



Research Article

Assessment of Road Safety in Relation to Public Transport Driver Behavior in Addis Ababa, Ethiopia

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Abstract

Road traffic accidents (RTAs) present critical socio-economic, environmental, and public health challenges in developing urban regions. Global crash metrics attribute over 90% of traffic collisions in low- and middle-income nations to human error and driver behavioral patterns. In Addis Ababa, Ethiopia, public transit relies heavily on minibus taxis and city buses. Official crash metrics attribute 86% to 90% of traffic collisions in the city to driver errors and aberrant behavioral patterns. This study assesses road safety practices in relation to public transport driver behaviors in Addis Ababa using primary survey data ($N=45$) alongside 16-year historical crash trends (2002–2017). Statistical procedures—including K-Means Cluster Analysis, ANOVA, Pearson Correlation, and cross-tabulations—were executed via IBM SPSS Statistics. K-Means clustering established three distinct driver risk profiles: *Young Novices* (60.0%), *Mid-Career Drivers* (37.8%), and *Senior Outliers* (2.2%). Age ($F=66.64$, $p<0.001$) and driving experience ($F=71.44$, $p<0.001$) proved to be statistically significant predictors partitioning driver risk profiles. Younger drivers exhibited higher exposure to occupational fatigue (8+ driving hours daily), vehicle rental financial pressures, lower seatbelt compliance, and aggressive maneuvers.

Keywords

Addis Ababa, Bus Drivers, Driver Behavior, Minibus, Public Transport, Road Safety, Traffic Accidents

1. Introduction

1.1. Background of the Study

Each year, countless socioeconomic declines, health and property damages, and losses of lives are caused globally by road traffic accidents. [2, 10] According to international reports, unsafe driving behaviors—such as distracted driving, irresponsibility, ignoring traffic rules, and aggressiveness—play the primary role in traffic crashes. [5, 6] Sub-Saharan African nations like Ethiopia face an escalating burden where vulnerable road users are exposed to high risks. Although low-

and middle-income countries account for approximately 60% of registered motor vehicles globally, they suffer over 90% of road traffic fatalities. [3, 9, 14]

In Addis Ababa, rapid internal migration (over 839,000 migrants between 2016 and 2021) has accelerated urbanization, traffic density, and mobility demands. [4] Public transport, which comprises taxis, minibuses, and buses, provides essential daily transit but suffers from frequent unsafe driver behaviors including speeding, red-light running, low seatbelt compliance, and driving under the influence of alcohol. Official records indicate driver error accounts for 86% to 90% of

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crashes in Addis Ababa. [11, 15]

1.2. Statement of the Problem

Many public transport drivers in Addis Ababa operate without adequate formal training, periodic refresher courses, or proper safety awareness. [12] Recent studies indicate that nearly 49% of public transport drivers in the city exhibit risky driving behaviors characterized by anger and speeding. Weak law enforcement further reinforces these dangerous habits. While infrastructure expansions are underway, addressing the human behavioral factor remains the critical missing link in reducing preventable road traffic collisions. [13, 15, 16]

1.3. Research Objectives

General Objective: To assess road safety practices among

taxi and bus drivers in relation to their driving behaviors in Addis Ababa.

Specific Objectives:

- 1) Classify common driver behavior typologies in Addis Ababa.
- 2) Evaluate social, psychological, financial, and family issues influencing driver behavior (e.g., seatbelt usage, alcohol, workloads).
- 3) Investigate driver behaviors in relation to traffic law enforcement.
- 4) Determine the impact of traffic safety regulations and awareness/training programs.
- 5) Assess direct road environmental conditions that influence driver behavior.

2. Methodology

2.1. Research Design & Study Area

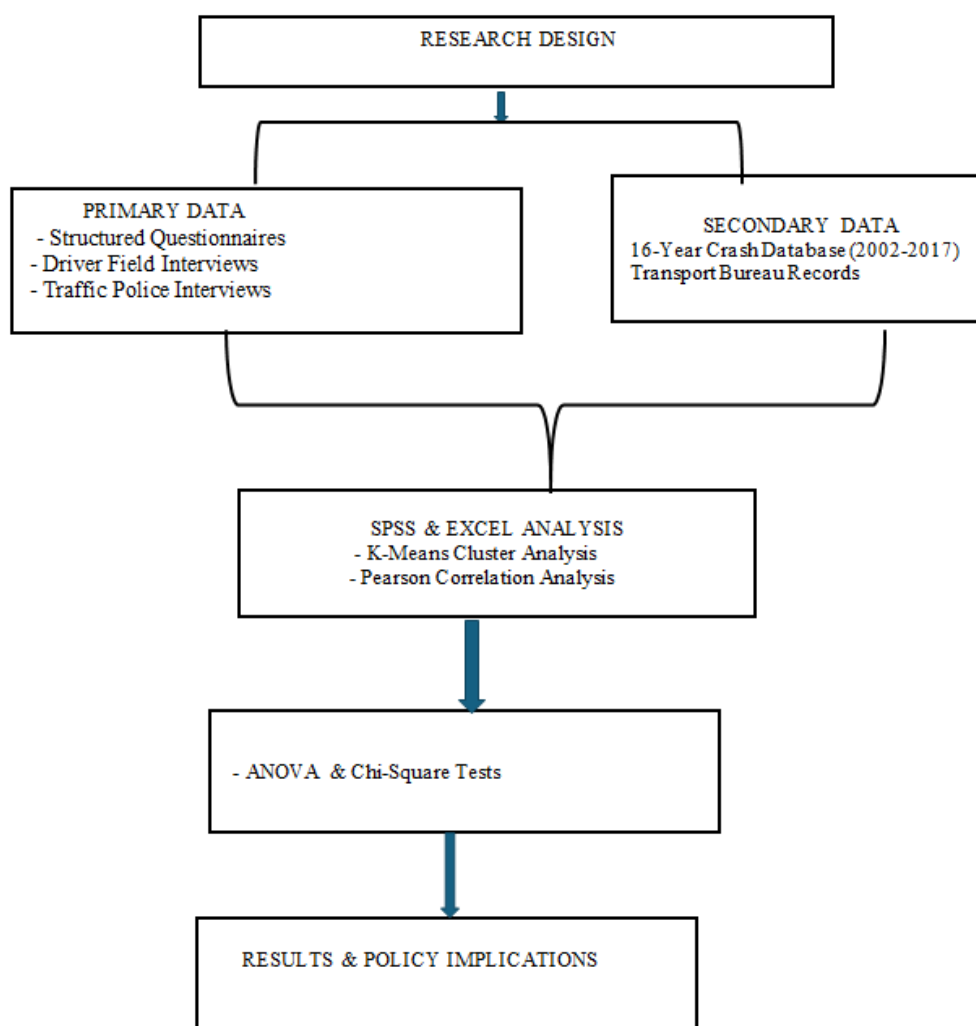


Figure 1. Metodological Flow Chart.

Study Area

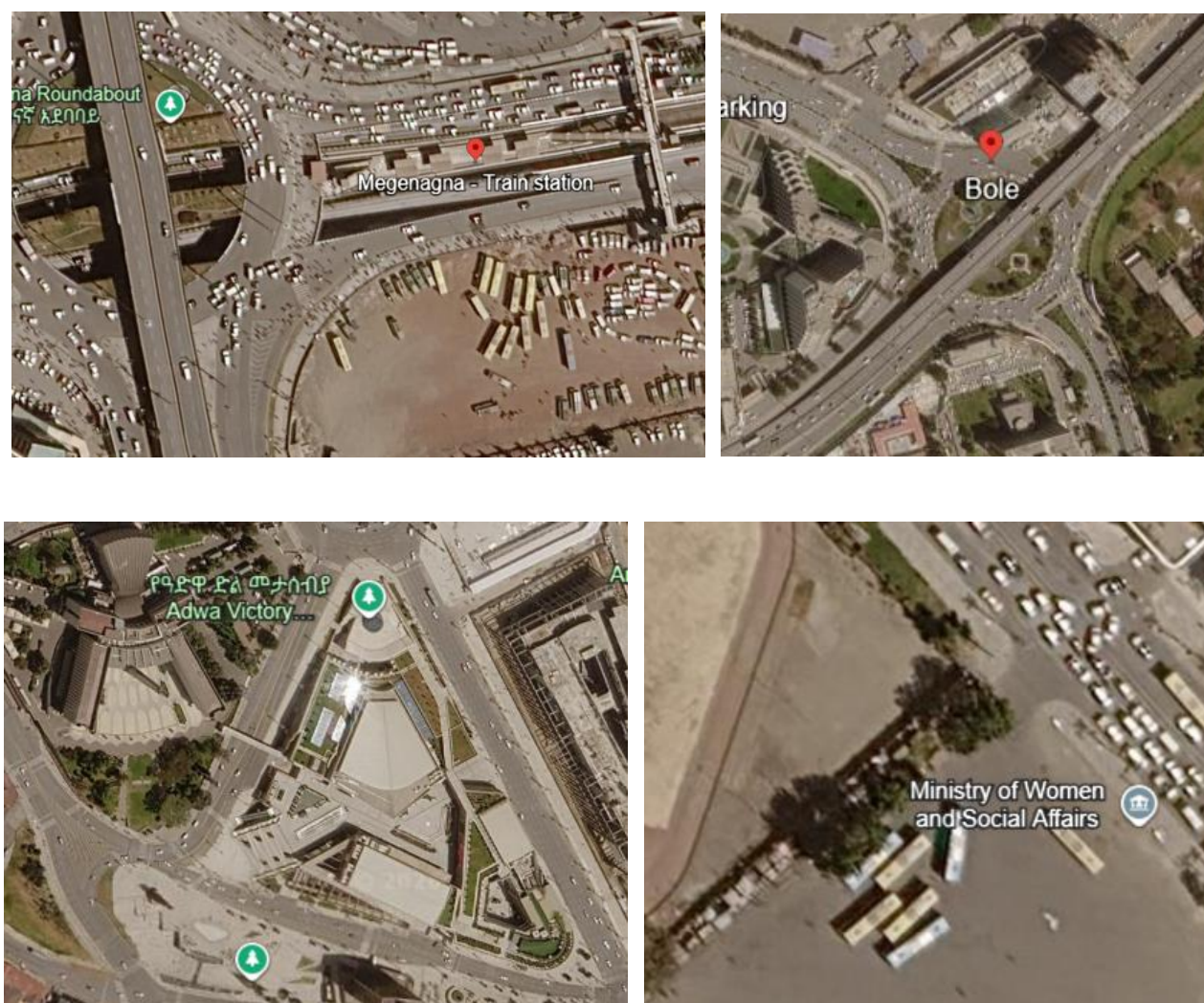


Figure 2. Study area of the research.

2.2. Sampling Technique and Data Collection

Primary Data: Structured questionnaires and semi-structured interviews were conducted with $N = 46$ commercial drivers (minibus/taxi and bus operators), traffic enforcement officers, and transport stakeholders.

Secondary Data: Historical crash records spanning 16 years (2002–2017) were extracted from the Addis Ababa Traffic Police Department and municipal authorities to evaluate temporal, demographic, and vehicle-related collision trends. [7, 8]

2.3. Statistical Analysis

Data were analyzed using IBM SPSS Statistics and MS Excel. Statistical procedures included:

K-Means Cluster Analysis:- to classify driver behavioral typologies.

Two-Way and One-Way ANOVA:- to test differences across driver clusters.

Pearson Correlation Analysis:- to evaluate linear dependencies between continuous variables.

Chi-Square (χ^2) Tests of Independence:- to measure categorical associations.

3. Results and Discussion

3.1. Driver Behavioral Typologies (K-Means Clustering)

K-Means cluster analysis ($N = 45$ valid cases) categorized public transport drivers into three distinct behavioral clusters based on Age, Driving Experience, Days Driving per Week, and Daily Driving Hours:

Table 1. Proportional Distribution of Identified Driver Clusters.

Parameter	Cluster 1 (Mid-Career)	Cluster 2 (Senior Outlier)	Cluster 3 (Young Novice)
Mean Age (Years)	47.0	76.0	31.0
Mean Driving Experience (Years)	16.0	54.0	7.0
Days Driving per Week	7.0	7.0	6.0
Daily Driving Duration (Hours)	8.0	10.0	10.0
Dominant Transit Mode	City Bus	City Bus	Minibus Taxi

Statistical Significance of Driver Profiling (ANOVA)

A Two-Way ANOVA confirmed that Age ($F=66.64$, $p<0.001$) and Driving Experience ($F=71.44$, $p<0.001$) serve as primary statistically significant variables separating the

driver clusters. Workload variables (days driving per week and daily duration) showed higher homogeneity across the public transport workforce.

Table 2. Distribution of Cluster Analysis.

Variable	Cluster Mean Square	Error Mean Square	F-Ratio	Significance (p-value)
Age	2121.630	31.838	66.639	<0.001
Driving Experience	1418.348	19.854	71.438	<0.001
Days Driving / Week	0.458	0.338	1.354	0.269
Daily Driving Hours	10.034	4.419	2.271	0.116

Correlation Analysis:- Pearson correlation analysis demonstrated a strong positive linear relationship between Age and Driving Experience ($r=0.873$, $p<0.001$). Conversely, daily

driving duration and days worked per week did not exhibit linear correlation with driver age or tenure, reflecting systemic operational demands imposed on commercial drivers regardless of age.

Experience (Years)

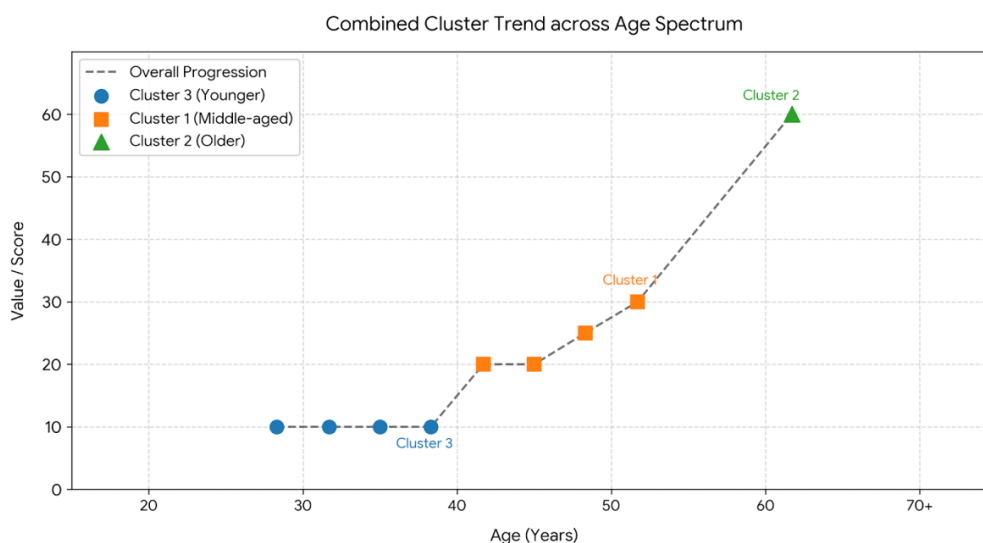
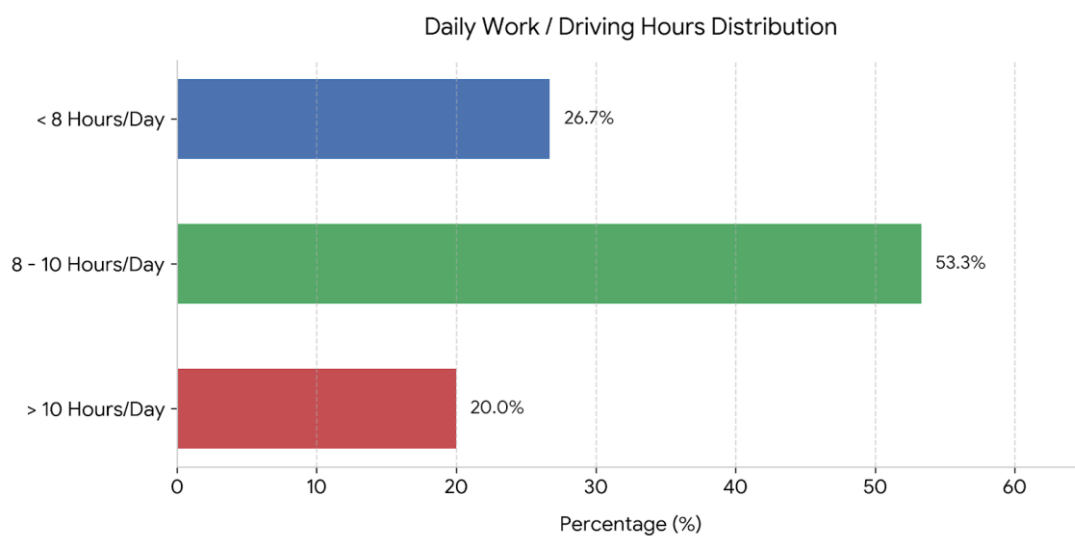
**Figure 3.** Scatter Plot Matrix Representing Linear Correlation Between Age and Experience.

Table 3. Distribution of Cluster Analysis.

Variable	Age	Driving Experience	Days Driving / Week	Daily Driving Hours
Age	1.000	0.873**	0.165	-0.245
Driving Experience	0.873**	1.000	0.142	-0.052
Days Driving / Week	0.165	0.142	1.000	-0.219
Daily Driving Hours	-0.245	-0.052	-0.219	1.000

Note: Correlation is significant at the 0.01 level (2-tailed).

Demographic & Socio-Economic Influences on Driver Risk Profiles

**Figure 4.** Daily Operational Driving Duration Breakdown (N=45).

- 1) *Vehicle Type & Fleet Share:* Minibus taxis comprise 62.2% of the sampled commercial fleet, while city buses account for 37.8%. All drivers under the age of 28 operate taxis, whereas operators over age 50 are predominantly city bus drivers.
- 2) *Fatigue Exposure:* Over 73.3% of drivers operate their vehicles for 8 to 12+ hours daily (Figure 3). Prolonged daily exposure induces physical fatigue, mental stress, and heightened aggressiveness in congested corridors.
- 3) *Education Attainment:* 51.1% of operators hold Grade 10 secondary education, 17.8% completed Grade 12,

13.3% hold a diploma, and 6.7% hold a university degree. Higher formal qualifications occur almost exclusively among younger drivers (<40 years).

- 4) *Economic & Ownership Pressures:* 40.0% of drivers operate vehicles under daily rental agreements, and 37.8% operate fleet cars under commission or family contracts. Rental contract structures impose fixed daily quotas, forcing operators to engage in speed competition, aggressive lane changing, and passenger overloading to achieve financial margins.

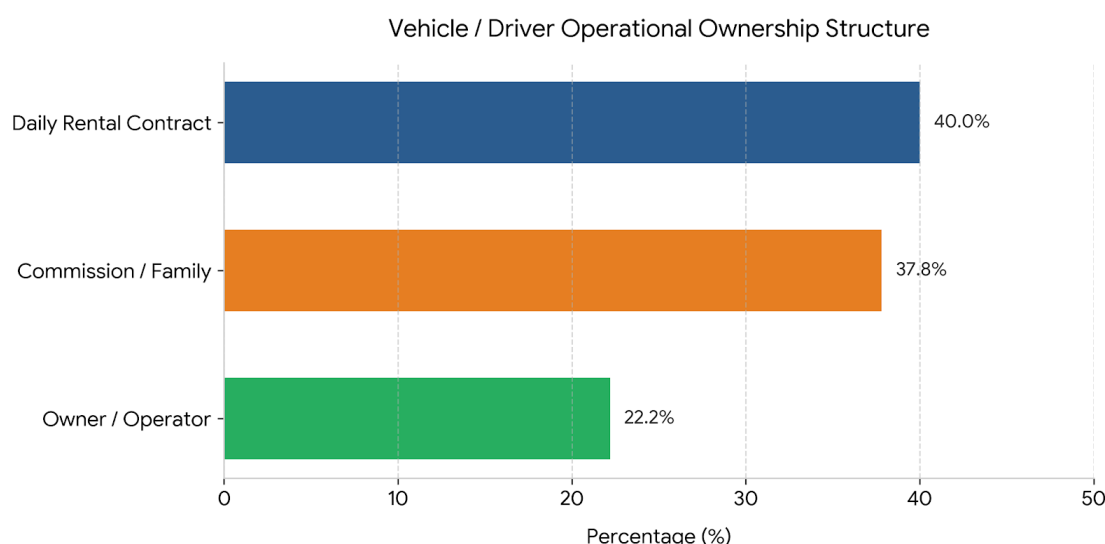


Figure 5. Vehicle Ownership and Economic Contract Structure.

Cluster 3 (Young Novices): Represents the dominant operational demographic (60.0%). These drivers exhibit the highest daily driving workload (approx 9.6 hours/day) combined with lower driving experience (approx 6.7 years).

Cluster Separation: ANOVA confirms that Age ($F = 31.84$, $p < 0.001$) and Driving Experience ($F = 19.85$, $p < 0.001$) serve as the statistically significant dimensions partitioning driver risk groups.

3.2. Correlation and Socioeconomic Analysis

Pearson correlation revealed a strong, statistically significant positive relationship between driver age and driving experience ($r = 0.873$, $p < 0.001$). However, daily exposure hours showed no significant linear correlation with age or experience, proving that prolonged work hours are an industry-wide commercial demand.

Summary of Key correlation findings

Driver age=, $r=0.873$ = Experience

$P(<0.001)$

Driver age=, $r=-0.245$ =daily hours

$(P=0.105)$

Cross-tabulation and Chi-Square analysis highlighted key demographic patterns:

Vehicle Type: Minibus/taxi driving is dominated by younger operators (< 28 years old), whereas bus drivers are predominantly older (> 50 years old).

Educational Attainment: 51.1% ($n = 23$) completed Grade 10, 17.8% completed Grade 12, 13.3% held a diploma, and 6.7% held a degree. Educational level showed a significant association with driver age ($\chi^2 = 136.034$, $p = 0.022$).

Gender: Males accounted for 91.1% of the survey sample and 95%-98% of historical police crash records, reflecting extreme commercial driving imbalance.

3.3. Financial, Environmental, and Enforcement Drivers

Financial Pressure & Vehicle Rental: Most minibus operators do not own their vehicles. To meet daily owner-rental quotas and generate personal income, drivers frequently engage in aggressive driving, speeding, tailgating, and passenger overloading.

Fatigue & Workload: Operating 6 to 7 days a week for 8 to 12 hours daily induces severe fatigue, sluggish reaction times, and emotional exhaustion, directly impeding safe driving decisions.

Historical Crash Trends (2002–2017): [7]

Drivers aged 18–30 years contributed to the highest proportion of fatal collisions.

Drivers with 0–5 years of experience committed the majority of severe crash-causing infractions.

Public transport vehicle categories Public 1 and Public 2 consistently accounted for higher collision volumes than specialized long-distance options.

4. Conclusion and Recommendations

4.1. Conclusion

This study demonstrates that human behavioral factors—compounded by commercial financial pressures, extended daily driving schedules, and occupational fatigue—are the primary catalysts for road traffic accidents in Addis Ababa. Younger commercial taxi drivers (under 30 years old) operating under daily vehicle-rental quotas represent the highest-risk group on the city's road network. Traditional infrastructure improvements alone will not solve Addis Ababa's road safety crisis without direct, targeted intervention in driver behavior,

licensing rigor, and commercial fleet management. [1]

4.2. Recommendations

Mandatory Refresher & Defensive Driving Courses: Establish mandatory, periodic defensive driving and fatigue management certification programs for public transport drivers prior to commercial license renewal.

Work Hour Regulations & Fleet Oversight: Enforce strict maximum daily driving limits (e.g., maximum 8 hours/day) and mandate shift rotations to prevent driver fatigue among taxi and minibus operators.

Targeted Law Enforcement: Deploy traffic police and speed enforcement checks at identified high-density corridors and hubs (Megenagna, Mexico, Bole, Piassa) focusing on seat-belt compliance, red-light violations, and lane discipline.

Restructuring Commercial Rental Contracts: Policy intervention is needed to address predatory daily rental quota systems, shifting towards structured wages or regulated operator contracts to reduce drivers' financial incentive for reckless driving.

Abbreviations

AATMA	Addis Ababa Traffic Management Agency
AHP	Analytical Hierarchy Process
ATES	Automated Traffic Enforcement Systems
CSA	Central Statistical Agency
DBQ	Driver Behavior Questionnaire
EDA	Exploratory Data Analysis
ERA	Ethiopian Road Authority
GDP	Gross National Product
GNP	Gross National Product
IOM	International Organization of Migration
MKD	Mapping Knowledge Domain
PCM	Pair wise Comparison Matrix
RDB	Risky Driving Behavior
RTAs	Road Traffic Accident
RTI	Road Traffic Injuries
SPSS	Statistical Package for Social Science

Author Contributions

Zebider Nega: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflict of Interest

The author declares no conflicts of interest.

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