Krumdieck, Associate Professor, Susan
Watcharasukarn, Montira
Page, Dr, Shannon
University of Canterbury
Department of Mechanical Engineering, University of Canterbury, Private Bag 4800, Christchurch, New Zealand
Phone: +64 3 364 2987 ext. 7249
Fax: +64 3 364-2078
Email: susan.krumdieck@canterbury.ac.nz

TACA Sim: a survey for adaptability assessment

Intended category: Resilient Societies

Abstract

Uncertainty of future fuel supplies and a requirement to reduce green house gas emissions are two pressures that may cause significant travel behavior change in the long-term. Understanding how people can change to carry out their activities without using a car; i.e. how adaptable they are, and how this adaptability depends on urban from, will aid local authorities planners and policy makers to develop transport systems and urban forms that are resilient to fuel shortages and high prices.This paper describes TACA Sim online travel survey in which one of the questions was "*Could you get to the activity another way*" The answer to this question for each trip taken was used to measure the adaptability of the survey participant. The results from a case study of two areas: the city of Christchurch and the small rural town of Oamaru showed that most participants did have another transport mode. Although participants were given the option of participating in the activity without travelling (i.e. working from home) this choice was not a popular alternative. From comparison between two groups, the surveyed group in Oamaru had a lower adaptability than the surveyed group in Christchurch, primarily due to the lack of public transport services in Oamaru. The results from this study are expected to contribute Oamaru authorities in improving local transport services and long-term planning for resilient urban form in the future.

1. Introduction

Previous travel adaptability studies have examined behaviour change in response to a fuel crisis, such as that of the 2000 UK fuel protests, or 1980's oil embargo. Travel behaviour change during fuel crises consists of mode shifting, reducing travel distance, reducing unnecessary trips made by car, and changing destination (Habermann 1980; Lyons and Chatterjee 2002). The studies show that it is not easy for car commuters to adapt without feasible public transport services. For example, over half of 563 respondents, who normally drive to work, school or college, declared difficulties in using another mode, and 15% said that they did not go to work during the 2000 fuel crisis in UK (Thorpe et *al*. 2002). Long-range transport planning is beginning to consider fossil fuel reduction scenarios. As individual private vehicle transport is the

most energy intensive mode, knowledge of preferred alternative modes or travel behaviour would be valuable for transport planning in the case of reduced energy availability.

Transport engineering currently predicts future travel patterns and demand using base-year data and historical growth rates (Ortúzar and Willumsen, 2001). Adaptability is not included as a parameter in these analytical models. Conventional travel surveys do not include an adaptability measurement, as the objective is to capture current travel behaviour only. Previous travel adaptation studies surveyed what people *did* during a fuel shortage and how people responded to rising fuel prices. For example, Chatterjee and Lyons (2002) surveyed car users before and within 34 days after the 2000 fuel crisis in five areas of England; Hampshire/Wiltshire, West Yorkshire, London Borough of Hillingdon, Leicester and Hertford. Of 10,000 mail back questionnaires distributed, 16% responded to the survey. The results showed 12% of 1,065 car users reduced their trip to/from work, and 16% reduced their business trips. Of these car users, 14% changed the destination for grocery shopping. 12% of respondents shared car, and this was predominantly for the work trip, while walking was the most popular mode change for school travel (21%). Other studies of Gärling et *al.* 2000, Kingham et *al.* 2001 and UC Survey 2009 have surveyed perceptions of the likely options to reduce car use. These studies focus on understanding what options would get people out of their car. Travel alternatives for a given urban area or activity centre can be used as an indicator of adaptability. This paper therefore aims to present a method to evaluate the travel alternatives of a population in a particular urban form. Two urban forms are examined in this paper: an urban area activity system and the general population of a rural town. A Travel Activity Constraint Adaptation Simulation (TACA Sim) online survey tool developed from a computer-based TACA Sim survey (Watcharasukarn et *al*., 2010) is used to capture the travel behaviour of a regular week (travel activities that are conducted weekly or fortnightly). The adaptability of normal travel behaviour was then measured through a question "*Could you get to the activity another way?*" with options of alternative provided.

2. Method

Survey participants were taken through the TACA Sim online travel survey to capture normal weekly travel behavior. The surveyors provided help to participants by entering in data, operating Google Maps, clarifying the meaning of questions and prompting the participants to recall their travel activities. The TACA Sim online survey has three sections: personal information, vehicle information, and travel schedule. The personal information section records information such as age, sex, occupational status, family status, personal income, number of people in household, number of children at school age and number and of vehicles in household. The vehicle information section records vehicle information such as type, make, model, year, engine size and type of fuel. The participant fills in details for each vehicle they use in a week. The travel schedule section is where the participant enters their weekly normal travel activities details. On a screen representing each day of the week (Figure 1), participants firstly type in a description of the activity that they make a trip to participate in, select a trip purpose from a drop down menu, and type in the departure and arrival times. They then either enter the addresses of origin and destination or they use a Google Maps to plot their journey. The transport mode for the journey is selected from a drop-down list which includes the private vehicles they entered earlier. The participants provide the vehicle occupancy if they travelled by car or motorbike. When a participant entered transport mode for a trip they are asked "*Could you get to the activity another*

way?" They then select up to three transport alternatives from a list (see in Table 1) ranking in order of preference. The participants are also asked about the importance of the activity related to the impact on household wellbeing if they could not carry out the activity.

This study collects "regular" travel behaviour that is associated with typical weekly activities as we aim to measure the maximum adaptability of the participants. Participants have a clearer perception of their possible adaptation based on usual activities, than random activities. The participants were asked to fill in their travel schedule, using the activity description to prompt their memory, as people have better memory of what they do than where they go, particularly for non-home-based trips (Stopher, 1992). Trip legs and multimodal trips are recorded separately, but connected to the departure and arrival time, origin, destination, mode, and route that the participants normally take. If the participants undertake non-regular trips, they can enter in any one-off activities they engaged in over the previous week as representative of normal random errands, social engagements or entertainment activities.

The TACA Sim survey was conducted in two areas: University of Canterbury (UC) as an activity center in Christchurch, and the small rural town of Oamaru. Christchurch is located on the South Island's east coast of New Zealand. It has a population of 372,600 (StatisticsNZ, 2009) with a spatial sizes of 141,260 hectares (CCC, 2007). The University of Canterbury (UC) is a destination for work and education for 24,075 people (UC, 2010) and is located approximately 6 kilometres from the Christchurch City centre. Oamaru is a small town of population 12,750 (StatisticsNZ, 2009) located in North Otago, the south island of New Zealand. Oamaru is about 250 kilometres south of Christchurch and 120 kilometres north of the city of Dunedin. Oamaru's main service and commercial areas are located in the city center along the main street (Thames Street) and State Highway 1. Oamaru provides commercial services for surrounding remote rural areas and communities in North Otago (WDB, 2010). The objective of surveying residences in two distinct areas is to examine if/how travel options, and hence adaptability, depends on the urban form.

During the TACA Sim survey at UC, 1369 invitation email and letters were sent to students, staff, and academics. In addition, advertisements with pull-off contact details were posted put up around campus for students to take part in the survey and were entered into the draw to win an i-pod. A grocery voucher $10 or a gift voucher at popular campus café was offered for general staff and academic staff who took the survey. In Oamaru, 870 invitation post cards were sent to rate payers (people who own homes) asking people to return the post card with preferred day and time to participate in the survey. People were also approached on the main street of Oamaru with an offer of a chocolate bar and $10 supermarket voucher for their participation. The survey in both areas was successful with response rate 19.8% for UC and 13.8% for Oamaru. The total number of participants for both areas was 391 participants, which is 17.5% of the total invitations. A good geographical distribution of participants in both survey areas was gained.

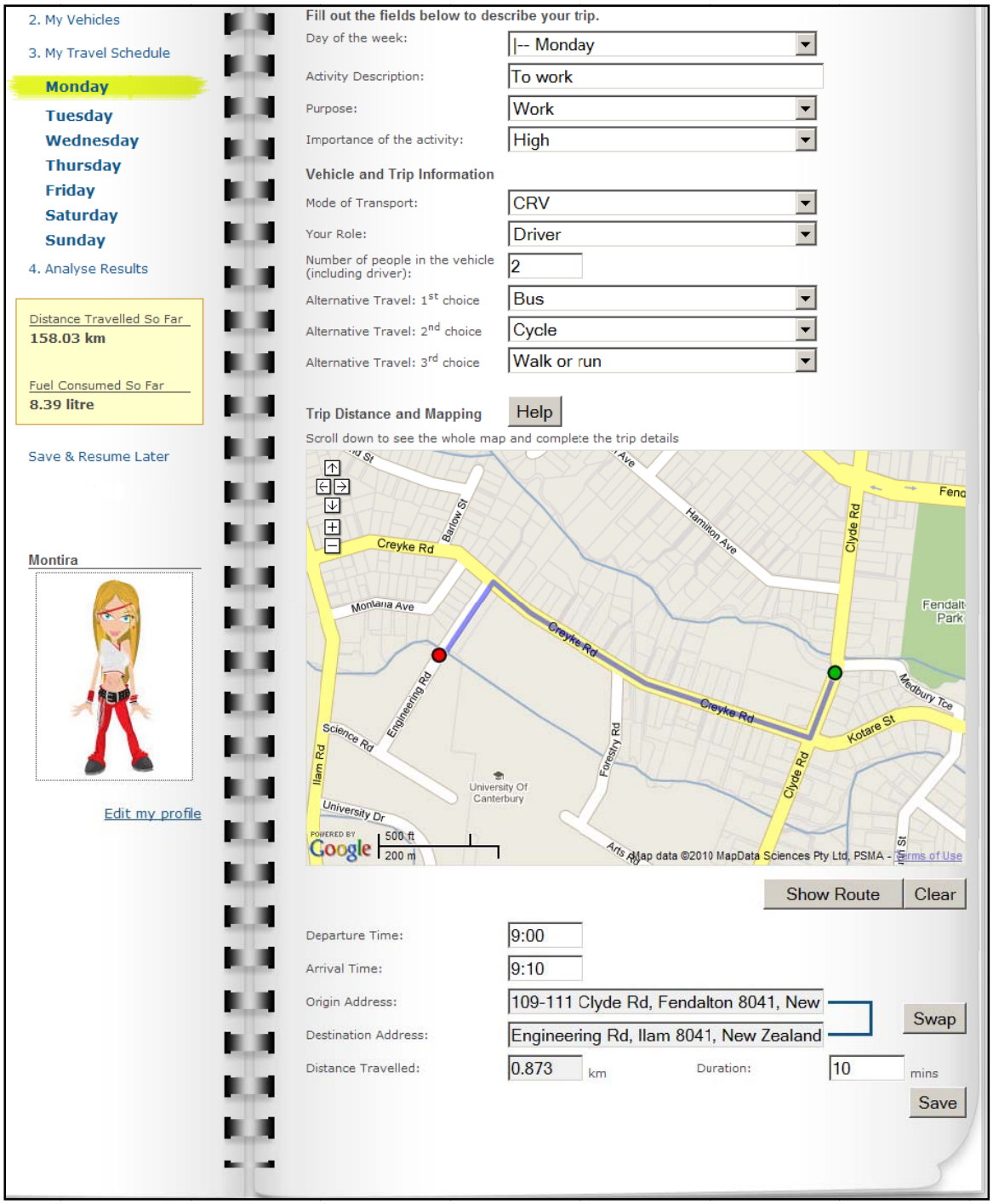

Figure 1: A screenshot travel schedule on Monday in TACA Sim online survey with travel activity questions for a trip.

Table 1: Essentiality and adaptability questions and answer sets.

Questions	Answer sets
Could you get to this activity another way? (Rank in order of preference)	None I could do this activity without travelling I could get a ride with someone Cycle Walk or run Rollerblades/skateboard/roller scooter Bus Train Ferry Plane Park and ride -bus Park and ride -train

3. Adaptability Analysis

After each activity and mode choice are entered in the survey, the participants then were asked: "Could you get to the activity another way?" In this adaptability analysis, alternatives to car trips were focused. The first preferred alternatives to the mode choice of cars were analysed to gain understanding of the adaptability. There are several related measures of adaptability. *Trip Adaptability* measures the car trips that can be adapted. The ability to engage in the activity without travel such as working from home is a measure of *Activity Adaptability*. The ability to change mode and still engage in the activity is called the *Mode Adaptability*. The ability to reduce fuel energy by the implementation of all mode and activity changes on distance basis gives a measure of the *Distance Adaptability*. All adaptability measures refer only to trips reported as normally taken by personal car.

Trip Adaptability (TA_{trip}) is defined as a fraction car trips in which the participant selected an option for getting to the activity another way.

$$TA_{trip} = \frac{\sum t_i}{\sum T_{car}} \qquad \textbf{(Equation 1)}$$

where $\sum t_i$ is the number of car trips in which the activity could be carried out another way. $\sum T_{car}$ is total number car trips. If participants do not travel by car in a normal week, then TA_{trip} is not applied.

Activity Adaptability (AA) is defined as a fraction of car trips in which the participant selected "No, I can participate without travelling" to the question "Could you get to this activity another way".

$$AA = \frac{\sum a_i}{\sum T_{car}} \qquad \textbf{(Equation 2)}$$

where $\sum a_i$ is the number of car trips in which the activity could be carried out without travelling. If participants do not travel by car in a normal week, *AA* is not applied.

Mode adaptability (MA) is defined as a fraction of car trips in which the participant selected either Cycle, Walk or run, Rollerblades/skateboard/roller scooter, Bus, Train, Ferry, Plane' to the question "If you could not take your car, could you get to this activity another way".

$$MA = \frac{\sum m_i}{\sum T_{car}} \quad \textbf{(Equation 3)}$$

where $\sum m_i$ is the number of car trips in that the participant had an alternative mode of transport. If participants do not have car trips in a normal week, *MA* is not applied.

Distance Adaptability (DA_{travel}) is defined as a fraction of car kilometres in which the participant could get to their activities another way.

$$DA_{travel} = \frac{\sum d_i}{\sum d_{car}} \quad \textbf{(Equation 4)}$$

where $\sum d_i$ is car travel distance by participants in which they selected either participate in activity without travelling and/or by changing to alternative modes, and $\sum d_{car}$ is the total distance travelled by car . If participants do not travel by car in a normal week, DA_{travel} is then not applied.

4. Results and discussion

Mode adaptability

The stated ability to get to the activity another way for car trips in both Oamaru and Christchurch was high. Table 2 presents trip and distance adaptabilities of Oamaru and Christchurch. Trip Adaptability of people in Christchurch was more than people in Oamaru. The largest share of Mode Adaptability in Oamaru was walking while the highest Mode Adaptability in Christchurch among all surveyed groups was riding a bus. The adaptability to bus in Oamaru was very low as Oamaru do not have a local bus to serve within the area. Only a taxi bus service was provided from the rest home to the city centre in Oamaru. Figure 2 gives the data for reported alternatives to normal car trips for all of the participants.

The ability of people in Christchurch to take a bus is pronounced, although the local bus service is considered under-utilised (3% of total trips) by the regional council (MOT, 2009b). The most mode-adaptable participants are students as they are younger than staff and may have had the most recent experience of not being able to drive. The total mode adaptability varies with age and occupation in both urban forms. However, it appears independent of income (see Table 3). The most elderly cohort of participants was in Oamaru. Most of them were retired, and their stated alternatives to private car transport were very low at 0.33. Gender differences were found to be most pronounced for professional university staff, some differences for general staff and students and almost similar for Oamaru citizens.

Table 2: Aggregate Trip Adaptability and Distance Adaptability of Oamaru and Christchurch.

	Trip Adaptability	Distance Adaptability
Oamaru	0.42	0.18
Students	0.86	0.83
General staff	0.64	0.47
Academic staff	0.60	0.46

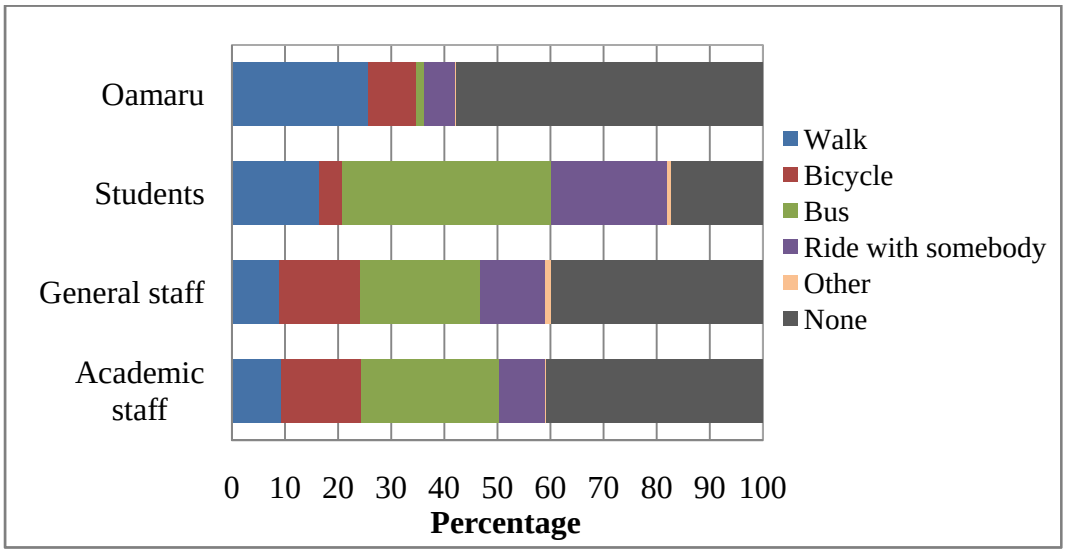

Figure 2: Mode Adaptability for all participants.

Participating without travelling

Results from both Oamaru and Christchurch show very low ability or preference for participants to participate in activities without travelling i.e. work from home. Even in Christchurch, where high speed internet is available and the participants were students and staff at a university, the Activity Adaptability was less than 0.01%. None of the 120 participants in Oamaru reported being able to participate without travelling. Only 2.9% of participants in Christchurch could adapt by participating in activities without travelling.

Distance adaptability

The surveyed groups in Christchurch can adapt more kilometres travelled by car than the group in Oamaru (see Table 2). Most adaptable trips in Oamaru were short distance trips (within 5 kilometres). Figure 3 shows that participants in Christchurch can adapt at long travel distance (over 5 kilometres) more than the participants in Oamaru. The long distance travelled by private car in Christchurch can be replaced by local bus and carpooling as shown in Figure 4. Riding bus was a favourite alternative mode for short and long distance travelling for the participants in Christchurch, while the intercity bus in Oamaru was available only for long distance travelling between cities. The small share of riding bus as an alternative for short distance travel in Oamaru was from an availability of taxi bus service. However, this taxi bus service only served for

seniors from the rest home to the city centre. Therefore, walking and cycling were the most popular adaptable modes for short distance travels in Oamaru.

Table 3: Aggregate Mode Adaptability of alternatives to normal car trips for Oamaru and Christchurch with age, gender and income.

	Aggregate Mode Adaptability			
	Oamaru	**Academic**	**Staff**	**Student**
Age				
younger than 18 years	0.50	N/A	N/A	N/A
18-24 years	0.59	N/A	N/A	0.87
25-34 years	0.64	0.82	0.86	0.82
35-44 years	0.44	0.56	0.42	0.56
45-54 years	0.53	0.58	0.67	N/A
55-64 years	0.46	0.49	0.51	N/A
Older than 64 years	0.33	0.71	0.80	N/A
Gender				
Female	0.46	0.70	0.64	0.73
Male	0.40	0.55	0.56	0.87
Income				
Under 10000	0.46	0.57	N/A	0.77
10001 to 20000	0.42	N/A	N/A	0.84
20001 to 30000	0.39	0.63	0.58	0.78
30001 to 40000	0.45	N/A	0.50	1.00
40001 to 50000	0.44	N/A	0.70	0.94
50001 to 70000	0.43	0.55	0.67	N/A
70001 to 100000	0.43	0.57	0.52	0.81
100001 or more	0.30	0.64	0.50	N/A

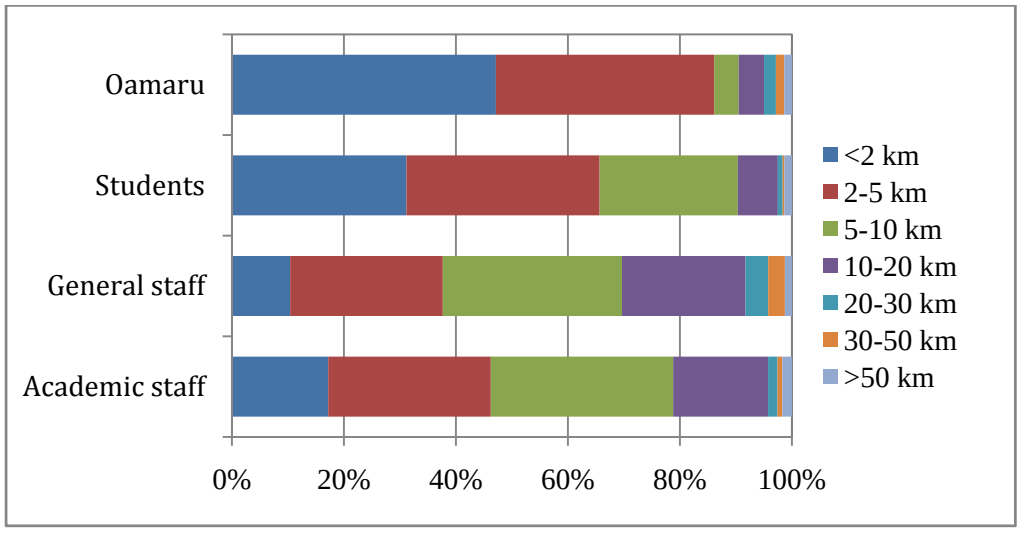

Figure 3: Percentage of adaptable travel distance for all participants.

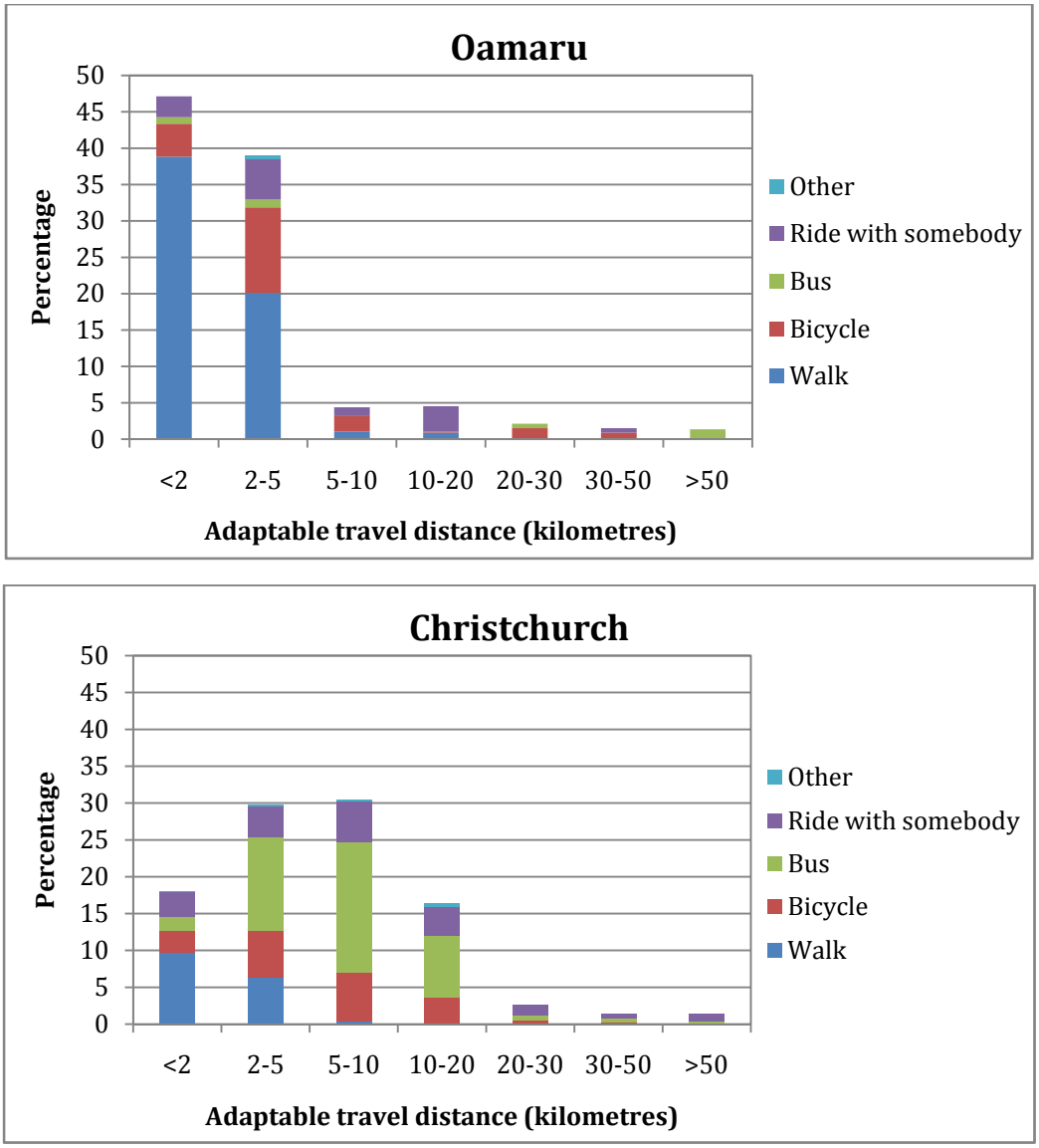

Figure 4: Mode split with different adaptable travel distance for Oamaru and Christchurch.

5. Conclusion

TACA Sim method was designed specifically for adaptability assessment. Asking participants to consider their alternatives to car travel revealed how adaptable they could be. According to the results of case study, adaptability was found to be a function of the urban form. Within the same urban form, accessibility of alternative transport modes, age and occupation were found to be factors of how adaptable the participants could be. Most participants selected a change of mode as an alternative to a car trip. Less than 1% of the car trips could be replaced by participating in the activities without travelling. These results show that walking and cycling were the favourite alternative methods for short distance travel. A lack of public transport service in Oamaru was found to limit people's adaptability for travelling long distance. Although all participants seem to have some level of adaptability providing greater accesses to alternative modes and methods

would enhance their ability to reduce private car use. Finally, the results from this study are expected to contribute Oamaru authorities in improving local transport services and long-term planning for resilient urban form in the future.

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