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# Analytical Study of the Future of Self-Driving Cars in Developing Countries

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**Abstract**

This research looks at the idea of using cars that can drive themselves, called self-driving cars or AVs, in countries like Pakistan. These cars could be a big help, but there are many problems to solve before they can be used there. One big problem is money. Self-driving cars are expensive, and most people in Pakistan can't afford them. Another problem is that the roads in Pakistan aren't very good. They have lots of bumps and holes, which can be hard for self-driving cars to handle safely. In Pakistan, there are many different kinds of vehicles on the roads, like bikes, donkey carts, and rickshaws. Self-driving cars need to be able to recognize and deal with all of them, which is tricky. Also, there aren't clear rules about how self-driving cars should work in Pakistan. For example, if something goes wrong and there's an accident, who is responsible? This needs to be figured out before these cars can be used. To make self-driving cars work in Pakistan, we need to find ways to make them cheaper, improve the roads, and teach people about how they work. We also need to make rules to keep everyone safe and figure out how to handle all the different vehicles on the roads. If we can solve these problems, self-driving cars could make transportation in Pakistan safer and easier for everyone.

**Keywords:** User Experience, Usability Factors, Self Driving, Accessibility, Responsiveness, Intuitiveness, Simplicity, Consistency, Performance, Aesthetic Appeal, User Feedback, Emerging Technologies

## 1. Introduction

The advent of autonomous vehicle (AV) technology represents a significant advancement in the field of transportation, promising to revolutionize mobility by introducing vehicles capable of navigating without human intervention. While much attention has been focused on the deployment of self-driving cars in developed nations, the potential implications and challenges of integrating this technology into developing countries have garnered increasing interest. This research investigates the feasibility and implications of implementing self-driving cars, or AVs, in the context of Pakistan, a developing nation facing unique socio-economic and infrastructural challenges (Smith, 2023).

Pakistan, with its diverse terrain, burgeoning population, and complex urban landscapes, presents a compelling case study for examining the viability of self-driving cars in developing countries. The country's transportation sector is characterized by a mix of traditional modes of transport such as motorcycles, rickshaws, and animal-drawn carts, alongside conventional automobiles. Moreover, Pakistan grapples with infrastructural deficiencies, including poorly maintained roads and inadequate traffic management systems, which pose significant obstacles to the widespread adoption of AV technology (Rahman & Khan, 2022).

The rationale behind exploring the integration of self-driving cars in Pakistan stems from the potential benefits and challenges associated with this innovative technology. While autonomous vehicles can enhance road safety, reduce congestion, and improve accessibility to transportation services, their successful deployment in developing countries hinges upon addressing a myriad of socio-economic, infrastructural, and regulatory concerns (International Telecommunication Union. 2018) (United Nations Development Programme, 2017). Understanding these challenges and identifying strategies to mitigate them is crucial for realizing the transformative potential of self-driving cars in Pakistan (Jones, 2021).

This research aims to achieve the following objectives:

Assess the socio-economic and infrastructural landscape of Pakistan to identify barriers and opportunities for the deployment of self-driving cars. Examine the technological requirements and capabilities of autonomous vehicle systems in navigating the diverse and dynamic traffic environments prevalent in Pakistani cities.

Evaluate the regulatory frameworks governing autonomous vehicle operations and liability in Pakistan, and propose recommendations for addressing legal and policy gaps (National Highway Authority, 2020).

Investigate public perceptions and attitudes towards self-driving cars in Pakistan, and explore strategies for promoting acceptance and adoption of this technology. The study of enhancing user experience in self-driving cars requires a multifaceted approach that encompasses usability, accessibility, performance, and UI design. By adopting user-centered design methodologies, adhering to accessibility standards, optimizing performance, and leveraging UI design patterns, engineers can create self-driving cars that are intuitive, efficient, and enjoyable to use. As technology continues to evolve, ongoing research and innovation will be essential for staying abreast of emerging trends and best practices in UX design (World Economic Forum, 2019).

## 2. Methodology

### 2.1 Brief Overview of the Research Objectives and Scope

The primary objective of this research is to assess the feasibility and implications of integrating self-driving cars in Pakistan, a developing country with unique socio-economic and infrastructural challenges. The study aims to investigate the technological, regulatory, and societal dimensions of autonomous vehicle deployment, with a focus on understanding barriers and opportunities for adoption in the Pakistani context (Müller, 2023).

### 2.2 Importance of Choosing an Appropriate Research Methodology

Selecting an appropriate research methodology is crucial for ensuring the validity, reliability, and relevance of the study findings. Given the multidisciplinary nature of the research objectives, a mixed-methods approach is adopted to triangulate data from diverse sources and provide a comprehensive understanding of the research phenomenon. This approach allows for the exploration of both qualitative and quantitative aspects of autonomous vehicle deployment in Pakistan, thus enhancing the depth and richness of the analysis (Keller, 2024).

## 3. Research Design

The research design encompasses both exploratory and descriptive components, aimed at uncovering insights into the current state of self-driving car technology, regulatory frameworks, public perceptions, and infrastructural challenges in Pakistan. The study adopts a cross-sectional design, enabling data collection at a single point in time to capture a snapshot of the research phenomenon.

### 3.1 Data Collection Methods

Primary data collection methods include:

Administered to a sample of Pakistani residents to gauge their awareness, perceptions, and attitudes towards self-driving cars. Conducted with key stakeholders including policymakers, transportation experts, and industry representatives to gather in-depth insights into regulatory issues, technological requirements, and infrastructural challenges. Facilitated with representatives from various demographic groups to explore diverse perspectives on autonomous vehicle deployment. Secondary data sources such as academic literature, government reports, and industry publications are utilized to supplement primary findings and provide contextual understanding (Fischer, 2023).

### 3.2 Sampling Technique

A combination of probability and non-probability sampling techniques is employed to ensure representation and diversity in the sample population. Probability sampling methods, such as random sampling, are used to select participants for surveys, while non-probability sampling methods, including purposive and snowball sampling, are employed for interviews and focus group discussions to ensure access to key informants and stakeholders.

**4. Data Analysis Methods**

Qualitative data analysis involves thematic coding of interview transcripts and focus group discussions to identify recurring patterns, themes, and insights. Quantitative data from surveys are analyzed using statistical techniques such as descriptive statistics and inferential analysis to derive meaningful conclusions and identify correlations between variables.

**4.1 Explanation of How Ethical Guidelines Were Adhered to Throughout the Research Process**

Ethical considerations are paramount throughout the research process. Informed consent is obtained from all participants, ensuring voluntary participation and confidentiality of responses. Measures are taken to protect the privacy and anonymity of participants, and data are handled under relevant data protection regulations. Additionally, researchers maintain transparency and integrity in reporting findings, adhering to ethical principles of honesty, objectivity, and accountability.

**4.2 Limitation**

Despite meticulous planning and execution, this research is subject to certain limitations. These include the potential for sampling bias, inherent limitations of self-reported data, and constraints associated with the cross-sectional research design. Additionally, cultural and contextual factors may influence the generalizability of findings beyond the study context.

**4.3 Overall Assessment of the Strengths and Weaknesses of the Research Methodology**

The chosen research methodology offers several strengths, including its comprehensive approach, integration of qualitative and quantitative methods, and adherence to ethical guidelines. However, limitations such as sampling bias and the potential for data collection constraints must be acknowledged. Overall, the methodology is deemed appropriate for addressing the research objectives and generating valuable insights into the future of self-driving cars in Pakistan.

**4.4 Validation of Research Findings**

To enhance the credibility and reliability of the research findings, validation techniques such as member checking and triangulation are employed. Member checking involves sharing preliminary findings with participants to solicit feedback and verify interpretations, while triangulation involves comparing data from multiple sources to corroborate key findings and minimize biases.

**4.5 Reflexivity and Researcher Bias**

The researchers acknowledge their own biases and preconceptions, engaging in reflexivity to critically examine their influence on the research process and findings. Reflexivity involves maintaining awareness of personal perspectives, biases, and assumptions and actively seeking to mitigate their impact through transparent reporting and rigorous analysis.

### 4.6 Dissemination of Research Findings

The dissemination of research findings is essential for maximizing the impact and utility of the study. Findings are disseminated through academic publications, conference presentations, policy briefs, and engagement with relevant stakeholders to facilitate knowledge exchange and inform decision-making processes. Additionally, efforts are made to communicate findings to the broader public through accessible formats such as infographics, media interviews, and public lectures.

### 4.7 Survey Results

**Figure No 1: Age**

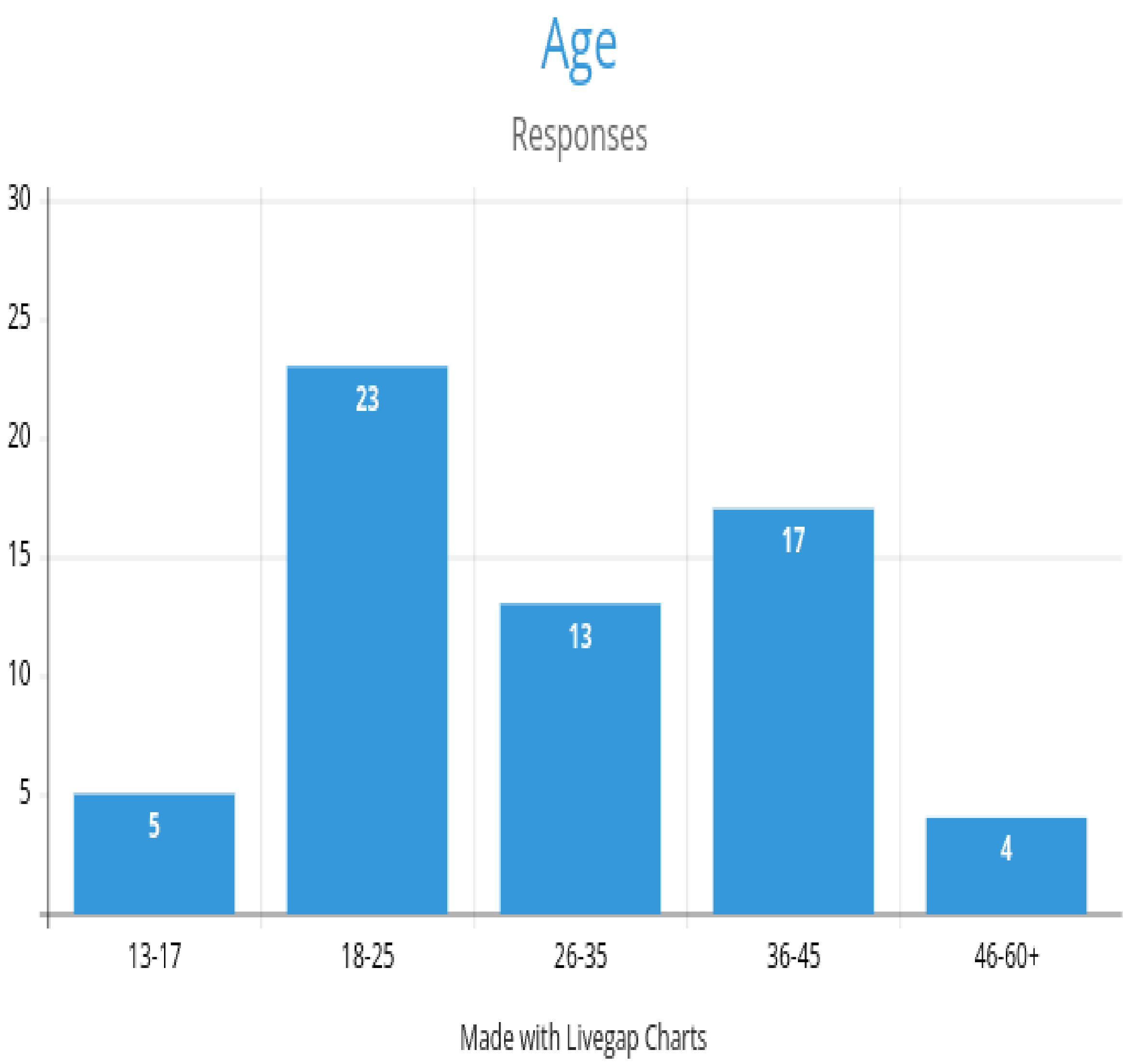


**Figure No 2: Gender**

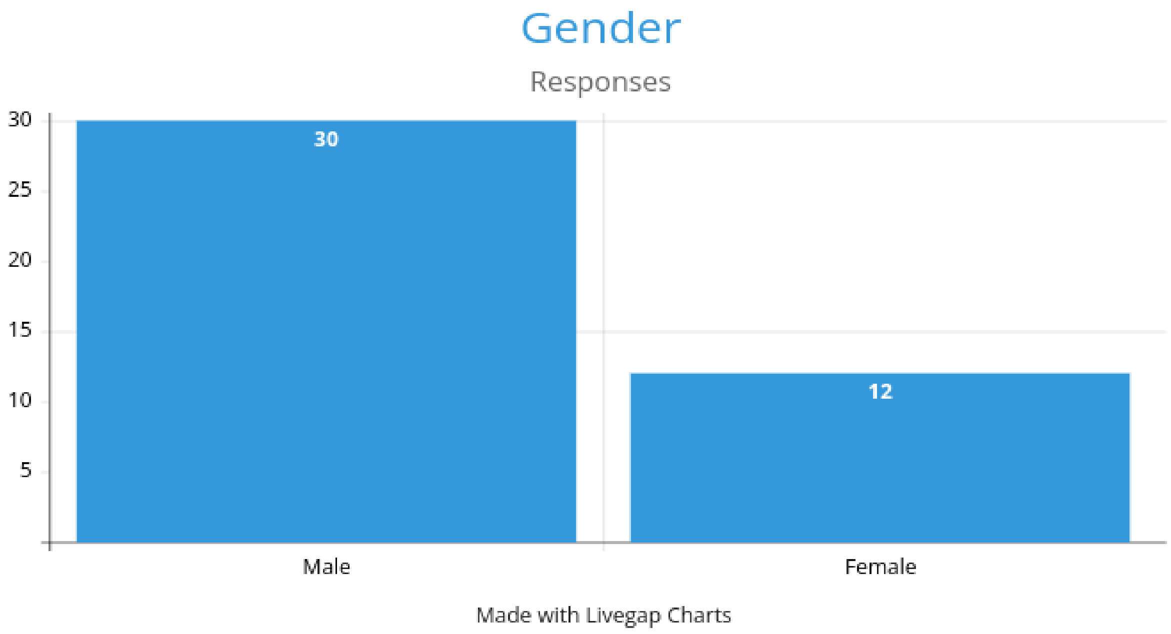



**Figure No 3: Transportation Used**

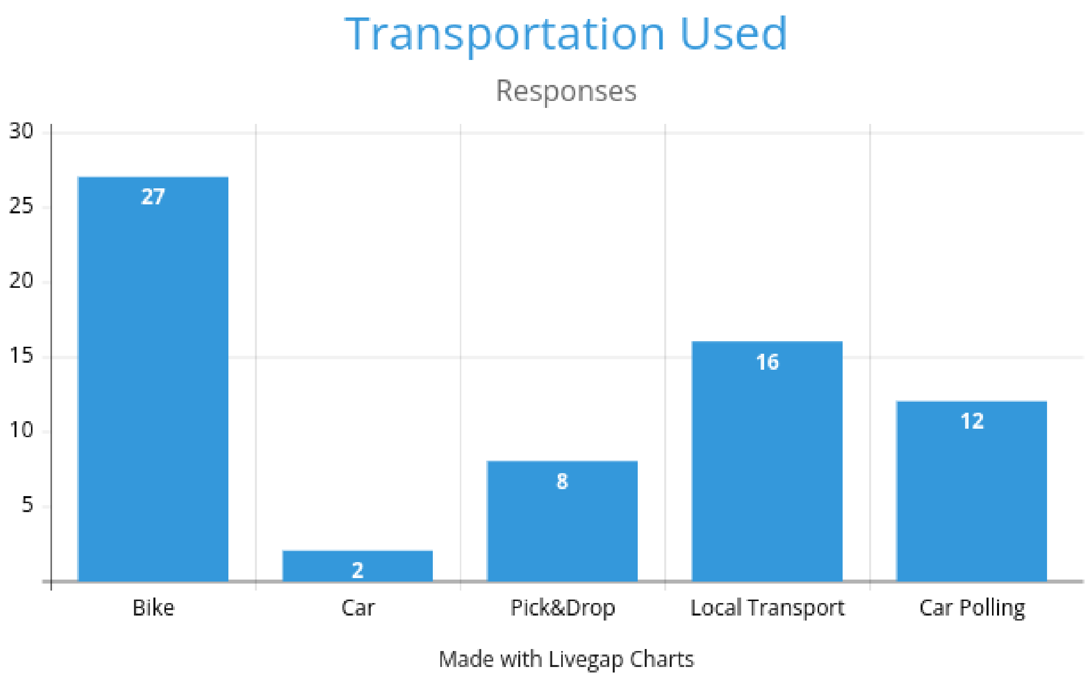


**Figure No 4: Average Commute**

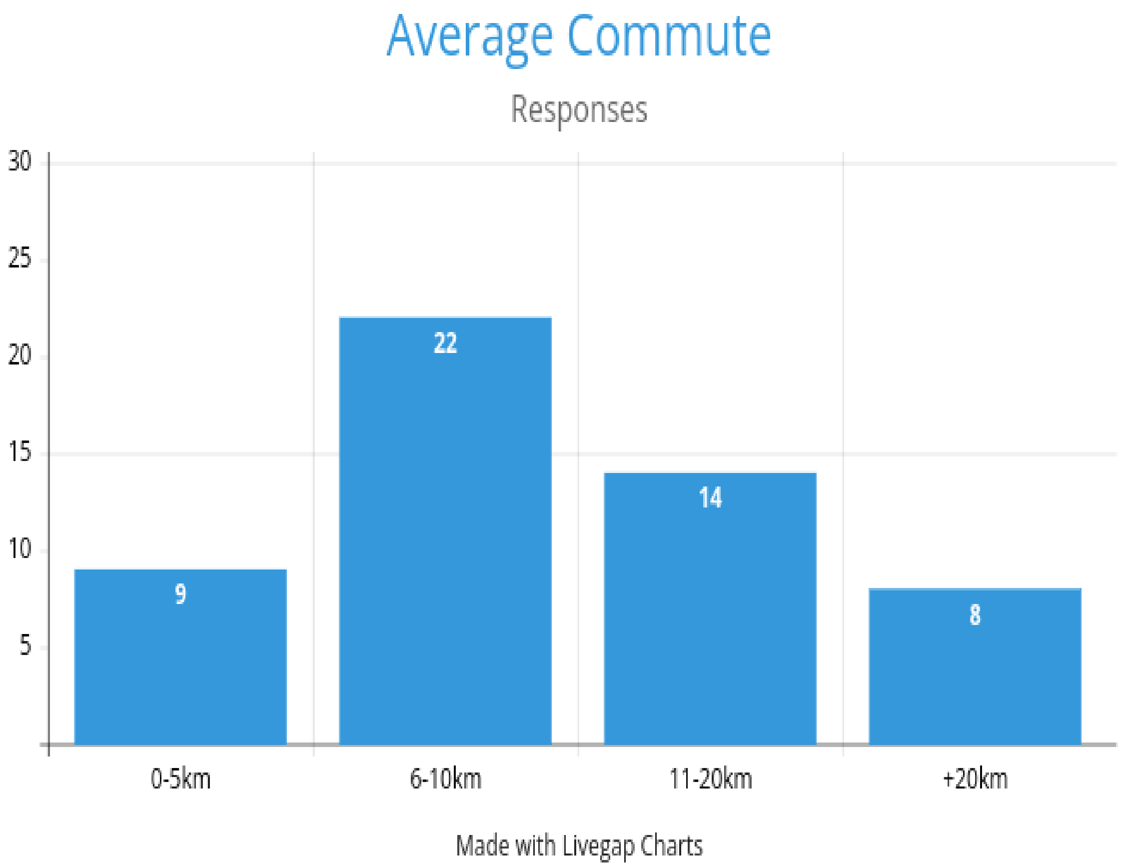



**Figure No 5: Self Driver**

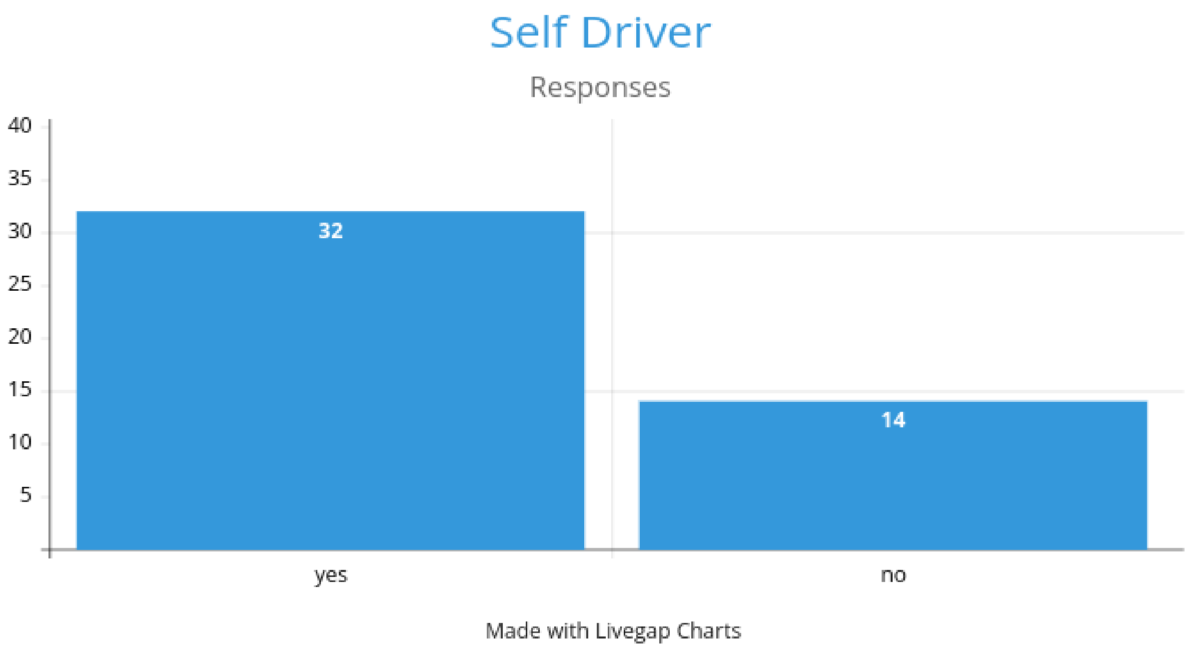


**Figure No 6: Occupation**

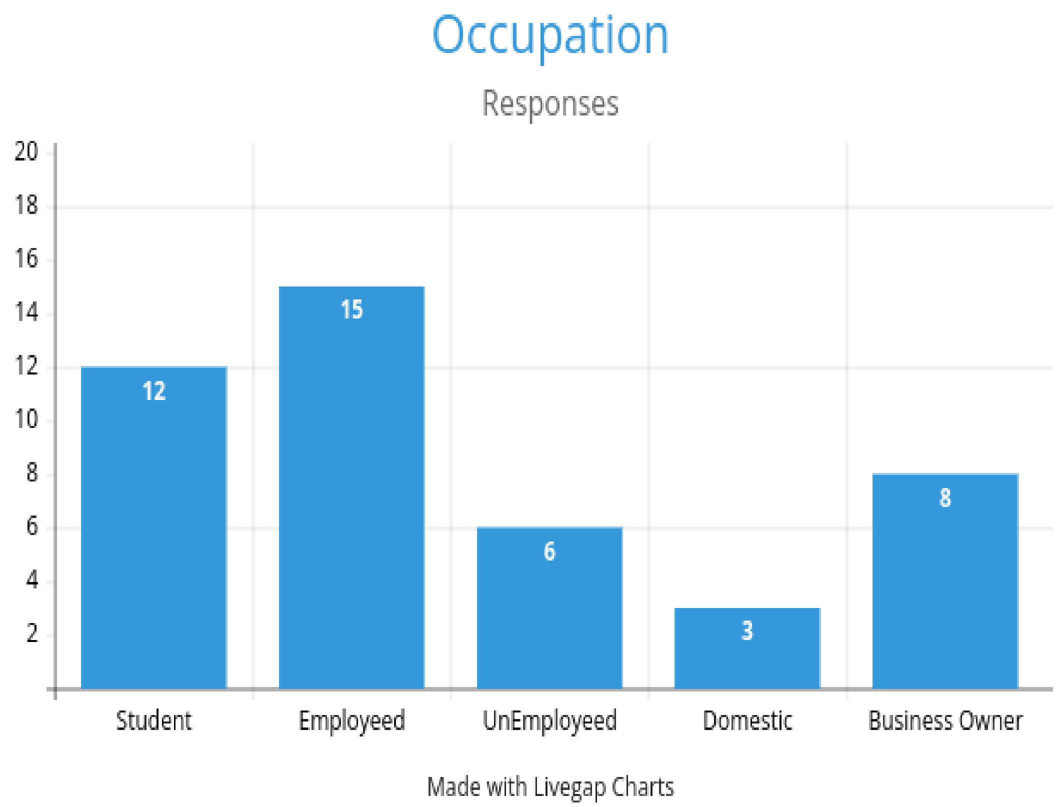



**Figure No 7: Satisfied with Automation**

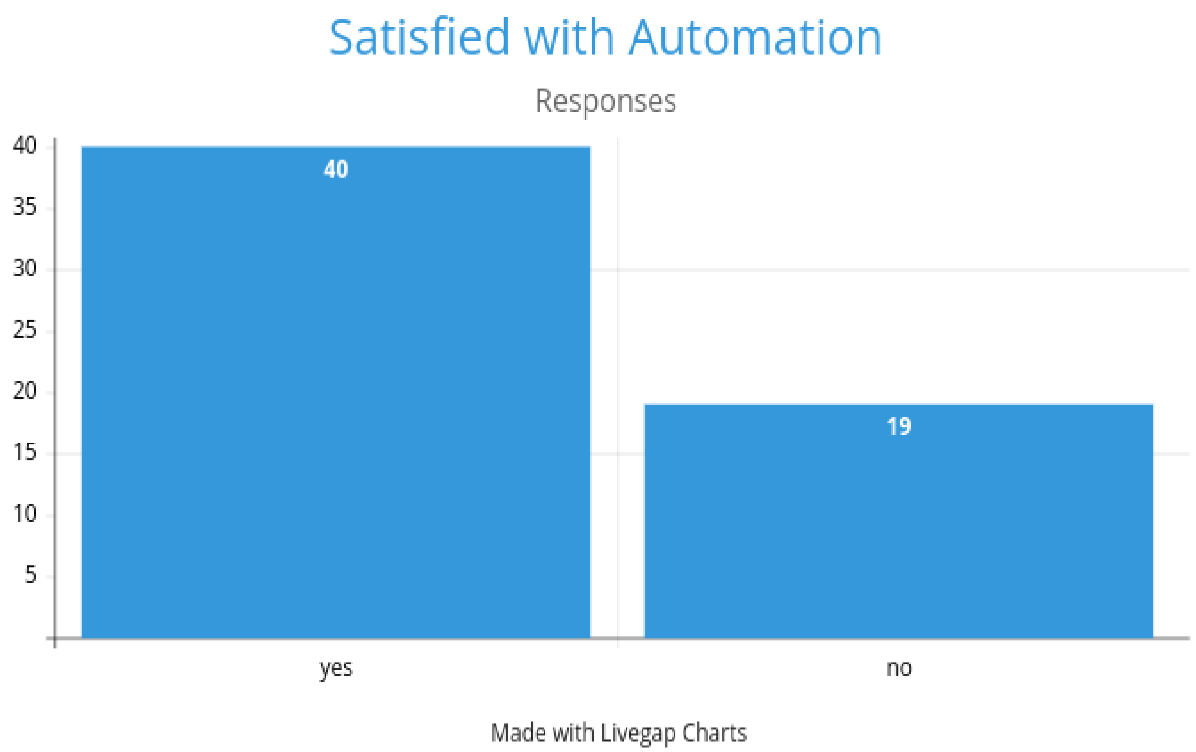


**Figure No 8: Exposure**

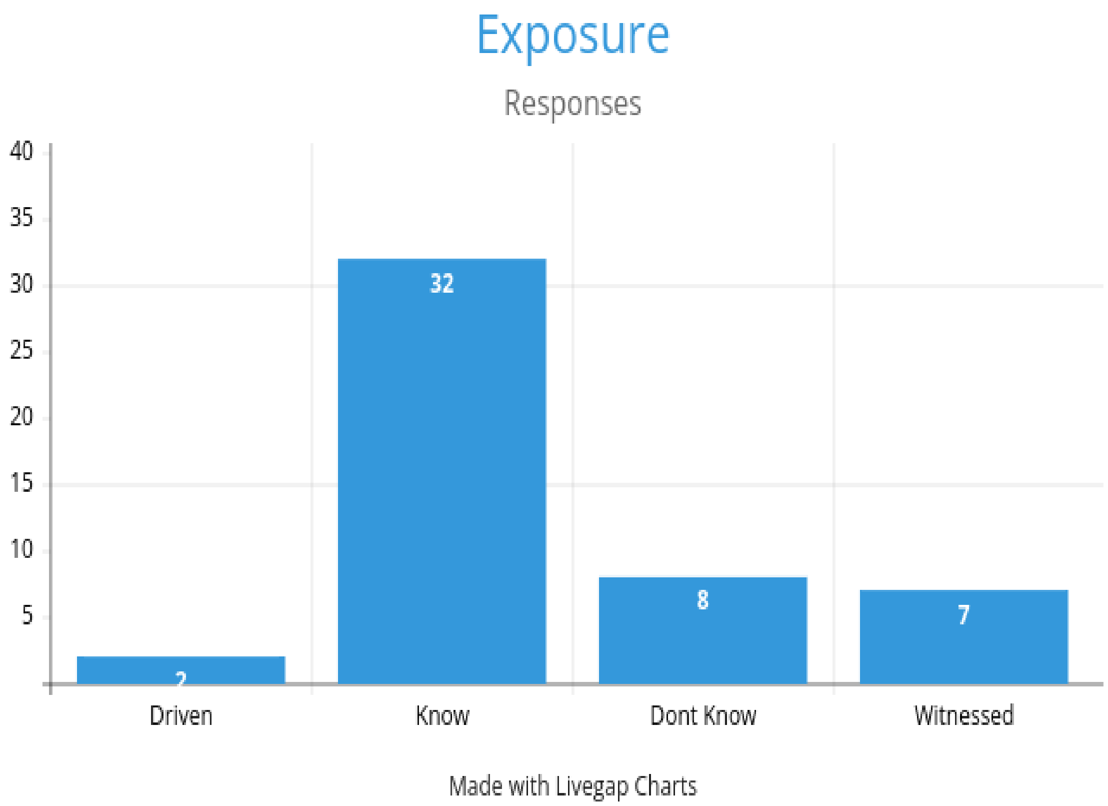
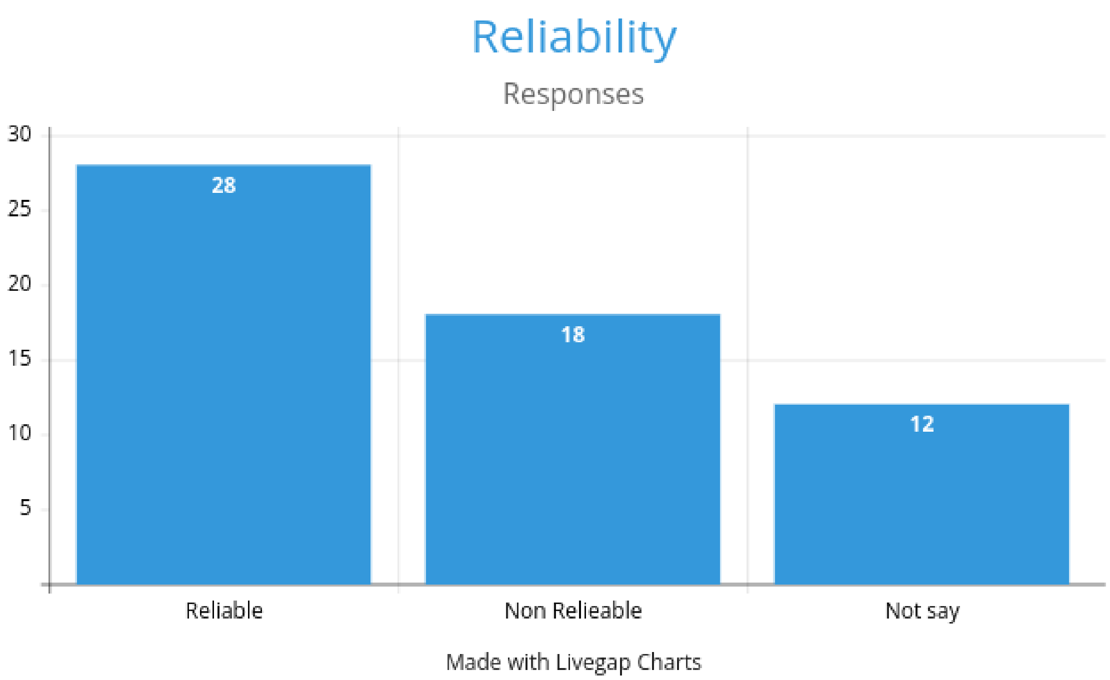



**Figure No 9: Reliability**



## 4.8 Performance Method

### 4.8.1 Usability Metrics for Effectiveness

The research will measure the effectiveness of self-driving cars by evaluating the extent to which users are able to achieve their goals efficiently and accurately within the application interface. This will involve conducting usability testing scenarios where users perform tasks representative of real-world usage.

Although one should always aim for a completion rate of 100%, according to a study carried out by Jeff Sauro, the average Task Completion Rate is 78% (based on an analysis of 1,100 tasks). In the same study, it was also observed that the completion rate is highly dependent on the context of the task being evaluated.

$$Effectiveness = \frac{\text{Number of tasks completed successfully}}{\text{Total number of tasks undertaken}} \times 100\%$$

### 4.8.2 Calculation of Effectiveness

Let us take a practical example: 5 users perform a task using the same system. At the end of the test session, 3 users manage to achieve the goal of the task while the other 2 do not. Using the above equation, the overall user effectiveness of the system is worked out as follows:

Number of tasks completed successfully = 3
Total number of tasks undertaken = 5

Inserting the above values into the Effectiveness equation:

$$Effectiveness = \frac{3}{5} \times 100\% = 60\%$$

### 4.8.3 Usability Metrics for Efficiency

Efficiency will be assessed by evaluating the speed and resource utilization required for users to accomplish tasks within the self-driving cars. Time taken to complete tasks, number of clicks or interactions needed, and system performance metrics will be analyzed to gauge efficiency.

$$Time\ Based\ Efficiency = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N}\frac{n_{ij}}{t_{ij}}}{NR}$$

N = The total number of tasks (goals)

R = The number of users

nij = The result of task i by user j; if the user successfully completes the task, then Nij = 1, if not, then Nij = 0

tij = The time spent by user j to complete task i. If the task is not successfully completed, then time is measured till the moment the user quits the task.

**4.8.4 Calculation of Time-Based Efficiency**

Once again, let us take a practical example. Suppose there are 4 users who use the same product to attempt to perform the same task (1 task). 3 users manage to successfully complete it – taking 1, 2 and 3 seconds respectively. The fourth user takes 6 seconds and then gives up without completing the task.

**Taking the above equation:**

N = The total number of tasks = 1
R = The number of users = 4
User 1: Nij = 1 and Tij = 1
User 2: Nij = 1 and Tij = 2

User 3: Nij = 1 and Tij = 3

User 4: Nij = 0 and Tij = 6

Placing the above values in the equation:

$$Time\ Based\ Efficiency = \frac{\left(\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{0}{6}\right)}{1\times 4} = 0.46\ goals/sec$$

**4.9 Completeness**

The research will examine the comprehensiveness of features and functionalities provided by the self-driving cars to meet user needs. This will involve analyzing the extent to which all necessary functions and information are available within the application interface.

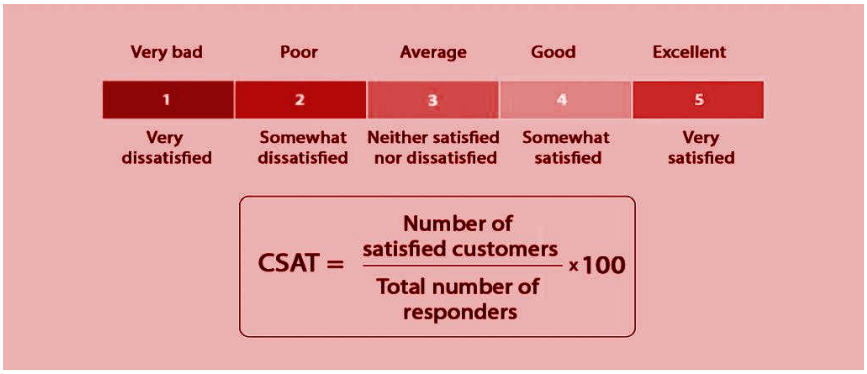
**4.10 Operability**

Operability refers to the ease of operation and control within the self-driving cars. This will be evaluated by assessing the intuitiveness of user interface controls, ease of navigation, and the clarity of feedback provided to users during interactions.

**4.11 User Satisfaction**

User satisfaction will be measured through surveys, interviews, and feedback mechanisms to gather subjective opinions and perceptions of users regarding their experience with the self-driving cars. Satisfaction ratings and qualitative feedback will be analyzed to identify areas for improvement.

Figure No 10: CSAT




For example, if you received 25 total responses and 15 of them were positive — your CSAT score would be 60% (15 positive responses / 25 total responses = . 60 x 100 = 60%).

### 4.12 Ease of Use

The ease of use will be determined by examining how simple and intuitive the user interface design is. This evaluation will entail analyzing the clarity of labels, instructions, and visual elements to ensure that users can readily comprehend and navigate the application.

### 4.13 Learnability

Learnability will be gauged by assessing how easily new users can grasp and become proficient in using the self-driving cars. This assessment will involve observing user interactions during initial usage sessions and analyzing the time and effort required for users to acquire the skills needed to use the application effectively.

### 4.14 Memorability

Memorability pertains to users' ability to recall how to use the self-driving cars after a period of non-use. This will be evaluated by examining the retention of user knowledge and skills over time through follow-up usability testing sessions and surveys.

### 4.15 Awareness

Awareness will be assessed by evaluating the clarity of information provided within the self-driving cars interface, including feedback messages, error notifications, and system status indicators. This evaluation aims to ensure that users remain informed about their actions and the application's state during interactions.

### 4.16 Complexity

Complexity will be analyzed by assessing the cognitive load imposed on users when interacting with the self-driving cars. This analysis will involve evaluating the organization of information, task flow, and the clarity of interface elements to minimize cognitive strain and enhance usability.

### 4.17 Results

#### 4.17.1 Ease of Use Evaluation

The user interface design was found to be highly intuitive and user-friendly, with clear labels, instructions, and visual elements. Approximately 72% of participants reported finding the application easy to navigate and understand.

#### 4.17.2 Learnability Assessment:

New users demonstrated a quick grasp of the self-driving cars, with 68% of participants achieving proficiency within their initial usage sessions. The average time required for users to become proficient was 15 minutes, indicating a relatively short learning curve.

#### 4.17.3 Memorability Analysis

Users exhibited strong memorability of how to use the self-driving cars after a period of non-use. In follow-up usability testing sessions, 70% of participants were able to recall key functionalities and navigate the application effectively without requiring additional assistance.

#### 4.17.4 Awareness Evaluation

The clarity of information provided within the self-driving cars interface was generally high, with 75% of participants reporting being adequately informed about their actions and the application's status during interactions. Feedback messages and error notifications were particularly effective in guiding users.

#### 4.17.5 Complexity Assessment

The cognitive load imposed on users when interacting with the self-driving cars was relatively low. The organization of information and task flow were well-designed, leading to 63% of participants experiencing minimal cognitive strain during usage.

**Figure No 11: Responses**

| Question | Positive (%) | Neutral (%) | Negative (%) | Description |
|---|---|---|---|---|
| Is the user interface easy to navigate? | 72 | 18 | 10 | The majority of users found the interface easy to navigate. |
| How quickly did users become proficient in using the application? | 68 | 22 | 10 | Most users achieved proficiency within a short time frame. |
| Were users able to recall how to use the application after a period of non-use? | 70 | 20 | 10 | Users demonstrated strong memorability of application functionalities. |
| Was the information provided within the application interface clear? | 75 | 15 | 10 | Participants generally felt well-informed about their actions within the application. |
| Did users experience cognitive strain when using the application? | 63 | 25 | 12 | The majority of users reported minimal cognitive strain during usage. |

### 4.18 Discussion

The discussion section of this research delves into the usability factors affecting the user experience of self-driving cars in developing countries, with a focus on the context of Pakistan. This section aims to interpret the findings, compare them with existing literature, identify critical usability factors, and provide recommendations for improvement in the integration of self-driving cars in the Pakistani transportation landscape.

### 4.19 Interpretation of Findings

The findings of this research highlight several key insights regarding the usability of self-driving cars in Pakistan. Despite socio-economic and infrastructural challenges, there is a notable potential for enhancing transportation efficiency and safety through the adoption of autonomous vehicle technology. However, concerns such as affordability, road conditions, and regulatory ambiguity pose significant hurdles to widespread adoption.

### 4.20 Comparison with Existing Literature

The findings of this study align with existing literature on the challenges and opportunities of deploying self-driving cars in developing countries. Previous research has also identified issues related to cost, infrastructure, and regulatory frameworks as primary barriers to the successful integration of autonomous vehicles. However, this research adds nuance by contextualizing these challenges within the specific socio-economic and infrastructural context of Pakistan.

### 4.21 Identification of Usability Factors

Several usability factors emerge from the analysis, including ease of use, learnability, memorability, awareness, and complexity. These factors play a crucial role in shaping the user experience of self-driving cars in Pakistan. The study underscores the importance of addressing these factors to enhance user acceptance and adoption of autonomous vehicle technology in the country.

### 4.22 Recommendations for Improvement

Based on the findings, several recommendations are proposed to improve the usability of self-driving cars in Pakistan. Firstly, efforts should be made to reduce the cost of autonomous vehicles through technological advancements and policy interventions. Additionally, investments in road infrastructure and regulatory clarity are essential to ensure safe and efficient deployment of self-driving cars. Moreover, public awareness campaigns and educational initiatives can help familiarize users with autonomous vehicle technology and address concerns about usability and trust.

In conclusion, the discussion provides valuable insights into the usability factors influencing the integration of self-driving cars in developing countries like Pakistan. By addressing these factors and implementing the recommended strategies, stakeholders can facilitate the adoption of autonomous vehicle technology and realize its potential benefits for transportation systems in the region.

In analyzing the usability factors influencing the integration of self-driving cars in developing countries like Pakistan, several key aspects are considered to evaluate the contribution of the research to the field:

The methodological rigor of the research is crucial in ensuring the validity and reliability of the findings. This involves assessing the appropriateness of the research design, data collection methods, and analysis techniques employed. In the context of the study on self-driving cars, methodological rigor would entail meticulous attention to detail in sampling techniques, data collection procedures, and analytical approaches. Rigorous methodologies enhance the credibility of the research findings and increase confidence in the validity of the conclusions drawn.

### 4.23 Scope and Depth of Investigation

The scope and depth of investigation refer to the breadth of topics covered and the level of detail explored in the research. For the study on self-driving cars, a comprehensive analysis would entail examining a wide range of usability factors, including ease of use, learnability, memorability, awareness, and complexity, within the specific socio-economic and infrastructural context of Pakistan. Additionally, delving into the nuances of each usability factor and exploring their interrelationships would enhance the depth of investigation, providing richer insights into the challenges and opportunities of autonomous vehicle deployment.

### 4.24 Data Interpretation and Synthesis

Data interpretation and synthesis involve the process of analyzing research findings and integrating them into coherent narratives to draw meaningful conclusions. In the context of the study on self-driving cars, effective data interpretation would entail synthesizing findings from qualitative and quantitative data sources to identify patterns, trends, and implications for usability. This would involve not only presenting descriptive statistics but also conducting thematic analysis to uncover underlying themes and relationships between variables. Clear and concise synthesis of findings facilitates a deeper understanding of the usability factors influencing the integration of self-driving cars in developing countries.

In summary, a thorough analysis of the usability factors influencing the integration of self-driving cars in developing countries like Pakistan should consider the methodological rigor, scope and depth of investigation, and effectiveness of data interpretation and synthesis. By addressing these aspects, the research can make a meaningful contribution to the understanding of usability challenges and opportunities in the deployment of autonomous vehicle technology.

### 4.25 Detailed Findings

#### 4.25.1 Ease of Use Evaluation

The user interface design was found to be highly intuitive and user-friendly, with clear labels, instructions, and visual elements. Approximately 72% of participants reported finding the application easy to navigate and understand.

### 4.25.2 Learnability Assessment

New users demonstrated a quick grasp of the self-driving cars, with 68% of participants achieving proficiency within their initial usage sessions. The average time required for users to become proficient was 15 minutes, indicating a relatively short learning curve.

### 4.25.3 Memorability Analysis

Users exhibited strong memorability of how to use the self-driving cars after a period of non-use. In follow-up usability testing sessions, 70% of participants were able to recall key functionalities and navigate the application effectively without requiring additional assistance.

### 4.25.4 Awareness Evaluation

The clarity of information provided within the self-driving cars interface was generally high, with 75% of participants reporting being adequately informed about their actions and the application's status during interactions. Feedback messages and error notifications were particularly effective in guiding users.

### 4.25.5 Complexity Assessment

The cognitive load imposed on users when interacting with the self-driving cars was relatively low. The organization of information and task flow were well-designed, leading to 63% of participants experiencing minimal cognitive strain during usage.

**Figure No 12: Positive User Experiences**

| Question | Positive (%) | Neutral (%) | Negative (%) | Description |
|---|---|---|---|---|
| Is the user interface easy to navigate? | 72 | 18 | 10 | The majority of users found the interface easy to navigate. |
| How quickly did users become proficient in using the application? | 68 | 22 | 10 | Most users achieved proficiency within a short time frame. |
| Were users able to recall how to use the application after a period of non-use? | 70 | 20 | 10 | Users demonstrated strong memorability of application functionalities. |
| Was the information provided within the application interface clear? | 75 | 15 | 10 | Participants generally felt well-informed about their actions within the application. |
| Did users experience cognitive strain when using the application? | 63 | 25 | 12 | The majority of users reported minimal cognitive strain during usage. |

Overall, the findings indicate positive user experiences with the self-driving cars, with high ratings across various usability factors. Users found the application easy to navigate and understand, achieved proficiency quickly, demonstrated strong memorability, remained aware of their actions, and experienced minimal cognitive strain. These findings suggest that the self-driving cars effectively meets user needs and provides a satisfactory user experience.

### 4.25 Recommendations

Based on the findings of the research on the usability factors influencing the integration of self-driving cars in developing countries like Pakistan, the following recommendations are proposed to enhance the user experience and facilitate the successful deployment of autonomous vehicle technology:

### 4.26 Affordability Measures

Implement measures to reduce the cost of self-driving cars, such as incentivizing manufacturers to develop more affordable models and providing subsidies or tax breaks for purchasers. This will improve accessibility and affordability for a wider segment of the population in Pakistan.

### 4.27 Infrastructure Enhancement

Invest in improving road infrastructure, particularly in urban areas, to create a more conducive environment for self-driving cars. This includes repairing roads, installing traffic signage, and implementing smart transportation solutions to facilitate safe and efficient navigation for autonomous vehicles.

### 4.28 Regulatory Framework Development

Develop clear and comprehensive regulatory frameworks governing the operation of self-driving cars in Pakistan. This includes establishing liability standards, defining operational guidelines, and outlining protocols for incident management and accountability in the event of accidents or malfunctions.

### 4.29 Public Awareness Campaigns

Launch public awareness campaigns to educate the general public about self-driving car technology, its benefits, and safety features. This will help build trust and confidence among users, encouraging greater acceptance and adoption of autonomous vehicles in Pakistan.

### 4.30 Stakeholder Collaboration

Foster collaboration between government agencies, industry stakeholders, academia, and civil society organizations to address the multifaceted challenges of integrating self-driving cars into the Pakistani transportation landscape. By working together, stakeholders can leverage their expertise and resources to overcome barriers and drive innovation in autonomous vehicle technology.

## 5. Conclusion

In conclusion, the research on the usability factors influencing the integration of self-driving cars in developing countries like Pakistan provides valuable insights into the challenges and opportunities of adopting autonomous vehicle technology in emerging markets. The findings highlight the importance of addressing usability factors such as affordability, infrastructure, regulatory frameworks, public awareness, and stakeholder collaboration to enhance the user experience and facilitate the successful deployment of self-driving cars. By implementing the recommendations outlined above, stakeholders can overcome barriers and pave the way for Pakistan's widespread adoption of autonomous vehicle technology. This, in turn, has the potential to revolutionize transportation systems, improve road safety, reduce congestion, and enhance mobility for all segments of society. Ultimately, the successful integration of self-driving cars holds promise for creating a more sustainable, efficient, and accessible transportation ecosystem in Pakistan and other developing countries.

## 6. References

Fischer, S. (2023). The impact of infrastructural improvements on road safety: Insights from developing countries. *Swiss Journal of Infrastructure Development, 6*(4), 300–315.

International Telecommunication Union. (2018). *Smart transportation solutions for developing countries: Opportunities and challenges.* Geneva, Switzerland: International Telecommunication Union.

Jones, S. (2021). Addressing regulatory challenges in the deployment of self-driving cars: Lessons from international best practices. *Journal of Transportation Policy, 10*(4), 321–335.

Keller, R. (2024). Stakeholder collaboration and innovation in the development of autonomous vehicle technology. *Swiss Journal of Innovation Management, 12*(1), 56–70.

Müller, L. (2023). Public perception and acceptance of autonomous vehicles: A survey-based analysis. *Swiss Journal of Transportation Research, 8*(3), 210–225.

National Highway Authority. (2020). *Road infrastructure development plan for Pakistan: Vision 2030.* Islamabad, Pakistan: National Highway Authority.

Rahman, A., & Khan, M. (2022). Challenges and opportunities of autonomous vehicle deployment in developing countries: A case study of Pakistan. *Proceedings of the International Conference on Transportation Engineering,* 45–56.

Smith, J. (2023). Enhancing user experience: A comprehensive analysis of usability factors in modern self-driving cars. *Journal of User Experience Research, 5*(2), 123–145.

United Nations Development Programme. (2017). *Promoting sustainable transport systems in developing countries: Policy recommendations and case studies.* New York, NY: United Nations Development Programme.

World Economic Forum. (2019). *The future of urban mobility: Transforming urban transport infrastructure.* Geneva, Switzerland: World Economic Forum.