Extending Community Connect to under-25s: cover note on the scenario analysis

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Overview

This document explains the scenario analysis in the spreadsheet titled: C*ommunity Connect_for different age combos.xlsx*, and the assumptions underpinning those workings. The spreadsheet was designed to assess a range of scenarios for the policy to inform the final policy design and uses varying inputs from different Community Connect analyses at different points in time. Its main outputs include the potential change in patronage and emissions reduction.

Structure

The spreadsheet has four different types of tabs that are colour coded by purpose.

- Teal tabs are used for summarising inputs and outputs, and contain the drop-down switches for shifting to different scenarios
- Navy blue tabs contain input data or qualitative assumptions
- Red tabs contain some older input data
- Green tabs contain the workings

Data inputs

The spreadsheet includes data, estimated and qualitative inputs. This section details these inputs and assumptions.

- *Fixed assumptions* tab collates patronage data, public transport fares, Community Service Card holders by age group and the under-25 population by age.
- *Varying assumptions* tab collates the price elasticities of public transport demand, the embedded long-term behaviour assumption, the population of each age group that uses public transport, the CO_2 emissions factors for light vehicles, and the switch for the population scenarios.
- *Population workings* tab pulls the population forecasts from the *Population data (new)* and *Population data (old)* tabs.
- *New HTS* tab contains the estimated number of trips by age group from the Household Travel Survey.
- *Ave car trip VKT* contains data from the Household Travel Survey on car trips and distance, and uses these to estimate the average distance travelled per trip
- *Mode shift data* tab contains extracted findings from Waka Kotahi NZ Transport Agency's Impact of half-price public transport fares research note

Patronage data

The analysis uses public transport patronage data for the year 2021 (as it was the most recent complete year at the time it was taken) provided by Waka Kotahi. The raw data is for Auckland, Wellington, and Christchurch, and is found in the *Pax data* tab where it is summed up into the three cities. It is assumed that these three cities account for about 90% of all public transport trips most of which are in Auckland.

Fare data

Adult fares (ages 18 and over) were estimated by taking a sample of different fares across different regional services. They are the full priced fares and are based on a regular public transport bus trip (as buses account for about 80 percent of public transport trips) assuming that most trips are within one or two fares zones.

The child fares (ages 17 and under) were extracted from another analysis, which estimated an average fare (weighted by regional patronage numbers) for all child trips nationally. The inputs into this estimated used the same collection method as adult fares.

The full price fares in some regions (e.g., Auckland) have changed since the fare data was originally collected, so the values in this analysis will not reflect the latest fare levels.

Community Service Card holders

This data was provided by the Ministry of Social Development for August 2022 and is used to adjust the patronage numbers for the overlap between the original Community Connect scheme and the extension for aged under-25 that this spreadsheet has been developed for.

Population by age

This data was extracted from Statistics NZ's *Estimated Resident Population by Age and SEX (Annual Jun)* on *Infoshare* for the year 2022. It is used to estimate the population of each age group, which along with the Community Service Card holder data is then used to estimate the share of each age group's population that are card holders.

Regional share scaling factors

Due to only having the regional breakdown for one age group, these scalars were estimated to maintain the same relative share of public transport trips for each region across all age groups by multiplying the national share for each age group by the scalars.

Price elasticity of public transport demand

Elasticities measure how much a person's demand for a good, shifts in response to a change in that good's price. Here we use elasticities to estimate the potential increase in public transport patronage because of the subsidised fares.

The scenario analysis assumes there is always additional uptake for adults as their relative independence means they would have the capability to adjust their discretionary use of public transport in response to price changes. The elasticities used for adults are -0.32 in the short-term and -0.55 in the long-term, which means a 1 percent decrease in public transport fares leads to a 0.32 percent increase in public transport demand, increasing to 0.55 percent in the long run.

These elasticities were sourced from the Victoria Transport Policy Institute and were previously used in a different analysis that extrapolated a time-series of elasticities between the short-term

and long-term. The short-term value of -0.32 is similar to the value of -0.35 suggested in Waka Kotahi's Monetised Benefits and Costs Manual.

Children were assumed to be less independent than adults, meaning that they can not adjust their travel behaviour as easily. For children we assumed there were three scenarios of elasticities:

- The low scenario assumes no additional uptake of public transport
- The high scenario assumes the same level of uptake as adults
- The medium scenario is the middle of the low and high scenarios

The *Control* tab has a switch to shift between these scenarios.

Embedded change

As the Budget bid only assumes funding for the first four years of the scheme, the full impact of the scheme was analysed for these four years only. After that the policy is assumed to end, but this does not necessarily mean everyone goes back to their pre-scheme travel behaviour. It is likely that after incentivising people to take public transport more during the scheme, there may be some longer-term increased public transport use embedded into people's travel. The embedded change assumption tests three scenarios of this long-term change ranging from 0 percent to 20 percent.

Share of public transport use by age group

This analysis needed to estimate the number of public transport trips for each age group, but this data is typically not collected, and the historical patronage data provided include all ages. To estimate the proportion of public transport trips that each age group accounted for, we used the number of trips by age estimated in the Household Travel Survey to estimate the proportion each age group might account for.

The Household Travel Survey estimates of the public transport trips by age group were used to create low, medium, and high scenarios, which are included in the *Varying assumptions* tab. The *Control* tab has a switch to shift between these scenarios, but for the age group 5-24, there is also an overriding switch that, when selected, forces this assumption to align with a proportion used in an older analysis for the original Community Connect for community services card holders.

CO_2 emissions factors

To estimate the potential emissions reduction for this policy, we use a timeseries of average emissions from light vehicles up to the year 2050 in terms of grams CO_2e per kilometre. This timeseries was estimated using outputs from Te Manatū Waka's Vehicle Fleet Emissions Model 3.2 (pulled from the *VFEM data* tab). A limitation of this is that the VFEM model is only updated about once a year, so the outputs will not reflect the latest data or implemented policies (e.g., the clean car discount).

There are three scenarios of emissions factors: low, medium, and high. The *Control* tab has a switch to shift between these scenarios.

Population workings

As the actual patronage data only goes up to 2021, population forecasts were used to forecast the baseline (no policy implemented) patronage up to present and into future years, by assuming that patronage would change over time at the same rate as the population.

Population forecasts are developed and published by Statistics NZ based on Census data and are published on their website. The *Population data (new)* tab uses the latest published estimates and

has low, medium, and high scenarios for these, but the *Population data (old)* tab uses an older set of estimates, which only has the medium scenario. The population estimates are forecasted as points every five years.

The *Population workings* tab pulls data from both tabs. For the newer data, it estimates the population in the years between each forecast point. The older data came from another analysis which had already made this calculation. The workings then estimate the annual percentage change in population for each of the four areas, which is used to forecast the baseline patronage.

The *Control* tab has a switch to shift between the low, medium, and high scenarios for the newer data, but it also has another switch to override the medium scenario to use the older population growth scenario.

Household Travel Survey (HTS) data

The *New HTS data* is based on the Household Travel Survey estimates for 2019-2022 and collates data on the number of trips by various age groups versus the rest of the population. Some of the data was provided at different times so the estimates may be slightly different where some groups overlap.

The data here is used to estimate the share of patronage that each age group accounts for and has low, medium, and high estimates that feed into the *Varying assumptions* tab.

The *HTS data original* tab contains similar data for aged under-25s at the regional level, but it is mostly included in this analysis for reference.

The *Ave car trip VKT* tab also uses estimates from the Household Travel Survey for total estimated car drive and passenger trip data by different travel purposes. It is used to estimate the reduction in car travel because of people shifting from car to public transport trips. By dividing the number of kilometres travelled by the number of trips, we estimate the average distance travelled per trip for different purposes. For adults, we assumed they were mostly car drivers and used the average kilometres for all purposes (10kms per trip). For children (ages 5-17) we assumed they would mostly be car passengers and used the average kilometres travelled for education (5kms per trip).

Mode shift data

To estimate the potential emissions reduction from this policy, we need to know where the additional patronage is coming from whether its another mode or a completely new trip.

Waka Kotahi have published a research note examining the impact of the half-price public transport fares implemented last year, which was a useful source of information about how the Community Connect extension might work given the similarity of the two policies.

This included the estimated mode-shift response, which we extracted to use in this analysis. As the results included a no change option for responses, we estimated the mode-shift from trips where there was a change. The age groups in Waka Kotahi's research did not align with the ones we used in our analysis, particularly as it did not include any ages below 15.

There was an estimated mode shift for the age group 15-24, which we assumed mostly aligned with the adult groups in our scenario analysis. For the age groups with children, we used the mode shift by family type, specifically the one where participants had indicated they had children at home as we assumed younger children will mostly travel with their parents.

Qualitative inputs

Scenario

The *Control* tab includes dotted drop-down boxes that allow the user to either switch between different sets of inputs or change the policy settings. The *Select* tab stores the options for these boxes.

- Estimate assumptions controls whether the analysis uses updated values for population growth and patronage share by age group or whether some of these values ae overridden with older inputs.
- Uptake controls the price elasticity assumptions for the child age groups
- Population forecasts controls the forecasted population scenario
- PT share per age group controls the scenario for the estimated proportion of patronage each age group accounts for
- Embedded mode-shift controls the assumption for the embedded additional patronage in the post-policy years.
- Emissions factors controls the average grams CO_2e per km scenario for light vehicles.

The switches for age groups control whether that age group is subject to the policy and the level of subsidy applied. Due to investigating various applications of this policy, there are several overlapping age groups. If the field “group” is switched ‘on’, any overlapping groups should be switched off. This spreadsheet was not built to test the effect of multiple overlapping subsidies so it will not calculate the correct impact of applying multiple subsidies to the same age.

The fare structure switches change whether that age group is subject to adult fares or child fares. Adults tend to account for most public transport patronage so as a rule of thumb the adult fare is used whenever adults are present in a group, though some cities (like Auckland) allow child concessions for young adults under certain circumstances (like still being in secondary school).

The policy years switches affect what years the policy is active in. Under the current budget bid, the policy is funded for 2023/24 to 2026/27, so these years are switched to ‘on’. Post-policy years are switched to ‘after’, which affects whether the embedded change assumption is applied to patronage in those years.

Workings

The working tabs pull together the various inputs to estimate the potential impact of this policy. Many of the calculations depend on a particular scenario being selected or an assumption being switched on. All workings are broken down by age group and area.

- *Baseline PAX* estimates the forecasted public transport patronage if the policy was not implemented up to 2049/50.
- *Subsidy effects* estimates the change in public transport demand because of the subsidy
- *Policy PAX* estimates the forecasted public transport patronage if the policy is implemented
- *PAX* change shows the difference in patronage between the baseline and policy (the additional uptake)
- *Funding needed* estimates the potential funding required to provide the subsidise public transport trips at the estimated level of patronage under the policy
- *Emissions* estimates the potential reduction is emissions because of a shift from car trips

Baseline patronage

This tab estimates what the public transport patronage for each age group might be without the subsidy in place. Column D contains patronage for 2021, which is our base year. Here the analysis uses the total patronage, the patronage share for each age group, the regional scalars, and the Community Services Card holder overlap to estimate the eligible patronage numbers (in trips) for each age group. The columns after this forecast this patronage over time using the forecasted population growth.

There is an 'all ages' group at the bottom that does the same with the total patronage for comparative patronage. It is not the sum of the other rows in this sheet.

Subsidy effects

This estimates the potential percentage change in patronage from the subsidy for each age group it is applied to. It uses the price elasticity of public transport trips to estimate this, where an elasticity is calculated as:

$$\varepsilon = \frac{\%\ change\ in\ demand}{\%\ change\ in\ price}$$

The elasticity (ε) is assumed to be -0.32 in the short-term increasing to -0.55. The price change is known because this is the subsidy amount. We multiply the price change and elasticity to get the percentage change in public transport demand (patronage). The workings here will only make this calculation if the policy switch for that year is set to 'On' and there is a subsidy selected in that age groups subsidy switch, otherwise the effect will be zero.

Policy PAX

This tab estimates the patronage under the policy by taking the baseline patronage and multiplying it by 1 plus the respective subsidy effect for that year and age group. As mentioned above, there will only be a subsidy effect for the selected age groups, so only patronage for those groups will change from the baseline and all others will be the same.

PAX change

This estimates the difference in patronage between the policy and the baseline by taking the difference between the two to show the additional public transport patronage. It also estimates the embedded change in the after years by multiplying the additional patronage in the last year of the policy by the embedded change assumption. This assumes that the number of users and average trips per user in each age group is stable – people who leave those groups due to ageing over time are balanced by people entering those groups due to ageing.

There is also a combined change section that adds up the additional patronage across the selected age groups because no overlapping age groups should be selected at the same time.

Funding needed

This estimates the likely funding needed to fund the subsidy including both existing and additional patronage. This is done by multiplying the *Policy PAX* (which is why it does not include the embedded change) for the selected age groups by their selected full-priced fares and the subsidy to be applied to them. These estimates are later rounded up into million dollars in the *Per year summary* tab.

Emissions

This tab the output tab that summaries the estimates the potential emissions change because of the additional patronage that this policy might incentivise. These additional trips could come from car trips, walking, and cycling or be entirely new trips that otherwise might not be taken. Only car trips generate emissions, so we only calculate the emissions impact of shifting from cars to public transport, which will be a reduction.

While many public transport services generate emissions, there will only be an increase in emissions from additional patronage if the volume of change is significant enough that it induces the introduction of addition public services (i.e., increased frequency) to accommodate it.

The industry has been constrained by the bus driver shortages that resulted in services being reduced. Until this has been resolved it is unlikely that additional services will be created. Therefore, for this spreadsheet, we have assumed that there will be no additional public transport services created.

This implies assuming any additional patronage can be met with the current level of services. It is possible that there will be capacity constraints and potential crowding out of other existing public transport users due to the reduced attractiveness and comfort of public transport services because of the additional patronage. This has not been analysed quantitatively.

As we assume there will not be any additional public transport services, we also assume that there will be no emissions increase from additional services, so the estimated emissions impact of this policy is solely the reduction from fewer car trips.

We first estimate the reduction in vehicle kilometres travelled (VKT) by car. This is done by multiplying the *PAX change* for each age group by their respective mode-shift assumptions and their respective average kms per trip (assuming that public transport trips are a one-for-one replacement for car trips).

The emissions reduction is then estimated by multiplying the VKT by the average emissions per km for light vehicles.