Mental Workload Assessment and Neuroergonomics Approach of Private Car Drivers Passing Along the Epifanio de los Santos Avenue (EDSA)

Ma. Isabelle J. Delos Santos
Researcher
Industrial Engineering Department, Adamson University
ma.isadelossantos@gmail.com

Regille Kyle C.Villareal
Researcher
Industrial Engineering Department, Adamson University
regille.villareal@gmail.com

Sheily Mendoza, PIE, ASEAN Eng.
Research Co-Adviser
Adamson University
sheily.mendoza@adamson.edu.ph

Dr. Venusmar C. Quevedo, PIE, ASEAN Eng.
Research Adviser
Vice President for Administration
Adamson University
vcquevedo@gmail.com

Abstract

Research has shown that driving is a task that demands high cognitive resources for drivers to manage visual and auditory functions, execute decision-making actions, and perform manual operations to achieve their motivation in traveling from and to different locations. This can influence the mental workload of the drivers. This study aims to assess the mental workload of private car drivers passing along Epifanio de los Santos Avenue (EDSA) and the factors that influence their driving performance. Based on the subjective mental workload assessment tool, NASA Task Load Index (NASA-TLX), an online survey was randomly distributed among private motorists driving in EDSA. The responses were assessed to obtain the mental workload scores. Further analysis of the responses shows the significant factors of the drivers' mental workload through the use of Student's t-Test, Pearson Correlation, and Simple Linear Regression, and the contribution of the neuroergonomics approach. The results indicate that private car drivers in EDSA experience an overall high mental workload in performing their driving tasks in relation to the factors that significantly impact their performance. On this basis, it is recommended that the mental workload of private car drivers is seen as a key factor in EDSA's traffic congestion and accident-prone nature.

Keywords
Driving, Mental Workload, Neuroergonomics, Subjective Mental Workload Assessment, NASA Task Load Index, Mental Workload Score

1. Introduction

The driving task is a situation in which a driver is in an environment that highlights the relationship between humans and machines. In further detail, the lack of attention to relevant factors in the driving environment is one of the causes of traffic accidents, and it is commonly based on various forms of distraction. It is also stated that a high workload can contribute to the development of fatigue, illness, and other issues that can lead to a reduction in performance which then may limit a worker's capacity to do work. This would mean that work demand and the tasks involved can contribute to the relationship of workload and fatigue especially if it is carried through a long period of time. In between the demands of tasks and the resource capacity of an individual is mental workload. As mental workload is linked to changes in performance in which it is declining regardless of whether it is too high or too low, mental workload measurement and assessment is a useful human factor approach in order to determine how a task or series of tasks as well as other factors affect the worker's performance.

In measuring the mental workload, there has been both a subjective and objective approach to collect data and information which would help in assessing the mental workload of a worker from doing their work. Another approach in measuring the workload objectively is through the incorporation of neuroergonomics, where the study focuses on the relationship between human behavior and the brain at work. The interaction between cognition, action, and attention is key to advancing neuroergonomics as a discipline and increasing the benefit of its research products to society.

Understanding the interactions between neurobiological resources with reference to fundamental processes in brain physiology represents a crucial approach within neuroergonomic analysis of mental workload (Parasuraman and Rizzo, 2008; Ayaz and Dehais, 2018).

1.1 Objectives

The primary objective of this research is to measure and study the mental workload of private car drivers driving along Epifanio de los Santos Avenue (EDSA). The researchers believe that the conduction of this study will pave the way in having a better understanding of drivers' behavior with regards to different factors present that may affect their driving performance.

The researchers' specific objectives are the following:

a) To identify the degrees of mental workload of private car drivers passing along the Epifanio de los Santos Avenue (EDSA).
b) To identify the significant factors that affect the mental workload of private car drivers passing along the Epifanio de los Santos Avenue (EDSA) with the application of neuroergonomics approach.

2. Literature Review

Driving

Driving is defined as the operation of the mechanism and controls to direct a course of a vehicle (Merriam-Webster, nd). Whether what type of vehicle is being driven, the major task with regards to driving is the movement from one place to another using the vehicle. The movement requires the use of steering wheel, levers, buttons, and pedals in order to mechanically operate the automotive (LTO, 2018). Another driving task constant to all motorists is to constantly be mindful of the laws and regulations as well as to the traffic lights and signals and the different road signs present on the road. According to LTO, there are seven (7) types of road sign classifications which are Regulatory signs, Warning signs, Guide/Informative signs, Expressways signs, Traffic Instruction signs, Hazard markers, and Road Work signs.

Other aspects of the driving tasks include backing or reversing which is the process of driving the vehicle in the reverse direction in order to maneuver (LTO, 2018). Braking which is the ability to halt the vehicle, turning which is the ability to switch directions in the road, overtaking another vehicle, switching of lanes, and parking which is the placement of the vehicle to desired location (LTO, 2018).

Table 1. Total Road Crash Statistics for EDSA Grouped Per District

DISTRICT (CITY)	DAMAGE TO PROPERTY	FATAL	NON-FATAL INJURY	GRAND TOTAL
Central (Quezon)	7076	6	626	7708
Eastern (Mandaluyong)	3518	1	241	3760
Eastern (San Juan)	270	1	16	287
Northern (Caloocan)	448	2	108	558
Southern (Makati)	3267	8	278	3553
Southern (Pasay)	1338	1	177	1516
Grand Total	**15,917**	**19**	**1,446**	**17,382**

Mental Workload

Originally, there is no exact definition for mental workload but it can be simplified as the relationship between a task's mental demand and the worker's being (N.I Abd Rahman, et al., 2020). Mental workload can be seen as the reflection of the required amount of mental resources needed to perform a set of tasks (Li, et al., 2020). Workload is the general term of the mental cost of accomplishing task requirements and it can be either physical or mental as it is usually connected to one another almost impossible to completely separate when a worker operates or performs their tasks (M. Fallahi, et al., 2016). An operator that was given a task will allocate a certain amount of physical, mental, and emotional effort in order to succeed in accomplishing the task. It is essential to an individual to experience a suitable level of mental workload as it is expected and anticipated once a task has been performed. Performance indicators will degrade if the mental workload is too high or too low (N.I. Abd Rahman, et al., 2020). Furthermore, they also stated that if the given task is demanding and complex, it requires more effort from the person to work harder in order to perform the task in which the operator may exhibit delayed information processing due to the amount of information that outstrips their capacity thus demonstrating an increase in the mental workload (N.I. Abd Rahman, et al., 2020).

Relationship of Mental Workload to Driving

Mental Workload is one of the aspects many researchers are focusing on to further understand a worker's capability in doing the tasks. It is taken into consideration to gauge how the work will be done efficiently and effectively as well as look after the safety, well-being, and health of the workers. This can hugely impact a complex task like driving which requires drivers' large deviations in mental workload. Reduction of mental workload is the guiding principle for minimizing distractions that might affect driver's performance and prevent them from achieving optimal human-machine interface (Bergasa, 2018). Workload is affected by individual capabilities and characteristics such as driving experience, proficiency in driving skill, age, existing health conditions, motivation in performing the task, and other factors that might contribute as well as the current physical and emotional state of the driver (Bergasa, 2018). There have been studies regarding connection between driving task demands, performance, and human capacity all in hopes of improving the driving experience of the driver and preventing accidents from occuring. The workload of processing information can open up risks and affect the driver's ability to focus on the task, especially when unexpected driving hazards arise (Bergasa, 2018). The performance indicator for most human operators will degrade if the mental workload is either too high or too low (N. Rahman, et al., 2013).

Mental Workload Assessment

Mental Workload Assessment is a part of the evaluation capacity of the information that is needed to achieve the system demands (Aquino and Seva, 2017). It can be further defined as the measurement of an individual's ability to process information while doing their assigned tasks. The measurement and assessment of mental workload is a complex multidisciplinary research area that combines theoretical and practical approaches in the identification of factors that might affect the mental workload and performance of an individual (Moustafa, et al., 2017). Robust models are made to fully capture the concept of the experienced mental workload of an individual that can be read through subjective and objective means.

Subjective Mental Workload Assessment

Subjective assessment tools are available for individuals to rank their current workload (Edmonds, 2016). While biases may occur with the rating of mental workload, individuals are generally good in gauging their own level of workload (Edmonds, 2016). Usually, subjective assessment tools are administered before, during, and after completion of tasks or simulations when it comes to demonstrated studies. Some of the most frequently used subjective mental workload assessment tools are the Instantaneous Self-Assessment (ISA), Subjective Workload Assessment Technique (SWAT), National Aeronautics and Space Administration Task Load Index (NASA-TLX), and The Borg Rating of Perceived Exertion (RPE).

NASA Task Load Index

The National Aeronautics and Space Administration Task Load Index or commonly known as (NASA-TLX), is one if not the most widely used subjective assessment tool in measuring an individual's mental workload due to its standardization where different industries choose to use it (Edmonds, 2016). This multidisciplinary tool takes consideration of six (6) workload elements namely physical demand, mental demand, temporal demand, performance, effort, and frustration which are assessed individually after an individual rates their perceived mental workload whether low or high depending on their experience and self-evaluation (T. Yared, P. Patterson, 2020).

Pairwise Comparison

The NASA Task Load Index employs a paired comparison procedure which involves fifteen (15) pairwise combinations based from the six (6) workload elements which asks the subjects to scale each pair to determine which pairing has the most effect on the workload of the task being performed and to be analyzed (AHRQ, nd).

Mental Workload Score Computation

After the pairwise comparison and the answering of the NASA TLX questionnaire, the mental workload score can be computed by looking at the lines that the participant ranked in which the scale is essentially a line with twenty-one (21) marks. Subtract one (1) and then multiply by five (5). Weighted averages are computed by multiplying the raw score of each scale by the number of times the associated workload factor was chosen in the paired-choice task, then dividing by the sum of the weights (Hart, 2006). Furthermore, Unweighted or raw Task Load Index scores are also commonly published and just as useful. An Interpretation score can be seen as a guide or basis relating the value of the mental workload score to a scale on how high or low it is.

Table 2. Interpretation Score for Mental Workload

WORKLOAD	VALUE
Low	0-9
Medium	10-29
Somewhat high	30-49
High	50-79
Very high	80-100

Neuroergonomics

The last three decades have witnessed a revolution in our understanding of neural mechanisms that are fundamental to attention and human performance. Progress in the field has been driven by the development of advanced and portable neuroimaging techniques, which permit non-invasive examination of the "brain at work." Neuroergonomics is a multidisciplinary field born from these technical innovations that is broadly defined as the study of the human brain in relation to performance at work and in everyday settings. The goal of this field is to integrate both theories and principles from ergonomics, neuroscience, and human factors in order to provide insights into the relationship between brain function and behavioral outcomes in the context of work and everyday life. Neuroergonomics studies the boundaries of human factors, cognitive psychology, and cognitive neuroscience. The boundaries are broken down to provide the understanding for future research (McKendrick, 2019). Understanding the interactions between neurobiological resources with reference to fundamental processes in brain physiology represents a crucial approach within neuroergonomics analysis of mental workload (Dehais, Lafont, Roy, Fairclough, 2018).

Neuroergonomics research involves brain functioning metrics, either through brain imaging or through indirect physiological metrics such as eye tracking and heart monitoring. Neuroergonomics also involves designing systems based on models of brain functioning and use of behavioral measures to infer brain functioning (Baldwin, 2019). Most research on neuroergonomics is solely focused on addressing real-world issues outside the laboratory. The approach of neuroergonomics offers two benefits: first, to define and describe the neural basis associated with behavioral actions, and second, to develop and refine traditional theories in ergonomics (Navarro, Reynaud, Osiurak, 2018).

Student's t-test

Student's t-test, or commonly known as t-test, is one of the methods used to test the hypothesis for comparison of means between two groups. There is no need for multiple comparisons as a unique P value is observed. For this method, the dependent variable should be in continuous scale and approximately normally distributed (Mishra, Singh, Pandey, 2019).

Pearson Product-Moment Correlation

The Pearson Product-Moment Correlation Coefficient was developed by Karl Pearson that was derived from an idea introduced by Sir Francis Galton during the late 1800s. It is not only the first correlational measure to be established, but it's also the most frequently used measure of association. The subsequent correlation tests are variations to Pearson's equation designed to control for deviations of the assumptions that must be satisfied in order to use Pearson's equation. Pearson's r is a representation of the linear relationship between two interval or ratio variables, with value ranging from -1 to 1. That is the same as the point-biserial correlation; a calculation of the relationship between two dichotomous variables and one interval/ratio variable. The advantage of using Pearson's r is that it is an easy way to measure the interaction between two variables; whether they share variance, whether the relationship is positive or negative, and the degree to which they correlate. The drawbacks of using Pearson's r is that it cannot detect nonlinear correlations and can display a correlation of zero where a correlation occurs. The disadvantages of using Pearson's r is that it cannot distinguish nonlinear correlations and which display a correlation of zero where the correlation has a relationship that is not linear (Chee, 2015).

Simple Linear Regression

Simple linear regression is a statistical approach that allows us to summarize and analyze connectivity between two quantitative variables. The first variable, indicated by x, is one of the two variables stated. The independent variable is x. The second variable, indicated by y, is known as the dependent variable. The linear regression model takes the form of $\hat{y}$=b0+b1x, where b0 is the intercept, b1 is the slope, x is the independent variable, and $\hat{y}$ is the dependent variable.

After identifying the regression equation based on the computation of b0 and b1, the Analysis of Variance is used to determine the variation due to regression and the variation due to random error. The sums of squares of total variability about the mean (SST), sums of squares due to regression (SSR), and the sum of squares due to error (SSE) are computed in the analysis of variance. The sums of squares and mean sums of squares are present in the regression analysis. The mean sums of squares for the regression (MSR) and mean sum of squares for error (MSE) ratios are used to compute the F-test statistic of the regression model, which will be used to test the significance of the model.

To test the model, the R-squared or the Coefficient of Determination is computed. It is the measure of percent variation in the dependent variable that is explained by the independent variable. The R-squared values of <0.05 or close to zero means that the model has a significant explanatory power.

3. Methods

A quantitative research design is introduced in this study. It is a method of conducting research involving the collection of statistical data or the qualification of inferring variables to determine which factors are to be submitted for statistical analysis. The study also uses descriptive research that seeks to provide information about one or more variables that is used to answer the questions that focus on the what, where, when, and how.

As this study is regarded as a descriptive research, this study involves describing the facts and characteristics of a given population or area of interest systematically and accurately; providing an accurate portrayal of characteristics of particular individuals, situations, or groups and the frequency that it occurs; discovering relationships between variables, and answering the questions based on the events occurring at present (Dulock, 1993).

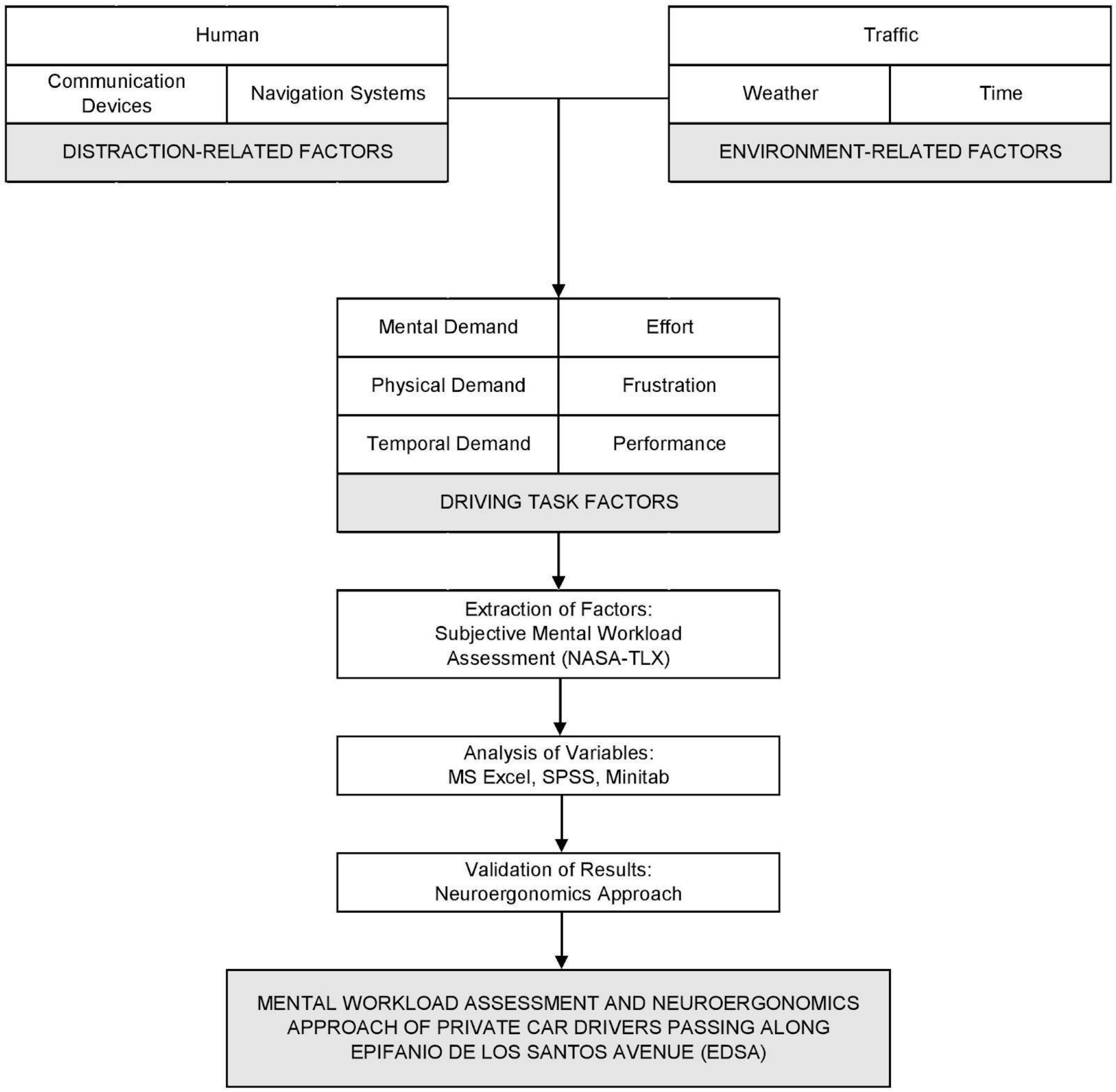

Fig. 1. Conceptual Framework

The survey questionnaire will be used by the researchers as a primary data collection method for the study. This instrument will be used to gather significant and specific information from a specified group of people. The researchers will be incorporating the NASA Task Load Index subjective mental workload assessment tool (NASA-TLX) for the measurement of the six (6) workload elements consisting of mental demand, physical demand, temporal demand, performance, effort, and frustration that will represent the perceived mental workload of private car drivers. NASA-TLX is one of the most popular subjective multidimensional assessment tools used to evaluate the perceived task workload developed by the human performance research group from NASA.

This study aims for the assessment of mental workload of private car drivers passing along EDSA. The researchers will be using a probability sampling method, specifically, the random sampling for the participant selection. Probability sampling is a technique in which each population member has a known, non-zero chance of participating in the study. Randomization or chance is the core of probability sampling technique. The participant selection will be selected in the area of Metro Manila, in which the population structure will be taken from the Land Transportation Office. For the questionnaire, the researchers will make use of Slovin's Formula in order to calculate the required number of participants, and sample size with the margin of error of 10% (90% confidence level) for the population of the participants.

n= N1+Ne2
n= 255,7321+(255,732)(0.10)2
n=99.96 ≈ 100

Where:
n = sample size
N = average number of Daily Traffic in Epifanio de los Santos Avenue (EDSA) at 90% confidence level
e = margin of error at 10%

The survey questionnaire formed by the researchers is developed to measure the degree of workload in driving-related factors. To be internally consistent, the researchers used Cronbach's Alpha to assess the reliability of the data. The data collected from the survey is entered in the SPSS and Minitab software. The Cronbach's Alpha was used to evaluate the reliability of the scale used in the survey questionnaire. The reliability test is performed to ensure that the data obtained is appropriate and to evaluate if the scale is reliable. The reliability test result of $0.9 > \alpha \geq 0.8$ or Good Internal Consistency is considered to be accurate and reasonable.

In addition, the researchers will use data from journals, articles, and previous studies to assist in the analysis of the findings. These instruments involve previous research on mental workload, neuroergonomic approach, and the circumstances revolving on private car drivers passing along Epifanio de los Santos Avenue (EDSA). The researchers will use records of EDSA's daily traffic, and road statistics from the Metro Manila Development Office (MMDA) and records concerning private car drivers from the Land Transportation Office (LTO).

4. Data Collection

The researchers will collect and garner data through survey questionnaires, interviews, and the data gathered from internal and external sources. Before conducting the data collection, the researchers will present ways of collecting information and seek approval from the research adviser. The researchers will be considering the population of private car drivers that are passing through Epifanio de los Santos Avenue (EDSA) in finding the right number of samples with the use of Slovin's Formula. Also included are records concerning private car drivers in Metro Manila, and EDSA's road statistics and daily traffic, with the assistance of the data that will be collected from the Metro Manila Development Authority (MMDA) and the Land Transportation Office (LTO). The survey questionnaires and interviews will be the primary research instruments that will help the researchers define, assess, and understand the mental workload of private car drivers and the factors that affect their performance.

5. Results and Discussion

Reliability Test

Cronbach's Alpha test was used by the researchers to evaluate the internal consistency of the survey test items. Considered to be a measure of scale reliability, Cronbach's Alpha test is usually used for multiple likert questions generating a scale.

The generated output of the reliability test for the NASA-TLX Scale for Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration with 5 items was 0.878 which is $0.9 > \alpha \geq 0.8$, having a good internal consistency. For the NASA-TLX Scale for Performance with 9 items, the result was 0.885 which is $0.9 > \alpha \geq 0.8$, having a good internal consistency.

Mental Workload Assessment

The researchers assess the degree of workload elements in order to identify the overall mental workload score and the diagnostic subscores for the six (6) workload elements: Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration.

The mental workload scores are interpreted as Low Workload if the mental workload scores are from 0 to 9, Medium Workload if the mental workload scores are from 10 to 29, Somewhat High Workload if the mental workload scores are from 30 to 49, High Workload if the mental workload scores are from 50 to 79, and Very High Workload if the mental workload scores are from 80 to 100 and above. In Table 3, it can be observed that the overall mental workload score for the General Degree of Workload Elements is 74.72 which shows a High Workload due to the score being within the value range of 50-79.

The diagnostic subscores show that Mental Demand, Effort and Frustration have a Very High Workload due to the score being within the value range of 80-100 with a score of 79.39, 81.59 and 82.07, respectively. The rest of the workload elements have a High Workload due to the scores being within the value range of 50-79 with Physical Demand having a score of 76.34, Temporal Demand having a score of 64.45, and Performance having a score of 60.12.

Table 3: Mental Workload Assessment using the NASA Task Load Index (NASA-TLX)

Factors	Overall Score	Mental Demand	Physical Demand	Temporal Demand	Performance	Effort	Frustration
Section C2-C7: Regular Driving Task	70.57	77.80	71.95	63.17	55.73	71.71	75.61
Section C8: Driving Task w/COVID-19 Protocols	59.37	62.30	60.40	56.90	58.20	60.70	59.00
Section D3: Driving Task while having passengers	66.64	74.20	68.50	63.50	55.70	66.00	64.20
Section D6: Driving Task while using Communication Device	59.15	61.30	55.10	61.20	56.90	61.10	55.10
Section D9: Driving Task while using navigation systems	60,56	66.20	58.10	60.80	54.80	58.70	58.70
Section E1: Driving Task while raining	72.85	83.05	76.71	61.28	57.56	78.17	76.59
Section E2: Driving Task while Daytime	65.69	71.34	66.36	60.67	51.83	66.10	68.90
Section E3: Driving Task while Nigh Time	69.02	77.68	70.98	64.88	57.44	70.85	64.88
Section E4: Driving Task while Rush Hour	74.72	79.39	76.34	64.45	60.12	81.59	82.07

The results of the Mental Workload Assessment, specifically the Mental Workload Diagnostic Subscores of the degree of workload elements are used to identify the impact of mental workload to the performance of private car drivers passing along EDSA. referencing Table 4, Sections D3, E1, E2, E3, and E4 all have shown very strong correlation in relation to the performance of the drivers. This shows that doing the driving task under the section's corresponding situations has the highest tendency in impacting the driver's performance due to changes in their mental workload level. Sections C8 and D9 showed strong correlations noting that upon changes in the mental workload of the drivers, situations like driving under COVID-19 protocols and while using navigation systems can have a big effect towards their performance. Only driving tasks while using communication devices (Section D6) showed no correlation.

Table 4. Correlation Analysis of the Mental Workload Diagnostic Subscores with Section C2-C7: Regular Driving Task

Factors	r
Section C8: Driving Task with COVID-19 Protocols	0.738
Section D3: Driving Task while having Passengers	0.866
Section D6: Driving Task while using Communication Devices	0.037
Section D9: Driving Task while using Navigation Systems	0.647
Section E1: Driving Task while Raining	0.964
Section E2: Driving Task during Daytime	0.992
Section E3: Driving Task during Nighttime	0.829
Section E4: Driving Task during Rush Hours	0.941

To confirm the impact of the mental workload to private car drivers passing along the Epifanio de los Santos Avenue (EDSA) analyzed from the Pearson Product-Moment Correlation, the Simple Linear Regression Model is utilized. The sections having the highest coefficient of determination (R Square) are Sections E1, E2 and E4 with 92.9%, 98.4%, and 88.6% respectively which means that conducting the driving task under the situation of each section are most likely to impact the driver's performance upon the increase of their mental workload. Furthermore, Sections D3, E1, E2, E3, and E4 have a P-value of less than 0.05 which means that they are significant.

Table 5. Regression Statistics of the Mental Workload Diagnostic Subscores and Section C2-C7: Regular Driving Task

Factors	Multiple R	R Square	Adjusted R Square	P-Value
Section C8: Driving Task with COVID-19 Protocols	0.738	54.5%	43.1%	0.094
Section D3: Driving Task while having Passengers	0.866	75%	68.7%	0.026
Section D6: Driving Task while using Communication Devices	0.037	0.1%	0.0%	0.944
Section D9: Driving Task while using Navigation Systems	0.647	41.8%	27.3%	0.165
Section E1: Driving Task while Raining	0.964	92.9%	91.2%	0.002
Section E2: Driving Task during Daytime	0.992	98.4%	98.0%	0.000
Section E3: Driving Task during Nighttime	0.829	68.7%	60.9%	0.041
Section E4: Driving Task during Rush Hours	0.941	88.6%	85.8%	0.005

Table 6: Student's t-test

STUDENT'S t-TEST: ASSUMING UNEQUAL VARIANCES					
	Mean	Variance	t Statistics	P-Value	t Critical
SECTION C2-C7: Regular Driving Task	70.569	134.377	4.049	**0.000**	1.980
SECTION C8: Driving Task with COVID-19 Protocols	59.370	492.842			
SECTION C2-C7: Regular Driving Task	70.569	134.377	1.667	0.099	1.986
SECTION D3: Driving Task while having Passengers	66.635	208.172			
SECTION C2-C7: Regular Driving Task	70.569	134.377	4.997	**0.000**	1.979
SECTION D6: Driving Task while using Communication Devices	59.155	254.038			
SECTION C2-C7: Regular Driving Task	70.569	134.377	4.126	**0.000**	1.982
SECTION D9: Driving Task while using Navigation Systems	60.556	267.742			
SECTION C2-C7: Regular Driving Task	70.569	134.377	-1.133	0.259	1.975
SECTION E1: Driving Task while Raining	72.846	196.398			
SECTION C2-C7: Regular Driving Task	70.569	134.377	2.320	**0.022**	1.976
SECTION E2: Driving Task during Daytime	65.691	228.186			
SECTION C2-C7: Regular Driving Task	70.569	134.377	0.713	0.477	1.976
SECTION E3: Driving Task during Nighttime	69.024	251.025			
SECTION C2-C7: Regular Driving Task	70.569	134.377	-2.249	**0.026**	1.975
SECTION E4: Driving Task during Rush Hours	74.715	144.294			

The researcher's used two-sample unequal variance with two tailed distribution t-test. The two samples used are the unweighted mean regular driving task mental workload score and the corresponding unweighted mean mental workload scores from the distraction-related factors, environmental-related factors, and the COVID-19 Protocols in Epifanio de los Santos Avenue (EDSA). Sections D3, E1, E2, and E3 showed no significant difference since the p-value is below the alpha level of 0.05 and states that the null hypothesis must be accepted. Driving tasks under Sections C8, D6, D9, and E4 show significant difference and the null hypothesis must be rejected.

Neuroergonomics Approach

The researchers, through the collection of different research studies, journals, and articles, were able to relate the results of the mental workload of driver's driving along Epifanio de los Santos Avenue (EDSA) to the neuroergonomics approach as this will be considered as the objective side of the mental workload assessment which will serve as further justification to support the results of the NASA-TLX subjective assessment since the researchers were unable to conduct a driving simulation to measure objective metrics due to the constraints stated in the scope and delimitations of the study.

The results of the mental workload score of the regular driving task and the driving task under the corresponding distraction and environment related factors all had a mean score in the range of 50 to 79 which translates to the respondents having high mental workload based on the interpretation score. Results from a conducted study shows a higher perceived mental workload in using navigation devices with small screen displays compared to devices having larger displays. This can be attributed to the drivers spending more attention and focus with the navigation devices with smaller screen displays because they are having difficulties in seeing the directions projected on the screen which leads to more perceived distraction. Furthermore, driving at night in urban areas leads to an increase in mental workload as higher traffic load and increased number of people in urban areas demands higher cognitive resources from the driver and increased effort due to the low level of illumination requiring more attention compared to driving during daytime and in rural areas (T. Yared, et al., 2020).

The degree on how much the drivers are being affected differs regarding the kind of conversation they are having with their phones. The content of the mobile phone conversation while driving is the cause of the persistent changes in the behavioral and brain functions. In circumstances where the conversation has low cognitive processing, there were no significant changes with regards to performing the driving task (M. Zokaei, et al., 2020). Drivers also experience reduced levels of vigilance during rainy night conditions due to the difficulties in the visual tasks of driving as well as higher level of sleepiness and lower levels of alertness due to a decrease in the mental workload especially when it is nearing the end of the driving task period (N. Abd Rahman, et al., 2013). It was observed that even though overall mental workload scores are near the middle, participants showed middle to high burnout levels with the risk of higher burnout levels as the pandemic continues (A. Rodriguez-Lopez, et al., 2021).

6. Conclusion

This research aims to study the mental workload of private car drivers through the support of neuroergonomics approach. A survey instrument was deployed to a random sample of a total of 82 respondents, which are the private car drivers passing along Epifanio de los Santos Avenue (EDSA). Based on the results, all factors produce a high to very high mental workload on the respondents, with significant differences to the following factors: driving task with COVID-19 protocols, driving task while using communication devices, driving task while using navigation devices, driving task during daytime, and driving task during rush hours. The results from the analysis determined the percent effect of the significant factors to the regular driving task.

The researchers conclude that the neuroergonomics approach supports the subjective part of the mental workload assessment such as the NASA Task Load Index (NASA-TLX) and other subjective mental workload tools by measuring the brain signals activity through physiological reactions such as eye motion and blink rate, and heart rate which serves as the objective side of the mental workload assessment as it provides reliability which is very crucial for driving tasks where safety of the drivers

With this, the researchers recommend for drivers to prepare accordingly and follow driving rules and regulations in relation to checking their cognitive disposition, preparing a face mask before driving, learning the driving route ahead of time, preventing in engaging with electronic devices for communication activities, and observing high traffic jams and rush hours in order to plan accordingly. The researchers also recommend proceeding with in-vehicle adjustments for the seat height, lower limb position, seat pan, backrest, lumbar support, steering wheel, headrest, and mirrors.
In the application process for driving licenses, the researchers recommend including a cognitive assessment test that challenges the drivers' estimated distance and speed, attention, auditory and visual perception, and reaction time. For rerouting, the researchers recommend exploring the "Better Safe than Sorry" method which implements a non-deterministic optimization algorithm that takes consideration of the mobility and safety measures. In the context of designing the driving controls of vehicles, the researchers recommend using a cognitive neuroscience approach in building in-vehicle warning signals, especially for distracted drivers.

For future research, the researchers recommend the inclusion of driving simulations and measurement of drivers' physiological metrics to cover the objective side of the mental workload assessment. Also, the researchers recommend widening the scope of the study to public transportation vehicle drivers, and drivers passing along rural regions with alarming road crash statistics.

References

Abd Rahman, N. I., Md Dawal, S. Z., & Yusoff, N. Driving mental workload and performance of ageing drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, *69*, 265–285. https://doi.org/10.1016/j.trf.2020.01.019 (2020)

Al-Achi, A. *The Student's T-test: A Brief Description*. ResearchGate. Retrieved from https://www.researchgate.net/publication/332182802_The_Student's_t-Test_A_Brief_Description. (2019, February)

Baldwin, C. L. *Neuroergonomics of Simulators and Behavioral Research Methods*, 49–53. https://doi.org/10.1016/b978-0-12-811926-6.00008-7 (2019)

Broggi, A., Zelinsky, A., Özgüner, Ü., & Laugier, C. Intelligent Vehicles. *Springer Handbook of Robotics*, 1627–1656. https://doi.org/10.1007/978-3-319-32552-1_62 (2016)

Carrieri, M., Petracca, A., Lancia, S., Basso Moro, S., Brigadoi, S., Spezialetti, M., Ferrari, M., Placidi, G., & Quaresima, V. Prefrontal Cortex Activation Upon a Demanding Virtual Hand-Controlled Task: A New Frontier for Neuroergonomics. *Frontiers in Human Neuroscience*, *10*. https://doi.org/10.3389/fnhum.2016.00053 (2016)

Chee, J. D. Pearson's Product-Moment Correlation: Sample Analysis. https://doi.org/10.13140/RG.2.1.1856.2726 (2015)

Curtin, A., & Ayaz, H. The Age of Neuroergonomics: Towards Ubiquitous and Continuous Measurement of Brain Function with fNIRS. *Japanese Psychological Research*, *60*(4), 374–386. https://doi.org/10.1111/jpr.12227 (2018)

de Souza, A. M., Braun, T., Botega, L. C., Cabral, R., Garcia, I. C., & Villas, L. A. Better safe than sorry: a vehicular traffic re-routing based on traffic conditions and public safety issues. *Journal of Internet Services and Applications*, *10*(1). https://doi.org/10.1186/s13174-019-0116-9 (2019)

de Winter, J. C. F. Using the Student's t-test with extremely small sample sizes. *Practical Assessment, Research, and Evaluation*, *18*(10). https://doi.org/10.7275/e4r6-dj05 (2013)

Dehais, F., & Ayaz, H. Progress and Direction in Neuroergonomics. *Neuroergonomics*, 3–7. https://doi.org/10.1016/b978-0-12-811926-6.00001-4 (2019)

Dehais, F., Lafont, A., Roy, R., & Fairclough, S. A Neuroergonomics Approach to Mental Workload, Engagement and Human Performance. *Frontiers in Neuroscience*, *14*. https://doi.org/10.3389/fnins.2020.00268 (2020)

Di Flumeri, G., Borghini, G., Aricò, P., Sciaraffa, N., Lanzi, P., Pozzi, S., Vignali, V., Lantieri, C., Bichicchi, A., Simone, A., & Babiloni, F. EEG-Based Mental Workload Neurometric to Evaluate the Impact of Different Traffic and Road Conditions in Real Driving Settings. *Frontiers in Human Neuroscience*, *12*. https://doi.org/10.3389/fnhum.2018.00509 (2018)

Di Flumeri, G., Borghini, G., Aricò, P., Sciaraffa, N., Lanzi, P., Pozzi, S., Vignali, V., Lantieri, C., Bichicchi, A., Simone, A., & Babiloni, F. EEG-Based Mental Workload Assessment During Real Driving: A Taxonomic Tool for Neuroergonomics in Highly Automated Environments. *Neuroergonomics*, 121–126. https://doi.org/10.1016/b978-0-12-811926-6.00020-8 (2019)

Ding, Y., Cao, Y., Duffy, V. G., Wang, Y., & Zhang, X. Measurement and identification of mental workload during simulated computer tasks with multimodal methods and machine learning. *Ergonomics*, *63*(7), 896–908. https://doi.org/10.1080/00140139.2020.1759699 (2020)

Dulock, H. L. Research Design: Descriptive Research. *Journal of Pediatric Oncology Nursing*, *10*(4), 154–157. (1993)

Edmonds, J. Staffing the operation. *Human Factors in the Chemical and Process Industries*, 357–415. https://doi.org/10.1016/b978-0-12-803806-2.00020-0 (2016)

Efron, B. Student's t-test Under Symmetry Conditions. *Journal of the American Statistical Association*, *64*(328), 1278–1302. https://doi.org/10.1080/01621459.1969.10501056 (1969)

Fan, J., & Smith, A. P. The Impact of Workload and Fatigue on Performance. *Communications in Computer and Information Science*, 90–105. https://doi.org/10.1007/978-3-319-61061-0_6 (2017)

Fan, X., Zhao, C., Zhang, X., Luo, H., & Zhang, W. Assessment of mental workload based on multi-physiological signals. *Technology and Health Care*, *28*, 67–80. https://doi.org/10.3233/thc-209008 (2020)

Fastenmeier, W., & Gstalter, H. Driving task analysis as a tool in traffic safety research and practice. *Safety Science*, *45*(9), 952–979. https://doi.org/10.1016/j.ssci.2006.08.023 (2007)

Faure, V., Lobjois, R., & Benguigui, N. The effects of driving environment complexity and dual tasking on drivers' mental workload and eye blink behavior. *Transportation Research Part F: Traffic Psychology and Behaviour*, *40*, 78–90. https://doi.org/10.1016/j.trf.2016.04.007 (2016)

Foy, H. J., & Chapman, P. Mental workload is reflected in driver behaviour, physiology, eye movements and prefrontal cortex activation. *Applied Ergonomics*, *73*, 90–99. https://doi.org/10.1016/j.apergo.2018.06.006 (2018)

Fritz, M., & Berger, P. D. Can you relate? Correlation and Simple Linear Regression. *Improving the User Experience Through Practical Data Analytics*, 205–237. https://doi.org/10.1016/b978-0-12-800635-1.00009-4 (2015)

Galy, E. A multidimensional scale of mental workload evaluation based on Individual–Workload–Activity (IWA) model: Validation and relationships with job satisfaction. *The Quantitative Methods for Psychology*, *16*(3), 240–252. https://doi.org/10.20982/tqmp.16.3.p240 (2020)

Galy, E., Paxion, J., & Berthelon, C. Measuring mental workload with the NASA-TLX needs to examine each dimension rather than relying on the global score: An example with driving. *Ergonomics*, *61*(4), 517–527. https://doi.org/10.1080/00140139.2017.1369583 (2017)

Giraudet, L., Imbert, J.-P., Bérenger, M., Tremblay, S., & Causse, M. The Neuroergonomic Evaluation of Human Machine Interface Design in Air Traffic Control using behavioral and EGG/ERP measures. *Behavioural Brain Research*, *294*, 246–253. https://doi.org/10.1016/j.bbr.2015.07.041 (2015)

Grier, R. A. How high is high? A meta-analysis of NASA-TLX Global Workload Scores. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *59*(1), 1727–1731. https://doi.org/10.1177/1541931215591373 (2015)

Hani, A. F., Feng, Y. X., & Tang, T. B. Negative Mood States in Neuroergonomics. *Neuroergonomics*, 325–326. https://doi.org/10.1016/b978-0-12-811926-6.00097-x (2018)

Hanley, J. A. Simple and multiple linear regression: Sample size considerations. *Journal of Clinical Epidemiology*, *79*, 112–119. https://doi.org/10.1016/j.jclinepi.2016.05.014 (2016)

Hart, S. G. NASA-Task Load Index (NASA-TLX); 20 years later. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *50*(9), 904–908. https://doi.org/10.1177/154193120605000909 (2006)

Heine, T., Lenis, G., Reichensperger, P., Beran, T., Doessel, O., & Deml, B. Electrocardiographic features for the measurement of drivers' mental workload. *Applied Ergonomics*, *61*, 31–43. https://doi.org/10.1016/j.apergo.2016.12.015 (2017)

Human Factors. *Intelligent Vehicles*, 345–394. https://doi.org/10.1016/b978-0-12-812800-8.00009-6 (2018)

Ihme, K., Unni, A., Rieger, J. W., & Jipp, M Assessing Driver Frustration Using Functional Near-Infrared Spectroscopy (fNIRS). *Neuroergonomics*, 215–216. https://doi.org/10.1016/b978-0-12-811926-6.00042-7 (2018)

Kaduk, S. I., Roberts, A. P., & Stanton, N. A. Driving performance, sleepiness, fatigue, and mental workload throughout the time course of semi-automated driving—Experimental data from the driving simulator. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *31*(1), 143–154. https://doi.org/10.1002/hfm.20875 (2020)

Karwowski, W., Siemionow, W., & Gielo-Perczak, K. Physical neuroergonomics: The human brain in control of physical work activities. *Theoretical Issues in Ergonomics Science*, *4*(1-2), 175–199. https://doi.org/10.1080/1463922021000032339 (2003)

Katrakazas, C., Michelaraki, E., Sekadakis, M., & Yannis, G. A descriptive analysis of the effect of the COVID-19 pandemic on driving behavior and Road Safety. *Transportation Research Interdisciplinary Perspectives*, *7*, 100186. https://doi.org/10.1016/j.trip.2020.100186 (2020)

Kummetha, V. C., Kondyli, A., Chrysikou, E. G., & Schrock, S. D. Safety analysis of work zone complexity with respect to driver characteristics — A simulator study employing performance and Gaze Measures. *Accident Analysis & Prevention*, *142*, 105566. https://doi.org/10.1016/j.aap.2020.105566 (2020)

Kurata, Y. B., Bano, R. M., & Matias, A. C. Effects of workload on academic performance among working students in an undergraduate engineering program. *Procedia Manufacturing*, *3*, 3360–3367. https://doi.org/10.1016/j.promfg.2015.07.497 (2015)

Le, A. S., Suzuki, T., & Aoki, H. Evaluating driver cognitive distraction by eye tracking: From simulator to driving. *Transportation Research Interdisciplinary Perspectives*, *4*, 100087. https://doi.org/10.1016/j.trip.2019.100087 (2020)

Lees, M. N., Cosman, J. D., Lee, J. D., Fricke, N., & Rizzo, M. Translating cognitive neuroscience to the driver's operational environment: A neuroergonomic approach. *The American Journal of Psychology*, *123*(4), 391. https://doi.org/10.5406/amerjpsyc.123.4.0391 (2010)

Li, D., Wang, X., Menassa, C. C., & Kamat, V. R. Understanding the impact of building thermal environments on occupants' comfort and mental workload demand through human physiological sensing. *Start-Up Creation*, 291–341. https://doi.org/10.1016/b978-0-12-819946-6.00012-6 (2020)

Li, S., Zhang, T., Zhang, W., Liu, N., & Lyu, G. Effects of speech-based intervention with positive comments on reduction of driver's anger state and perceived workload, and improvement of driving performance. *Applied Ergonomics*, *86*, 103098. https://doi.org/10.1016/j.apergo.2020.103098 (2020)

Longo, L., & Leva, M. C. (Eds.) *Human Mental Workload: Models and Applications* (1st ed., Vol. 1107, Ser. Communications in Computer and Information Science). Springer International Publishing. (2019)

Makishita, H., & Matsunaga, K. Differences of drivers' reaction times according to age and mental workload. *Accident Analysis & Prevention*, *40*(2), 567–575. https://doi.org/10.1016/j.aap.2007.08.012 (2008)

Mandrick, K., Chua, Z., Causse, M., Perrey, S., & Dehais, F. Why a Comprehensive Understanding of Mental Workload through the Measurement of Neurovascular Coupling is a Key Issue for Neuroergonomics? *Frontiers in Human Neuroscience*, *10*. https://doi.org/10.3389/fnhum.2016.00250 (2016)

Marquart, G., Cabrall, C., & de Winter, J. Review of Eye-related Measures of Drivers' Mental Workload. *Procedia Manufacturing*, *3*, 2854–2861. https://doi.org/10.1016/j.promfg.2015.07.783 (2015)

Mars, F., & Chevrel, P. A Psychophysiology-Based Driver Model for the Design of Driving Assistance Systems. *Neuroergonomics*, 223. https://doi.org/10.1016/b978-0-12-811926-6.00046-4 (2018)

McKendrick, R. Mobile Neuroergonomics: Action, Interfaces, Cognitive Load, and Selective Attention. *Neuroergonomics*, 111–116. https://doi.org/10.1016/b978-0-12-811926-6.00018-x (2019)

Mehta, R. K., & Agnew, M. J. Subjective Evaluation of Physical and Mental Workload Interactions Across Different Muscle Groups. *Journal of Occupational and Environmental Hygiene*, *12*(1), 62–68. https://doi.org/10.1080/15459624.2014.942455 (2014)

Mishra, P., Singh, U., Pandey, C. M., Mishra, P., & Pandey, G. Application of Student's t-test, Analysis of Variance, and Covariance. *Annals of Cardiac Anaesthesia*, *22*(4), 407. https://doi.org/10.4103/aca.aca_94_19 (2019)

Naismith, L. M., Cheung, J. J. H., Sibbald, M., Tavares, W., Cavalcanti, R. B., Haji, F. A., & Fraser, K. L. Using Cognitive Load Theory to Optimize Simulation Design. *Clinical Simulation*, 129–141. https://doi.org/10.1016/b978-0-12-815657-5.00010-3 (2019)

Navarro, J., Reynaud, E., & Osiurak, F. Neuroergonomics of car driving: A critical meta-analysis of neuroimaging data on the human brain behind the wheel. *Neuroscience & Biobehavioral Reviews*, *95*, 464–479. https://doi.org/10.1016/j.neubiorev.2018.10.016 (2018)

Nuamah, J. K., Seong, Y., Jiang, S., Park, E., & Mountjoy, D. Evaluating effectiveness of information visualizations using cognitive fit theory: A neuroergonomics approach. *Applied Ergonomics*, *88*, 103173. https://doi.org/10.1016/j.apergo.2020.103173 (2020)

Owen, D. B. The Power of Student's t-test. *Journal of the American Statistical Association*, *60*(309), 320–333. https://doi.org/10.1080/01621459.1965.10480794 (1965)

Parasuraman, R. Neuroergonomics: Research and Practice. *Theoretical Issues in Ergonomics Science*, *4*(1-2), 5–20. https://doi.org/10.1080/14639220210199753 (2003)

Parasuraman, R., & Rizzo, M. *Neuroergonomics: The brain at work*. Oxford University Press. (2007)

Pavelescu, F. M. Considerations on the correlation between student test statistics in cases of simple and multiple linear regressions. *Procedia Economics and Finance*, *32*, 68–76. https://doi.org/10.1016/s2212-5671(15)01366-0 (2015)

Paxion, J., Galy, E., & Berthelon, C. Mental workload and driving. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01344 (2014)

Peruzzini, M., Tonietti, M., & Iani, C. Transdisciplinary design approach based on driver's workload monitoring. *Journal of Industrial Information Integration*, *15*, 91–102. https://doi.org/10.1016/j.jii.2019.04.001 (2019)

Prabaswari, A. D., Basumerda, C., & Utomo, B. W. The Mental Workload Analysis of staff in Study Program of Private Educational Organization. *IOP Conference Series: Materials Science and Engineering*, *528*, 012018. https://doi.org/10.1088/1757-899x/528/1/012018 (2019)

Prion, S. K., & Haerling, K. A. Making Sense of Methods and Measurements: Simple Linear Regression. *Clinical Simulation in Nursing*, *48*, 94–95. https://doi.org/10.1016/j.ecns.2020.07.004 (2020)

Quiban, Gann & Caventa, Bryan & Corpuz, Patricia & Datu, Francesco & Millet, Rica & Kurata, Yoshiki. Human Error Assessment in the Accident Causations Experienced among Vehicle Drivers in the Philippines. (2019)

Rahman, M., Karwowski, W., Fafrowicz, M., & Hancock, P. A. Neuroergonomics Applications of Electroencephalography in Physical Activities: A Systematic Review. *Frontiers in Human Neuroscience*, *13*. https://doi.org/10.3389/fnhum.2019.00182 (2019)

Rahman, N. I., Dawal, S. Z., & Yusoff, N. Subjective responses of mental workload during Real time driving: A pilot field study. *IOP Conference Series: Materials Science and Engineering*, *210*, 012076. https://doi.org/10.1088/1757-899x/210/1/012076 (2017)

Recarte, M. A., & Nunes, L. M. Mental Workload While Driving: Effects on Visual Search, Discrimination, and Decision Making. *Journal of Experimental Psychology: Applied*, *9*(2), 119–137. https://doi.org/10.1037/1076-898x.9.2.119 (2003)

Rodríguez del Águila, M. M., & Benítez-Parejo, N. Simple Linear and Multivariate Regression Models. *Allergologia Et Immunopathologia*, *39*(3), 159–173. https://doi.org/10.1016/j.aller.2011.02.001 (2011)

Rodríguez-López, A. M., Rubio-Valdehita, S., & Díaz-Ramiro, E. M. Influence of the COVID-19 pandemic on Mental Workload and burnout of fashion retailing workers in Spain. *International Journal of Environmental Research and Public Health*, *18*(3), 983. https://doi.org/10.3390/ijerph18030983 (2021)

Rusnock, C. F., & Borghetti, B. J. Workload profiles: A continuous measure of mental workload. *International Journal of Industrial Ergonomics*, *63*, 49–64. https://doi.org/10.1016/j.ergon.2016.09.003 . (2018).

Shuggi, I. M., Oh, H., Wu, H., Ayoub, M. J., Moreno, A., Shaw, E. P., Shewokis, P. A., & Gentili, R. J. Motor Performance, Mental Workload and Self-Efficacy Dynamics during Learning of Reaching Movements throughout Multiple Practice Sessions. *Neuroscience*, *423*, 232–248. https://doi.org/10.1016/j.neuroscience.2019.07.001 (2019).

Thompson, H. W., Mera, R., & Prasad, C. A Description of the Appropriate Use of Student'st-test. *Nutritional Neuroscience*, *1*(2), 165–172. https://doi.org/10.1080/1028415x.1998.11747226 (1998).

Waard, D. de. *The Measurement of Drivers' Mental Workload*. Traffic Research Centre, Univ. of Groningen. (1996).

Yang, Z., Fang, K.-T., & Kotz, S. On the Student's t-distribution and the t-Statistic. *Journal of Multivariate Analysis*, *98*(6), 1293–1304. https://doi.org/10.1016/j.jmva.2006.11.003 (2007).

Yared, T., & Patterson, P.. The impact of navigation system display size and environmental illumination on young driver mental workload. *Transportation Research Part F: Traffic Psychology and Behaviour*, *74*, 330–344. https://doi.org/10.1016/j.trf.2020.08.027 (2020)

Zhang, Y., & Kumada, T. Relationship between workload and mind-wandering in simulated driving. *PLOS ONE*, *12*(5). https://doi.org/10.1371/journal.pone.0176962 (2017).

Zokaei, M., Jafari, M. J., Khosrowabadi, R., Nahvi, A., Khodakarim, S., & Pouyakian, M. (2020). Tracing the physiological response and behavioral performance of drivers at different levels of mental workload using driving simulators. *Journal of Safety Research*, *72*, 213–223. https://doi.org/10.1016/j.jsr.2019.12.022

Biography / Biographies

Ma. Isabelle J. Delos Santos is a graduate of Bachelor of Science in Industrial Engineering at Adamson University, and is certified in Lean Six Sigma Yellow Belt. For 4 years, she has been elected and appointed in director and executive officer positions in PIIE-ORSP Adamson University Chapter, a recognized student organization for Industrial Engineering students in the university. Currently, she is a member-advocate of the 2030 Youth Force in the Philippines Inc., a national non-profit organization dedicated to the promotion of The Global Goals. During her spare time, she reads fiction books which fuels her creativity and passion for writing.

Regille Kyle C. Villareal is a Bachelor of Science in Industrial Engineering graduate from Adamson University. He was an active member and officer of PIIE-ORSP Adamson University Chapter who held the positions of Sports Director, Vice President for External Affiliations, and AUSG Representative respectively for 3 consecutive years of service. He was also a senior writer at the Pioneer Newsletter which is the official publication of the Industrial Engineering Department of Adamson University. He was also an officer for 2 years at the national level with Operations Research Society of the Philippines Student's Federation (ORSP-SF) which held the positions of Operations Manager and Executive Vice President, respectively.

Sheily Mendoza Engr. Sheily Mendoza is an Industrial Engineering graduate at the Mapua Institute of Technology and finished her Master of Science in Management Engineering at the Pamantasan ng Lungsod ng Maynila. She is a management consultant focusing on Operations Management, Six Sigma implementation and Business Process Improvement. She is also a Professional Industrial Engineering and earned her ASEAN Engineer registry.

Venusar Quevedo. Dr. Venusmar is a Associate Professor of the Industrial Engineering Department at Adamson University, Manila, Philippines**.** Dr. Quevedo holds a Bachelor of Science degree in Industrial Engineering from Adamson University and both her Master's degree in Industrial Engineering and Doctor of Philosophy in Educational Evaluation and Research from University of the Philippines. She has been recognized as one of the Inspiring Woman Engineer by the Philippine Technological Council with her more than 35 years of experience and contribution in the industry. She has taught courses in management, feasibility and engineering research for engineers. She has published and presented research papers both local and international.