# MODEL-BASED RELATIONSHIP BETWEEN RISK-TAKING BEHAVIOR OF MOTORCYCLISTS AND ITS CORRESPONDING FACTORS. A CASE STUDY AT SRINAGAR HIGHWAY ISLAMABAD AFTER MAKING IT SIGNAL-FREE ALIGNMENT

***[a] Haseeb Ahsan*, [b] Syed Bilal Ahmed Zaidi***

a: Department of Civil Engineering, UET, Taxila, Pakistan, ahsanhaseeb829@gmail.com
b: Department of Civil Engineering, UET, Taxila, Pakistan, bilal.zaidi@uettaxila.edu.pk.
* Haseeb Ahsan: Email ID: ahsanhaseeb829@gmail.com

**Abstract-** This study examines the factors affecting the risk-taking behavior (RTB) of motorcyclists on the Srinagar Highway in Islamabad. The reason for studying this specific area is that an abrupt change in driving behavior was observed, especially in motorcyclists. Instead of taking U-Turns, illegal crossing through the median and the use of the wrong side of the road were observed after the provision of protected U-Turns on the highway. Questionnaire-based data was collected from 350 respondents in the vicinity of the targeted area. The SPSS software was used for data screening to handle missing data. This study uses partial least squares structural equation Modelling to develop a relationship between one endogenous variable (RTB) and eight exogenous variables (demographics, arrival on time, Stress, Road Characteristics, Peer influence, special pathway for bikes, traffic rules violations, and vehicle conditions). The findings of the study show that road characteristics, peer influence, and arrival time are the most significant factors that influence the risk-taking behavior of a motorcyclist. It is suggested that instead of at-grade U-turns at the Srinagar Highway, there should be an overpass or underpass, according to the requirement. If this solution is not possible, a steel footbridge must be provided where U-Turns have been provided so that motorcyclists can cross the road easily instead of taking U-Turns. To validate the results, multinomial logistic regression was used with SPSS software. The results showed that the results obtained using the structural model were satisfactory and reliable.

***Keywords-*** Endogenous & Exogenous variables, Footbridge, Multinomial logistic regression, Protected U-Turns, PLS-Structure Equation Modeling.

## 1 Introduction

Motorcycles have become a vital mode of mobility in middle-income countries and make up a significant portion of the fleet of vehicles as one entity. Although they are widely used, motorbikes still have serious safety dangers to both riders and other road users due to their high prevalence on the road and the risky driving habits of motorcycle drivers. Therefore, it is essential to identify and address the underlying factors that contribute to risky motorbike riding behaviors to reduce the incidence of accidents and promote safer travel [1]. Identifying the specific types of traffic errors and violations that contribute to motorcycle accidents is an important step in developing effective interventions to reduce the incidence of these accidents and to promote safer roadways for all users [2]. Among various causes of road accidents, two-wheeler riding is a significant contributor to injuries sustained by teenagers. This group is particularly vulnerable, and understanding the factors that contribute to these injuries is crucial for developing effective preventive strategies [3].

The Capital Development Authority (CDA) implemented measures to transform the Srinagar Highway in Islamabad into a signal-free corridor. This has been achieved through the strategic integration of U-turns, despite opposition from the majority of stakeholders. The primary objective of this initiative is to alleviate traffic congestion and enhance overall traffic movement within Islamabad. The integration of U-Turns at the Srinagar Highway in Islamabad encountered resistance from Islamabad citizens. They argued that these U-Turns have led to an increase in travel duration and unnecessary fuel consumption, thereby incurring additional costs. After making the Srinagar highway signal-free alignment traffic rule violation, an increased number of accidents have been observed. Most motorcyclists used the wrong practice to cross the road through the median. They also used the wrong way to reach their destination.

It is important to study the behavior of drivers to investigate the factors that influence their behavior. These can be road characteristics, such as high-speed moving vehicles, and most motorcyclists face difficulty in taking U-Turns. There can also be a factor of increased distance for drivers to take U-Turns. Due to the increase in fuel prices, motorcyclists try to use short paths to reach their destination although it is dangerous for their life, they take a risk. So, it is important to investigate the main cause of this risky driving behavior of motorcyclists. The act of vehicles making turns and changing directions at median U-turn openings disrupts traffic flow, resulting in reduced driving speeds and diminished road capacity. Considering the distinctive physical characteristics and driving behaviors observed in such areas, the impact of median U-turns on capacity is an intriguing subject for investigation [4]. According to estimates, driver behavior has been identified as a contributing factor in approximately 90% of traffic accidents. This means that the way drivers behave on the road, including their actions, decisions, and adherence to traffic laws, plays a significant role in the occurrence of most accidents. These findings highlight the importance of promoting responsible and safe driving practices to reduce the risk of collisions and improve overall road safety [5]. A study has found that three factors affect risk-taking behavior in motorcycle riders: peer influence, confidence level, and past crash involvement. Peer influence is the most significant factor, with people who are encouraged by their friends to take risks being more likely to do so. People who are more confident in their riding skills are also more likely to take risks. Finally, people who have been in a crash in the past are more likely to take risks in the future.[6]

Our study aims to use SEM to analyze the risk-taking behavior of a motorbike user [7] stated that Structural Equation Modeling (SEM) is preferred over first-generation data analysis techniques like ANOVA and linear regression due to its ability to simultaneously analyze multiple relationships among variables, incorporate latent variables for a comprehensive understanding, asses, and account for measurement error in observed variables, evaluate model fit to assess the goodness-of-fit of the proposed model, and test complex hypotheses, including direct and indirect effects, mediation, moderation, and latent variable interactions.

This study demonstrates the previously unexplored model-based relationship between risk-taking behavior of motorcyclists and significant factors, including role violation driven by time constraints, U-turn avoidance due to road characteristics, and the influence of peer dynamics on decision-making. By understanding these relationships, policymakers and safety advocates can develop targeted interventions and strategies to reduce risk-taking behaviors among motorcyclists and promote safer riding practices. Further research in this field will contribute to the ongoing efforts to enhance road safety and protect the well-being of motorcyclists. By identifying and analyzing the complex interplay between human behavior, environmental factors, and social dynamics, this research contributes to a deeper understanding of the factors influencing road safety. The insights gained from this analysis can inform the development of road safety interventions and policies that effectively target the identified factors. By addressing these factors comprehensively, we can work towards reducing the number of road accidents, injuries, and fatalities, creating safer road environments for all.

This study investigates the relationship between risk-taking behavior of motorcyclists and significant factors, such as role violation driven by time constraints, U-turn avoidance due to road characteristics, and the influence of peer dynamics on decision-making. By understanding these relationships, policymakers and safety professionals can develop targeted interventions and strategies to reduce risk-taking behaviors among motorcyclists and promote safer riding practices.

Further research in this field will contribute to the ongoing efforts to enhance road safety and protect the well-being of motorcyclists. By identifying and analyzing the complex interplay between human behavior, environmental factors, and social dynamics, this research contributes to a deeper understanding of the factors influencing road safety. The insights gained from this analysis can inform the development of road safety interventions and policies that effectively target the identified factors.

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## 2 Research Methodology

This section outlines the steps involved in the data collection and analysis. key aspects, such as the selection of a suitable site for data collection, development of research hypotheses, preparation and validation of a questionnaire, distribution of the questionnaire, calculation of sample size, data screening, and development of the SEM model for data analysis has been discussed in this section. A clear understanding of the methodology is essential to evaluate the credibility and accuracy of the study. The methodology flow chart is shown below in Figure 1.

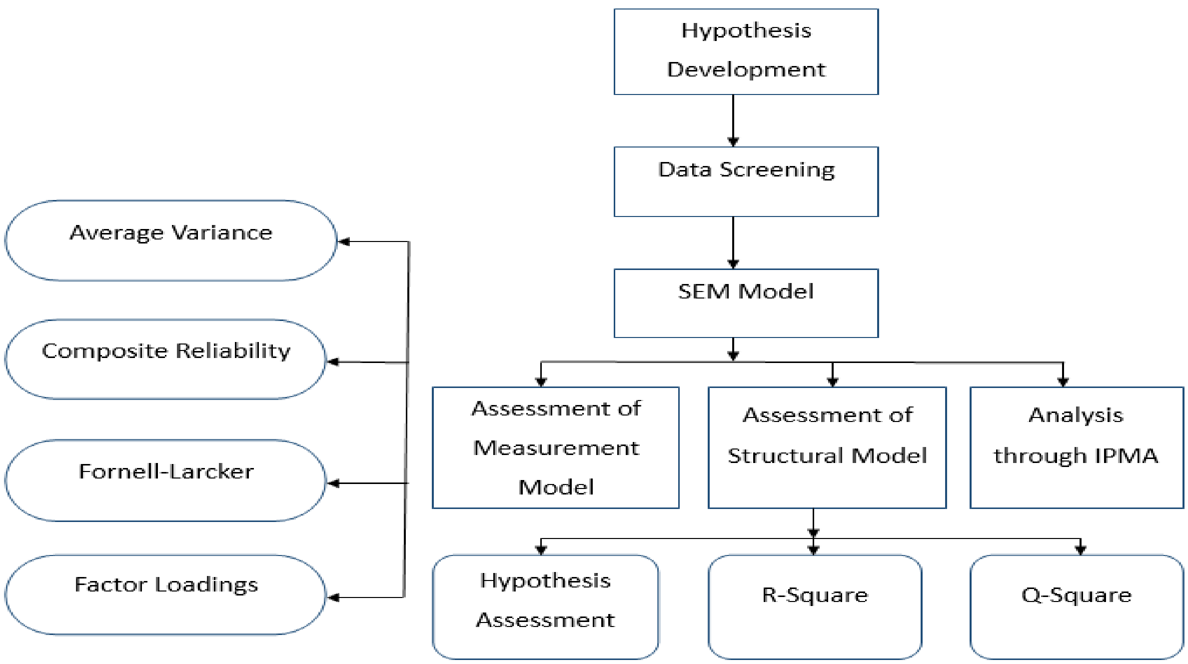


*Figure 1: Methodology flow chart*

In the methodology section, the study commences by formulating hypotheses to explore the influence of various exogenous variables on risk-taking behavior. The study focuses on eight specific exogenous variables, namely demographics, stress, arriving on time, road characteristics, traffic rule violations, peer influence, dedicated pathways for bikers, and vehicle condition. These variables are identified as potential factors that may affect an individual's propensity for taking risks. To collect the necessary data, a questionnaire was developed, comprising a set of structured questions tailored to the study's objectives. A diverse group of respondents provided a total of 350 responses, ensuring a wide range of perspectives. Subsequently, the collected data underwent screening and analysis using SPSS software, a widely-used tool for statistical analysis in the social sciences. This step ensured the reliability and validity of the data, facilitating a comprehensive examination of the relationships between the exogenous variables and risk-taking behavior. The analysis in this study utilized Smart PLS-4, a software tool for structural equation modeling (SEM). With Smart PLS-4, a structural equation model was constructed, consisting of a measurement model and a structural model. The measurement model was employed to assess the reliability and validity of the measured variables, ensuring the consistency and accuracy of the measurements. On the other hand, the structural model examined the relationships between the exogenous variables and risk-taking behavior, exploring how these variables influenced risk-taking. To evaluate the models' appropriateness for the study, expert-set criteria were utilized, providing a thorough assessment of their suitability and enhancing the overall validity of the analysis

# 3 Data Analysis and Results

Data screening is an important step in data analysis. It includes handling missing data and outliers etc. There are different methods to handle missing data, according to our data series mean method was suitable to handle missing data. SPSS software was used to employ this method. After handling missing values, Smart-PLS Software was used to analyze the data. A structural equation model was developed using data. This model consists of two inner models, Measurement Model, and Structural Model. The structural equation model is briefly described in Figure 2 given below.

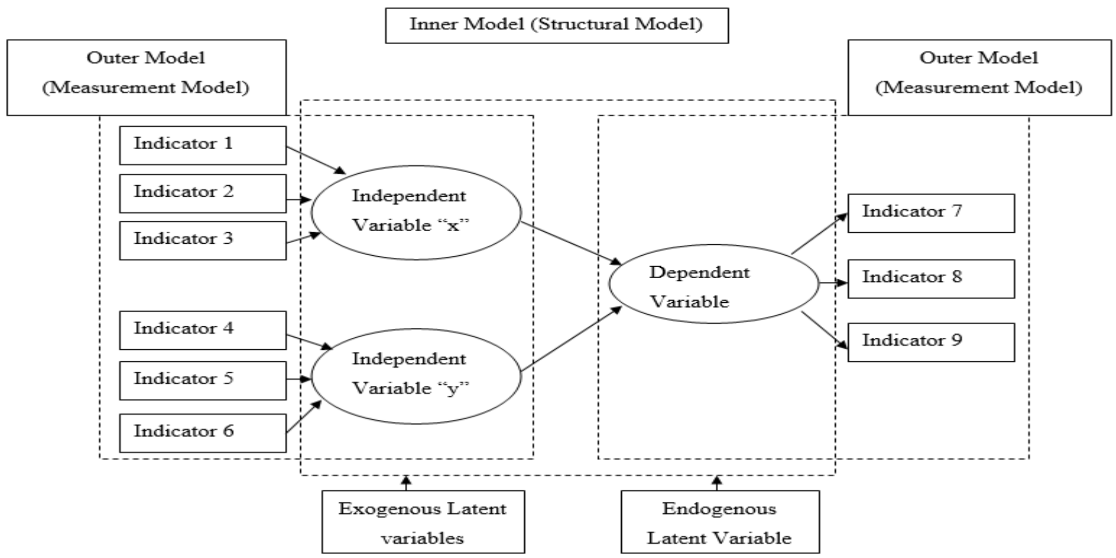


*Figure 2: Structural Equation Model*

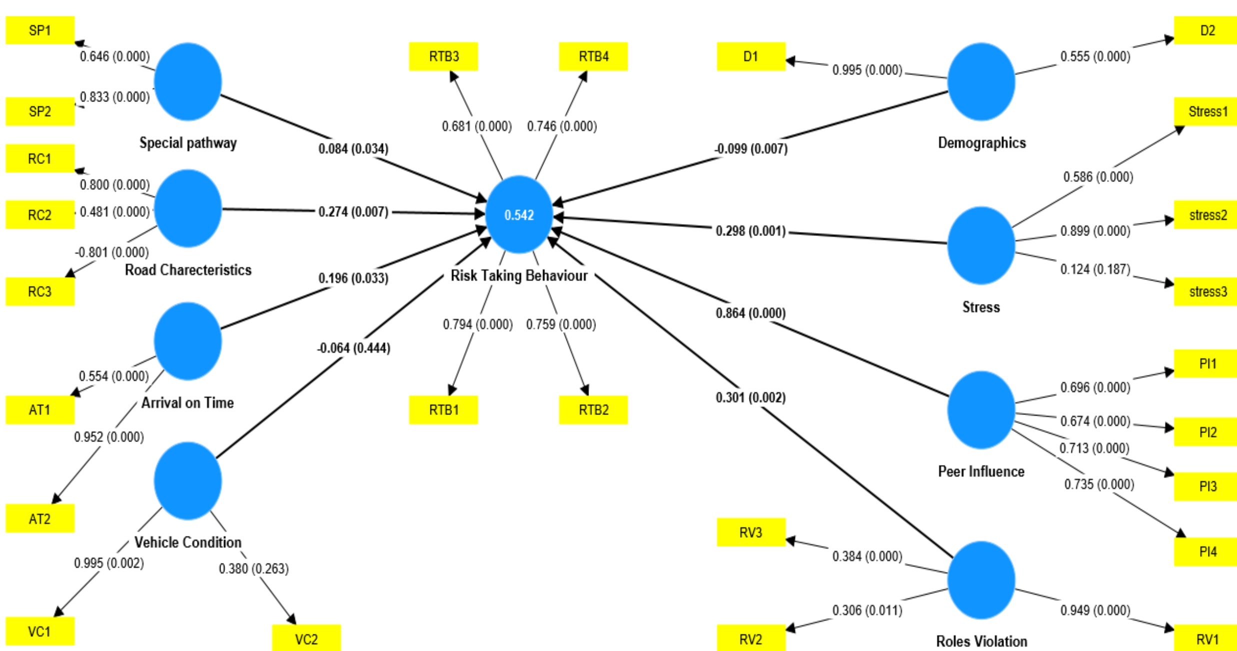


*Figure 3: Structural Model Developed in Smart- PLS Software*

The visual representation of the SEM model obtained from the Smart PLS software given in Figure 3 provides an overview of the relationships between exogenous and endogenous variables, along with their constructs. This representation serves as a valuable reference for understanding the conceptual framework of this study. In the first step measurement model is evaluated using different criteria set by experts. Such as average variance extracted value, composite reliability value, Fornell Larcker criteria, etc. The Average Variance Extracted (AVE) is a statistical measure used to assess the convergent validity of constructs in a research study. Generally, an AVE value greater than 0.5 is considered an acceptable threshold for establishing convergent validity. Based on the results presented by [8], the AVE values for constructs D, AT, RC, SP, and VC are reported as 0.649, 0.621, 0.504, 0.556, and 0.567, respectively. Following [9], a CR value above 0.708 was considered satisfactory. Therefore, we compared the CR values of the constructs with this threshold value. Upon evaluation, we found that constructs D (demographics), AT (arrival on time), PI (Peer Influence), and SP (a Special Pathway for Motorcyclists) had CR values above the satisfactory threshold. The CR values for these constructs are 0.774, 0.760, 0.798, and 0.711, respectively. However, constructs S (stress), RC (Road Characteristics), traffic rule violations (TRV), and vehicle conditions (VC) had CR values below the satisfactory threshold. The CR values for these constructs are 0.586, 0.163, 0.642, and 0.686, respectively. All values discussed above for average variance extracted and composite reliability are given in Table 1. Based on these findings, we can conclude that constructs D, AT, PI, and SP in the reflective measurement model demonstrated satisfactory internal consistency, as their CR values exceeded the threshold. However, constructs S, RC, TRV, and VC exhibited weaker internal consistency as their CR values fell below the threshold. These results provide insight into the reliability of the reflective measurement model. Constructs with satisfactory internal consistency can be considered reliable, whereas those with weaker internal consistency may require further investigation or refinement. The Fornell–Larcker criterion was used to assess the discriminant validity of the model. The Fornell-Larcker criterion provides guidelines for evaluating the discriminant validity of constructs in a research model. According to this criterion, the diagonal value of each construct should be larger than all the values in the corresponding column of the correlation matrix [10]. Discriminant validity was examined by assessing the AVE squared inter-correlation between constructs, following the guidelines established by [11] and [12]. Values for Discriminant Validity are given in Table 2.

*Table 1: Assessment of Measurement Model Through CR & AVE Values*

| **Variables** | **Composite Reliability Value** | **Average Variance Extracted value** |
|---|---|---|
| Demographics | 0.774 | 0.649 |
| Stress | 0.586 | 0.389 |
| Arriving on time | 0.760 | 0.621 |
| Road Characteristics | 0.163 | 0.504 |
| Peer Influence | 0.798 | 0.497 |
| Special Pathway for Bikers | 0.711 | 0.556 |
| Implementation of traffic rules | 0.642 | 0.402 |
| Vehicle Condition | 0.686 | 0.567 |

*Table 2: Fornell-Larcker Criteria*

| **Latent Constructs** | **AT** | **D** | **PI** | **RTB** | **RC** | **RV** | **SP** | **S** | **VC** |
|---|---|---|---|---|---|---|---|---|---|
| AT | **0.788** | | | | | | | | |
| D | -0.089 | **0.808** | | | | | | | |
| PI | 0.398 | -0.202 | **0.705** | | | | | | |
| RTB | 0.404 | -0.288 | 0.649 | **0.746** | | | | | |
| RC | 0.208 | -0.209 | 0.359 | 0.425 | **0.710** | | | | |
| RV | 0.325 | -0.126 | 0.466 | 0.446 | 0.356 | **0.634** | | | |
| SP | 0.156 | -0.209 | 0.171 | 0.265 | 0.243 | 0.160 | **0.746** | | |
| S | 0.400 | -0.238 | 0.367 | 0.453 | 0.354 | 0.290 | 0.172 | **0.624** | |
| VC | 0.184 | 0.105 | 0.175 | 0.110 | 0.065 | 0.158 | 0.126 | 0.133 | **0.753** |

the assessment of the structural model revealed that the combination of the eight factors explained a substantial portion of the variance in RTB, with an $R^2$ value of 54.2% shown in Figure 3. Additionally, the results from Table 3 confirm that all factors, except the vehicle condition, significantly contribute to explaining RTB.

*Table 3: Assessment of structural model through p-value and t value*

| Hypothesis | Proposed Relationship | t-statistics >1.96 | p-value<0.05 | Selection/Rejection |
|---|---|---|---|---|
| H1 | Demographics → RTB | 2.61 | 0.009 | Supported |
| H2 | Stress → RTB | 3.31 | 0.001 | Supported |
| H3 | Arriving on time → RTB | 2.05 | 0.040 | Supported |
| H4 | Road Characteristics → RTB | 5.71 | 0.007 | Supported |
| H5 | Vehicle Condition → RTB | 0.70 | 0.482 | Not Supported |
| H6 | Special Pathway → RTB | 2.18 | 0.029 | Supported |
| H7 | Peer Influence → RTB | 10.18 | 0.00 | Supported |
| H8 | Traffic Rules Violation → RTB | 2.19 | 0.029 | Supported |

A hypothesis was developed to test the relationship between eight factors and risk-taking behavior in motorcycle riders. The hypothesis was that the eight factors would have a significant impact on risk-taking behavior, as measured by a p-value less than 0.05 and a t-value greater than 1.96.

The results of the hypothesis testing showed that seven of the eight factors were supported. The factor of vehicle condition was not supported, as the p-value of 0.482 was greater than the threshold value and the t-value of 0.70 was less than the threshold value.

The results of the hypothesis testing suggest that the seven factors of past crash involvement, confidence level, peer influence, age, gender, riding experience, and helmet use are all significant predictors of risk-taking behavior in motorcycle riders. The factor of vehicle condition was not found to be a significant predictor of risk-taking behavior.

The results of this study have implications for the development of interventions to reduce risk-taking behavior in motorcycle riders. Interventions should focus on the seven factors that were found to be significant predictors of risk-taking behavior. For example, interventions could educate riders about the risks of taking risks, provide training on how to ride safely, and encourage riders to find friends who do not encourage risky behavior.

*Table 4: Results from MLR technique for assessment of model fitness.*

| Model Fitting Information | | | | |
|---|---|---|---|---|
| | | | | |
| | Model Fitting Criteria | Likelihood Ratio Tests | | |
| Model | -2 Log Likelihood | Chi-Square | df | Sig. |
| Intercept Only | 744.976 | | | |
| Final | 475.284 | 269.691 | 54 | .000 |
| **Pseudo R-Square** | | | | |
| Cox and Snell | .541 | | | |
| Nagelkerke | .612 | | | |
| McFadden | .361 | | | |

### *3.1 Use of MLR for Assessment of Model*

To evaluate the fitness of our structural model, we conducted a model fitness assessment using the multinomial logistic regression (MLR) technique in SPSS. The results of the MLR analysis provided important information for evaluating the overall fit of our structural model and its ability to explain and predict the categorical outcome variables under investigation. These findings contribute to the overall assessment of model fitness and strengthen the validity of our research findings.

A p-value of less than .05 indicates a satisfactory model fit. The goodness of fit can be assessed using the Pearson and Deviance chi-square tests, with p-values greater than .05 suggesting a better fit. Likelihood ratio tests were used to ascertain the contribution of each independent variable to the dependent variable, with p-values lower than .05 shown in Table 4, indicating a significant contribution [13]. The pseudo-$R^2$ values shown in Table 4 obtained for this analysis were as follows: Cox and Snell, .541; Nagelkerke, .612; and McFadden, .361. In the case of McFadden's pseudo $R^2$, values ranging from .2 to .4 are typically considered "highly satisfactory. Cox and Snell pseudo-$R^2$, which is also derived from log-likelihoods and accounts for the sample size, cannot reach a maximum value of 1. However, Nagelkerke pseudo-$R^2$ adjusts the Cox and Snell measure to attain a value of 1 [14]. In SEM, the most commonly used method for estimation in practical applications is the minimum likelihood (ML), as highlighted by [15]. By employing ML estimation, the researchers aimed to determine the best-fitting model that would closely align the observed sample data with the expected covariances implied by the model.

## 4 Conclusions & Recommendations

The findings of the study highlight factors that influence risk-taking behavior:

1. Peer influence, Stress, Road characteristics, and arrival on time play important role in determining the RTB of motorcyclists.
2. From all of these influencing factors, peer influence has the most significant effect on RTB with an importance value of 0.895.
3. Motorcyclists who are encouraged by their friends to engage in overspeeding are at high risk of accidents.
4. The use of illegal road paths to reach the destination is also a significant factor that affects RTB.
5. Three U-turns have been provided at different sections of the Srinagar Highway. So, the provision of steel footbridges where U-turns have been provided can be an economical solution to minimize accident rates and they have to cover less distance comparatively.
6. It is important to educate about stress-related issues. There is a need to encourage riders to make their decision on their behalf rather than the person sitting with the driver. Both the drive and passenger must be educated about the risk and potential consequences of impaired and distracted driving behavior.

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