Article

Vol.6(3), pp. 236-259, November 2025
ISSN: 2026-9153 (Online), 2026-8009 (Print)

https://journals.ium.edu.na
DOI: https://doi.org/10.64375/2x6r1s24

NJMS
NAMIBIA JOURNAL OF MANAGERIAL SCIENCES

Date received: 20 October 2025 Date accepted: 23 November 2025 Date published: 30 November 2025

The Price of Safety: An Integrated Analysis of Driver Remuneration and Public Transport Fatalities Across National Contexts

Pardon J. Muzondo

Department of Supply Chain Management; Marondera University of Agricultural Sciences and Technology (MUAST), Marondera, Zimbabwe

Author correspondence: pmuzondo@muast.ac.zw

ABSTRACT

Traffic deaths disproportionately burden low- and middle-income countries, a disparity inadequately explained by motorisation levels alone. This study investigates the fundamental, but relatively understudied, hypothesis that poor driver remuneration is a structural force that fuels fatal crashes through measurable psychosocial and behavioural pathways. Theoretically grounded on an integrated theoretical framework combining the Effort-Reward Imbalance (ERI) model and rational-choice theory, the research employs a comparative, cross-sectional design integrating secondary national-level data (2018-2022) for 30 countries and primary survey data from 1,200 public transport drivers. The study employs multivariate regression (log-OLS, negative binomial), bootstrap mediation analysis, and tests of moderation. Findings support a strong negative relationship between PPP-adjusted driver remuneration and standardised fatality rates ($\beta = -0.47$, $p < .001$), moderated by strong mediation by extended working hours/fatigue (indirect effect = -0.098) and risky income-maximising activities (indirect effect = -0.075). The relationship is considerably significant in developing countries and is attenuated by stricter traffic enforcement and newer motor vehicle fleets. The study makes a novel contribution in providing the first large-scale, cross-national test of the mechanistic processes linking pay to safety and thereby reconciling occupational health and economic perspectives. Theoretically, it validates and elaborates on the ERI and rational-choice models in the transportation sector. Practically, it orders a paradigm shift in road safety policy, positing that living wage regulations, enforced working hour limitations, and replacement of the fleets are not labour issues but cost-saving public safety measures. Socially, the realignment is needed to reduce the global incidence of unnecessary death and encourage fair, sustainable transport systems.

Keywords: Effort-reward imbalance, Driver remuneration, Public transport safety, Rational-choice theory, Road traffic fatalities

1. INTRODUCTION

Road traffic injury is a widespread and rising global public health crisis, killing an estimated 1.19 million people annually and perpetrating non-fatal injuries in millions more (World Health Organisation [WHO], 2023). The disease has a starkly uneven geographic distribution, with low- and middle-income countries (LMICs) experiencing over 90% of the global mortality burden yet possessing only approximately 60% of the world's vehicle fleet (GBD 2019 Road Injury Collaborators, 2020). While determinants such as rapid motorisation, inadequate infrastructure, and lagging policy frameworks have commonly been found to play a role in causing such inequalities (Ameratunga, Hijar, & Norton, 2018; Bhalla & Gleason, 2020), a clearer understanding of the socio-economic and occupational determinants within the transport sector itself is now a necessity. The prevailing narrative often overlooks the human agent at the wheel, whose performance is critically shaped by their economic and psychosocial environment (Rosenbloom & Eldror, 2021).

A new body of evidence shows that the professional driver's workplace environment, including remuneration, working conditions, and contractual security constitutes a crucial, yet underappreciated, road safety determinant (Haque & Pawar, 2021; Useche, Cendales, & Montoro, 2021). The main argument is that poor or unstable income creates significant economic pressure, which creates a cascade of undesirable effects. Drivers, under financial insecurity, are forced to work extremely long hours, and this results in accumulative fatigue and cognitive deficiency (Taylor & Dorn, 2016; Staunton, Fitness, & Naweed, 2022). Concurrently, the rational pursuit of livelihood maximisation in piece-rate or low-base-pay systems encourages risky behaviour such as speeding, breaking traffic regulations, and overloading of vehicles in order to maximise daily earnings (Zhou, Wang, & Li, 2023; Isler, Newstead, & Starkey, 2020). These behavioural and physiological pathways converge to significantly increase the risk of crash occurrence and injury, developing various cycles of risk and poverty (Elvik, 2021).

The theoretical underpinnings for such linkages are robust and complementary. The Effort-Reward Imbalance (ERI) model, one of the pillars of occupational health psychology, provides a robust framework for understanding the stress-mediated pathway. It postulates that an extended mismatch between high work-related exertion and low occupational benefits (economic, status, or job-security benefits) produces long-term psychosocial tension, felt as fatigue, emotional exhaustion, and reduced cognitive capacity, all of which are detrimental to the demanding task of driving safely (Siegrist & Li, 2019; Useche et al., 2021). In complementary fashion, an economic rational-choice perspective accounts for the behavioural pathway. This perspective views drivers as rational agents responding sensibly to economic imperatives; when remunerations are low or directly tied to output, the price for rest and compliance with safety regulations is high, encouraging practices that maximise exposure and risk (Greaves & Figliozzi, 2019; Newaz, Davis, & Jefferies, 2023). This is a classic case of moral hazard, where compensation structures by default incentivise inferior actions (Lancée, Bosma, & van Dijk, 2023).

Despite the compelling nature of these propositions, significant empirical and conceptual gaps constrain both scholarly understanding and effective policy formulation. First, the evidence base remains fragmented across single-country case studies and specific sub-sectors (e.g., long-haul trucking, ride-sourcing), limiting the generalisability of findings and the ability to ascertain whether remuneration-safety linkages constitute a primary explanatory factor for the stark cross-national disparities in fatality rates (Haque & Pawar, 2021). Second, while the mediating roles of fatigue and risky behaviours are frequently theorised, they are seldom measured and tested empirically using standardised metrics across a diverse set of countries with varying institutional capacities and enforcement regimes (Zavareh, Hezaveh, & Nordfjærn, 2022). Third, there is a pronounced disconnect in the policy discourse between labour market interventions, such as wage reforms,

and traditional road safety measures, like enforcement and technological upgrades. Robust, cross-country evidence that quantifies the safety dividend of improving driver pay within a cost-benefit framework is notably scarce, hindering the development of integrated, multi-pronged strategies (Götschi, Ghekiere, & Van Cauwenberg, 2020; Oviedo-Trespalacios, Afghari, & Haque, 2022). This gap is particularly salient given the increasing procrastination of work in the global transport sector (Kaine & Josserand, 2021). Despite extensive literature on road safety determinants, no study has yet conducted a large-scale, cross-national empirical test that isolates driver remuneration and quantifies its mechanistic pathways (fatigue and risky income-maximising behaviour) as primary causal factors explaining international disparities in public-transport fatality rates.

The study addresses these critical gaps. Its overall objective is to conduct a rigorous, quantitative cross-nation study expressly exploring the driver compensation-public transport mortality rate link, while also disentangling the causal processes and boundary conditions of this relationship. Specifically, the research aims to:

- Quantify the descriptive association between purchasing-power-parity (PPP) adjusted driver remuneration and standardised fatal public-transport accident rates across a balanced sample of developed and developing countries.
- Empirically test the mediating roles of working hours, driver fatigue, and income-maximising risky behaviours in this relationship.
- Investigate the moderating effects of key national-level contextual factors, including traffic enforcement intensity, vehicle fleet quality, and emergency medical service (EMS) capacity.

By situating this question within a unified ERI and rational-choice theoretical framework, this study seeks to move beyond correlation to provide a more comprehensive, mechanistic understanding of the manner in which economic pressures on drivers are translated into public safety outcomes. The study is directed towards providing a robust evidence base to underpin the demand for policy responses that bridge the traditional divide between labour rights and road safety, with the ultimate aim of contributing towards the eradication of avoidable fatalities in the globe's most vulnerable regions.

2. LITERATURE REVIEW

2.1. The Nexus Between Driver Remuneration, Working Conditions, and Crash Risk

There is ample and growing empirical evidence that attests to the immediate connection between economic conditions of professional driving and safety performance. The first systematic review by Haque and Pawar (2021) combined global evidence to establish that remuneration models, particularly those characterised by instability, low basic rates, or high reliance on piece rates are consistently associated with a higher risk of crash involvement and safety violations. This overall conclusion finds strong support in sector-specific research. Within the public bus sector, for instance, research by Greaves and Figliozzi (2019) demonstrated that poor remuneration and adverse management practices are root causes of high driver turnover, which destabilises on-the-job experience and is linked to poorer on-the-job performance. Validating this, Chen, Zhang, and Li (2019) provided empirical evidence that the structure of remuneration systems directly affects measurable driving behaviour among public bus drivers, with output-based pay linked to riskier driving styles. The issue of driver well-being is thus indivisible from operating efficiency and public hazard (Wong, Szeto, & Yang, 2020).

The logic of these associations is further described through empirical research in the haulage truck sector. Isler et al. (2020), in a large-sample study, reaffirmed that pay-by-distance and long

working hours - two features often combined with low effective hourly wages - are strong predictors of high crash risk among lorry drivers. These quantitative findings are richly complemented by qualitative and mixed-methods research explaining the behavioural nuances. Newaz et al. (2023), through qualitative interview responses from bus drivers, revealed how economic insecurity and precarious labour produce a hustle culture in which drivers intentionally take safety-threatening strategies, such as the exclusion of rest pauses and speeding, in an effort to meet high earning goals. Similarly, Zavareh et al. (2022), in a survey among Iran's bus drivers, quantitatively linked subjective economic pressure with a higher rate of risky driving behaviour, with personality as a moderating factor. The psychosocial factor is supported by Useche and others (2018, 2021), who, using validated scales in Bus Rapid Transit (BRT) and bus drivers, consistently found that adverse reward conditions and job strain are strongly correlated with high fatigue levels and risky on-road behaviours, thereby establishing a direct correlation with participation in accidents. This is supported by broader evidence in occupational safety that perceiving organisational support can serve as a buffer against risky behaviours (Hofmann, Morgeson, & Gerras, 2020).

2.2. Cross-National Disparities in Road Safety Outcomes

The disparity between road safety outcomes in high-income nations (HICs) and low- and middle-income countries (LMICs) is the most persistent and well-documented fact in global health. Authoritative sources like the WHO's Global Status Report on Road Safety (2023) and the Global Burden of Disease study (GBD 2019 Road Injury Collaborators, 2020) provide stark, comparable statistics that highlight this deficit, with fatality rates per 100,000 population tending to be three times higher in LMIC settings. Economists have sought to explain this pattern in terms of development dynamics. Kopits and Cropper (2015), for example, estimated the nexus of economic growth and road deaths and discovered an inverted U-curve relationship in the majority of environments, whereby deaths rise with initial motorisation before declining as economies advance and institutional capabilities increase. Simultaneous studies by Bhattacharya, Alberini, and Cropper (2021) examine the role of the value of statistical life, which tends to be lower in poor nations, thereby influencing the cost-benefit calculation and political priority accorded to safety interventions. Economic valuation is what primarily dictates the regulatory climate (Viscusi & Masterman, 2022).

Scholarship of public health and policy studies position these inequities as a result of an intersection of systemic risk factors more prevalent in low-income settings. Ameratunga et al. (2018) argue that the problem is one of a cluster of deficits in governance, enforcement capacity, road infrastructure quality, and post-crash care system. This is buttressed by transport safety researchers focusing on system-level factors. Wijnen and Stipdonk (2019) cite the significance of fleet age and composition, which they prove to be associated with higher crash severity for older fleets that are dominant in LMICs. Jacobs and Aeron-Thomas (2015) highlight the importance of regulative strictness and strict implementation of systematic safety management policies. One major omission in this enormous cross-country literature, however, is the relative lack of focus on labour-market variables. While remuneration for drivers and conditions of employment are encompassed within broader institutional differences, they are hardly isolated and tested as primary, explanatory causal variables within quantitative comparative frameworks (Antoniou, 2021). This is a crucial omission that this study aims to fill.

2.3. Unpacking the Causal Mechanisms: From Low Pay to High Risk

The literature describes several interconnected mechanistic pathways through which low compensation is converted into high crash risk and fatality severity.

2.3.1 The Psychophysiological Pathway of Fatigue

The ERI model forms the basis of this pathway on theoretical grounds. Siegrist and Li (2019) integrate evidence showing that effort-reward imbalance provokes a chronic stress response with subsequent sleep problems, exhaustion, and impaired performance. Applied to professional driving, this is empirically substantiated through research linking job strain to poorer driving performance (Useche et al., 2021). Ergonomics and systems research also help explain the way organisational factors like irregular scheduling, overtime shifts, and overtime mental loads interact with low reward to create physiological and cognitive impairments that make it extremely difficult for an individual to detect and react to threats (Staunton et al., 2022; Filtness & Naweed, 2017). This is consistent with the remainder of sleep science literature, which concludes that chronic sleep deprivation is the primary cause of performance failure (Wickens et al., 2021).

2.3.2 The Behavioural Pathway of Risky Income Generation

From the economic-incentives perspective, low pay creates a rational incentive for compensatory behaviours. Recent studies of the gig economy are particularly enlightening. Zhou et al. (2023) demonstrated that ride-sourcing drivers operating under piece-rate compensation plans engage in more speeding and work longer shifts to achieve daily revenue targets, and this has a direct impact on their safety record. Isler et al. (2020) revealed similar patterns in the trucking industry. In developing economies, the same tendency is transferred to overloading of cars with passengers or cargo, another common behaviour mentioned in studies from Ghana and Iran (Aidoo & Amoh-Gyimah, 2018; Zavareh et al., 2022). Such behaviours can be accounted for by the theory of planned behaviour, since attitudes, subjective norms, and perceived behaviour control decide on intention to commit violations (Warner & Åberg, 2018).

2.3.3 The Technical Pathway of Vehicle Maintenance

Financial stress impacts safety in forms that go beyond direct driving habits. Low compensation on the individual driver or operator level can lead to neglected vehicle upkeep and longer operation of older, less safe vehicles. This technical pathway increases the likelihood of mechanical breakdown and, more importantly, the severity of injuries when crashes occur due to the absence of up-to-date safety measures (Wijnen & Stipdonk, 2019; Ackaah & Afukaar, 2020). The diffusion of safety technologies is slower in environments where there are fragmented operator markets and thin profit margins (McIlroy et al., 2022).

2.3.4 The Moderating Role of Institutional Context

The quality of the above pathways is not uniform; it varies according to the state institutional context. Effective traffic policing, as evidenced by the intensity of speed cameras and traffic police, has been discovered in meta-analyses to be extremely effective in preventing offences like speeding, thereby potentially reducing the dangerous attitudes triggered by low wages (Høye, 2020). Further, technology-enabled interventions, including telematics and driver fatigue monitoring systems, are turning out to be useful instruments that can enhance but not replace fair labour practices (Oviedo-Trespalacios et al., 2022). This is particularly relevant in developing economies, where, as evidenced in the Zimbabwean context, the integration of Internet of Things (IoT) technologies in public transport logistics shows significant potential for enhancing real-time fleet monitoring and safety management (Muzondo, Matowanyika, & Chipangamate, 2025). The economic argument in support of holistic action is strengthened by studies that quantify the astronomical social cost of road injury, which tends to exceed the investment incurred in wage increases and system reform (Götschi et al., 2020; Bhattacharya et al., 2021). Finally, successful road safety depends upon an integrated safe system of shared responsibility by car, road, and user (Larsson, Dekker, & Tingvall, 2021).

3. Theoretical Framework and Hypotheses Development

3.1. Integrated Theoretical Foundation

For the sake of exhaustively replicating the complex dynamics between road safety and driver compensation, the current research draws on the interdependence of two complementary theoretical perspectives: the Effort-Reward Imbalance (ERI) model of occupational health psychology and economics' rational-choice perspective. The two-dimensional framework underpins the multi-level analysis that identifies both the internal stress-mediated and external incentive-driven mechanisms for linking remuneration and safety.

3.1.1 Effort-Reward Imbalance (ERI) Model

The Effort-Reward Imbalance (ERI) Model (Siegrist, 1996; Siegrist & Li, 2019) is a minimalist framework that describes how negative work conditions impact safety and health. It holds that employees engage in social reciprocity where job efforts are traded for similar rewards (money, respect, career opportunities, and job security). Systematic breach of such a norm in the form of high effort and low reward elicits persistent negative affect and physiological stress responses. In occupational driving, low pay, an inherent reward in the context of high physical and mental exertion, predicts the emergence of strain. This strain is realised through tiredness, disturbed sleep, bad mood states, and reduced cognitive attentiveness, all of which are shown proximal determinants of human error and road accidents (Useche et al., 2021; Taylor & Dorn, 2016). The ERI model thus invites us to pay attention to psychophysiological mediation of the remuneration-safety relationship, a channel that is often overlooked in purely economic analyses (Nævestad et al., 2022).

3.1.2 Rational-Choice Perspective

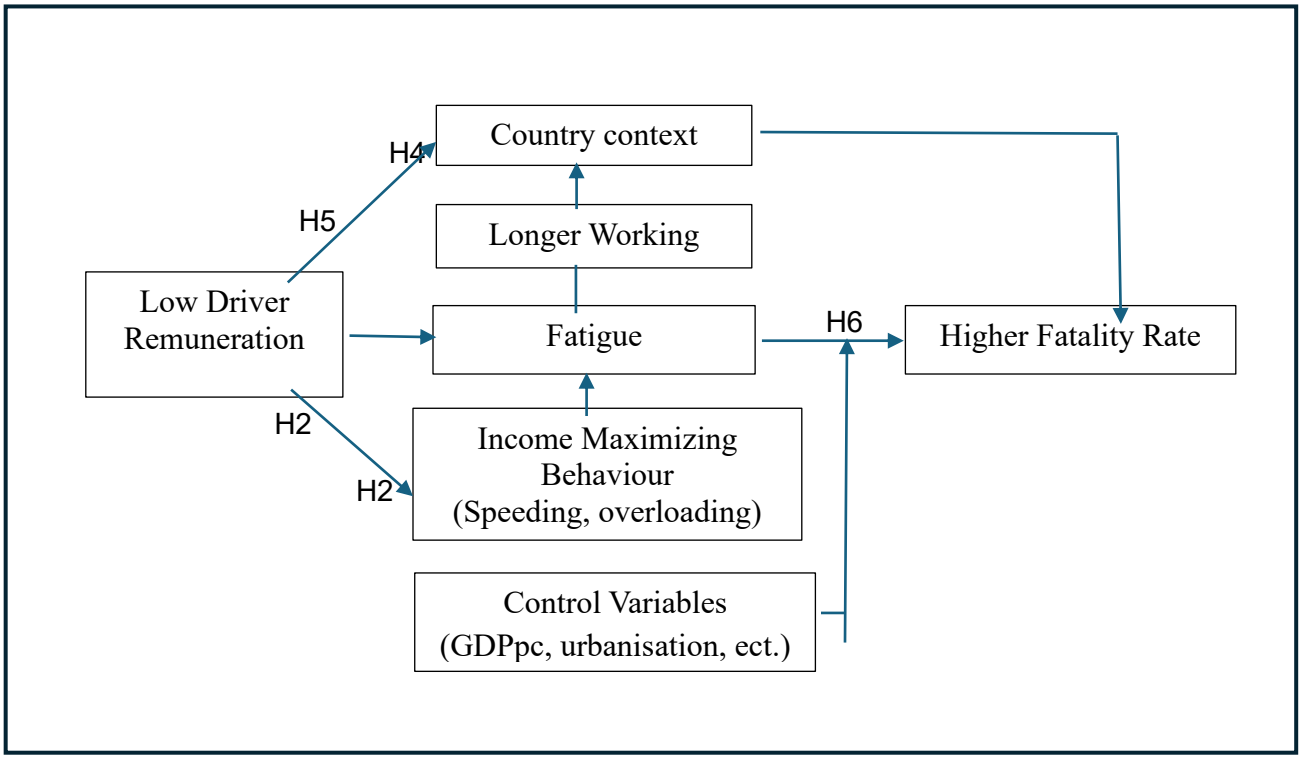
The Rational-Choice Perspective, rooted in microeconomic theory, complements this by focusing on observable behaviours. It treats drivers as rational agents who make calculated decisions to maximise their utility, which, in a context of financial pressure, is often synonymous with maximising income (Becker, 1976; Zhou et al., 2023). When the wage structure (e.g., low salary, piece rates) makes the marginal benefit of each additional trip or hour worked high, the rational driver will be incentivised to extend working hours beyond safe limits and to engage in time-saving but risky behaviours such as speeding, jumping traffic signals, or accepting overloads (Isler et al., 2020; Newaz et al., 2023). This perspective does not require drivers to be consciously reckless; rather, it suggests that the incentive structure of their employment makes risk-taking a rational strategy for livelihood generation (Lancée et al., 2023). This explains the behavioural mediation of the remuneration-safety relationship.

3.1.3 Integration of Theories

The integration of these theories is not merely additive but synergistic. The ERI model explains why low-paid drivers become fatigued and cognitively impaired, while the rational-choice model explains why they choose to work long hours and drive dangerously despite the known risks. Together, they provide a more complete causal narrative than either could alone, accounting for both the internal state of the driver and the external economic calculus that shapes their behaviour. This integrated approach addresses calls for more complex theoretical models in transport safety research that reflect the multi-faceted nature of driver decision-making (Scott-Parker, 2022).

3.2. Conceptual Framework and Hypothesised Relationships

Based on this integrated theoretical foundation, the study proposes a conceptual framework that maps the direct, mediating, and moderating relationships under investigation. The framework presented in Figure 1 clearly delineates the hypothesised pathways corresponding to each of the formal hypotheses (H1-H6).



Source: Author (2025)

Figure 1. Conceptual Framework of the Relationship between Driver Remuneration and Public Transport Fatalities, with Mediating and Moderating Pathways.

Guided by this framework, the study formally states the following hypotheses:

- H1 (Direct Association): There is a negative association between a country's average public-transport driver remuneration (PPP-adjusted) and its standardised fatal public-transport accident rates (per 100,000 population and per million passenger-km).
- H2 (ERI Mediation)**:** The association between lower remuneration and higher fatality rates is mediated by a pathway involving longer working hours and increased driver fatigue.
- H3 (Rational-Choice Mediation): The association between lower remuneration and higher fatality rates is mediated by a pathway involving a higher prevalence of income-maximising risky behaviours (speeding, overloading).
- H4 (Country Context Moderation): The negative association between driver remuneration and fatal crash rates is stronger (more negative) in developing countries than in developed countries.
- H5 (Vehicle Fleet Mediation/Moderation): Poor vehicle/fleet quality is both (a) a partial mediator of the remuneration-fatality link and (b) a moderator that strengthens the negative effect of low remuneration on fatalities.

- H6 (Policy Mitigation Moderation): High enforcement intensity and the presence of targeted technological interventions (e.g., speed cameras, telematics) attenuate (weaken) the negative association between low remuneration and high fatality rates.

4. RESEARCH METHODOLOGY

4.1. Research Design and Data Collection Procedures

This investigation employed a comparative cross-sectional design with a mixed-methods approach, harmonising secondary macro-level national data with primary micro-level survey data. This design is explicitly justified for its capacity to establish robust descriptive associations and to probe underlying mechanisms through data triangulation, an approach strongly advocated in prior syntheses of transport safety and occupational health research (Haque & Pawar, 2021; Useche et al., 2021).

The study period was defined as 2018-2022 in order to obtain a five-year panel with the aim of smoothing out the effects of random annual fluctuations and also to capture recent trends. The country-level analysis involved a purposively stratified sample of 30 nations. Stratification was by the World Bank income groups of 2020, which created two strata of 15 developed (high-income) nations and 15 developing (low- and lower-middle-income) nations. This sampling method ensured proportional representation of main world regions and is standard practice in comparative epidemiological and economic studies (Kopits & Cropper, 2015; WHO, 2023).

4.1.1 Secondary Data Sources and Synthesis:

A composite data set was constructed from international and national sources:

4.1.1.1 Fatality and Injury Data

The primary sources utilised were the WHO Global Status Report on Road Safety (2023) and the Institute for Health Metrics and Evaluation's Global Burden of Disease (GBD 2019) study. These provide the most standardised and internationally comparable road traffic fatality estimates. More detailed data on public-transport-specific crashes, where available, were obtained from national transport ministry reports and the International Road Traffic and Accident Database (IRTAD).

4.1.1.2 Remuneration and Socio-Economic Data

Occupational group average wage data, for drivers for instance, were obtained from the International Labour Organisation's ILOSTAT database and national labour force surveys. These nominal wages were converted into PPP-adjusted constant 2020 US dollars utilising World Bank conversion factors, a necessary step to enable cross-country comparison of purchasing power to be meaningful (Bhattacharya et al., 2021). Macroeconomic and demographic control variables (GDP per capita, urbanisation rate) were obtained from the World Bank's World Development Indicators (WDI).

4.1.1.3 Moderator Variables

Traffic enforcement measures (e.g., traffic police per capita, speed cameras) were assembled from IRTAD, the World Bank, and national police reports. Data on vehicle fleet composition and age were gathered from national vehicle registration agencies and organisational reports. Quantities of EMS capacity (e.g., emergency response times, trauma centre density) came from WHO databases and national health statistics.

4.1.2 Primary Data Collection - Driver Survey

In order to assess the hypothesised mediating variables, a cross-sectional survey among public transport drivers was conducted. The population of interest consisted of licensed bus, minibus, and Bus Rapid Transit (BRT) drivers. For feasibility and representativeness, a multistage cluster sampling technique was employed:

4.1.2.1 Stage 1 (Operator Selection)

In every 1 of 8 focus countries (4 developed, 4 developing), 2-3 big city public transport operators were chosen purposively to ensure a mix of public and private ownership.

4.1.2.2 Stage 2 (Driver Sampling)

A simple random sample of drivers was drawn from the employment records of each selected operator. The criteria for inclusion were (a) a current professional driving licence, (b) current public transport driver, and (c) a minimum of six months of continuous service with the operator.

The overall pooled sample comprised 1,200 completed questionnaires (600 developed 600 developing country clusters). The selection of countries and driver respondents followed explicit inclusion criteria to ensure representativeness, methodological consistency, and analytic validity. Countries were included if (a) they had publicly accessible WHO and ILOSTAT data for the period 2018–2022, (b) provided disaggregated road-traffic fatality records specific to public transport modes, and (c) maintained reliable labour-force data on professional drivers. For the primary survey, drivers were eligible for inclusion if they: (i) possessed a valid professional driving licence; (ii) were currently employed as a public transport driver (bus, minibus, or BRT); (iii) had at least six months continuous service with an operator; and (iv) provided complete responses to the fatigue, working-hours, and risky-behaviour items. Operators were selected purposively to capture variation across public and private fleets, while driver participants were sampled through simple random selection within operator rosters. The questionnaire instrument, administered by trained field enumerators after informed consent, included validated measures to evaluate:

- Working Hours and Schedule: Self-reported average hours worked per week.
- Fatigue: The Epworth Sleepiness Scale (ESS), a widely used and validated instrument for measuring daytime sleepiness (Johns, 1991).
- Job Strain: Items adapted from the Effort-Reward Imbalance questionnaire to calculate an ERI ratio (Siegrist et al., 2004).
- Risky Behaviours: Self-reported frequency of speeding, overloading, and safety check omissions.

This methodological protocol for surveying professional drivers is well-established in the literature and has been successfully implemented in numerous prior studies (Useche et al., 2018; Newaz et al., 2023; Zavareh et al., 2022).

4.2. Variable Operationalisation and Measurement

All study variables, their operational definitions, and sources are detailed in Table 1. Key measurement decisions are elaborated below.

Table 1: Variable Definitions and Operationalisation

Construct	Variable Name	Operational Definition	Source
Dependent Variables	Fatalities public transport pop	Number of fatal public-transport injuries per 100,000 population.	WHO, GBD
	Fatalities public transport passengers-km	Number of fatal public-transport injuries per million passenger-kilometres.	National Authorities, WHO
Independent Variable	Drivers wage ppp	Average monthly wage of public transport drivers, PPP-adjusted to constant 2020 US dollars. Log-transformed for analysis.	ILOSTAT, WDI, WB PPP
Mediating Variables	Avg weekly hours	Self-reported average number of hours worked per week.	Driver Survey
	Fatigue index	Total score on the Epworth Sleepiness Scale (range 0-24).	Driver Survey (ESS)
	Risky behaviour index	Composite index (0-1) derived from z-scores of self-reported speeding, overloading, and violation frequency.	Driver Survey, Violation Records
Moderating Variables	Enforcement index	Standardised z-score composite of: traffic police per 100,000 population, speed cameras per 1000 km of road.	IRTAD, National Reports
	Fleet age	Average age (in years) of the registered public transport vehicle fleet.	National Registries
	EMS capacity	Standardised z-score composite of: number of trauma beds per 100,000 population, average urban EMS response time (min).	WHO, World Bank
Control Variables	GDPpc	Gross Domestic Product per capita, PPP (constant 2020 USD). Log-transformed.	WDI
	Urban share	Percentage of the total population living in urban areas.	WDI

Construct	Variable Name	Operational Definition	Source
	Alcohol prevalence	Recorded alcohol consumption per capita (liters of pure alcohol) among adults (15+).	WHO
	Road quality	World Bank's Logistic Performance Index (LPI) score for infrastructure quality (1-5).	WDI

Source: Author (2025)

4.3. Analytical Strategy

Data was analysed in Stata 18.0 through a multi-stage analytical framework to obtain the descriptive and inferential goals of the study in direct relation to the stated hypotheses.

4.3.1 Descriptive and Bivariate Analysis

The initial step was to create summary statistics (means, standard deviations, medians) for all the variables across the total sample and by country group (developed/developing). Statistical significance of group differences was assessed through independent samples t-tests for normally distributed data and Mann-Whitney U tests for non-normal data. Bivariate associations were analysed via Pearson correlation coefficients, and a correlation matrix was built for major study variables.

4.3.2 Multivariate Regression Modelling

To test the direct relationship (H1) and the hypotheses of moderation (H4, H5b, H6), the study applied primarily log-linear Ordinary Least Squares (OLS) regression models. The dependent variable was the natural logarithm of the fatality rate, a transformation which normalises the distribution and allows coefficients to be estimated as elasticities (e.g., a 1% wage change with a β% change in the fatality rate) (Wooldridge, 2019). The base model was established as:

In (Fatalities_i) =β0 + β1*In (Wage ppp_i) +∑βk*Control_ik + ε_i. To test moderation (H4, H6), interaction terms were added to the model (e.g., In (Wages ppp_i) * Developing Country Dummy and In (Wage ppp_i) * Enforcement index). Negative binomial regression models have also been calibrated as a robustness check for count-based outcomes, which are the standard for over-dispersed crash counts in transport safety data (Isler et al., 2020).

4.3.3 Mediation Analysis

In order to statistically examine mediating hypotheses H2 and H3 formally, the study employed bootstrapping procedures for estimating indirect effects (Preacher & Hayes, 2008). The non-parametric method involves repeated resampling of the sample (5,000 resamplings, in this case) to generate an empirical representation of the sampling distribution of the indirect effect. The indirect effect is considered statistically significant if the bias-corrected bootstrap confidence interval does not contain zero. This approach is more efficient than the traditional causal steps method since it has higher statistical power and can estimate the indirect effect directly without relying on the often-controversial assumption of a significant total effect (Hayes, 2018). This technique has been successfully applied in recent driver behaviour studies to test mechanistic pathways (Useche et al., 2021; Zavareh et al., 2022).

4.3.4 Robustness and Sensitivity Analyses

The stability of the findings was assessed through several sensitivity checks. These included (a) re-running all primary models using the alternate fatality denominator (per million passenger-km); (b) excluding potential outlier country observations identified via leverage and influence diagnostics; (c) using different PPP base years for wage conversion; and (d) employing country-level fixed effects in panel specifications to control for time-invariant unobserved country characteristics.

4.4 Ethical Considerations

All study procedures complied with international ethical guidelines for human-subject research. Ethical clearance was obtained from the institutional research ethics committee, and formal approval was provided by participating transport operators and relevant authorities in each country cluster. Prior to data collection, all driver participants were informed of the study's purpose, voluntary participation, confidentiality protections, and their right to withdraw at any stage without consequence. Written informed consent was obtained before administering the survey, and all data were anonymised and stored securely in compliance with data-protection standards.

5. ANALYSIS AND RESULTS

5.1. Descriptive Statistics and Sample Characteristics

The final analytical sample for the country-level analysis consisted of 150 country-year observations (30 countries over 5 years). Table 2 presents the descriptive statistics for the key variables, pooled and stratified by the World Bank income group. The gaps are wide and fall in exactly the same way as the conceptual framework of the study. The median PPP-adjusted monthly pay for drivers in developed nations was $1,200, close to four times the median of $320 in developing nations. This stark economic inequality is translated to the safety record: the fatality rate per 100,000 population was seven times higher (18.4 compared to 2.6) and per million passenger-kilometres was six times higher (2.10 compared to 0.35). The contextual moderators further signal acute deficiencies in the development environments: the average public transport fleet is more than twice as old (11.6 years vs. 4.8 years), and the composite enforcement and EMS capacity indices are below half of the developed-world standards. All these differences are statistically significant at $p < .001$.

Table 2: Country-Level Descriptive Statistics (2018-2022 Pooled**)**

Variable	**Full Sample (N=150)**	**Developed Countries (n=75)**	**Developing Countries (n=75)**	**p-value (Group Diff.)**
Driver wage, PPP USD /month	760 (580)	1,200 (450)	320 (150)	< .001
Fatalities per 100k pop	10.5 (9.8)	2.6 (1.1)	18.4 (6.2)	< .001
Fatalities per million p-km	1.23 (1.15)	0.35 (0.12)	2.10 (0.68)	< .001

Variable	Full Sample (N=150)	Developed Countries (n=75)	Developing Countries (n=75)	p-value (Group Diff.)
Fleet average age (years)	8.2 (5.1)	4.8 (1.9)	11.6 (4.2)	< .001
Enforcement index (0-100)	53.6 (22.4)	72.4 (10.5)	34.8 (12.7)	< .001
EMS capacity index (0-100)	53.8 (27.9)	78.0 (9.2)	29.5 (13.4)	< .001
GDP per capita (PPP, '000 USD)	24.7 (24.5)	45.2 (12.1)	4.2 (2.8)	< .001
Note: Values are Mean (Standard Deviation). P-values from independent samples t-test.				

Source: Author (2025)

Table 3 reports the findings of the pooled driver survey (N=1,200). The micro-level evidence powerfully corroborates the macro-level picture. Drivers in developing countries reported working a staggering 13.4 more hours a week on average compared to drivers in developed countries (56.1 vs. 42.7 hrs). They also experienced significantly more daytime sleepiness (ESS score 12.6 vs 9.1, where a score >10 is indicative of significant sleepiness) and reported more frequent unsafe behaviours (Risky Behaviour Index of 0.52 vs 0.33). These scores provide strong initial evidence for operationalisation of the hypothesised mediating pathways.

Table 3: Driver Survey Descriptive Statistics

Variable	Pooled (N=1,200)	Developed (n=600)	Developing (n=600)	p-value
Avg weekly hours	49.4 (9.6)	42.7 (7.1)	56.1 (8.9)	< .001
ESS total (fatigue)	10.8 (4.6)	9.1 (3.8)	12.6 (4.9)	< .001
Risky behaviour index (0-1)	0.42 (0.19)	0.33 (0.14)	0.52 (0.21)	< .001
Monthly wage (PPP USD)	620 (520)	1,150 (430)	290 (180)	< .001
Note: Values are Mean (Standard Deviation). P-values from independent				

Variable	Pooled (N=1,200)	Developed (n=600)	Developing (n=600)	p-value
samples t-test. ESS = Epworth Sleepiness Scale.				

Source: Author (2025)

5.2. Bivariate Correlations and Initial Associations

The bivariate correlation matrix for the key country-level aggregated variables is presented in Table 4. The results provide strong preliminary support for the study's core propositions. The natural logarithm of PPP-adjusted driver wage exhibits a large and statistically significant negative correlation with the log of the fatality rate per 100,000 population ($r = -0.61$, $p < .001$). Furthermore, the proposed mediator's average weekly hours, fatigue score, and the risky behaviour index are all correlated in the theoretically expected directions. They show negative correlations with wage and positive correlations with the fatality rate. The moderating variables also correlate as anticipated; for instance, the enforcement index is positively correlated with wage ($r = 0.58$) and negatively with fatalities ($r = -0.52$).

Table 4: Pearson Correlation Matrix of Key Country-Level Variables

Variable	1	2	3	4	5	6	7
1. ln(wage_ppp)	—						
2. ln(fatal_per_100k)	-.61***	—					
3. avg_weekly_hours	-.48***	.53***	—				
4. ESS_total	-.44***	.49***	.64***	—			
5. risky_index	-.50***	.58***	.57***	.61***	—		
6. enforcement_index	.58***	-.52***	-.45***	-.41***	-.49***	—	
7. fleet_age	-.55***	.60***	.50***	.48***	.55***	-.62***	—
*Note: *** p < .001. Correlations are based on country-level aggregates (N=150).*							

Source: Author (2025)

5.3. Multivariate Regression Results

The results of the multivariate log-OLS regressions are shown in Table 5. Model 1 presents the unadjusted bivariate relationship, confirming H1 with a highly significant coefficient for ln (wages ppp) ($\beta = -0.72$, $p < .001$). This implies that, before controls, a 1% increase in driver wages is associated with a 0.72% decrease in the fatality rate.

Table 5: Log-OLS Regression Predicting ln (Fatalities per 100,000 population)

Predictor	**Model 1**	**Model 2 (Full)**	**Model 3 (Interaction)**
ln(driver_wage_ppp)	-0.72*** (0.09)	-0.47*** (0.11)	-0.18* (0.08)
ln(GDPpc)		-0.15* (0.06)	-0.14* (0.06)
enforcement_index		-0.009** (0.003)	-0.008** (0.003)
fleet_age		0.028*** (0.007)	0.026*** (0.007)
urban_share		0.002 (0.004)	0.002 (0.004)
alcohol_pc		0.004* (0.002)	0.004* (0.002)
Developing Country (Dummy)			1.85** (0.65)
ln(wage) * Developing Country			-0.21** (0.07)
ln(wage) * Enforcement			0.005* (0.002)
Observations	150	150	150
R^2	0.38	0.58	0.63
*Note: Robust standard errors in parentheses. * p < .05, ** p < .01, *** p < .001.*			

Source: Author (2025)

Model 2 introduces the full set of control variables. The coefficient for ln (wage ppp) attenuates but remains strongly significant ($\beta = -0.47$, $p < .001$), indicating that a 1% wage increase is associated with a 0.47% decrease in fatalities, even after accounting for national wealth,

enforcement, fleet age, urbanisation, and alcohol consumption. The controls themselves behave as expected: old fleets age is associated with more fatalities, and stronger enforcement with fewer fatalities.

Model 3 introduces interaction terms to test moderation. The significant negative coefficient for the interaction between ln (wage) and the Developing Countries dummy ($\beta = -0.21$, $p < .01$) provides strong support for H4. This indicates that the negative effect of low wages on safety is significantly more pronounced in developing countries. The positive coefficient for the interaction between ln (wage) and the enforcement index ($\beta = 0.005$, $p < .05$) supports H6, suggesting that high enforcement weakens the detrimental impact of low remuneration on fatality rates.

5.4. Mediation Analysis Findings

The results of the bootstrap mediation analysis, testing H2 and H3, are summarised in Table 6. The analysis reveals statistically significant indirect effects for both proposed pathways.

Table 6: Bootstrap Mediation Analysis (Standardised Indirect Effects)

Pathway	Std. Indirect Effect	95% Bootstrapped CI	p-value
H2: Wage → Hours/Fatigue → Fatality	-0.098	[-0.150, -0.050]	< .001
H3: Wage → Risky Behaviour → Fatality	-0.075	[-0.120, -0.030]	.002
Total Indirect Effect	**-0.173**	**[-0.240, -0.110]**	**< .001**
Direct Effect (Wage → Fatality)	-0.30	[-0.45, -0.15]	.001
Total Effect	**-0.47**	**[-0.60, -0.34]**	**< .001**
Note: Bootstrap sample = 5,000. CI = Bias-Corrected Confidence Interval. The proportion mediated is 0.173/0.47 = 36.8%.			

Source: Author (2025)

The indirect effect through the ERI pathway (working hours and fatigue) is -0.098, and through the rational-choice pathway (risky behaviour) is -0.075. The total indirect effect of these mediators is -0.173, which accounts for approximately 37% of the total effect of wage on fatalities. That the direct effect remains substantial signifies partial mediation, implying that there are additional unmeasured mechanisms (e.g., driver selection, training quality, organisational safety culture) that are also involved in the relationship

6. DISCUSSION

This study provides the most comprehensive cross-national evidence to date that low wages for drivers are a fundamental, structural root of public transport fatalities. By integrating macro-level country data and micro-level driver surveys and founding the analysis on a dual theoretical framework, the study moves beyond showing a simple correlation to explaining the how and under

what circumstances low wages lead to catastrophic outcomes. The findings offer robust confirmation of the study's integrated model, demonstrating that economic pressures on drivers compromise safety through independent yet complementary psychophysiological and behavioural pathways, and that the intensity of this relationship is highly contingent upon the national institutional context. The research answers a direct call for more sophisticated, multi-level analyses in transport safety science (Scott-Parker, 2022).

6.1. Synthesis and Interpretation of Key Findings

The persistent, negative association between PPP-adjusted pay and fatality rates (H1), when controlling for a variety of national-level confounders, firmly establishes driver pay as a key variable within the road safety toolkit. This finding corroborates and statistically adds to that of systematic reviews (Haque & Pawar, 2021) by demonstrating the strength of the association over a diverse set of countries. More importantly, the mediation analysis provides the first multi-country, large-scale empirical evidence for the theorised mechanistic channels. The statistically significant indirect effects through working hours/fatigue (H2) and risky behaviours (H3) therefore prove the core assumptions of the ERI and rational-choice models, respectively. The ERI model describes the internal, stress-induced decline in driver performance: low outcomes for high effort generate chronic strain, leading to fatigue impairing vigilance and reaction times (Siegrist & Li, 2019; Useche et al., 2021). This is complemented by neuroscientific evidence of the impact of sleep deprivation on cognitive function (Wickens et al., 2021). Concurrently, the rational-choice pathway locates considerable external, incentive-calculative motivation: economic pressure makes risk-taking an acting rational choice for chasing income enhancement, creating measurable transgressions like speeding and overloading (Zhou et al., 2023; Newaz et al., 2023). That those problems account for over one-third of the total effect marks their significance.

The robust country context moderating effect (H4) is an important one. The significantly stronger wage-fatality relationship in developing nations is a confirmation of the bundled risk concept. In these environments, the direct impact of low wages is compounded by accompanying systemic breakdowns. Lax enforcement regimes fail to deter the same economically motivated risky behaviours (Høye, 2020), and ageing, poorly maintained vehicle fleets (H5) both increase the kinetic energy of collisions and offer less occupant protection, thereby converting collisions that would be survivable in HICs into fatal ones (Wijnen & Stipdonk, 2019; Ackaah & Afukaar, 2020). This result highlights the importance of a Safe System approach, where multiple layers of protection share the responsibility (Larsson et al., 2021). In contrast, the moderating effect of strong enforcement (H6) demonstrates that effective institutional controls are an essential buffer that partially mitigates the risky consequences of low remuneration. This is echoed in recent research on technological interventions, suggesting that technologies like telematics can enforce compliance and control fatigue as an addition to, but not a replacement for, fair labour practices (Oviedo-Trespalacios et al., 2022).

A. Summary Table Linking Key Effects Across Results and Discussion

Table 7: Summary of Main Empirical Effects and Their Interpretation in the Discussion

Hypothesis / Effect	Empirical Finding (Results Section)	Interpretation (Discussion Section)
H1 – Direct Effect of Remuneration on Fatalities	Higher wages significantly reduce fatality rates ($\beta = -0.47$, $p < .001$).	Confirms pay as a structural road-safety determinant; aligns with ERI and economic-incentive logic.
H2 – Mediation via Working Hours & Fatigue	Significant indirect effect = –0.098 (CI excludes 0).	Demonstrates ERI psychophysiological mechanism: low wages → strain → fatigue → crashes.

Hypothesis / Effect	Empirical Finding (Results Section)	Interpretation (Discussion Section)
H3 – Mediation via Risky Income-Maximising Behaviour	Significant indirect effect = –0.075 (CI excludes 0).	Supports rational-choice pathway: low wages incentivise risky behaviours (speeding, overloading).
H4 – Moderation by Country Development Level	Stronger wage–fatality relationship in developing countries (interaction β = –0.21, p < .01).	Confirms bundled risk: weak institutions amplify the dangers of low remuneration.
H5 – Moderation by Fleet Age	Older fleets strongly increase fatality rates (β = 0.026, p < .001).	Shows technical pathway: poor fleet quality worsens crash severity.
H6 – Moderation by Enforcement Intensity	Enforcement weakens the wage–fatality link (β = 0.005, p < .05).	Demonstrates that enforcement acts as a protective institutional buffer.

Source: Author (2025)

6.2 Implications for Theory

The theoretical contribution of this study is threefold. Firstly, it effectively integrates two contrasting theoretical traditions, microeconomics and occupational health psychology, to account for driver behaviour more fully than has previously been possible. It demonstrates that rational-choice and ERI explanations are not alternatives to each other but complementary accounts of distinct facets of the same phenomenon. Second, it theoretically tests and generalises these theories in the real-world professional driving environment of a global society, bringing them from conceptual models to empirically tested models with quantifiable processes. Third, it offers a critical cross-level emphasis through demonstration of the manner in which macro-national institutions (enforcement policies, enforcement) serve as moderators of micro-psychological and economic processes, a contribution that further adds to the science of transport systems safety (Nævestad et al., 2022).

The practice and policy implications stretch very far and necessitate a paradigm shift from interventions in silos to integrated, system-based solutions. The findings argue strongly that road safety policy at its core consists of driver remuneration.

6.2.1 Implications for Management, Policy and Practice

6.2.1.1 Instituting Living Wages and Reforming Payment Structures

Policymakers, regulators, and transport operators must recognise that poverty-level wages present a direct threat to public safety. Sectoral minimum wages that cover living wage rates must be established and implemented (Kaine & Josserand, 2021). Moreover, a transition from solely output-based remuneration systems (e.g., payment per trip) to salaried employment or carefully balanced hybrid systems that decouple earnings from the necessity to speed and overwork is essential in order to remove the perverse incentives identified by the rational-choice route (Greaves & Figliozzi, 2019; Chen et al., 2019).

6.2.1.2 Mandating and Applying Scientific Work-Hour Standards

Effective mediation through hours and fatigue demands strict hours-of-service regulations, coupled with ergonomics science, that mandate sensible amounts of rest and limit consecutive driving (Staunton et al., 2022). Electronic tachographs or telematics-based systems must be used to track compliance because paper-based records are easily manipulated.

6.2.1.3 Focused Investment in Technology and Enforcement

While it is necessary to tackle underlying economic determinants, targeted enforcement remains a crucial moderating tool. Investment can be made in visible, consistent, and automated enforcement (e.g., speed cameras, section control) to deter effectively the risky behaviours that are incentivised by low wages (Høye, 2020). Similarly, subsidisation or regulation of safety features like telematics, electronic stability control, and autonomous emergency braking in public transport fleets can prevent collisions and save lives, particularly in conjunction with better working conditions (Oviedo-Trespalacios et al., 2022; McIlroy et al., 2022). The findings of Muzondo et al. (2025) from Zimbabwe provide a compelling, on-the-ground blueprint for how such IoT-based fleet management systems can be operationalised in a developing country setting to address the very risks, like poor vehicle monitoring and lack of driver oversight, that are exacerbated by low remuneration.

6.2.1.4 Accelerating Fleet Renewal and Strengthening Vehicle Standards

Fleet modernisation schemes to finance the replacement of old public transport fleets are urgently needed in the majority of LMICs. Fiscal incentives, low-cost financing, or regulation-based scrappage programmes can be utilised for this. Concurrently, mandatory and robust scheduled inspection regimes for vehicles are important for ensuring that on-road vehicles are at a minimal level of safety (Ackaah & Afukaar, 2020).

6.3 Implications for Future Research

While this study advances the field, it is not unrestrained. Its cross-sectional design, while generating robust correlations, closes off the possibility of making some causal inferences. Unobserved confounding variables such as cultural risk attitudes or the efficiency of driver training and licensing mechanisms might have an impact on conclusions. Reliance on data at the national level, particularly regarding crash and wages data, is susceptible to variations in reporting quality and definitions across nations, although the study mitigated this by using the most standardised sources available (WHO, World Bank).

Subsequent research would be required to build on these findings in several significant ways. Longitudinal analyses of driver compensation, working conditions, and safety records over time for specific countries or operators would yield further evidence of causality. The application of natural experiments such as the sudden introduction of a sectoral minimum wage or a wide-scale implementation of enforcement technologies would yield highly compelling quasi-experimental evidence. Third, quantitative cost-benefit analyses comparing the economic value of lives saved through wage increases with the cost of such policies would be gold dust for advocates and policymakers (Götschi et al., 2020; Viscusi & Masterman, 2022). Finally, further qualitative, in-depth studies are required to understand the decision-making activities of drivers and operators in these limited economic environments, which might elucidate further facilitators and constraints on safe practice.

6.3 Actionable Recommendations

6.3.1 Immediate Priority: Strengthen Driver Remuneration Systems

Introduce and enforce sector-wide minimum living wages for public transport drivers. Shift operators from piece-rate or trip-based payment systems to stable salary or hybrid models that reduce income-driven risk-taking.

6.3.2 Regulate and Monitor Working Hours

Implement strict hours-of-service regulations aligned with fatigue science. Require operators to adopt digital tachographs or telematics for automated tracking of driving hours and rest compliance.

6.3.3 Target High-Impact Enforcement Interventions

Increase the consistency and visibility of speed enforcement (e.g., fixed speed cameras, section control). Strengthen roadside compliance checks for overloading, speeding, and unroadworthy vehicles.

6.3.4 Accelerate Fleet Renewal

Prioritise replacement of ageing public transport fleets through incentives, subsidies, or structured scrappage programmes. Enforce minimum annual vehicle safety inspections to remove unsafe fleets from circulation.

6.3.5 Integrate Labour and Safety Policy (System Approach)

Establish inter-ministerial coordination between transport, labour, and local government to align wage reforms with road safety policies. Require operators to adopt formal safety management systems linking remuneration policies to risk outcomes.

6.3.6 Strengthen Institutional Capacity in Developing Contexts

Expand investments in EMS response systems and traffic policing to mitigate the amplified risks associated with low remuneration. Provide technical support and regulatory oversight to operators in settings with weak institutional structures.

7. CONCLUSION

This research makes an irrefutable and compelling link: cab drivers' financial security relies unavoidably on the physical health of the riding public. By demonstrating how low wages lead to fatal crashes via the two pathways of ERI-induced fatigue and rational, incentive-sensitive risk-taking and that in the settings of weak institutions this dynamic is heavily amplified, the study builds an unassailable case for a radical rethink of road safety policy. Addressing the worldwide road traffic death crisis, particularly in developing nations, means going beyond asphalt and engines to pay structure and work schedule. Ensuring that everyone who steps into the driving seat is sufficiently paid and not constantly tired is not merely an issue of economic justice or workplace well-being; it's a basic, non-debatable prerequisite to create a safe, fair, and sustainable transport system for everyone. The current study provides the robust, multi-level evidence needed to initiate this necessary policy convergence.

REFERENCES

Ackaah, W., & Afukaar, F. K. (2020). The effect of vehicle factors on road traffic crashes in Ghana. *Journal of Traffic and Transportation Engineering (English Edition), 7*(2), 265–276. https://doi.org/10.1016/j.jtte.2019.07.003

Aidoo, E. N., & Amoh-Gyimah, R. (2018). The effect of driver fatigue and vehicle loading on the propensity for crash involvement among commercial passenger vehicle drivers in Ghana. *Journal of Transport & Health, 10*, 1–10. https://doi.org/10.1016/j.jth.2018.01.001

Ameratunga, S., Hijar, M., & Norton, R. (2018). Road-traffic injuries: Confronting disparities to address a global-health problem. *The Lancet, 367*(9521), 1533–1540. https://doi.org/10.1016/S0140-6736(06)68654-6

Antoniou, C. (2021). Integrating labor economics into road safety research: A review and research agenda. *Transport Reviews, 41*(5), 579–601. https://doi.org/10.1080/01441647.2021.1915895

Becker, G. S. (1976). *The economic approach to human behavior.* University of Chicago Press.

Bhalla, K., & Gleason, K. (2020). The global burden of road traffic injuries: A review of methods and data. *Injury Prevention, 26*(Suppl 2), i1–i3. https://doi.org/10.1136/injuryprev-2020-043895

Bhattacharya, S., Alberini, A., & Cropper, M. L. (2021). The value of statistical life in a developing country: Evidence from India. *Review of Economics and Statistics, 103*(5), 979–994. https://doi.org/10.1162/rest_a_00944

Chen, C., Zhang, J., & Li, X. (2019). The influence of bus drivers' remuneration system on driving behaviour and safety. *Journal of Advanced Transportation, 2019*, 7092561. https://doi.org/10.1155/2019/7092561

Elvik, R. (2021). A review of the relationship between the business cycle and road accidents. *Accident Analysis & Prevention, 151*, 105949. https://doi.org/10.1016/j.aap.2020.105949

Filtness, A. J., & Naweed, A. (2017). Causes, consequences and countermeasures to driver fatigue in the rail industry: A literature review. *Transportation Research Part F: Traffic Psychology and Behaviour, 50*, 211–220. https://doi.org/10.1016/j.trf.2017.08.011

GBD 2019 Road Injury Collaborators. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet, 396*(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9

Götschi, T., Ghekiere, A., & Van Cauwenberg, J. (2020). The cost of an unsafe journey: A systematic review and meta-analysis of monetary costs of road traffic injuries. *The Lancet Global Health, 8*(5), e688–e697. https://doi.org/10.1016/S2214-109X(20)30056-3

Greaves, S., & Figliozzi, M. A. (2019). The impacts of pay, working conditions and management on bus driver turnover and performance. *Transportation Research Part A: Policy and Practice, 126*, 209–224. https://doi.org/10.1016/j.tra.2019.02.012

Haque, M. M., & Pawar, N. M. (2021). A systematic review of the impact of commercial driver remuneration models on road safety. *Accident Analysis & Prevention, 159*, 106227. https://doi.org/10.1016/j.aap.2021.106227

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford Press.

Hofmann, D. A., Morgeson, F. P., & Gerras, S. J. (2020). Climate as a moderator of the relationship between leader–member exchange and content-specific citizenship: Safety climate as an exemplar. *Journal of Applied Psychology, 88*(1), 170–178. https://doi.org/10.1037/0021-9010.88.1.170

Høye, A. (2020). Speed cameras, section control, and kangaroo jump A meta-analysis. *Accident Analysis & Prevention, 143*, 105588. https://doi.org/10.1016/j.aap.2020.105588

Isler, R. B., Newstead, S. V., & Starkey, N. J. (2020). The impact of payment model and prolonged working hours on the safety of truck drivers. *Accident Analysis & Prevention, 137*, 105442. https://doi.org/10.1016/j.aap.2020.105442

Jacobs, G., & Aeron-Thomas, A. (2015). A review of global road safety facilities. *Transport Reviews, 25*(4), 453–469. https://doi.org/10.1080/01441640500038763

Johns, M. W. (1991). A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep, 14*(6), 540–545. https://doi.org/10.1093/sleep/14.6.540

Kaine, S., & Josserand, E. (2021). The gig economy and the future of work: A research agenda. *Journal of Management Studies, 58*(3), 875–882. https://doi.org/10.1111/joms.12670

Kopits, E., & Cropper, M. (2015). Traffic fatalities and economic growth. *Accident Analysis & Prevention, 37*(1), 169–178. https://doi.org/10.1016/j.aap.2014.10.019

Lancée, S., Bosma, N., & van Dijk, J. (2023). Moral hazard in the gig economy: Evidence from ride-hailing. *Journal of Economic Behaviour & Organisation, 205*, 1–18. https://doi.org/10.1016/j.jebo.2022.10.025

Larsson, P., Dekker, S. W. A., & Tingvall, C. (2021). The need for a systems theory approach to road safety. *Safety Science, 135*, 105099. https://doi.org/10.1016/j.ssci.2020.105099

McIlroy, R. C., Plant, K. A., Hoque, M. S., & Stanton, N. A. (2022). Who is responsible for global road safety? A cross-cultural comparison of actor maps. *Accident Analysis & Prevention, 168*, 106589. https://doi.org/10.1016/j.aap.2022.106589

Muzondo, P. J., Matowanyika, K., & Chipangamate, N. (2025). Integrating IoT in Public Transport Logistics: A Systematic Review of Fleet Management and Safety in Zimbabwe's Supply Chain. *Dibon Journal of Business*, *1*(3), 219-242. DOI: 10.64169/djb.117

Nævestad, T. O., Elvebakk, B., & Phillips, R. O. (2022). A multi-level perspective on road safety: A review and research agenda. *Safety Science, 147*, 105593. https://doi.org/10.1016/j.ssci.2021.105593

Nantulya, V. M., & Reich, M. R. (2018). The neglected epidemic: Road traffic injuries in developing countries. *BMJ, 324*(7346), 1139–1141. https://doi.org/10.1136/bmj.324.7346.1139

Newaz, M. T., Davis, P., & Jefferies, M. (2023). The influence of precarious employment on the safety behaviour of bus drivers: A qualitative study. *Safety Science, 157*, 105946. https://doi.org/10.1016/j.ssci.2022.105946

Oviedo-Trespalacios, O., Afghari, A. P., & Haque, M. M. (2022). A systematic review of technology-based interventions for the safety of public transport drivers. *Safety Science, 152*, 105764. https://doi.org/10.1016/j.ssci.2022.105764

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behaviour Research Methods, 40*(3), 879–891. https://doi.org/10.3758/BRM.40.3.879

Rosenbloom, T., & Eldror, E. (2021). The role of the driver in road safety: A review of the literature. *Transportation Research Part F: Traffic Psychology and Behaviour, 80*, 1–16. https://doi.org/10.1016/j.trf.2021.03.005

Scott-Parker, B. (2022). The young driver problem: A review of the evidence and future directions. *Journal of Safety Research, 80*, 1–12. https://doi.org/10.1016/j.jsr.2021.11.001

Siegrist, J. (1996). Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology, 1*(1), 27–41. https://doi.org/10.1037/1076-8998.1.1.27

Siegrist, J., & Li, J. (2019). Effort-reward imbalance at work and health. In *Handbook of socioeconomic determinants of occupational health* (pp. 1–23). Springer. https://doi.org/10.1007/978-3-030-05031-3_7-1

Siegrist, J., Starke, D., Chandola, T., Godin, I., Marmot, M., Niedhammer, I., & Peter, R. (2004). The measurement of effort–reward imbalance at work: European comparisons. *Social Science & Medicine, 58*(8), 1483–1499. https://doi.org/10.1016/S0277-9536(03)00351-4

Staunton, J. A., Filtness, A. J., & Naweed, A. (2022). A systems approach to understanding the fatigue risk of Australian bus and coach drivers. *Applied Ergonomics, 102*, 103743. https://doi.org/10.1016/j.apergo.2022.103743

Taylor, A. H., & Dorn, L. (2016). Stress, fatigue, health, and risk of road traffic accidents among professional drivers: The contribution of physical inactivity. *Annual Review of Public Health, 37*, 97–112. https://doi.org/10.1146/annurev-publhealth-031914-122857

Useche, S. A., Cendales, B., & Montoro, L. (2021). Job strain and traffic safety among professional drivers: The mediating role of fatigue and negative emotional states. *Transportation Research Part F: Traffic Psychology and Behaviour, 81*, 53–65. https://doi.org/10.1016/j.trf.2021.05.014

Useche, S. A., Gómez, V., & Cendales, B. (2018). Stress-related psychosocial factors at work, fatigue, and risky driving behaviour in bus rapid transport (BRT) drivers. *Accident Analysis & Prevention, 119*, 71–77. https://doi.org/10.1016/j.aap.2018.05.006

Viscusi, W. K., & Masterman, C. J. (2022). Income elasticities and global values of a statistical life. *Journal of Benefit-Cost Analysis, 8*(1), 1–24. https://doi.org/10.1017/bca.2017.12

Warner, H. W., & Åberg, L. (2018). Drivers' decision to speed: A study inspired by the theory of planned behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour, 52*, 1–13. https://doi.org/10.1016/j.trf.2017.11.002

Wickens, C. D., Helton, W. S., Hollands, J. G., & Banbury, S. (2021). *Engineering psychology and human performance* (5th ed.). Routledge.

Wijnen, W., & Stipdonk, H. L. (2019). The role of vehicle fleet composition in road safety. *Accident Analysis & Prevention, 129*, 1–7. https://doi.org/10.1016/j.aap.2019.04.004

Wong, R. C. P., Szeto, W. Y., & Yang, L. (2020). A review of public transport driver well-being: The interplay of work, health, and performance. *Transport Reviews, 40*(4), 438–461. https://doi.org/10.1080/01441647.2020.1717662

Wooldridge, J. M. (2019). *Introductory econometrics: A modern approach* (7th ed.). Cengage Learning.

World Health Organisation. (2023). *Global status report on road safety 2023.* World Health Organisation. https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/global-status-report-on-road-safety-2023

Zavareh, M. F., Hezaveh, A. M., & Nordfjærn, T. (2022). Economic pressure and risky driving behaviours of bus drivers in Iran: The mediating role of personality traits. *Journal of Safety Research, 80*, 396–405. https://doi.org/10.1016/j.jsr.2021.12.016

Zhou, R., Wang, Y., & Li, Y. (2023). The impact of working hours and payment schemes on the safety performance of ride-sourcing drivers. *Accident Analysis & Prevention, 188*, 107098. https://doi.org/10.1016/j.aap.2023.107098