A Study on Resident Acceptance Willingness of Autonomous Taxis under the Dual - Carbon Policy

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Abstract. Against the backdrop of intensifying global climate change, carbon peaking and neutrality have become a global consensus. Investigating residents' acceptance of autonomous taxis is of great significance for promoting the green and low-carbon transformation of the transportation sector. This study takes Nanchang, China, as the research object. Through in-depth interviews with 30 residents, we obtained 21,000 words of interview transcripts. Using LDA topic analysis, we identified 11 key themes related to acceptance willingness. These themes were categorized into five dimensions based on the Theory of Consumer Value and a conceptual model was constructed. We designed a questionnaire and conducted two rounds of surveys, collecting 586 and 253 valid questionnaires, respectively. Factor analysis and SEM were performed using SPSS and AMOS software. Finally, based on the research findings, we proposed recommendations to promote the development of the autonomous taxi industry.

Keywords: Autonomous Taxis, Acceptance Willingness, Dual Carbon Policy, LDA, SEM.

1 Introduction

1.1 A Subsection Sample

Global climate change has intensified, leading to a global consensus on achieving carbon peaking and carbon neutrality. China has put forward its "Dual Carbon" goals, emphasizing the establishment of a green, low - carbon economic system and promoting industrial restructuring. China's Ministry of Transport issued the "14th Five - Year Plan for Green Transportation Development," supporting the development of intelligent transportation systems, particularly the promotion of autonomous taxis. Autonomous taxis, through precise route planning and intelligent driving, significantly reduce energy consumption and emissions, aligning closely with the "Dual Carbon" goals. Therefore, studying residents' acceptance of autonomous taxis under this policy is practically significant for promoting green transportation.

As a revolutionary technology in transportation, autonomous vehicles have drawn extensive attention. Safety, highlighted by Yuen et al. (2020)[1] as the primary public concern, is crucial. Hussain et al. (2021)[2] noted public worries about potential risks

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and system failures. Penmetsa et al. (2019)[3] found positive service experiences significantly influence perceptions. Zhang et al. (2024)[4] emphasized building trust through enhanced human - vehicle interactions. Merfeld et al. (2019)[5] identified convenience as a key acceptance factor. Huo et al. (2024)[6] investigated perceived risk's indirect impact on usage behavior. Lu et al. (2023)[7] indicated perceived benefits and ethical considerations positively influence usage willingness, while perceived risks negatively impact it. Jing et al. (2021)[8] proposed trust significantly affects willingness to pay. Existing studies provide valuable theoretical references but mostly focus on single factors' impact on usage willingness, lacking comprehensive analysis. This study aims to comprehensively explore consumer usage willingness by integrating multiple theoretical approaches, analyzing residents' acceptance of autonomous taxis, providing evidence for the development of autonomous taxis and promoting the "Dual Carbon" policy.

2 Research Design

2.1 Interview Design

This study employed a semi-structured interview approach. The survey participants for both interviews and questionnaires were residents from various districts of Nanchang, China. Drawing on expert opinions, five core themes were identified: basic awareness, the impact of the "Dual Carbon" policy on acceptance, safety and trust, willingness to use and usage scenarios, and expectations regarding policies and regulations. Corresponding interview questions were designed based on these themes. Through the interviews, residents' views and suggestions were collected, providing a basis for the questionnaire design.

2.2 Research Approach

The research approach of this study is illustrated in **Fig. 1**.

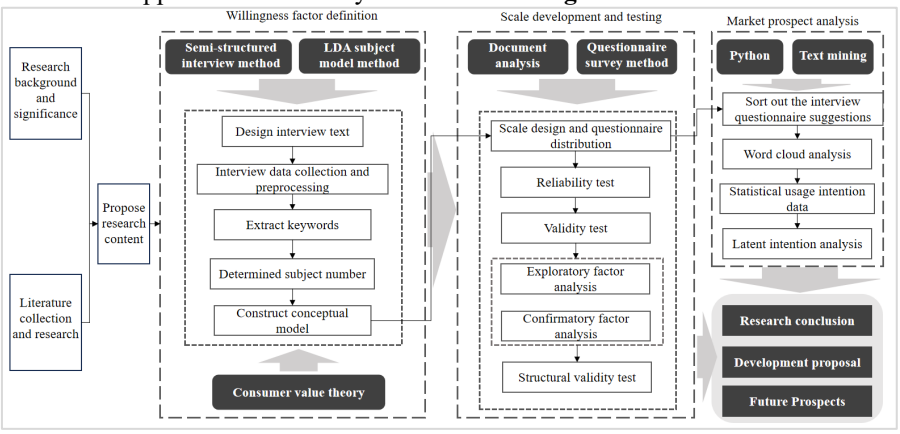

Fig. 1. Research Approach Diagram

3 Empirical Analysis

3.1 Data Collection and Preprocessing

This paper conducts in-depth interviews with 30 residents, with each interview lasting more than 15 minutes. The text is preprocessed using Python, combined with the "Harbin Institute of Technology stopword list" and others, and non-informative words are removed using Jieba word segmentation.

3.2 LDA Topic Model Analysis

The study utilized perplexity and coherence scores to determine the optimal number of topics, K. The range of topics was set between 1 and 15. The analysis revealed that perplexity reached local minima at K=11 and K=14, indicating better model performance. Coherence scores peaked at local maxima for K=5, K=9, K=11, and K=13, suggesting greater model stability. Considering both perplexity and coherence, the optimal number of topics was determined to be K=11. The corresponding word distribution for each topic is showed in **Table 1**.

Table 1. Topic-Keyword Table.

Theme	Willingness Factors	Keywords
1	Technical Trust	Passengers, Driving, Technology, Driver, Safety
2	Policy Regulation	Policy, Regulations, Measures, Government
3	System Maturity	Impact, Vehicle, Trust, System, Malfunction
4	Infrastructure	Testing, Construction, Network, Charging
5	Data Management	Data, Traffic, Inspection, Danger, Collection
6	Environmental Travel	New Energy, Dual Carbon, Electric Vehicle,
7	Service Experience	Experience, Ride-hailing, Driving, Service
8	Intelligent Operation	Guarantee, Enterprise, Operation
9	Sustainable Development	Penalty, Downfall, Green, Country, Speed
10	Technical Implementation	Large-scale, Launch, New Technology
11	Energy Transition	Gasoline Vehicle, Road, Reflection, Transition,

3.3 Conceptual Model of Willingness Factors

This study draws on the five dimensions of consumer value theory (social value, functional value, emotional value, perceived value, and conditional value) to integrate the factors influencing residents' acceptance of autonomous taxis and constructs a conceptual model (see **Table 2** for details).

Table 2. Classification of Residents' Acceptance Willingness Factors.

Level	Factors	Theme
Social Value	Technical Trust Sustainable Development	1,9
Functional Value	Policy Regulation System Maturity Infrastructure Data Management	2,3,4,5,10

Level	Factors	Theme
	Technical Implementation	
Emotional Value	Service Experience Energy Transition	7,11
Perceived value	Environmental Travel Intelligent Operation	6,8
Conditional Value	Technical Implementation Energy Transition	10,11

4 Scale Development and Validation

4.1 Scale Development

This study employed a Likert 5-point scale to design the questionnaire. Following a pre-test, the content of the questionnaire was appropriately revised based on the test results and feedback. The specific measurement items are shown in **Table 3**.

Table 3. Measurement Items for the Questionnaire

Level	Code	Measurement Items
SV	SV1	I trust in driverless technology
	SV2	Technical trust is key to riding
	SV3	The long-term impact of driverless technology on the environment
FV	FV1	The country should enact relevant laws and regulations
	FV2	Technical maturity affects functionality and reliability
	FV3	Improved infrastructure is the basis for technological implementation
	FV4	Functional value is reflected in technological applications
EV	EV1	A comfortable travel experience should be provided
	EV2	I prefer riding driverless taxis with price discounts
	EV3	I look forward to new energy driverless taxis
PV	PV1	Using new energy driverless taxis is low-carbon travel
	PV2	Driverless taxis can shorten travel time
	PV3	Driverless technology can improve traffic efficiency and safety
CV	CV1	Driverless technology can adapt to rural roads
	CV2	Using driverless taxis in urban areas is more appropriate
	CV3	Driverless technology can promote balanced urban-rural development

Note: SV means Social Value, FV means Functional Value, EV means Emotional Value, PV means Perceived value, CV means Conditional Value.

4.2 Reliability Analysis

This study employed Cronbach's alpha coefficient to assess the reliability of the questionnaire. The overall Cronbach's alpha coefficient for the scale was found to be 0.955, indicating excellent reliability. Additionally, the Cronbach's alpha coefficients for all five variables exceeded 0.75, suggesting satisfactory reliability for each variable. Therefore, the questionnaire demonstrates good reliability and is suitable for subsequent validity assessment and analysis.

4.3 Validity Analysis

Exploratory Factor Analysis. This study used exploratory factor analysis to identify the measurement items for the acceptance scale of autonomous taxis in Nanchang. Data were gathered via field surveys and online questionnaires, yielding 632 responses. After removing 46 invalid ones, 586 valid responses remained, at a response rate of 92.72%. The sample was gender-balanced: 287 males (49%) and 299 females (51%). Most respondents were aged 25 and under (46.06%), followed by those aged 26-40 (30%). In terms of education, 52.48% had a bachelor's degree, 27.70% an associate degree or lower, and 20% a master's degree or higher. The sample also had varied regional and occupational backgrounds.

Using SPSS 27, we first ran the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity to check if the data were suitable for factor analysis. With a KMO value of 0.976 and a significant Bartlett's test, the data were deemed suitable. Then, using the principal component method, we extracted five common factors, which explained 71.8% of the variance. This suggests the scale has good construct validity.

Confirmatory Factor Analysis. After the exploratory factor analysis, a second round of surveys was conducted, distributing 275 questionnaires and receiving 253 valid responses (a 92% response rate) from a well-balanced sample. Using AMOS software, we performed confirmatory factor analysis on the 16 items and assessed reliability. The scale's overall Cronbach's α was 0.847, and the coefficients for each dimension were 0.827, 0.853, 0.838, 0.842, and 0.859, showing good reliability. To check the construct validity, we built six models: a five-factor model, a four-factor model, a three-factor model, a two-factor model, and a single-factor model. The model fit index results are in **Table 4**.

Table 4. Model Fit Indices for Confirmatory Factor Analysis.

Model	CMIN/DF	RMSEA	IFI	TLI	CFI
Model 1	1.794	0.056	0.956	0.959	0.956
Model 2	7.513	0.147	0.874	0.842	0.855
Model 3	13.425	0.126	0.753	0.738	0.714
Model 4	18.317	0.154	0.667	0.697	0.676
Model 5	23.139	0.182	0.632	0.594	0.611
Model 6	1.407	0.04	0.967	0.964	0.967

Structural Validity Test. Based on the second-order CFA model, this study calculated the standardized factor loadings of each item on its first-order factor and of each first-order factor on the second-order factor. Using relevant formulas, we then calculated the convergent validity and composite reliability values for both first-order and second-order factors. As required, an AVE $\geq$ 0.5 and a CR $\geq$ 0.7 indicate good convergent validity and composite reliability. The study found all factors met these criteria (AVE $\geq$ 0.5, CR $\geq$ 0.7). Additionally, the square root of the AVE values exceeded the standardized correlation coefficients between the five dimensions, showing good discriminant validity. RA denotes Resident Acceptance. See **Table 5** for details.

Table 5. Scale Convergent Validity Test.

Path Relationship			Standardized Factor Loadings	Error	CR	AVE
SV	<---	RA	0.90	0.077		
FV	<---	RA	0.908	0.072		
EV	<---	RA	0.897	0.074	0.9535	0.8039
PV	<---	RA	0.891	0.071		
CV	<---	RA	0.887	0.075		
SV1	<---	SV	0.79	0.077		
SV2	<---	SV	0.773	0.073	0.8196	0.6023
SV3	<---	SV	0.765	0.074		
FV1	<---	FV	0.851	0.051		
FV2	<---	FV	0.772	0.058	0.8871	0.663
FV3	<---	FV	0.814	0.061		
FV4	<---	FV	0.818	0.059		
EV1	<---	EV	0.773	0.053		
EV2	<---	EV	0.828	0.076	0.8454	0.6459
EV3	<---	EV	0.809	0.074		
PV1	<---	PV	0.772	0.077		
PV2	<---	PV	0.767	0.079	0.8089	0.5853
PV3	<---	PV	0.776	0.076		
CV1	<---	CV	0.772	0.072		
CV2	<---	CV	0.811	0.074	0.8301	0.6197
CV3	<---	CV	0.778	0.076		

5 Conclusion

This study examines Nanchang residents' acceptance of driverless taxis under China's "dual carbon" policy. Using semi - structured interviews, LDA topic analysis, questionnaires, and structural equation modeling, it identifies core factors affecting acceptance. Based on consumer value theory, the study constructs a conceptual model and distributes questionnaires to residents in different Nanchang areas. After rigorous reliability, validity, and structural equation tests, the study concludes:(1)The acceptance willingness of Nanchang residents is influenced by 5 dimensions and 11 factors, including social value (technological trust and sustainable development), functional value (policy regulation, system maturity, infrastructure, data management and technological implementation), emotional value (service experience and energy transition), cognitive value (environmental protection travel and intelligent operation) and situational value (technological implementation and energy transition).(2)The sample is diverse and scientific, ensuring reliable and representative results.(3)Functional value most strongly impacts acceptance, with government laws and regulations are the most concerned.

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