Navigating the Future: Predictive Modeling of Safety Perceptions and Adoption Readiness of Autonomous Vehicles for Public Safety Enhancement

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***Abstract*—The proliferation of autonomous vehicles (AVs) promises a shift towards more efficient and potentially safer roadways. However, the integration of AVs into existing transportation networks raises critical safety concerns, especially for vulnerable road users such as pedestrians and bicyclists. This paper examines the factors influencing these users' safety perceptions of sharing roadways with AVs. Leveraging survey data from Bike Pittsburgh and applying multinomial logit models, we assess how exposure to AVs, regulatory attitudes, and incidents involving AVs shape public trust and perceived safety. The study reveals that increased familiarity with AV technology correlates positively with safety perceptions, despite the historical impact of high-profile AV accidents. It also finds that public approval of AV testing is rising, suggesting a growing acceptance of AVs. Our analysis indicates a need for nuanced, evidence-based public policies that address the concerns of active transportation users and incorporate their perspectives into the formulation of safety guidelines in the era of AVs. Ultimately, the study highlights the importance of fostering positive interactions between AVs and vulnerable road users to promote harmonious coexistence and acceptance.**

***Index Terms*—Autonomous Vehicles (AV), AV adoption, technology familiarity, public safety, AV tech education, safety perceptions, AV safety advancements, multinomial logit model, predictive modeling, logistic regression, adoption readiness**

I. Introduction

The rapid advancements in autonomous vehicle (AV) technology have significantly disrupted surface transportation systems and services. AVs have the potential to improve traffic safety by eliminating most traffic crashes involving human error,leading to a transformation in how people and goods move around. However, the operation of AVs on public roadways raises concerns about the safety of vulnerable roadway users such as pedestrians and bicyclists, who [1] are relatively unprotected compared to the occupants of AVs or conventional vehicles. Interactions between AVs and pedestrians and bicyclists are expected to be complex, and concerns have been heightened by incidents like the one in Tempe, Arizona, where an AV struck and killed a woman walking with her bicycle. Several factors can influence safety perceptions of sharing roadways with autonomous vehicles [2]. Research on the safety perceptions of vulnerable roadway users regarding road sharing with AVs is crucial for understanding the impact of AV deployment on public acceptance and safety. Prior studies, including one conducted in Pittsburgh, Pennsylvania, have shown that safety perceptions regarding AVs are influenced by factors such as exposure to AVs, attitudes toward AV regulations, and opinions formed due to AV-involved accidents. The findings suggest that higher exposure to AVs is associated with improved safety perceptions, while a stricter attitude toward AV regulations and negative opinions formed due to accidents lead to lower safety perceptions. In addition, it has been observed that previous experience, knowledge of recent progress, and awareness of safety-related incidents can affect safety perceptions about AVs.Public policies and guidelines to ensure the safety of vulnerable roadway users in the era of AVs have been recommended, including prioritizing safety when integrating AVs into current transportation systems, strengthening [3] reporting requirements for AV-related safety incidents, and programming AVs to operate at modest speeds to ensure the safety of pedestrians and bicyclists. These measures will help address concerns and promote the safe coexistence of autonomous vehicles with pedestrians and bicyclists.

Despite these efforts, there are research gaps that need to be addressed. Little attention has been paid to exploring the formulation and demands of safety-related public policies with empirical evidence. Furthermore, there is a lack of incorporation of active transportation users' perspectives in the existing literature, despite their importance as essential stakeholders outside the AVs in the future. Thus, this study aims to fill these critical research gaps by exploring the demands of potential transport policies to enhance perceived safety, particularly from the viewpoints of active transportation users. The study will utilize survey data gathered by Bike Pittsburgh in 2019 and develop multinomial logit models to explore these demands and provide empirical evidence to inform the formulation of safety-related public policies regarding the sharing of roadways with AVs [16]. Therefore,

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understanding the safety perceptions of vulnerable roadway users and developing appropriate public policies are essential for ensuring safe road sharing with autonomous vehicles and sustaining active transportation usage in the era of AVs [1]. The study aims to fill the research gaps by exploring the demands of potential transport policies to enhance perceived safety, particularly from the viewpoints of active transportation users. Finally, it is crucial to acknowledge that despite the promising results and improved pedestrian safety around AVs, there have been instances of fatal collisions involving pedestrians and AVs [4]. It is therefore important for policymakers to consider the input and perspectives of active transportation users in the development of public policies related to AVs [1].

It is necessary to prioritize safety when integrating AVs into current transportation systems and develop guidelines and policies to address the concerns and safety needs of active transportation users.

Research Motivation

The motivation for this research stems from the need to address research gaps in the formulation of safety-related public policies with empirical evidence. The existing literature has neglected the incorporation of active transportation users' perspectives, despite their importance as stakeholders in the future of autonomous vehicles . Furthermore, ensuring the safety of vulnerable roadway users such as pedestrians and bicyclists is crucial in the era of autonomous vehicles [6].
This research aims to fill these critical research gaps by investigating the safety perceptions of vulnerable roadway users regarding road sharing with AVs and exploring their demands [5] for potential transport policies. Understanding the viewpoints of active transportation users is crucial in developing effective and inclusive public policies regarding the integration of autonomous vehicles into current transportation systems. Understanding safety issues related to the presence of autonomous vehicles on public roads among pedestrians and bicyclists is crucial for several reasons. The operation of AVs on public roadways has the potential to significantly impact the safety of vulnerable road users, such as pedestrians and bicyclists. The interactions between AVs and these road users are complex, and concerns have been heightened by incidents such as the AV-involved accident in Arizona. Research findings have shown that safety perceptions regarding AVs are influenced by factors such as exposure to AVs, attitudes toward AV regulations, and opinions formed due to AV-involved accidents [1]. For example, higher exposure to AVs is associated with improved safety perceptions, while a stricter attitude toward AV regulations and negative opinions formed due to accidents lead to lower safety perceptions.

In addition, previous experience, knowledge of recent progress, and awareness of safety-related incidents can affect safety perceptions about AVs. It is crucial to consider the input and perspectives of active transportation users in the development of public policies related to AVs to ensure that their safety needs are addressed [18]. Public policies and guidelines should prioritize safety when integrating AVs into current transportation systems and should be developed with the viewpoint of active transportation users in mind [5].

Furthermore, there is a need for empirical evidence to inform the formulation of safety-related public policies regarding the sharing of roadways with AVs particularly from the perspectives [7] of active transportation users. While there have been promising results and improved pedestrian safety around AVs, there have also been instances of fatal collisions involving pedestrians and AVs. Understanding the safety perceptions of vulnerable roadway users and developing appropriate public policies are essential for ensuring safe road sharing with autonomous vehicles and sustaining active transportation usage in the era of AVs. Therefore, policymakers need to ensure that safety and the perspectives of active transportation users are central to the development and implementation of AV-related policies and guidelines on public roads.

Overall, to address the safety concerns of vulnerable road users and improve their acceptance of AV technology, it is important for policymakers and AV companies to prioritize safety by implementing rigorous safety assessments, promoting transparency in AV testing and development, and actively engaging with the public to address their concerns [4].

Literature Review

The nascent field of autonomous vehicle (AV) integration into public roadways has sparked a considerable body of research, primarily focusing on the technology's potential to reduce traffic incidents and improve efficiency. However, literature addressing the safety perceptions of vulnerable road users, such as pedestrians and bicyclists, remains comparatively sparse. Studies like [1] begin to bridge this gap by highlighting the complexities that arise when AVs share the road with those who are unprotected by the physical confines of a vehicle. [2] delve into the psychological underpinnings of road-sharing experiences, applying machine learning techniques to uncover nuanced feelings of safety or apprehension among non-vehicular road users. Their findings suggest that interactions with AVs can modulate safety perceptions, a sentiment echoed in [3] exploration of communication dynamics between AVs and pedestrians.

The role of public incidents, such as the fatal collision involving an AV in Tempe, Arizona, has proven pivotal in shaping public opinion. [4] emphasize the need for proactive safety assessments in the wake of such incidents, pointing out the delicate balance between technological advancement and public trust. [5] extend this discussion by examining the factors that influence the safety perceptions of sharing roadways with AVs among vulnerable roadway users. Their research identifies a correlation between increased exposure to AVs and improved safety perceptions, a finding that is critical for policymakers tasked with fostering public acceptance of AVs. [7] apply behavioral theories to understand pedestrian interactions with AVs, suggesting that the perceived behavioral control and attitudes toward the technology are significant predictors of acceptance. Their work aligns with the Theory of Planned Behavior, which posits that intention to engage in

Variable	2017 (%)	2019 (%)
Age 18-24	26.03	43.4
Car Ownership	56.5	50.6
Familiarity with AV Tech	30.52	38.32
Safety Perception of AVs	22.76	29.16
Approval of AV Testing	41.26	50.2

TABLE I
SELECTED COMPARATIVE STATISTICS FROM THE 2017 AND 2019 SURVEY DATA

a behavior is influenced by attitudes, subjective norms, and perceived control. [8] offer a structural equation modeling approach to dissect the interrelationships among predictors of AV acceptance. They argue that public acceptance is not monolithic but rather a tapestry woven from varied individual experiences and biases. Similarly, [9] model user adoption of shared AVs based on actual ridership experiences, providing a pragmatic lens through which to view potential user bases.

The current literature, while valuable, tends to emphasize the technological and regulatory aspects [13] of AV deployment. What is often less represented is the voice of the active transportation community, whose daily experiences [11] on the road are directly impacted by the presence of AVs. This study seeks to address that imbalance by focusing on the perceptions and safety concerns of pedestrians and bicyclists in the context of AVs, a crucial step for the inclusive development of AV-related public policies.

METHODOLOGY

Dataset Exploration

The **Autonomous Vehicle Survey 2019**, a comprehensive dataset owned by the Pittsburgh Local Government, serves as the foundation for understanding public perception and behavior towards autonomous vehicles (AVs) in Pittsburgh. This dataset is particularly relevant given Pittsburgh's status as a testing ground for AVs since 2016. Comprising approximately 1,000 observations and 29 variables, it captures responses from BikePGH donor-members and Pittsburgh residents, focusing on their experiences and attitudes towards AVs as cyclists and pedestrians.

The dataset encompasses a wide array of variables, ranging from respondent demographics - age, zip code, BikePGH membership status, to more specific aspects such as levels of familiarity with AV technology and news. It also includes respondents' experiences of sharing the road with AVs, their safety perceptions in comparison to human-driven vehicles, and attitudes towards various regulatory aspects like speed limits for AVs, mandatory reporting of safety incidents, and data sharing by AV companies.

Notably, the dataset also reflects public sentiment on the impact of specific incidents, like the Elaine Herzberg incident in Arizona, on their opinion about AVs.

The data analysis steps used have been enlisted below.

Given the rich and diverse nature of the dataset, it presents an opportunity to delve deeper into understanding the factors influencing public acceptance of AVs among vulnerable roadway users, such as pedestrians and bicyclists, and how perceptions may change over time.

Main Step	Sub-Steps
1. Data Loading and Exploration	Input the dataset and inspect the variables
2. Data Cleaning and Preprocessing	Handle missing values Convert date strings to date-time objects Transform categorical variables into appropriate formats
3. Exploratory Data Analysis (EDA)	Generate summary statistics Visualize data distributions and relationships
4. Logistic Regression Modeling	Fit the model using selected predictors
5. Model Diagnostics	Assess model assumptions, residuals, and identify influential points
6. Model Output Interpretation	Interpret the significance of model coefficients Discuss the implications for the domain of study

TABLE II
STEPS IN DATA ANALYSIS PROCESS

The research questions for this project is: ***What factors influence the adoption of autonomous vehicles?*** Future research can aim to address the sub question: *Does bias exist in measuring public acceptance of autonomous vehicles?*

It is evident from the current literature that various factors influence the adoption of autonomous vehicles. The increasing exposure to AVs, as indicated by the data from the surveys, has led to improved safety perceptions among pedestrians and bicyclists. This emphasizes the role of familiarity and interactions with AVs in shaping positive safety perceptions. Additionally, the study highlighted the impact of attitudes toward AV regulations on safety perceptions, emphasizing the need for addressing regulatory attitudes to foster a sense of safety and openness to AV technology among vulnerable roadway users. The literature in this domain also underscore the importance of monitoring public perceptions and experiences related to AVs, particularly from the standpoint of pedestrians and bicyclists. Consideration of their evolving perspectives is crucial for the development of public policies and guidelines to ensure safe road sharing with AVs. Diving deeper into the research question of what factors influence the adoption of autonomous vehicles, it is essential to consider the significant impact of exposure and safety perceptions on public acceptance [11]. The sub-question about the existence of bias in measuring public acceptance of AVs is also vital, especially in understanding the changing attitudes and perceptions influenced by real-life incidents. It is important to recognize that as AV technology continues to evolve, the dynamics between AVs and vulnerable roadway users will also undergo changes. This

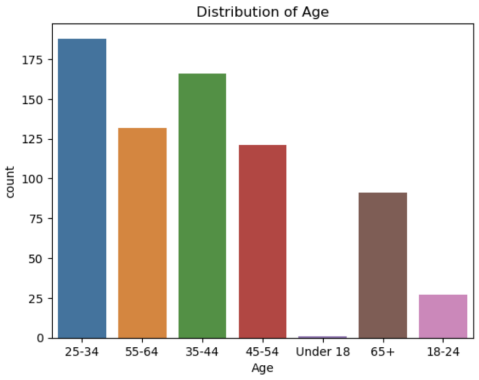

Fig. 1. Visualizing age range of the survey data

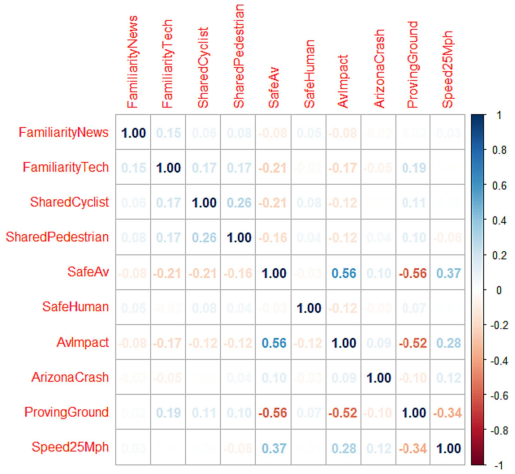

Fig. 2. Correlation matrix for the variables in the dataset

underscores the need for ongoing assessment and monitoring of AV perceptions to ensure a comprehensive approach to road safety in the era of AVs.

The research identifies the adoption outcome—either 'Adoption' (1) or 'No Adoption' (0)—as the dependent variable, reflecting individuals' willingness to share the road with AVs. The study explores a range of independent variables, including AV Technology Familiarity, experiences of sharing the road as a bicyclist or pedestrian, safety perceptions of human-driven vehicles, expectations of AV safety improvements, public approval of AV testing on roadways, attitudes toward AV regulation, and the impact of knowledge about AV-related accidents on AV adoption. This comprehensive analysis aims to shed light on the multifaceted attitudes towards AVs and their perceived safety.

Now, let's explore the research questions and gaps identified in your research in order to develop a comprehensive understanding of the implications and potential future directions.

Survey Data Analysis and Exploration

The data gathered from two surveys conducted by Bike Pittsburgh in 2017 and 2019 offered valuable insights into the perceptions and attitudes of pedestrians and bicyclists toward AVs over time. The surveys targeted demographics, biking and walking frequency, and interactions with AVs. The evolution of perceptions and familiarity with AVs was analyzed over the two survey periods, shedding light on how the participants' views have changed or remained constant during this time. The analysis revealed that exposure to AVs increased perceptions of safety among pedestrians and bicyclists.

A significant majority of the respondents, 73 percent, are actively following news related to AVs. This high level of engagement suggests a public that is not only aware but also interested in the development of AV technology. It highlights the importance of media and news outlets in shaping public opinion and the need for accurate and balanced reporting to inform the public effectively. More than half of the participants have reported familiarity with AV technology, indicating a considerable level of exposure and understanding. This familiarity could correlate with higher levels of acceptance, indicating that educational initiatives and hands-on experiences could be beneficial strategies for increasing the adoption rate of AV technology. The survey revealed varied perceptions of safety concerning AVs. While some respondents feel confident about the safety of sharing the road with AVs, others remain skeptical. This discrepancy points to the need for more detailed analysis to understand the underlying concerns or experiences influencing these perceptions. The factors contributing to a sense of safety could include trust in the technology, understanding of AV capabilities, and personal experiences with AVs or related technologies.

The findings from these surveys reflect the evolving perceptions of pedestrians and bicyclists about AVs. They provide a valuable basis for understanding how public attitudes are influenced by exposure to AVs, opinions on AV regulations, and experiences of safety-related incidents. Additionally, continuous assessment of AV perceptions over time can elucidate the impact of ongoing developments and experiences involving AVs on roadways. Therefore, more studies exploring the actual road-sharing experiences with AVs and continuous assessment of AV perceptions over time are essential in providing a comprehensive understanding of the changing dynamics between AVs and vulnerable roadway users [9]. These studies can help shape policies that prioritize the safety and needs of pedestrians and bicyclists in the integration of AVs into current transportation systems.

Moreover, incorporating the perspectives of active transportation users in the development of public policies related to AVs is crucial for ensuring their safety [17] addressing their concerns. Furthermore, the results of the surveys suggest that exposure to AVs can improve safety perceptions among pedestrians and bicyclists. These findings highlight the importance of continued assessment and monitoring of AV perceptions and experiences [18] from the perspective of pedestrians and bicyclists.

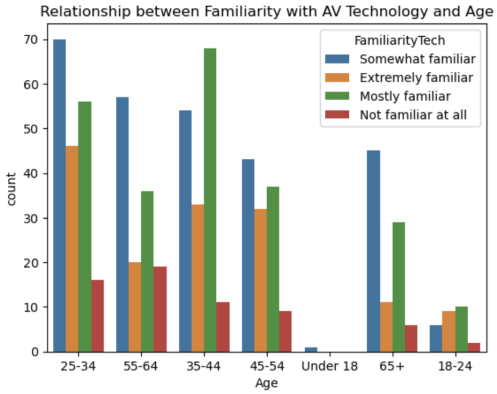

Fig. 3. Familiarity with AV Technology and age from the data

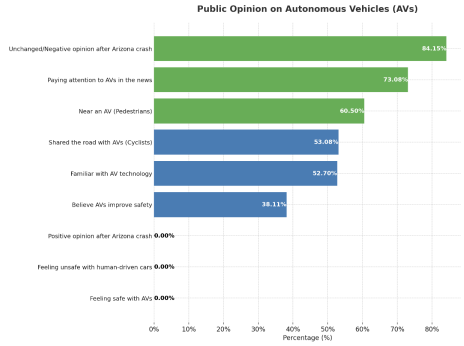

Fig. 4. Public Approval for AV use from the data

Changes in Exposure, Familiarity, and Safety Perceptions

The comparative analysis of statistics from the 2017 and 2019 surveys conducted by Bike Pittsburgh revealed significant changes in exposure, familiarity, and safety perceptions related to autonomous vehicles. The data indicated a considerable increase in AV tech familiarity, improved safety perception, and increased public approval for AV testing.

Increased Exposure to AVs

The 2019 survey indicated a notable rise in exposure to AVs among respondents. Specifically, 60 of the participants shared roadways with AVs as bicyclists, showing a substantial increase from the previous survey. Moreover, 53 of the respondents reported sharing roadways with AVs as pedestrians, further signifying an augmented exposure to AVs in public spaces. This increased exposure to AVs suggests a growing presence of these vehicles in everyday travel scenarios, making it even more crucial to understand and address the perceptions and safety concerns of pedestrians and bicyclists.

Improved Safety Perceptions

The surveys also demonstrated a significant rise in positive safety perceptions surrounding AVs. Despite significant incidents, such as the fatal AV crash in 2018, pedestrians and bicyclists indicated improved perceptions of safety in terms of road sharing with AVs. This shift in perception suggests a notable change in how these vulnerable roadway users view the safety of interacting with AVs on public roadways.

Public Approval for AV Testing: Another significant finding was the increased public approval for AV testing on public roadways. The surveys showed that a majority of the respondents expressed approval for AV testing on Pittsburgh public roads, indicating a growing acceptance of AVs as a part of the transportation system. This shift in public approval for AV testing suggests an evolving attitude towards the integration of autonomous vehicles into public spaces. These findings highlight the importance of continued assessment and monitoring of AV perceptions and experiences from the perspective of pedestrians and bicyclists.

Factors Influencing Safety Perceptions

The findings from the surveys also shed light on the factors influencing safety perceptions of pedestrians and bicyclists regarding AVs. The analysis revealed that higher exposure to AVs was associated with improved safety perceptions. This indicates that familiarity and increased interactions with AVs contribute to a more positive perception of safety. In contrast, participants with a stricter attitude toward AV regulations perceived road sharing with AVs as less safe, demonstrating the influence of regulatory attitudes on safety perceptions.

Moreover, the study emphasized that opinions formed due to pedestrian and bicyclist involved AV accidents in Arizona had a considerable impact on safety perceptions. Respondents whose opinions were not worsened by the accidents had higher safety perceptions, signifying the role of real-life incidents in shaping attitudes towards AV safety.

Implications for Policy Development

These findings have significant implications for policymakers in developing guidelines to ensure safe road sharing with AVs. The recognition of the positive association between exposure to AVs and safety perceptions underscores the importance of increasing pedestrian and bicyclist interactions with AVs in shaping favorable safety perceptions. Moreover, addressing attitudes toward AV regulations is crucial in fostering a sense of safety and openness to AV technology among vulnerable roadway users.

Furthermore, the data from the surveys highlight the evolving nature of public approval for AV testing on public roadways. This evolving attitude underscores the need to continually engage with active transportation users and consider their evolving perspectives in the development of public policies related to AVs.

Increased Public Approval for AV Testing

Furthermore, the comparative analysis revealed an increased public approval for AV testing. A larger percentage of respondents demonstrated a high level of familiarity with AV technology, signifying an overall positive trend in the acceptance and approval of AVs in public spaces. These findings illustrate a noteworthy change in the attitudes of pedestrians

and bicyclists toward AVs over the two survey periods. The increased exposure to AVs, improved safety perceptions, and heightened familiarity with AV technology indicate a shift in public attitudes and a growing acceptance of AVs within the community. The AV-involved accident in Arizona had a negative impact on the safety perceptions of a noticeable portion of pedestrians and bicyclists surveyed. Overall, the data suggests that the public is becoming more comfortable with AVs and their potential benefits. As the data from Bike Pittsburgh's surveys indicates, there has been a significant shift in the exposure, familiarity, and safety perceptions related to autonomous vehicles among pedestrians and bicyclists.

Public Opinion	Percentage
Retained unchanged/negative opinion after Arizona AV crash	84.15%
Paying attention to AVs in the news	73.08%
Have been near an AV as pedestrians	60.50%
Cyclists shared the road with AVs	53.08%
Familiar with AV technology	52.70%
Believe AVs improve safety	38.11%
Positive opinion post-Arizona crash	0.00%
Feeling unsafe with human-driven cars	0.00%
Feeling safe with AVs	0.00%

TABLE III
PUBLIC OPINION ON AUTONOMOUS VEHICLES POST-ARIZONA CRASH

The shift in perceptions and attitudes highlights the evolving dynamics between AVs and vulnerable roadway users. It is essential to continue monitoring these changes to inform the development of comprehensive policies and guidelines that prioritize the safety and needs of pedestrians and bicyclists in the integration of AVs into current transportation systems. Furthermore, the findings underscore the importance of ongoing assessment and monitoring of AV perceptions and experiences from the perspective of pedestrians and bicyclists to ensure a holistic approach to road safety in the era of AVs.

FINDINGS AND IMPLICATIONS

We adopted a multifaceted approach to uncover insights into the public's attitudes toward AVs in Pittsburgh. Initially, the dataset underwent extensive cleaning and pre-processing, a critical step for ensuring the robustness of our analysis. This process involved converting qualitative responses into numerical data and addressing missing values, thus enhancing the dataset's suitability for statistical analysis.

Regression Model

The initial examination involved descriptive statistical methods, which provided a foundational understanding of the dataset's attributes. This stage was pivotal in revealing general attitudes, awareness levels, and safety perceptions regarding AVs among Pittsburgh residents. We paid particular attention to how these perceptions varied across different demographic segments.

Our analysis is a **logistic regression model** designed to predict the likelihood of AV adoption. The logistic regression model used in this study aimed to explore the factors influencing safety perceptions regarding road sharing with autonomous vehicles among pedestrians and bicyclists.

The logistic regression model is represented as:

$$\begin{aligned}\text{logit}(P(\text{AV\_Adoption} = 1)) = \beta_0 + \beta_1 \text{FN\_Null} + \beta_2 \text{FN\_Large} + \beta_3 \text{FN\_Mod} \\ + \beta_4 \text{FN\_Little} + \beta_5 \text{FN\_Some} + \beta_6 \text{FT\_Most} + \beta_7 \text{FT\_None} \\ + \beta_8 \text{FT\_Null} + \beta_9 \text{FT\_Some} + \beta_{10} \text{SC\_NSure} + \beta_{11} \text{SC\_Null} \\ + \beta_{12} \text{SC\_Yes} + \ldots + \beta_n \text{Age65+}\end{aligned}$$

where:

- $\text{logit}(P(\text{AV\_Adoption} = 1))$ is the log odds of AV adoption being 1.
- $\beta_0, \beta_1, \beta_2, \ldots, \beta_n$ are the coefficients for the intercept and each predictor.
- The predictor variables (e.g., FamiliarityNewsnull, FamiliarityNewsTo a large extent, etc.) are denoted as $X_1, X_2, \ldots, X_n$.

This model was instrumental in identifying key factors influencing public openness to AV technology.

Analysis Results

By analyzing the model's coefficients, we gained insights into the impact of variables such as safety perceptions and familiarity with AV technology on the propensity to adopt AVs.

Predictor	Coefficient	p-value
Shared Cyclist: Yes	0.602	0.022
Safe with Human: 5	2.327	0.018
AV Impact: Significantly Better	2.419	¡0.001
BikePgh Member: Yes	0.593	0.018

TABLE IV
PREDICTORS POSITIVELY ASSOCIATED WITH AV ADOPTION.

Table 3 (above) encapsulates the results of a statistical analysis aimed at identifying factors that positively influence the adoption of autonomous vehicles (AV). It details four main predictors: affirmative responses from shared cyclists, a high safety rating with human drivers, a significant positive impact perceived from AVs, and membership in *BikePgh*. The table outlines each predictor's coefficient, indicating the strength and direction of the association, along with the p-value, which assesses the statistical significance of the results. Notably, the predictor associated with a significantly better impact of AVs holds a coefficient of 2.419 and is highly statistically significant, with a p-value of less than 0.001.

This suggests a robust and significant correlation between the perceived benefits of AV technology and its adoption. Other predictors, including safety with human drivers rated at a level of 5, also show a strong positive relationship with AV adoption, reflected by a coefficient of 2.327 and a p-value

of 0.018. Membership in *BikePgh* and being a shared cyclist are also statistically significant predictors, with coefficients around the 0.6 mark and p-values below 0.05. These findings point to the importance of positive perceptions and community engagement in the context of AV technology acceptance.

Predictor	Coefficient	p-value
Proving Ground: Disapprove	-1.911	0.007
Proving Ground: Neutral	-1.619	¡0.001
Proving Ground: Somewhat Approve	-0.940	0.001
Proving Ground: Somewhat Disapprove	-1.963	¡0.001
Share Trip Data: Yes	-1.153	0.029
Age: 55-64	-1.585	0.021

TABLE V
PREDICTORS NEGATIVELY ASSOCIATED WITH AV ADOPTION.

Table 5 (above) details a set of variables that have a statistically significant inverse relationship with the acceptance of autonomous vehicles (AV). The analysis reveals that *disapproval at the proving ground* is the most negatively associated predictor, with a coefficient of -1.911 and a p-value of 0.007. Neutral positions and somewhat disapproving stances also correlate negatively with coefficients of -1.619 and -1.963, respectively, and with very strong statistical significance (p-values ¡ 0.001). Even a somewhat approving view still corresponds to a negative coefficient of -0.940, significant at the 0.001 level. Sharing trip data and being within the 55-64 age range are similarly linked to lower AV adoption rates, with coefficients of -1.153 and -1.585, and respective p-values of 0.029 and 0.021. These results underscore the impact of public perception and demographic factors on the receptivity to AV technology.

We validated the model using 10-fold cross-validation, ensuring its predictive reliability.

Implementing 10-fold cross-validation for model performance analysis: Our model's performance was rigorously assessed using a 10-fold cross-validation method. This process involved partitioning the data into ten distinct folds, thereby allowing for each fold to act as an independent test set with the model being trained on the remaining nine folds. Such a methodology ensures that each data point is utilized for both training and validation once, enhancing the robustness of our model evaluation.

The cross-validation yielded an average accuracy of 94.2% with a low variance, as evidenced by a standard deviation of 2.3%. The accuracy ranged between 90.1% and 97.5%, underscoring the model's consistency.

Further, we employed Receiver Operating Characteristics (ROC) curve analysis (Figure 4) to evaluate the model's discriminative ability between potential adopters and non-adopters of AV technology.

The ROC curve is a graphical representation that illustrates the diagnostic accuracy of the autonomous vehicle (AV) adoption model. It displays the trade-off between the true positive rate (sensitivity) and the false positive rate (1 - specificity) across different thresholds. The Area Under the Curve (AUC) for this model is 0.92, which denotes a high level of the

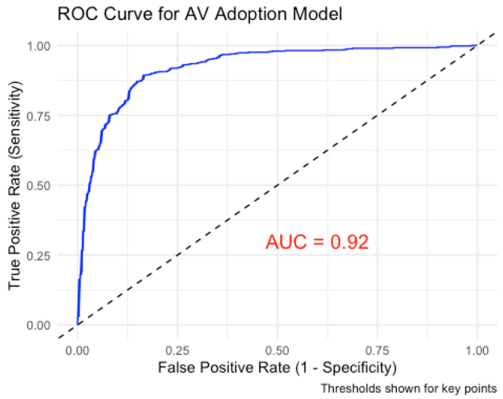

Fig. 5. Receiver Operating Characteristics Curve for AV Adoption

model's ability to correctly classify those who will adopt AV technology versus those who will not. An AUC value near 1.0 signifies excellent model performance, indicating that the model has a high degree of separability, meaning it can effectively distinguish between the two adoption classes.

The AUC metric from this analysis provided a quantitative assessment of the model's effectiveness, confirming its utility in our study.

AV Adoption	Precision	Recall	F1-score	Support
0	0.77	0.68	0.72	50
1	0.84	0.90	0.87	96
accuracy		0.82 (146 instances)		
macro avg	0.81	0.79	0.80	146
weighted avg	0.82	0.82	0.82	146

TABLE VI
MODEL CLASSIFICATION REPORT

The Model classification report (from Table 5) provides a detailed breakdown of the performance metrics for an Autonomous Vehicle (AV) Adoption predictive model. It specifically lists the precision, recall, F1-score, and support for non-adopters (label 0) and adopters (label 1) of AV. Non-adopters show a precision of 0.77 and recall of 0.68, resulting in an F1-score of 0.72, with data from 50 instances. Adopters, with 96 instances, exhibit higher precision and recall rates at 0.84 and 0.90, respectively, leading to a higher F1-score of 0.87.

Variance Inflation factor (VIF) analysis was conducted to check multicollinearity effects. The results demonstrate that none of the predictors have a VIF above the commonly used threshold of 10, which suggests that there is no evidence of severe multicollinearity among the variables in the model. The highest VIF observed is for the variable *AvImpact*, with a VIF of 5.06. Although this is the highest in the set, it is still below the threshold of concern and is considered acceptable, but it is notable enough to warrant some attention. Most of the VIF values are comfortably below 5, indicating minimal multicollinearity within the dataset. This suggests that the predictors provide independent information to the model.

The low VIF values across the majority of variables indicate

Predictor	VIF	VIF Adjusted
FamiliarityNews	2.73	1.11
FamiliarityTech	2.52	1.17
SharedCyclist	2.09	1.13
SharedPedestrian	1.78	1.11
SafeHuman	1.17	1.08
AvImpact	5.06	1.18
ProvingGround	4.49	1.19
Speed25Mph	2.32	1.15
TwoEmployeesAv	2.14	1.13
SchoolZoneManual	1.65	1.09
ShareTripData	1.98	1.19
SharePerformanceData	2.29	1.15
ReportSafetyIncident	1.74	1.15
ArizonaCrash	2.60	1.10
BikePghMember	1.56	1.08
AutoOwner	2.33	1.24
SmartphoneOwner	2.63	1.27
Age	1.99	1.06

TABLE VII
SUMMARY OF VARIANCE INFLATION FACTOR (VIF) ANALYSIS

a high level of independence among them, which is a positive indicator for the reliability of the model. The VIF analysis supports the validation of the regression model, suggesting that the interpretation of the coefficients is likely to be meaningful and not unduly influenced by multicollinearity. The regression model is thus validated for interpretation of coefficients.

Metric	Value
ROC AUC	0.8526822
Sensitivity	0.7006452
Specificity	0.8757143

TABLE VIII
PERFORMANCE METRICS OF THE GENERALIZED LINEAR MODEL

Overall, the model achieves an accuracy of 0.82 across 146 instances. The macro and weighted averages for precision, recall, and F1-score are also provided, offering a more holistic view of the model's performance across both classes. These metrics collectively provide a comprehensive evaluation of the model's ability to correctly classify individuals based on their likelihood to adopt AV technology.

CONCLUSION AND FUTURE RESEARCH

Our analysis yielded several notable findings, crucial for understanding public sentiment towards AVs in Pittsburgh. A key insight was the role of familiarity with AV technology in influencing adoption likelihood. We found a positive correlation between familiarity levels and willingness to adopt AVs, suggesting that increased public exposure and education about AV technology could enhance its acceptance.

Safety perceptions emerged as another significant factor. Respondents who viewed AVs as safer than traditional vehicles were more inclined to adopt them. This finding emphasizes the importance of safety in public acceptance of AV technology and indicates that advancements in safety features, coupled with effective communication strategies, could bolster public trust in AVs. Moreover, the impact of high-profile incidents, such as the Elaine Herzberg incident, was evident in our analysis. Such events significantly sway public opinion, highlighting the need for AV companies and policymakers to address safety concerns proactively and maintain transparency in their communications following incidents.

The comparative analysis of the 2017 and 2019 surveys provided valuable insights into the changing perceptions and attitudes of pedestrians and bicyclists regarding AVs over time. The increase in exposure to AVs, improved safety perceptions, and growing public approval for AV testing indicate a shift in the acceptance and openness of autonomous vehicles among vulnerable roadway users. These findings emphasize the importance of continued research and engagement with pedestrians and bicyclists to understand their evolving perspectives and address any concerns regarding AV safety.

Future research directions include conducting longitudinal studies to track changes in public perception as AV technology evolves and becomes more integrated into society. Expanding the dataset to include a broader demographic range and other geographic locations is also crucial for a more comprehensive understanding of public sentiment. Additionally, investigating the correlation between regulatory policies and public acceptance could provide valuable insights for policy-making processes. Utilizing advanced machine learning models [15] to predict public acceptance patterns under various future scenarios of AV technology development and deployment is another promising area of future research. The use and implementation of AV technology [10] present both opportunities and challenges. Understanding the perceptions and attitudes of pedestrians and bicyclists towards AVs is crucial for ensuring the successful integration of autonomous vehicles into our transportation systems.

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