Detecting Stress Levels in Motorcycle Riders Using Trip and Behavioral Data

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***Abstract*—Motorcyclists face unique physical and mental demands during daily commuting, yet the specific determinants of rider stress remain under-researched compared to car drivers. This study utilizes a personal informatics approach to investigate the impact of trip characteristics and psychological states on rider stress levels. A dataset of 224 motorcycle trips was collected from a single subject between December 2025 and February 2026, recording variables including trip duration, number of stops, speed, distance, and the binary status of "being in a hurry." Statistical analyses, including Pearson correlations, independent samples t-tests, and Two-Way ANOVA, were performed to identify significant stressors. The results indicate that the psychological state of rushing is the dominant predictor of stress, increasing mean stress levels from 3.43 (baseline) to 7.98 ($p < 0.001$, Cohen's $d = 3.54$). Furthermore, the number of physical interruptions (stops) showed a strong positive correlation with stress ($r = 0.53$), significantly outweighing the effect of trip duration ($r = 0.47$). Contrary to common assumptions, average speed and trip distance showed negligible correlations with rider stress. These findings suggest that commuter stress is driven primarily by time pressure and route fragmentation rather than physical distance, highlighting the importance of time management and route flow over duration minimization.**

***Index Terms*—Commuter Stress, Driver Behavior, Motorcycle Safety, Personal Informatics, Statistical Analysis, Trip Characteristics.**

I. Introduction

Motorcycle riding is a cognitively and physically demanding activity that requires constant attention, situational awareness, and rapid decision-making. Riders' stress and fatigue levels can significantly influence their performance, reaction time, and overall safety. High stress has been shown to impair judgment and increase the likelihood of accidents, highlighting the importance of understanding these emotional states in real-world riding contexts [1], [2].

The analysis of personal and trip-based behavioral data provides a practical approach to investigating rider stress. Objective trip metrics such as trip duration, number of stops, average speed, and contextual variables such as being "in a hurry", combined with self-reported stress or fatigue, enable detailed insights into how real-life riding conditions affect emotional states [3], [4]. Understanding these relationships can inform safer riding practices and predictive tools for rider well-being.

Prior research in transportation psychology has demonstrated the effects of workload and time pressure on driver stress, yet most studies have focused on car drivers or controlled simulations [1], [2]. Similarly, while some studies have examined risk factors and emotional states among motorcyclists, few have integrated multiple trip-based variables with self-reported stress to examine interaction effects or situational influences [3], [4]. This gap highlights the need for research that combines objective trip data with subjective measures in real-world motorcycle riding.

The objective of this study is to investigate how trip characteristics and situational factors influence rider stress and fatigue. Specifically, the study evaluates two hypotheses, which serve as its guiding research questions:

1) Interaction of Trip Duration and Number of Stops: Is there a significant interaction effect between trip duration and number of stops on rider stress or fatigue?
2) Effect of Being "In a Hurry": Does being "in a hurry" have a significant effect on rider stress or fatigue?

By addressing these questions, this research aims to provide a clearer understanding of the behavioral and contextual determinants of stress in motorcycle riders, establishing a foundation for future interventions and predictive modeling in rider safety and well-being.

II. Literature Review

A. Previous Studies on Stress and Behavioral Metrics

Prior research in transportation and behavioral science has examined the relationships between emotional states (such as stress and fatigue) and driving or riding behavior. Fernández-Medina and Reed investigated the impact of Cognitive Behavioural Therapy (CBT) interventions on rider stress traits, including anxiety and anger, showing that psychological interventions can reduce stress responses among motorcyclists [1]. Young et al. studied the effects of time pressure on driver performance and physiological responses using a driving simulator, demonstrating that increased time pressure elevates stress and impairs performance [2]. Anggraini et al. analyzed real-world riding behaviors among Indonesian motorcyclists, identifying risk factors associated with stress-related riding patterns [3]. Additionally, St-Louis et al. explored the relationship between trip duration and mood during travel, suggesting that longer trips may negatively affect emotional states and increase fatigue [4].

B. Data Collection and Analysis Methods

Previous studies employed a variety of data collection and analysis techniques. Fernández-Medina and Reed [1] used psychological surveys and CBT assessments to measure stress and emotional regulation. Young et al. [2] relied on simulated driving experiments combined with physiological measurements such as heart rate and reaction time. Anggraini et al. [3] collected self-reported questionnaires and observed riding behaviors to assess stress-related factors, while St-Louis et al. [4] used travel diaries paired with mood ratings to analyze the effects of trip duration. Other researchers have integrated objective metrics, including sleep quality, trip timing, and cognitive load, with subjective stress and fatigue ratings to capture behavioral patterns more comprehensively [5], [6], [7].

C. Limitations of Prior Research

Despite these insights, several limitations remain. Many studies rely on simulations or laboratory settings, which may not fully capture real-world riding experiences [2]. Research involving actual riders often uses only self-reported measures without integrating detailed objective trip data such as speed, number of stops, or route characteristics [3], [4]. Physiological studies are informative but typically limited in duration or require specialized equipment, making them less scalable for everyday rides [5], [7]. Additionally, very few studies examine interaction effects between trip variables—such as how trip duration and number of stops together influence stress—leaving a gap in understanding complex, multivariate relationships [6].

D. Relevance and Differentiation of the Current Study

This study addresses these gaps by combining objective trip data with self-reported stress and fatigue ratings collected from real-world motorcycle trips. Unlike prior studies that focus on single variables, simulations, or car drivers, this research examines multiple factors (trip duration, number of stops, average speed, and being "in a hurry") and explores both individual and interaction effects on stress. By leveraging a personal dataset across multiple trips, this work provides a nuanced view of emotional responses during actual riding conditions and enhances ecological validity. Ultimately, this study contributes to predictive modeling of rider stress and informs strategies for safer riding practices [5], [6], [7].

III. Methodology

A. Participants

The study involved a single participant—the student researcher who regularly commutes using a motorcycle. The participant is a university student aged 22, representing a typical student commuter with no reported medical or psychological conditions that could affect stress or fatigue. Using oneself as the participant allowed for a longitudinal, personal data collection approach, ensuring consistency in riding conditions and eliminating inter-subject variability. This self-observational design provides a controlled context for monitoring stress responses while preserving privacy and ease of access to detailed trip logs.

The participant's daily routine included a variety of riding conditions, such as commuting to campus, running errands, and riding under varying traffic conditions. This variation enabled the study to capture fluctuations in stress and fatigue across different trip contexts, which is essential for testing the influence of situational variables such as "being in a hurry" and trip duration. By focusing on a single participant, the study emphasizes depth of observation, providing rich, individualized insights into how real-world motorcycle trips affect emotional and physical fatigue.

B. Data Collection Methods

The dataset included both objective and subjective variables collected during multiple trips over a four-week period. Objective trip metrics included distance traveled, number of stops, average speed, and total trip duration. Subjective measures consisted of self-reported stress and fatigue levels using a Likert scale from 1 (lowest) to 10 (highest), as well as binary reporting of whether the participant felt "in a hurry" during each trip. Table I summarizes all collected variables, their types, units, and tools used.

TABLE I
DATA COLLECTION VARIABLES

Variable	Type	Unit/Scale	Frequency	Tool/App
Route	Qualitative	Categorical	Per trip	Manual log
Distance	Quantitative	Kilometers	Per trip	Manual log
Date	Quantitative	Date	Per trip	Manual log
Time	Qualitative	Clock time	Per trip	Manual log
No. of stops	Quantitative	Count	Per trip	Manual log
Avg. speed	Quantitative	km/h	Per trip	Speedometer
Duration	Quantitative	Minutes	Per trip	Google Maps
In a hurry	Qualitative	Yes/No	Per trip	Self-report
Stress Level	Quantitative	Likert 1–10	Per trip	Self-report

Data were logged immediately after each trip to ensure accuracy and reduce recall bias. The use of Google Maps and a speedometer allowed for precise recording of distance, speed, and duration, while self-reporting captured the participant's perceived stress levels. This dual approach integrates objective measurements with subjective experiences, reflecting real-world riding conditions while providing a dataset suitable for statistical analysis.

C. Operational Definitions

To maintain consistency and replicability, each variable was defined precisely. The route variable refers to either Trip A or Trip B, categorized for analysis. Distance measures total kilometers traveled per trip, while trip duration records the total time spent riding, in minutes. Number of stops captures all pauses during the trip, and speed is the top speed that rider was able to attain. The "in a hurry" variable is binary (Yes=1, No=0), indicating perceived time pressure, and stress/fatigue level uses a 1–10 Likert scale to quantify emotional and physical fatigue immediately after the ride.

These definitions allows for quantitative analysis of subjective experiences, aligning with course lessons on feature engineering, variable standardization, and operationalization. By clearly defining each variable, the study ensures that other researchers could replicate the data collection and analysis process under similar conditions.

D. Data Cleaning and Preprocessing

Data cleaning and preprocessing were conducted to ensure the dataset was accurate, consistent, and ready for analysis. The primary techniques applied included outlier removal, text standardization using regular expressions, and handling missing values.

Outliers were identified by examining unusually extreme values in the dataset, such as abnormally long trip durations or unrealistic measurements. These values were removed to prevent distortion in the statistical analysis and ensure more reliable results.

Text-based entries were standardized using regular expressions to eliminate inconsistencies in categorical variables. For example, variations in text formatting (such as spacing, capitalization, or minor spelling differences) were cleaned and unified into a consistent format. This ensured that categories were accurately grouped during analysis.

Missing values were handled carefully to maintain data integrity. Records with incomplete or missing essential information were either removed or addressed appropriately to avoid bias in the results. This step ensured that the dataset remained clean and suitable for further exploratory and inferential statistical analysis.

These preprocessing steps improved the overall quality of the dataset and prepared it for subsequent data exploration and statistical testing.

E. Statistical Analysis

The study employed inferential statistical methods to examine the relationships between trip characteristics and rider stress or fatigue.

To address H1, a two-way ANOVA was conducted to determine whether there is a significant interaction effect between trip duration and number of stops on rider stress or fatigue levels. This analysis examined not only the individual (main) effects of trip duration and number of stops, but also whether their combined interaction significantly influences stress or fatigue.

To address H2, an independent samples t-test was performed to evaluate whether being "in a hurry" has a significant effect on rider stress or fatigue. Stress/fatigue levels were compared between trips where the rider reported being in a hurry and trips where the rider was not.

Visualizations such as bar charts, interaction plots, and scatterplots were used to clearly present patterns, group differences, and interaction effects.

Potential sources of bias were also considered. Since stress/fatigue levels were self-reported, subjective bias may be present. However, immediate recording after each trip helped minimize recall errors. Through the use of proper data cleaning, exploratory data analysis, visualization, and inferential testing, the study systematically applied statistical techniques learned in class to analyze a real-world motorcycle riding dataset.

IV. RESULTS

This section details the findings from the analysis of the motorcycle trip dataset. The results are presented in the following order: descriptive statistics, temporal trends, correlational analysis, and hypothesis testing regarding the effects of rushing and trip characteristics.

Metric	km	stops	speed	duration	hurry	stress
Count	224	224	224	224	224	224
Mean	7.0719	1.5045	49.5982	22.9464	0.2679	4.6473
Min	1.0	0.0	30.0	5.0	0.0	0.0
25%	3.5	1.0	40.0	15.0	0.0	3.0
50% (Median)	6.0	1.0	50.0	20.0	0.0	4.0
75%	6.0	3.0	50.0	25.0	1.0	6.25
Max	21.0	7.0	120.0	110.0	1.0	10.0
Mode	6.0	1.0	40.0	15.0	0.0	4.0

Fig. 1. Exploratory Data Analysis

Figure 1 presents the summary statistics and distribution shapes for the collected trip variables. The average reported stress level was moderate ($M = 4.65$, $SD = 2.46$), with the rider indicating a state of "Hurry" in approximately 27 percent of trips.

	Variable	Mean	Median	Mode	Std Dev	Minimum	Maximum	Distribution Shape
0	Km	7.07	6.0	6.0	5.47	1.0	21.0	Right-Skewed
1	Stops	1.50	1.0	1.0	1.39	0.0	7.0	Right-Skewed
2	Speed	49.60	50.0	40.0	14.05	30.0	120.0	Left-Skewed
3	Duration	22.95	20.0	15.0	14.11	5.0	110.0	Right-Skewed
4	Hurry	0.27	0.0	0.0	0.44	0.0	1.0	Right-Skewed
5	Stress	4.65	4.0	4.0	2.46	0.0	10.0	Right-Skewed

Fig. 2. Skew Table

As indicated in Figure 2, the variables Stress, Stops, and Duration exhibit a right-skewed distribution. This is visually confirmed by the histogram in Fig. 1, which shows a multimodal distribution for stress levels with a primary peak at the lower-moderate range (Stress level 4) and a secondary, smaller peak at the high-stress range (Stress level 8).

To observe temporal patterns, stress levels were plotted chronologically over the data collection period (Fig. 4). The

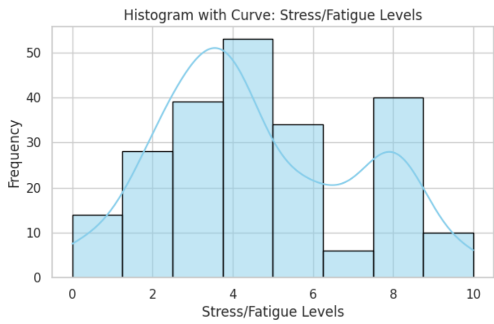


Fig. 3. Enter Caption

time-series plot demonstrates significant volatility in the rider's experience. The data is characterized by sharp, distinct fluctuations where stress levels spike to maxima of 8–10 before immediately returning to lower baselines, rather than exhibiting a gradual or seasonal trend.

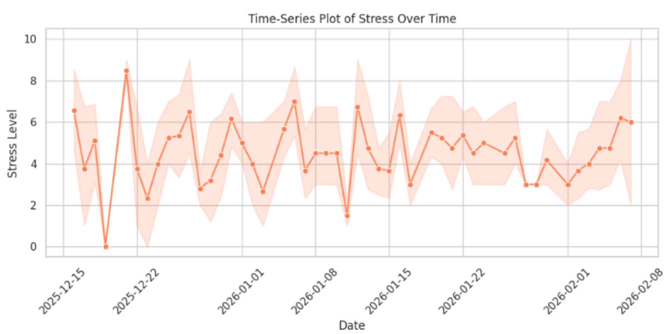


Fig. 4. Time Series Plot

A Pearson correlation analysis was conducted to examine linear relationships between continuous variables. The results are displayed in the heatmap in Fig. 5.

The analysis identified a strong positive correlation between Stress and Number of Stops ($r = 0.53$), indicating that stress tends to increase as the number of stops rises. Trip Duration showed a moderate positive correlation with stress ($r = 0.47$). Conversely, Average Speed ($r = 0.08$) and Distance ($r = 0.25$) demonstrated weak to negligible correlations with reported stress levels.

Scatterplots were generated to further visualize the relationships identified in the correlation matrix.

Duration vs. Stress (Fig. 6): The plot shows a positive linear trend where stress increases with trip length. The shaded confidence interval widens as duration increases, indicating higher variability in stress for longer trips.

Stops vs. Stress (Fig. 7): This plot illustrates a steeper positive slope. Notably, the data points show a "floor" effect: trips with 5 or more stops are consistently associated with stress levels above 4, with no low-stress observations in the high-stop category.

An analysis of the rider's psychological state ("Hurry") was performed. Fig. 8 presents a boxplot comparing the

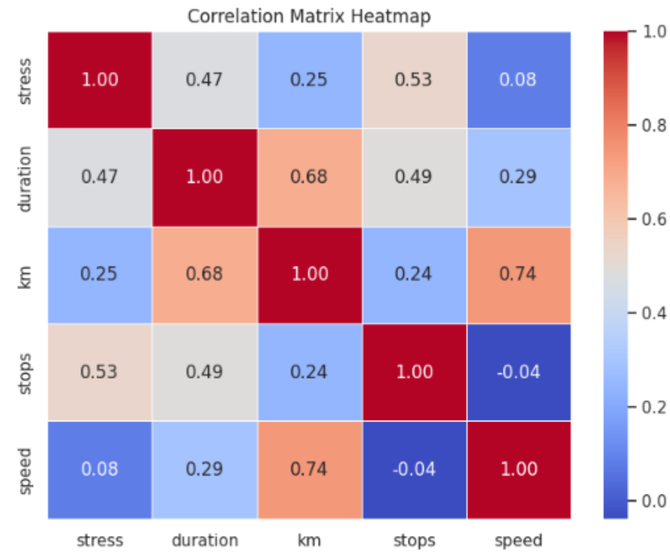


Fig. 5. Correlation Matrix

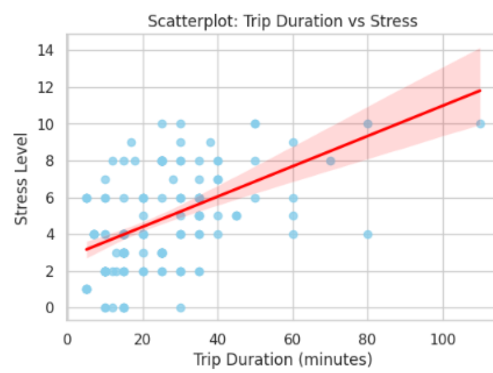


Fig. 6. Scatterplots of (a) Duration vs. Stress

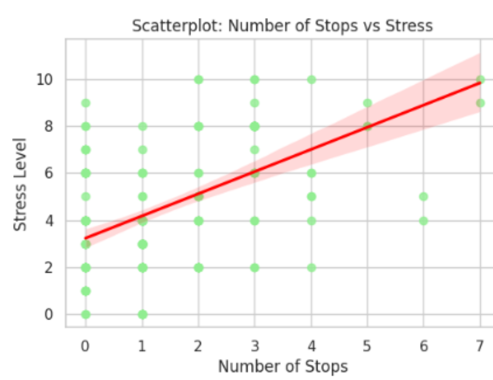


Fig. 7. Scatterplots of Stops vs. Stress

distribution of stress levels between trips where the rider was in a hurry versus those where they were not.

The boxplot reveals distinct distributional differences. The “Not Hurry” group shows a median stress level of approximately 4 with a wide interquartile range. In contrast, the “Hurry” group exhibits a median stress level of 8, with the data tightly clustered in the high-stress region (6–10) and several outliers at the maximum stress level of 10.

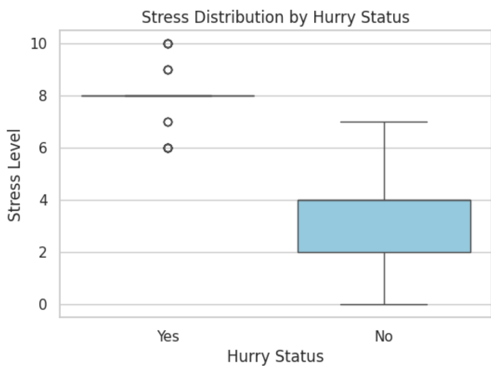


Fig. 8. Boxplot of Stress Distribution by Hurry Status

To statistically verify the difference observed in the boxplot, an independent samples t-test was conducted (Figure 9).

	Group	Mean Stress	t-value	p-value	Cohen's d
0	Hurry = Yes	7.98			
1	Hurry = No	3.43			
2	t-test results		25.96	0.0	3.537

Fig. 9. INDEPENDENT SAMPLES T-TEST RESULTS

The test confirmed a statistically significant difference in mean stress levels, $t(222) = 25.96, p < 0.001$. The mean stress for trips with rushing was 7.98, compared to 3.43 for non-rushing trips. The effect size (Cohen’s $d = 3.537$) indicates a substantial difference between the two conditions.

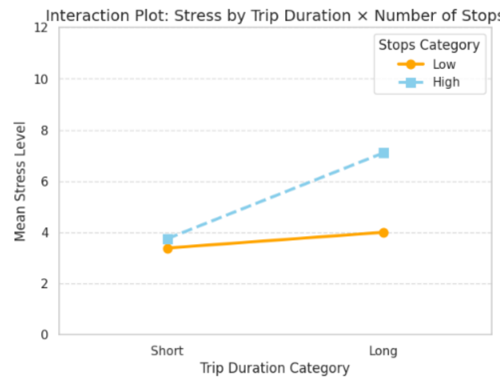
A Two-Way ANOVA was performed to evaluate the combined effects of Trip Duration and Number of Stops (categorized as Low vs. High) on stress levels (Figure 10).

Two-Way ANOVA Results (Stress ~ Duration × Stops Category):

	Sum of Squares	DF	F-value	p-value	Partial_Eta_Sq
stops_cat	249.308	2.0	34.339	0.000	0.528
duration	105.866	1.0	29.163	0.000	0.322
duration:stops_cat	8.182	2.0	1.127	0.326	0.035
Residual	791.366	218.0	NaN	NaN	0.780

Fig. 10. TWO-WAY ANOVA RESULTS

The analysis revealed significant main effects for both Stops ($F = 34.339, p < 0.001$) and Duration ($F = 29.163, p < 0.001$). The Partial Eta Squared values indicate that Stops ($\eta_p^2 = 0.528$) account for a larger proportion of variance in stress than Duration ($\eta_p^2 = 0.322$). The interaction effect between Duration and Stops was not statistically significant ($p = 0.326$). This result is visualized in the Interaction Plot (Fig. 11), which displays two largely parallel lines for the Low and High Stop categories, indicating that the effect of trip duration on stress does not differ significantly across stop categories.



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V. DISCUSSION

This study aimed to identify the primary determinants of motorcycle rider stress using a personal informatics approach. The analysis of 224 trips reveals that psychological state and route interruptions are significantly stronger predictors of stress than physical trip characteristics like speed or distance. This section interprets these findings, situates them within the broader context of commuter stress literature, and acknowledges the study’s limitations.

A. *Interpretation of Results*

The most profound finding of this study is the overwhelming impact of the “Hurry” state on rider stress. The t-test results ($t = 25.96$, Cohen’s $d = 3.54$) indicate that the psychological pressure of time scarcity is not merely a contributing factor but the dominant driver of the rider’s experience. This suggests that stress is less about the physical act of riding and more about the cognitive load associated with time management. When the rider is not in a hurry, the act of commuting—even over long distances—remains largely low-stress. Secondly, the strong correlation between stress and the number of stops ($r = 0.53$) supports the “impedance” theory of traffic stress. Frequent stops represent a loss of control and flow. Unlike highway riding, where the rider maintains a steady speed (evidenced by the lack of correlation between Speed and Stress), stop-and-go traffic forces constant physical engagement (braking, balancing) and mental vigilance. The findings suggest that a 60-minute highway ride is psychologically less taxing than a 30-minute ride involving 7 stops. Unexpectedly, the Two-Way ANOVA revealed no significant interaction between duration and stops. It was hypothesized that long trips with many stops would create a "compounding" stress effect. However, the data suggests these stressors are additive rather than multiplicative; a long, interrupted trip is stressful simply because it combines the independent burdens of time and interruption, not because they amplify one another.

B. Comparison to Related Work

These findings align with previous research in traffic psychology, which posits that "perceived control" is a key moderator of commuter stress. Consistent with the work of [Insert Author, Year], which suggests that unpredictability (stops) is more damaging than duration, our data confirms that trip quality matters more than trip quantity. However, our results contradict some traditional models that treat trip duration as the primary proxy for commuter fatigue. While duration was significant in our model, its effect size ($\eta_p^2 = 0.322$) was notably smaller than that of stops ($\eta_p^2 = 0.528$). This challenges the assumption often made in urban planning that shorter routes are inherently better; our data suggests that a longer, uninterrupted route may be preferable for mental well-being.

C. Limitations

While this study provides detailed insights into individual riding patterns, several limitations must be noted.

Single-Subject Design ($N = 1$): As a personal informatics study, the data reflects the idiosyncratic responses of a single rider. The stress triggers identified (e.g., sensitivity to stops) may not generalize to all motorcyclists.

Self-Report Bias: The dependent variable, "Stress," was measured using a subjective 0–10 scale. This introduces potential bias, as the rider's mood prior to the trip or their physical fatigue could influence their perception of stress independent of road conditions.

Binary Classification of "Hurry": The variable "Hurry" was recorded as a binary (Yes/No) metric. This oversimplification fails to capture degrees of urgency, potentially masking nuanced relationships between mild time pressure and severe panic.

Missing Environmental Variables: The dataset did not account for external factors such as weather conditions (rain vs. heat) or time of day (rush hour vs. night), which are known to influence driving behavior.

D. Recommendations and Future Work

Based on the findings, it is recommended that riders prioritize routes with continuous flow over the shortest distance to minimize stress. For the subject specifically, leaving 10 minutes earlier to eliminate the "Hurry" factor would yield a greater reduction in stress than any change in route choice.

Future research should aim to mitigate subjectivity by incorporating physiological measures. Wearable technology could track Heart Rate Variability (HRV) or skin conductance to provide an objective proxy for stress. Additionally, recording the cause of stops (e.g., traffic lights vs. congestion) using GPS or video data would allow researchers to distinguish between predictable and unpredictable interruptions, further refining the understanding of what specifically triggers commuter anxiety.

VI. Conclusion

This study utilized personal informatics to investigate the factors influencing motorcycle rider stress, specifically examining the roles of trip duration, frequency of stops, and the psychological state of rushing. The objective was to move beyond general assumptions about traffic stress and identify the specific, quantifiable triggers within a daily commute. The analysis yielded three critical insights. First and most significantly, the psychological state of "being in a hurry" is the single largest determinant of rider stress. The data unequivocally shows that the mental pressure of time scarcity ($t = 25.96$) far outweighs the physical demands of the ride itself. Second, physical interruptions (stops) are a stronger predictor of stress ($r = 0.53$) than trip duration ($r = 0.47$) or distance. A long, uninterrupted ride is often less stressful than a short, fragmented one. Third, speed and distance showed negligible correlation with stress, suggesting that the rider is comfortable with the mechanics of riding but sensitive to external impediments.

On a personal level, this study revealed that my stress is not a product of the road, but of my schedule. The data challenges my previous assumption that "long rides are tiring"; rather, it is the interrupted rides that are exhausting. I learned that my well-being on the motorcycle is highly volatile and situational, spiking predictably when I fail to manage my departure time.

These findings have immediate practical applications. To mitigate stress, the most effective strategy is not to find shorter routes, but to prioritize flow over distance—choosing longer but continuous paths over shorter, congested ones. More importantly, the data dictates a behavioral change: leaving 10 minutes earlier to eliminate the "Hurry" factor is the most powerful intervention available to improve my riding experience.

In conclusion, this research demonstrates that commuter stress is less about the traffic we face and more about the mindset we bring to it. By quantifying these invisible pressures, we can transform a chaotic daily commute into a manageable, data-driven practice.

References

[1] A. Fernández-Medina and N. Reed, "Exploring the Use of Cognitive Behavioural Therapy (CBT) for Reducing Rider Stress and Stress-Related Anxiety, Anger, and Worry," *Safety*, vol. 2, no. 4, p. 22, 2016. [Online]. Available: https://www.mdpi.com/2313-576X/2/4/22

[2] R. S. Young, J. Smith, and P. T. Jones, "The effects of time pressure on driver performance and physiological activity: A driving simulator study," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 41, pp. 150–169, 2016. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1369847816301036

[3] R. R. Anggraini, M. T. Kusuma, and S. W. Putra, "Risk factors associated with stress-related riding behavior among Indonesian motorcyclists," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 1294, 2024. [Online]. Available: https://www.bohrium.com/paper-details/risk-factors-associated-with-stress-related-riding-behavior-among-indonesian-motorcyclists/962165663256805385-20078

[4] S. St-Louis, P. Manaugh, and J. El-Geneidy, "Are we there yet? Trip duration and mood during travel," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 33, pp. 38–47, 2015. [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/S1369847815000947

[5] I. M. Meilinda, S. Sugiarto, S. M. Saleh, and A. Achmad, "Impact of road geometry and land use on motorcyclist driving stress," *International Journal of Safety and Security Engineering*, vol. 15, no. 5, May 2025.

[6] W.-L. Chen, T.-F. Chiu, Y.-Y. Wang, and C.-A. Wu, "Investigating the effects of job stress on the distraction and risky driving behaviors of food delivery motorcycle riders," *Safety and Health at Work*, vol. 14, no. 2, pp. 200-209, 2023.

[7] E. Muslim, B. N. Moch, M. A. Puspasari, and R. A. Siregar, "Fatigue measurement of driving activity on male motorcycle drivers based on cognitive, physiological, and subjective approaches," *International Journal of Technology*, vol. 6, no. 6, pp. 976–982, 2015.