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🌐 Survey Protocol for Investigating Public Acceptance of Autonomous Driving Based on Psychological Empowerment V.1

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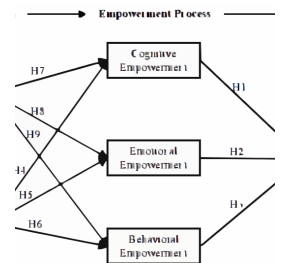
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Abstract

This protocol provides the dataset and methodology for a survey study examining public acceptance of autonomous driving technology in China through the lens of psychological empowerment. The questionnaire captures responses from 412 participants, measuring six latent variables—subjective norms, personal norms, cognitive/emotional/behavioral empowerment, and acceptance of autonomous driving technology—using a validated 5-point Likert scale. Data were collected via [Wenjuan.com](https://wenjuan.com) in June 2024 and analyzed using structural equation modeling (SEM) and Bayesian networks. Key findings reveal that behavioral empowerment is the strongest predictor of acceptance (path coefficient: 0.520***), with subjective norms exerting a greater influence on psychological empowerment than personal norms. The dataset supports replication studies and further exploration of cultural and behavioral factors in the adoption of autonomous driving technology.

Image Attribution

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Guidelines

Overview

This dataset contains responses from a survey conducted to investigate public acceptance of autonomous driving technology in China, focusing on the role of psychological empowerment. The study integrates the Theory of Planned Behavior (subjective norms), Norm Activation Theory (personal norms), and psychological empowerment theory (cognitive, emotional, and behavioral dimensions). The dataset was collected via an online platform ("Wenjuan.com") from June 10 to June 30, 2024, and includes 412 valid responses.

Dataset Description

The dataset is provided in an Excel file named "Raw data.xlsx". It contains responses to a structured questionnaire designed to measure constructs related to autonomous driving acceptance. Each row represents a respondent, and columns correspond to individual questionnaire items or calculated construct means.

Constructs and Variables

The questionnaire measures six key constructs, each assessed with multiple items on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The constructs and their corresponding items are:

1. **Subjective Norms (SN):** Influence of social expectations on adopting autonomous driving.

SN1, SN2, SN3, SN4

Mean: SN (average of SN1–SN4)

2. **Personal Norms (PN):** Internal moral obligations to adopt autonomous driving.

PN1, PN2, PN3, PN4

Mean: PN (average of PN1–PN4)

3. **Cognitive Empowerment (CE):** Perceived knowledge and understanding of autonomous driving.

CE1, CE2, CE3

Mean: CE (average of CE1–CE3)

4. **Emotional Empowerment (EE):** Emotional confidence and trust in autonomous driving.

EE1, EE2, EE3

Mean: EE (average of EE1–EE3)

5. **Behavioral Empowerment (BE):** Perceived control and ability to use autonomous driving technology.

BE1, BE2, BE3

Mean: BE (average of BE1–BE3)

6. **Acceptance (AC):** Intention to adopt autonomous driving technology.

AC1, AC2, AC3

Mean: AC (average of AC1–AC3)

Data Structure

Rows: 412 (one per respondent).

Columns: 26

Columns 1–20:

Individual items (SN1–SN4, PN1–PN4, CE1–CE3, EE1–EE3, BE1–BE3, AC1–AC3).

Columns 21–26:

Calculated means for each construct (SN, PN, CE, EE, BE, AC).

Data Type: Numeric (integer for individual items, float for mean values).

Missing Values: None (dataset includes only valid responses after cleaning).

Usage Instructions

1. **Accessing the Data:**

Download the "Raw data.xlsx" file from the protocols.io repository.

Use software like Microsoft Excel, or SPSS to open and analyze the file.

2. **Data Cleaning:**

The dataset has been pre-cleaned to include only valid responses (n=412). No further removal of missing or incomplete responses is required.

Verify data integrity by checking that individual item values are within the 1–5 range and that mean values (SN, PN, CE, EE, BE, AC) accurately reflect the average of their respective items.

3. **Analysis:**

Descriptive Statistics: Calculate means, standard deviations, and distributions for each construct to understand respondent attitudes.

Structural Equation Modeling (SEM): Use the data to replicate the study's SEM analysis, testing relationships between subjective norms, personal norms, psychological empowerment dimensions, and acceptance.

Mediation Analysis: Examine the mediating role of psychological empowerment (CE, EE, BE) between norms (SN, PN) and acceptance (AC).

Importance-Performance Analysis (IPA): Assess the importance and performance of empowerment dimensions to identify areas for improvement.

Bayesian Network Modeling: Validate predictive relationships using a Bayesian approach, as described in the study.

Software recommendations: AMOS or Smart PLS for SEM, Netica for Bayesian networks, and Excel or SPSS for IPA.

4. **Considerations:**

The dataset reflects responses from a Chinese population, influenced by collectivist cultural factors.

Generalizability to other cultural contexts may be limited.

The survey was conducted online, potentially introducing self-selection bias.

Responses capture behavioral intentions, not actual adoption behaviors.

Ethical Considerations

- The data is anonymized, with no personally identifiable information included.
- Respondents provided informed consent for their data to be used in research and shared publicly in anonymized form.
- When using this dataset, cite the original study and this protocol to acknowledge the contributors.

Contact

For questions about the dataset or its usage, contact the protocol author via protocols.io or refer to the original study's corresponding author.

Materials

1. Online survey platform: www.wenjuan.com
2. Statistical software: IBM SPSS 24.0, AMOS 24.0
3. Bayesian network software: Netica 7.1
4. Microsoft Excel, Visio
5. Ethical approval letter: 2024LL(01), Xihua University

Safety warnings

- ❗ **Cultural Bias:** Data from China may not apply to other cultures due to collectivist influences.
- **Self-Selection Risk:** Online survey may overrepresent tech-savvy respondents.
- **Intention-Behavior Gap:** Measures intentions, not actual adoption.
- **Time Sensitivity:** Collected June 2024; attitudes may have shifted.
- **Statistical Assumptions:** Verify SEM, mediation, and Bayesian model conditions.
- **Ethical Use:** Anonymized data; cite study and avoid misuse.
- **Limited Scope:** Excludes factors like cost or infrastructure.
- **Software Variability:** Results may vary by software; confirm compatibility.

Ethics statement

(1) This study was approved by the Ethics Committee of the School of Automotive and Transportation, Xihua University (Approval No. 2024LL(01)) and was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all subjects for this study.

(2) The survey began on June 10, 2024, and concluded on June 30, 2024. At the beginning of the questionnaire, we concisely presented our team's background, the details of the experiment, and the purpose of the survey results, while ensuring the protection of participants' privacy. After presenting this information, we posted the following question on the "Wenjuan.com": "Have you been fully informed and agreed to participate in this survey? (If you are a minor, please ensure that your guardian has been informed and has agreed)." We set the system so that only participants who selected "Yes" could proceed to complete the questionnaire, while those who selected "No" were considered to have declined participation and could not continue.

(3) The results of this study were obtained with the participants' informed consent, and throughout and after the survey period, the information collected was limited to what was specified in the questionnaire. Additionally, no other personal information of the participants was collected. Therefore, the survey findings are suitable for long-term use by researchers.

Research Background

- 1 The rapid advancement of autonomous driving technology has sparked a global interest in understanding how the public perceives and accepts this transformative technology. Public acceptance plays a crucial role in the widespread adoption and integration of autonomous vehicles (AVs) into society. Traditional models for technology acceptance, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), provide valuable insights into the factors influencing user adoption. However, these models often focus on cognitive aspects like perceived ease of use and usefulness, neglecting the deeper psychological processes that shape user behavior.

To address this gap, recent studies have highlighted the importance of psychological empowerment in influencing user acceptance of new technologies. Psychological empowerment, which includes cognitive, emotional, and behavioral dimensions, can significantly affect individuals' willingness to embrace new technologies. While much of the existing research has focused on cognitive empowerment, little attention has been paid to the roles of emotional and behavioral empowerment in the acceptance of autonomous driving technology.

Furthermore, autonomous driving is not only a technological innovation but also a socio-cultural phenomenon that may be shaped by individual and societal values, social norms, and psychological factors. This is especially pertinent in the context of China, where cultural factors such as collectivism and the influence of traditional norms may have a substantial impact on technology acceptance. Understanding how subjective and personal norms, along with psychological empowerment, contribute to autonomous driving acceptance is essential for designing more effective strategies to promote AV adoption in culturally diverse societies.

In light of these considerations, this study aims to investigate the factors influencing public acceptance of autonomous driving technology, with a particular focus on the mediating role of psychological empowerment. By integrating theories from social psychology, technology acceptance models, and cultural studies, this research will provide valuable insights into the psychological mechanisms underlying the adoption of autonomous vehicles in China.

Technical Approach

- 2 This research employs a multi-step approach to investigate the public acceptance of autonomous driving technology, incorporating psychological empowerment as a mediating variable. The methodology integrates several advanced statistical and machine learning techniques, organized into the following stages:

1. Survey Design and Data Collection

A structured online survey was designed to assess public attitudes toward

autonomous driving. The survey includes six latent variables: Subjective Norms (SN), Personal Norms (PN), Cognitive Empowerment (CE), Emotional Empowerment (EE), Behavioral Empowerment (BE), and Acceptance of Autonomous Driving (AC). Each latent variable is measured by multiple items using a 5-point Likert scale. The survey was conducted using an online platform in China, targeting a representative sample of participants. Data collection was carried out between June 10 and June 30, 2024.

2. Data Preprocessing and Cleaning

After data collection, raw responses were exported to Excel for preprocessing. Invalid responses (e.g., those with identical answers or completed too quickly) were removed. The remaining valid responses were cleaned and scored for each latent variable by averaging the individual items. The final dataset consisted of 412 valid responses, which were used for subsequent analysis.

3. Confirmatory Factor Analysis (CFA)

To validate the measurement model, Confirmatory Factor Analysis (CFA) was performed using AMOS. This step assesses the factor loadings, construct reliability (CR), average variance extracted (AVE), and discriminant validity. Model fit was evaluated using common indices such as CMIN/DF, RMSEA, GFI, TLI, and CFI.

4. Structural Equation Modeling (SEM)

A Structural Equation Modeling (SEM) approach was used to test the proposed hypotheses. The model aimed to explain how Subjective Norms (SN) and Personal Norms (PN) influence Psychological Empowerment and how these variables subsequently affect Acceptance (AC) of autonomous driving. SEM allows for the analysis of both direct and indirect relationships between variables. Path analysis was conducted to examine the causal effects and the goodness of fit was assessed.

5. Mediation Effect Analysis

To further explore the underlying psychological processes, mediation effect analysis was performed using the SPSS PROCESS Macro (Model 4). This analysis tested the indirect effects of Psychological Empowerment on the relationship between Norms and Acceptance. The Bootstrapping method was applied with 5000 samples to generate confidence intervals (CI) for indirect effects, and the significance of these effects was assessed.

6. Importance-Performance Analysis (IPA)

Importance-Performance Analysis (IPA) was employed to assess the relative importance and performance of the identified variables. The performance score for each variable was calculated and plotted against the importance score derived from the path coefficients in the SEM model. This allowed for the identification of critical areas that need attention in promoting autonomous driving technology adoption.

7. Bayesian Network Modeling

A Bayesian Network (BN) was used to validate the predictive accuracy of the model. The latent variables were discretized into three categories: Low, Medium, and High, based on their mean scores. The Bayesian network was trained using the EM algorithm to predict the likelihood of different acceptance outcomes based on the

psychological empowerment factors. The model's performance was validated using a confusion matrix, with a 70% training and 30% testing split.

8. Model Validation and Evaluation

The final model was evaluated using various metrics, including model fit indices, hypothesis testing results, and predictive accuracy from the Bayesian network. The robustness of the findings was ensured through cross-validation and sensitivity analysis.

Procedure

3 Step 1: Questionnaire Design

1. Define six latent variables: Subjective Norms (SN), Personal Norms (PN), Cognitive Empowerment (CE), Emotional Empowerment (EE), Behavioral Empowerment (BE), and Acceptance of Autonomous Driving (AC).
2. For each latent variable, design 3–4 measurement items using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).
3. Base measurement items on established literature:
SN and AC: Nielsen & Haustein (2018), Hajjafari (2018)
PN: Schwartz (1977)
CE, EE, BE: Christens (2012), Speer & Peterson (2000)
4. Consult 5 domain experts for content validation.

4 Step 2: Survey Implementation

1. Publish the questionnaire on wenjuan.com from June 10 to June 30, 2024.
2. Present an informed consent form at the beginning of the questionnaire.
3. Disqualify participants who select "No" for consent.
4. Collect 447 responses; after excluding responses completed in under 200 seconds or with identical answers, retain 412 valid responses.

5 Step 3: Data Cleaning and Scoring

1. Export raw responses as Excel (.xlsx).
2. Calculate mean scores for each latent variable by averaging their items:
e.g., $SN = \text{MEAN}(SN1, SN2, SN3, SN4)$
3. Validate all data entries and normalize if needed.

6 Step 4: Statistical Analysis

(A) Common Method Bias

- Conduct Harman's one-factor test in SPSS.

(B) Confirmatory Factor Analysis (CFA)

- Use AMOS to assess:
 1. Factor loadings
 2. CR, AVE
 3. Discriminant validity via $\sqrt{AVE}$ vs inter-variable correlations

(C) Structural Equation Modeling (SEM)

- Evaluate model fit with indices: CMIN/DF, RMSEA, GFI, TLI, CFI
- Test hypotheses H1–H10

(D) Mediation Effect Analysis

- Use SPSS PROCESS Macro (Model 4)
- Apply Bootstrap method with 5000 samples
- Report direct, indirect, and total effects with 95% CI

(E) Importance-Performance Analysis (IPA)

- Compute performance score using:
$$Score = [(Mean - 1)/4] * 100$$
- Plot importance (path coefficient) vs. performance (score)

(F) Bayesian Network Modeling

1. Discretize latent scores into low/medium/high categories:
 - Low: [1–2.33], Medium: (2.33–3.67), High: [3.67–5]
2. Use Netica to:
 - Create directed acyclic graph
 - Train with EM algorithm
 - Validate model via confusion matrix (70% train, 30% test split)

Original data and other attachments

7 Questionnaire Questionnaire.docx**8 Ethical approval letter** Approval Letter(En).pdf Approval Letter(zh).pdf**9 Model** Fig 1. The autonomous driving acce...**10 Raw data** Raw data.xlsx 60.3KB

Results

11 Results of model testing Results of model testing.pdf**12 Importance & Performance analysis**



Importance & Performance analysi...

13 Bayesian network after updating using EM algorithm



Bayesian network after updating us...

Conclusion

- 14 (1)Both subjective norms and personal norms significantly and positively influence user psychological empowerment, with subjective norms exerting a stronger influence. Additionally, subjective norms have a significant positive impact on personal norms.
- (2)Psychological empowerment positively influences the public acceptance of autonomous driving technology, with behavioral empowerment having a significantly stronger effect than cognitive and emotional empowerment.
- (3)Psychological empowerment partially mediates the relationship between both subjective norms and acceptance, as well as between personal norms and acceptance. Among the dimensions, behavioral empowerment demonstrates the strongest mediating effect.
- (4)The importance-performance analysis reveals that behavioral empowerment holds the highest importance and performance in relation to acceptance.
- (5)By constructing a Bayesian network model with latent variables from the structural equation model as state nodes, and validating it using confusion matrices and error rates, this study confirms the model's robust predictive capability for user acceptance.

Protocol references

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