Demand-Side Intentions for Ride-Sharing Services in Countries Yet to Introduce Full-Spectrum Ride-Sharing: Evidence from a Choice-Based Conjoint Analysis in Japan

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Abstract

With the global expansion of Mobility as a service (Maas), many studies have investigated demand-side intentions toward ride-sharing services. However, little is known about demand-side intentions toward ride-sharing services in countries that have yet to introduce full-spectrum ride-sharing services. Therefore, this study investigated demand-side intentions toward ride-sharing services in a country where ride-sharing services are yet to be introduced. Using Japan as a case study and choice-based conjoint analysis (n = 1277), this study investigated preferred service attributes. In addition, this study investigated the demand-side intention toward other incumbent services (taxi services) and compared it with the results of ride-sharing services. The results revealed the following four main findings. First, price, safety (accident rate), and reliability (class 2 license) are the most critical attributions of demand-side intentions toward ride-sharing services. Second, the demand-side intentions for ride-sharing and other incumbent services are similar. Third, demand-side intentions in ride-sharing services and differences in intentions with other incumbent services also depend on sociodemographic information on the demand side, such as the scale of the living region and level of income. Finally, people do not only want ride-sharing services to be inexpensive. Thus, the results are essential for countries where introducing ride-sharing services remains controversial.

Keywords

Mobility as a service, Demand-side intentions, Ride-sharing services, Conjoint analysis, Japan.

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1 Introduction

The rise of ride-sharing services that provide paid transportation using private vehicles has been integral to recent transport planning, policies, and studies. Services based on an efficient system matching between drivers and passengers and dynamic pricing (Yan et al., 2020) are central to changing on-demand transport and symbolize Mobility as a service (Maas) or sharing economies. Companies that provide ride-sharing services, such as Uber Technologies and DIDI Chuxing, are now expanding globally.

With the rise of ride-sharing services globally, many studies have considered ride-sharing services as a theme. These studies have mainly either of two viewpoints. One is the supply side and the other is the demand side.

Studies on the supply side explore competition between ride-sharing services and other actors, mainly taxi services (Bagchi, 2018; Cetin and Deakin, 2019; Chang, 2017; Daryanto et al., 2019), technologies such as matching systems and dynamic pricing (Cohen et al., 2016; Yan et al., 2020), and political controversies and discussions on ride-sharing services and regulations (Garud et al., 2022; Paik et al., 2019). These studies have found that the financial situation of taxis is negatively affected by the market entry of ride-sharing services (Bagchi, 2018; Chang, 2017), ride-sharing through statistical and actuarial approaches, achieving low surplus losses for both drivers and passengers (Yan et al., 2020), and the degree to which ride-sharing services are regulated, which is influenced by the political environment such as electoral competition (Paik et al., 2019).

Studies are conducted not only from the supply side but also from the demand side. These studies mainly focus on demand-side intentions that determine service preferences. Those studies suggest that price (Etminani-Ghasrodashti and Hamidi, 2019; Lee et al., 2018; Sung et al., 2018; Zhang et al., 2016), safety (Ali et al., 2022; Elmeguid et al., 2018; Etminani-Ghasrodashti and Hamidi, 2019; Raj et al., 2023; Raza et al., 2023; Zhang et al., 2016), technological element (Aguilera-García et al., 2022; Elmeguid et al., 2018; Etminani-Ghasrodashti and Hamidi, 2019), reliability (Adam et al., 2020; Elmeguid et al., 2018; Kuswanto et al., 2019), time efficiency (Adam et al., 2020; Etminani-Ghasrodashti and Hamidi, 2019; Raj et al., 2023; Zhang et al., 2016), and offline service quality (Kuswanto et al., 2019) are essential for preferences of service.

Despite the findings of these studies, we know little about demand-side intentions toward ride-sharing services in countries that have yet to introduce full-spectrum ride-sharing services. Previous studies on demand-side intentions toward ride-sharing have been conducted in countries that have already introduced ride-sharing services. Studies on the supply side, such as financial situations, are challenging in these countries because they are inevitably highly inductive. However, unlike supply-side studies, demand-side studies are easier to investigate and analyze empirically on the demand-side intention toward ride-sharing services, even if full-spectrum ride-sharing services are yet to be introduced, if a survey can be conducted. Nevertheless, previous studies have not yet addressed demand-side intentions in countries that have yet to introduce ride-sharing services.

Furthermore, investigating and analyzing the demand-side intention toward ride-sharing services in countries where ride-sharing services have not yet been introduced may make policy discussions about introducing ride-sharing services in those countries more constructive by providing a viewpoint from the demand side, not only industrial actors or policy makers.

Therefore, this study investigated demand-side intention toward ride-sharing services in a country where ride-sharing services are yet to be introduced. Using Japan as a case study and a choice-based conjoint analysis (n = 1277), this study investigated which type of service is preferred and which differs from taxi services. The results revealed the following four main findings. First, price, safety (accident rate), and reliability (class 2 license) are the most critical attributes of demand-side intentions toward ridesharing services. Second, the demand-side intentions for ride-sharing and other incumbent services (taxi services) are similar. Third, demand-side intentions in ride-sharing services and differences in intentions with other incumbent services (taxi services) also depend on sociodemographic information on the demand side, such as the scale of the living region and level of income. Finally, people do not only want ride-sharing services to be inexpensive. The results of this study provide new perspectives for studies on ride-sharing services and their policies as well as valuable implications for policy discussions on introducing ride-sharing services in countries that have not yet introduced them.

Policy discussion based on empirical evidence of demand-side intentions is a mainstream trend in transportation planning and policy studies (e.g., An et al., 2021; Aryal et al., 2022; Maas, 2021; Matyas and Kamargianni, 2019; Merlin et al., 2022). This study contributes to this strand of research.This study contributes to this strand of research.

The remainder of this paper is organized as follows. Section 2 outlines the methods. Section 3 presents empirical aspects of the study. Section 4 reports the results, and Section 5 provides a discussion. Finally, Section 6 concludes the study.

2 Materials and Methods

2.1 The Case: Ride-Sharing Service in Japan

This study uses Japan as a case study. There are two advantages to using Japan as a case study.

First, providing full-spectrum ride-sharing services is illegal in Japan. In Japan, a full-spectrum ride-sharing service that provides paid transportation using private vehicles is illegal (Road Transportation Act, Article 78). While the government allowed ride-sharing services to be offered only in depopulated areas and other areas where it was challenging to provide taxi services in 2019, the actors allowed to provide the service were limited to NPOs and local governments (Ministry of Land, Infrastructure, Transport and Tourism: MLIT, 2019). In addition, although volunteer-based ride-sharing services are offered in some small, low-density areas (Yotsuji et al., 2013) and services that do not exceed the framework of cost-sharing, such as gasoline expenses (e.g., notteco), have appeared, they do not belong to paid transportation. They differ from full-spectrum ride-sharing services, in which drivers use their vehicles for paid transportation offered in other countries.

The government is also focusing on whether transportation services that use private vehicles step into the border of paid transportation. The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) recommended that the verification experiment of Uber Technologies ride-sharing in Fukuoka in 2015 be stopped, as it violated the Road Transport Law (Nihon Keizai Shimbun, 2015). The government view on full-spectrum ride-sharing is that "it is based on the premise that only drivers of private cars are responsible for transportation without any entity responsible for operation management and vehicle maintenance, and we believe that this is problematic from the perspective of ensuring safety and protecting users." (Japanese National Diet, 2023). Moreover, the government also states that "We are not considering allowing ride-sharing even in the form of special zones (Tokku)." (Japanese National Diet, 2023). Even in areas where particular deregulation is permitted (Tokku), full-spectrum ride-sharing is not allowed. Therefore, these environments allow us to investigate the demand-side intention of ride-sharing services in countries where ride-sharing services have yet to be introduced, which is little explored in previous studies.

Second, only a few policy discussions on introducing full-spectrum ride sharing in Japan have been based on the demand side. The introduction of full-spectrum ride-sharing has become a controversial issue in transportation policy in Japan (Nakamura, 2017). In the policy discussion on introducing full-spectrum ride-sharing in Japan, a trade association, mainly in the ICT sector (Japan Association of New Economies), is actively calling on the government to introduce full-spectrum ride-sharing services (Japan Association of New Economy, 2018) whereas a trade association in the taxi industry (All rights reserved Japan Federation of Hire-Taxi Associations) is also calling on the government to oppose the introduction of full-spectrum ride-sharing services (House of Councillor, 2019). These are in direct conflict within the policy arena.

However, these discussions mainly focused on the supply side, such as government and industry associations. There have been few discussions concerning the demand side. In this situation, attempting to introduce the missing viewpoint of the demand side may have important implications for policy discussions about introducing ride-sharing services by providing a missing perspective.

From the above viewpoints, using Japan as a case study allows us to learn about demand-side intentions toward ride-sharing services in a country where ride-sharing services have yet to be introduced, which previous studies provided little knowledge about. Furthermore, it has practical implications for policy discussions on ride-sharing services in countries where introducing ride-sharing services is controversial.

2.2 Choice-Based Conjoint Analysis

This study employs a choice-based conjoint analysis to investigate the intention to use ride-sharing services on the demand side. Choice-based conjoint analysis is one of the standard methods for measuring preferences in marketing, transportation, or medical studies, and it considers services or policies as bundles of attributions and varies the level of attributions of these (Eggers et al., 2022). It is possible to investigate which attributions people value and how their preferences change when it comes to the level of attribution change by making participants compare and select services and policies with various levels of attribution.

The reason for using choice-based conjoint analysis in this study is its robustness. This could be explained from two perspectives. The first is social desirability bias (SDB). SDB is less likely to occur in choice-based conjoint analyses (Horiuchi et al., 2022). SDB is often a bias in social surveys, in which respondents provide answers that differ from their original intentions regarding social norms (Fisher, 1993). Of course, because we want to know the subjects' original intentions or preferences, we would like to avoid SDB in the surveys. Therefore, we conducted robust surveys against SDB using choice-based conjoint analysis, in which subjects were asked to express their intentions and preferences based on relative rather than absolute evaluations of the objects.

The second factor was endogeneity. Endogeneity is a bias in which the treatment variable correlates with the residual term in the model (Hill et al., 2021). This causes a problem in that the consistency of the treatment effect on the dependent variable cannot be guaranteed when this bias occurs. One way to address this bias is to randomize treatments (Hill et al., 2021). Choice-based conjoint analysis can randomize the level of attribution, which is a treatment variable. Randomizing the treatment ensures conditional independence, where the treatment variables and the model's residual terms are not dependent on each other, and guarantees the consistency of the treatment effect on the dependent variable.

In summary, employing choice-based conjoint analysis in this study makes it possible to investigate the intention of the demand side to use ride-sharing services while considering the biases of SDB and endogeneity, which are often a problem in social surveys.

2.3 Survey Design

2.3.1 Survey Flow

The survey was based on the flowchart shown in Figure 1. In the first step, subjects were asked about their age, sex, occupation, experience of using ride-sharing services, income, living region, taxi frequency, and the purpose of using taxi services, and were then randomly assigned into two groups: a ride-sharing group and a taxi group in the second step.

In the second step, the reason for dividing the subjects into a ride-sharing (RS) group and a taxi group was to compare ride-sharing services with taxi

Table 1: The Scenario

We will ask you about your use of {ride-sharing services(RS), taxi}*. Suppose you urgently need to go somewhere 5km from your current location and you can only use a {ride-sharing services(RS), taxi}. On the next screen, we will present you with several pairs of {ride-sharing services(RS), taxi} and ask you to choose which you would prefer to use in a situation where you can only use one or the other. Please note that both drivers have a normal body temperature and are in good health.
*The contents inside the brackets { } will be displayed as either one.

services in terms of demand-side intentions. By comparing the differences in demand-side intentions and preferences for ride-sharing services with those for taxi services, which is a competing incumbent sector, it is easy for policymakers and industrial actors to estimate how introducing ride-sharing services will lead to change. In other words, it will be possible to discuss the competitiveness of ride-sharing services with other incumbent sectors, such as taxi services, in addition to discussing the demand-side intentions of ride-sharing services based on empirical data in policy discussions, such as in countries (e.g., Japan) that have not introduced full-spectrum ride-sharing services. Moreover, the survey assigned the two groups randomly, so it was possible to compare them in terms of robustness.

After the subjects were assigned into RS and taxi groups, they were presented with the scenario from Table 1. Using the interface shown in Figure 2, they performed five binary comparative tasks through choice-based conjoint analysis. In this scenario, ride-sharing and taxi services do not compete with other types of transportation, and the subject is asked to compare the same type of services (ride-sharing services or taxi services). Subjects were randomly assigned service attributes and asked to select their preferred service from two options.

All the surveys described above were created and conducted using Qualtrics[1] in a Japanese language environment.

2.3.2 Components of attributions

This study prepared six attributions for conjoint analysis, as shown in Table 2.

The first is price. Many previous studies have suggested that the low cost of consumption or cheapness on the demand side leads to a preference for sharing economy services or on-demand transportation such as ride-sharing and taxi services (Etminani-Ghasrodashti and Hamidi, 2019; Lee et al., 2018; Sung et al., 2018; Zhang et al., 2016). Therefore, this study also employs price as an attribute in the conjoint analysis.

The level of attribution was set according to the Japanese context because the subjects in this study were Japanese. The low price was set at 1,200 yen (ap-

[1] `https://www.qualtrics.com`

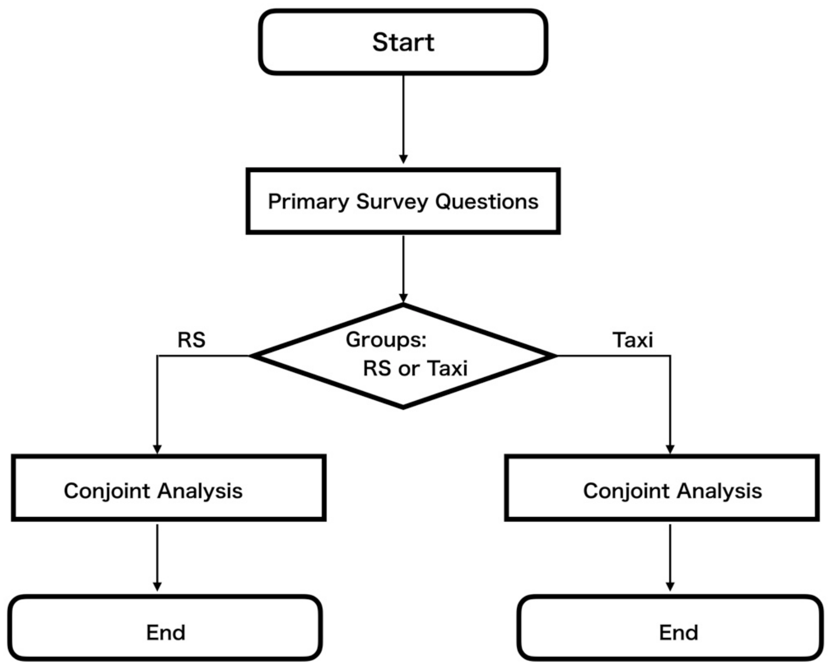

Figure 1: Survey Flow Chart

proximately 12 dollars), and the high price was set at 1,500 yen (approximately 15 dollars). Regarding the low price, at the time of the survey (Oct 2021), a 5-km taxi ride would cost about 1,142 yen when using the distance-based fare in Okinawa Prefecture (All rights reserved Japan Federation of Hire-Taxi Associations, 2021), the cheapest taxi fare in Japan. In addition, to reduce the cognitive burden of the subjects, this study set a low price of 1,200 yen. The high price was set at 1,500 (+300 yen from the low price), which is not based on theoretical considerations but to prevent a significant price level difference from visually reducing the level difference in other attribution levels in the survey design.

The second is safety. Many previous studies have suggested that the safety of the service leads to a preference for on-demand transportation such as ride-sharing and taxi services (Ali et al., 2022; Elmeguid et al., 2018; Etminani-Ghasrodashti and Hamidi, 2019; Raj et al., 2023; Raza et al., 2023; Zhang et al., 2016). In addition, safety is one of the most important points in policy discussions on introducing ride-sharing services (Garud et al., 2022).

This study set the accident rate as the attribution of safety. The accident rate is defined as the probability for a passenger in a vehicle they ride (occupied vehicle) to cause some accident, and this definition was explained to the subjects in this study. The high safety was set at a 1% accident rate, and the low safety

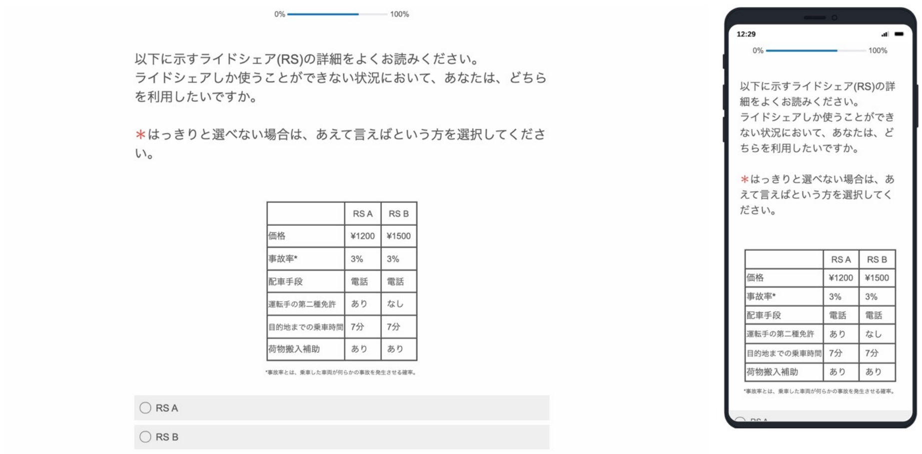

Figure 2: The Image for the Interface of Conjoint Analysis (utilizing by Qualtrics)

was set at a 3% accident rate as the level of attribution in the conjoint analysis. The 1% accident rate was calculated by multiplying 62 accidents per 1,000 taxis in 1991(National Federation of Automobile Transport Workers' Unions), which was the lowest number of accidents per 1,000 taxis in Japan to date, by the average rate of accidents in occupied vehicles from 2002 to 2019, which was 24% (MLIT, 2021, 2013); this was then divided by 1,000 and rounded to the second decimal place. The average rate of accidents in occupied vehicles is not for the current year because it was not provided in the cited data. Furthermore, the 3% accident rate is the rate of 104 accidents per 1,000 taxis in 2003 (National Federation of Automobile Transport Workers' Unions), the year with the highest number of accidents per 1,000 taxis in Japan, multiplied by 25% (MLIT, 2013), the rate of accidents in occupied vehicles in 2003; this was then divided by 1,000 and rounded to the second decimal place. The reason for rounding to the second decimal place in both cases was to reduce the cognitive burden for the subjects when making their choices.

The third is the technological element. Previous studies have also suggested that the technological advantages of a service, such as efficient matching systems, lead to a preference for a sharing economy or on-demand transportation (Aguilera-García et al., 2022; Elmeguid et al., 2018; Etminani-Ghasrodashti and Hamidi, 2019). Therefore, this study sets the dispatch method through the application as a high-tech service. In contrast, the dispatch method through phone calls is a low-tech service. In Japan, the two main dispatch methods for taxis are phone calls and apps (except for cruising). Phone calls have traditionally been used as a dispatch method for taxis in Japan. However, in recent years, the share of app dispatches in taxi use has increased, similar to that in other countries (DIDI Mobility Japan Inc, 2022). In addition, considering the situation in which large tech companies such as Uber or DIDI designed their apps with efficient matching and pricing systems, helping grow ride-sharing or app-dispatched taxis (Yan et al., 2020), dispatch through the app has been a crucial technological evolution for ride-sharing or taxis in recent years. Therefore, this study analyzes how much the growing technological element influences the preference of the demand side for services by comparing the traditional dispatch through phone calls, which plays a similar role to dispatch through an app.

The fourth is reliability. In taxis, ride-sharing, or other sharing economies, the reliability of services is also crucial to a preference for services (Adam et al., 2020; Elmeguid et al., 2018; Kuswanto et al., 2019)—however, definitions of reliability vary study by study.

In this study, following the Japanese context, a driver's class 2 license was set as reliability. In Japan, drivers must hold a class 2 license (commercial driver's license) when driving passenger vehicles, such as taxis and buses (Road Traffic Act, Article 86). A class 2 license is one way to legally guarantee the minimum reliability of public transportation. In addition, the existence of a class 2 license for drivers has been a frequent point of contention in discussions on introducing ride-sharing services in Japan (Japan Association of New Economy, 2018; Watanabe, 2017). Therefore, in this study, the existence of a driver's class 2 license is suitable for the attribution of reliability, as it is generally recognized as a legal standard and is also considered controversial in discussions about introducing ride-sharing services in the context.

The fifth is time efficiency. Previous studies have also suggested that time efficacy, in particular, the time taken to reach the destination and the time spent waiting for vehicles, influences customer satisfaction or preference for ride-sharing or taxi services (Adam et al., 2020; Etminani-Ghasrodashti and Hamidi, 2019; Raj et al., 2023; Zhang et al., 2016). Reducing waiting time is also considered a technological element (Yan et al., 2020), so this study set the time taken to reach the destination as the attribution of time efficiency.

The distance to the destination was set to 5 km in the scenario used in this study, and the legal speed on ordinary roads in Japan is 60 km/h (Road Traffic Act Enforcement Order, Article 11). It would take five minutes to reach the destination. However, it is essential to note that the actual time can vary owing to the number of traffic signals, road conditions, and driving style. Therefore, this study assumes that it takes more time than theoretically, even if the service is time efficient. Therefore, 10 minutes was set as the baseline time, which is realistic under these circumstances, and 7 minutes as the efficient time for this study.

The last is offline service quality. Some previous studies have also suggested that offline service quality, not just functional aspects such as price or app, influences the preference for ride-sharing services and taxis (Kuswanto et al., 2019). Therefore, this study sets offline service quality as one of the attributions.

Service quality is an ambiguous concept that can be perceived differently from one person to another if used directly as an attribute. Therefore, this study set a concrete behavior that subjects more objectively perceive as quality. In this study, the presence or absence of a luggage assistant was used as

Table 2: Attribution and Level of Conjoint experiment

Attribute	Level
Price(JPY)	{1500, 1200}
Safety: Accident rate	{ 3%, 1%}
Technological element: Dispatch method	{Phone call, App}
Reliability: Driver's Class 2 license (: Commercial Driver's License)	{No, Yes}
Time: Time to reach destination	{10 min, 7 min}
Offline Service Quality: Luggage assistance	{No, Yes}

the level of attribution. The luggage assistant is a service in which the driver assists the passenger in loading luggage into the trunk or inside of the vehicle and is one of the offline services of taxis often seen in Japan. Providing this service is expected to reduce the physical burden on passengers when they get in and off a vehicle. In contrast, not providing this service is expected to increase the physical burden on passengers when they are getting on and off a vehicle. Therefore, the luggage assistant can be perceived as customer-focused and has high offline service quality.

3 Empirical Analysis

3.1 Model

This study used the logistic regression model in Equation (1) to analyze the demand-side intention for ride-sharing and taxis. y_{itj} defines the probability of option j's in choice session t for subject i. y_{itj} is the probability estimated from the logistic function. X_{itj} defines the level of attributions in option j in the choice session t for subject i. Z_i defines the personal characteristics of subject i, such as income or frequency of daily taxi use.

The final aim of this study was to estimate b^* as described in Equation (2), where b^* describes the increase in the probability y when the level of the attributions X increases by one unit. In other words, b^* indicates the influence of each service attribution on the service preference.

This study uses cluster-robust standard errors clustered by subject in Equation (3). The matrix Ω in Equation (3) represents the diagonal elements of the variance-covariance matrix of the error terms clustered by sample. This method considers correlations in the same sample as in the model.

$$y_{itj} = \frac{1}{1 + \exp^{-(\alpha + X'_{itj}\beta + Z'_i\gamma)}} \tag{1}$$

$$b^* = E[\beta \times y_{itj} \times (1 - y_{itj})] \tag{2}$$

$$SE(b^*) = E\left[\sqrt{\mathrm{diag}(\Omega)} \times y_{itj} \times (1 - y_{itj})\right] \tag{3}$$

3.2 Data

This study conducted a survey experiment with 1,500 respondents using Yahoo Crowdsourcing[2] in October 2021[3]. The subjects who completed the survey were paid 25 JPY (approximately 0.25 US Dollars). First, this study asked subjects the following primary survey questions: age, sex, income, occupation, scale of living region, taxi frequency, purpose of taxi use, and experience of using ride-sharing services. The subjects were then randomly assigned into ride-sharing (RS) and taxi groups according to the scenario in Table 1. Finally, the subjects expressed their preferences by comparing the attributions of the two services in each session, as shown in the interface in Figure 2. There were five sessions for each subject to express their preferences.

After removing subjects who did not complete the survey or who did not agree to provide informed consent, the sample sizes were 666 and 621 for the RS and taxi groups, respectively. The mean response time for the survey was 205 seconds (SD = 377) for the RS group and 199 seconds (SD = 314) for the taxi group. The difference in the mean response time between the two groups was not statistically significant (p = 0.33). In addition, this study removed subjects whose absolute z-score of response time in each group was over three to remove extremely early or slow responses. The final sample sizes are 660 and 617 for the RS and taxi groups, respectively.

Tables 3 and 4 summarize the primary survey questions. To ensure the representativeness of the subjects, the recent census in Japan in 2020 had a mean age of 47.6 years (Ministry of Internal Affairs and Communications: MIC, 2021). On the contrary, the average age for the RS group is 47.6 years (SD $\simeq$ 11.9)[4], and the taxi group has an average age of 47.3 years (SD $\simeq$ 11.9). Regarding the gender balance, the proportion of females in Japan's total population is 51.3% (MIC, 2021). The proportion of females in the RS group is 38.7%, and the proportion of females in the taxi group is 36.6%. Regarding the usual frequency of taxi use, according to a survey about usage in 2015, 85.6% of people in Japan used taxis several times a year or did not use taxis (MILT, 2015). In this survey, 89.7 % of the subjects in the RS group responded that they used taxis several times a year or did not, while 91.4% of the subjects in the taxi group responded that they used taxis several times a year or did not.

In Figure 3, we compare the standardized bias[5] of the covariates between

[2] `https://crowdsourcing.yahoo.co.jp/`

[3] The entire protocol of this survey was approved by the Ethical Review Board at Kobe University Graduate School of Law (receipt number: 03003)

[4] Weighted mean and weighted variance are calculated using the median of each class as the class value, excluding the class 'Prefer not to answer'. The weighted mean is computed by frequency.

[5] To calculate the standardized bias of covariates between the RS group and the taxi group, this study uses the formula : $\frac{(\mu_r - \mu_t)}{\sqrt{0.5(\mu_r(1-\mu_r)+\mu_t(1-\mu_t))}}$, where μ_r and μ_t are the means of the

the RS and taxi groups to confirm whether it succeeded in randomly assigning subjects to the two groups. All absolute standardized biases of the covariates were less than 10. It was assumed that this study succeeded in randomly assigning subjects to the two groups (Austin and Mamdani, 2006; Normand et al., 2001). Therefore, this study could compare the intentions of the demand side toward services between the RS and taxi groups.

covariates (binary variable) for the RS group and the taxi group.

Table 3: Descriptive Statistics of Ride-sharing (RS) Group

Category	Subcategory	Freaquency
Age:	Prefer not to answer	5
	10s	8
	20s	41
	30s	109
	40s	218
	50s	187
	60s	78
	70s	14
Sex:	Prefer not to answer	10
	Male	397
	Female	251
	Other	2
Occupation:	Prefer not to answer	12
	Other	9
	Student	15
	Part-time job	90
	Full-time employee (mainly private companies)	267
	Temporary staff	21
	Self-employed	55
	Public servant	33
	Full-time housewife (husband)	70
	Unemployed (including after retirement)	85
	Agriculture, forestry and fisheries	3
RS Experience:	Prefer not to answer	0
	No	641
	Yes	19
Income(JPY):	Prefer not to answer	95
	Less than 1M	149
	1M or more and less than 2M	65
	2M or more and less than 3M	78
	3M or more and less than 4M	82
	4M or more and less than 5M	53
	5M or more and less than 6M	45
	6M or more and less than 7M	27
	7M or more and less than 8M	23
	8M or more and less than 9M	14
	9M or more and less than 10M	9
	10M or more	20
Region:	Prefer not to answer	20
	Population of Less than 100K	150
	Population of 100K or more and less than 500K	228
	Population of 500K or more	262
Taxi Frequency:	Prefer not to answer	4
	Do not use	333
	Several times a year	259
	Several times a month	44
	About once a week	15
	Several times a week	4
	Almost every day	1
Taxi Purpose:	Prefer not to answer	4
	Other	43
	Shopping	27
	Visit to hospital	32
	Commuting	10
	Moving for work	89
	Leisure	118
	Do not use	337

Table 4: Descriptive Statistics of Taxi Group

Category	Subcategory	Freaquency
Age:	Prefer not to answer	10
	10s	11
	20s	35
	30s	104
	40s	196
	50s	182
	60s	68
	70s	11
Sex:	Prefer not to answer	9
	Male	379
	Female	229
	Other	0
Occupation:	Prefer not to answer	11
	Other	15
	Student	16
	Part-time job	75
	Full-time employee (mainly private companies)	256
	Temporary staff	20
	Self-employed	59
	Public servant	26
	Full-time housewife (husband)	63
	Unemployed (including after retirement)	74
	Agriculture, forestry and fisheries	2
RS Experience:	Prefer not to answer	2
	No	594
	Yes	21
Income(JPY):	Prefer not to answer	88
	Less than 1M	131
	1M or more and less than 2M	64
	2M or more and less than 3M	74
	3M or more and less than 4M	68
	4M or more and less than 5M	55
	5M or more and less than 6M	37
	6M or more and less than 7M	35
	7M or more and less than 8M	25
	8M or more and less than 9M	17
	9M or more and less than 10M	4
	10M or more	19
Region:	Prefer not to answer	27
	Population of Less than 100K	141
	Population of 100K or more and less than 500K	209
	Population of 500K or more	240
Taxi Frequency:	Prefer not to answer	3
	Do not use	312
	Several times a year	252
	Several times a month	33
	About once a week	6
	Several times a week	7
	Almost every day	4
Taxi Purpose:	Prefer not to answer	5
	Other	41
	Shopping	34
	Visit to hospital	25
	Commuting	10
	Moving for work	86
	Leisure	101
	Do not use	315

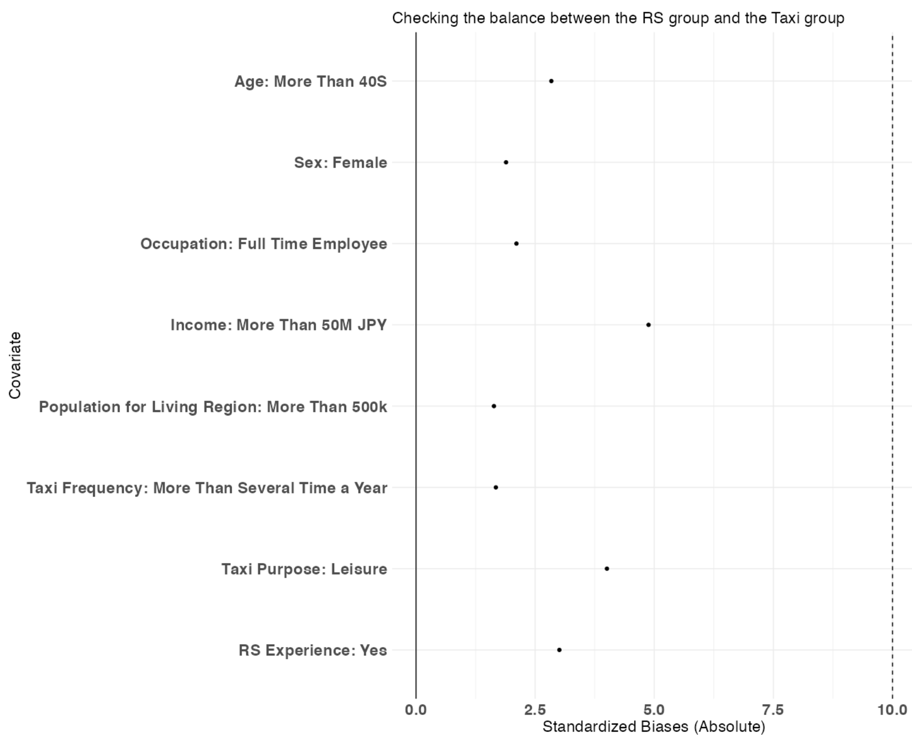

Figure 3: Checking the balance between the Ride-sharing Group and the Taxi Group

4 Results

4.1 Comprehensive Sample

Figure 4 shows the results of estimating the effects in the level of attributions of the RS and taxi groups on their service preferences under the scenario. Points describe the average treatment effects of each attribution, and the range of bars describes the 95% confidence intervals in the figure.

First, the effects in the level of attribution of the RS and taxi groups on their service preferences under the scenario are similar. Concerning the inclusion of a 95% confidence interval for each coefficient and comparing two groups, all of the effects in the level of attribution of the RS group and taxi group on their service preferences under the scenario are not different in the two groups.

Second, attributions have different effects on service preferences. In both groups, price was the most effective attribution. If the price changes from 1,500 JPY to 1,200 JPY, then the probability of choosing the service increases 19.9% points (95% CI: [18.1% points: 21.6% points]) for the RS group and 21.2%

points (95% CI: [19.3% points: 23.0% points]) for the taxi group. These are significantly larger than other effects of attributions, even when a 95% CI is considered.

Safety is a crucial attribution, following price. If the accident rate changes from 3% to 1%, then the probability of choosing the service increases by 15.4% points (95% CI: [13.6% points: 17.2% points]) for the RS group and 16.0% points (95% CI: [14.1% points: 17.9% points]) for the taxi group. These are significantly larger than other effects of attributions, except for price and reliability.

Reliability is also a crucial attribution. If the driver has a class 2 license, then the probability of choosing the service increases by 11.3% points (95% CI: [8.9% points: 13.7% points]) for the RS group and 11.8% points (95% CI: [9.4% points: 14.3% points]) for the taxi group, compared with the driver not having such a license. These are significantly larger than other effects of attributions, except for price, safety, and technological element (only in the RS group).

For the other three attributions (technological element, time efficiency, and offline service quality), the effects of attributions on preferences are also significantly larger than 0. However, these values are relatively small for all of the attributions.

Two conclusions can be drawn from these comprehensive results. First, price, safety (accident rate), and reliability (class 2 license) are the most critical attributions of demand-side intentions toward ride-sharing services: these significantly influence preference for the service. Second, the demand-side intentions for ride-sharing and taxi services are similar.

4.2 Subgroup Experiment

4.2.1 Living Region

Considering the heterogeneity of the treatment effects, this study also conducted some subgroup analyses.

The first was a subgroup divided by the living region of the subjects. In Japan, taxi business models vary according to the city size. In metropolitan areas, cruising taxis are relatively common, whereas in rural areas, dispatching vehicles are relatively common (Goto, 2017; Matsuno, 2017). Therefore, differences in the attribution of importance may emerge depending on the differences in the services to which the subjects are exposed to daily.

In Figure 5, this study divided the subgroup of the living region population of 500,000 or more as a metropolitan area in Japan (MIC) and others (excluded subjects who responded "Prefer not to answer" to this question) in both groups and compared the effect of attributions on the preference for services under the scenario.

First, some parts of the effects regarding their technological elements and offline service quality at the level of attribution of the RS and taxi groups on the service preferences of the subjects who live in metropolitan areas under the

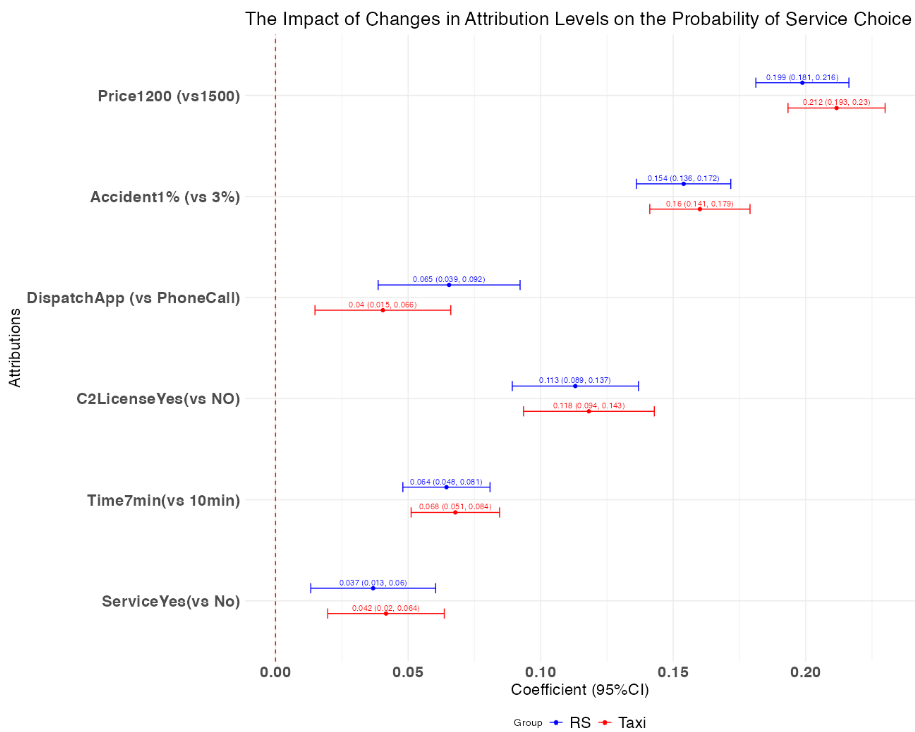

Figure 4: The Impact of Changes in Attribution Levels on the Probability of Service Choice

scenario are different. While people who live in metropolitan areas wanted technological efficiency and advantages for ride-sharing services (9.3% points, 95% CI: [5.1% points: 13.6% points]), in contrast, they did not want technological efficiency and advantages as much when it comes to taxis (3.5% points, 95% CI: [-0.7% points: 7.8% points]). In addition, while people who live in metropolitan areas did not want offline service quality for ride-sharing services (2.5% points, 95% CI: [-1.2% points: 6.2% points]), in contrast, they wanted offline service quality for taxis (6.0% points, 95% CI: [2.5% points: 9.5% points]). This implies that there are some differences between the preferences for ride-sharing services and taxi services among people living in metropolitan areas.

Second, even within the same RS group, preferences for ride-sharing services differed slightly between subjects in the metropolitan area and those in other areas. Offline service quality in the RS group had different influences of attribution on preference, depending on the city scale where the subjects lived. In the RS group, the subjects who lived in metropolitan areas do not want offline service quality to the services (2.5% points, 95% CI: [-1.2% points: 6.2% points]), whereas other subjects wanted offline service quality to the services (4.7% points, 95% CI: [1.6% points: 7.8% points]).

These results suggest that preferences for ride-sharing services differ slightly from those for taxi services in metropolitan areas. In addition, within the same RS group, there was a difference between the intention of the demand side in the metropolitan area and the intention of the demand side in other areas toward ride-sharing services. In other words, these results imply that the competitiveness of ride-sharing with other incumbent sectors and the intention of the demand side toward the service vary according to city size.

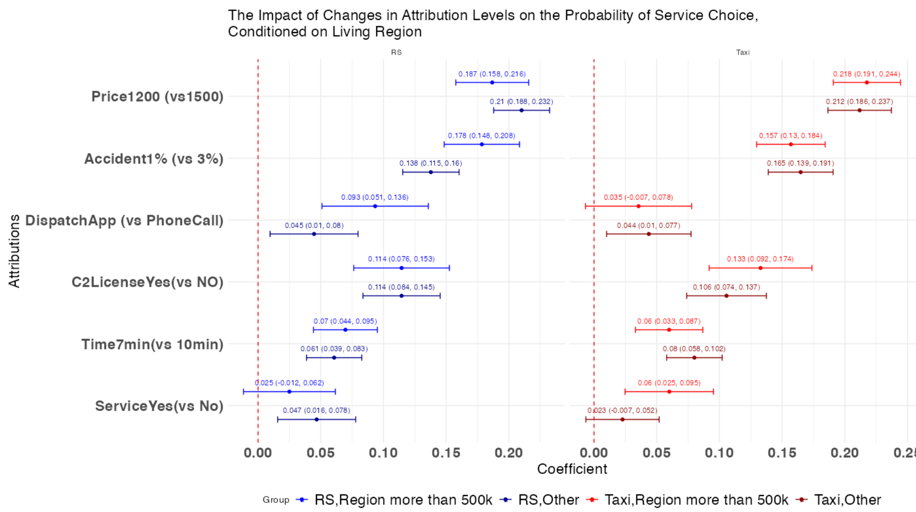

Figure 5: The Impact of Changes in Attribution Levels on the Probability of Service Choice, Conditioned on Living Region

4.2.2 Income

Some previous studies suggested that individual income level influences the preference for ride-sharing and taxi services (e.g., Zhang et al., 2016).

Therefore, in Figure 6, this study also divided a subgroup of yearly income of 5 million or more JPY, which is higher than the average income of 4.4 million JPY in 2021 (National Tax Agency, 2022), and other (excluded subjects who responded "Prefer not to answer" to this question) and compared the effect of attributions on the preference for services under the scenario.

First, among high-income subjects, there were differences between the RS and taxi groups regarding the influence of technological elements on service preferences. The high-income subjects in the RS group did not want technological efficiency and advantages of the ride-sharing services (3.3% points, 95% CI: [-3.8% points: 10.3% points]). In contrast, the high-income subjects in the taxi group wanted technological efficiency and advantages of the taxi services (10.6% points, 95% CI: [3.4% points: 17.9% points]).

Second, there are differences within the same RS group. In the RS group, there were differences in technological elements and offline service quality. As mentioned, the high-income subjects did not want technological efficiency and advantages of the services (3.3% points, 95% CI: [-3.8% points: 10.3% points]). In contrast, other subjects wanted technological efficiency and advantages of the ride-sharing services (6.8% points, 95% CI: [3.7% points: 9.9% points]). In addition, while the high-income subjects did not want offline service quality of the services (5.4% points, 95% CI: [-1.3% points: 12.0% points]), in contrast, other subjects wanted this service (3.2% points, 95% CI: [0.5% points: 6.0% points]).

These results suggest that the preferences for ride-sharing services differ slightly from those for taxi services among high-income individuals. In addition, within the same RS group, there was a difference between the intention on the demand side among high-income people and the intention on the demand side among other people toward ride-sharing services.

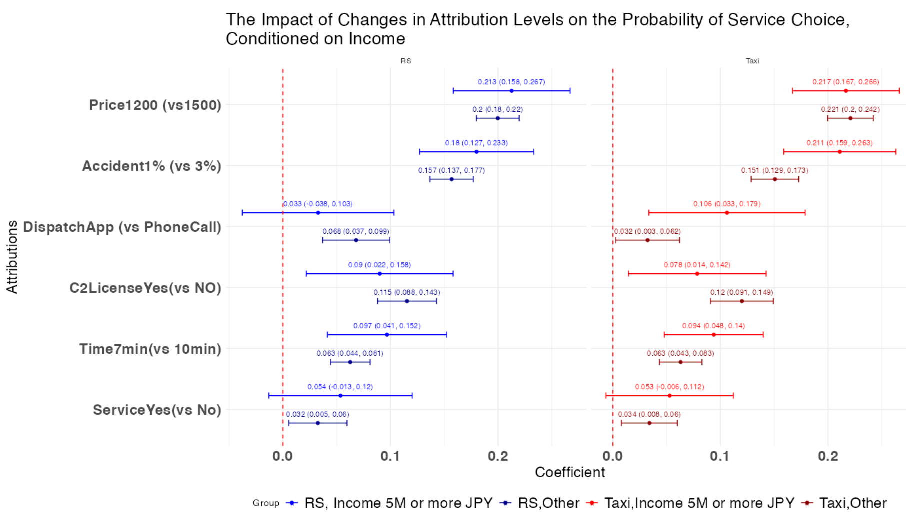

Figure 6: The Impact of Changes in Attribution Levels on the Probability of Service Choice, Conditioned on Income

4.3 The Trade-Off Between Price and Safety

In the controversy surrounding the introduction of full-spectrum ride-sharing or regulation of the taxi industry, it is often mentioned that introducing ride-sharing services or deregulation for entry into the taxi market causes excessive price competition, which can lead to a decline in the safety of services (e.g., House of Councillor, 2019). However, many of these arguments are based on deductive reasoning and are rarely accompanied by empirical data.

Therefore, Figure 7 compares the influence of safety attributions on service preference under both high- and low-price attributions in both the RS and taxi groups. Suppose on the demand side there is a tendency to disregard safety due to pursuing low prices, which is often controversial. In this case, the subjects in this study likely tended to experience a weak effect on service preferences when the price was low.

There were no differences in the influence of attribution of safety on the service preference between the subjects regarding exposure to low price and high price in the RS group (1,500 JPY: 14.4% points [12.0% points: 16.8% points], 1,200 JPY: 16.3% points [14.0% points: 18.7% points]). In addition, there was no difference in the influence of attribution with the taxi group, not only in the same price range but also in different price ranges (RS, 1,500 JPY: 14.4% points [12.0% points: 16.8% points], RS, 1,200 JPY: 16.3% points [14.0% points: 18.7% points], taxi, 1,500 JPY: 15.8% points [13.4% points: 18.1% points], taxi, 1,200 JPY: 16.3% points [13.8% points: 18.9% points]).

These results suggest a lower tendency to perceive price and safety as a trade-off in demand-side perceptions and that high safety is an essential attribution in both high- and low-price services from the demand side.

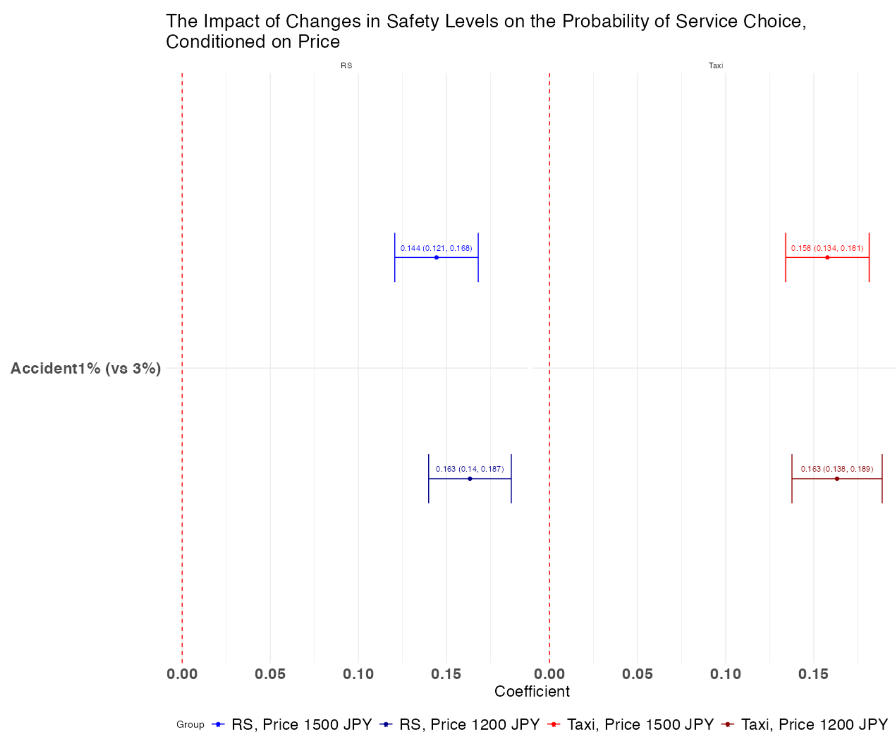

Figure 7: The Impact of Changes in Safety Levels on the Probability of Service Choice, Conditioned on Price

5 Discussion

This study found four things about the intention of the demand side toward ride-sharing services in a country where ride-sharing services are yet to be introduced from the choice-based conjoint analysis in this study.

First, price, safety (accident rate), and reliability (class 2 license) are the most critical attributions of the demand side intentions toward ride-sharing services. The subjects in this study preferred ride-sharing services that were cheaper, had a low accident rate, and had drivers having a class 2 license. Previous studies on demand-side intentions toward ride-sharing in countries that introduced full-spectrum ride-sharing also suggested that price, safety, and reliability are critical factors for service preference (Adam et al., 2020; Ali et al., 2022; Elmeguid et al., 2018; Etminani-Ghasrodashti and Hamidi, 2019; Kuswanto et al., 2019; Lee et al., 2018; Raj et al., 2023; Raza et al., 2023; Sung et al., 2018; Zhang et al., 2016). This study suggests that these tendencies could also be present in countries where ride-sharing services have yet to be introduced.

Second, the demand-side intentions for ride-sharing and those for other incumbent services (taxi services) are similar. The subjects in this study preferred a cheaper taxi service, a low accident rate, and a driver with a class 2 license, similar to ride-sharing services. This result can be seen as a causal mechanism by which other incumbent sectors, such as taxi services, are affected by the entry of ride-sharing services into the market that previous studies have suggested (Bagchi, 2018; Cetin and Deakin, 2019; Chang, 2017; Daryanto et al., 2019). In short, taxi services are vulnerable to trends in ride-sharing services because they are judged based on criteria similar to ride-sharing services in terms of demand-side perceptions. Although full-spectrum ride-sharing services have not yet been introduced in Japan, where the study was conducted, the ride-sharing services through a causal mechanism like the one suggested could impact other incumbent sectors like taxi services if and when they are introduced.

Third, the results of the subgroup analysis suggested that the intention of the demand side in ride-sharing services and differences in the intention of the demand side with taxi services also depend on the sociodemographic information of the demand side, such as the scale of the living region and level of income. While subjects living in metropolitan areas wanted technological efficiency in ride-sharing services, they did not want it in taxi services. In addition, subjects who live in metropolitan areas did not want offline service quality in ride-sharing services. In contrast, they wanted it in taxi services, and subjects in other areas wanted it in ride-sharing services. Furthermore, while high-income subjects did not want technological efficiency in ride-sharing services, they did want it in taxi services. Moreover, high-income subjects did not want offline service quality in ride-sharing services. In contrast, the other subjects wanted it in ride-sharing services.

Previous studies have suggested that preferences for ride-sharing services and relative evaluations of other services such as taxis differ according to the environment in which individuals live, their psychological traits, and the economic situation in which they are placed (Aguilera-García et al., 2022; Etminani-

Ghasrodashti and Hamidi, 2019; Raj et al., 2023; Raza et al., 2023; Zhang et al., 2016). The results of this study suggest that these tendencies may also be observed in countries such as Japan, where ride-sharing services are yet to be introduced. In future studies or policy discussions, we need further research and discussion on why differences in preference for ride-sharing services and differences in comparison with a preference for other incumbent services occur due to sociodemographic information of the individual and why differences occur in that attribution and not in other attributions, even in countries where ride-sharing services are yet to be introduced. This could help predict a more personalized response on the demand side when introducing ride-sharing services.

The fourth finding of this study is that there is less tendency to perceive price and safety as trade-offs in demand-side perceptions. The subjects in this study likely perceived safety as a crucial attribution of services, even when the price is low. In the controversy surrounding the introduction of full-spectrum ride-sharing or regulation of the taxi industry, it is often mentioned that introducing ride-sharing services or deregulation for entry into the taxi market causes excessive price competition, which can lead to a decline in the safety of services (e.g., House of Councillor, 2019). However, the results of this study suggest that people do not only want ride-sharing services to be inexpensive. Instead, they can be said to be seeking, on balance, price efficiency and service safety vis-á-vis services. Of course, these do not negate concerns, such as excessive price competition on the supply side and market failure, as raised in the controversy. However, this result implies that such phenomena do not occur as quickly as the controversy suggests. Suppose that the demand side requires safer and more price-efficient services. In this case, there may be an incentive for the supply side to provide safer and more price-efficient services to meet demand-side expectations and survive in the market.

Furthermore, considering the practical environment, the concept of safety is more complex to visualize than the concept of price. Therefore, we must consider a form of regulation and announcement that stimulates a demand-side desire to pursue safety.

6 Conclusion

This study investigated demand-side intentions toward ride-sharing services in a country where ride-sharing services are yet to be introduced. Using Japan as a case study and choice-based conjoint analysis (n = 1277), this study investigated preferred service attributes. In addition, this study investigated the demand-side intention toward other incumbent services (taxi services) and compared it with the results of ride-sharing services.

The results revealed the following four main findings. First, price, safety (accident rate), and reliability (class 2 license) are the most critical attributions of demand-side intentions toward ride-sharing services. Second, the demand-side intentions for ride-sharing and other incumbent services (taxi services) are similar. Third, demand-side intentions in ride-sharing services and differences in intentions with other incumbent services (taxi services) also depend on sociodemographic information on the demand side, such as the scale of the living region and level of income. Finally, people do not only want ride-sharing services to be inexpensive.

These results make several significant contributions to studies and discussions on ride-sharing services. The first is the results from a country where ride-sharing services are yet to be introduced. Until now, leading studies on demand-side intention toward ride-sharing have been from countries that have already introduced ride-sharing services.

Therefore, the results of this study, in a country where ride-sharing services have yet to be introduced, provide new insights into a context that was not available in previous studies.

Furthermore, the results are essential for countries where introducing ride-sharing services is controversial in their societies. Even in countries that have not introduced ride-sharing services, it will be necessary to consider demand-side intentions and preferences in discussions or controversies to make comprehensive decisions, as well as in transportation planning and policy studies (e.g., An et al., 2021; Aryal et al., 2022; Maas, 2021; Matyas and Kamargianni, 2019; Merlin et al., 2022). This study's findings will support decision-making in such countries. Even if limited to Japan, which is the case study, the policy discussion about introducing full-spectrum ride-sharing services has so far focused on the perspective from the supply side, with findings on the demand side being anecdotal or missing; therefore, the value of findings such as those in this study is considered to be significant.

However, this study had several limitations. First, the results are based on something other than a practical environment, namely, on a survey experiment. When choosing a service, the demand-side intentions observed under scenarios or in environments with no real cost burden may differ from those in natural environments. It may be worthwhile to use data from countries where future field experiments can be conducted. Second, for the most part, subjects in this study had never used ride-sharing services. In this study, 97.1% of subjects in the ride-sharing group reported never using a ride-sharing service. Although this study considered such a situation by explaining ride-sharing services in the experiment, the experience of never using a ride-sharing service may have influenced the experimental results regarding the recall of the image of using that service. Future studies in countries where ride-sharing services are yet to be introduced should involve setting a target for the sample size of subjects who have used ride-sharing services and comparing the differences in intention with those who have not. Finally, this study was a one-shot survey focusing only on Japan as a case study. A one-shot survey in one country alone has low external validity and few implications for many societies and people. Future studies should follow up on the experiments in this study and conduct experiments in other countries where ride-sharing services are yet to be introduced.

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Data Access

You can access the data used in this study, and the code to replicate the analysis, from the author's GitHub `https://onl.sc/6MjFce2`.

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