestion. The Bureau of Philippine Standards issued specifications for four classes of modern jeepneys, focusing on dimensional limits. Despite millions of Filipinos using the Jeepneys, daily exposure to poorly designed jeepneys can lead to Musculoskeletal Disorders (MSDs) among passengers, affecting their ability to work effectively and safely. Existing studies indicate that discrepancies in seat design and measurement exacerbate MSDs. To assess whether modern jeepneys align with the anthropometric measurements of Filipino commuters, researchers collected various dimensions, including seat height, depth, and backrest height. The researchers measured 120 Filipino passengers, obtaining eight key anthropometric measurements such as popliteal height and sitting shoulder height. Using z-tests for analysis, it was found that seat width and ceiling height had the lowest percentage of unfit users. A mismatch analysis was created, utilizing the 5th and 95th percentiles of the anthropometric measurements to offer recommendations for improving modern jeepney dimensions. This research highlights the importance of ergonomic design in public transportation to enhance passenger comfort and prevent the onset of MSDs.

Keywords

Modern Jeepney, Anthropometry, Commuters, Mismatch Analysis, Ergonomics.

1. Introduction

In 2017, based on Department Order No. 2017-011: Omnibus Guidelines on the Planning and Identification of Public Road Transportation Services and Franchise Issuance, the Public Utility Vehicle Modernization Program (PUVMP) was launched. The Philippine government has worked to improve public transportation in Metro Manila by 2020 to address air pollution, traffic congestion, and passenger safety. This includes introducing modern jeepneys with ergonomic features like comfortable seating and proper ventilation. In the Philippines, over 40% of public motorized transportation trips are served by jeepneys, as (Romero et al. 2014) discussed. However, the country will see and use more modernized jeepneys on roads since after December 31, 2024, Public Utility Vehicle (PUV) operators are given twenty-seven (27) months to transition into modern jeepneys, minibusses, or e-jeeps, phasing out the existing traditional style per (Relativo J. 2023). Transitioning from the iconic jeepney design, known for its painted art and music, to a modernized version resembling a smaller bus will take time, as the old jeepneys have been in use since the 1950s. This shift presents a challenge for current drivers since the government will not replace traditional jeepneys, but it also offers an opportunity to reduce pollution and enhance safety in daily transportation.

According to Romero J.V (2024), the modern jeepneys the public is using are currently being imported as a whole or assembled in parts here in the Philippines. Due to its foreign sourcing, an analysis of Filipino anthropometric compatibility is needed to ensure that commuter body dimensions align with the standard measurements of modern jeepneys. This is important as millions rely on jeepneys for daily transportation, and using vehicles that do not fit their dimensions can result in musculoskeletal disorders and discomfort during travel. Table 1 and Figure 1 below consist of the modern jeepney measurements for one (1) to four (4) classes:

Table 1. Modern Jeepney Measurements

Class	**Seat Layout**	**Floor-to-ceiling height (h_{fc})**	**Gangway Width (w_g)**	**Seat Depth (d_s)**	**Width seat cushion (hip)(w_{sh})**	**Width seat back (shoulder) (w_{ss})**
1	Side-Facing Front-Facing	150 cm	60 cm 35 cm	35 cm	40 cm	40 cm
2	Side-Facing	175 cm	80 cm	35 cm	40 cm	40 cm
3	Front-Facing	175 cm	35 cm	35 cm	40 cm	40 cm
4	Front-Facing	175 cm	35 cm	35 cm	40 cm	40 cm

Class	**Floor-to-top seat cushion (h_{fts})**	**Minimum distance between backseats: front-facing (D_{bff})**	**Minimum distance between backseats: side-facing (D_{bpf})**	**Bottom of handrail from the floor (h_{bhr}), maximum**	**Backrest Height (H_b)**
1	40 cm to 50 cm	65 cm	130 cm	140 cm	70 cm
2	40 cm to 50 cm	-	150 cm	165 cm	70 cm
3	40 cm to 50 cm	65 cm	-	165 cm	70 cm
4	40 cm to 50 cm	65 cm	-	165 cm	70 cm

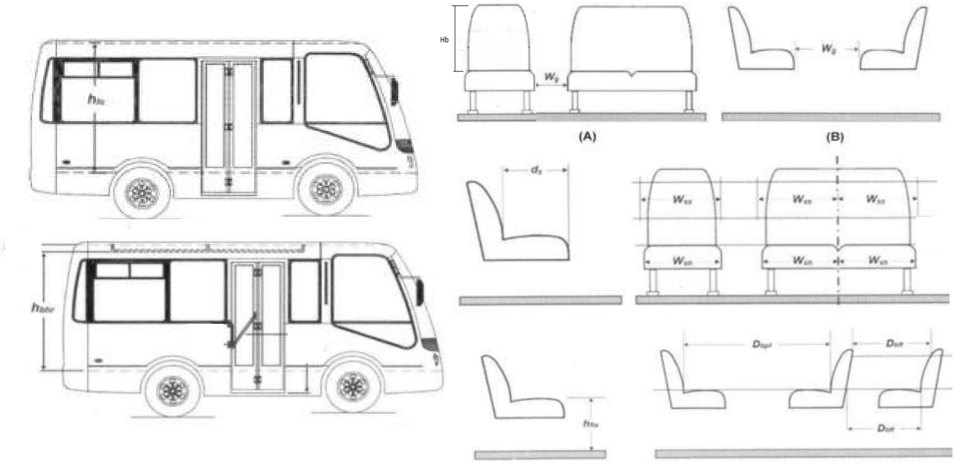

Figure 1. Modern Jeepney Measurements

Figure 1 was taken from the memorandum circular numbers 2021 - 002 and 2022 - 027 from the Land Transportation and Franchising and Regulatory Board. The anthropometric measurements of Filipino Manufacturing Workers taken by Del Prado-Lu (2007) were considered when designing the dimensions of the modern jeepneys.Metro Manila's public transportation system underwent significant modernization to improve the commuter experience and address challenges faced by traditional jeepneys, including safety and emissions. Understanding the perspectives of both commuters and drivers is crucial for a smooth transition to modernized transportation.

By examining modern jeepneys' interior dimensions alongside Filipino commuters' anthropometric measurements, researchers can identify areas needing improvement for enhanced travel comfort. Proper seat space, headroom, leg clearance, and handholds can reduce discomfort and fatigue, as noted by Solo Abadi (2023). Ergonomically designed seats are vital for passenger comfort and safety, minimizing injury risks during sudden stops and turns, and lowering the likelihood of Musculoskeletal Disorders (MSD). Improving jeepney infrastructure can promote public transportation, reducing road congestion. This study will aid manufacturers, policymakers, and designers in optimizing vehicle layouts for commuters' needs. Wirtzfeld A. (2012) emphasizes the importance of incorporating diverse body types in public transport design. Filipino anthropometry can help develop modern jeepneys that serve daily commuter needs while enhancing competitiveness with other transport modes. More comfortable commutes, as noted by Hanssen P. et al. (2016), can improve well-being and productivity by reducing travel fatigue. Gaur R. et al. (2020) highlight comfort as a key factor in public transport usage; thus, improving modern jeepneys could increase ridership and revenue for operators. Ergonomically designed interiors can prevent deterioration and encourage usage, ultimately alleviating traffic by reducing the number of cars on the road.

1.1 Objectives

The study's primary objective is to conduct a comprehensive anthropometric study to determine the percentage of Filipino commuters in Metro Manila who can comfortably use and ride the modern jeepney classes from one (1) to four (4) in terms of their compatibility on the modern jeepney measurements. Government agencies and manufacturers could use this study to implement changes in the current cabin dimensions of modern jeepneys to increase the comfort of the passengers. Specifically, this study aims to:

To determine the optimal modern jeepney dimensions by collecting and analyzing the eight physical dimensions of the modern jeepney.

To collect the passengers' anthropometric data by measuring the eight anthropometric measurements in different selected locations.

To identify necessary design modifications to enhance passenger comfort and compatibility in modern jeepneys based on analysis of modern jeepney dimensions and anthropometric measurements.

2. Literature Review

Musculoskeletal disorders (MSD) impact the entire body, limiting safe and effective work capabilities and contributing to the pain epidemic and addiction to painkillers. Injuries to limbs, muscles, nerves, joints, and tendons can arise from repetitive movements, difficult positions, and forceful actions (NIOSH 2022). A study by Ali et al. (2021) found a positive relationship between road traffic delays and musculoskeletal health complaints among desk workers, linking longer commute times to issues such as low back pain, neck pain, upper back pain, and leg pain. Onawumi et al. (2023) examined the mismatch between vehicle seat designs and the anthropometric characteristics of drivers, revealing that such incompatibilities increase the risk of MSDs. Proper seat design can enhance driver safety, comfort, and overall experience in non-local commercial vehicles.

A commuter's transportation mode of choice is essential for themselves and the country when aiming for a sustainable transportation system. A sustainable transport mode can enable safe and environmentally friendly transportation for people's mobility needs, such as providing access to public transit for their jobs and other services, contributing to sustainable development goals (United Nations 2021). Public Utility Jeepneys are one of the most popular modes of transport in the Philippines due to different route availability and cheap fares. A study on Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) assessments of Jeepney Passengers revealed scores of 4 to 7, with 5 being the most common, indicating a medium risk for MSDs. This suggests a need for improvements in jeepney design. The current cabin measurement of jeepneys needs to be ergonomically designed for its users because the passengers are put through awkward positions, leading to passenger discomfort (Gumasing et al. 2020).

Jianghong and Long (1994) investigated the connection between the anthropometric measurements of passengers and the design specifications of public utility vehicles (PUVs), focusing on how the measurements affect passenger comfort. The study analyzed anthropometric data from public transportation users to investigate the relationship between body measurements, vehicle seats, and overall passenger comfort. This understanding can help develop design guidelines for public utility vehicles, accommodating a more diverse passenger population and enhancing satisfaction and ridership.

3. Methods

This study employed an evaluation research design to assess the compatibility of modern jeepney dimensions for users, categorized into young adults (15-24), middle-aged adults (25-64), and older adults (65+). All respondents were frequent jeepney users, taking rides at least three times a week. Passengers' anthropometric measurements were compared with the cabin dimensions of modern jeepneys (classes 1-4). Researchers trained in measurement techniques and recorded data using a measuring tape, storing it in Excel for validation and analysis. Statistical analysis was conducted using Excel and Minitab Statistical Software version 22.1.0 to evaluate the fit between passenger measurements and jeepney designs. The findings highlighted discrepancies and led to recommendations for design improvements to better accommodate the diverse body measurements of Metro Manila commuters.

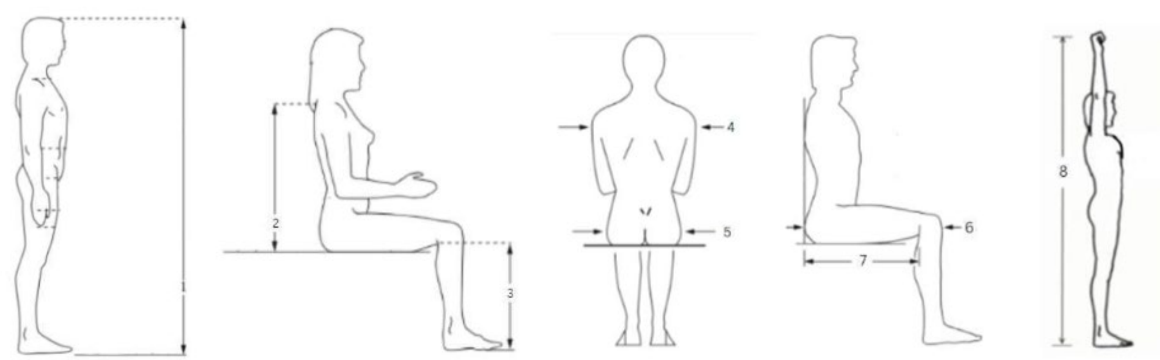

Figure 2. Anthropometric Measurements

The figure above illustrates the different anthropometric measurements that were collected. The names for these measurements are as follows: one (1) is stature height, two (2) is sitting shoulder height, three (3) is popliteal height, four (4) is shoulder breadth, five (5) is hip breadth, six (6) is buttock-knee length, seven (7) is buttock-popliteal height, and eight (8) is for standing vertical grip reach.

4. Data Collection

To calculate how many respondents would be needed in the study, the researchers conducted a sample size of 60 respondents for pilot testing and used the formula:

$$n = \left(\frac{Z\sigma}{E}\right)^2$$

Equation 1. Sample Size for One Sample, Continuous Outcome

Where n is the calculated sample size, Z is the value from the standard normal distribution reflecting the confidence level, σ is the standard deviation of the outcome variable, and E is the desired margin of error. A pilot test was conducted to achieve two goals. One was to train the researchers in enhancing the efficiency of gathering the anthropometric measurements, ensuring consistency and accuracy. The second was to obtain all respondents' data to compute each body measurement's mean and standard deviation to obtain the calculated sample size. The pilot test results showed that a minimum of 91 sample size is needed to be 95 percent confident that the true population mean of the anthropometric body measurements is within the three percent (3%) margin of error of the estimated mean of the collected anthropometric body measurements. During the data gathering and collection, the respondents were able to measure 127 respondents and their eight anthropometric measurements using a measuring tape.

In the 127 samples collected, normality and outlier tests were conducted to identify potential anomalies within the data. Assumptions for conducting z-test analysis include data to be normality distributed (FasterCapital 2024). Recognizing and addressing outliers is crucial, as they can substantially influence the results of statistical analyses and distort the outcomes of hypothesis testing (Bhandari P. 2024). Utilizing Grubbs' test for outliers in Minitab Statistical Software version 22.1.0, 6 males and one female were classified as outliers and subsequently removed from the dataset. This adjustment resulted in a final sample comprising 77 males and 43 females, which will be utilized for all subsequent statistical analyses.

Statistics

Variable	N	Mean	StDev	Variance	CoefVar	Minimum	Q1	Median
Popliteal Height	77	44.0519	2.47033	6.10253	5.61	39	42	44
Buttock Popliteal Length	77	44.2727	3.46272	11.9904	7.82	36	42	44
Shoulder to Shoulder Breadth	77	45.4935	3.16903	10.0427	6.97	36	44	46
Sitting Shoulder Height	77	58.6883	5.73828	32.9279	9.78	48	54	58
Buttock Knee Length	77	54.1169	3.64177	13.2625	6.73	46	52	54
Stature Height	77	168.481	6.44125	41.4897	3.82	157	163.5	168
Hip Breadth	77	34.0649	2.23217	4.98257	6.55	30	32	34
Standing Vertical Grip Reach	77	201.727	10.1186	102.385	5.02	183	194	203

Variable	Q3	Maximum	Range	IQR	Skewness	Kurtosis
Popliteal Height	46	51	12	4	0.5302	0.6667
Buttock Popliteal Length	47	52	16	5	0.0117	-0.3171
Shoulder to Shoulder Breadth	47	52	16	3	-0.5438	0.8907
Sitting Shoulder Height	63	72	24	9	0.2781	-0.5979
Buttock Knee Length	57	61	15	5	-0.4186	-0.1948
Stature Height	173	185	28	9.5	0.4246	-0.2081
Hip Breadth	35	41	11	3	0.6525	0.8020
Standing Vertical Grip Reach	209	222	39	15	-0.0534	-0.7350

Grubbs' Test

Variable	N	Mean	StDev	Min	Max	G	P
Popliteal Height	77	44.052	2.470	39.000	51.000	2.81	0.305
Buttock Popliteal Length	77	44.273	3.463	36.000	52.000	2.39	1.000
Shoulder to Shoulder Breadth	77	45.494	3.169	36.000	52.000	3.00	0.159
Sitting Shoulder Height	77	58.688	5.738	48.000	72.000	2.32	1.000
Buttock Knee Length	77	54.117	3.642	46.000	61.000	2.23	1.000
Stature Height	77	168.48	6.44	157.00	185.00	2.56	0.687
Hip Breadth	77	34.065	2.232	30.000	41.000	3.11	0.105
Standing Vertical Grip Reach	77	201.73	10.12	183.00	222.00	2.00	1.000

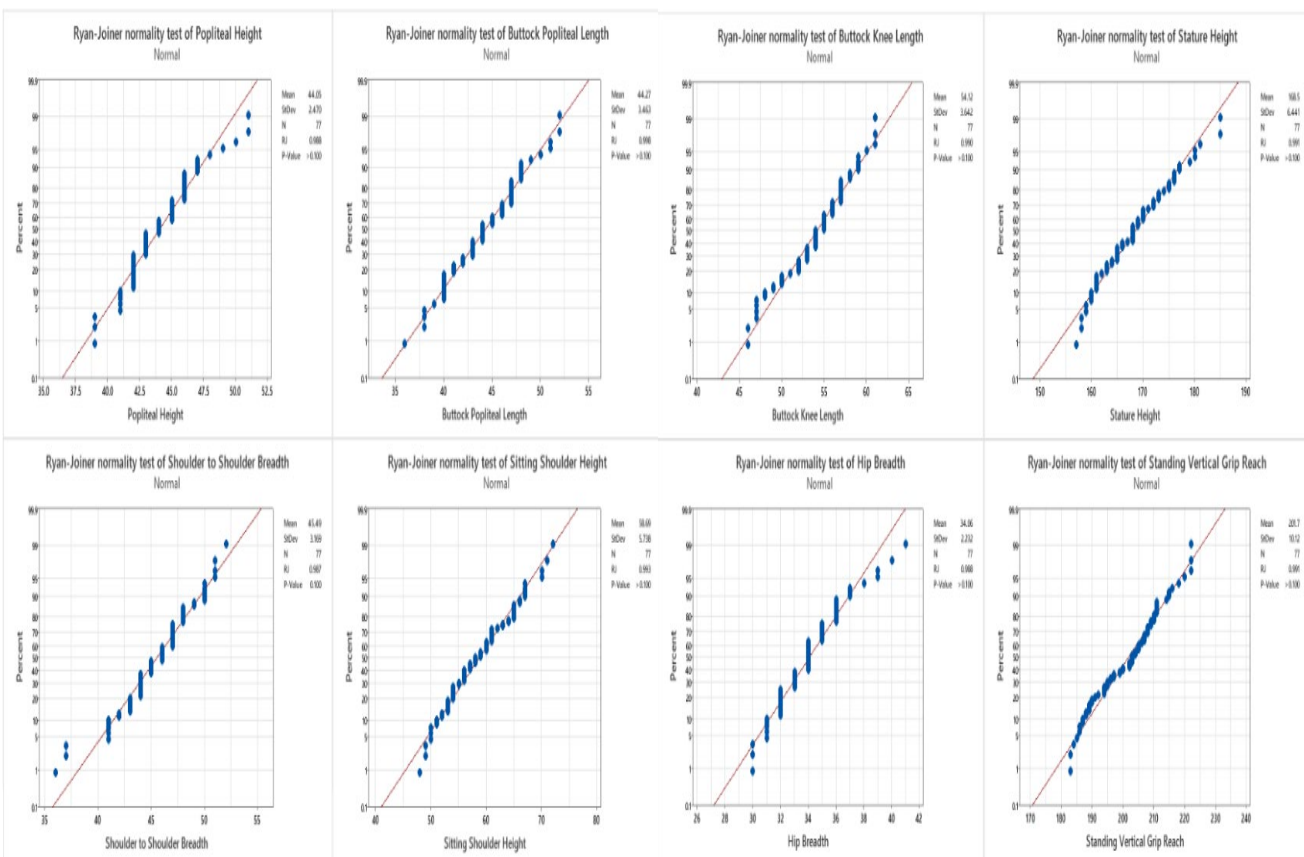

Figure 3. Male Anthropometric Measurements Descriptive Analyses

Statistics

Variable	N	Mean	StDev	Variance	CoefVar	Minimum	Q1	Median	Q3
Popliteal Height	43	41.6279	3.28795	10.8106	7.90	35	40	41	44
Buttock Popliteal Length	43	41	5.55492	30.8571	13.55	25	38	42	44
Shoulder to Shoulder Breadth	43	41.3721	5.30509	28.1440	12.82	31	38	42	45
Sitting Shoulder Height	43	56.5814	5.47389	29.9635	9.67	49	52	56	61
Buttock Knee Length	43	51.3023	4.14347	17.1683	8.08	44	48	51	53
Stature Height	43	158.256	7.37142	54.3378	4.66	145	153	158	162
Hip Breadth	43	35.6279	4.84042	23.4297	13.59	22	33	36	38
Standing Vertical Grip Reach	43	189.209	9.87676	97.5504	5.22	163	182	191	196

Variable	Maximum	Range	IQR	Skewness	Kurtosis
Popliteal Height	50	15	4	0.2832	0.1176
Buttock Popliteal Length	55	30	6	-0.3356	1.7242
Shoulder to Shoulder Breadth	57	26	7	0.3044	0.6842
Sitting Shoulder Height	70	21	9	0.5206	-0.5793
Buttock Knee Length	62	18	5	0.5391	0.5593
Stature Height	179	34	9	0.8243	1.1045
Hip Breadth	49	27	5	0.1001	1.4625
Standing Vertical Grip Reach	207	44	14	-0.3420	-0.0487

Grubbs' Test

Variable	N	Mean	StDev	Min	Max	G	P
Popliteal Height	43	41.628	3.288	35.000	50.000	2.55	0.357
Buttock Popliteal Length	43	41.000	5.555	25.000	55.000	2.88	0.107
Shoulder to Shoulder Breadth	43	41.372	5.305	31.000	57.000	2.95	0.082
Sitting Shoulder Height	43	56.581	5.474	49.000	70.000	2.45	0.486
Buttock Knee Length	43	51.302	4.143	44.000	62.000	2.58	0.316
Stature Height	43	158.26	7.37	145.00	179.00	2.81	0.138
Hip Breadth	43	35.628	4.840	22.000	49.000	2.82	0.137
Standing Vertical Grip Reach	43	189.21	9.88	163.00	207.00	2.65	0.247

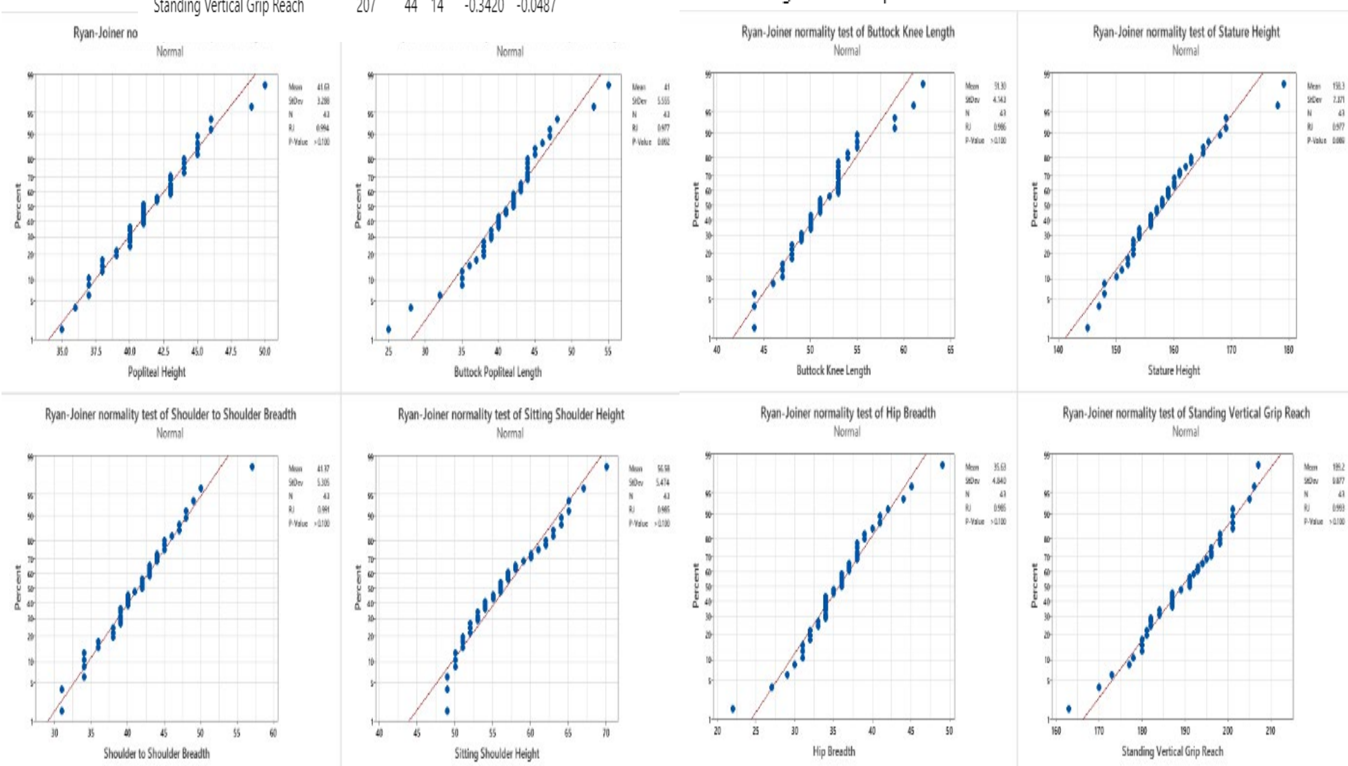

Figure 4. Female Anthropometric Measurements Descriptive Analyses

Figures 3. and 4. show all the descriptive analyses conducted in Minitab Statistical Software 22.1.0. Using Ryan-Joiner normality tests, p-value of the eight (8) anthropometric measurements for male (p: >0.100, >0.100, >0.100, >0.100, >0.100, >0.100, >0.100, and >0.100) and female (p: >0.100, 0.092, >0.100, >0.100, >0.100, 0.089, >0.100, and >0.100) are all greater than the significant level of 0.05, concluding that all of the data are typically distributed. Another Grubbs' test for outliers is conducted for males (p: 0.305, 1.000, 0.159, 1.000, 1.000, 0.687, 0.105, and 1.000) and females (p: 0.357, 0.107, 0.082, 0.486, 0.316, 0.138, 0.137, and 0.247) with all p-values greater than the significance level of 0.05, resulting with no outliers present.

Table 2. Modern Jeepney Dimensions (in cm)

Dimensions / Classes	**Class 1**	**Class 2**	**Class 3**	**Class 4**
Seat Height	40	40	40	40
Seat Depth	35	35	35	35
Upper Seat Width	40	40	40	40
Backrest Height	70	70	70	70
In-between Seat Distance	65	65	65	65
Ceiling Height	150	175	175	175
Seat Width	40	40	40	40
Handrail Height	140	165	165	165

Table 2 summarizes the different dimensions of modern jeepneys in classes 1 to 4. The eight (8) jeepney dimensions are listed: seat height, seat depth, upper seat width, backrest height, in-between seat distance, ceiling height, seat width, and handrail height.

Table 3. Male and Female Body Dimensions (in cm)

Dimension	**Male (cm)**					**Female (cm)**				
	P5	**Median**	**P95**	**Mean**	**SD**	**P5**	**Median**	**P95**	**Mean**	**SD**
Popliteal Height	41	44	48.2	44.05	2.47	37	41	46	41.63	3.298
Buttock Popliteal Length	38.8	44	50.2	44.27	3.46	32.3	42	47.9	41.37	5.55
Shoulder to Shoulder Breadth	41	46	50.2	45.49	3.17	34	42	48.9	21	5.31
Sitting Shoulder Height	50	58	67.6	58.69	5.74	49.1	56	65	56.58	5.47
Buttock Knee Length	47	54	59.2	54.12	3.64	44.2	51	59	51.30	4.144
Stature Height	159	168	180	168.48	6.44	148	158	169	158.26	7.37
Hip Breadth	31	34	38.2	34.06	2.32	29.1	36	43.8	35.63	4.84
Standing Vertical Grip Reach	185.8	203	218.4	201.73	10.12	173.4	191	204.6	189.21	9.88

Table 3. shows the male and female anthropometric body dimensions. Means and standard deviations were used for the z-scores analyses, and the percentiles were used to identify the 5th and 95th rankings for both genders and provide recommendations for possible mismatches in the modern jeepney dimensions.

5. Results and Discussion

5.1 Numerical Results

The Z-score analysis is the primary statistical method for the study to determine the percentages of passengers, according to their anthropometric characteristics, who ergonomically fit the different modern jeepney classes in terms of their dimensions. To calculate the z-score for each measurement to determine the percentage of passengers, the researchers used the formula:

$$z = \frac{X - \bar{X}}{s}$$

Equation 2. Z-score Formula

Where Z is the value from the standard normal distribution reflecting the confidence level, X (in cm) is the score of the measurements in each of the modern jeepney classes, , $\bar{X}$ (in cm) is the mean anthropometric measurement of the passengers, and s (in cm) is the standard deviation of each anthropometric measurement of the passengers.

Table 4. Anthropometric Measurement Mean, Standard Deviation, Z-Scores, and Fit Probabilities

Dimension / Anthropometric Measurement	**Seat Height**		**Seat Depth**		**Upper Seat Width**		**Backrest Height**	
	Popliteal Height		Buttock Popliteal Height		Shoulder to Shoulder Breadth		Sitting Shoulder Height	
	40 cm		35 cm		40 cm		70 cm	
Sex	Male	Female	Male	Female	Male	Female	Male	Female
Mean (cm)	44.0519	41.6279	44.2727	41.0000	45.4935	41.3721	58.6883	56.5814
SD (cm)	2.4703	3.2880	3.4627	5.5549	3.1690	5.3051	5.7383	5.4739
Z	-1.64	-0.50	-2.68	-1.08	-1.73	-0.26	1.97	2.45
P (%)	5.05%	30.85%	0.37%	14.01%	4.18%	39.74%	97.56%	99.29%

Dimension / Anthropometric Measurement	**In-between Seat Distance**		**Ceiling Height**		**Ceiling Height**		**Seat Width**	
	Buttock-Knee Length		Stature Height		Stature Height		Hip Breadth	
	65 cm		150 cm (Class 1)		175 cm (Class 2-4)		40 cm	
Sex	Male	Female	Male	Female	Male	Female	Male	Female
Mean (cm)	54.1169	51.3023	168.4805	158.2558	168.4805	158.2558	34.0649	35.6279
SD (cm)	3.6418	4.1435	6.4413	7.3714	6.4413	7.3714	2.2322	4.8404
Z	2.99	3.31	-2.87	-1.12	1.01	2.27	2.66	0.90
P (%)	99.86%	99.95%	0.21%	13.14%	84.38%	98.84%	99.61%	81.59%

Dimension / Anthropometric Measurement	**Handrail Height**		**Handrail Height**	
	Standing Vertical Grip Reach		**Standing Vertical Grip Reach**	
	140 cm (Class 1)		165 cm (Class 2-4)	
Sex	Male	Female	Male	Female
Mean (cm)	201.7273	189.2093	201.7273	189.2093
SD (cm)	10.1186	9.8768	10.1186	9.8768
Z	-6.10	-4.98	-3.63	-2.45
P (%)	0.00%	0.00%	0.00%	0.01%

Table 4 summarizes the Z-score statistical analyses of the respondents' anthropometric measurements. It was determined in the ceiling height that in class 1 modern jeepneys, 0.21% of the male and 13.14% of the female respondents, and in classes 2-4, 84.38% of the male and 98.44% of the female respondents would comfortably stand straight when riding a modern jeepney. Poor posture can cause pain in a person's neck and shoulders and speed up the wear and tear of the affected areas of not standing properly (The Cleveland Clinic, 2024). Additionally, slouching promotes incontinence when a person leaks a slight amount of urine when laughing or coughing, and heartburn is caused by acid reflux (Harvard Health Publishing, 2023).

It was found that 97.56% of male and 99.29% of female respondents can sit comfortably in modern jeepneys with respect to backrest height and sitting shoulder height. The backrest is crucial for supporting the head and spine, aiding comfort for varying heights and weights (Chen and Tsai, 2024).

In terms of seat height, 94.95% of males and 69.15% of females sit comfortably based on popliteal height, while 5.05% of males and 30.85% of females feel uncomfortable, often resulting in dangling feet and related discomfort. Proper foot placement is essential for distributing body weight (Seating Matters, 2023).

For upper seat width, only 4.18% of males and 39.74% of females sit comfortably according to shoulder-to-shoulder breadth, as men typically have broader shoulders (Langdon and Hudson, 2023). In terms of seat width, 99.61% of males and 81.59% of females are comfortable, as hip structures differ significantly between genders (Zidon, 2019).

Regarding the in-between seat distance, 99.86% of males and 99.95% of females can sit comfortably with respect to buttock-knee length. Legroom is crucial for perceived comfort (Fiorillo and Nasti, 2021). 99.63% of males and 85.99% of females feel comfortable with seat depth related to buttock popliteal length. A seat depth of too long can disrupt the incline and support needed, leading to discomfort (Chen and Tsai, 2024) (Crosby et al., 2024). Ideally, a gap of 2-3 inches between the seat and the back of the knees is recommended for comfort.

It was determined in the handrail height in class 1 modern jeepneys, 100% of the male and 100% of the female respondents, and in classes 2-4, 100% of the male and 99.99% of the female respondents could reach the standard Handrail Height without flexing their ankles. Based on the study of Sarraf et al.(2018), maintaining balance while in a moving vehicle would be challenging without handrails. These handrails increase the base support of an individual to resist vehicle acceleration or deceleration.

Percentages on the dimensions in backrest height, in-between seat distance, and handrail height (for all classes) were extremely high and therefore considered a match, posing no threat to the commuters and not needing to be adjusted. However, there is a considerably low percentage in the upper seat width (4.18% of males and 39.74% of females) and in the ceiling height of class 1 modern jeepneys (0.21% of males and 13.14% of females), considering it a mismatch and posing as an immediate threat to the comfortability of the commuters, needing its proper adjustment. Mismatches were also considered in seat height (only 69.15% for the females), seat depth (85.99% for the females), ceiling height of class 2-4 modern jeepneys (84.38% for the males), and seat width (81.59% of the females), and can still be able to make adjustments to better fit the modern jeepney dimensions to the commuters.

5.2 Graphical Results

Figure 5 below shows all the p-values or fit probabilities represented as bell curves from Table 4.

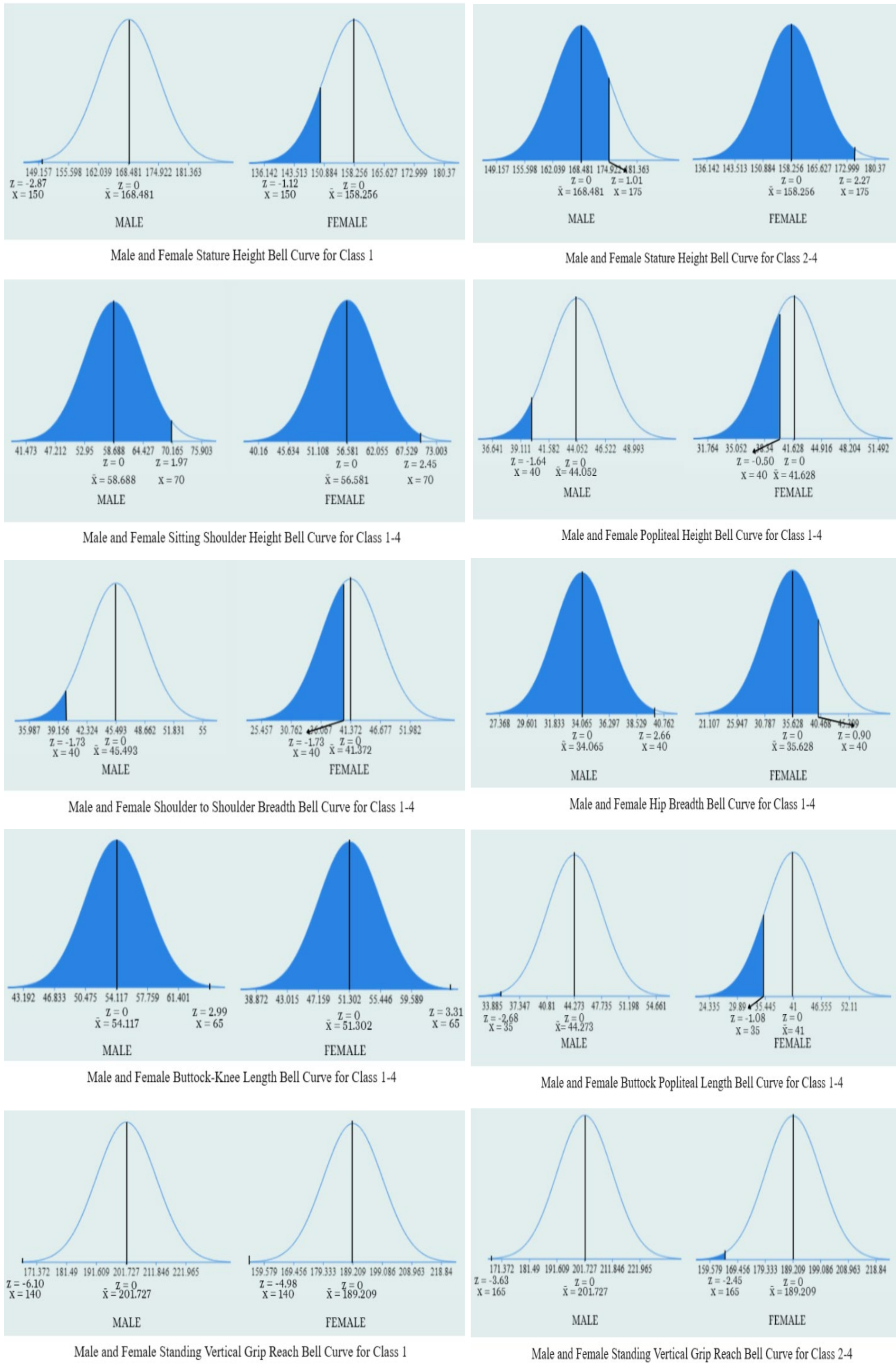

Figure 5. Anthropometric Measurement Bell Curves

5.3 Proposed Improvements

Table 5 summarizes the proposed dimensions for the modern jeepney, focusing on seat and cabin measurements. The seats are designed with a height of 37 cm, a depth of 32.3 cm, and a width of 43.8 cm. The cabin features a ceiling height of 180 cm and an upper seat width of 50.2 cm. As shown in Table 5, measurements of the recommended dimensions of the modern jeepneys were based on either the 5th lowest percentile in females or the 95th highest percentile in males of the commuters. When using anthropometric data in creating ergonomic designs, it should meet the dimensional needs of 90%, which is the population between the 5th and 95th percentiles (Ross J.M. 2011). Osinski P. et al. (2021) emphasized that small reductions in measurements can impact the commuter's comfort and satisfaction in public transport seats, especially in buses. Additionally Rao M. et al. (2021) explained that the need for optimum seat design, according to anthropometry for most users, is essential as seat discomfort results from a mismatch of measurements.

One inch is equivalent to 2.54 cm, and the study by Anjani S. et al. (2021) highlighted that an inch difference from 17 cm to 18 in seat measurement made passengers more comfortable as the 18-inch measurement reduced discomfort for most parts of the body. Gumasing M.J. et al. (2022) explained that when individuals are subjected to risk factors, their bodies become fatigued, which outruns the body's recuperation system. This develops musculoskeletal disorders over time as fatigue buildup is faster than recovery, which is where musculoskeletal imbalance develops. Moreover, compatibility with human and work systems can act as a preventive measure. Compatibility of equipment reduces the prevalence of Repetitive Strain Injuries. An ergonomically designed office chair is pivotal in preventive occupational safety (Strasser 2022).

To implement the proposed improvements regarding seat and structure changes, an implementation strategy by Summers (2020) highlights the crucial role of community coalitions, partnerships with academic institutions, and dedicated organizations in systematically driving changes in public transportation policy. In the context of jeepneys and modern jeepneys in the Philippines, existing coalitions, such as Manibela—a group of public utility vehicle operators opposing the Public Utility Vehicle Modernization Program (PUVMP)—are already at work, as noted by Mangaluz (2025). Additionally, academic institutions like the University of the Philippines National Center for Transportation Studies (UP-NCTS) and government agencies focused on transportation, such as the Land Transportation Office (LTO) and the Department of Transportation (DOTr), contribute valuable resources to the cause. To ensure effective implementation, it is essential to engage in comprehensive community mobilization to educate the public and initiate pilot programs for testing and refinement. By diligently following this strategy, the proposed measures can be successfully enacted, ultimately providing Filipino commuters with safer and more comfortable transportation options in the Philippines.

Table 5. Proposed Recommendations

Specification	**Seat Height**	**Seat Depth**	**Upper Seat Width**	**Ceiling Height**	**Seat Width**
Proposed Recommendation	37 cm	32.3 cm	50.2 cm	180 cm	43.8 cm

5.4 Validation

Table 6. Z scores and Fit Probabilities of the Proposed Dimensions to the Anthropometric Measurements

	Seat Height		**Seat Depth**		**Upper Seat Width**		**Ceiling Height**		**Seat Width**	
Proposed Dimension	Popliteal Height		Buttock Popliteal Height		Shoulder to Shoulder Breadth		Stature Height		Hip Breadth	
	37 cm		32.3 cm		50.2 cm		180 cm		43.8 cm	
Sex	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean (cm)	44.0519	41.6279	44.2727	41	45.4935	41.3721	168.4805	158.2558	34.0649	35.6279
SD (cm)	2.4703	3.2880	3.4627	5.5549	3.1690	5.3051	6.4413	7.3714	2.2322	4.8404
Z	-2.85	-1.41	-3.46	-1.57	1.49	1.66	1.79	2.95	4.36	1.69
P (%)	0.22%	7.93%	0.03%	5.82%	93.19%	95.15%	96.33%	99.84%	100%	95.45%

Table 6 summarizes the proposed modern jeepney dimensions relative to its anthropometric measurements. The analysis for these numbers is as follows: the proposed seat height of 37 cm resulted in 99.78% male and 92.07% female comfortability, the proposed seat depth of 32.3 cm resulted in 99.97% male and 94.18% female comfortability, the proposed upper seat width of 50.2 cm resulted in 93.19% male and 95.15% female comfortability, the proposed ceiling height of 180 cm resulted in 96.33% male and 99.84% comfortability, and the proposed seat width of 43.8 cm resulted in 100% male and 95.54% female comfortability.

6. Conclusion

In conclusion, the study highlights significant ergonomic issues in passenger seating and modern jeepney design, particularly concerning upper seat width and ceiling height in class 1 modern jeepneys. These shortcomings lead to passenger discomfort and increased injury risk, as current dimensions do not align with Filipino anthropometric measurements. Poor ergonomic design affects factors like posture, legroom, and cushioning, resulting in health issues such as musculoskeletal strains. Using Gaussian probability distribution, the study identified the percentage of Filipino passengers experiencing discomfort with existing measurements. Proposed adjustments to seat height, depth, width, and ceiling height, as detailed in Table 5, aim to enhance travel comfort for Filipino commuters.

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