# An exploratory study of MaaS in Shandong

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**Abstract.** As a new service concept, Maas (mobility as a service) was initially defined as providing an available travel service mode for residents in low-density areas and low-income populations. Maas was first implemented in western countries to study the situation of low density and low salary in various countries[1]. In contrast, in China, because the complex national conditions are diametrically opposite to the low density and low salary situation in the west, China urgently needs to explore a new paradigm of the Sinicization of Maas[2]. Based on the national conditions of high density and high car ownership, this research conducted an exploratory research on the problem of private car owners' changing from owning vehicles to owning transportation services, in order to explore how to add private cars to the Maas public travel chain.

**Keywords:** MaaS; high density; carbon credits; public service

## 1. Introduction

### 1.1 Research Background

1.1.1 China's urban traffic problems

During the two sessions in 2022, the transportation proposal of CPPCC member Guo Jifu triggered a nationwide heated debate. In China, nearly 40% of cities have poor traffic during peak periods, and the demand gap for parking spaces is nearly 200million. In addition, under the pressure of the "double carbon" goal, urban traffic problems have become an urgent problem to be solved. In 2019, Maas took the lead in exploring and practicing in Beijing[3], providing reference and experience for alleviating urban traffic problems in China. Today, Maas has become an extremely important new solution to alleviate urban traffic problems in China.

1.1.2 The practice and sinicization of MaaS

After MaaS was first proposed and defined by Mr.Hetanen (Paa S) in 2014, many cities around the world have carried out pilot and experiment. The new concept with sharing, integration, green, personalized service characteristics, at the beginning of the definition is for low-density area residents, low-income population available, fair, reliable, door to door travel services, and to "from owning vehicles to have traffic services, through the integration of transportation and one-stop service, improve the public travel experience" as the core[4].

At present, many platforms such as Gaode map, baidu Apollo and didi travel have entered the research and development of Maas system framework[5]. However, China's Maas is still in the exploration stage, and the national conditions are different from those of western countries. "From owning vehicles to owning transportation services" has become an inevitable requirement for China's Maas exploration.

### 1.2 Research Status

Although the research on Maas in China started late, the research content is rich, including a lot of research results. The research content is more about the exploration and development of Maas at home and abroad, in the research direction of meeting the diversified travel needs of users and improving the operation efficiency of the whole service system[9]. In addition, low-carbon travel is also the research direction of many scholars. Maas development model should be quickly adjusted

in the context of dual carbon[6].Domestic for high density, high car ownership under the Maa S framework established insufficient research, less empirical research, for private passenger cars how to join the public travel chain under the framework of the Maa S research lack, so this research based on the previous research, for "from own vehicles to have traffic service" problem[7][8].

## 1.3 Research Meaning

Starting from the essence of Maas, this paper integrates various research methods to investigate the urban heterogeneity of the mode and willingness of "changing from owning vehicles to owning transportation services", and uses the model to make an empirical analysis on the willingness of cars, so as to provide methodological guidance for the research on the localization of Maas in China and how private cars join the public travel chain under the domestic Maas framework. It aims to solve problems in real life and provide experience and reference for the exploration of Maas in China.

## 2. Survey Plan

### 2.1 Research Area

Shandong province, as the top three provinces in China, has the top three industries and technological innovation in China.. While the high population density and huge car ownership bring great pressure on urban traffic operation and vehicle parking, it also brings great challenges to the realization of the grand goal of "carbon neutrality" and "carbon peak", which also creates a realistic situation for the research of private cars' problem "from owning vehicles to owning transportation services". Therefore, this survey chooses Shandong Province as the survey area, and conducts multi-stage sampling according to the city level.

### 2.2 Subject Investigated

This survey to private car owners in Shandong province as the survey object, and urban commuting as the main research moment, according to the different urban conditions, using the combination of multi-stage random sampling, is expected to extract 900 samples, actual 876 samples, including 120 new first-tier cities, 189 second-tier cities, 356 third-tier cities, 311 fourth-tier cities.

## 3. Pre-investigation

### 3.1 Pre-research

The pre-survey was distributed by random sampling, and a total of 80 questionnaires and 72 valid questionnaires were collected. KMO and Bartlett test were used to verify the validity. The research data were very suitable for information extraction, and the validity was very good.Bartlett test indicated that the validity of the questionnaire was good and the results were valid. The credit validity test was conducted according to the pre-survey data to determine that the questionnaire structure was scientific.

### 3.2 Formal Research

Through Cronbach reliability analysis, the value of the reliability coefficient is 0.731, greater than 0.7, which shows that the reliability quality of the research data is very good and can be used for further analysis. Kmo and Bartlett test were used to verify the validity. Kmo value is 0.912, and kmo value is greater than 0.8. The research data is very suitable for extracting information, and the validity is very good from the side.

3.2.1 Describe the statistical analysis

Among the surveyed subjects, the new first-tier city survey subjects accounted for 13.29%, a total of 112 subjects; The respondents in second-tier cities accounted for 21.83% (184 subjects); the respondents in third-tier cities accounted for 29.18% (246 subjects); The fourth-tier cities accounted for 35.71% of the respondents, a total of 301 subjects.

According to the analysis of travel frequency samples, most of the samples are "less than 5 times" in frequency distribution, the proportion is 38.20%. This survey respondents to different city public service attitude are detailed analysis, the results showed that a new line of cities to choose public transport to the high proportion of attitude, as high as 82%, in terms of carrying lift people intend to new cities are willing to degree is relatively high, accounted for 29.46%, while in terms of spare car rental, cities are generally not willing to.

## 3.3 The Degree of Willingness to Increase the Public Transport Choice Based on the Logistic Regression Model

In this research, the value of "willing to increase the use of public transport" is 0 and the value of "unwilling to increase the use of public transport" is 1.Sig. =0.14 through the Hosmer-Lemeshow test, the model fit degree is good, that is, there is no significant difference between the predicted value and the real value.

From the P-values in Table 1, the most significant factors- -first-tier cities and travel navigation information. There is a significant relationship between residents in first-tier cities and their willingness to increase the use of public transport. The B value of the new first-tier cities is-0.891, indicating that the new first-tier cities are more willing to increase public transport.

Table 1. Equation variables for increasing willingness by public transport

|  |  | B | S.E, | Wals | df | Conspicu-ousness | Exp (B) |
|---|---|---|---|---|---|---|---|
| Step 1 | city |  |  | 13.153 | 3 | .004 |  |
|  | New first-tier cities | -.891 | .294 | 9.199 | 1 | .002 | .410 |
|  | Satisfied degree with travel navigation information | .274 | .095 | 8.344 | 1 | .004 | 1.315 |

## 3.4 Analysis of the Willingness and Influencing Factors of Private Cars Based on Linear Regression Model

"Hitch ride", that is, when driving, paid for carrying passengers on the same route, to improve the use efficiency of idle seats, to achieve energy saving and emission reduction, smooth travel. "Idle car rental", that is, in the state of idle vehicle, the owner transfers the use right of the vehicle, reduce the idle rate of the vehicle, so that the purchase amount of the vehicle, and finally achieve a certain degree of environmental protection.After "ANOVA", each regression analysis was met, indicating that the regression model of this study was statistically significant.According to the model collinearity test, all the VIF values in the model are less than 5, which means that there is no collinearity problem, and there is no correlation between the factors.

3.4.1 Empirical results of the overall sample

According to the total sample analysis, among the parameter weights obtained in the regression analysis under the "hitch" mode, the respondents have the largest worry weight about the multi-destination route planning. This shows that the more concerned about multi-destination navigation, the less people want to pick up passengers while driving. Among the regression analysis parameter weights under the mode of "idle car rental", the survey object have the largest weight about the division of accident liability. This shows that the more worried people are about the division of responsibilities, the less people want to rent their private cars to others when they are

idle. How to make multi-point navigation more satisfactory and clarify the accident responsibilities of both parties are the focus of this survey.

Table 2. Weight table of the factors affecting the public service willingness of private cars

| explanatory variable | | Total sample | subsample | | | |
|---|---|---|---|---|---|---|
| | | All cities | first-tier city | second-tier city | Third-tier cities | Fourth-tier cities |
| free ride | Multidestination route planning | 0.146*** | 0.108** | 0.176*** | 0.149*** | 0.129*** |
| | | (0.035) | (0.115) | (0.066) | (0.069) | (0.058) |
| | The epidemic transmission | 0.029** | 0.125*** | 0.006 | 0.020 | 0.021 |
| | | (0.036) | (0.097) | (0.072) | (0.069) | (0.062) |
| | Personal and property safety | 0.032* | -0.074** | 0.089*** | 0.020 | 0.031 |
| | | (0.041) | (0.129) | (0.079) | (0.075) | (0.072) |
| | Car crowding | 0.039** | 0.092** | -0.044 | 0.074** | 0.058** |
| | | (0.040) | (0.117) | (0.086) | (0.078) | (0.065) |
| | Time cost | 0.090*** | 0.045 | 0.093*** | 0.102*** | 0.102*** |
| | | (0.039) | (0.123) | (0.078) | (0.071) | (0.069) |
| Idle car rental | he division of accident liability | 0.299*** | 0.527** | 0.309 | 0.336*** | 0.181 |
| | | (0.038) | (0.100) | (0.087) | (0.069) | (0.062) |
| | Daily car use trouble | 0.049*** | 0.071 | 0.033 | 0.101*** | 0.027*** |
| | | (0.040) | (0.106) | (0.101) | (0.065) | (0.066) |
| | Epidemic prevention | 0.066*** | 0.040 | 0.042 | 0.074 | 0.074*** |
| | | (0.040) | (0.120) | (0.101) | (0.064) | (0.067) |
| | Interior environment | 0.041*** | 0.008** | 0.052* | 0.002*** | 0.075 |
| | | (0.043) | (0.141) | (0.110) | (0.068) | (0.071) |
| | Emergency of car convenience | 0.053*** | 0.106 | 0.071** | 0.107** | -0.004*** |
| | | (0.040) | (0.146) | (0.093) | (0.067) | (0.063) |
| | (constant) | 1.310 | 1.577 | 1.373 | 1.025 | 1.335 |
| | N | 843 | 112 | 184 | 245 | 301 |

Note: Standard error is included in brackets, * represents 10% level, * * represents 5% level, and * * * represents 1% level.

3.4.2 Empirical results of the subsamples for ―― urban heterogeneity analysis

For urban heterogeneity, this survey uses further regression analysis of different levels of cities, so as to obtain the factor weights of the two modes, so as to find out different problems and different suggestions are put forward for different city levels. In addition to the willingness of "hitch", except for multi-destination navigation, the spread of the epidemic has become a major concern among people in first-tier cities. At the same time, the two cities had a large floating population, and the new first-tier cities accounted for a higher proportion..2

Among the factors affecting the willingness of "idle car rental", in addition to the main factor of accident responsibility division, the weight of car use problems in the first, second and third-tier cities is generally large, and the people in the third-tier cities also weigh heavily on the inconvenience and convenience of daily car use. It shows that the convenience of car use caused in the "idle car rental" needs to focus on exploring the solutions in the first, second and third tier cities. Although the first, second and third-tier cities are different, their different cities may play different roles (for example, Linyi is the logistics center of the whole southern Shandong[16]). Although some cities are not of a high grade, they play a strong commercial role. Temporary cars may be a lot of, personal car may delay the usual car.

# 4. conclusion and suggestion

## 4.1 Conclusion

### 4.1.1 New first-tier city groups are more willing to increase the use of public transport

According to the analysis of the survey results, new first-tier cities are more willing to increase the use of public transport. People in second-tier and third-tier cities are unwilling to increase the use of public transportation due to their incomplete urban planning, incomplete bus categories and imperfect navigation platforms[14].

### 4.1.2 The public's willingness to make public private cars is generally low

Uunder the "hitch" mode, the public is generally worried about the level of multi-destination navigation services, among which people in first-tier cities are very worried about the epidemic, while people in second, third and fourth tier cities are very worried about increasing the time cost. Under the factor of "idle car rental", the public is generally concerned about the problem of the responsibility division after the accident and the inconvenience of using the car, and the attitude is very consistent.

### 4.1.3 Carbon integral incentive effect is insufficient

According to the Kano model, there is little difference between the respondents' willingness to make private car public service under the condition of carbon integral incentive and no carbon integral incentive. According to the previous data, various factors affecting the public service of private cars are the important reasons for people's weak sensitivity to carbon score reward. However, respondents in new first-tier cities are relatively willing to serve private cars under the carbon points reward.

## 4.2 Propose

### 4.2.1 Dig deep into the first-line market, and expand the sinking market.

The high population density in first-tier cities, the large number of cars, the traffic congestion and parking difficulties force people to consider the transfer of private cars to public services[14] [18]. In addition, the relatively perfect urban function planning provides a realistic basis for the transfer of private cars to public services.

Compared with first-tier cities, travel services in second and third tier cities are underdeveloped.First of all, the government should improve the urban public transport facilities according to local conditions to provide practical support for China's M a aS[15] [16]. Secondly, the public transport information sharing in the second-tier and third-tier cities is not perfect enough. Local bus companies actively cooperate and communicate with the navigation platform, so that the second, third and fourth line people can obtain real-time bus information at their fingertips.

### 4.2.2 Improve the MaaS system

Through investigation and analysis, it is found that there are problems to be improved in the process of private cars to be practiced.

Firstly, improve the multi destination navigation system. Expand the scope of use of multi-point navigation and intelligently adjust the order of places, so that multi-destination navigation can effectively help travelers improve travel efficiency[17]. Let them save both time and money, so as to achieve a win-win situation of money and time.

Secondly, improve the norms of responsibility division. Establish reasonable standards for the publicity of private cars. You can create an insurance for the beneficiary and the sharer to ensure that the rights and interests of both parties are respected in the event of an accident.

Thirdly, we need to strengthen epidemic prevention and control. At present, the epidemic is in a relatively serious and complex period, and the epidemic prevention and control is at a critical stage. This outbreak has not only increased car sales rapidly, but also raised public doubts about public transportation. Strengthening preventive measures against the epidemic has become a top priority. It

can realize the information network between car owners and passengers, so that peers can detect the health situation of each other at any time, so as to protect the health of both sides and prevent the new coronavirus from hurting you and me.

### 4.2.3 Establish a popular carbon incentive mechanism

In the face of traffic congestion, parking difficulties, oil price fluctuations and other practical problems, people are more willing to increase the choice of public transport, while people are less willing to pay for the two modes of free ride passengers and idle car rental. Therefore, incentive mechanisms can be established, such as the exchange of credit goods and the popularization of carbon credits, so that green travel can be deeply rooted in the hearts of the people.

## 4.3 Shortage of Research

### 4.3.1 Insufficient pattern richness

This research according to the current market related mode, relative to the public transport choice, lift, idle car rental three modes of research, not to explore and study other emerging models, such as in new energy vehicles travel (electric cars, for example), for our country tram range is limited, charging facilities, charging time, can realize through the vehicle relay public service, etc[19].

### 4.3.2 "Demand Side" research is missing, and no combination analysis of supply and demand sides is conducted

On the issue of private car public service conversion, this survey only investigates private car owners (i. e., suppliers) to explore the willingness of private car owners to the public service conversion, so as to analyze the possibilities of various modes and methods. However, the survey did not conduct research on transportation service demand users (the demand side, i. e., the demand side). According to the problems of private car public service conversion, explore the impact of service pricing and security, and explore China's Maa S development model and ideas according to the combination of supply and demand.

### 4.3.3 Research is limited to urban commuting only

This survey is only based on the typical situation, around the urban commuting survey, but the public service of private cars has long appeared in the countryside, but it has not become a link in the public travel chain under the Maa S framework, its way is relatively backward, the lack of certain supervision, and does not form a real sense of "travel as a service".Despite the introduction of a series of government policies for management, but this situation still exists, and even to the "black car not driving" development.

## Acknowledgment

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