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Determining Factors Affecting Perceived Safe-Driving Behavior of Filipino Private Car Drivers

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Abstract

Globally, road traffic accidents pose a significant and pressing issue, resulting in numerous fatalities and injuries. In the Philippines, the escalating rates of road-related deaths and accidents underscore the critical need to comprehend the factors influencing safe driving behavior, particularly among Filipino private car drivers. This research explores the determinants impacting perceived safe driving behaviors, employing the framework of the Protection Motivation Theory and the Three Broad Domains of Ergonomics framework. Utilizing a survey questionnaire and structural equation modeling (SEM), the study seeks to uncover the intricate correlation between driving experience, geographical perception, level of understanding, perceived severity, perceived vulnerability, physical ergonomics, cognitive ergonomics, macro ergonomics, and perceived safe driving. The study garnered responses from 510 respondents through a digital survey questionnaire using a convenience sampling method. The results show that the latent variables driving experience, geographical perception, level of understanding, perceived severity, perceived vulnerability, physical ergonomics, and cognitive ergonomics were identified as factors that have a significant impact on the perceived safe driving behavior of Filipino Private car drivers. Among these latent variables, perceived vulnerability is the most crucial factor in perceived safe driving behavior, with a p-value of 0.006. However, macro ergonomics shows an insignificant effect on Filipino private car drivers' perceived safe driving behavior. The study provides insights into the factors influencing perceived safe driving behavior among Filipino private car drivers. The findings can be used to develop interventions and policies to improve road safety in the Philippines.

Keywords
Safe Driving Behavior, Filipino private car drivers, Protection Motivation Theory, Three Domains of Ergonomics, and Structural Equation Modeling

1. Introduction
1.1 Problem Rationale
Traffic accidents are unexpected and unintentional events that occur on roadways, involving individuals using the roads and resulting in property damage, injuries, and fatalities. Annually, road-related accidents contribute to about 1.35 million documented fatalities and at least 20 million cases of minor injuries (WHO 2022). This issue ranks as the tenth-leading cause of death globally, making it a matter of significant concern (WHO 2018).

Shinar (2017) emphasized that 95% of road accidents are attributed to driver behavior and human factors, establishing them as the most critical elements in accident occurrences. In the Philippines, it has been discussed that human error is responsible for 8 out of 10 road accidents nationwide, ranking it among the leading causes of such incidents (MMDA 2022). Despite the government's implementation of traffic rules and regulations to instill discipline among drivers and motorists and the emphasis on road safety education, instances of road accidents due to human error and driving behavior continue to rise (MMDA 2021).

Lu et al. (2022) highlighted that the Philippines is also experiencing a rising trend in vehicular crashes, showing an average annual increase of 25.58%. According to the MMDA, road-related accidents, including property damage and non-fatal and fatal accidents, accounted for 121,771 recorded cases in the specified year. This represents a notable increase compared to 2005 when there were only 65,111 cases, indicating an upward trajectory.

Bucsuházy et al. (2020) discovered that different road traffic accidents are caused by various human factors. Some of these factors include lack of sleep, rest, and concentration, causing drivers to assess their situation incorrectly, drive recklessly, and neglect traffic regulations. Notably, inattention emerged as the most prominent contributing factor. Thus, there is a strong call for studies investigating the factors influencing safe driving behavior in the Philippines.

It is essential to grasp the interplay of various factors, some within drivers' control and others beyond it. This understanding is critical for crafting targeted interventions and comprehensive strategies to promote safe driving and minimize the occurrence of traffic accidents among private car drivers in the Philippines.

1.2 Objectives
This study delves into the factors shaping safe driving attitudes among Filipino private car drivers using a combined framework of motivation theory and ergonomics. Analyzing existing data and driver factors, it aims to identify both internal (perceptions and experience) and external (ergonomic) influences on behavior, culminating in recommendations for promoting safer roads in the Philippines through targeted interventions.

2. Literature Review
The investigation into the variables influencing driving behavior and road safety is approached through various lenses, each shedding light on different aspects. The Protection Motivation Theory (PMT) is a behavioral theory that aims to delve into the cognitive processes that drive behavioral changes (Kurata et al. 2022). PMT is utilized in disaster-related studies and understanding drivers' engagement in risky behaviors, providing insights into threat, and coping appraisals, influencing the intention to conduct adaptive or maladaptive reactions (Ong et al. 2021; Budhathoki et al. 2020; Harbeck et al. 2018; Clubb et al. 2015).

In parallel, the exploration extends to the three broad domains of ergonomics—macro-ergonomics, physical, and cognitive (Dul and Weerdmeester 2008). Physical ergonomics optimizes workplace design, impacting the driver's posture, comfort, and familiarity with vehicle features (University of California Berkeley 2020; Gumasing 2022; Hemesath and Tepe 2022; Walker and Trick 2018). Cognitive ergonomics focuses on the effectiveness of human cognitive processes within a system, with attention to issues such as fatigue, attention, and distraction (CDC 2019; Grahn et al. 2020; Lohani et al. 2019; Hong et al. 2021). Macro-ergonomics delves into the arrangement of work systems and environmental factors, including road infrastructure and weather conditions, impacting road safety (Hendricks 1996; Acerra 2013; Gorzelanczyk et al. 2023; Malin et al. 2019; Fernandes and Neves 2013; Üzümcüoğlu, 2020).

The analysis then shifts to driving experience, highlighting the disparities between inexperienced and novice drivers and their more experienced counterparts (Sheykhfard et al. 2022; DeGuzman & Donmez 2022; Amoudo 2023; Harms et al. 2021; Ahmed et al. 2023). Factors such as late-night driving and extended hours, route familiarity, and geographical perception contribute to the heightened risk of crashes (Harms et al. 2021; Amoudo 2023; Zinebi et al. 2018). Geographical perception emerges as a pivotal variable, with urban and rural environments significantly influencing driving behavior (LYTX 2017; NHTSA 2022; Texas Department of Insurance n.d; Lu 2022; Useche et al. 2021; Statista 2023; Faisal et al. 2023; Berrio et al. 2022; Bañares et al. 2018). The risks posed by traffic congestion in urban areas and challenges faced by truck drivers in rural roads underscore the impact of geographical factors on road safety.

Perceived severity and vulnerability are explored as key psychological elements influencing driving behavior (Harbeck et al. 2018; Kuang 2020; Attard et al. 2020; Gumasing et al. 2022; Tabone et al. 2021; Metzger et al. 2020; Hu et al. 2020; Kurata et al. 2022). The subjective assessment of risk (perceived severity) and individuals' belief in their vulnerability significantly shape their response to threats, impacting attitudes and behaviors towards safe driving practices.

The work environment's actual design, encompassing both the ergonomics of vehicles and broader road safety features, is scrutinized (Douma et al. 2018; Gao et al. 2022; Becerra et al. 2023; Shariff et al. 2021; NHTSA 2020; JUSTIA 2018; Gordon & Partners 2013; ESCAP 2016). Vehicle design factors such as size, weight, and safety features contribute to the likelihood and severity of accidents. Furthermore, the study emphasizes the role of street lighting in enhancing traffic safety, particularly at night (Yannis et al. 2013). Cognitive ergonomics comes into play, revealing the importance of understanding human drivers' abilities and addressing distracted thinking to prevent accidents (Walker and Trick 2018; CDC 2019; Lohani et al. 2019; Hong et al. 2021). Macroergonomics examines the effect of the environment and weather conditions on drivers' behavior, contributing to road safety (Acerra 2013; Gorzelanczyk et al. 2023; Malin et al. 2019; Fernandes and Neves 2013). However, it is acknowledged that macro-ergonomic factors may not directly impact individual drivers' perceptions or specific driving behaviors (Üzümcüoğlu 2020).

Lastly, the concept of perceived safe driving is introduced, evaluating drivers' own assessments of their ability to drive safely (Akalin et al. 2022; Sun et al. 2019; Cordillieri et al. 2019; Rahman et al. 2022; Armitage et al. 2022). The increasing of driving issues due to the escalating number of vehicles on the road and factors affecting perceived safe driving, such as risk perception and attitude toward traffic safety, underscore the importance of addressing psychological aspects for effective road safety policies.

3. Methods

The research employed a quantitative, non-experimental design using structural equation modeling to investigate the factors influencing perceived safe driving behavior among Filipino private car drivers. The study focused on a diverse sample of 510 respondents, including both male and female drivers aged 17 and above, holding either non-professional or professional driver's licenses. The chosen methodology, centered on a causal research design, aimed to identify, and analyze cause-and-effect relationships among nine variables. The inclusion criteria ensured representation from various regions and excluded drivers engaged in commercial activities, contributing to a comprehensive understanding of the elements impacting safe driving behavior in the Philippines.

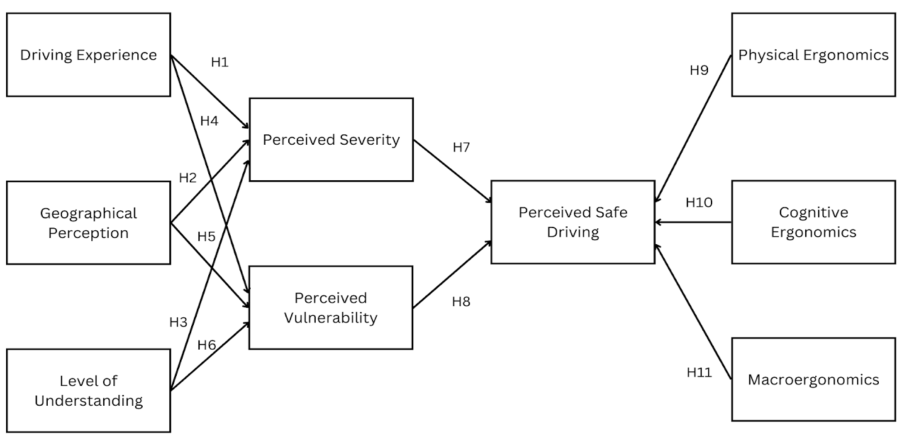

Figure 1. Conceptual Framework

The research framework as shown in Figure 1, illustrates the constructs of latent variables and the corresponding hypotheses. This study utilized the Protection Motivation Theory (PMT) and the Three Domains of Ergonomics to identify factors influencing Filipino private car drivers' perceived safe driving behaviors. The research variables used are Driving Experience (D), Geographical Perception (GP) and Level of Understanding (LU). Under the Protection Motivation Theory, Perceived Severity (PS) and Perceived Vulnerability (PV). Lastly under the Three Broad Domains of Ergonomics are Physical Ergonomics (PE), Cognitive Ergonomics (CE), and Macroergonomics (ME).

4. Data Collection

The data collection for the thesis involved the utilization of a self-administered survey questionnaire designed to explore driving behavior among Filipino private car drivers (Zikmund et al. 2012). The questionnaire covered demographic information and various research variables, employing a five-point Likert scale for measurement. The study also utilized IBM's SPSS AMOS 24 for structural equation modeling (SEM) analysis, enabling the inspection of complex interactions among the variables and the validation of theoretical models (IBM 2023). The data gathering procedure included problem identification through the Ishikawa Diagram, comprehensive literature reviews, and the distribution of online self-assessment forms. Ethical considerations were addressed through participant consent forms, confidentiality measures, and adherence to safety protocols. The mode of data analysis involved SEM, considering assumptions such as linearity, normalcy, error independence, absence of multicollinearity, and a sufficiently large sample size to ensure the reliability and validity of the results (Hair et al. 2023; Civelek 2018).

5. Results and Discussion

5.1 Demographic Results

Table 1. Respondent's Descriptive Statistics.

Characteristics	Category	N	%
Gender	Male	266	52.16%
	Female	230	45.10%
	Prefer not to say	14	2.75%
Age Bracket	17-24 years of age	141	27.65%
	25-34 years of age	133	26.08%
	35-44 years of age	96	18.82%
	45-54 years of age	111	21.76%
	55-64 years of age	27	5.29%
	65 years of age & above	2	0.39%
Employment Status	Student	137	26.86%
	Employed (Full-Time)	235	46.08%
	Employed (Part-Time)	28	5.49%
	Freelance / Contractor	27	5.29%
	Self-Employed	64	12.55%
	Unemployed	16	3.14%
	Retired	3	0.59%
Highest Educational Attainment	Elementary Graduate	0	0.00%
	Secondary Graduate	10	1.96%
	Senior High School Graduate	126	24.71%
	Training / Certification Graduate	16	3.14%
	Bachelor's Degree Holder	315	61.76%
	Masters' Degree Holder	35	6.86%
	Doctorate Degree Holder	8	1.57%
Type of Driver's License	Non-Professional	420	82.35%
	Professional	90	17.65%
Transmission of Vehicle	Automatic	375	73.53%

	Manual	135	26.47%
Car Model/s	Toyota Vios	86	16.86%
	Mitsubishi Montero	23	4.51%
	Toyota Innova	22	4.31%
	Toyota Hilux	20	3.92%
	Mitsubishi Xpander	13	2.55%
	Toyota Wigo	13	2.55%
	Ford Ranger	10	1.96%
	Others	70	13.73%
With Insurance	Yes	416	81.57%
	No	94	18.43%
Region	National Capital Region	290	56.86%
	Cordillera Administrative Region	62	12.16%
	Region I: Ilocos Region	57	11.18%
	Region II: Cagayan Valley	57	11.18%
	Region III: Central Luzon	104	20.39%
	Region IV-A: CALABARZON	191	37.45%
	Region IV-B: MIMAROPA	27	5.29%
	Region V: Bicol Region	34	6.67%
	Region VI: Western Visayas	29	5.69%
	Region VII: Central Visayas	32	6.27%
	Region VIII: Eastern Visayas	46	9.02%
	Region IX: Zamboanga Peninsula	36	7.06%
	Region X: Northern Mindanao	35	6.86%
	Region XI: Davao Region	34	6.67%
	Region XII: SOCCSKSARGEN	58	11.37%
	Region XIII: CARAGA Region	55	10.78%
	ARMM	59	11.57%
Geographic Area	Urban	102	20.00%
	Rural	52	10.20%
	Both Urban & Rural	356	69.80%
Time	Daytime	104	20.39%
	Nighttime	2	0.39%
	Both Day & Night time	404	79.22%
Accident	Yes	263	51.57%
	No	247	48.43%
Cause of Accident	Human Error	218	42.75%
	Road Condition	106	20.78%
	Vehicle Defect	96	18.82%
Cause of Accident	Disregarding Road Signs	52	10.20%

	Limited Geographical Perception	32	6.27%
	Environmental Factor/s	20	3.92%
	Weather	12	2.35%
	N/A	235	46.08%
Safety-Conscious	Yes	501	98.24%
	No	9	1.76%

As shown in Table 1, the researchers collected responses from five hundred ten (510) Filipino private car drivers, who agreed and willingly took part in the study by answering the questionnaire through convenience sampling.

5.2 Structural Equation Modeling Results

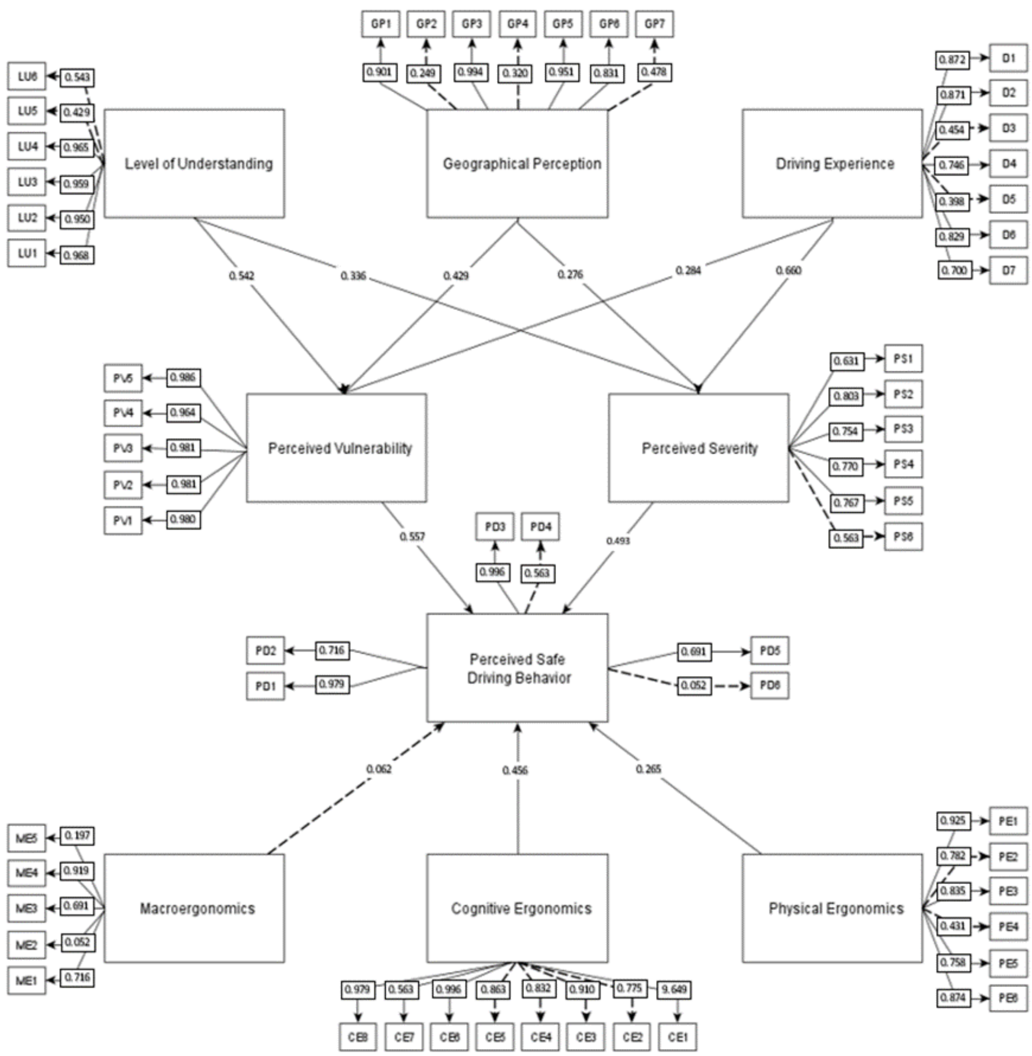

Figure 2. Initial SEM Results

Figure 2 depicts the initial Structural Equation Model (SEM) for the factors affecting Filipino Private Car Drivers' perceived safe driving behavior in the Philippines. Utilizing SPSS AMOS, it was discerned that only one hypothesis, namely Macroergonomics to Perceived Safe Driving Behavior (Hypothesis 11), was deemed insignificant due to its p-value exceeding 0.05. One plausible explanation is that macro-ergonomic factors might not directly impact an individual driver's perception of safety or their specific driving behaviors, as suggested by (Üzümcüoğlu et al. 2020).

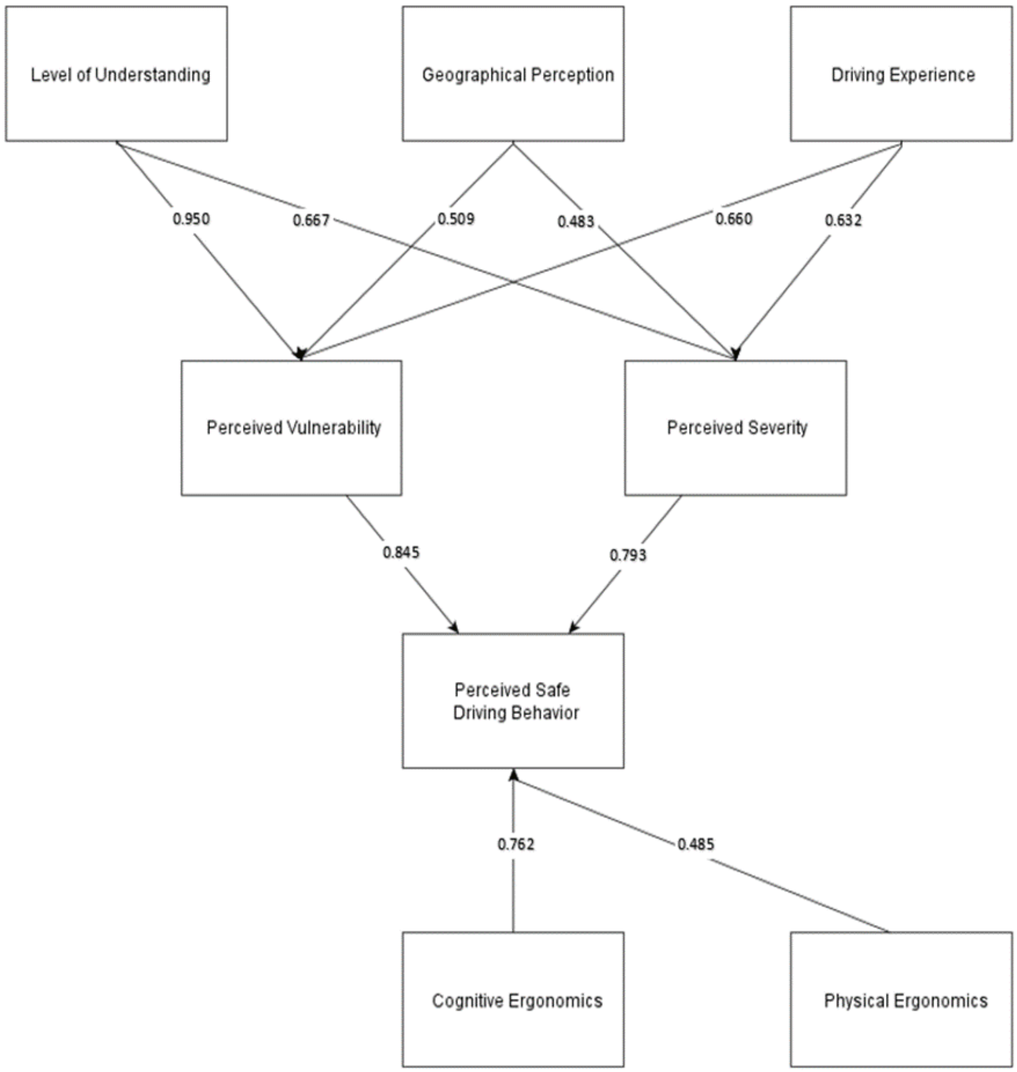

Figure 3. Final SEM Results

Figure 3 illustrates the final Structural Equation Model (SEM) for the factors influencing Filipino private car drivers' perceived safe driving behavior in the Philippines. To enhance model fit, the researchers refined the initial model by excluding constructs with factor loadings below 0.6, as recommended by Latan and Ghozali (2012). Several Constructs across different latent variables, such as Driving Experience, Level of Understanding, Geographical Perception, Perceived Severity, Cognitive Ergonomics, and Perceived Safe Driving Behavior, were removed due to their factor loadings being below the threshold. Additionally, Macroergonomics, with an initial factor loading of 0.062 and a p-value of 0.180, surpassing the 0.05 threshold, was eliminated to optimize model fit. As shown in figure 3, the final SEM model includes significant latent variables such as Driving Experience, Geographical Perception, Level of Understanding, Perceived Vulnerability, Perceived Severity, Physical Ergonomics, Cognitive Ergonomics, and Perceived Safe Driving Behavior.

Table 2. Factor Loading of Results

Variable	Item	Mean	StD	Variance	Factor Loading	
					Initial	Final
Driving Experience	D1	4.655	0.719	0.517	0.872	0.893
	D2	4.571	0.756	0.572	0.871	0.877
	D3	4.645	0.753	0.567	0.454	-
	D4	4.359	0.797	0.635	0.746	0.766
	D5	4.429	0.702	0.493	0.398	-
	D6	4.575	0.743	0.551	0.829	0.810
	D7	4.537	0.756	0.571	0.700	0.683
Geographical Perception	GP1	4.704	0.848	0.720	0.901	0.856
	GP2	4.822	0.622	0.387	0.249	-
	GP3	4.557	0.852	0.727	0.994	0.982
	GP4	4.659	0.811	0.657	0.320	-
	GP5	4.596	0.776	0.603	0.951	0.960
	GP6	4.592	0.779	0.607	0.831	0.843
	GP7	5.731	0.704	0.495	0.478	0.973
Level of Understanding	LU1	4.641	0.680	0.462	0.968	0.943
	LU2	4.633	0.664	0.441	0.950	0.947
	LU3	4.635	0.681	0.464	0.959	0.966
	LU4	4.607	0.711	0.506	0.965	-
	LU5	4.688	0.635	0.404	0.429	-
	LU6	4.565	0.817	0.667	0.543	-
Perceived Severity	PS1	4.694	0.630	0.397	0.631	0.615
	PS2	4.571	0.647	0.418	0.803	0.719
	PS3	4.651	0.654	0.428	0.754	0.791
	PS4	4.586	0.639	0.408	0.770	0.701
	PS5	4.702	0.664	0.441	0.767	0.821
	PS6	4.467	0.784	0.615	0.563	-
Perceived Vulnerability	PV1	4.655	0.694	0.482	0.980	0.978
	PV2	4.584	0.817	0.668	0.981	0.986
	PV3	4.588	0.838	0.702	0.981	0.980
	PV4	4.559	0.807	0.652	0.964	0.970
	PV5	4.635	0.729	0.531	0.986	0.978
Physical Ergonomics	PE1	4.763	0.426	0.181	0.925	0.931
	PE2	4.639	0.757	0.573	0.782	-
	PE3	4.777	0.417	0.174	0.835	0.830
	PE4	4.500	0.904	0.816	0.431	-
	PE5	4.600	0.820	0.673	0.758	0.759
	PE6	4.667	0.472	0.223	0.874	0.869

Variable	Item	Mean	StD	Variance	Factor Loading	
					Initial	Final
Cognitive Ergonomics	CE1	4.739	0.701	0.492	0.649	0.923
	CE2	4.851	0.491	0.241	0.775	-
	CE3	4.835	0.540	0.291	0.910	-
	CE4	4.892	1.361	1.853	0.832	-
	CE5	4.802	0.596	0.356	0.863	-
	CE6	4.753	0.685	0.469	0.996	0.864
	CE7	4.759	0.689	0.474	0.563	0.882
	CE8	4.743	0.717	0.513	0.979	0.883
Macroergonomics	ME1	3.871	0.897	0.804	0.716	0.645
	ME2	4.563	0.948	0.899	0.052	0.782
	ME3	4.390	1.101	1.213	0.691	0.905
	ME4	4.420	1.082	1.171	0.919	0.831
	ME5	4.428	1.021	1.043	0.197	0.866
Perceived Safe Driving Behavior	PD1	4.708	0.580	0.337	0.979	0.972
	PD2	4.647	0.637	0.406	0.716	0.691
	PD3	4.702	0.602	0.363	0.467	0.984
	PD4	4.614	0.656	0.430	0.866	-
	PD5	4.700	0.603	0.364	0.887	0.666
	PD6	4.698	0.700	0.490	0.052	-

Table 2 presents the initial and final factor loading outcomes of the constructs within each latent variable employed in this study. Regarding convergent validity, the preferred loading factor for constructs is > 0.7, while those falling between 0.6 to 0.7 are considered acceptable, per Latan and Ghozali's guidelines (2012). Constructs with loading factors below the acceptable range have been eliminated from the initial Structural Equation Model (SEM) to enhance the Model Fit Indices, in line with the recommendations of Latif (2023).

Table 3. Model Fit Indices

Goodness of Fit Measure	**Parameter Estimates**	**Minimum Cut off**	**Suggested by**
Incremental Fit Index (IFI)	0.848	> 0.8	Gefen et al. (2000)
Tucker Lewis Index (TLI)	0.834	> 0.80	Gefen et al. (2000)
Comparative Fit Index (CFI)	0.848	> 0.80	Gefen et al. (2000)
Goodness of Fit Index (GFI)	0.821	> 0.80	Gefen et al. (2000)
Adjusted Goodness of Fit Index (AGFI)	0.804	> 0.80	Gefen et al. (2000)
Room Mean Square Error of Approximation (RMSEA)	0.062	< 0.07	Steiger, J.H. (2007)

The study thoroughly analyzes the final Structural Equation Model (SEM) using various fit indices as shown in Table 3. Gefen et al. (2000) provided a criteria on how to assess a model fit where a minumum value of 0.80 must be attained to consider it a strong fit. The Incremental Fit Index (IFI) is 0.848, the Tucker-Lewis Index (TLI) is 0.834, the Comparative Fit Index (CFI) is 0.848, the Goodness of Fit Index (GFI) is 0.821, and the Adjusted Goodness of Fit Index (AGFI) is 0.804. These values surpass the recommended threshold of 0.80, affirming a robust model fit. Additionally, the Root Mean Square Error of Approximation (RMSEA) is 0.062, below the 0.07 threshold, indicating an acceptable fit for the model.

5.3 Direct, Indirect, and Total Effects

Table 4. Direct, Indirect, and Total Effects

No.	Variable	Direct Effects	P-Value	Indirect Effects	P-Value	Total Effects	P-Value
1.	D → PV	0.660	0.001	-	-	0.66	0.001
2.	D → PS	0.632	0.001	-	-	0.632	0.001
3.	D → PD	-	-	0.644	0.001	0.644	0.001
4.	GP → PV	0.509	0.003	-	-	0.509	0.003
5.	GP → PS	0.483	0.003	-	-	0.483	0.003
6.	GP → PD	-	-	0.541	0.003	0.541	0.003
7.	LU → PV	0.96	0.001	-	-	0.96	0.001
8.	LU → PS	0.667	0.003	-	-	0.667	0.003
9.	LU → PD	-	-	0.611	0.002	0.611	0.002
10.	PS → PD	0.845	0.001	-	-	0.845	0.001
11.	PV → PD	0.793	0.002	-	-	0.793	0.002
12.	PE → PD	0.062	0.18	-	-	0.062	0.180
13.	CE → PD	0.762	0.002	-	-	0.762	0.002
14.	ME → PD	0.485	0.003	-	-	0.485	0.003

Table 4 shows the direct, indirect, and total effects involving the correlation between independent variable and dependent variable while there is a present mediating variable. These effects manifest when no mediator is required for the variables to influence each other (Rijnhart 2017). The combination of direct and indirect effects constitutes the total effects. As shown in the total effects, all variables exert a significant influence on each other except ME → PD, which has a total effect less than the acceptable effect of 0.500 and P-value greater than the threshold of 0.005.

5.4 Validation

Table 5. Construct Validity

Construct	Items	Cronbach's Alpha	Average	Composite Reliability
Driving Experience	D1	0.800	0.517	0.823
	D2			
	D4			
	D6			
	D7			
Geographical Perception	GP1	0.841	0.541	0.851
	GP3			
	GP5			
	GP6			
	GP7			
Level of Understanding	LU1	0.899	0.695	0.916
	LU2			
	LU3			
Perceived Severity	PS1	0.857	0.518	0.864
	PS2			

	PS3 PS4 PS5			
Perceived Vulnerability	PV1 PV2 PV3 PV4 PV5	0.990	0.957	0.978
Physical Ergonomics	PE1 PE3 PE5 PE6	0.675	0.615	0.819
Cognitive Ergonomics	CE1 CE6 CE7 CE8	0.700	0.700	0.905
Macroergonomics	ME1 ME2 ME3 ME4 ME5	0.902	0.657	0.854
Perceived Safe Driving	PD1 PD2 PD3 PD5 PD6	0.837	0.627	0.784

The reliability and validity of the study were evaluated through measures such as Cronbach's Alpha (CA), Average Variance Extracted (AVE), and Composite Reliability (CR). According to the findings presented in Table 5, Cronbach's Alpha values for both variables and constructs consistently meet or exceed the recommended range of 0.6 to 0.7. This consistency indicates strong internal validity and reliability, aligning with guidelines provided by (Ursachi et al 2015 and Hair 2010). The robust adherence to this range suggests that the measurement tools employed to capture variables are reliable and consistent, instilling confidence in the internal validity and reliability of the data. Furthermore, the average variance extracted shows a great threshold value which is above 0.50. This shows alignment with the Cronbach's Alpha and Composite Reliability results and highlights the research's accuracy and dependability.

Table 6. Discriminant Validity: Fornell-Larcker Criterion

	D	GP	LU	PS	PV	PE	CE	ME	PD
D	0.719								
GP	.352	0.736							
LU	.139	.719	0.834						
PS	.507	.001	-.124	0.720					
PV	.235	.702	.778	-.097	0.978				
PE	.214	.624	.612	.005	.673	0.850			
CE	.528	.613	.488	.278	.579	.454	0.833		
ME	.362	.355	.307	.225	.289	.520	.409	0.613	
PD	.336	.541	.501	.079	.594	.459	.590	.368	0.734

Shown in Table 6 is the result of a validity assessment of the constructs. The researchers employed the Fornell-Larcker Criterion (FLC), as recommended by Hair (2010). In applying this criterion, the average variance extracted (AVE) of each construct was compared to the squared correlation values of the constructs in the model. For the validity to be confirmed, the diagonal values after applying FLC should be greater than the off-diagonal values. According to the results obtained from the FLC, the diagonal values are indeed higher compared to the off-diagonal values, showing that the criterion is met, and the construct validity is deemed acceptable.

Table 7. Heterotrait-Monotrait Ratio

	D	GP	LU	PS	PV	PE	CE	ME	PD
D									
GP	0.672								
LU	0.623	0.692							
PS	0.692	0.817	0.352						
PV	0.618	0.768	0.307	0.683					
PE	-	-	-	-	-				
CE	-	-	-	-	-	-			
ME	-	-	-	-	-	-	-		
PD	0.621	0.839	0.717	0.645	0.588	0.629	0.692	0.698	

Additionally, the researchers tested the discriminant validity using the Heterotrait-Monotrait Ratio (HTMT), known for its extreme specificity and sensitivity in detecting discriminant validity issues (Ab Hamid et al. 2017). To verify the model's validity, the HTMT values should not exceed the thresholds of 0.850 or 0.90, as suggested by Kline (2011) and Teo et al. (2008). According to the results from the HTMT criterion, the values did not surpass the specified threshold, indicating that discriminant validity is upheld and confirming the validity of the model (Table 7).

5.5 Discussion

The SEM results show that D, GP, and LU showed a positive direct impact to PV and PS. Harms et al. 2021 discussed that experienced drivers have an enhanced understanding of different road conditions, hazards, and potential risks that they may encounter on the road. Sheykhfard et al. 2022 also discussed that drivers with minimal experience shows poor hazard awareness and are more likely to violate driving rules and regulations. Furthermore, lack of driving experience can be a contributing factor to lower the perception of vulnerability of drivers (Hu et al. 2020).

Since GP has a positive correlation with PV and PS, this implies that drivers who drives and understands the intricacies of different driving environments are more inclined to perceive accidents as more severe and potentially life-threatening (LYTX 2017; NHTSA 2022). In addition, drivers are inclined to drive cautiously, adhere to traffic regulations, and adopt preventive measures when they perceive themselves as more vulnerable when driving (Tabone et al. 2021). Furthermore, drivers with a high LU are more likely to perceive accidents as more severe and life-threatening (Zinebi et al. 2018). Useche et al. 2021 also indicated that drivers with proficient knowledge. In relation to LU, drivers with better knowledge tend to perceive themselves as more prone to accident-related risks (Useche et al. 2021).

The researchers also found that PS and PV has a significant effect to PD. This is aligned with a study that about perceived severity of threat wherein it influences an individual’s response and lets them guide their actions that may lead to a larger impact (Gumasing et al. 2022). In addition, a positive impact from PV to PD implies that when drivers perceive themselves to be more vulnerable to accidents, they are most likely to follow traffic regulations and practice safe driving.

Based on the outcome, PE and CE also have a positive direct effect to PD. Physical ergonomics is a variable that affects perceived safe driving behavior significantly (Becerra et al. 2022). This also implies that Filipino private car drivers may be distracted while driving if they experience uncomfortable posture or if they are unfamiliar on how the feature of their car works. Additionally, an in-depth understanding of human drivers’ ability to see and anticipate road accidents is crucial for their safety (Grahn et al. 2020). Among all factors that were considered in this study, only ME presented an insignificant relationship to PD. Üzümcüoğlu, 2020 discussed that macro-ergonomic factors may contribute to the overall safety of the driving environment, however, he also stated that it may not directly influence an individual driver’s perception of safety on their specific driving behaviors.

Overall, understanding the perceived safe driving behavior of Filipino private drivers holds significance in devising impactful road safety policies aimed at mitigating traffic accidents (Rahman et al. 2022). Insight into how these factors influence safe driving behavior contributes to the researchers' objective of accident reduction.

6. Conclusion

The Philippines is one of the countries with an increasing trend of vehicular accidents caused by human/driver errors. Studies have shown that despite implementing measures such as traffic law enforcement, road safety education, and training requirements, the number of road accidents caused by human error and driving mistakes continues to rise (Publico 2022; Tucay 2016; MMARAS 2019). Through the integration of PMT and the Three Broad Domains of Ergonomics, this study aimed to understand how these factors affect the perceived safe-driving behavior of Filipino private car drivers.. The variables considered are driving experience (D), geographical perception (GP), level of understanding (LU), perceived vulnerability (PV), perceived severity (PS), perceived safe driving (PD), physical ergonomics (PE), cognitive ergonomics (CE), and macro ergonomics (ME).

The variables are evaluated through Structural Equation Modeling, where the results show that the latent variables driving experience, geographical perception, level of understanding, perceived severity, perceived vulnerability, physical ergonomics, and cognitive ergonomics were identified as factors that has a significant impact to the perceived safe driving behavior of Filipino Private car drivers. Among these latent variables, perceived vulnerability is determined to be the most significant factor to perceived safe driving behavior with a beta value of ß = 0.845 and p-value of p = 0.006. However, macroergonomics shows an insignificant effect on Filipino private car drivers' perceived safe driving behavior. Üzümcüoğlu, Y. 2020 stated that macro-ergonomic factors may not directly influence a driver's perception of safety as it only contributes to the overall safety of the driving environment and has nothing to do with the driver's specific driving behaviors.

Given these results, the accepted hypotheses established are as follows:

H1: Driver Experience has a positive direct impact on the perceived severity of Filipino private car drivers.
H2: Driver Experience has a positive direct impact on the perceived severity of Filipino private car drivers.
H3: Geographical Perception has a positive direct impact on the perceived severity of Filipino private car drivers.
H4: Geographical Perception has a positive direct impact on the perceived severity of Filipino private car drivers.H5: Level of understanding of Traffic Policies has a positive direct impact on the perceived severity of Filipino private car drivers.
H6: Level of understanding of Traffic Policies has a positive direct impact on the perceived severity of Filipino private car drivers.
H7: Perceived Severity has a positive direct impact on the perceived severity of Filipino private car drivers.
H8: Perceived Vulnerability has a positive direct impact on the perceived severity of Filipino private car drivers.
H9: Physical Ergonomics has a positive direct impact on the perceived severity of Filipino private car drivers.
H10: Cognitive Ergonomics has a positive direct impact on the perceived severity of Filipino private car drivers.

The study highlighted perceived vulnerability as the most significant factor that affects the perceived safe driving behavior of Filipino private car drivers. This is evident as drivers who believe that they are less vulnerable will undoubtedly engage in unsafe driving behaviors (Hu et al. 2020).

References

Acerra, E. M., Lantieri, C., Vignali, V., Pazzini, M., & Andrea, S. Safety roads: the analysis of driving behavior and the effects on the infrastructural design. *Science Direct, 69*, 336–343, 2023.

Ahmed, S., Hossain, M. A., Ray, S. K., Bhuiyan, M. M. I., & Sabuj, S. R. A study on road accident prediction and contributing factors using explainable machine learning models: Analysis and performance. *Transportation Research Interdisciplinary Perspectives, 19*, 100814, 2023.

Armitage, S., Rodwell, D., & Lewis, I. Applying an extended theory of planned behavior to understand influences on safe driving intentions and behaviors. *Transportation Research Part F: Traffic Psychology and Behaviour, 90*, 347-364, 2022.

Berrio, S., Barrero, L. H., Zambrano, L., & Papadimitriou, E. Ergonomic factors affecting comprehension levels of traffic signs: A critical review. *International Journal of Transportation Science and Technology*. Available: https://doi.org/10.1016/j.ijtst.2022.08.004, 2022.

Clubb, Audrey & Hinkle, Joshua. Protection motivation theory as a theoretical framework for understanding the use of protective measures. *Criminal Justice Studies, 28*, 2015. Available: https://doi.org/10.1080/1478601X.2015.1050590

D. Shinar Traffic safety and human behavior. *Emerald Group Publishing, Bingley, UK: Emerald Group Publishing*, pp. 87– 100, 2017.

DeGuzman, C.A., & Donmez, B., Do Drivers Need to Know all ADAS Limitations? A Comparison of Two Training Approaches for Advanced Driver Assistance Systems. Available: https://doi.org/10.1177/1071181322661312, 2022.

Dul, J. & Weerdmeester, B. *Ergonomics for beginners: a quick reference guide.*, 2008.

Faisal, A., Yigitcanlar, T., Kamruzzaman, M., & Currie, G. Understanding autonomous vehicles: A systematic literature review on capability, impact, planning, and policy. *Journal of Transport and Land Use, 12(1), 2019*. Available: https://doi.org/10.5198/jtlu.2019.1405, 2019.

Fernandes, A., & Neves, J. An approach to accidents modeling based on compounds road environments. *Accident Analysis & Prevention, 53*, 39-45. Available: https://doi.org/10.1016/j.aap.2012.12.041, 2013.

Gorzelanczyk, P. Using neural networks to forecast the number of road accidents in Poland taking into account weather conditions. *Results in Engineering, 17*, 100981. Available: https://doi.org/10.1016/j.rineng.2023.100981, 2023.

Gumasing, M.J., Prasetyo, Y.T., Ong, A.K., Nadlifatin, R., & Persada, S.F. Determining Factors Affecting the Perceived Preparedness of Super Typhoon: Three Broad Domains of Ergonomics Approach. *Sustainability*. Available: https://doi.org/10.3390/su141912202, 2022.

Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., Danks, N.P., Ray, S. An Introduction to Structural Equation Modeling. In: Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R. Classroom Companion: Business. Available: https://doi.org/10.1007/978-3-030-80519-7_1, 2021.

Harbeck, E.L., Glendon, A. I., & Hine, T.J. Young driver perceived risk and risky driving: A theoretical approach to the “fatal five”. Available: https://doi.org/10.1016/j.trf.2018.06.018, 2018.

Harms, I. M., Burdett, B. R., & Charlton, S. G. The role of route familiarity in traffic participants’ behaviour and transport psychology research: A systematic review. *Transportation Research Interdisciplinary Perspectives, 9*, 100331. Available: https://doi.org/10.1016/j.trip.2021.100331, 2021.

Kuang, K. The use of interactive technologies in health promotion and education: Theorizing potential interaction between health message content and message modality. Available: https://doi.org/10.1016/B978-0-12-816958-2.00001-0, 2020.

Kurata, Y. B., Prasetyo, Y. T., Ong, A. K. S., Cahigas, M. M. L., Robas, K. P. E., Nadlifatin, R., Persada, S. F., Chuenyindee, T., & Thana, K. Predicting factors influencing intention to donate for super Typhoon Odette victims: A structural equation model forest classifier approach. *International Journal of Disaster Risk Reduction, 81*, 103287. Available: https://doi.org/10.1016/j.ijdrr.2022.103287, 2022.

Lu SF. Analysis of human error to road crash in metro Manila (2005–2015). Available: https://injuryprevention.bmj.com/content/28/Suppl_2/A11.2.abstract, 2023.

Lu, J.L., Herbosa, T.J., & Lu, S.F. Analysis of Transport and Vehicular Crash Cases Using the Online National Electronic Injury Surveillance System (ONEISS) from 2010 to 2019. Available: https://actamedicaphilippina.upm.edu.ph/index.php/acta/article/download/3874/3097/, 2022.

Malin, F., Norros, I., & Innamaa, S. Accident risk of road and weather conditions on different road types. *Accident Analysis & Prevention, 122*, 181-188. Available: https://doi.org/10.1016/j.aap.2018.10.014, 2019.

NHTSA. Newer cars are safer cars. https://www.nhtsa.gov/newer-cars-are-safer-cars

Ong, A. K. S., Prasetyo, Y. T., Lagura, F. C., Ramos, R. N., Sigua, K. M., Villas, J. A., Young, M. N., Diaz, J. F. T., Persada, S. F., & Redi, A. A. N. P. Factors affecting intention to prepare for mitigation of “the big one” earthquake in the Philippines: Integrating protection motivation theory and extended theory of planned behavior. *International Journal of Disaster Risk Reduction, 63*, 102467. Available: https://doi.org/10.1016/j.ijdrr.2021.102467, 2021.

Oz, B., Ozkan, T., Lajunen, T. Trip-focused organizational safety climate: Investigating the relationships with eros, violations and positive driver behaviours in professional driving. Available: https://doi.org/10.1016/j.trf.2014.03.004, 2014.

Rahman, Muhit & Islam, Md & Al-Shayeb, Ammar & Arifuzzaman, Md. Towards Sustainable Road Safety in Saudi Arabia: Exploring Traffic Accident Causes Associated with Driving Behavior Using a Bayesian Belief Network. *Sustainability, 14*, 6315. Available: https://doi.org/10.3390/su14106315

ESCAP. Road safety status in the Asia-Pacific region. Available: https://www.unescap.org/announcement/road-safety-status-asia-pacific-region, n.d.-a.

Sheykhfard, A., Qin, X., Shaaban, K., & Koppel, S. An exploration of the role of driving experience on self-reported and real-world aberrant driving behaviors. *Accident Analysis & Prevention, 178*, 106873. Available: https://doi.org/10.1016/j.aap.2022.106873

Statista. Number of Registered Private cars in the Philippines. Statista Research Department. Available: https://www.statista.com/statistics/1115299/philippines-vehicle-ownership-among-filipino-households/#: , 2023.

Tucay, R.B., Water, J.D., Effectiveness of Public Order and Safety Office of the City Government of Tabuk, Province of Kalinga, Philippines, 2016. Available: https://garph.co.uk/IJARMSS/Sep2016/16.pdf

University of California, Berkeley. The Difference between Physical Ergonomics, Cognitive Ergonomics, and Macroergonomics, 2020. Available: https://www.coeh.berkeley.edu/news/difference-between-physical-ergonomics-cognitive-ergonomics-and-macroergonomics#:~:text=Physical%20ergonomics%20focuses%20on%20injury,reduce%20quality%20issues%20and%20error.

Üzümcüoğlu, The Difference between Physical Ergonomics, Cognitive Ergonomics, and Macroergonomics, 2020. Available: https://doi.org/10.1016/j.jsr.2020.08.004.

World Health Organization, New WHO report highlights progress, but cities need for more actions to tackle road safety in the Philippines, 2018. Available: https://www.who.int/philippines/news/detail/21-12-2018-new-who-report-highlights-progress-but-cites-need-for-more-actions-to-tackle-road-safety-in-the-philippines

Yannis, G., Kondyli, A., & Mitzalis, N., Effect of Road Lighting Conditions on the Frequency and Severity of Road Accidents, 2023. Available: http://dx.doi.org/10.1680/tran.11.00047

Zinebi, Kawtar & Souissi, Nissrine & Tikito, Kawtar, Driver Behavior Analysis Methods: Applications-oriented study, 2018. Available: https://rb.gy/vxpxk

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