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Comparing the Performance Evaluation of an Adaptive Left Throttling Pedal for V-Boot Wagon 230 for Right Leg Paraplegic Patient with Existing Model Using R' Console

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Abstract: ***This work is problem- solving oriented. A Design and Fabrication of an Adaptive Left Throttling Pedal for V-Boot Wagon 230 was done for right leg Paraplegic Patient who has a problem with his right leg and still desire to drive his car with ease. The uniqueness of this work is that this adaptation could be used for any modern car. Although there were various car adaptations in existence mainly customized for paraplegia that have been developed by different International Automobile industries. Nigeria is yet to have one. The clauses behind the design of this work are the difficulties to access left adaptive throttling accessories for V-Boot Wagon 230 for Right Leg Paraplegic patient and possibility of driving the car upon reverting the car to its existing state. On the course of achieving this research work, the following factors were considered; Anthropometric data of the client, Physical dimensions of available spaces for left throttle, design analysis which includes adaptive link mechanism, material selection, strength, and forces were determined, fabrication, machining of parts and assembling, Installation of the product, equipment maintenance and Performance evaluation. Ordinarily the engines speed runs 2000rpm at an idle position of the existing pedal compared to what has been adapted which runs at 1500rpm. This low speed indicates improved efficiency and minimizes fuel consumption. Also when the two pedals were activated and pressed through an arc length of 45mm, both engine speeds read 6000rpm. Although there were little deviations in the curves at displacement position 20mm and 30mm of which R' Console was used to test the significance of this deviation on the performance of the adapted throttling pedal. Welch Two Sample t-test was computed in R'console module to investigate the results obtained upon using both adapted pedal and the existing pedal under the same displacement values. It was observed that the analysis yielded p-value of 0.4557 which is less than 0.95 confidence level chosen for t-test computation with sample means estimates of 3900rpm and 3750rpm. This result indicates that there is no significance difference in the performance evaluation of the two systems.***

Keywords: Disability; left leg throttling pedal; performance evaluation; R'console.

1. Introduction

R is a flexible statistical software package that offers the environment for object-oriented programming and statistical data analysis.

It offers a plethora of statistical tools in the areas of classical estimation and hypothesis testing, regression, ANOVA, multivariate analysis, time series, survival analysis, robust methods, nonparametric methods, density estimation, etc. It also offers excellent graphical tools ideal for Explorative Data Analysis (EDA).

R was initially written by Ross Ihaka and Robert Gentleman at the Department of Statistics of the University of Auckland in Auckland, New Zealand. In addition, a large group of individuals has contributed to R by sending code and bug reports. Disability has been seen in this context as an inability to perform some or all of the tasks of daily life .

Anthropometry has been defined as the study of the measurement of the human body in terms of the dimensions of bone, muscle, and adipose (fat) tissue (National Health and Nutrition Examination Survey III, 1988). In making life comfortable for human being through engineering innovations and inventions, the physically challenged human beings must not be left out. The left foot accelerator pedal (LFAP) is an inexpensive low-tech device commonly prescribed by driver rehabilitation specialists to allow persons who cannot use their right foot to operate a motor vehicle. Persons with amputations or right hemiplegia from any number of causes (such as traumatic nerve or muscular damage, post polio effects, stroke, multiple sclerosis, arthritic damage and others) benefit from this automotive adaptive aid.

The ability to drive a motor car can radically alter the quality of life led by disabled people as inability to drive causes brooding and frustration when they cannot do a useful day's work or occupy themselves. Well-advised disabled drivers can drive to offices, shops, pubs, and cinemas without the need of a helper (Tachakra, 1981). The objective of this work is to report the design and fabrication of an adaptive left throttling pedal for v-boot wagon 230 for right paraplegic patient. This is based on collected information to determine the need for standards or guidelines to govern the design, manufacture, installation, prescription and use of Left Foot Adapted Pedals (LFAPs) in a safe manner.

2. T-Test Computation with R'Console

2.1 Variance test (T-test)

t.test(es1,es2,alternative="greater",var.equal=TRUE,conf.level=0.95)

Two Sample t-test
data: es1 and es2
t = 0.1162, df = 6, p-value = 0.4557
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
-2359.262 Inf
sample estimates:
mean of x mean of y
3900 3750

2.2 Welch Two Sample t-test

Welch Two Sample t-test is computed with the following format;

t.test(es1,es2,alternative="less",var.equal=FALSE,conf.level=0.95)

data: es1 and es2
t = 0.1162, df = 5.909, p-value = 0.5443
alternative hypothesis: true difference in means is less than 0
95 percent confidence interval: -Inf 2666.238
sample estimates:
mean of x mean of y
3900 3750

2.3 Pearson's product-moment correlation

Pearson's product-moment correlation is computed with the following format;
cor.test(es1,es2,alternative="two.sided",method="pearson",conf.level=0.95)
data: es1 and es2
t = 19.0526, df = 2, p-value = 0.002743
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
0.8705110 0.9999455
sample estimates:
cor
0.9972565

2.4 Variance test (F-test)

var.test(es1,es2,alternative="less",conf.level=0.95)

F test to compare two variances
data: es1 and es2
F = 0.7787, num df = 3, denom df = 3, p-value = 0.421
alternative hypothesis: true ratio of variances is less than 1
95 percent confidence interval:
0.000000 7.223401
sample estimates:
ratio of variances
0.7786667

2.5 Data Extraction and Detachment

Data extraction and detachment are computed with the following formats;
Attach (es.dat) # attaches es.dat
es1<- es1# extracts es1 variable from data frame
es2<- es2# extracts es2 variable from data frame

detach(es.dat)
summary(es1.dat)
Pd ES1
Min. : 0.00 Min. :2000
1st Qu.:15.00 1st Qu.:2900
Median :25.00 Median :3800
Mean :23.75 Mean :3900
3rd Qu.:33.75 3rd Qu.:4800
Max. :45.00 Max. :6000

2.6 Data Detachment and Attachment

> attach(es1.dat)
> es1<-ES1
> Pd<-Pd
> detach(es1.dat)

plot(Pd, es1, type="l",pch="o",col="green",main="displacement,Pd against Speed,es1",ylab="speed(Km/h)", xlab="Pedal Displacement(mm)",axes= TRUE, frame.plot= TRUE)

3. Performance Evaluation

3.1 Existing Pedal

The car was fueled and started to read a number of various engine speeds with the corresponding pedal displacements from idle position. Table 6 shows the tabulated reading of engine Speed in RPM with its corresponding displacement in millimeters.

Table 6: Readings obtained from testing the Existing Pedal

S/No	*Engine SpeedX100(RPM)*	*Displacement of pedal from neutral position (mm)*
01	20	0
02	32	20
03	44	30
04	60	45

3.2 Adapted Pedal

The car was also fueled and ignited in order to read a number of various engine speeds with the corresponding pedal displacements from idle position. Table 7 shows the reading of engine Speed in revolution per minute with its corresponding displacement in millimeters.

Table 7: Readings obtained from testing the Adapted pedal

S/No	*Engine SpeedX100(RPM)*	*Displacement of pedal from neutral position (mm)*
01	15	0
02	30	20
03	45	30
04	60	45

Table 8: comparison of existing pedal and adapted petal

S/No	Engine Speedx100(RPM) Before	Engine Speedx100(RPM) After
1	20	15
2	32	30
3	44	45
4	60	60

4. Discussion

The engines speed runs 2000rpm at an idle position of the existing pedal as shown by the red line in Figure 8 compared to the adapted pedal which runs at 1500rpm. This low speed indicates improved efficiency and minimizes fuel consumption. Also when the two pedals were activated and pressed through an arc length of 45mm, both engine speeds read 6000rpm. Although there were little deviations in the curves at displacement position 20mm and 30mm respectively. These deviations have no significant effect on the performance of the engine.

5. Conclusion

The Left Foot Adapted Pedal, LFAP design and fabrication were based on the anthropometric data of the client, evaluating the performance of the existing pedal as basis for functionality comparison .The above facts have been justified by using the design parameters to fabricate the project as reflected in figure I and II. Concurrent revolution of engine speed of 6000rpm through 45mm displacement arc of left foot pedal was achieved as compared with the existing pedal..Since Engineering is all about problem solving and making life comfortable for people, this design goes along way putting smile in the face of disables who intend to drive himself around with ease.The left foot accelerator pedal (LFAP) is an inexpensive low-tech device commonly prescribed by driver rehabilitation specialists to allow persons who cannot use their right foot to operate a motor vehicle. The LFAP is a mechanical adaptive device that allows left foot operation of the accelerator. This device transfers the throttling mechanism on the right side of the vehicle throttle pedal to the right. This work was initiated in response to a Right Leg Paraplegic Patient (RLPP) coupled with the Supervisions to conduct technical and ergonomics evaluations of the LFAP to determine the degree to which this adaptation could be better compared with the existing right foot pedal. Although great progress has been made by manufacturers and mobility equipment dealers in the field of automotive adaptive devices, the performance and safety of LFAPs is not currently regulated by Nigeria standards or guidelines.

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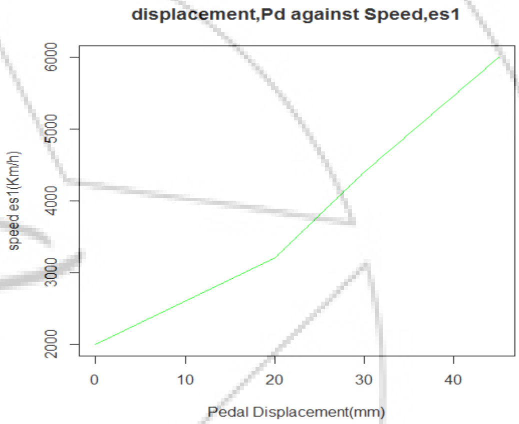

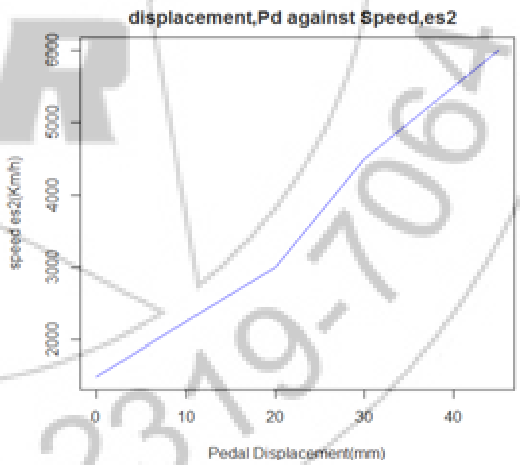

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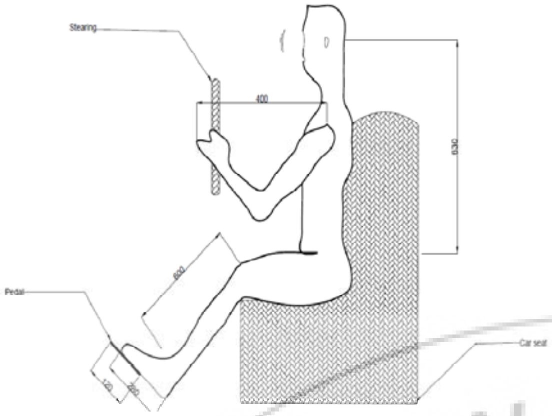

Figure 1: Anthropometric data of the patient taken and used for the design

Figure 2: Position of the Driver on Vee-Boot Wagon Mercedes 230

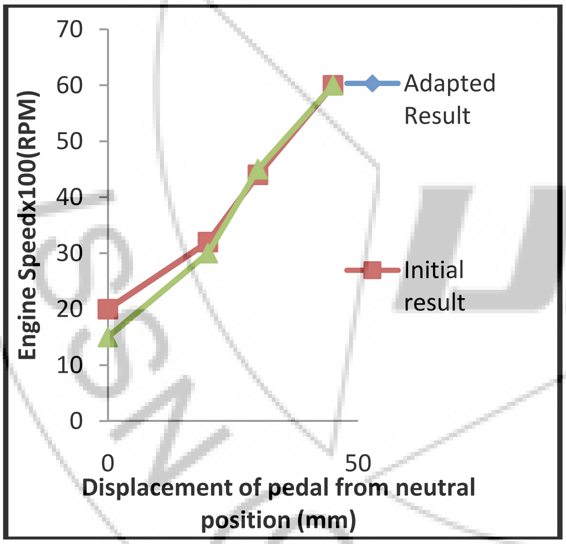

Figure 8: Combined Result showing the data range before and after Adaptation