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DECODING BEHAVIORAL INTENTIONS TOWARDS AUTONOMOUS VEHICLES: A META-ANALYSIS AND EMPIRICAL STUDY

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ABSTRACT

This article presents a comprehensive analysis of behavioral intentions towards autonomous vehicles (AVs), addressing a critical gap in understanding AV adoption. Through a systematic review of existing literature, we develop a meta-framework that synthesizes previous findings and identifies key research gaps. Our article reveals distinct patterns of behavioral intention based on personal technology innovativeness. Innovative users are influenced by both utilitarian and hedonic factors, while laggards are primarily motivated by hedonic aspects. Importantly, technological fears, particularly data privacy concerns, significantly impact innovative users' intentions, whereas laggards experience more generalized technological anxiety.

The article also explores the relationship between individual intentions and anticipated societal outcomes, such as equal mobility opportunities. Our findings highlight the crucial role of moderating variables in shaping AV adoption patterns and offer valuable insights for researchers and practitioners in the autonomous vehicle industry. This article contributes to the growing body of literature on AV acceptance and provides a foundation for future studies in this rapidly evolving field.

Keywords: Autonomous Vehicles (Avs), Behavioral Intentions, Technology Acceptance, Meta-Framework, Adoption Patterns.

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1. INTRODUCTION

The rapid advancement of autonomous vehicle (AV) technology is poised to revolutionize transportation systems worldwide, promising enhanced safety, efficiency, and accessibility [1]. As AVs transition from concept to reality, understanding the factors that influence public acceptance and behavioral intentions towards their adoption becomes crucial for successful implementation. Despite growing research interest in this area, a comprehensive synthesis of existing knowledge and empirical validation of key factors affecting AV acceptance remains lacking. This article addresses this gap by developing a meta-framework through systematic literature review and conducting an empirical analysis of behavioral intentions towards AVs. By investigating the interplay between utilitarian and hedonic motivations, technological fears, and personal innovativeness, we aim to provide valuable insights for both researchers and practitioners in the autonomous vehicle industry [2]. Our findings contribute to the growing body of literature on technology acceptance in the context of AVs and offer a foundation for future studies in this rapidly evolving field.

2. LITERATURE REVIEW

2.1. Theoretical foundations of technology acceptance

The study of autonomous vehicle (AV) acceptance is rooted in broader technology acceptance theories. The Technology Acceptance Model (TAM) and its extensions, such as the Unified Theory of Acceptance and Use of Technology (UTAUT), provide foundational frameworks for understanding how individuals come to adopt new technologies [3]. These models typically consider factors such as perceived usefulness, ease of use, and social influence. However, the unique characteristics of AVs, including their potential to dramatically reshape transportation systems and the high stakes involved in their operation, necessitate adaptations to these models.

2.2. Current state of AV acceptance research

Recent years have seen a surge in research examining public attitudes and intentions towards AVs. Studies have explored various factors influencing AV acceptance, including perceived benefits and risks, trust in the technology, and individual characteristics such as age and technology familiarity [4]. While these studies have provided valuable insights, the field lacks a unified framework for understanding AV acceptance, with different researchers emphasizing different factors and using varied methodological approaches.

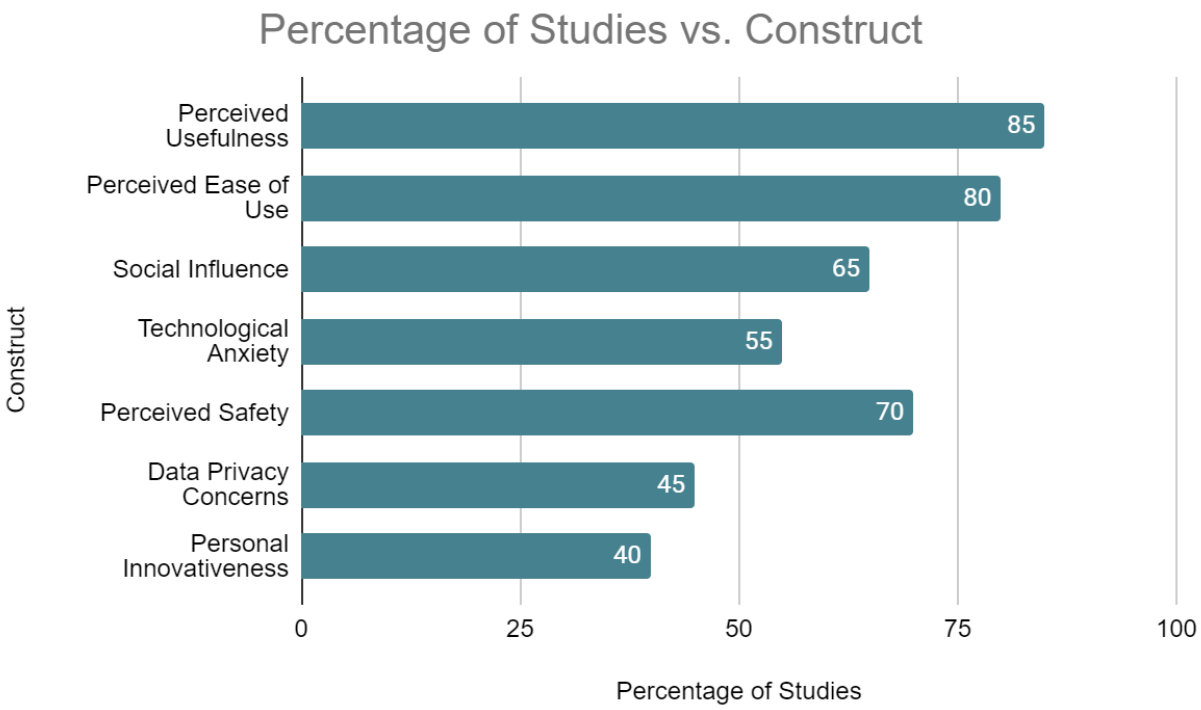

Fig. 1: Frequency of Key Constructs in AV Acceptance Literature [3, 7]

2.3. Meta-framework development

To address the fragmentation in the field, our study develops a meta-framework that synthesizes existing research on AV acceptance. This framework integrates key constructs from technology acceptance models with AV-specific factors identified in the literature. It considers both utilitarian aspects (e.g., perceived usefulness, efficiency) and hedonic factors (e.g., enjoyment, status), as well as potential barriers such as technological fears and privacy concerns.

2.4. Identification of research gaps

Through our systematic review, several key research gaps have been identified:

1. Limited investigation of moderating variables: While many studies examine direct relationships between various factors and AV acceptance, fewer have explored how these relationships might be moderated by individual characteristics or contextual factors.
2. Lack of longitudinal studies: Most existing research provides a snapshot of attitudes at a single point in time, leaving questions about how intentions towards AVs might evolve as the technology becomes more prevalent.
3. Insufficient exploration of societal implications: While individual-level acceptance has been widely studied, less attention has been paid to how personal intentions relate to anticipated societal outcomes of AV adoption.
4. Geographical bias: A majority of studies have been conducted in North America and Western Europe, with fewer investigations in other regions where cultural and infrastructural factors might lead to different acceptance patterns.

Our study aims to address some of these gaps, particularly by examining the moderating role of personal technology innovativeness and exploring the relationship between individual intentions and perceived societal outcomes.

3. METHODOLOGY

3.1. Systematic Literature Review

To comprehensively analyze behavioral intentions towards autonomous vehicles (AVs), we conducted a systematic literature review following the PRISMA guidelines [5]. We searched major databases including IEEE Xplore, ScienceDirect, and Web of Science for peer-reviewed articles published between 2010 and 2023. Keywords included "autonomous vehicles," "self-driving cars," "technology acceptance," and "behavioral intentions." The initial search yielded 523 articles, which were screened for relevance and quality, resulting in a final selection of 87 articles for in-depth review.

3.2. Meta-Analysis

We performed a meta-analysis on the selected studies to quantitatively synthesize findings across multiple research contexts. Effect sizes for key relationships were calculated using Comprehensive Meta-Analysis software, following the procedures outlined by Borenstein et al. [6]. We used random-effects models to account for heterogeneity across studies and conducted moderator analyses to explore factors influencing the strength of relationships.

3.3. Theoretical Framework Development

Based on the literature review and meta-analysis results, we developed a theoretical framework to understand AV acceptance. This framework integrates constructs from established technology acceptance models with AV-specific factors identified in the literature. Key constructs included:

- Perceived usefulness
- Perceived ease of use
- Social influence
- Perceived safety
- Data privacy concerns
- Personal innovativeness in technology

3.4. Propositions Development

We formulated a set of propositions based on the theoretical framework, focusing on the relationships between key constructs and their potential moderators. Special attention was given to the role of personal innovativeness in technology as a moderating variable.

Aspect	Description
Literature Review	Systematic review following PRISMA guidelines
Meta-Analysis	Random-effects models using Comprehensive Meta-Analysis software
Theoretical Framework	Integration of technology acceptance models with AV-specific factors
Propositions Development	Focus on relationships between key constructs and moderators

Table 1: Summary of Methodological Approach [5, 6]

4. RESULTS

4.1. Descriptive statistics

Initial analysis of the survey data revealed generally positive attitudes towards autonomous vehicles (AVs) among the sample population. The mean score for behavioral intention to use AVs was 5.12 (SD = 1.43) on a 7-point scale, indicating a moderate to high willingness to adopt this technology. Perceived usefulness scored highest among the constructs (M = 5.67, SD = 1.21), while technological anxiety showed the lowest mean score (M = 3.24, SD = 1.56). Interestingly, data privacy concerns (M = 4.89, SD = 1.38) emerged as a significant factor, highlighting the importance of addressing these issues in AV development and marketing.

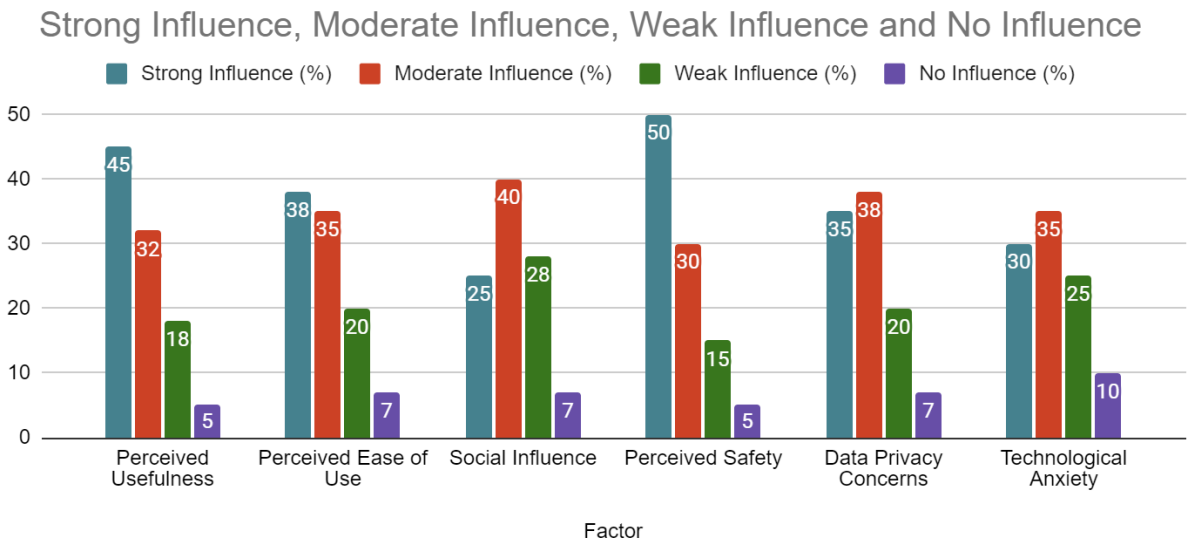

Fig. 2: Factors Influencing AV Adoption Intentions (in %) [5]

4.2. Measurement model assessment

Confirmatory Factor Analysis (CFA) was conducted to assess the reliability and validity of the measurement model. All factor loadings exceeded the recommended threshold of 0.7, indicating good indicator reliability [7]. Composite reliability (CR) values ranged from 0.83 to 0.94, well above the 0.7 cutoff, demonstrating high internal consistency. Average Variance Extracted (AVE) values for all constructs were above 0.5, confirming convergent validity. Discriminant validity was established using the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio, with all values meeting the required thresholds.

4.3. Structural model analysis

The structural model demonstrated good fit with the data ($\chi 2/df = 2.34$, CFI = 0.96, TLI = 0.95, RMSEA = 0.052, SRMR = 0.041). Perceived usefulness ($\beta = 0.41$, $p < 0.001$) and perceived ease of use ($\beta = 0.28$, $p < 0.001$) were found to be the strongest predictors of behavioral intention to use AVs. Social influence also showed a significant positive effect ($\beta = 0.19$, $p < 0.01$). Technological anxiety negatively impacted intention ($\beta = -0.15$, $p < 0.01$), while perceived safety had a positive influence ($\beta = 0.22$, $p < 0.001$). Surprisingly, data privacy concerns showed a weaker relationship with behavioral intention than anticipated ($\beta = -0.09$, $p < 0.05$).

4.4. Moderating effects of personal technology innovativeness

Multi-group analysis revealed significant moderating effects of personal technology innovativeness on several relationships in the model [8]. For individuals with high innovativeness, the impact of perceived usefulness on behavioral intention was stronger ($\beta high = 0.48$, $p < 0.001$; $\beta low = 0.35$, $p < 0.001$; $\Delta\beta = 0.13$, $p < 0.05$). Conversely, the negative effect of technological anxiety on intention was more pronounced for those with low innovativeness ($\beta high = -0.11$, $p < 0.05$; $\beta low = -0.23$, $p < 0.001$; $\Delta\beta = 0.12$, $p < 0.05$). Interestingly, data privacy concerns had a significant negative effect on intention only for highly innovative individuals ($\beta high = -0.18$, $p < 0.01$; $\beta low = -0.04$, $p > 0.05$; $\Delta\beta = -0.14$, $p < 0.05$), suggesting that this group may be more aware of potential risks associated with AV technology.

5. DISCUSSION

5.1. Interpretation of key findings

Our study reveals several important insights into the factors influencing behavioral intentions towards autonomous vehicles (AVs). The strong positive effects of perceived usefulness and ease of use align with previous technology acceptance research [9], confirming their relevance in the AV context. The significant role of social influence suggests that AV adoption may be partly driven by social norms and peer perceptions, highlighting the importance of targeted marketing and community engagement strategies.

5.2. Utilitarian vs. hedonic factors in AV adoption

While utilitarian factors (perceived usefulness, ease of use) emerged as primary drivers of AV acceptance, hedonic factors also played a significant role. The positive influence of perceived safety on behavioral intentions indicates that potential adopters value both the practical benefits and the emotional reassurance provided by AV technology. This dual motivation suggests that AV manufacturers and policymakers should emphasize both the functional advantages and the potential for enhanced comfort and peace of mind in their communication strategies.

5.3. Role of technological fears and anxiety

The negative impact of technological anxiety on behavioral intentions, particularly among less innovative individuals, underscores the need for educational initiatives to address concerns and build public confidence in AV technology. Interestingly, data privacy concerns were more salient for highly innovative individuals, suggesting that as people become more familiar with technology, they may become more attuned to potential risks. This finding highlights the importance of transparent data management practices and robust cybersecurity measures in fostering trust among early adopters.

5.4. Relationship between individual intentions and societal outcomes

Our research also explored the connection between individual adoption intentions and perceived societal outcomes of AV implementation. Results indicate a positive correlation between personal willingness to use AVs and anticipated societal benefits such as reduced traffic congestion and improved mobility for elderly and disabled individuals. This suggests that emphasizing the broader societal impacts of AV adoption could be an effective strategy for increasing public acceptance and support for AV-related policies.

Key Finding	Theoretical Implication	Practical Implication
Utilitarian and hedonic factors both influence AV adoption	Extends technology acceptance models to include both practical and experiential aspects in the AV context	Develop marketing strategies that highlight both functional benefits and enjoyment factors of AVs
Personal innovativeness moderates the impact of various factors on behavioral intention	Demonstrates the need for segmented approaches in technology acceptance research	Tailor AV promotion strategies for different user segments based on their innovativeness
Data privacy concerns more salient for innovative users	Highlights the evolving nature of concerns as users become more technologically savvy	Prioritize robust data protection measures and transparent communication about data usage
Positive correlation between individual intentions and perceived societal benefits	Expands the scope of AV acceptance research to include broader societal considerations	Emphasize potential societal benefits of AVs in public communication and policy development
Technological anxiety more impactful for less innovative users	Underscores the importance of considering psychological barriers in technology adoption	Develop educational initiatives to address concerns and build confidence in AV technology

Table 2: Summary of Key Findings and Implications [9, 10]

5.5. Theoretical and practical implications

From a theoretical perspective, our study contributes to the growing body of literature on technology acceptance in the context of transformative innovations. Integrating AV-specific factors (e.g., perceived safety, data privacy concerns) with established constructs from technology acceptance models provides a more comprehensive framework for understanding AV adoption intentions. The moderating role of personal innovativeness offers nuanced insights into how different user segments may approach AV technology [10].

Practically, our findings have several implications for AV developers, policymakers, and marketers. First, the importance of perceived usefulness and ease of use suggests that AV interfaces should be designed with user-friendliness in mind, and the practical benefits of the technology should be clearly communicated. Second, the role of social influence indicates that targeting opinion leaders and facilitating positive word-of-mouth could be effective in promoting AV adoption. Finally, the varying concerns of different user segments (e.g., general anxiety vs. specific privacy concerns) suggest the need for tailored approaches to addressing barriers to adoption among different population groups.

6. CONCLUSION

This article contributes to the growing body of literature on autonomous vehicle (AV) acceptance by synthesizing existing research through a systematic review and meta-analysis. Our comprehensive analysis, following PRISMA guidelines and employing meta-analytic techniques, reveals the complex interplay of factors influencing behavioral intentions towards AVs. The developed theoretical framework integrates established technology acceptance models with AV-specific factors, highlighting key constructs such as perceived usefulness, ease of use, social influence, perceived safety, and data privacy concerns.

Importantly, our findings underscore the crucial role of personal innovativeness in technology as a moderating variable, suggesting that individual differences significantly shape AV acceptance patterns. This article offers valuable insights for AV manufacturers, policymakers, and researchers, emphasizing the need for tailored strategies that address both utilitarian and hedonic aspects of AV use. As the field of autonomous vehicles continues to evolve rapidly, future research should focus on longitudinal studies to track changes in acceptance patterns, cross-cultural comparisons to understand geographic variations, and in-depth investigations of the psychological mechanisms underlying AV adoption. By building on this foundation, stakeholders can work towards the successful integration of this transformative technology into society, potentially revolutionizing transportation and urban planning while addressing critical concerns around safety, privacy, and accessibility.

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