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Car Sharing In a Compact City: Pinning Down the Benefits and Barriers

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ABSTRACT

New Zealand's sprawling urban development and high levels of car dependency have resulted in significant environmental impacts, including increased carbon emissions and pollution. Car sharing can support sustainable transport patterns by offering an alternative to private vehicle ownership. Internationally, it has become increasingly popular but is still in the early stages of development in New Zealand. A survey of 356 Wellington residents and interviews with 13 car share stakeholders collected data on interest in car sharing and barriers facing the service in New Zealand's capital. The results suggest that car sharing could become an important mobility option in Wellington and further policy support for car sharing could enable Wellington to take full advantage of its benefits.

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Introduction

New Zealand is one of the most urbanised countries in the world, with 86 percent of New Zealanders living in cities and towns [1]. However, New Zealand's main cities are characterised by urban sprawl and high levels of car dependency [1]. The car ownership rate is the highest in the Organisation for Economic Co-operation and Development [50]. In 2013, 76 percent of New Zealand households had one or two vehicles, and over 16 percent had three or more vehicles [2]. This high level of car dependency has led to adverse environmental impacts, including growing transport carbon emissions and pollution. In 2015, the energy sector produced 40.5 percent of New Zealand's gross greenhouse gas emissions, and over 40 percent of these emissions came from road transport [3]. Road transport emissions have increased by over 70 percent since 1990 [3].

Car sharing can help countries transition towards more sustainable transport patterns by offering an alternative to private car ownership. 'Car sharing' refers to a system in which a fleet of vehicles is used throughout the day by different individuals [4]. Individuals and businesses can benefit from having access to a car without the responsibilities and costs of private vehicle ownership [5]. Car sharing can reduce car ownership and vehicle kilometres travelled (VKT), in turn reducing carbon emissions and pollution [5,6]. It can also facilitate the uptake of alternative transport modes, improve public health, improve people's transport choices and equity, and save individuals and businesses money [7,8]. As of 2014, car sharing was operating in 33 countries, five continents, and an estimated 1,531 cities with approximately 4.8 million users sharing over 104,000 vehicles [9].

Most car sharing schemes are 'round-trip' as the user must return the car to the same place it was accessed, and pay for the entire time from gaining access to the car, to returning it [10]. Some cities have also introduced 'point-to-point' or 'free-floating' car sharing, which enables users to pick up the car share vehicle from one car park and return it to a different car park. This allows one-way journeys, providing greater flexibility for users' travel journeys. In these models, the fleet of car share vehicles is generally owned (or leased) by a professional car share operator [10]. An alternative business model is peer-to-peer car sharing, in which the vehicles are owned by private individuals rather than a central operator. The car share organisation facilitates an online marketplace to connect vehicle owners with prospective renters [10].

In recent decades, car sharing has been fostered by technological developments such as automated booking and smart-card vehicle access [5]. Technology will likely continue to play a significant role in the development of car sharing, in particular the integration of electric vehicles (EVs) and plug-in hybrid vehicles into car sharing fleets [5,11]. This could have a significant influence on the impact of car sharing on carbon emissions, especially in countries with a high level of renewable electricity [5,11]. In 2016, a total of 84.8 percent of electricity generation in New Zealand came from renewable resources [12]. Accordingly, widespread EV use could significantly reduce vehicle carbon emissions in New Zealand.

Despite the benefits of car sharing and its increasing popularity overseas, it is still in the early stages of development in New Zealand. Car sharing is not well known or widely used, even in the biggest cities, Auckland, Christchurch and Wellington. This study contributes to the literature by exploring car sharing in New Zealand, specifically in Wellington, New Zealand's capital and third largest city. It investigates who is interested in using car sharing, and whether this is comparable to international

patterns of car share use. It also explores concerns people have with using the service, and potential encouragements. In addition, this study examines the barriers facing car sharing in Wellington and potential policy solutions from the perspective of a range of car share stakeholders. The paper begins with an overview of the international evidence on the benefits of car sharing and common barriers, and the current car sharing situation in New Zealand. Following a summary of this study's methodology, the results from both the survey and interviews are presented, and the paper concludes with a summary of the key findings [13].

Background

Car Sharing Benefits

Internationally, car sharing has resulted in a wide range of economic and environmental benefits. Shaheen and Cohen analysed a range of studies on the impact car sharing has on car ownership. They found that one car sharing vehicle replaces the need for 4 to 10 privately owned cars in Europe, 9 to 13 cars in North America, and 7 to 10 cars in Australia [5]. Car sharing can significantly reduce car ownership in households that already own one vehicle or more. In Europe 15 to 34 percent, and in North America 11 to 29 percent, of car share participants sold their private vehicle after joining car share [5]. Car sharing is also an important tool for deterring carless households from acquiring a vehicle: North American research found that about 25 percent of car share members would consider purchasing a vehicle if car sharing was no longer available [14].

Car sharing can also encourage people to use cars more sparingly. Shaheen and Cohen estimated that car sharing reduced VKT in Europe by 28 to 45 percent, and on average by 44 percent in North America. Car sharing can increase car use for households who previously did not have access to a car; however, this is usually offset by the reduced VKT among drivers who would otherwise own a personal vehicle [6,7]. Research undertaken in North America found that most people who joined car sharing were carless; therefore, car sharing provided additional vehicle access which came at the expense of public transport usage [8]. However, this drop in public transport use was offset by a similarly sized increase from others who joined car sharing and reduced their car ownership and VKT. In contrast the modal share of walking and cycling increased within the sample [8]. By reducing car ownership and VKT, and encouraging the uptake of walking and cycling, car sharing can result in a range of health and other benefits, including reduced congestion, parking demand, pollution and carbon emissions [7].

Several studies have looked at the impact of car sharing on carbon emissions, but results are inconsistent due to different evaluation methods and sample sizes [6,15-19]. Martin and Shaheen found that in North America, on average car share users' carbon emissions were reduced by 29 percent for observed impact and 47 percent for full impact (where the latter includes emissions that would have occurred in the absence of car sharing but did not because car sharing was available). Avoided emissions were estimated based on forgone vehicle purchases resulting from the availability of car sharing [6]. Car share organisations are increasingly incorporating hybrid vehicles and EVs into their car share fleets, further reducing carbon emissions from car sharing [5,11].

Car sharing's potential to generate health benefits for city residents is highly salient. Decreased VKT results in reductions in emissions of nitrogen dioxide, carbon monoxide and particulate matter, helping to reduce mortality and morbidity from respiratory disease [20]. Reduced carbon emissions has clear benefits for health in the medium to long term, including vulnerability to 'natural' disasters [21]. Increased physical activity from more walking and cycling reduces the risk of mortality and morbidity from a range of illnesses, including obesity [22]. In addition, car sharing can improve equity by offering a cost-effective alternative service to people who are disadvantaged by their current transport choices, for example, low-income households who cannot afford to drive at all [7,20].

Car sharing can also save individuals and businesses money [23-25]. It can provide the benefits of private vehicle use without the costs and responsibilities of car ownership [5]. The cost of operating and maintaining a private car is increasing in many cities around the world. Much of this cost is fixed, paid regardless of how much the car is driven [26]. For people and businesses who only need to use a car occasionally, car sharing can be a more affordable alternative to ownership, especially for cars driven less than 10,000 kilometres per year [7]. Overall, the international evidence suggests that car sharing offers a range of benefits, especially as a result of reducing car ownership and VKT.

Car Sharing Barriers and Policy Support

Internationally, car share operations have faced a range of barriers before they began to provide the full benefits of their services. Start-up costs for car share providers has been a significant barrier. Car sharing only becomes financially viable when the car share vehicles are used intensively [4,7,27,28]. Relatively few car share systems are self-supported from user fees; most depend on financial assistance from government and private investors [4,29]. Public policy support has included start-up grants and guaranteed use of the service by central or local government agencies [28]. Private developers have invested in car share companies by incorporating car share into new developments, helping overcome parking constraints [28].

Internationally, most car sharing services have required free (or reduced cost) access to on-street car parking spaces in order to operate [5,10,30]. Gaining access to such spaces, which are typically owned and controlled by local governments, can often be a barrier for car share providers. Local governments can be fragmented, subject to changes in policy direction, under pressure to deliver a range of outcomes (such as parking for local residents or shops), are under no obligation to support car share operators, and may respond more slowly than the private sector [10]. In 2010, on-street reduced-cost parking was available for car sharing companies in 76 percent of car sharing countries. The countries that did not have parking available for car share tended to be new car sharing markets; the mature markets generally have public policy support to enable reduced-cost on-street parking [5]. Due to the public good benefits that car sharing can offer, there is an argument for public authorities to support car share providers, particularly in the early stages of their development [28].

The State of Car Sharing in New Zealand

Car sharing has been operating in New Zealand for approximately ten years; however, the service is still not widely used or well-known, particularly outside Auckland and Wellington. At the time of writing, five car share providers operated in New Zealand.

The most established car share operation in New Zealand is Cityhop – a round-trip service based in Auckland (New Zealand's largest city) and Wellington (New Zealand's capital). As of July 2017, the company had over 2,500 customers, with 35 vehicles in Auckland, and four vehicles in Wellington [31]. In addition to Cityhop, Wellington also has a free-floating scheme called Mevo, which allows members to drop off vehicles in any Wellington City

Council car park within a designated 'home zone' [32]. As of May 2018, Mevo had a fleet of ten plug-in hybrid electric vehicles [32]. Mevo claims to be the world's first 'climate positive car share'; i.e. the company uses carbon credits to remove more emissions from the atmosphere than it produces [33].

In November 2017, a company called Yoogo launched a round-trip car share service in Christchurch with a fleet of 100 fully electric vehicles [34]. The Christchurch City Council, together with a number of other Christchurch-based organisations, agreed to use the car share company in place of their regular fleets, guaranteeing demand for the provider [35]. New Zealand also has two peer-to-peer car share companies YourDrive and Roam. As of September 2017, Your Drive had over 400 vehicles available to rent across New Zealand [36]. Roam is a smaller peer-to-peer company, operating only in Wellington. Roam differs from the other car share providers because it was developed for the purpose of testing car share software [37].

As at May 2018, the central government of New Zealand did not have a specific policy regarding car sharing, although it does have one in relation to electric vehicles. The government's aim was to double the number of EVs in the country every year, to reach approximately 64,000 by 2021. So far, New Zealand has been slow to adopt EV technology. As of December 2016, only 0.067 percent of New Zealand's car fleet comprises EVs [38]. To reach its uptake target, the government supports several initiatives, including a Low Emission Vehicles Contestable Fund which provides up to $6 million per year to co-fund projects which support the uptake of EVs [39]. Car share companies can apply for this funding if they include EV technology in their services. Mevo was awarded funding through this scheme. Auckland, Wellington, and Christchurch city councils all have policies in place to support car sharing through the provision of public car parks (Auckland Transport, 2015; Christchurch City Council, 2016; Wellington City Council, 2016a, 2016b) [40-43]. As stated earlier, Christchurch also supports Yoogo by using the service in place of its regular fleet.

Method

The focus of this paper, on car sharing in Wellington, was influenced by the positive outlook for car sharing in New Zealand at the time this research was undertaken. Car sharing looks set to expand considerably in Wellington due to the support of both local and central government. In addition, Wellington appears to be particularly suited to car sharing due to its compact central city, higher rates of carless and single-car households, and higher rates of public transport use, when compared with the rest of New Zealand. Higher population densities, low car ownership rates, and the availability of alternative transport modes are all thought to be important for the success of car sharing.

An online survey was conducted which was designed to gather information on residential, travel and car ownership characteristics of Wellington residents, as well as their interest in using car sharing and their concerns with the service. This survey was conducted between November 2016 and February 2017 and collected 356 viable responses. Recruitment for the survey was undertaken using the snowball method, in which an email containing a link to the survey was sent to a number of individuals and organisations in the Wellington Region, who were also invited to send it on to others. Participation in the survey was limited to those living in the Wellington Region and 18 years of age or older. A carefully tailored description of car sharing was given, before any questions were asked, as physical examples of car sharing were not widespread and well known in Wellington. Some of the respondents answered questions on car sharing having never before heard of or used the service. Therefore, results should be considered exploratory. Statistical analysis included multinomial logistic regression, and open-ended questions were analysed using a thematic analysis approach.

In addition, thirteen car share stakeholders were asked about barriers to car sharing in Wellington. The interviewees all had experience with car sharing, and diverse knowledge and perspectives on car sharing in Wellington. Business sector interviews were undertaken with representatives of the four Wellington-based car share providers and Meridian Energy. Meridian Energy has a business partnership with Mevo, one of the four, to supply the electricity for Mevo's hybrid-electric vehicles, and is a client of Mevo. Government sector interviews were also carried out with two officers and a councillor from Wellington City Council (WCC), two officers from Greater Wellington Regional Council (GWRC), two officials from the Ministry of Transport (MoT), and one official from the Energy Efficiency and Conservation Authority (EECA). The interviews with these agencies were particularly important in providing local and central government context, in the absence of New Zealand based academic research on car sharing. The interview data was analysed using a thematic analysis approach.

Results and Discussion

Survey results

As little knowledge exists about potential car sharers in Wellington, it is impossible to say whether the survey sample is representative of this group. Compared to the general population of Wellington, the sample over-represents females, young people, higher income people and those with a tertiary degree. In addition, Wellington City, although it has the largest population base in the Wellington Region, and is likely to be the focus of developing car share activity, was in principle over-represented in the sample compared to the other cities in the region. The results do provide insight into the characteristics of people who are interested in car sharing in Wellington. Importantly, these people appear to have similar characteristics to members of international car share organisations.

The survey respondents' socio-demographics, dwelling and neighbourhood characteristics, access to a car, car ownership and car use were compared with their interest in using car sharing. A strong finding of this study relates to car ownership, access and use. The survey respondents' interest in car sharing was statistically significantly associated with how often they had access to a car, whether they owned a car, and how often they used a car ($\chi2(1) = 38.4$, $p < 0.0001$; $\chi2(1) = 18.4$, $p = 0.0001$; $\chi2(1) = 42.0$, $p < 0.0001$ respectively).

In terms of car access, the respondents who rarely had access to a car were the highest percentage to be 'very interested' in car sharing (Figure 1). The survey respondents who did not own a car were far more likely to be 'very interested' in car sharing than those who did own one or more vehicles (Figure 2). Wellington has the highest percentage of households with no access to a vehicle in New Zealand, at 11.7 percent, and this suggests that there is a significant proportion of carless households in Wellington who might be interested in car sharing. Internationally, car sharing is popular with carless or single-car households [2,6,10,44]. The respondents who used a car one day or less a week were the most likely to be very interested in car sharing (Figure 3). Conversely, the group who were the least likely to be interested in car sharing used their car every day of the week. Internationally, car sharing is

popular with people who need a car infrequently, relying instead on non-car forms of transport, such as public transport, walking and cycling [6,10,44].

Household type also had a statistically significant association with the survey respondents' interest in car sharing ($\chi^2(1) = 15.8$, $p = 0.015$). Flats/groups of people living together were more likely to be 'very interested' in car sharing than any other household type, followed closely by single people living alone and couples without children at home. Couples with children living at home were far more likely to be 'not at all interested' in car sharing than any other group. Internationally, round-trip car sharing is popular with households comprising single people living alone, and couples without children living at home [6,10,44].

While dwelling type did not have a statistically significant association with the survey respondents' interest in car sharing ($\chi^2(1) = 8.2$, $p = 0.086$), a higher percentage of the survey respondents who lived in apartments were 'very interested' in car sharing compared to the other dwelling types. Again, while neighbourhood density also did not have a statistically significant association with the survey respondents' interest in car sharing ($\chi^2(1) = 7.8$, $p = 0.100$), the respondents who lived in neighbourhoods primarily comprising apartments/town houses or a mix of standalone houses and apartments/town houses had higher percentages in the 'very interested' category in comparison to those who lived in areas comprising primarily standalone houses. While these variables did not have statistically significant associations, these results do align with international evidence which shows that car share users tend to live in higher-density central neighbourhoods [6,10,44].

Gender, age group, personal income, education and employment did not have statistically significant associations with interest in car sharing.

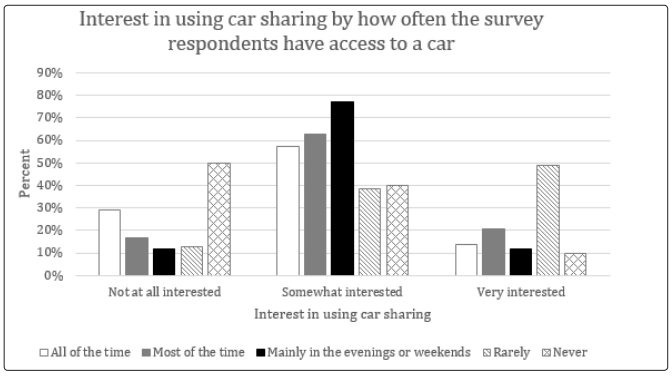

Figure 1: Interest in using car sharing by access to a car (n=345)

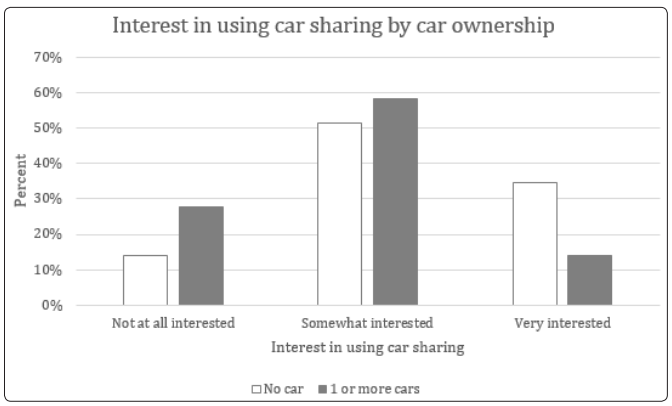

Figure 2: Interest in using car sharing by car ownership (n=345)

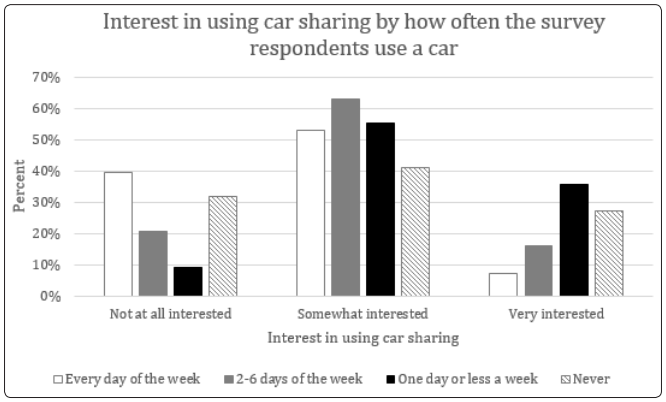

Figure 3: Interest in using car sharing by car use (n=345)

Multinomial logistic regression analysis was undertaken to determine which, if any, of the variables discussed above is the best predictor of interest in car sharing. Figure 4 shows the variables used in the multinomial regression model.

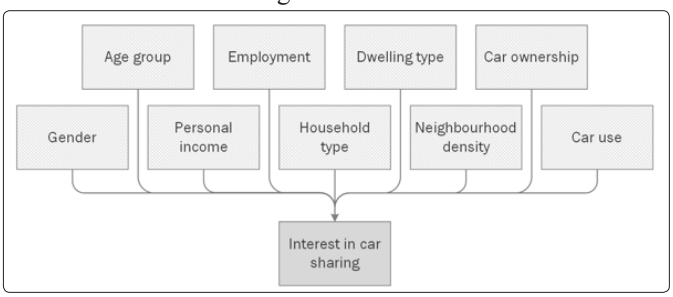

Figure 4: Multinomial logistic regression model

The Pearson and Deviance chi-square tests indicate that the model is a good fit for the data (Pearson: $X^2(458) = 500.206$, $p = 0.084$, Deviance: $X^2(458) = 441.886$, $p = 0.697$). The model explains between 21.8 and 25.5 percent of the variance in interest in using car sharing (Cox and Snell R^2 and Nagelkerke R^2). However, the independent variable 'car use' is the only statistically significant predictor of interest in car sharing, of all the variables included in the model, suggesting that car sharing is of interest across a range of household and neighbourhood types.

The survey respondents' interest in car sharing was also compared to their access to parking both at home and at their place of work or study. A higher percentage of the survey respondents who only had access to paid parking at their place of residence were 'very interested' in car sharing in comparison to those with access to free parking. However, these variables did not have a statistically significant association ($\chi^2(1) = 3.9$, $p = 0.144$). Those respondents with no access to parking at their place of work/study had a higher percentage in the 'very interested' category in comparison to those who had free access (Figure 5). There was a statistically significant association between the two variables ($\chi^2(1) = 10.2$, $p = 0.037$). International evidence also shows that successful car sharing neighbourhoods often have limited parking available for private vehicles, making car sharing more attractive [45].

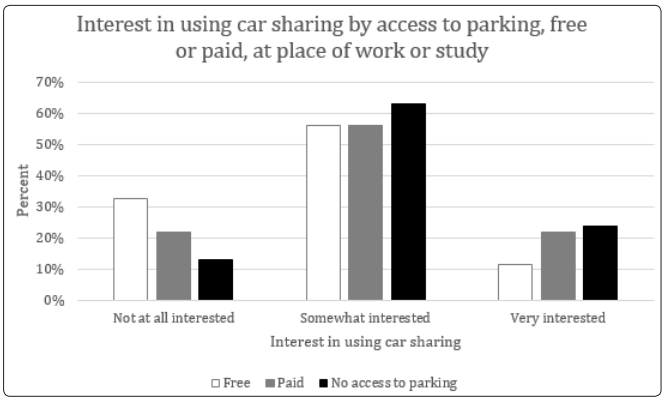

Figure 5: Interest in using car sharing by access to parking at place of work or study (n=303)

The survey results also usefully illuminate whether car sharing is complementary to public transport, walking and cycling. There was a statistically significant association between the survey respondents' main mode of travel to work or study ($\chi^2(1) = 23.5$, $p = 0.0001$), grocery shopping ($\chi^2(1) = 28.1$, $p < 0.0001$) and to regular leisure activities ($\chi^2(1) = 11.6$, $p = 0.020$) and their interest in car sharing. The respondents who travel for the most part by active or public transport are far more likely to be very interested in car sharing than those who travel by motor vehicle (Figure 6-8). This indicates that car sharing could act as a substitute for car ownership for people who only need to drive occasionally as most of the time other modes meet their travel needs. Internationally, car share members tend to be relatively heavy users of non-car forms of transport [10,45]. Wellington's already high rates of public transport usage and walking in New Zealand may help to support car share schemes [2].

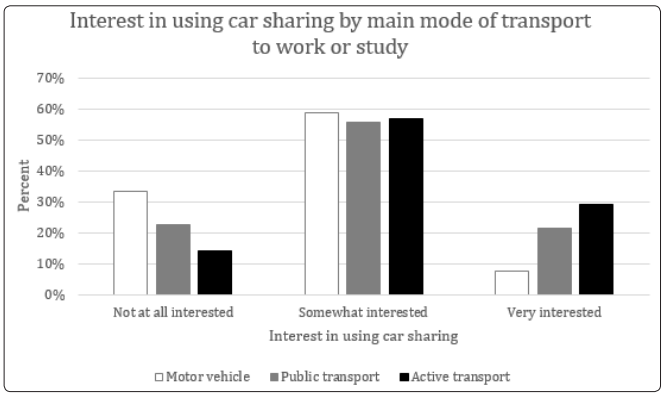

Figure 6: Interest in car sharing by main mode of transport to work or study (n=317)

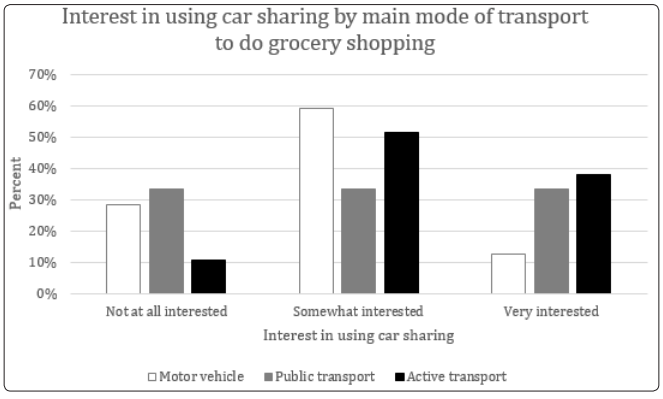

Figure 7: Interest in car sharing by main mode of transport to do grocery shopping (n=337)

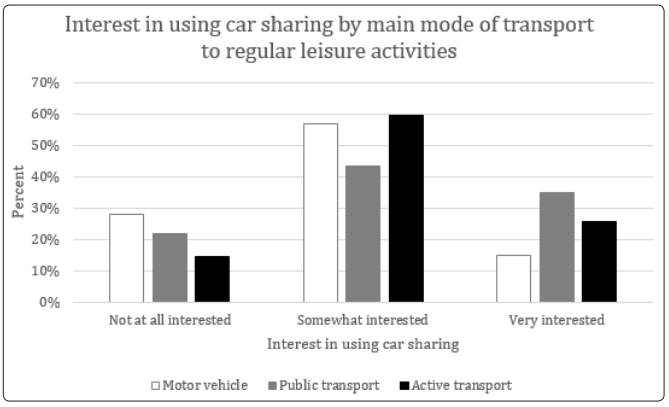

Figure 8: Interest in car sharing by main mode of transport to regular leisure activities (n=341)

The survey respondents were also asked to what extent they agreed with a range of statements on car ownership, travel preferences and car sharing. A Spearman's rank-order correlation matrix was generated to help provide insight into the relationship between these statements and interest in car sharing. The matrix results suggest that the survey respondents who thought car ownership was important also believed that it was important to have access to a car all the time, and they preferred to drive over other transport modes. The respondents who thought car ownership and access were important did not consider car sharing to be a convenient alternative to car ownership.

The most salient result is that the respondents most interested in car sharing considered it to be more convenient than owning a car and that it could improve their transport choices, as well as offering an environmentally friendly alternative to car ownership. The survey respondents who thought that car sharing would be more convenient than car ownership also believed that it would be more affordable, and could improve their transport choices by giving them greater access to amenities. Those most concerned about the impact of car ownership on the environment would be more likely to use car sharing if the service used EVs. Also, those who were more likely to use car sharing if the service used EVs were also more likely to be motivated by the use of smartphone technology. In addition, the respondents most interested in car sharing would be incentivised by the service using smartphone technology for locating and booking the car share vehicles.

These findings suggest that car sharing does offer an alternative to car ownership in Wellington, especially for people who want access to a car occasionally but consider car ownership too inconvenient or harmful for the environment. For these individuals, car sharing could also improve their transport choices. Driving is sometimes the best mode for a journey, and taxi or traditional car rental are not always suitable. This is supported by international literature which argues that car sharing is an important component of a wider transport network [7,46,47].

Certain attributes of car sharing may attract people to or discourage them from car sharing. In terms of concerns with car sharing, most of the participants agreed that they would be concerned with the availability of the vehicles, how much car sharing costs, having to pick-up/return the vehicles at set times, the proximity of the vehicles, cleanliness of the vehicles, and insurance. In addition, the survey respondents also raised concerns about installing car seats in the car share vehicles, the safety and maintenance of the vehicles, sharing with other people, a range of operational concerns, and car sharing having a negative environmental impact

through encouraging people to drive.

Conversely, many of the respondents highlighted that if car sharing was more affordable than car ownership, or if there were more restrictions on car ownership, they would be encouraged to use the service. Many of the respondents also suggested they would be encouraged to use the service if it had good availability and proximity, as well as being convenient and flexible. The use of EVs and the potential of car sharing to reduce emissions was also another significant motivation. Overall, the survey results reflect a range of concerns and motivations in relation to car sharing. Many of these concerns can be overcome by offering an affordable, cost effective, convenient and environmentally friendly alternative to car ownership. Car sharing can benefit from its ability to overcome many of the inconveniences of car ownership, including not being readily able to park.

Interview results

Internationally, car sharing has faced a range of barriers before becoming successful. To understand whether car sharing in Wellington faces similar barriers, the stakeholder interview participants (described earlier) were asked what they see as the main barriers facing the service in Wellington.

Access to Public Car Parks

Most of the stakeholders identified access to parking as one of the main barriers facing car sharing. Car share providers were clear that access to subsidised on-street parking was critical for their business model to succeed. Under its 2016 Low Carbon Capital Plan, the Wellington City Council had already committed 100 car parks, over 3 years, across the city for car share and EVs. All the car share providers were positive about this policy, and believed it to be a good start, especially considering the restrictive nature of the earlier council policy. Concerns remained, however, that the policy's requirement to prove demand before any allocation of parks might prevent the companies from getting quickly to the scale necessary for a successful car share scheme. At the time of writing, a recent policy change enabled 'free floating' parking - the right for car share vehicles to be able to park in any public car park within a certain zone. This has goes some way in addressing concerns around the limited number of parks dedicated to car share.

The international literature makes it clear that providing some free or reduced cost public car parks is important for supporting the growth of car sharing [5,10]. The process of allocating (and charging for) public space to a commercial business is a politically delicate matter. The price paid for parking in Wellington may become more of a barrier in the future as car share companies grow and require more parking spaces. Future research providing more empirical evidence of the public benefits of car sharing in Wellington could help address this issue.

New Zealand's Car Culture and Awareness of Car Sharing

Several interviewees identified lack of awareness of car sharing, and understanding about how car sharing works, as a key barrier. Local governments could help overcome this barrier by helping the car share providers advertise their service.

Several participants identified another key barrier to car sharing as New Zealand's car culture and the low cost of car operation. They suggested that it will be difficult to convince many New Zealanders to give up car ownership in favour of sharing. Cars are relatively cheap to buy and run in New Zealand, and people often do not understand or ignore the full cost of car ownership (including depreciation, insurance, registration, warrant of fitness, petrol, environmental impacts, etc.). If the full cost of car ownership is not considered, then car sharing can appear expensive in comparison. In terms of overcoming these barriers, several interviewees noted that local and central government policy could highlight the cost of car ownership and remove incentives for driving such as free parking.

Wellington has lower rates of car ownership and car use than the rest of New Zealand. This suggests there is less of a car culture in Wellington, and this may present less of a barrier than elsewhere in New Zealand. The impact of New Zealand's car culture on car sharing, and car sharing's ability to help the country transition towards more sustainable transport patterns is an area for further exploration.

Wellington's small population and financing car sharing

Several participants spoke about the difficulty of developing car sharing in Wellington because of its small population, which can make it difficult to finance car sharing and build it to a successful scale. Research undertaken in New Zealand found that lack of funding was a key barrier facing transport innovators in the country, including car share schemes [48,49]. The overseas literature also identified financing of car sharing as a key barrier, especially for new entrants in the market [4,7,27,28]. Relatively few car sharing schemes are completely self-supported from user fees, and depend on financial assistance from government and private investors [4,29]. Public funding has included start-up grants, guaranteed use by government agencies and subsidised access to public parking. The Low Emission Vehicle Contestable Fund has provided one avenue for support for car share providers in New Zealand. However, this fund is geared towards projects which encourage the uptake of EVs. Car share providers could be supported by funding that is specifically aimed at their services, and which acknowledges and is proportionate to the public good benefits that car sharing offers regardless of whether they include EVs in their vehicle fleets.

Most of the participants spoke about Wellington's small population and how that makes it difficult to provide services like car sharing. Several participants spoke about whether car share providers can get the scale necessary to be successful in Wellington. On the positive side, the interviewee from Mevo noted that New Zealand's small population means that it is not a market priority for global car share operators, and this gives local operators an opportunity in the space.

Conclusion

This study addresses the lack of research on car sharing in New Zealand, and Wellington in particular. This research gap matters because car sharing offers a range of public benefits, including those arising from reduced car ownership and vehicle use, in turn reducing carbon emissions and pollution. Car sharing can also facilitate the uptake of walking and cycling, improve public health, improve people's transport choices, and save individuals and businesses money. Due to the public good benefits that car sharing can offer, there is an argument for local and central government in New Zealand to support car share providers, particularly in the early stages of their development.

This research has provided evidence that the people most interested in using car sharing in Wellington have similar characteristics to car share members overseas. This includes people who use a car occasionally but do not necessarily own one, and households made up of flats/groups of people living together, single people living

alone, and couples without children at home. Car sharing also appears to be more attractive to people who have limited access to parking and to people who for the most part travel by public transport, walking and cycling. Car sharing could act as a substitute for car ownership for people who only drive occasionally as most of the time other modes meet their travel needs. Many residents of inner Wellington fit this description, and this population is growing rapidly. The survey results also indicate that the respondents most interested in car sharing considered it to be more convenient than owning a car, and that it would improve their transport choices, as well as offering an environmentally friendly alternative to car ownership.

This study has also provided insight into the barriers that face car sharing in Wellington. The survey results reflect a range of concerns people have in relation to car sharing, such as the availability of the car share vehicles, and the cost of car sharing. Many of these concerns can be overcome by providers offering an affordable, cost effective, convenient and environmentally friendly alternative to car ownership. In addition, car sharing can benefit from its ability to overcome many of the inconveniences of car ownership including, for city residents, the cost of parking. For car share providers, a key barrier has been gaining access to low-cost or free public parking, but the city council's accommodation of new parking arrangements, particularly the free-floating model, eases this constraint. Further barriers include finance for car sharing, lack of public awareness and New Zealand's car culture. Significant progress has already been made in Wellington to remove the barriers facing car sharing. Future research providing more empirical evidence on the extent of the public benefits of car sharing in Wellington would be valuable in assessing this innovation in urban mobility.

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