

Factors that Influence the Compliance of Motorcycle Delivery Riders in Metro Manila to Road Safety

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Abstract

This study examines the factors influencing road safety compliance among motorcycle delivery riders in Metro Manila using Partial Least Squares Structural Equation Modeling (PLS-SEM). With the rapid growth of e-commerce and delivery services following the COVID-19 pandemic, motorcycle-related accidents have increased significantly, highlighting the urgent need to understand compliance behavior. Using a modified Motorcycle Rider Behavior Questionnaire (MRBQ), data were collected from 150 delivery riders across various platforms including Grab, Foodpanda, and Lalamove. The analysis identified five significant latent variables affecting compliance: Cultural Conditions ($\beta = 0.521$, $p < 0.001$), Situational Factors ($\beta = 0.209$, $p = 0.003$), Road and Traffic Conditions ($\beta = 0.207$, $p = 0.004$), Legal and Regulatory Framework ($\beta = 0.166$, $p = 0.016$), and Job/Work Pressure ($\beta = 0.129$, $p = 0.049$). Demographic variables including age, gender, platform, experience, schedule, working hours, and type of goods delivered showed no statistical significance. The final model explained 88% of variance in compliance behavior ($R^2 = 0.88$). Cultural conditions emerged as the strongest predictor, emphasizing the role of workplace norms and societal expectations. Evidence-based recommendations are provided for delivery companies, policymakers, and stakeholders to enhance rider safety through targeted interventions addressing cultural, environmental, and regulatory dimensions.

Keywords

Motorcycle Delivery Riders, Road Safety Compliance, Structural Equation Modeling, Metro Manila

1. Introduction

The gig economy has expanded rapidly worldwide, with motorcycle delivery services becoming a critical component of urban logistics and last-mile distribution systems (Singh 2024; Kinyua et al. 2023). In the Philippines, the COVID-19 pandemic accelerated the adoption of e-commerce and platform-based delivery services, significantly increasing the number of motorcycle delivery riders (Stemmler n.d.). The country's e-commerce market reached approximately USD 17 billion, with platforms such as Shopee and Lazada leading the sector (International Trade Administration 2024). Metro Manila serves as the primary hub for these operations, with an estimated 22,000 active motorcycle delivery riders as of 2023 (Saludes 2023).

Despite its economic contribution, this expansion has been accompanied by rising road safety concerns. Metropolitan Manila Development Authority (MMDA) data indicate that motorcycle-related incidents increased by 9,718 cases between 2021 and 2023, resulting in 879 fatalities (MMDA 2021, 2022, 2023). Additionally, motorcycles comprised 13,442 of 16,861 impounded vehicles due to traffic violations in 2022, highlighting persistent compliance issues

(Caliwan 2022). These statistics suggest that the operational demands of gig-based delivery may be intensifying exposure to road risks.

While prior research has examined gig work dynamics and general motorcycle safety, limited studies have systematically modeled the determinants of road safety compliance among motorcycle delivery riders in Metro Manila. The lack of an integrated, context-specific analytical framework constrains the development of targeted interventions. Therefore, this study is among the first to investigate the factors influencing road safety compliance among motorcycle delivery riders in Metro Manila, using a structured behavioral model analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM) by integrating occupational, regulatory, environmental, and cultural dimensions.

1.1 Objectives

While existing literature has examined motorcycle safety in various global contexts, limited research has specifically focused on motorcycle delivery riders within the Philippine setting, particularly in Metro Manila's complex urban traffic environment. Previous studies have often explored individual determinants or applied theoretical models in isolation (Nguyen-Phuoc et al. 2022; Mai et al. 2025) with few attempts to integrate personal, occupational, and external factors into a unified framework. To address the gap, this study identifies and categorizes the key factors of road safety compliance among motorcycle delivery riders and develops a multidimensional structural model using Partial Least Squares Structural Equation Modeling (PLS-SEM). The study further quantifies the relative importance and statistical significance of these factors and provides evidence-based recommendations to inform key stakeholders, such as the motorcycle delivery riders, the local government units and policymakers, and the Metro Manila community, on the interventions aimed at improving road safety compliance.

1.2 Limitations

This study is subject to several limitations. The use of self-reported compliance measures may introduce social desirability bias (Durmaz et al. 2019), particularly in group-based responses and where concerns about reporting unsafe behaviors were observed. Participation depended on rider willingness and availability, which may result in non-response bias, while the focus on riders in Metro Manila may limit generalizability. The cross-sectional design further restricts temporal interpretation of the findings.

2. Literature Review

Motorcycle usage in the Philippines has increased significantly due to affordability and advantages in terms of mobility, particularly in congested urban areas (De Vera 2024). However, this growth has been accompanied by rising motorcycle-related accidents and fatalities, as reported by the Metropolitan Manila Development Authority (MMDA) (2021, 2022, 2023). Helmet compliance remains inconsistent, with studies showing that knowledge about helmet usage benefits and prior driving education significantly increases the likelihood of helmet use (Dela Cruz et al. 2022). Regional differences in enforcement, such as varying implementation of helmet laws and local ordinances, further complicate compliance efforts (Vicmundo 2024). Evidence consistently shows that proper helmet use reduces injury severity and fatalities (Chaichan et al. 2020; Kumphong 2018).

Beyond helmet use, rider behavior and infrastructure conditions significantly influence road safety outcomes. Many riders rely on informal training (Kamid et al. 2024). Limitations in infrastructures remain critical, as only 14% of Philippine roads meet minimum safety standards for motorcyclists (Asian Transport Observatory 2025). Environmental conditions such as poor lighting also increase crash risks (Villanueva 2019; Dela Cruz 2021). With that, technological innovations, including smart helmets and ignition interlock systems, offer potential safety improvements (Estil et al. 2024; Borja 2020).

Research further identifies personal, occupational, and external factors as key determinants of compliance. Demographic characteristics such as age, marital status, and riding experience have been associated with compliance in some contexts (Nzuchi et al. 2022; Hagan et al. 2021). Work-related pressures also influence safety behavior; the Job Demand–Resource (JD-R) Model suggests that job strain and delivery pressures may reduce compliance (Nguyen-Phuoc et al. 2022), while positive safety climates and organizational communication improve adherence (Mai et al. 2023). External factors such as enforcement effectiveness and infrastructure quality likewise shape compliance outcomes (Vicmundo 2024; Asian Transport Outlook 2025).

The consequences of non-compliance extend beyond injury risks to severe economic burdens. Illegal riding behaviors significantly increase crash severity (Li et al. 2022), and helmet non-use raises the likelihood of major trauma and mortality (Liasidis et al. 2023). Motorcycle crashes also impose catastrophic financial strain on victims, particularly in low-income contexts (Oladeji et al. 2024), while nationally, road crashes cost the Philippines approximately 3% of GDP (Asian Transport Outlook 2025).

To explain the cognitive mechanisms underlying compliance decisions, this study integrates established behavioral theories. The Theory of Planned Behavior (Ajzen 1991) explains how attitudes, subjective norms, and perceived behavioral control shape compliance intentions, while Protection Motivation Theory (Rogers 1975) accounts for how riders assess perceived risk severity, vulnerability, and coping efficacy. These models provide a structured explanation of how individual decision-making processes mediate the effects of occupational and environmental pressures on safety behavior.

The Motorcycle Rider Behavior Questionnaire (MRBQ), originally developed by Elliott et al. (2007), serves as a validated instrument for assessing rider behaviors across domains such as traffic errors, control errors, speed violations, stunt performance, and safety equipment use. International adaptations of the MRBQ in Indonesia and Brazil demonstrate that contextual modification is methodologically acceptable when supported by appropriate validation procedures (Setyowati et al. 2024; Coelho et al. 2012). Guided by these precedents, this study adopts and contextualizes the MRBQ to reflect the unique working conditions and operational realities of motorcycle delivery riders in Metro Manila, thereby strengthening its applicability within a localized urban delivery context.

3. Methods

The research employed a quantitative, non-experimental, cross-sectional design using Structural Equation Modeling (SEM) to investigate the factors influencing road safety compliance among motorcycle delivery riders in Metro Manila. The study focused on active delivery riders affiliated with major e-commerce and logistics platforms operating within the region. A minimum sample of 150 respondents was determined Daniel Soper's A Prior Sample Size Calculator for Structural Equation Modeling, assuming a medium effect size ($f^2 = 0.30$), an alpha level of 0.05, statistical power of 0.80, five latent variables, and twenty-five observed indicators. Eligibility criteria required respondents to be between 20 and 50 years old (Robbins et al. 2024), possess a valid motorcycle driver's license, and have at least six months of continuous delivery experience (Ward et al. 2024). Riders who did not meet these criteria were excluded from the final analysis. The selected methodology, centered on a predictive-causal modeling approach, aimed to identify and analyze direct and indirect relationships among different factors of compliance behavior.

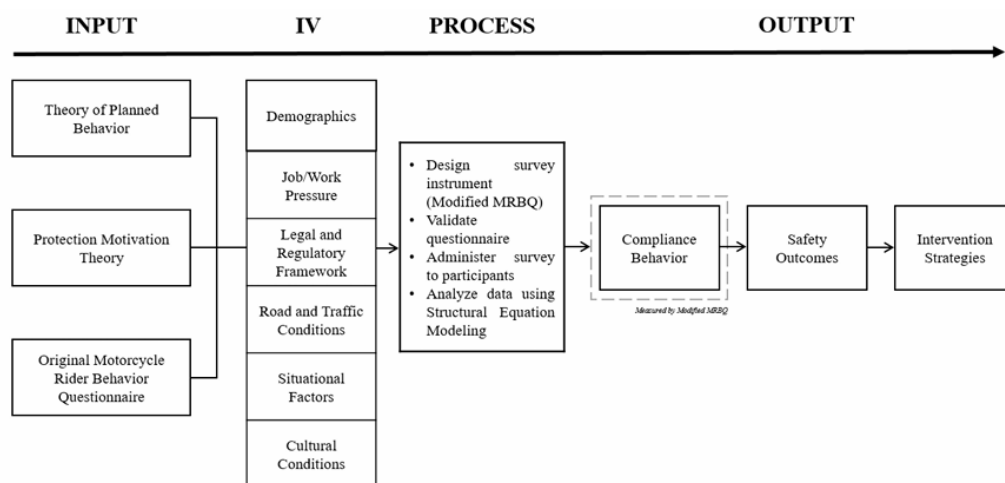


Figure 1. Conceptual Framework

The research framework, as shown in Figure 1, illustrates the latent constructs and the hypothesized structural relationships. This study integrated the Theory of Planned Behavior (TPB), the Protection Motivation Theory (PMT), and the Motorcycle Rider Behavior Questionnaire (MRBQ) to explain compliance behavior among motorcycle delivery riders.

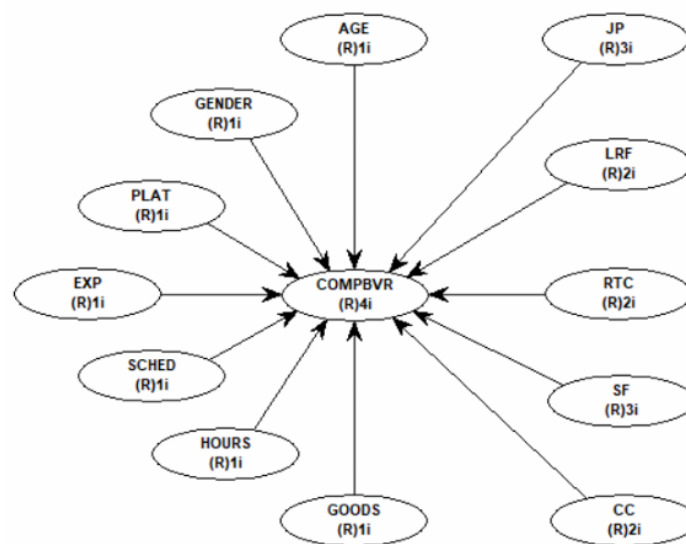


Figure 2. Structural Model

From the theoretical foundations, five primary latent variables were identified: Job/Work Pressure (JWP), Legal and Regulatory Framework (LRF), Road and Traffic Conditions (RTC), Situational Factors (SF), and Cultural Conditions (CC), as shown in Figure 2. These constructs represent the input components of the model and are hypothesized to influence the dependent latent variable, Compliance Behavior, which reflects compliance to road safety practices. Demographics: the age, gender, primary platform used, employment duration, work schedule, average working hours per day, and type of goods delivered, were mainly used as observed variables to contextualize rider characteristics.

4. Data Collection

Data were collected from motorcycle delivery riders operating within Metro Manila using random sampling. Riders encountered in selected high-activity areas were invited to participate in the survey, allowing representation across different delivery platforms and working conditions.

Respondents were selected based on the following inclusion criteria: active motorcycle delivery riders aged 20-50 years old, affiliated with any delivery platform, currently operating within Metro Manila, and with at least six months of experience as a delivery rider. Only those who voluntarily agreed and completed the questionnaire were included in the dataset. A total of 150 valid responses were obtained, meeting the required sample size for Structural Equation Modeling (SEM).

The primary instrument used was a structured questionnaire adapted from the Motorcycle Rider Behavior Questionnaire (MRBQ) and modified to reflect the local context of delivery riders. The survey measured job-related, legal, environmental, situational, and cultural factors, as well as self-reported road safety compliance. Data were gathered through both Google Forms and printed questionnaires distributed in areas with a high concentration of delivery riders.

All responses were treated with confidentiality and collected with informed consent. Completed questionnaires were screened for completeness and encoded for analysis. Data were analyzed using WarpPLS software through descriptive statistics and Partial Least Squares Structural Equation Modeling (PLS-SEM) to determine the factors influencing road safety compliance among motorcycle delivery riders.

5. Results and Discussion

5.1 Numerical Results

Table 1 presents the structural model results of the PLS-SEM analysis, summarizing the path coefficients (β), p-values, and hypothesis testing outcomes for all proposed relationships with road safety compliance.

Table 1. Structural Model Results: Path Coefficients and Hypothesis Testing

No.	Hypothesis	Path Coefficient (β)	P-Value (p)	Remarks
H1	Age $\rightarrow$ Compliance Behavior	-0.004	0.482	Insignificant
H2	Gender $\rightarrow$ Compliance Behavior	0.072	0.180	Insignificant
H3	Platform $\rightarrow$ Compliance Behavior	-0.098	0.105	Insignificant
H4	Years of Experience $\rightarrow$ Compliance Behavior	-0.003	0.484	Insignificant
H5	Schedule $\rightarrow$ Compliance Behavior	-0.073	0.175	Insignificant
H6	Working Hours $\rightarrow$ Compliance Behavior	0.013	0.433	Insignificant
H7	Type of Goods Delivered $\rightarrow$ Compliance Behavior	0.051	0.258	Insignificant
H8	Job/Work Pressure $\rightarrow$ Compliance Behavior	0.129	0.049	Significant
H9	Legal and Regulatory Framework $\rightarrow$ Compliance Behavior	0.166	0.016	Significant
H10	Road and Traffic Conditions $\rightarrow$ Compliance Behavior	0.207	0.004	Significant
H11	Situational Factors $\rightarrow$ Compliance Behavior	0.209	0.003	Significant
H12	Cultural Conditions $\rightarrow$ Compliance Behavior	0.521	<0.001	Significant

The results indicate that demographic variables do not significantly predict compliance behavior. Age ($\beta = -0.004$) showed a weak and non-significant negative relationship, suggesting a slight decline in compliance with increasing age, contrasting with findings by Hagan et al. (2021), possibly due to contextual differences in Metro Manila. Gender ($\beta = 0.072$), coded with males as 1 and females as 2, reflected a weak positive but non-significant tendency toward higher compliance among female riders, consistent with Nguyen-Phuoc et al. (2022), although no statistically meaningful gender difference was confirmed. Similarly, Platform ($\beta = -0.098$) and Years of Experience ($\beta = -0.003$) exhibited weak inverse and non-significant effects, supporting the view that organizational safety practices may be more influential than platform affiliation or accumulated riding exposure (Duri 2025; Rusli et al. 2022). Work Schedule ($\beta = -0.073$) showed a weak negative association, while Working Hours ($\beta = 0.013$) demonstrated a negligible positive effect, reinforcing that job structure and strain, rather than duration alone, shape compliance tendencies (Laphrom et al. 2024; Nguyen-Phuoc et al. 2022). Type of Goods Delivered ($\beta = 0.051$) also showed a weak and non-significant positive relationship, suggesting that delivery complexity may indirectly influence safety behavior through workload mechanisms (Chen et al. 2022; Ye et al. 2023).

In contrast, all latent constructs demonstrated statistically significant positive effects. Job/Work Pressure ($\beta = 0.129$) significantly predicted compliance, indicating that structured delivery demands may motivate regulated riding behavior despite inherent stress (Chen et al. 2022). The Legal and Regulatory Framework ($\beta = 0.166$) significantly strengthened compliance, underscoring the role of consistent enforcement and policy clarity (Nzuchi et al. 2022; Mumuni et al. 2023). Road and Traffic Conditions ($\beta = 0.207$) and Situational Factors ($\beta = 0.209$) both significantly influenced compliance, suggesting that riders adapt their behavior in response to infrastructure quality and immediate operational contexts (Memon et al. 2024; Malik et al. 2023). Most notably, Cultural Conditions ($\beta = 0.521$) exhibited the strongest effect, highlighting the dominant influence of workplace norms, peer expectations, and shared safety values, consistent with international findings on safety culture (Nævestad et al. 2020; Subramaniam et al. 2023). Overall, the structural results demonstrate that contextual, regulatory, and cultural factors exert substantially stronger influence on road safety compliance than demographic characteristics alone.

5.2 Graphical Results

Figure 3 presents the final structural model derived after a series of iterative refinements involving the systematic removal of weak and problematic indicators, guided by the criteria for convergent validity, discriminant validity, and collinearity diagnostics. The final structural equation model demonstrates substantial explanatory power, with $R^2 =$

0.88, indicating that 88% of the variance in the endogenous construct Compliance Behavior (COMPBVR) is accounted for by the included predictors.

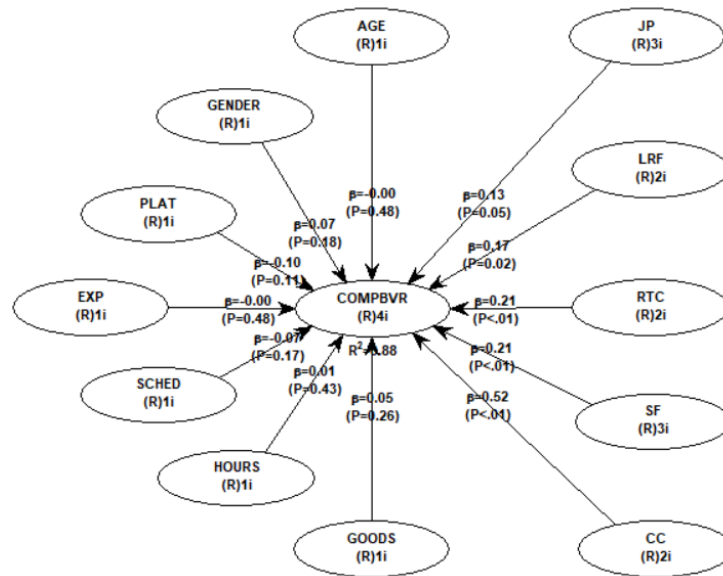


Figure 3. Final Structural Equation Model

The final structural equation model demonstrates which latent variables significantly influence motorcycle delivery riders' compliance behavior, and the interpretation must be consistent with the earlier diagnostics (C1–C3). As shown, Cultural Conditions ($\beta = 0.52$, $p < 0.01$) emerged as the strongest and most significant determinant, indicating that the cultural environment and prevailing norms strongly shape riders' decisions to comply with safety measures. Following this, Road and Traffic Conditions ($\beta = 0.21$, $p < 0.01$) and Situational Factors ($\beta = 0.21$, $p < 0.01$) were also significant, highlighting the role of infrastructure, road quality, and immediate environmental factors in influencing compliance. Legal and Regulatory Framework ($\beta = 0.17$, $p = 0.02$) further showed a positive and significant effect, underscoring the importance of formal rules and enforcement mechanisms in guiding behavior. Lastly, Job Pressure ($\beta = 0.13$, $p = 0.05$) was found to be marginally significant, suggesting that work-related demands may contribute to compliance, albeit to a lesser extent compared to contextual and cultural determinants.

In contrast, all observed variables—age, gender, platform mainly used, employment duration, work schedule, average number of working hours per day, and type of goods delivered were not statistically significant, as reflected by their low path coefficients and non-significant p-values. This reinforces that riders' compliance behavior is not shaped by personal or demographic characteristics, but is instead driven primarily by contextual, regulatory, and cultural influences.

5.3 Validation

The model was first assessed to establish reliability and validity prior to structural analysis (Table 2).

Table 2. Convergent Validity (Factor Loadings)

	AGE	GENDER	PLAT	EXP	SCHED	HOURS	GOODS	JP	LRF	RTC	SF	CC	COMPBVR	TYPE	SE	P-VALUE
1) JP (Job/Work Pressure)																
JP1	0.029	0.015	-0.039	-0.036	-0.002	-0.018	0.094	(0.900)	-0.236	0.203	0.166	-0.147	-0.042	Reflective	0.065	<0.001
JP3	-0.061	-0.030	-0.008	0.013	-0.060	-0.034	-0.041	(0.920)	0.201	-0.098	0.000	-0.074	0.117	Reflective	0.065	<0.001
JP6	0.035	0.016	0.049	0.024	0.066	0.055	-0.053	(0.872)	0.032	-0.106	-0.171	0.231	-0.080	Reflective	0.066	<0.001
2) LRF (Legal and Regulatory Framework)																
LRF2	0.033	0.019	0.010	0.011	0.055	-0.071	-0.040	-0.099	(0.939)	-0.123	0.049	0.043	0.012	Reflective	0.065	<0.001

LRF3	-0.033	-0.019	-0.010	-0.011	-0.055	0.071	0.040	0.099	(0.939)	0.123	-0.049	-0.043	-0.012	Reflective	0.065	<0.001
3) RTC (Road and Traffic Conditions)																
RTC2	0.018	0.032	-0.039	-0.044	0.086	0.091	-0.021	-0.130	-0.039	(0.941)	-0.059	-0.129	0.034	Reflective	0.065	<0.001
RTC4	-0.018	-0.032	0.039	0.044	-0.086	-0.091	0.021	0.130	0.039	(0.941)	0.059	0.129	-0.034	Reflective	0.065	<0.001
4) SF (Situational Factors)																
SF1	0.019	-0.014	-0.007	-0.104	-0.015	0.015	0.023	-0.105	0.177	-0.008	(0.920)	0.148	-0.029	Reflective	0.065	<0.001
SF5	-0.008	0.014	0.057	0.075	-0.093	-0.117	-0.038	-0.106	0.046	-0.080	(0.903)	-0.082	0.060	Reflective	0.065	<0.001
SF6	-0.012	0.000	-0.050	0.031	0.110	0.103	0.014	0.217	-0.230	0.089	(0.887)	-0.070	-0.031	Reflective	0.066	<0.001
5) CC (Cultural Conditions)																
CC1	-0.022	-0.073	-0.022	0.052	-0.027	0.073	-0.067	0.070	-0.080	0.104	-0.072	(0.923)	0.006	Reflective	0.065	<0.001
CC2	0.022	0.073	0.022	-0.052	0.027	-0.073	0.067	-0.070	0.080	-0.104	0.072	(0.923)	-0.006	Reflective	0.065	<0.001
6) COMPBVR (Compliance Behavior)																
TE1	0.085	0.002	0.026	-0.010	0.072	-0.040	0.008	-0.081	0.138	-0.089	0.161	-0.219	(0.854)	Reflective	0.066	<0.001
TE3	-0.014	0.016	-0.106	-0.092	0.044	0.068	0.060	-0.125	0.007	0.121	-0.037	0.191	(0.904)	Reflective	0.065	<0.001
TE4	0.000	0.023	0.072	0.089	-0.076	-0.024	-0.072	0.152	-0.069	0.017	-0.119	-0.183	(0.840)	Reflective	0.066	<0.001
TE6	-0.065	-0.038	0.014	0.018	-0.040	-0.007	0.000	0.059	-0.071	-0.052	-0.004	0.180	(0.935)	Reflective	0.065	<0.001

All retained indicators exceeded the recommended 0.50 threshold, with most values above 0.80 and all statistically significant ($p < 0.001$). These results confirm that the observed variables adequately represent their respective latent constructs and demonstrate strong convergent validity and internal consistency.

Table 3. Internal Consistency and Convergent Validity - Reliability and AVE

	AGE	GENDER	PLAT	EXP	SCHED	HOURS	GOODS	JP	LRF	RTC	SF	CC	COMP BVR
Composite Reliability	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.925	0.937	0.940	0.930	0.920	0.934
Cronbach's Alpha	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.879	0.865	0.872	0.887	0.826	0.906
Average Variance Extracted	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.805	0.881	0.886	0.816	0.852	0.781
Full Collinearity VIF	1.294	1.040	1.258	1.472	1.165	1.388	1.283	3.372	4.137	4.450	3.290	4.028	2.504

Composite Reliability values ranged from 0.920 to 0.940 and exceeded the 0.70 threshold, indicating strong internal consistency. Cronbach's alpha values (0.826–0.887) further confirmed construct reliability. Average Variance Extracted (AVE) values were all above 0.50, establishing convergent validity (Fornell & Larcker 1981), while full collinearity VIF values remained below 5, indicating no multicollinearity issues. Overall, these results confirm that the constructs are reliable and valid for structural model analysis.

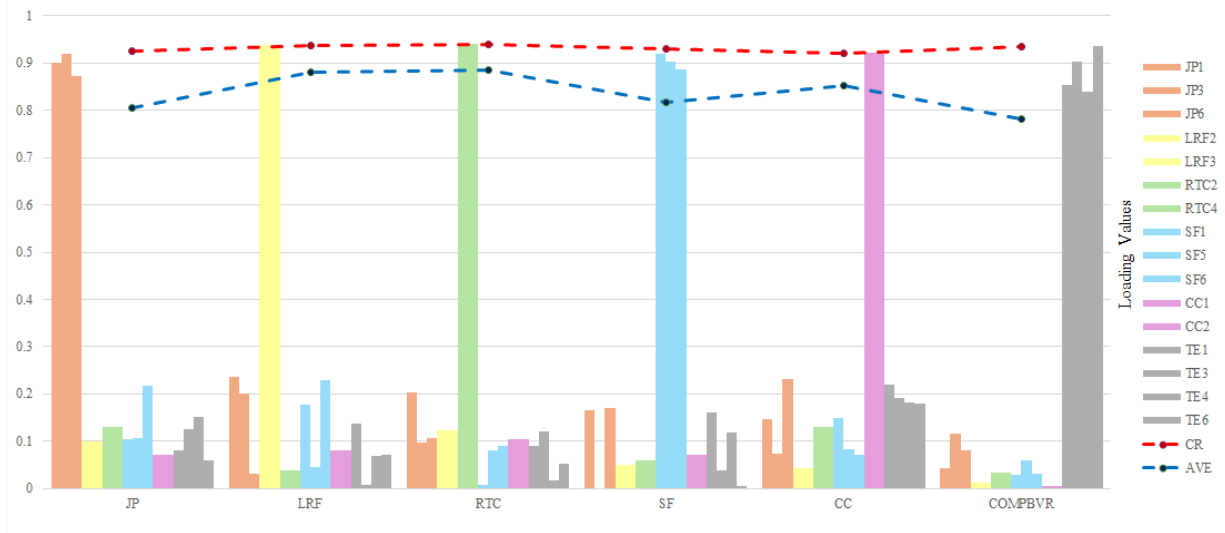


Figure 4. Model Reliability and Validity Evaluation

Figure 4 presents the reliability and validity evaluation of the measurement model through a visual representation of indicator loading values. The bars in the chart represent the individual indicator loadings for each construct. As shown, all indicator loadings, CR, and AVE values across constructs met the required thresholds, confirming the results presented in Tables 2 and 3.

Table 4. Discriminant Validity - Fornell-Larcker Criterion

	AGE	GENDE R	PLAT	EXP	SCHED	HOURS	GOODS	JP	LRF	RTC	SF	CC	COMPB VR
AGE	(1.000)	-0.098	-0.063	0.364	-0.174	0.095	-0.029	-0.003	-0.052	0.110	0.107	0.130	0.098
GENDER	-0.098	(1.000)	-0.006	-0.046	0.005	-0.106	-0.083	-0.009	-0.005	-0.028	0.008	-0.029	-0.011
PLAT	-0.063	-0.006	(1.000)	-0.073	0.107	-0.021	0.360	-0.137	-0.067	-0.138	-0.148	-0.196	-0.293
EXP	0.364	-0.046	-0.073	(1.000)	-0.212	0.449	-0.044	-0.039	-0.026	-0.056	-0.019	0.012	-0.049
SCHED	-0.174	0.005	0.107	-0.212	(1.000)	-0.263	0.206	0.105	0.111	0.093	0.061	0.059	0.027
HOURS	0.095	-0.106	-0.021	0.449	-0.263	(1.000)	-0.111	-0.058	-0.000	-0.110	-0.079	-0.066	-0.090
GOODS	-0.029	-0.083	0.360	-0.044	0.206	-0.111	(1.000)	-0.069	0.034	-0.107	-0.050	-0.082	-0.157
JP	-0.003	-0.009	-0.137	-0.039	0.105	-0.058	-0.069	(0.897)	0.795	0.718	0.682	0.610	0.590
LRF	-0.052	-0.005	-0.067	-0.026	0.111	-0.000	0.034	0.795	(0.939)	0.752	0.682	0.708	0.564
RTC	0.110	-0.028	-0.138	-0.056	0.093	-0.110	-0.107	0.718	0.752	(0.941)	0.795	0.789	0.664
SF	0.107	0.008	-0.148	-0.019	0.061	-0.079	-0.050	0.682	0.682	0.795	(0.903)	0.751	0.614
CC	0.130	-0.029	-0.196	0.012	0.059	-0.066	-0.082	0.610	0.708	0.789	0.751	(0.923)	0.729
COMPB VR	0.098	-0.011	-0.293	-0.049	0.027	-0.090	-0.157	0.590	0.564	0.664	0.614	0.729	(0.884)

As shown in Table 4, the square roots of the AVE for each construct (diagonal values in bold) were greater than their correlations with other constructs, thereby meeting the criterion proposed by Fornell and Larcker (1981). This indicates that each latent variable is empirically distinct and measures a unique concept within the model.

Table 5. Model Fit

	Value	P-Value	Criteria	Remark
Average Path Coefficient (APC)	0.129	0.024	P should be less than .05	Acceptable
Average R-squared (ARS)	0.883	<0.001	P should be less than .05	Acceptable
Average Adjusted R-squared (AARS)	0.874	<0.001	P should be less than .05	Acceptable
Average Block VIF	2.017	NA	Acceptable if ≤ 5 ; ideally ≤ 3.3	Ideal
Average Full Collinearity VIF	2.360	NA	Acceptable if ≤ 5 ; ideally ≤ 3.3	Ideal
Tenenhaus GoF	0.904	NA	small ≥ 0.1 , medium ≥ 0.25 , large ≥ 0.36	Large
SRMR	0.051	NA	Acceptable if less than or equal to 0.1	Acceptable
SMAR	0.038	NA	Acceptable if less than or equal to 0.1	Acceptable

The final model demonstrated acceptable fit and strong explanatory power. The APC (0.129, $p = 0.024$) confirmed the significance of the hypothesized paths, while ARS (0.883, $p < 0.001$) and AARS (0.874, $p < 0.001$) indicated that a high proportion of variance in compliance behavior was explained by the model. Collinearity diagnostics remained within ideal ranges, and the Tenenhaus GoF (0.904) reflected large explanatory power (Table 5). Global fit indices also improved, with SRMR (0.051) and SMAR (0.038) below the recommended threshold, confirming that the model is well-fitted and statistically robust.

5.3 Proposed Improvements

Several improvements are proposed to address their impact on delivery riders' road safety compliance. The findings indicate that cultural conditions significantly affect road safety compliance, suggesting that a company's initiatives and programs directly influence delivery riders' safety behavior. Thus, concerned organizations must establish peer-led safety initiatives and strengthen a culture of rule adherence through modeling programs.

The decision-making process of delivery riders is influenced by environmental conditions, as these situational factors prompt them to balance comfort, efficiency, and safety (Nguyen-Phuoc et al. 2024). To provide external support during these scenarios, companies and organizations should initiate developing comprehensive weather-responsive safety protocols, urgent delivery management systems, and advocate for infrastructure improvements in high-traffic delivery zones to reinforce safety behaviors.

Furthermore, at the macroscale, legal and regulatory frameworks regarding safety compliance behavior had a significant effect, underscoring the need for strengthened awareness and the restoration of belief in the protective system. This implies enhancing legal awareness programs and strengthening accountability systems for traffic law compliance to support safety behavior outcomes from the company level to government authorities. Government agencies should prioritize revisiting relevant labor laws to determine the correct classification of delivery riders and secure their working benefits and rights. To further emphasize the importance of delivery riders and elevate their safety standards, urban planners must learn to accommodate delivery riders as part of their urban landscapes. By improving road infrastructure and building parking zones and rest shelters, in considering the overall well-being and operational efficiency of delivery riders.

The high-demand nature of delivery riders comprises constant exposure to job/work pressure, which significantly affects compliance behavior. To address this, platform companies should redesign performance metrics and delivery algorithms to prioritize safety alongside speed and establish a comprehensive fatigue management system. Allocate for reliable healthcare insurance, subsidize high-quality safety gears, and ensure proper fare distribution.

Lastly, while societal changes must take place to make delivery rides safer, individual reform must also be pursued to foster a mindset that prioritizes their overall well-being. Delivery riders must join delivery rider organizations and participate in any programs that advocate for enhancements in the abilities to discern potential safety hazards. These proposed improvements highlight that continuous, sustained progress is attainable through extensive, comprehensive, and collaborative efforts among the involved institutions.

6. Conclusion

The significant factors influencing motorcycle delivery riders' road safety compliance in Metro Manila were identified and examined through the development and validation of a multidimensional structural model using Partial Least Squares Structural Equation Modeling (PLS-SEM). By integrating personal, occupational, and external factors into a unified framework, the analysis provided a comprehensive understanding of compliance behavior within the Metro Manila delivery context.

Demographic variables were found to be statistically insignificant predictors of compliance, whereas Job/Work Pressure, Legal and Regulatory Framework, Road and Traffic Conditions, Situational Factors, and Cultural Conditions demonstrated significant positive effects. Among these, Cultural Conditions emerged as the strongest variable, underscoring the influential role of social norms, workplace expectations, and collective attitudes toward safety. A key contribution of the research lies in the development of a context-specific, theory-integrated compliance framework tailored to motorcycle delivery riders in an urban Philippine setting. The results emphasize that road safety compliance is shaped more by structural and contextual systems than by demographic characteristics alone.

References

- Ajzen, I., The theory of planned behavior, *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179–211, 1991.
- Asian Transport Observatory, Philippines Road Safety Profile 2025, Available: <https://asiantransportobservatory.org/analytical-outputs/roadsafetyprofiles/philippines-road-safety-profile-2025/#:~:text=Infrastructure%20plays%20a%20crucial%20role,per%20thousand%20kilometers%20of%20road,2025>.
- Binghay, V. C., Lu, S. F., and Lu, J. L., Work, Health, and Safety Conditions of Delivery Riders in the Philippines during COVID-19 Pandemic, *Acta Medica Philippina*, vol. 56, no. 19, 2022.
- Borja, E. R., MotoSense - intelligent Motorcycle Safety Automation with Breathe Alcohol Content (BAC) and ignition interlock device, *Zenodo (CERN European Organization for Nuclear Research)*, vol. 3, no.1, 2020.
- Caliwan, C. L., PNP drive vs. traffic code violators nets 17K cars, motorcycles, Available: <https://www.pna.gov.ph/articles/1188822>, November 17, 2022.
- Chaichan, S., Asawalertsang, T., Veerapongtongchai, P., Chattakul, P., Khamsai, S., Pongkulkiat, P., Chotmongkol, V., Limpawattana, P., Chindaprasit, J., Senthong, V., Ngamjarus, C., Sittichanbuncha, Y., Kitkhuandee, A., and Sawanyawisuth, K., Are full-face helmets the most effective in preventing head and neck injury in motorcycle accidents? A meta-analysis, *Preventive Medicine Reports*, vol. 19, 101118, 2020.
- Chen, T., Tian, D., Deng, P., Zhou, E., and Huang, J., Study on instant delivery service riders' safety and health by the effects of labour intensity in China: a mediation analysis, *Frontiers in Public Health*, vol. 10, 2022.
- Coelho, R. P. S., Grassi-Oliveira, R., Machado, M., Williams, A. V., Matte, B. C., Pechansky, F., Rohde, L. a. P., and Szobot, C. M., Tradução e adaptação da escala Motorcycle Rider Behavior Questionnaire: versão brasileira, *Cadernos De Saúde Pública*, vol. 28, no.6, pp. 1205–1210, 2012.
- De Vera, B. A., 1-million motorcycles sold! Philippines leads ASEAN in two-wheeler boom, Available: <https://mb.com.ph/2024/10/30/ph-hits-1-million-motorcycle-sales>, October 30, 2024.
- Dela Cruz, J. R., Tupas, A. M., Acha, J. B., Dela Costa, V., Albar, I., II, and Castillo, E., Factors associated with the helmet use among motorcycle drivers in District IV, Quezon City, *Philippine Journal of Health Research and Development*, vol. 26, pp. 15–29, 2022.
- Dela Cruz, R.-A, A comparative analysis of the extent of light pollution in the cities of Mandaluyong and Pasig, *Journal of Biodiversity and Environmental Sciences*, vol. 19, pp. 32-40, 2021.
- Duri, B., E-commerce at the last-mile: Media narratives on safety and working conditions of motorcycle delivery drivers, *Journal of Infrastructure Policy and Development*, vol. 9, no.3, 11564, 2025.
- Durmaz, A., Dursun, I., and Kabadayi, E.T., Mitigating the effects of social desirability bias in Self-Report surveys. *Advances in Library and Information Science (ALIS) Book Series*, pp. 146-185, 2019.

- Elliott, M. A., Baughan, C. J., and Sexton, B. F., Errors and violations in relation to motorcyclists' crash risk, *Accident Analysis & Prevention*, vol. 39, no. 3, pp. 491–499, 2006.
- Estil, J. P., Ceballos, A. N., Dela Cruz, J. R., Matira, M. J. B., and Mimay, M. T., Design and Development of Solar-Powered Safety Motorcycle Helmet with Voice Warning System, *Ascendens Asia Singapore – Bestlink College of the Philippines Journal of Multidisciplinary Research*, vol. 3, no. 1A, 2024.
- Fornell, C., and Larcker, D. F., Evaluating Structural Equation Models with Unobservable Variables and Measurement Error, *Journal of Marketing Research*, vol.18, no.1, pp. 39–50, 1981.
- Hagan, D., Tarkang, E. E., and Aku, F. Y., Compliance of commercial motorcycle riders with road safety regulations in a peri-urban town of Ghana, *PLoS ONE*, vol. 16, no. 3, 2021.
- International Trade Administration, Philippines - eCommerce, Available: <https://www.trade.gov/country-commercial-guides/philippines-ecommerce>, 2024.
- Kinyua, W., M. G. and Kiambati, K., Motorcycles delivery innovation and performance of wholesale retail sector in Kenya, *International Journal of Research in Business and Social Science* vol.12, no.5, pp. 456–462, 2023.
- Kumphong, J. K., Correlations Among Motorcycle-Related Deaths, Helmet Law Enforcement, and Helmet Usage for ASEAN Countries, *International Journal of Geomate*, vol. 15, no. 49, 2018.
- Laphrom, W., Champahom, T., Se, C., Nanthawong, S., Wisutwattanasak, P., Ratanavaraha, V., and Jomnonkwao, S., Assessing Risky Riding Behaviors Among Food Delivery Motorcyclists in Thailand: Insights from the Motorcycle Rider Behavior Questionnaire and Health Belief Model, *Logistics*, vol. 8, no. 4, p. 125, 2024.
- Li, Z., Huang, Z., and Wang, J.A., Association of illegal motorcyclist behaviors and injury severity in urban motorcycle crashes, *Sustainability*, vol. 14, no. 21, 13923, 2022.
- Liasidis, P., Benjamin, E., Jakob, D., Lewis, M., and Demetriades, D. (2023). Injury patterns and outcomes in motorcycle passengers, *European Journal of Trauma and Emergency Surgery*, vol. 49, no. 6, pp. 2447–2457, 2023.
- Mai, N.X., Nguyen-Phuoc, D.Q., Van Nguyen, B., Pervez, A., and Oviedo-Trespalcacios, O., Traffic crash risk among on-demand food delivery riders in Danang city, Vietnam: Key contributing factors, *Travel Behaviour and Society* vol. 40, 100995, 2025.
- Malik, M., Rusli, R., Nusa, F. N. M., and Adinegoro, Y., Risky Behaviours Among Delivery Riders at Signalized Intersections in Malaysia, *Planning Malaysia*, vol. 21, no.4, 2023.
- Memon, T. F., Siddiqui, M. I., Wassan, S. M., Manzoor, K., Shaikh, F. D., and Nizamani, W. M., Road Safety in Pakistan: Examining Perceptions and Compliance with Traffic Regulations, *Journal of Population Therapeutics and Clinical Pharmacology*, vol. 31, no.4, 2024.
- Metropolitan Manila Development Authority (MMDA), MMARAS Annual Report 2021: Road Crash Statistics in Metro Manila, Available: https://mmda.gov.ph/images/Home/FOI/MMARAS/MMARAS_Annual_Report_2021.pdf, 2021.
- Metropolitan Manila Development Authority (MMDA), MMARAS Annual Report 2022: Road Crash Statistics in Metro Manila, Available: https://mmda.gov.ph/images/Home/FOI/MMARAS/MMARAS_Annual_Report_2022.pdf, 2022.
- Metropolitan Manila Development Authority (MMDA), Metro Manila Accident Reporting and Analysis System (MMARAS) Annual Report 2023: Road Crash Statistics in Metro Manila, Available: https://mmda.gov.ph/images/Home/FOI/MMARAS/MMARAS_Annual_Report_2023.pdf, 2023.
- Mumuni, A., Adebayo, L. A., and Chandra, S. M. K., Road Use Regulations: Knowledge and compliance among commercial motorcycle riders in Oluyole Local Government Area, Ibadan, Nigeria, *Journal of Health and Environmental Research*, vol.9, no.1, 2023.
- Nguyen-Phuoc, D. Q., Mai, N. X., and Oviedo-Trespalcacios, O., Not the same: How delivery, ride-hailing, and private riders' roles influence safety behavior, *Accident Analysis & Prevention*, vol. 208, 107762, 2024.
- Nguyen-Phuoc, D.Q., Nguyen, N.a.N., Nguyen, M.H., Nguyen, L.N.T., and Oviedo-Trespalcacios, O., Factors influencing road safety compliance among food delivery riders: An extension of the job demands-resources (JD-R) model, *Transportation Research Part A: Policy and Practice* vol. 166, pp. 541–556, 2022.
- Nzuchi, J. S., Ngoma, S. J., and Meshi, E. B., Commercial motorcyclists and road safety measures compliance. A case study of Dodoma city, central Tanzania, *Heliyon*, vol. 8, no. 8, e10297, 2022.
- Nævestad, T., Laiou, A., and Yannis, G., Safety culture among car drivers and motorcycle riders in Norway and Greece: Examining the influence of nationality, region, and transport mode, *Frontiers in Sustainable Cities*, vol. 2, 2020.
- Oladeji, E., Ezeme, C., Baiyewu, L., Okunola, M., and Ogunlade, S., The catastrophic cost of motorcycle road traffic injuries: Experience from a major reference centre in a lower-middle income country, *Injury*, vol. 55, no. 5, 111314, 2024.

- Robbins, C., & Chapman, P., How does drivers' visual search change as a function of experience? A systematic review and meta-analysis. *Accident Analysis & Prevention*, 132, 105266, 2019.
- Rogers, R. W., A Protection Motivation Theory of Fear Appeals and Attitude change, *The Journal of Psychology*, vol. 91, no.1, pp. 93–114, 1975.
- Rusli, R., Mohammad, M. Z., Kamaluddin, N. A., Bakar, H., and Isa, M. H. M., A comparison of characteristics between food delivery riders with and without traffic crash experience during delivery in Malaysia, *Case Studies on Transport Policy*, vol. 10, no. 4), pp. 2244–2250, 2022.
- Saludes, M., Not-so-safe delivery: Riders' trip to unsafe working conditions, May 14, 2023, <https://www.altermidya.net/not-so-safe-delivery-riders-trip-to-unsafe-working-conditions/#:~:text=In%20Metro%20Manila%20alone%2C%20there,their%20health%20and%20safety%20situations>. Accessed March 2025.
- Setyowati, D. L., Setyaningsih, Y., Suryawati, C., and Lestantyo, D., Indonesian version of the motorcycle rider behaviour questionnaire: cross-cultural adaptation and validation. *International Journal of Public Health Science (IJPHS)*, vol. 13, no. 3, 1276, 2024
- Singh, H., Gig Workers: A Comprehensive analysis of the rise, challenges, and future of the gig economy, *International Journal for Multidisciplinary Research* vol. 6, no.5, 2024.
- Stemmler, H., The effects of COVID-19 on businesses: key versus non-key firms, International Labour Organization, Available: <https://www.ilo.org/publications/effects-covid-19-businesses-key-versus-non-key-firms>, n.d.
- Subramaniam, S., Zulaikha, H., Zin, M., Shang, J., Nazrul, A., Ibrahim, H., Borhan, N., & Arham, A., Factors Influencing Risky Riding Behaviors among P-Hailing Riders in Malaysia. *Journal of Human University Natural Sciences*, vol. 50, no.11, 2023.
- Vicmudo, D. A., Implementation of the No-Helmet No-Travel Policy, *AIDE Interdisciplinary Research Journal*, vol. 9, no. 1, pp. 139–151, 2024.
- Villanueva, Cecilia, Community Engagement for Environmental Lighting and Acoustics in the Manila's University Belt, *Resourceedings*, vol. 2, no.1, pp. 140–156, 2019.
- Ward, J., Klopper, S., Louw, F., & Schmieschek, M., *The cost of convenience: initial costs to the state healthcare system of orthopaedic injuries in uninsured delivery motorcyclists in Cape Town. The South African Orthopaedic Journal (SAOJ)*, 23(4), 174–179, 2024.
- Ye, X., Hu, Y., Liu, L., Wang, T., Yan, X., and Chen, J., Analyzing Takeaway E-Bikers' Risky Riding Behaviors and Formation Mechanism at Urban Intersections with the Structural Equation Model, *Sustainability*, vol. 15, no.17, 13094, 2023.

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