The effects of accessible taxi service and taxi fare subsidy scheme on the elderly's willingness-to-travel

Abstract

Taxis provide a personalized, door-to-door, and demand-responsive service, and are an attractive transport mode for accommodating the needs of an aging population. Accessible taxis further enhance the level of comfort and accessibility by providing a larger compartment and a mechanical ramp to facilitate the boarding and alighting of wheelchairs. At present, however, both ordinary and accessible taxis are infrequently used by elderly passengers in Hong Kong, due in part to high fares and long walking and wait times. Because of these limitations, taxis cannot effectively cater for the travel demands of the elderly and hence cannot improve their mobility. In this study, 580 residents of Hong Kong aged 60 or above were interviewed regarding their decision to whether to make a trip by an ordinary/accessible taxi to attend a non-compulsory social activity in hypothetical scenarios. A total of 2,320 observations were obtained and a series of binary logistic regression models were calibrated to identify the significant factors influencing the elderly's willingness-to-travel. The model results show that the older elderly and those with a lower monthly expenditure were more reluctant to travel by taxi and preferred staying home. The elderly using crutches or a wheelchair had a stronger preference for accessible taxis rather than the non-walking aid users. The findings also indicate that the elderly were more sensitive to a taxi fare subsidy based on a percentage discount than one based on a fixed discount. Policy measures related to providing an accessible taxi service and taxi fare subsidy scheme to improve the mobility of the elderly are discussed: A step-wise taxi fare subsidy scheme is recommended to integrate with current transport policy measures to look after the needs of the elderly at different ages, and a supply-side subsidy is also recommended to support local taxi operators to purchase accessible taxis and increase the fleet size to minimize the wait time of users.

Keywords: aging population, public transport fare subsidy scheme, accessible taxis, elderly mobility, binary logistic regression model

1. Introduction

1.1. The aging population and its mobility

Populations are aging throughout the world. Hong Kong is by no means an exception in this regard. Hong Kong had the second-highest percentage of elderly residents (21.7%) in Asia in 2015, surpassed only by Japan (33.1%), which topped the global list (United Nations, 2015). Predominately due to a low fertility rate and extended life expectancy, both the absolute number and the relative proportion of the elderly have increased significantly in Hong Kong. The number of residents aged 60 or above in 2016 was 1.70 million, accounting for 22.7% of the total population. The elderly population is predicted to reach 2.89 million (35.4%) in 2036 and 2.97 million (38.6%) in 2066 (Census and Statistics Department, 2017). Moreover, Hong Kong has seen a sharp increase in the median age of its population, which is predicted to be 52.7 years in 2050 compared to 43.2 years in 2015 (United Nations, 2015).

The unprecedented and rapid increase in the elderly population is expected to have significant effects in many areas, including but not limited to, the economy, welfare payments, health care, housing provision, and retirement systems. The Hong Kong government has therefore actively adopted a wide variety of policies related to pensions, health care, and social benefits for the elderly (Financial Services and the Treasury Bureau, 2018). However, the effect of population aging on the transport system has been overlooked by policymakers (Szeto et al., 2017), although it is essential to improve the mobility of the

elderly in the transport sector to facilitate the promotion of overall societal development (Olawole and Aloba, 2014).

Mobility refers to the ability of individuals to move (or travel). It is essential, particularly for the elderly, to maintaining independence, quality of life, and well-being (Wachs, 1979; Metz, 2000; Banister and Bowling, 2004; Spinney et al., 2009; Mackett, 2015; Yang et al., 2019), which typically decrease with age (Rantakokko et al., 2013; Koh et al., 2015). Elderly people tend to make fewer trips and travel shorter distances than their younger counterparts (Szeto et al., 2017). One of the major reasons for these travel characteristics is deteriorating health. With deficits in their sensory functions and musculoskeletal strength, the elderly are a disadvantaged group that faces difficulties in using public transport services and requires special attention (Ipingbemi, 2010; Mollenkopf et al., 2011). However, most of the elderly are retirees without a steady income and some of them may not have any family financial support. To minimize their expenditure, they tend to stay home, which results in low morale, depression, and loneliness (Atkins, 2001). To ensure their mobility and accessibility to social, cultural, and recreational activities, as well as maintain their physical and mental well-being (Murray, 2015), provision of an age-friendly transport system that addresses the mobility needs of the elderly is vital (Broome et al., 2012, 2013; Shiau and Huang, 2014).

1.2. Elderly travel behaviors and transport policy measures

To facilitate the use of public transport and enhance the mobility of the elderly and people with disabilities, the Hong Kong government introduced a public transport fare concession scheme in 2012. The scheme encourages travel at any time by designated public transport modes (including railways, buses, public light buses, and ferries) at a concessionary fare of HK$2 (equivalent to US$0.26) per trip. However, the scheme emphasizes the role of money in determining willingness-to-travel while neglecting some other factors that may influence the elderly's preferences to make a trip. In addition to the fare, it has been shown that walking time, wait time, and seat availability significantly influence the elderly's decisions to travel and attend non-compulsory social activities (Wong et al., 2018). Most of them prefer taking buses to railways and public light buses because of easier access, more seats onboard, and better interchange experiences. Taxis are less likely to be selected because of high fares (Szeto et al., 2017). A recent study on elderly people's satisfaction with public transport services (Wong et al., 2017) recommended that to increase their willingness-to-travel, immediate improvements are required in seat availability, the condition of stations and stops, and drivers' awareness of their needs. However, these measures may not be sufficient to cater for the increasing travel demands of the elderly. In addition to improving existing public transport modes, new and different public transport options that are viable, affordable, accessible, safe, and coordinated to the needs of the elderly have been suggested (Whelan et al., 2006). Accessible taxis with subsidized fares are one such option.

1.3. Ordinary taxis and accessible taxis

Taxis have numerous favorable and desirable features such as a personalized, door-to-door, and demand-responsive service, with fewer barriers and higher accessibility for physically impaired users (Park and Chowdhury, 2018). However, ordinary taxis have two obvious inherent drawbacks that prevent them from being used frequently by the elderly. One is the high cost, which is substantially greater than other public transport modes and is not included in the HK$2 flat-rate public transport fare concession scheme at present. The other is the difficulty of boarding and alighting, which does not explicitly address the elderly's needs, especially for those using a wheelchair. Accessible taxis improve the level of passenger comfort and accessibility by providing a larger compartment and a mechanical ramp to facilitate the boarding and alighting of a wheelchair. Moreover, the dispatching mode of

accessible taxis (which allows passengers to wait for their taxi at home or in another comfortable environment) is more convenient for the elderly than the traditional cruising mode of ordinary taxis, which requires passengers to walk and wait on the street. However, accessible taxis are only a tiny proportion of the Hong Kong taxi market. Currently, there are more than 18,000 ordinary taxis, but only 82 accessible taxis in service (Transport and Housing Bureau, 2017). Due to the inadequate supply of accessible taxis and their higher fares compared with ordinary taxis, they are not widely used by elderly passengers. As stated in the Public Transport Strategy (Transport and Housing Bureau, 2017), the government is going to assist taxi operators in introducing more accessible taxis. Given that both the start-up and operating costs of accessible taxis are generally much higher than those of ordinary taxis, it is almost impossible for accessible taxi operators to reduce the fare for the elderly and eligible people with disabilities. Many international cities have implemented a taxi fare subsidy scheme to benefit certain transport-disadvantaged segments of the population and enhance their mobility, but there is currently no such scheme in Hong Kong.

1.4. Taxi fare subsidy schemes

Back in 1987, the Rehabilitation Development Coordinating Committee and the Hong Kong Jockey Club launched a one-year pilot taxi voucher scheme to encourage wheelchair users in Hong Kong to travel by taxi at a reduced fare (Transport and Housing Bureau, 2007). However, the scheme was not welcomed by wheelchair users and taxi drivers because the voucher application and redemption procedures were complicated, cumbersome, and inconvenient due to the limited number of designated venues for redemption. The taxi voucher scheme was shelved after the trial period. However, with advances in technology, the Elderly Citizen Octopus Card can now be used to avoid the complicated redemption procedure. The technical problem can be resolved. Internationally, Sydney, London, Seoul, Taipei, Singapore, and some other metropolitan cities have started their own taxi fare subsidy schemes in recent years. All of these schemes only provide a partial subsidy, and eligible passengers have to pay for a proportion of the taxi fare, which avoids the subsidy scheme being abused. The subsidy levels and operation mechanisms of the various schemes vary greatly. To establish appropriate policy measures, the Hong Kong government can refer to international experiences of accessible taxi services and taxi fare subsidy schemes, in addition to the local travel behavior of the elderly.

1.5. Research objectives, contributions, and paper outline

All in all, the elderly generally make fewer trips because of their deteriorating health, and not having a steady income. Ordinary taxis are inconvenient for their boarding and alighting, especially for those with dependency on walking aids, and not subsidized by the public transport fare concession scheme. The provision of an accessible taxi service and taxi fare subsidy scheme could be a feasible solution to enhance the elderly's willingness-to-travel.

A face-to-face questionnaire survey was conducted in January 2018 among 580 Hong Kong residents aged 60 and over. The respondents were asked whether they would either make a trip for a non-compulsory social activity by an ordinary/accessible taxi or stay home in hypothetical scenarios. Binary logistic regression models were developed to identify factors that significantly affect the elderly's willingness-to-travel, and investigate the influences of age, monthly expenditure, and dependency on walking aids to their travel decisions. Based on the findings of the model, the need for and feasibility of an accessible taxi service and taxi fare subsidy scheme are discussed. Policy insights are offered to accommodate the needs of the growing aging population by matching the travel demands of the elderly with the supply of accessible taxis. It is worth mentioning that the patronage of ordinary and accessible taxis

by the elderly in Hong Kong is currently very low (Szeto et al., 2017). The key objective of providing a subsidy to the elderly is to improve their mobility, not to make all the elderly use a taxi service. The taxi travel fare would only be partially subsidized, and therefore the abuse of the subsidy can be avoided.

The contributions of this paper are 1) identifying the factors that influence the elderly's willingness-to-travel by an ordinary/accessible taxi to engage in social activities; 2) studying the heterogeneous responses of the elderly with different socio-demographic characteristics (i.e., age, monthly expenditure, and dependency on walking aids); 3) investigating whether the taxi fare subsidy should be a fixed amount (as in Taipei) or a discount of a certain percentage of the fare (as in Singapore); 4) suggesting an operation mechanism for the proposed taxi fare subsidy scheme; and 5) recommending policy measures related to an accessible taxi service and taxi fare subsidy scheme to improve the mobility of the elderly and eligible people with disabilities.

The remainder of the paper is organized as follows. Section 2 introduces international experiences of accessible taxi services and taxi fare subsidy schemes. Section 3 describes the data collection method and the demographics of the interviewees. Section 4 provides the model results and discusses the policy implications. Section 5 concludes the paper and recommends a future research direction.

2. International experiences of accessible taxi services and taxi subsidy schemes

2.1. Sydney

Accessible taxis in Sydney are equipped with seven seats and a mechanical ramp designed for wheelchair users. Both the capital and operating costs of accessible taxis are substantially higher than those of ordinary taxis. Since 1981, the government of New South Wales has provided a taxi transport subsidy scheme for residents with impaired mobility, including ambulatory problems, physical disabilities, vision problems, and epilepsy. Under this scheme, eligible people can use a voucher for each accessible taxi trip. The maximum subsidy for each trip is half of the fare up to AUS$30 (equivalent to US$21.41). Notably, the New South Wales government provides a number of incentives to assist taxi operators in providing accessible taxi services. Taxi operators can borrow interest-free loans of up to AUS$30,000 (equivalent to US$21,413.80) or half the market value of the vehicle to purchase an accessible taxi. The loans are repayable over a term of five years. A comprehensive review of the provision of wheelchair accessible taxis in different states of Australia was done by Nicholls (2007).

2.2. London

Taxis in London have been gradually replaced by accessible taxis since January 2000. In accordance with the Disability Discrimination Act passed in 1995, all taxis should be wheelchair accessible by 2020. Although the London government has not provided incentives to assist taxi operators in converting taxis, it has adopted a taxicard scheme to offer reduced taxi fares for residents who are unable to use public transport due to serious mobility problems. Eligible people generally pay a flat fare of £2.50 (equivalent to US$3.22) per trip, plus any additional metered fare above the subsidy. The maximum subsidies are £10.30, £11.30, and £12.80 (equivalent to US$13.27, US$14.56, and US$16.49) for trips during the daytime, weekend, and nighttime, respectively (London Councils, 2017).

2.3. Seoul

The taxi industry in Seoul is regulated by the Seoul Metropolitan Government. There are over 72,000 taxis in Seoul, 68% and 32% of which are operated by individual taxi operators and corporate taxi operators, respectively. Apart from the regular taxis, there are a

number of wheelchair-accessible taxis designed for people with severe disabilities. These taxis are equipped with a wheelchair ramp and a tie-down strap, which are operated directly by the government at a highly subsidized rate. The fare for wheelchair-accessible taxis is the lowest among the different taxi types in Seoul, at ₩1,500 (equivalent to US$1.33) for the first 5 km, ₩300 (equivalent to US$0.27) per km for the next 5–10 km, and ₩35 (equivalent to US$0.03) per km thereafter. To use this service, it is necessary to book in advance. Although the service is relatively cheap, its wait time is unacceptably long. It is reported that the average wait time is 30 min during the day and 60 min after 5 pm. Seoul Metropolitan Government is improving the service and aims to cut the wait time down to 20 min (Korea4expats.com, 2013).

2.4. Taipei

There are approximately 30,000 taxis in Taipei, operated by three types of licensed operators, including taxi companies, taxi cooperatives run by a group of taxi drivers, and individual taxi drivers. The charging system for wheelchair-accessible taxis is the same as that for ordinary taxis. In recent years, Taipei City Government has cooperated with 11 taxi operators to provide a subsidy scheme to eligible senior citizens aged over 65 and disabled people. The government provides them with a deposit-based payment card called EasyCard. Users can pay for the taxi fare by scanning their card through the card reader installed in the taxi. The government subsidizes NT$32 (equivalent to US$1.04) of every trip with a cost of over NT$100 (equivalent to US$3.24), and the maximum amount of subsidy per month is NT$480 (equivalent to US$15.57). As in Seoul, to use this service, booking in advance is required (Department of Transportation, Taipei City Government, 2016).

2.5. Singapore

Taxi service in Singapore is predominantly operated by six licensed corporate taxi operators, which are distinguished by the color and design of their fleet. Between them, these operators have approximately 28,520 taxis. Currently, only one taxi operator provides wheelchair accessible taxi services, charging a flat rate of S$50 (equivalent to US$36.83) per trip, and booking 48 hours in advance is required. The government of Singapore provides a taxi subsidy scheme aimed at supporting persons with permanent disabilities who are dependent on taxis for mobility. The subsidy amount is dictated by individuals' income. Individuals with a monthly income of below S$2,600 (equivalent to US$1,915.21) are eligible for a subsidy ranging from 30% to 80% of the original fare. Eligible individuals are issued with a personalized Taxi Subsidy Scheme Card. They pay for their taxi fares upfront and then receive a monthly taxi utilization statement. Based on this statement and their subsidy level, the approved subsidy is reimbursed on a monthly basis to their bank account (SG Enable, 2015).

2.6. Lessons learned and way forward

Many cities have accessible taxi service provision and an associated taxi subsidy scheme to provide adequate mobility to the transport-disadvantaged segments of the population. The above international experiences can serve as a valuable reference. However, the implementation arrangements of these schemes differ substantially. Some cities provide a discount of a fixed amount (as in Taipei), while others provide a percentage discount (as in Singapore). There is no one-size-fits-all principle guiding the design and operation of the subsidy schemes. A comprehensive study of an accessible taxi service and taxi fare subsidy scheme for Hong Kong is therefore urgently needed.

3. Data

3.1. Data collection

A pilot survey was carried out in December 2017 to verify the feasibility of the survey approach and ensure the clarity of wording in the questionnaire that could effectively obtain the required information from individuals aged 60 or above. The main survey was conducted in January 2018 at numerous community centers, public housing estates, and parks, with the aim of alleviating sampling bias. The response rate was about 10%. Trained interviewers asked the respondents whether they would make a trip or stay at home in four hypothetical scenarios. We successfully interviewed 580 elderly respondents. Therefore, 2,320 observations were collected for model development. As noted above, the questionnaire consisted of two parts: 1) the socio-demographic characteristics of the respondents (age, gender, monthly expenditure, the requirement for crutches or a wheelchair, etc.), and 2) the respondents' decisions to use an ordinary/accessible taxi in four hypothetical scenarios for social activities.

3.2 Interviewees' socio-demographic characteristics

The socio-demographic characteristics of the respondents are shown in Figure 1. Respondents aged 80 or above were the largest group, constituting approximately 28% of the total. Slightly less than 70% of them aged 70 or above. The sample consisted of 53% female and 47% male participants. About one-fourth said that walking aids (crutches or a wheelchair) were necessary for their travel. Over 60% of the respondents were educated to the primary level or below. The majority (around 90%) of them were retirees. Only 4% of the elderly respondents had a private car available for their household use, substantially lower than the average (14.4%) for the whole Hong Kong population (Transport Department, 2014). Over 60% spent less than HK$5,000 each month, which indicates that most of the respondents could not spend much money on transport and that taxis were not a popular mode of transport. It should be noted that the distribution of the sample is very similar to that in previous research (Census and Statistics Department, 2011; Transport Department, 2014), which provides strong evidence for the representativeness of the sample.
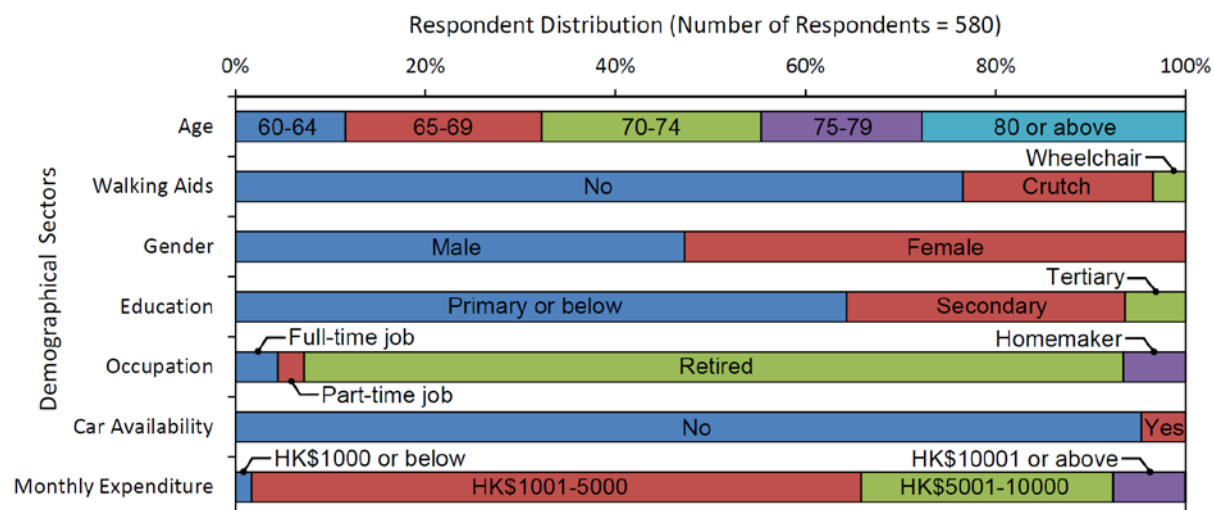

Figure 1. Demographic characteristics of the respondents

3.3 Stated preference survey

The respondents' decisions to either make a trip for a non-compulsory social activity by an ordinary/accessible taxi or stay home were assumed to be influenced by the following explanatory variables. Most of these variables were found to be significant in a previous study regarding the customers' selections between ordinary and premium taxis (Wong et al., 2020).

3.3.1. Subsidized taxi fare

Most of the elderly are unemployed or retired, and thus they cannot afford a high travel cost and have a lower travel propensity (Wong et al., 2018). A reduction in travel fares can make an important contribution to improving customer perceptions of public transport services (Hensher et al., 2003; De Witte et al., 2006; Baker and White, 2010; Eboli and Mazzulla, 2010). The proposed taxi fare subsidy scheme aims to offer a reasonable and affordable fare to the elderly and eligible people with disabilities.

3.3.2. Percentage discount

Providing a discount will lower the cost of taxi travel and decrease the financial burden of taking taxis. It is an incentive for the elderly to promote the usage of taxis and is used by many existing taxi fare subsidy schemes (Wachs, 1979). This attribute is similar to the subsidized taxi fare described above, but it presents the discount (as a percentage of the full fare) in addition to the actual taxi fare to pay.

3.3.3. Walking time

As one of the key features of taxis is the provision of a point-to-point transport service, taxi customers are expected to have shorter walking times than those for other public transport modes with stop-to-stop services. Walking time was found to be one of the most significant factors influencing customers' taxi-search decisions (Wong et al., 2015). More importantly, walking was identified as one of the major barriers to physically impaired users taking public transport (Park and Chowdhury, 2018). A longer walking time to reach a taxi will adversely affect the willingness-to-travel of elderly people with deficits in sensory function and musculoskeletal strength.

3.3.4. On-street wait time

Taxi stand facilities (e.g. provision of seats and shelters) in Hong Kong are inadequate, and this was identified as the second-worst service aspect of the local taxi service (Wong and Szeto, 2018). Elderly people waiting on the street for taxis normally have to contend with direct sunlight or rain due to a lack of shelter. This discomfort decreases their willingness-to-travel. Therefore, it is expected that minimizing the on-street wait time (for cruising ordinary taxis) will attract more elderly passengers.

3.3.5. At-home wait time

Alternatively, the elderly may use the dispatched accessible taxi service and wait at home (or in another comfortable environment). In this case, they do not have to wait on the street and also have a better prediction of the taxi arrival time. However, as the supply of accessible taxis is limited, the at-home wait time for accessible taxis is anticipated to be longer than the on-street wait time for ordinary taxis.

3.3.6. Survey design

Each interviewee was given four hypothetical situations to attend a non-compulsory social activity by a designated type of taxi (two for ordinary taxis and two for accessible taxis) which consisted of different combinations of subsidized taxi fare, percentage discount, walking time, on-street wait time, and at-home wait time. The respondents were asked to decide whether they would take an ordinary/accessible taxi or stay home based on the given scenarios. Their willingness-to-travel was then determined.

Table 1 presents the attributes for ordinary and accessible taxis in the stated preference survey. All the attributes were defined at three levels to capture their potential non-linear

effects on the respondents. It is noted that most of the elderly aged 60 or above usually make short trips (Szeto et al., 2017) and they are either unemployed or retired with a limited monthly personal expenditure to pay for transportation costs (Wong et al., 2018). A very small proportion of the elderly respondents would travel by taxis if the taxi fare was higher than HK$40 (equivalent to US$5.13) as in our pilot survey (the flag-down fare was HK$24, equivalent to US$3.08, for the first 2 km travel according to the 2017 fare structure). As a result, the subsidized travel fares for both ordinary and accessible taxis were set at affordable levels ranging from HK$18 to 35. Having too wide an attribute level range may result in choice tasks with dominated alternatives, whereas having too narrower a range may result in respondents having trouble distinguishing alternatives. The same approach was also applied to other attributes, in which the values were designed mainly based on the elderly's acceptance level as obtained in the pilot survey.

The orthogonal fractional factorial design, a subset of a full factorial design, which can reduce the size of the experiments while obtaining the main effects of the attributes, was applied to generate combinations of attributes. This approach was widely adopted in previous transport studies to depict respondents' decisions in stated preference surveys (e.g., Bliemer and Rose, 2011; Li et al., 2014; Kim et al., 2019; Wen et al., 2019). In total, 18 hypothetical scenarios (nine scenarios for ordinary taxis and the other nine scenarios for accessible taxis) were randomly assigned and distributed into five subsets of survey forms. Before we conducted the main survey, the combinations of attribute settings for each experimental run were reviewed to make sure that they are feasible and prevent unrealistic situations. A pilot survey was also carried out to test the experimental procedure.

Table 1. Attributes and levels used in the stated preference survey

Taxi mode	Attribute	Levels
Ordinary taxi	Subsidized taxi fare (HK$)	18, 23, 28
	Percentage discount (%)	20, 40, 60
	Walking time (min)	2, 4, 6
	On-street wait time (min)	3, 6, 9
Accessible taxi	Subsidized taxi fare (HK$)	25, 30, 35
	Percentage discount (%)	20, 40, 60
	At-home wait time (min)	14, 18, 22

Figure 2 shows an example of stated preference games from one set of survey forms. Overall, 40.4% of the elderly chose ordinary taxis in hypothetical games 1 and 2 of the stated preference survey, and 36.5% of them chose accessible taxis in the hypothetical games 3 and 4. The others chose to stay home.

Please tick as appropriate.

Given that the taxi subsidy scheme is implemented to provide discount to the eligible elderly for taking taxis. Assume that you are now at home, and you are invited by your friend to go out for a social activity. Taxi is the only possible transport mode to the destination. In the following four independent hypothetical games, please select whether you prefer going out or staying home.

Game	Scenario	Choice
1	Walk 2 minutes and wait 9 minutes on streets for an ordinary taxi. The subsidized fare is $28 (equivalent to 40% off of the original fare)	☐ Take taxi ☐ Stay home
2	Walk 6 minutes and wait 6 minutes on streets for an ordinary taxi. The subsidized fare is $18 (equivalent to 20% off of the original fare)	☐ Take taxi ☐ Stay home
3	Call for an accessible taxi and wait 14 minutes at home. The subsidized fare is $35 (equivalent to 30% off of the original fare)	☐ Take taxi ☐ Stay home
4	Call for an accessible taxi and wait 18 minutes at home. The subsidized fare is $25 (equivalent to 50% off of the original fare)	☐ Take taxi ☐ Stay home

Figure 2. Example of stated preference questions

4. Results and discussion

4.1. Binary logistic regression model

In this study, a series of binary logistic regression models were developed to demonstrate the elderly passengers' willingness-to-travel by an ordinary/accessible taxi based on the data collected in the questionnaire survey. The data analysis and statistical software package STATA was used to apply the maximum likelihood estimation method to estimate the coefficient associated with each explanatory variable. If the coefficient associated with a variable is significantly positive, the variable has a positive effect on the probability of making a trip by taxi. Otherwise, if a variable has a negative coefficient, it adversely influences the trip making probability. In the binary logistic regression models, the decision of taking an ordinary/accessible taxi is the dependent variable, while subsidized taxi fare, percentage discount, walking time, on-street wait time, at-home wait time, and the dummy variable for accessible taxis are the independent variables. The socio-demographic factors (i.e., not using crutches or a wheelchair, aged 70 years or above, and monthly expenditure of HK$5,000 or below) and their interactions with the usage of ordinary/accessible taxis are the additional independent variables in the advanced models to investigate the heterogeneous responses of the elderly. Table 2 shows the model results of 1) base model; 2) model with the socio-demographic factors; and 3) model with the interactions between the socio-demographic factors and the usage of ordinary/accessible taxis.

As shown in the base model, the coefficient associated with the percentage discount is positive, indicating that the respondents would be more likely to travel with a larger percentage discount. In contrast, the coefficient associated with the subsidized travel fare is negative, implying that the respondents preferred a trip with a lower fare. Although these results are reasonable and consistent, the subsidized travel fare is not significant in all three models. This interesting phenomenon suggests that the respondents had a greater interest in how much they could save than how much they would have to pay. The finding can be explained by the preference for a discount pricing strategy according to which customers are attracted by a product in a sales promotion but not a product at a lower undiscounted price. The coefficients associated with walking time and on-street/at-home wait time are negative. This confirms our expectation that the elderly would be less willing to take taxis in cases of long walking and wait times. Comparatively, the coefficient associated with walking time is the highest, indicating that it is the least preferred. The dummy variable for accessible taxis has a negative coefficient, which implies that most of the respondents did not prefer and

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considered unnecessary of selecting accessible taxis. This can be explained by the low proportion of the interviewed elderly using walking aids.

The model with the socio-demographic factors shows that age, monthly expenditure, and dependency on crutches or a wheelchair influence the taxi travel choices of the respondents. The older elderly aged 70 or above were more reluctant to travel by taxi and preferred staying home. It is understandable that the elderly mobility typically decreases with advancing age (Rantakokko et al., 2013). Similarly, the respondents with lower monthly expenditure (HK$5,000 or below) were more likely to choose to stay home and avoid making any unnecessary trips than their counterparts. In contrast, the elderly not using crutches or a wheelchair had a higher propensity of making trips because of their better physical condition.

The third model additionally incorporates the interactions between the socio-demographic factors and the usage of ordinary/accessible taxis. Most of the attributes were found to be significant at the 5% level, suggesting that they influence the elderly's propensity to travel. The coefficients for accessible taxis and ordinary taxis for non-crutches and non-wheelchair users are -0.286 and 0.356, respectively. The coefficients with different signs indicate that the elderly who were not using crutches or a wheelchair had a higher probability of taking ordinary taxis than the walking aid users. In contrast, elderly people with dependency on walking aids were more willing to choose accessible taxis, probably because accessible taxis have a larger compartment and a mechanical ramp to facilitate boarding and alighting. On the other hand, the coefficients for the interactions between age/monthly expenditure and the usage of ordinary/accessible taxis are all negative. The findings show that the elderly aged 70 or above slightly less preferred taking ordinary taxis and those with a monthly expenditure of HK$5,000 or below slightly less preferred taking accessible taxis.

Table 2. Coefficients and their *t*-statistics for the binary logistic regression models

Explanatory variable	Coefficient (t-statistic)		
Subsidized taxi fare	-0.010 (-0.9)	-0.009 (-0.8)	-0.009 (-0.8)
Percentage discount	0.005[c] (1.9)	0.005[c] (1.7)	0.005[c] (1.8)
Walking time	-0.142[a] (-3.6)	-0.137[a] (-3.5)	-0.140[a] (-3.7)
On-street wait time	-0.064[a] (-2.7)	-0.068[a] (-2.8)	-0.070[a] (-3.0)
At-home wait time	-0.029 (-1.5)	-0.035[c] (-1.9)	-0.034[b] (-2.5)
Accessible taxi	-0.594 (-1.4)	-0.480 (-1.1)	--
Not using crutches or a wheelchair	--	0.033 (0.3)	--
Aged 70 years or above	--	-0.380[a] (-4.0)	--
Monthly expenditure of HK$5,000 or below	--	-0.313[a] (-3.4)	--
Accessible taxi × not using crutches or a wheelchair	--	--	-0.286[b] (-2.0)
Ordinary taxi × not using crutches or a wheelchair	--	--	0.356[b] (2.4)
Accessible taxi × aged 70 years or above	--	--	-0.301[b] (-2.4)
Ordinary taxi × aged 70 years or above	--	--	-0.327[b] (-2.6)
Accessible taxi × monthly expenditure of HK$5,000 or below	--	--	-0.425[a] (-3.3)
Ordinary taxi × monthly expenditure of HK$5,000 or below	--	--	-0.338[a] (-2.6)
Constant	0.595[c] (1.7)	1.028[a] (2.7)	0.772[b] (2.0)

Notes: [a] Parameters are significant at the 1% level. [b] Parameters are significant at the 5% level. [c] Parameters are significant at the 10% level.

4.2. Policy implications

The mobility of the elderly is highly dictated by public transport in a transit-oriented city like Hong Kong. With a host of favorable and desirable features (e.g., door-to-door service, wide spatiotemporal coverage, and flexibility), taxis may be the means of transport most suited to accommodate the needs of the growing aging population, particularly to the older elderly and those with walking aids. To ensure the mobility of transport-disadvantaged segments of the population and their access to social, cultural, and recreational activities, many metropolitan cities all over the world have already offered dispatching accessible taxi services and taxi fare subsidy schemes. Note that generally, they reduce fares either by a fixed amount or by a percentage. To establish effective and appropriate measures for an accessible taxi service and taxi fare subsidy scheme in Hong Kong, it is essential to pinpoint the genuine transport needs of the elderly and eligible people with disabilities.

An intriguing outcome of the model is that compared with a fixed subsidy, a percentage-based discount has a more significant influence on the respondents' choice to use taxis. This implies that low taxi fares do not necessarily attract the elderly to go out by taxi but a high level of discount does. Therefore, we suggest that the government implements a subsidy based on a percentage discount of the original fare, similar to the fare subsidy scheme provided in Singapore. The elderly should also contribute a reasonable and affordable cost to prevent them from abusing the subsidy scheme. The economic and social burden on government revenue should be evaluated thoroughly before such a scheme is implemented. It is suggested that a pilot scheme is first implemented that subsidizes the elderly to travel by accessible taxi at 30% of the original taxi fare (equivalent to the lowest subsidy rate in Singapore) and its effectiveness in enhancing mobility is timely evaluated. Moreover, to truly benefit the elderly who are really in need, stringent application requirements are necessary to screen out those who are less dependent on taxis for their mobility.

Age was found to be a predictor of the elderly's propensity to choose travel. This can be explained by the observation that mobility typically decreases with advancing age (Koh et al., 2015; Yang, 2018). Therefore, in the full implementation of the taxi fare subsidy scheme, a step-wise taxi fare subsidy scheme for the elderly in different age groups could be considered as it may more effectively encourage older elderly people to travel by taxi. For instance, the elderly could be divided into two age groups (e.g., 60–70 and 70 or above). The scheme could provide a greater subsidy for the older group because they are more vulnerable than the younger group in terms of their physical condition and mobility. In addition, the majority of the older elderly are unemployed or retired with no income, so they often regard the use of taxis as a luxury and are reluctant to use taxi services. Therefore, providing this segment of the population with a bigger subsidy could offer them an additional incentive to participate in social, cultural, and recreational activities. In comparison, the fare subsidy to the younger elderly would be lower, because they generally are in a better physical condition and have better mobility for using other public transport modes. The older elderly have less access to the general public transport, predominately due to their impaired physical condition, and thus benefit less from the current HK$2 flat-rate public transport fare concession scheme. Thus, a higher taxi fare subsidy for them is appropriate. Note that both schemes could work together to meet the different needs of younger and older elderly people.

Due in part to the very limited fleet size of accessible taxis, most of the elderly respondents expressed that they had never taken accessible taxis and some had not even heard of them. At present, the service is only provided by private operators, and the market for accessible taxi services is immature, arising from insufficient support from the government. The fare is hence very high and the elderly cannot use the service even they are in need. As such, the government is suggested to take a more active role in promoting accessible taxi services. With a supply-side subsidy, the local taxi operators can be provided with incentives

to purchase accessible taxis (as in Sydney) or replace their ordinary taxis with accessible taxis (as in London). Taxi operators can borrow interest-free loans of up to half the market value of the vehicle to purchase an accessible taxi.

According to international experiences, there are two widely adopted types of taxi fare subsidy schemes, namely the voucher scheme and the subsidy card scheme. The former was introduced in Hong Kong in 1987 for the physically disabled. Locations for voucher applications and redemption are the key to the success of a voucher scheme. Such a scheme may not be convenient for the elderly if they have to apply manually for each trip. A subsidy card scheme is therefore preferable. Eligible users could use their Elderly Citizen Octopus Card to pay for a subsidized fare of accessible taxis (all accessible taxis in Hong Kong accept Octopus Card payment). A monthly taxi utilization statement would be issued by mail. The taxi operators could redeem the subsidies from the government through the Octopus Card online payment system. This effectively avoids the problem of faded or lost receipts or vouchers, which may result in financial losses for both the taxi drivers and elderly passengers.

5. Conclusion

Taxis provide a personalized, door-to-door service and are therefore perceived to better satisfy the travel demands of the elderly than conventional public transport modes do (e.g., railways and buses). Accessible taxis further enhance the level of comfort and accessibility of passengers by providing a larger compartment and a mechanical ramp to facilitate the boarding and alighting of a wheelchair. Yet, due to high fares and insufficient supply, accessible taxis are not widely used by the elderly in Hong Kong. Internationally, some city governments have implemented taxi fare subsidy schemes to benefit certain transport-disadvantaged segments of the population and enhance their mobility, but no such scheme is currently implemented in Hong Kong. A comprehensive evaluation of the situation in Hong Kong is hence necessary for the provision of an accessible taxi service and taxi fare subsidy scheme.

In this study, 580 questionnaire surveys were conducted and 2,320 stated-preference observations were collected to develop binary logistic regression models to determine the factors that influence elderly passengers' willingness-to-travel using ordinary/accessible taxi services. Percentage discount, walking time, on-street wait time, at-home wait time, and the interactions between the socio-demographic factors of the elderly respondents and the usage of ordinary/accessible taxis were determined to significantly affect their travel propensity. The model results show that the elderly aged 70 or above and those with a monthly expenditure of HK$5,000 or below were more reluctant to travel by taxi and preferred staying home, the respondents using crutches or a wheelchair had a stronger preference for traveling by accessible taxi, and overall the respondents were more sensitive to a taxi fare subsidy as a percentage discount than a fixed discount.

Based on the model results, several policy implications are investigated and discussed. The economic and social burden on the government should be evaluated thoroughly. It is suggested that the Hong Kong government should first implement a pilot taxi subsidy scheme to evaluate its effectiveness in enhancing the mobility of the elderly. In addition, a step-wise taxi fare subsidy scheme is recommended, to integrate with current transport policy measures to look after the needs of the elderly at different ages. A supply-side subsidy is also recommended, to financially support local taxi operators to purchase accessible taxis and increase the fleet size to minimize wait time for the users. Finally, a subsidy card scheme is suggested, through which eligible users can pay a subsidized taxi fare directly using their Elderly Citizen Octopus Card in the accessible taxis. This is considered to be the most convenient way for both elderly passengers and taxi drivers to apply and redeem the subsidy.

This study specifically focuses on the elderly's willingness-to-travel by ordinary/accessible taxis. Therefore, it designs a choice experiment and conducts a choice-based conjoint analysis for taxi use. Since the majority (over 90%) of Hong Kong elderly usually used transit for their daily travel (Szeto et al., 2017), developing a multinomial logit model to study the modal split of the elderly can provide more policy insights in further enhancing their mobility. This is left for future study.

Acknowledgments

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