Physical Assessment and Perceived Quality of E-jeepney in Metro Manila

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Abstract

The transportation sector made headway in terms of the service quality experienced by users of public utility vehicles like electric jeepneys through the modernization program regulated by the government. The gradual adaptation of E-jeepneys and promulgation on the operations concerning public road usage are governed based on the five principles of public transport which include criteria of reliability, safety, accessibility, environmental soundness, and comfort. At present, the electric jeepney is still in small stages in terms of public transit. With this, the study was conducted to measure the perceived quality of E-jeepney and validate the user's perception through qualitative and quantitative assessments to be able to recommend improved specifications which will increase the user's level of satisfaction. The assessment focused on Go electric E-jeepney operating at Paranaque Integrated Terminal Exchange. Using statistical analyses and link length system's acceptability, the important findings of the study include passengers' and driver's low satisfaction level on comfort determinants among the indicators established and unaccommodated dimensions of the passenger cabin and workspace for driver whereas improved specification of design variables was proposed using relevant design tools. This can be concluded that the current E-jeepney does not mostly conform in terms of comfort criterion as confirmed on the results of the evaluation.

Keywords
perceived quality, satisfaction level, indicators, physical assessment, link length system

1. Introduction

The shift from traditional public utility vehicles to eco-green vehicles such as electric jeepneys is progressively adapted here in the Philippines. With the assistance of advanced technology in the scope of public transportation, it aids the government to improve the quality of traveling for commuters by considering the population to have access to safe, clean, and efficient public transport. These criteria are translated to structured vehicle requirements that address the issues in specific areas to improve the use of Philippine transport.

With an increase in industrialization and urbanization over time, the demand for transportation has increased proportionately as well (Mayo, F.L., & Taboada, E.B., 2019). With network congestion being a global issue in urban cities due to commuters' reliance on cars, government agencies have been focusing on creating an attractive alternative (Chowdhury, S., et al., 2015). Reforming the transport sector must therefore be a matter of great urgency (Sunio et al., 2019). When the level of discomfort is higher than the passengers' acceptable level, private car usage may become more attractive than public transport because of its convenience and comfort (Imre, S., & Celebi, D., 2016). The current design of jeepneys in the country is not actually standardized and fit for the physique of its most frequent passengers in the Philippines (Baluyot M.K. et al., 2017). According to the Department of Transportation, claims of inconvenience raised by the commuters and other sustainability issues were addressed as the government introduced the Public Utility Vehicle (PUV) Modernization Program.

In reference to the Department Order No. 2017-011 on the subject of omnibus guidelines on the planning road transportation services and franchise issuance by the Department of Transportation, the public transport in the Philippines is expected to be in service by delivering the governed principles such as reliability, safety, accessibility, environmental soundness, and comfort. Attempts to introduce Alternative Fuel Vehicles have been made in many cities to reduce the reliance on fossil fuels and to minimize the environmental impact caused by heavy urban vehicular traffic (Loo, 2020). With the modernization program, the use of solar and electric vehicles can address the environmental problem such as air pollution which seems to be largely contributed by ordinary vehicles used for public transportation. However, Ettema et al., (2020) concluded that insight into how public transport commuters experience their commute and the factors that influence their commute experience is limited.

The reform of the transport sector by producing the E-jeepneys in the Philippines is dedicated to commuters as well as the operators and their drivers. With the jeepney's new design and nature, the satisfaction from commuters as well as the operators and their drivers may be perceived as comfort. Humans perceive the environment of a public transport vehicle with sight, hearing, smell, touch, temperature, proximity to others, and the physical setting (Wang, B., & Zacharias, J., 2020).

Nowadays, all manufacturers and suppliers already recognize ergonomics as an important aspect of vehicle design (Abidi et al, 2013). However, there is no adequate literature on designing an electric jeepney by standard criterion to improve the users' satisfaction. Physically, some design requirements are still applicable to the reformed legendary jeepneys but other aspects have been well innovated. This led the researchers to fill the gap by achieving the following objectives 1) Determine the passengers and drivers' perception of the existing electric jeepney to measure their level of satisfaction, 2) Evaluate the current specifications of the E-jeepney based on the principles of public transport such as in terms of reliability, safety, accessibility, environmental soundness, and comfort, and check whether they comply or within standards, 3) Assess the relationship between the perception of respondents on E-jeepney and the measurement indicators considered for evaluation, and 4) Recommendation of relevant improvements based on the results of the assessment.

2. Methodology

A total of 268 respondents consisting of passengers and drivers who were using the Go electric jeepney operating at PITX participated in the study. The survey covered five criteria to be rated which are reliability, accessibility, safety, environmental soundness, and comfort based on the respondent's satisfaction level. Relevant determinants were indicated per criterion. Section 1 was for the questions for passengers while section 2 was intended for the drivers. Section 3 was intended for both types of respondents since this required the overall rating for the five criteria presented. To interpret the perceived quality of passengers and drivers on the indicators, the Analysis of variance was utilized to determine the significant relationship between the variables. A 5-point Likert scale was used as a rubric. Each qualitative rating has a respective range of weight of satisfaction level rating which pertained to the scoring given by the respondents of the study.

The researchers analyzed if the determinants to consider under the criteria were followed as governed by the principles of public road transport by collecting the actual results of the assessment. This was also applied to the quantitative evaluation by measuring the actual dimensions of the physical components and gathering other data for other aspects to be considered in the design of E-jeepney. Link length system by Drillis and Contini was also used whereas the actual stature height was multiplied by the ratio corresponding to the relative anthropometric measurement and the 5^{th} and 95^{th} standard percentiles were also computed using the standard formula. Before the acceptability of the link length system, the researchers used a t-test for statistical analysis to determine if there was a significant difference between the 14 samples of actual body part dimensions and its resulted body dimensions from the link length system based on the stature height of these samples. When resulted non-significant, the standard anthropometric data of the 268 respondents resulted from the link system was used. Afterward, a comparative analysis between the current dimensions of the E-jeepney and the standard anthropometric measurements of Filipino users was performed to determine if the standard dimensions were accommodated.

Moreover, using regression analysis, the behavior of the dependent variables on the presented determinants for each criterion was analyzed to determine the impact of the determinants on the overall satisfaction rating model. The E-jeepney's strengths and weaknesses were sorted whereas the factors which were validated as weak were improved using the design tools such as Quality Function Deployment, Cost-benefit analysis, and Failure Mode and Effects Analysis to translate into alternatives ideal for the improvement of selected specification of E-jeepney to set with the governed principles of public transport as well as anthropometry.

3. Results and Discussion

3.1 Perceived Quality of passengers on E-jeepney

Table 1. Summary of passenger's perception of reliability, safety, accessibility, environmental soundness, and comfort

Determinant	Mean rating	Qualitative rating	p-value	Significance
Waiting time at the station (R1)	2.78	Neither dissatisfied nor satisfied	0.000	Significant
Schedule of available E-jeepney operating (R2)	3.40	Satisfied		
Availability of E-jeepney on surrounding areas (R3)	3.01	Neither dissatisfied nor satisfied		
Predictable in terms of travel time (R4)	3.66	Satisfied		
Not afraid of pickpockets (S1)	3.40	Satisfied	0.000	Significant
CCTV camera to monitor (S2)	2.36	Dissatisfied		
Handrails attached (S3)	4.11	Satisfied		
Point to point route destination (A1)	3.47	Satisfied	0.000	Significant
Designated stops, pick up, and drop off points (A2)	4.36	Very satisfied		
Accessible by senior citizens and disabled (A3)	2.88	Neither dissatisfied nor satisfied		
Use of renewable energy (E1)	4.92	Very satisfied	0.000	Significant
Ventilation inside the E-jeepney (E2)	3.02	Neither dissatisfied nor satisfied		
Level of lighting (E3)	3.61	Satisfied		
Sound level (E4)	4.72	Very satisfied		
Weather conditions (E5)	3.59	Satisfied		
Seat space provided for passengers (C1)	2.74	Neither dissatisfied nor satisfied	0.000	Significant
Aisle space when entering and descending (C2)	4.58	Very satisfied		
Platform height (C3)	4.11	Satisfied		
Leaning the back (C4)	2.52	Dissatisfied		
Leg comfort (C5)	3.63	Satisfied		
Seat cushion (C6)	2.61	Neither dissatisfied nor satisfied		

Table 1 shows passengers were satisfied with (R4) which also resulted as the highest determinant under reliability with a mean rating of 3.66 while the lowest determinant was (R1) with a mean rating of 2.78 which passengers were neither dissatisfied nor satisfied as perceived. It was validated that the range of waiting time at the terminal based on the interview with the passengers was 15 to 30 minutes before boarding. Travel time reliability is now recognized as a major determinant of travel behavior and as an important performance measure for transport systems operation. (Taylor, M. A. P., 2013). On the other hand, they were satisfied with (S3) and resulted as the highest determinant under the safety criterion with a satisfaction mean rating of 4.11 as also shown in Table 1. Accordingly, these vehicles are typically equipped with a variety of handrails to facilitate balance maintenance and prevent falls (Sarraf et al., 2014). On the other hand, they were dissatisfied with (S2) with a mean rating of 2.36 which resulted to be the lowest safety determinant and it was validated since the CCTV cameras were present but not working all the time based on the interview with the passengers.

Verseckienė, A., Meškauskas, V., & Batarlienė, N. (2016) defined public transport accessibility as the quality of transit, serving a particular location, and the ease with which people can access that service. As shown in Table 1, it tells that the passengers were very satisfied with (A2) resulting in the highest satisfaction level among the subfactors of accessibility with a mean rating of 4.36 while (A3) resulted in the lowest satisfaction level wherein passengers were neither dissatisfied nor satisfied with a mean rating of 2.88 since it was validated that there were no priority seats and the clamp rails for easy grasp were limited. On the other hand, (E1) resulted as the highest determinant with a satisfaction mean rating of 4.92 where passengers were very satisfied as perceived while they were neither dissatisfied nor satisfied with (E2). Clearly, the nature of the vehicle is electric and rechargeable which means that there was no gas emission. Franzitta et al., (2017) stated that electric vehicles represent one of the best promising technologies for green and sustainable transportation systems.

In terms of comfort, Table 1 shows that the passengers were very satisfied with (C2) wherein it also resulted as the highest determinant under the comfort criterion with a mean rating of 4.58 while they were dissatisfied with (C4) since it was also validated that the cushion for backrest was not present inside the E-jeepney during the assessment. Hamdani et al., (2019) stated that back pain is a commonly known problem for drivers and passengers traveling in long route vehicles.

Table 2. Summary of passenger's overall satisfaction rating

Criteria	Satisfaction Level		Statistical test result	
	Mean Rating	Qualitative rating	p-value	Significance
Reliability (R)	3.36	Neither dissatisfied nor satisfied	0.000	Significant
Safety (S)	3.64	Satisfied		
Accessibility (A)	3.56	Satisfied		
Environmental Soundness (E)	3.49	Satisfied		
Comfort (C)	3.20	Neither dissatisfied nor satisfied		

As shown in Table 2, the passengers were satisfied with the safety and resulted in the highest satisfaction mean rating of 3.64 while they were neither dissatisfied nor satisfied with comfort which also resulted in the lowest mean rating of 3.20. Joewono, T. B., & Kubota, H. (2006) revealed that the user or passengers proved to be the most important party involved in safety and security aspects. Moreover, Tukey's test suggested that safety was significant with environmental soundness (p = 0.042), significant with comfort and reliability (p = 0.000). It was also confirmed that comfort was significant to other criteria (p = 0.000).

3.2 Perceived Quality of drivers on E-jeepney

Table 3. Summary of driver's perception of reliability, safety, accessibility, environmental soundness, and comfort

Determinant	Mean rating	Qualitative rating	p-value	Significance
Reduced waiting time at the station (R1)	4.33	Very satisfied	0.002	Significant
Schedule of available E-jeepney operating (R2)	3.89	Satisfied		
Availability of E-jeepney on surrounding areas (R3)	3.50	Satisfied		
Predictable in terms of travel time (R4)	3.72	Satisfied		
Removal of cash usage for payment (S1)	2.40	Dissatisfied	0.079	Not significant
GPS to enable recording of vehicle location (S2)	2.67	Neither dissatisfied nor satisfied		
Dashboard camera adds safety when driving (S3)	3.00	Neither dissatisfied nor satisfied		
Point to point route destination (A1)	4.11	Satisfied	0.000	Significant
Designated stops, pick up, and drop off points (A2)	4.83	Very satisfied		
Accessible by senior citizens and disabled (A3)	3.56	Satisfied		
Use of renewable energy (E1)	4.68	Very satisfied	0.000	Significant
Ventilation in E-jeepney (E2)	2.89	Neither dissatisfied nor satisfied		
Level of lighting (E3)	3.83	Satisfied		
Sound level (E4)	3.67	Satisfied		
Weather conditions (E5)	3.56	Satisfied		
Adjustable driver seat (C1)	2.28	Dissatisfied	0.000	Significant
Distance of the steering wheel (C2)	3.94	Satisfied		
Leaning the back (C3)	4.17	Satisfied		
Leg and thigh support (C40	2.56	Dissatisfied		
Leg comfort (C5)	2.56	Dissatisfied		
Seat material (C6)	3.72	Satisfied		

Table 3 shows that the drivers rated (R1) as the highest determinant with a mean rating of 4.33 and they were very satisfied in terms of perceived quality. On the other hand, the (R3) was the lowest determinant with a mean rating of 3.50 where drivers were satisfied as perceived. Sam et al. (2014) stated that it could be argued that in many cases due to the availability of a limited number of vehicles in service and passengers' having short of time, the service quality becomes one of a major issue for many, especially in large cities.

Table 3 also suggests drivers were neither dissatisfied nor satisfied on (S3) but resulted in having the highest mean rating of 3.00. With dashboard camera video footage, it is possible to extract visual-based information such as speeds, traffic conditions, types, and driving characteristics of vehicles, as well as the occurrences of before and during the accidents (Witchyangkoon, B., & Sirimontree, S., 2016). They were dissatisfied with (S2) with a mean rating of 2.67 since there was no featured GPS on the dashcam installed inside the E-jeepney while the lowest mean rating of 2.40 was obtained by (S1) since there was an installed tap card technology in the E-jeepney but not working. On the other hand, they were very satisfied with (A3) which showed as the highest determinant with a mean satisfaction rating of 4.83 while they were satisfied with (A3) but resulted as the lowest determinant with a mean rating of 3.56. For people such as senior citizens, public transport needs to be accessible and affordable to provide them with the opportunity to fulfill their medical, shopping, and recreational needs (Fatimal, K., & Moridpour, S., 2019).

Furthermore, it suggests that the drivers were very satisfied with (E1) which also resulted as the highest determinant with a mean satisfaction rating of 4.68. It is generally believed that electric vehicles (EVs) have significant advantages compared to alternatives in terms of energy saving, emission reduction, and environmental protection (Wu, Y., & Zhang, L. 2017). On the other hand, they rated (E2) as the lowest determinant of environmental soundness criterion with a mean rating of 2.89 and perceived neither dissatisfied nor satisfied. Based on the driver's point of view, they were satisfied with (C3) which also resulted in the highest mean satisfaction rating of 4.17 while they perceived (C1), dissatisfied, in terms of quality, and had the lowest mean rating of 2.28 whereas the driver's seat of the E-jeepney was not adjustable as assessed.

Table 4. Summary of driver's overall satisfaction rating

Determinants	Satisfaction Level		Statistical test result	
	Mean rating	Qualitative rating	p-value	Significance
Reliability (R)	3.50	Satisfied	0.173	Not significant
Safety (S)	3.44	Satisfied		
Accessibility (A)	3.44	Satisfied		
Environmental Soundness (E)	3.28	Neither dissatisfied nor satisfied		
Comfort (C)	3.00	Neither dissatisfied nor satisfied		

Table 4 shows the drivers were satisfied with the E-jeepney's service reliability as it also resulted in the highest mean rating at 3.50. Second in rating was safety and accessibility which then followed by the criteria of environmental soundness. The drivers rated comfort with the least mean rating of 3.00. Yatskiv, I., Pticina, I., & Savrasovs, M. (2012) stated that the urban public transport system's (UPTS) reliability is an important characteristic of transportation service quality both from service recipients (customers, passengers) and service providers (public transport operators) points of view.

3.3 Physical Assessment of E-jeepney

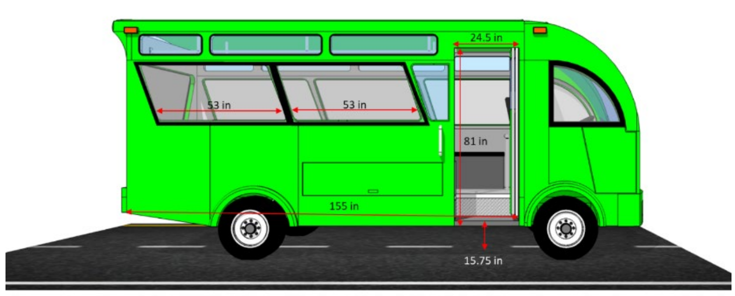

Figure 1. Current side view of Go electric E-jeepney

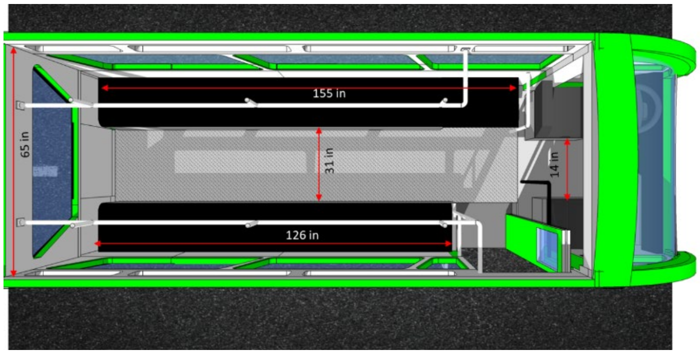

Figure 2. Current interior of the passenger cabin

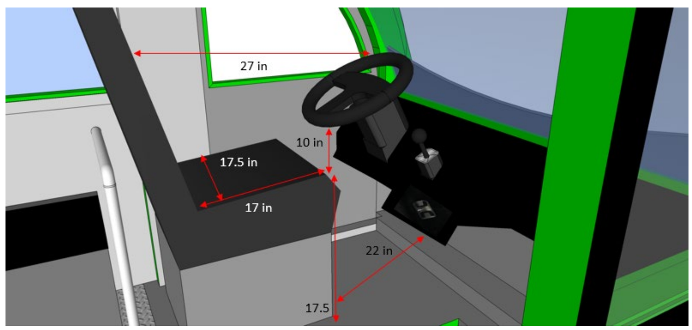

Figure 3. Current interior of driver's workspace

Figures 1 to 3 show the current design of Go electric E-jeepney which is composed of the cross-sectional, passenger cabin interior, and workspace for driver views. The actual measurements were collected and subjected to comparative analysis between the current dimensions and dimensions resulted from the standard anthropometric data resulted from the link length system.

3.4 Mismatch Analysis

Table 5. Mismatch analysis of passenger cabin

Current E-jeepney dimension (cm)		**Anthropometric dimension based on link length system (cm)**				**Difference (cm)**	**Remarks**
Passenger cabin dimension	Current measurement	Corresponding anthropometric dimension	Gender	Percentile	Mean Anthropometric measurement		
Seat height	44.45	Popliteal height	Female	5th	42.15	2.30	Above the standard but accommodated
Seat depth	43.18	Buttock popliteal length	Female	5th	39.19	3.99	Above the standard but accommodated
Seat width	32.81	Elbow to elbow breadth	Male	95th	44.12	-11.31	Below the standard
Backrest height	33.02	Shoulder height – popliteal height – buttock popliteal length	Male	95th	49.27	-16.25	Below the standard

Roof seat height	135.89	Sitting height	Male	95th	88.92	46.97	Above the standard but highly accommodated
Aisle clearance	78.74	Buttock knee depth	Male	95th	51.98	26.76	Above the standard but highly accommodated
Overhead handrail height	152.40	Sitting overhead fingertip reach	Female	5th	149.80	2.60	Above the standard but users should have the arm fully extended
Ceiling floor height	180.34	Stature height	Male	95th	171.00	9.34	Above the standard and accommodated
Platform height	40.01	Tibial height	Female	5th	42.15	-2.14	Below the standard but highly accommodated since the users could easily step on.
Cabin door height	205.74	Stature height	Male	95th	171.00	34.74	Above the standard but highly accommodated
Cabin door width	62.23	Hip breadth	Female	95th	43.15	19.08	Above the standard but highly accommodated

Table 5 shows the comparative analysis between the current passenger cabin's dimensions and standard mean anthropometric measurement resulted from the link length system. The column of remarks identifies if the design dimension accommodated the standard measurements. Based on the results, the seat width, backrest height, and overhead grab rail height were the existing dimensions that were not accommodated. This implied the need for recommended design requirements to address these remarks.

Table 6. Mismatch analysis of driver's workspace

Current E-jeepney dimension		**Anthropometric dimension based on link length system**					
Driver's workspace dimensions	Current measurements (cm)	Corresponding anthropometric dimension	Gender	Driver's workspace dimensions	Current measurements (cm)	**Difference** Corresponding anthropometric dimension	**Remarks** Gender
Seat height	44.45	Popliteal height	Male	Seat height	44.45	Popliteal height	Male
Seat depth	43.18	Buttock popliteal length	Male	Seat depth	43.18	Buttock popliteal length	Male
Seat width	44.45	Hip breadth	Male	Seat width	44.45	Hip breadth	Male
Backrest height	45.72	Shoulder height – popliteal height – buttock popliteal length	Male	Backrest height	45.72	Shoulder height – popliteal height – buttock popliteal length	Male
Roof seat height	135.89	Sitting height	Male	Roof seat height	135.89	Sitting height	Male
Aisle width	35.56	Hip breadth	Male	Aisle width	35.56	Hip breadth	Male
Distance from driver's seat to steering wheel	68.58	Functional forward reach	Male	Distance from driver's seat to steering wheel	68.58	Functional forward reach	Male
Vertical distance of seat edge from steering wheel	25.40	Thigh clearance	Male	Vertical distance of seat edge from steering wheel	25.40	Thigh clearance	Male
Height of the windshield	68.58	Sitting eye height	Male	Height of the windshield	68.58	Sitting eye height	Male

Distance of foot controls	55.88	Popliteal height	Male	Distance of foot controls	55.88	Popliteal height	Male

As shown in Table 6, the dimensions which needed recommended improvements based on their respective remarks were aisle width, the height of the windshield, and the distance of foot controls (Estember and Espinosa, 2020). The current vertical distance from seat edge to steering wheel's curvature was above the standard but requires further analysis in terms of allotment of thigh clearance. The analysis contributed to the recommended design requirements for driver's workspace.

3.5 Regression Analysis

Table 7. Summary of determinants with the highest and lowest contributions on the overall rating model using regression analysis based on passengers and driver's perception

Criteria / Indicator	Passenger's perception		Driver's perception	
	Determinants	Coefficient of regression equation	Determinants	Coefficient of regression equation
Reliability	Schedule of available E-jeepney's operating (R2)	0.1134	Predictable in terms of travel time (R4)	0.139
	Waiting time at the station (R1)	-0.1321	Reduced waiting time at the station (R1)	-0.070
Safety	CCTV camera to monitor (S2)	0.1280	Removal of cash usage for payment (S1)	0.854
	Handrails attached (S3)	-0.1036	GPS installed (S2)	-0.133
Accessibility	Point to point route destination (A1)	0.1274	Designated stops, pickup, and drop off (A2)	0.475
	Accessible by senior citizens and PWD (A3)	0.0009	Point to point route destination (A1)	0.061
Environmental Soundness	Level of lighting (E3)	0.1091	Ventilation in E-jeep (E2)	0.165
	Sound level (E4)	0.0253	Use of renewable energy (E1)	-0.116
Comfort	Leg comfort (C5)	0.1282	Seat material (C6)	0.278
	Leaning the back (C4)	-0.0980	Leg comfort (C5)	-0.368

Using the regression analysis, it was analyzed that the waiting time at the station was significant with a p-value of 0.028 which means that it affects the overall satisfaction rating of passengers in terms of E-jeepney's service reliability. However, Table 7 shows that the ratings of passengers were decreasing based on its resulted negative coefficient. On the other hand, based on the driver's point of view, the highest contributor to the reliability model was predictable in terms of travel time. The results also show that the satisfaction ratings of drivers on the reduced waiting time at the station and the availability of E-jeepneys in surrounding areas were decreasing, thus, resulted in negative coefficients. In terms of safety, the ratings on the handrails attached were decreasing based on passenger's perception while it was the GPS installed shows the lowest contribution from the point of view of drivers. In terms of accessibility, the passengers and drivers have to contradict perception whereas the point-to-point route destination shows the highest contribution to the overall rating model while it was the lowest contributor based on driver's perception. In terms of environmental soundness, the passengers perceived that the level of lighting has the highest contribution to the model while it was ventilation based on the driver's perception. Lastly, in terms of comfort, the passenger's perceived quality contradicts the driver's perceived quality. From the point of view of passengers, leg comfort has the highest contribution to the overall satisfaction rating model while it has the lowest contribution as perceived by drivers.

3.6 Recommended E-jeepney specifications

A focus group was interviewed about their needs and preferences of E-jeepney. The Quality Function Deployment was developed to determine the possible improvements on the E-jeepney. Based on the computed importance ratings, the attributes associated with comfort resulted in having the highest importance ratings which include the size of passenger seating room, the height of the backrest, adjustable driver's seat, distance of steering wheel, distance of foot controls, the vertical distance of the steering wheel, driver's aisle clearance, overhead grab rail height, and height of the windshield. These aided the researchers in identifying the design requirement which needed priority in improving the E-jeepney specification.

Table 8. Recommended specifications for passenger cabin

E-jeepney dimension attribute	Relevant measurement	Equivalent measurement (cm)	Improved specification (cm)
Total passenger seat length (left side)	Seat width 95th male * Capacity	44.12 (use std mean data) *11	485.32
Total passenger seat length (right side)	Seat width 95th male * capacity	44.12(use std mean data) *10	441.20
Total width of passenger cabin (with faced seated passengers)	Buttock knee depth 95th male*2 + hip breadth 95th male*2	51.98(use std mean data) *2 + 43.57 (use std mean data) *2	191.10
Height of backrest	Backrest height 95th male	49.27 (use std mean data)	49.27
Height of overhead handrail / grab handle (recommended)	Functional overhead reach 5th female – length (suggested) of suspended strap grab handle	149.80 (use std mean data) – 20	129.80
Seat height	Popliteal height 5th female + shoe heel allowance	42.15 (use std mean data) + 2.54	44.69
Total width of window (left)	Total passenger cabin – 2*[0.5*seat width 95th male]	529.44(recommended) – 2[0.5*44.12(std mean data)]	485.32
Total width of window (right)	Total passenger cabin length – 2[0.5*seat width 95th male]	441.20(recommended) – 2[0.5*44.12(use std mean data)]	397.08
Height of the window	[Sitting height 95th male + suggested clearance below the handrail bar] – backrest height (recommended)	[88.92(use mean data) + 17] – 49.27(use std mean data)	56.65

As shown in Table 8, The seat length for the left and right sides of the passenger cabin had different recommended measurements since the service door was designed to be on the right side of the cabin which makes the seat length less than the length of the seat on the left side. The total width of the passenger cabin was improved by considering the dimensions of the passengers facing each other as well as the width between them. The researchers made sure that other passengers could enter and descend the E-jeepney without bumping the knees of the seated passengers facing each other. The researchers also improved the handrail by recommending to attach a grab rail. An improved specification of grab rail height was proposed so it would not require the standing passengers to have their arms fully extended when reaching whereas the design implied a formed right angle on the arms of the standing passengers. The ventilation was improved by increasing the height and width of the window. The designed width of the window started on half of the seat width near the back of the driver's seat until half of the last seat width.

Table 9. Recommended specifications for driver’s workspace

E-jeepney dimension attribute	Relevant measurement	Equivalent measurement (cm)	Improved specification (cm)
Driver’s aisle entrance/exit	Hip breadth 95th male	43.57 (use std mean data)	43.57
Vertical distance from seat edge to curvature of steering wheel	Thigh clearance 95th male + clearance below the steering wheel’s curvature	16.89 (use std mean data) + 16	32.89
Distance of foot control	30º Popliteal height 5th male + foot allowance) + [Buttock knee depth 5th male – buttock popliteal length 5th male]	[45.41(use std mean data) +25] [sin 30º] + [48.44 (use std mean data) – 42.22(use std mean data)]	41.43
Distance of the seat from steering wheel	Functional forward reach 5th male – seat depth 5th male + suggested clearance	70.10(use std mean data) – 42.22(use std mean data) + 5.08	32.96
Height of backrest with head rest	Sitting height 95th male + suggested allowance	87.83 (use std mean data) + 2.54	90.37
Total length of driver’s area	Buttock knee depth 95th male + popliteal height 95th male + shoe heel allowance + clearance between steering wheel and windshield	51.34 (use std mean data) + 48.14 (use std mean data) + 2.54 + 13	115.02
Window height	(Refer to suggested passenger cabin window height to make the design standard)	(Refer to suggested passenger cabin window height to make the design standard)	56.65
Window width	Total length of driver’s area – [1/8 * seat depth 5th male – [1/8 * total length of driver’s area]	115.02 (suggested) – [1/8 * 42.22(use std mean data)] – [1/8 *115.02 (suggested)]	80.99

Leg clearance	(Buttock knee depth 95th male + popliteal height 95th male + shoe heel allowance) – seat depth 5th male	[51.34 (use std mean data) + 48.14 (use std mean data) + 2.54] – 42.22 (use std mean data)	59.8
Windshield height	Sitting eye height 95th male	76.17 (use std mean data)	76.17

As shown in Table 9, the standard mean data was used in improving the driver's aisle entrance and exit so that the drivers would not bump their hips when entering and descending the workspace. The vertical distance from the seat edge to the lower curvature of the steering wheel was also improved by designing an additional clearance so that the drivers could freely move their legs and reach the pedals, especially on sudden brakes. The distance of the foot controls was also improved by reducing the distance to allow the drivers to reach the pedals comfortably without having their legs fully stretched. The improved design implied a formed angle of 30 degrees between the thigh and the leg to ease the leg discomfort. The distance of the steering wheel was reduced so that the driver would be able to reach it without stretching their arms fully. The driver's backrest was improved by adding a headrest to support the head of the drivers during unexpected impact. The specification of the driver's leg clearance was improved by considering the buttock knee depth and popliteal height to fully maximize the legroom since drivers also need to change positions, especially during a long drive. The height of the windshield was also improved by adding a minimal distance to the original measurement to accommodate the standard anthropometric measurement of sitting eye height.

3.7 Proposed design of Go electric E-jeepney

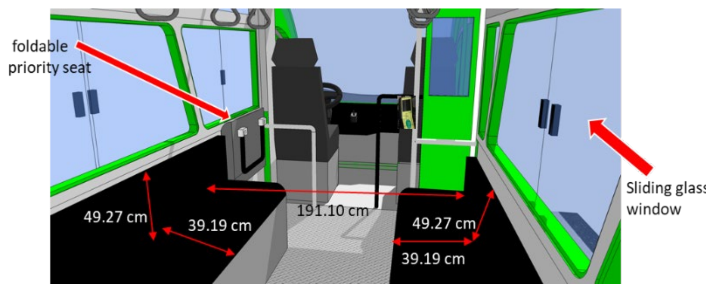

Figure 4. Proposed design requirements of E-jeepney's passenger cabin

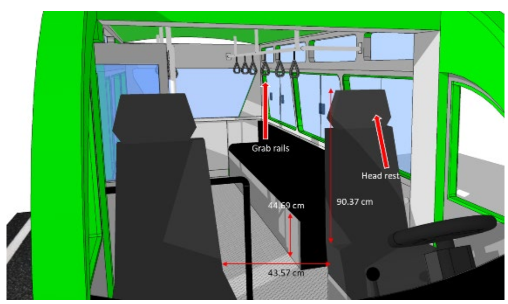

Figure 5. Proposed design requirements of E-jeepney's workspace for driver

Figure 6. Proposed design of E-jeepney with foldable ramp for PWD

The proposed designs of the E-jeepney are shown in Figures 4 to 6. The cost of the E-jeepney for the current design based on the interview with the operator at present is PHP 1,900,000.00. The total cost for the proposed design of E-jeepney including the electric vehicle and customization is PHP 2,090,500.00 whereas the total cost for customization was added to the current E-jeepney's cost. In cost-benefit analysis, the benefits enumerated for each cost were in terms of the recommended design's effect on the satisfaction of E-jeepney users. It resulted in an 11% increase in the E-jeepney's price but the improved specifications would contribute to an increase in the user's level of satisfaction when riding and driving the E-jeepney.

4. Conclusion

The passengers and drivers were neither dissatisfied nor satisfied on the comfort experienced with the current design of E-jeepney and resulted continuous low satisfaction ratings from both respondents. Among the measurement indicators, safety criterion was rated by the passengers with the highest satisfaction rating and satisfied as perceived while it was service reliability for drivers. Most of the dimensions of the passenger cabin accommodated the corresponding population for each cabin part of the E-jeepney while the driver's workspace obtained more unaccommodated standard dimensions which can be concluded that the driver's scope required more improvements. It can also be concluded that the determinants used under each criterion are essential in the overall satisfaction rating of E-jeepney's users since the behavior of the ratings given by the respondents reflect on the overall rating model. Lastly, most of the improvements on E-jeepney were in terms of comfort, environmental soundness, and accessibility whereas anthropometric principle was considered while other design input required compliance with operating equipment installed in E-jeepney to address reliability and safety.

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