MINISTRY OF TRANSPORT
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Moving people in 2055:

The Ministry of Transport's Long-term Insights Briefing 2025

Presented to the House of Representatives pursuant to schedule 6, clause 8 of the Public Service Act 2020.

August 2025

Not government policy

Acknowledgements

The Ministry of Transport thanks those who submitted on both the topic and the draft of our Long-term Insights Briefing for 2025. A summary of the feedback we received during consultation can be found on the Ministry's website here: https://www.transport.govt.nz/consultations/consultation-on-the-ministry-of-transports-draft-long-term-insights-briefing-2025-moving-people-in-2055.

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ISBN 978-0-473-75824-0 (Online)

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Foreword from the Secretary for Transport

The Ministry of Transport is the system lead for New Zealand's transport system. We support the Government to achieve its land, air and maritime transport priorities and drive performance improvement across the transport system for the benefit of all New Zealanders.

Transport touches the daily lives of New Zealanders in many ways. It contributes to the liveability of our cities and it connects us with each other. Considering what the future of transport will look like is critical to meeting our future transport needs. In this context, I'm pleased to present the draft Long-term Insights Briefing for 2025. This is the Ministry's second Long-term Insights Briefing. It considers the key drivers and trends that will influence the land-based transport system over the next 30 years, and scenarios for land-based transport in 2055.

The transport system has changed significantly over the past 30 years, given the impact of evolving technology on the way we travel and increased pressures and demands facing the transport system. This Long-term Insights Briefing gives us an opportunity to step back and consider these medium and long-term trends, risks and opportunities that may affect New Zealand. It also allows us to consider how these trends might shape the future.

The Ministry has a new tool that we've used to help us analyse future trends in this Briefing – the National Transport Model, or 'Monty'. We have used Monty to explore how the transport system might respond to 2055 population pressures and technological changes. While the scenarios are illustrative only, they demonstrate how Monty could be used in the future to help us to model the impacts of changes to our transport system.

Ruth Fairhall

Acting Secretary for Transport

I: Executive Summary

Government agencies have a responsibility to meet the challenges of today and understand and navigate the challenges of tomorrow. To help achieve this, departmental chief executives are required to present a Long-term Insights Briefing (a Briefing) at least once every three years.[1] These Briefings are designed to encourage thinking about future challenges, opportunities and risks on certain topics or issues.

This is the second Briefing that has been prepared by the Ministry of Transport under the Public Service Act 2020.

Long-term Insights Briefings are developed independently from Ministers and are not government policy. While they should not advocate for particular interventions or future pathways, they can explore future challenges and help New Zealand prepare for the change ahead.

Our Long-term Insights Briefing is about moving people in 2055

Over the last 30 years there have been significant changes to how we move people in New Zealand. Technology has changed the way we plan our travel, we have nearly doubled the number of cars on our roads, and natural disasters have disrupted or destroyed parts of the transport network.

This Long-term Insights Briefing explores two key questions:

- What are the key drivers and trends that will influence the land-based transport system in New Zealand over the next 30 years?
- What are possible scenarios for land-based transport in 2055?

New Zealand's population is anticipated to grow by one million people over the next 30 years, reaching a total of 6.25 million in 2055.[2] This larger population will need to access work, education and recreation opportunities, placing increased demands on the transport system.

Exploring possible scenarios for the future will help us better understand and prepare for change. They can also guide our thinking about how to respond and take advantage of opportunities that may emerge.

We have used a new agent-based modelling tool to analyse future demand patterns

In 2024, the Ministry of Transport completed development of its National Transport Model ('Monty'). Monty provides a detailed representation of a day of travel in New Zealand by creating a synthetic population of people (agents) and simulating their daily travel. In addition to agents representing people, Monty includes freight agents, allowing us to model freight activity alongside other travel demand.

This Briefing explores what Monty can tell us about current and future demand and behaviour within the transport system. To do so we used Monty to consider two illustrative future scenarios, comparing them against each other and to a 2023 'base case'. The first scenario was a 2055 national scenario based on median population growth projections, but with no other changes to settings or the transport system. In the second scenario we focused on a hypothetical example exploring what would happen if robotaxis (automated

1 Schedule 4, clauses 8 & 9, Public Service Act, 2020.

2 Stats NZ, 2022a. On 4 June 2025 Stats NZ updated its national scale population projections. The updated projections indicate that New Zealand's population has a 90 percent probability of increasing to between 6.12 and 7.21 million in 2051, which is higher than the 2022 projections. However, Stats NZ has not yet updated its neighbourhood level forecasts, which is what our modelling is based on.

taxis, like those currently operating in San Francisco, California and Austin, Texas) replaced all trips by private car in a small urban area in New Zealand (Napier).

This approach has confirmed some of our expectations about future demand in the transport system

Overall, the results for our 2055 national scenario are as we might expect: without significant changes to transport infrastructure, increased population will likely lead to increased road use. This increased road use will correspondingly increase travel times due to congestion.

We found that, compared to 2023, in our 2055 scenario:

- Vehicle kilometres travelled increase in almost all regions, except for on the West Coast where population is projected to decrease relative to the 2023 base case.
- Mean travel times increase in almost all regions, except for on the West Coast. This is caused by people taking both longer and slower trips (on average) which could suggest people are travelling greater distances due to urban sprawl or travelling more slowly due to more congestion. For example:
    - Auckland has the largest increase in travel times, with average travel times increasing from 18.6 to 25.2 minutes.
    - National mean speed per trip (across all modes but excluding freight) decreased from 37.48 km/h to 30.92 km/h.
- Nationally, we see a higher proportion of interpeak travel (i.e. we expect to see more consistent travel across the day as opposed to peaks and troughs) and reduced morning and evening peaks. This is consistent with travel that is time-sensitive being undertaken outside of peak commuter times, either to avoid congestion or because of demographic changes.

In our robotaxi scenario, the analysis suggests that replacing private car use with robotaxis does not alleviate the increases in travel time and congestion. Our key finding in this scenario was that vehicle kilometres travelled and network volumes actually increased in Napier due to robotaxis travelling empty between requests.

We will continue to use and develop Monty to inform our advice

The two scenarios considered in this briefing are narrow, but they demonstrate how Monty could be used to model possible futures.

Using Monty to assess possible changes to travel demand can help us to consider the benefits of potential investments and system changes. Monty can be used to stress test our assumptions about future behaviour and better plan for the introduction of new transport technology. Given the long-lived nature of assets in our transport system and the wide-reaching impact of transport regulation, this tool has the potential to materially improve our evidence base and associated decision-making.

In the future, the Ministry will consider how Monty could support our work to:

- Analyse the impact of various policy interventions on New Zealand's transport system, including changes to roading, rail, active, and public transport infrastructure, different public transport services/schedules, removing roads (e.g. due to weather events) and changing speed limits.
- Explore how different population scenarios affect travel demand and how different demographic groups are affected by each intervention.
- Incorporate different pricing mechanisms in the model, allowing us to examine how people might change their behaviour depending on different transport costs.
- Assess how transport evolves with shifts in activity patterns, such as an increase in remote work or different land-use scenarios.

II: Current System

New Zealand's land transport system includes the movement of people and goods, by road and rail, in cars, on bikes and in heavy vehicles. It enables businesses to transport goods and materials, and individuals, families and groups to travel for work and leisure. It allows tradespeople to get to and from job sites and school children to commute to and from school.

The land transport system includes:

- pedestrians
- personal travel devices (e.g., e-scooters and bikes)
- light and heavy vehicles (e.g., mopeds, cars, trains, and buses)
- physical infrastructure (e.g., the rail network, roads, and car parks)
- digital infrastructure (e.g., satellite-based navigation infrastructure and aids, travel apps, and communications technologies)
- commercial and public services (e.g., public transport, car-sharing and ridesharing)
- institutions and regulatory systems that influence how the transport system functions and changes (e.g., through their structures, management practices, regulations, policies and funding/investment tools).

Today, most people travel by private vehicle

New Zealand's transport and built environment has been predominantly designed around car travel. Car use dominates personal travel, accounting for 82 percent of all trips taken. Walking, cycling and public transport collectively comprise the remaining 18 percent (Figure 1).

There are notable variations in mode-use based on a range of factors including location, age, income, employment status, disability and trip purpose. For instance, public transport usage is higher in urban areas, among younger age groups, and for commuting to work and school.[3]

Figure 1: Mode share of personal trip legs, 2023-24

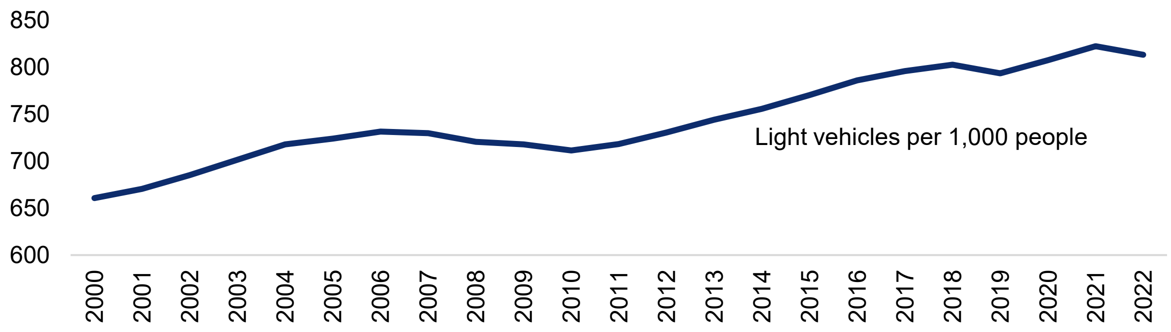
Car/ van driver	58%
Car/van passenger	25%
Pedestrian	12%
Public transport	3%
Cycling	2%
Other	1%

Adapted from Ministry of Transport (2024a).

3 Ministry of Transport, 2024a.

New Zealand has one of the highest per-capita car ownership rates in the world.[4] Over the past twenty years, per-capita ownership rates have grown to 813 cars per 1,000 people (Figure 2) and the average age of the vehicle fleet has increased to 15 years.[5] Despite owning more cars, the per-capita distances travelled by private cars and the time spent traveling each day have remained largely the same, averaging an hour a day and 8,700 kilometres each year.[6]

Figure 2: Car ownership rates

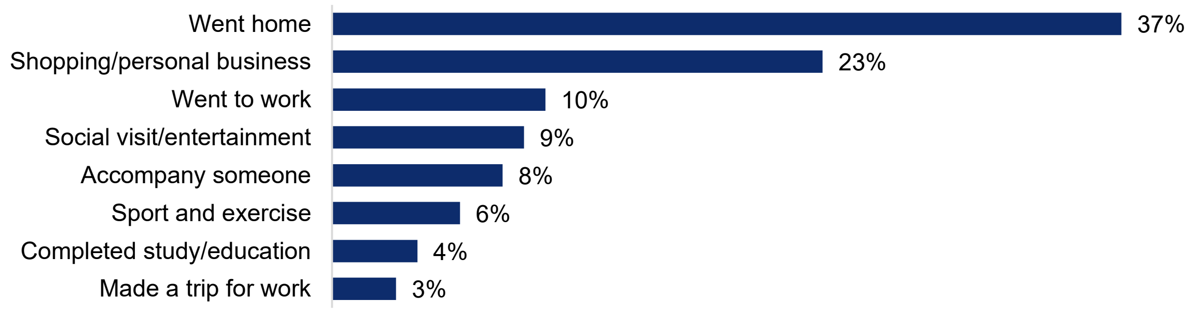


Adapted from Ministry of Transport (2024b).

Why people travel (or don't) depends on who they are

New Zealanders' most common purpose for personal travel is for shopping or personal business[7], followed by travel for work and social purposes (Figure 3). A range of factors influence the reasons we travel, such as employment and education status, as well as age and income.

Figure 3: Travel purpose, share by trip leg, 2023-24



Adapted from Ministry of Transport (2024a).

Age has a big impact on why we travel. Young people are most likely to travel for education, while adults aged 25-54 typically have the greatest travel demands (as they often need to transport others, like children). Shopping and personal errands are common travel reasons for everyone, but especially for those aged 65 and over.[8]

4 Ministry of Transport, 2022.
5 Ministry of Transport, 2024b.
6 NZ Transport Agency Waka Kotahi, 2024a.
7 Personal business includes stops made to transact personal business where no goods were involved. This includes (for example) stops made for medical or dental needs and for dealing with government agencies involved with social welfare.
8 Ministry of Transport, 2024a.

Conversely, why we don't travel also matters. On an average day, nearly one in four people do not travel at all.[9] The reasons for this are wide-ranging. Increasingly this may be due to people working or studying from home. However, some lack of travel may be driven by inadequate transport access.

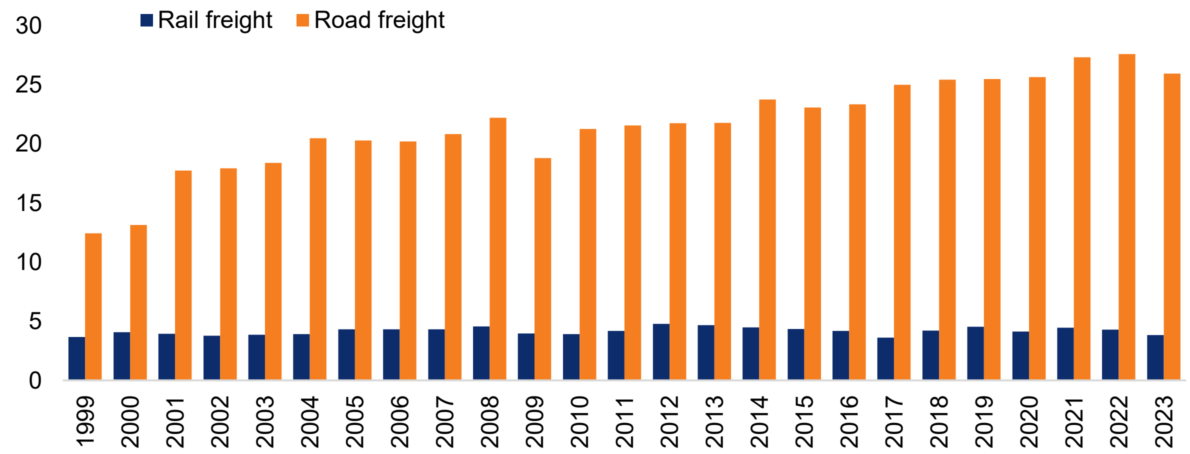
Certain groups are more likely to have unmet transport needs. One in five people with a disability cannot easily access most of the amenities they need to.[10] Māori, Pasifika, low-income households, women, older people, children and rural communities tend to be overburdened by negative transport impacts, such as road fatalities and pollution.[11] The barriers that groups experience to accessing transport can limit their participation in society, including their ability to access work, education, health and social opportunities, with significant flow on impacts to the economy and communities.

Most freight goes by road

In New Zealand, we rely on road, rail and coastal transport networks to move freight. Road freight is the predominant mode of freight transport. In 2023, approximately 25,000 million tonne-kilometres of freight was transported by road,[12] accounting for approximately 75 percent of the total domestic freight movement in terms of the volume of goods transported by distance and over 90 percent of goods transported by weight (tonne).[13] The remainder is moved by rail or coastal shipping.

Over the last two decades, the volume of freight moved by road has generally increased year-on-year to service a growing population (Figure 4).[14]

Figure 4: Freight moved by road & rail, billion tonne-kilometres

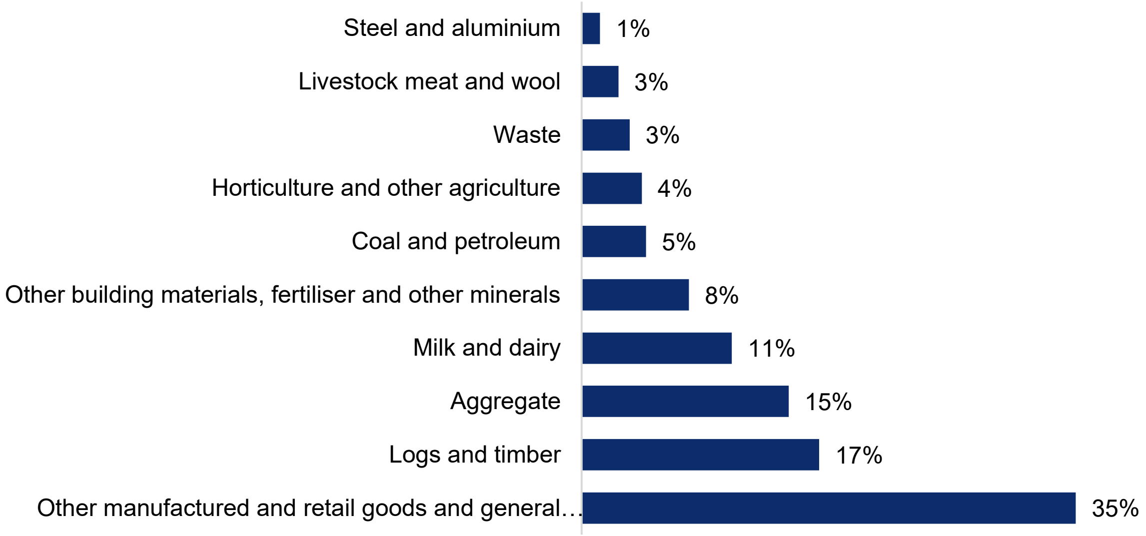


Adapted from OECD (2024).

Freight movement is influenced by New Zealand's geography, population distribution, production sites and transport hubs. Primary production sectors like horticulture, forestry and livestock form a significant part of total freight movements (Figure 5) and are often located in remote areas. These industries also tend to have specific freight needs due to the bulk and weight of goods.

9 Ministry of Transport, 2024a.
10 Ministry of Transport, 2024a.
11 Ministry of Transport, 2020.
12 A tonne-kilometre is a unit of measure used in freight to describe the transport of one tonne of goods over a kilometre distance.
13 Ministry of Transport, 2019.
14 Decreases in 2009 and 2023 were driven by the Global Financial Crisis and the rise in fuel prices following the Russian invasion of Ukraine respectively.

Figure 5: Freight movements in 2017/18, per cent of total tonnes



Adapted from Ministry of Transport, 2019.

III: What drove changes in how we move people and goods over the last 30 years?

Over the last 30 years a number of factors have influenced the ways that we travel and move freight around New Zealand. These include changes to our population, changes to the size and structure of our economy, and geopolitical, technological and climatic shifts. Regulation and policy changes in the transport system have also had an influence on behaviour.

Our population has grown, particularly in urban areas

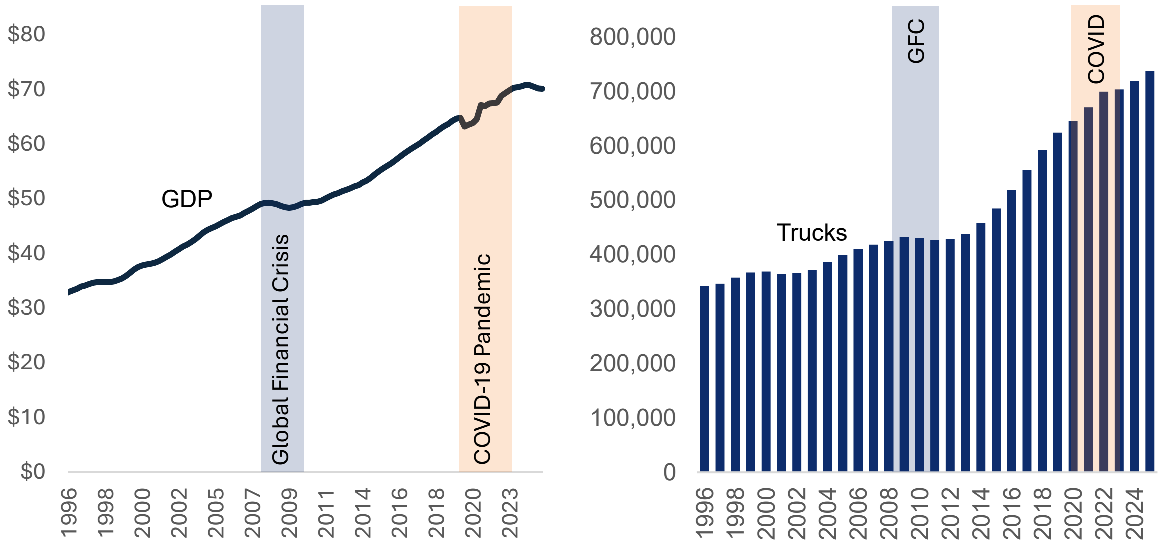
New Zealand's population has grown from 3.5 million in the early 1990s to over 5 million in 2025.[15] Population growth results in more people needing to use the transport system to travel for work, education, shopping and recreation, increasing demand on the transport network. Population growth also drives increases in freight volumes through increased demand for domestic and internationally produced goods.

New Zealand is a highly urbanised country, with 87 percent of our population residing in urban areas in 2023.[16] Though the proportion of our population living in urban areas has only increased slightly in the last 30 years (from 85 to 87 percent), this proportional structure means most of our population growth over the past three decades has been concentrated in urban areas, with some smaller rural and remote districts experiencing stable or declining populations.[17] This has placed pressure on urban transport networks.

The size and structure of our economy has changed

The economy affects travel demand by influencing incomes, job growth, consumer spending and the cost of raw materials. As our economy has grown over the last 30 years, vehicle kilometres travelled and freight demand have grown with it.

Figures 6 and 7: Production-based GDP, 2009/10 prices, $ billions; Number of licensed trucks



Adapted from Reserve Bank, 2025 and Stats NZ, 2025.

15 Stats NZ, 2025a.
16 World Bank, 2023.
17 Stats NZ, 2022b.

During economic downturns we typically see incomes stagnate and consumer spending drop. Over the past 30 years, during recessions, we have seen fewer goods being transported, less work-related travel and less discretionary personal travel being carried out. For example, after the 2009 Global Financial Crisis, road freight volumes dropped by 15 percent compared to 2008, to the lowest level in the preceding decade (Figure 4).

Alongside these economic fluctuations, structural changes have occurred to New Zealand's economy over the past three decades. While our exports remain primary industry-focused, the economic value of our service industry has grown significantly in the last 30 years.[18] This shift has led to more urban work travel and freight movement, where service businesses tend to be located.

Gradual and sudden changes to the way we move people and freight have occurred due to geopolitical, technological, social and climate shifts

Alongside population and economic changes, over the last 30 years the way we move people and freight has shifted both suddenly and gradually due to geopolitical, technological, social and climatic changes.

Distant global events can suddenly change how we move people and goods in New Zealand. The Russian invasion of Ukraine, for instance, caused dramatic increases in oil and gas prices, making fuel more expensive for both freight and personal travel. In the immediate aftermath this led to less discretionary personal travel and increased costs as well as increased complexity of moving freight, with flow-on effects for businesses. This reflects the role of prices in shaping the demand for travel.[19]

Severe weather events have increased in frequency and severity causing grave disruption to communities and transport networks

New Zealand has high exposure to natural hazards (particularly seismic hazards) and climate change has already begun affecting the frequency and severity of extreme weather events.[20] In recent decades natural disasters have caused significant disruption and irrevocably reshaped transport networks.

Cyclone Gabrielle in 2023 demonstrated that rural areas are likely to face particular challenges during, and following, severe weather events. Rural communities struggle to access essential services such as healthcare, fuel, groceries and emergency assistance in the aftermath of disruption. Businesses encounter difficulties with freight services and supporting tourism and recreational visitors.

In urban settings, severe weather events have created complex, widespread effects that cascade throughout the transport system. As illustrated by the 2023 Auckland Anniversary floods, weather-related main road closures caused delays and congestion, often spreading as traffic diverted to alternative routes. Extreme weather disrupted public transport. Network disruptions hindered access to critical infrastructure requiring repair, including power, water and telecommunications.

Following severe weather events, crucial decisions about infrastructure need to be made. These choices — whether to rebuild, improve resilience, or retreat — can significantly affect current and future transport and housing networks.

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18 Stats NZ, 2020.
19 Hyslop et al., 2023.
20 Frame et al., 2020.

Technological advancements have created an urban transport system that looks very different to 30 years ago

Technological advancements over the past 30 years have gradually, but quite radically, shifted the way we plan, pay and think about our travel, particularly in urban areas. They have been able to offer transport users new choices about the way they travel and create new efficiencies in our system. Examples of key technological changes over the last three decades include:

- Fundamental changes in journey planning through mobile GPS navigation, offering real-time traffic updates and dynamic routing.
- Upgrades to the public transport network such as the introduction of cashless payments, integration of interchanges and the electrification of bus and rail systems.
- Micromobility solutions have proliferated in urban areas, particularly e-scooters and e-bikes, alongside app-based ride-hailing services.
- Electric vehicles have entered mainstream use, supported by expanding charging infrastructure.

Regulation, policies, pricing and investment have shaped how we move people and freight

The way that the government regulates and invests in the transport system also has a huge impact on users. Regulations have enabled new travel modes to enter the market, while housing and transport policies and investment decisions at both central and local government level have made travel by different modes more or less attractive.

The government also has a strong lever in pricing, through which it can influence how people use the transport system. It does this through setting different charges for use of the transport system (for example through road user charges, fuel excise duty or public transport fares). The level of pricing influences consumer behaviour, incentivising uptake of certain transport modes. For example, estimates suggest that increasing the fuel excise duty by 1 percent would decrease vehicle use by around 0.15 percent and increase public transport patronage by around 0.6 percent in the long run[21], though this is offset by other factors influencing uptake (like population growth and service levels).

Over the long term these choices have affected whether freight moves by road, rail, or ship, and whether people travel by car, foot, or public transport. For instance, in the late 1990s, the decision to remove tariffs on imported vehicles led to a dramatic increase in imported second-hand vehicles. As the average cost of buying a car reduced and car ownership became much more widely affordable, the number of cars on New Zealand roads proliferated, nearly doubling over the past 30 years.

21 Principal Economics, 2024.

IV: Future pathways

As outlined in the previous chapter, the transport system has changed considerably over the last 30 years. It is reasonable to assume that the system will again undergo significant transformation over the next 30 years.

While predicting the future and making an informed decision about what to expect is difficult, we consider that the critical drivers of change discussed in the previous chapter (population growth, economic growth, technological change and climate change) are likely to continue to have a significant impact on our transport system over the next 30 years.

Of our four critical drivers for change in the transport system, we have chosen to develop two illustrative scenarios that look at:

- population growth, and
- technological uptake.

The sections that follow explore possible future changes in these drivers and how they might play out in the real-world transport system. We then explore some modelled scenarios of possible transport futures using the Ministry's National Transport Model ('Monty').

Population growth and demographic change

Population growth drives transport challenges and opportunities. A growing population means more people that need to travel to work, education and entertainment, and more goods that need to be moved. Business activity will also increase, leading to more business travel.

In 2055, New Zealand's population is expected to be approximately 6.25 million, up from 5.22 million in 2023.[22] Future population growth is likely to come from migration. While natural population increase has been the primary driver of population growth in the past, net migration has typically played a larger role since 2014.[23]

Given New Zealand has a highly urban population, growth may be more likely to occur in existing urban areas, especially in the Upper North Island. This could put pressure on transport networks, including freight movement around ports in Tauranga and Auckland. In smaller rural and remote areas population numbers are expected to decline or remain the same. Ongoing access to travel opportunities will play a critical role in supporting these communities' economic and social wellbeing.

Our ageing population will also affect how we use the transport network. People aged 25 to 65 travel the most, mainly by car or van. Those under 15 and over 75 travel less and are more likely to walk or be passengers. Most of our projected population increase is expected to be concentrated around the adult population, in particular, post-retirement age (Figures 8 and 9). Conversely, the child and teenage population is forecast to stay about the same, meaning it comprises a smaller proportion of the overall population.

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22 Stats NZ, 2024a.
23 Stats NZ, 2021a.

Figure 8: Population by age band in 2023 and 2055 scenarios, thousands

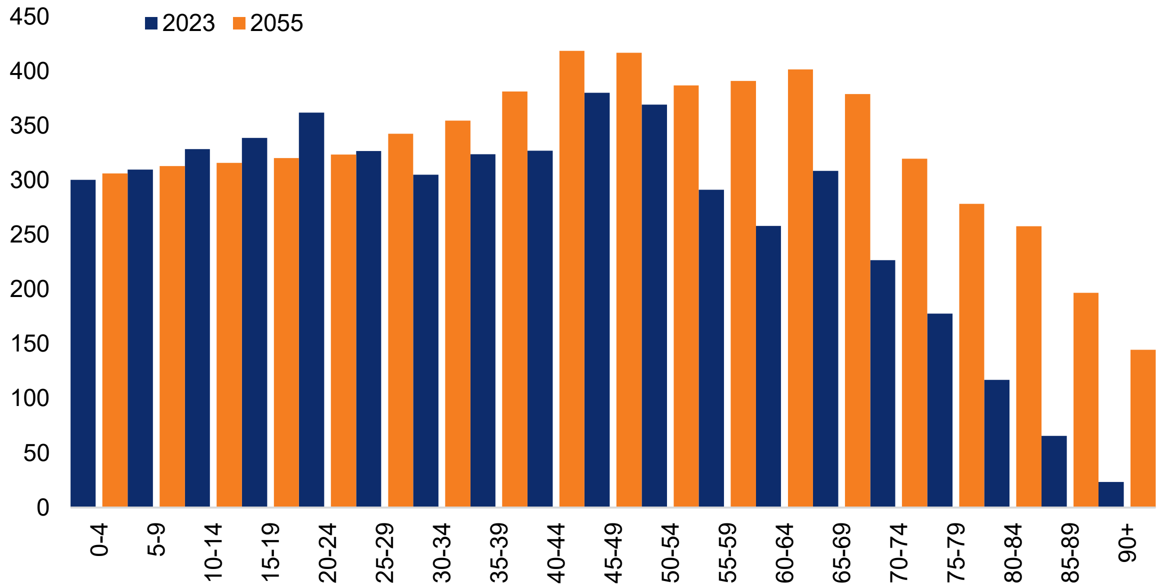
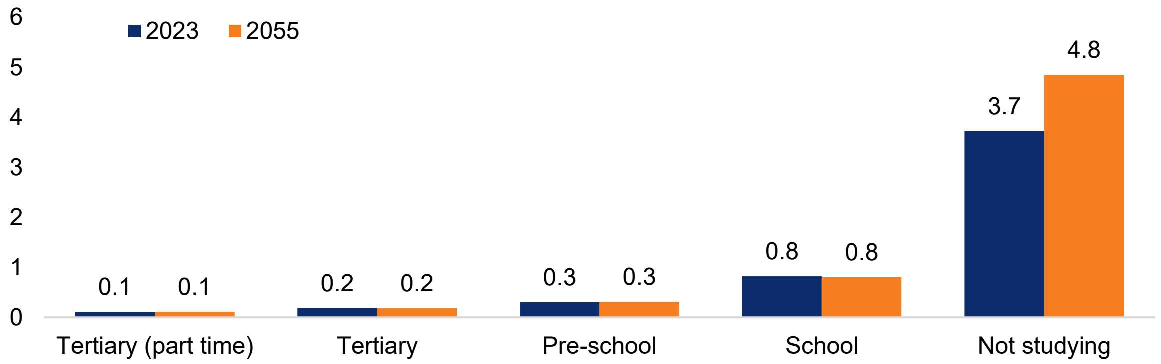


Figure 9: Population by student status in 2023 and 2055 scenarios, millions

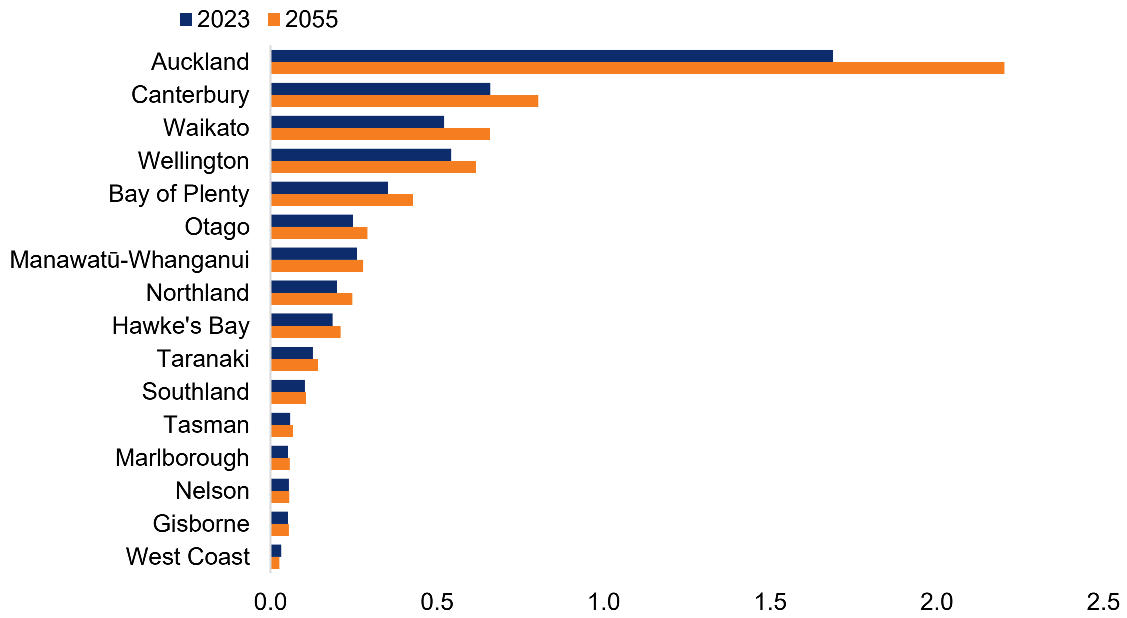


Some of these demographic changes will be more pronounced in certain regions. For example, by 2048 the percentage of people over 65 in areas such as Thames-Coromandel, Hauraki and the Kāpiti Coast is projected to exceed 30 percent.[24] If current travel patterns continue, this could substantially decrease the demand for light vehicle travel in these regions and increase demand for public transport.

Looking at the regional populations, roughly half of the (absolute) growth is happening in Auckland, with Otago, Bay of Plenty, Waikato and Canterbury also growing quite quickly. Some regions such as the West Coast, Southland and Marlborough are forecast to have minimal or negative growth.

24 Stats NZ, 2021a.

Figure 10: Population by region in 2023 and 2055 scenarios, millions



Emerging technologies

Technological advances are happening rapidly and can create significant opportunities for the way we use and manage the transport system. Advances in artificial intelligence (AI), robotics and energy storage and use technology could all have major impacts on the ways we travel.

How we regulate and manage access to the network through new platforms, services and providers may need to change. This may ultimately lessen compliance costs for regulators and system users.

The cost of electric vehicles is expected to reach parity with combustion engines by 2030,[25] and as vehicles are increasingly connected, automated and shared, there will be yet unknown impacts on private vehicle demand. If nothing changes, we expect increasing demand for electrified vehicles — with the associated environmental, safety, security, economic, trade and logistics issues that this transition represents.

While uptake of fully automated vehicles has been slower than anticipated, we continue to expect that connected vehicle technology and new autonomous driving functionality could offer new mobility solutions in the future. Autonomous schemes have been implemented over the last couple of years in Austin, Texas and San Francisco, California. New Zealand has embarked on its own autonomous vehicle pilot: a driverless shuttle bus now running in Christchurch Airport.[26]

Meet 'Monty': Our National Transport Model

We analysed how New Zealand's transport network might respond to population growth and technological change scenarios using the Ministry's National Transport Model ('Monty'). Monty provides a detailed representation of travel in New Zealand under current, future and counterfactual conditions. We used Monty to examine three scenarios:

- A base-case 2023 simulation (for comparison)

25 Asia-Pacific Economic Cooperation, 2022.
26 Christchurch Airport, 2019.

- A national-scale 2055 simulation, based on 2055 population projections, but no other changes to current settings or the transport network
- A 2055 case study in Napier which replaces car and car passenger journeys with automated taxis (robotaxis).

What is Monty?

Monty provides a detailed representation of a day of travel in New Zealand by creating a synthetic population of people (agents) and simulating their daily travel plans on the transport network. A daily travel plan is a sequence of locations with activities and times assigned to them and a mode used to travel between them. The core simulated modes are: car, car passenger, walking, biking[27], rail, bus, ferry and cable car. The activity types are: home, work, education, shopping, leisure, business, and accompanying (i.e. driving another person to an activity).

To determine their daily travel plans, each agent has a set of demographic attributes based on census counts. The plans come from an activity model which decides the number of activities, their types, locations and times. The procedure uses distributions calculated from the Household Travel Survey and also combines some other key datasets such as LINZ data, census data, school enrolments, and network accessibility metrics. [28]

Do Monty agents pay for their travel?

In Monty we use a proxy for price ('Monty dollars') and can make assumptions about the relevant costs to users for different travel modes. For example, walking and cycling are free, while public transport has fares attached to it that mirror real-world costs. We also apply prices to car travel to represent the costs users pay to access the roading network, like fuel excise duty and road user charges. However, we do not include other costs of car ownership (like purchasing a car or paying for registration and insurance) in the model. These are introduced by proxy through other Monty assumptions about how many cars each household will have.[29]

Monty agents also experience other less literal "costs" based on the modes that they use, like time and distance travelled. These can influence their choices. For instance, all other things being equal, travelling an hour by train is more attractive than car to a Monty agent, as we assume they prefer a mode where they don't have to focus on driving. Monty agents will also get tired if they travel long distances using active modes (like walking and biking).

In addition to travel time, agents are penalised for time spent waiting for public transport or robotaxis (in our scenario, below). While there is no maximum wait time, agents who experience long waits will have a poor utility score for that day and are unlikely to select that plan in subsequent iterations.

Monty also includes freight travel in its simulation. The model includes freight agents which have delivery and depot activity types. The plans for freight agents are derived from real freight telemetry data.[30]

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27 In Monty bikes are treated as one mode, which covers both bikes and e-bikes, weighted by how common ownership of each is, based on the Household Travel Survey (Ministry of Transport, 2024a).

28 Ministry of Transport, 2024a; Stats NZ, 2018a; Stats NZ, 2018b; Stats NZ, 2018c; Stats NZ, 2023; Stats NZ, 2024b; NZ Transport Agency Waka Kotahi, 2024b; Ministry of Education, 2024; Ministry of Education, 2025; ERoad Limited, 2022; OpenStreetMap contributors, n.d.; GTFS contributors, n.d.; Google Maps Platform, n.d.; NZ Transport Agency Waka Kotahi, 2025.

29 These assumptions are based on census data.

30 ERoad Limited, 2022.

In the simulation, Monty agents seek to fulfil their plans in an optimal way. They are rewarded for completing activities and penalised for travelling. Over the course of the simulation many 'days' (iterations) are run. Over these iterations the agents can change their routes, modes and departure times. Eventually this converges to an optimal state as the agents learn how to best complete their travel plans while competing with other agents for limited transport resources (e.g. road capacity and public transport seats).

Within this framework we can test different interventions on the transport network and see how Monty responds. The travel network that Monty agents can access includes the roading network (as well as various road attributes such as the speed limit, number of lanes and length) and the public transport network and schedules.

An example agent and their daily plans

By way of example, a 13-year-old female from Waikato who goes to school[31], doesn't work, and lives in a four-person household would have the following attributes:

Figure 11: Attributes of a sample agent in Monty

Variable	Value
Person ID	3038680
Age	13
Gender	F
Student status	In school full time
Labour force status	Not in labour force
Home region	Waikato region
Household ID	1069560
Household size	Four people
Car availability	Always

The car availability refers to the household level car availability, as agents under 16 are not allowed to drive in the simulation. Her input travel plan would be as follows:

Figure 12: Travel plans of a sample agent in Monty

Start activity	End activity	Arrival	Mode of transport
Home	Education	9:06:17	Car passenger
Education	Home	16:21:29	Car passenger
Home	Leisure	17:06:45	Car passenger
Leisure	Home	21:22:58	Car passenger

Over the course of her day, this agent is planning to travel from home to school, back to home, leave again for a leisure activity, and return home once more. The locations of these activities are also chosen during the plan creation. Initially these are all planned to

31 Our assumptions about education trips are drawn from the Household Travel Survey (Ministry of Transport, 2024a). This means that factors like school enrolments, holidays and sickness will be taken into account in our modelling.

be car passenger trips. Over the course of the simulation this agent will try different modes and routes to fulfil this plan, so the final result (the output plan) may be slightly different.

What scenarios did we model?

For this Briefing we ran three scenarios. The first was our 2023 base comparison case. The second was a 2055 national scenario where we increased population size to match expected population levels in 2055 but otherwise held settings and the transport network constant. In the third scenario we again used 2055 population levels, but focused on an illustrative example that explored what would happen if robotaxis (automated taxis, like those currently operating in San Francisco, California and Austin, Texas) replaced all trips by private car in Napier.

Our base scenario

For our **2023 base case** we used a population based on 2023 population projections. The whole of New Zealand was simulated. The network was the current road network and public transport schedule. The agents (the population) included people and freight with behaviour typical of current observed patterns.

In the national scenario we have a 2055 population of 6.25 million,[32] and in the Napier robotaxi scenario we have the same population but filtered to only people and freight (agents) who start or end their trips in Napier. The other main difference between the two 2055 scenarios is that in the national scenario people who have cars available to them can choose to use car or car passenger as a mode. Whereas in the Napier taxi scenario, the cars are replaced by a fleet of 15,000 autonomous taxis available for use by all. In our robotaxi scenario, prices for the taxis are set at 85% of the cost per kilometre of normal car journeys.[33]

For both scenarios the network used was the current road network and public transport schedule, with a small number of future improvements included. Note, the future network does not include all of the improvements that will be available in 2055. The freight population is scaled up from the 2023 scenario by the same percentage as the population is forecast to grow.

Both scenarios also model freight patterns, and in them we have assumed that the amount of freight linearly scales with the projected population growth.

In both scenarios we ran a 10 percent simulation. This means that 10 percent of the population was sampled and fed to the simulation, and each agent represents 10 real-world people. In Monty agents without travel plans are not modelled, reducing the total number of agents modelled. For the national scenario this yields 467,140 people agents and 9,945 freight agents. For the Napier scenario, this gives 7,507 people agents and 263 freight agents.

What were our findings?

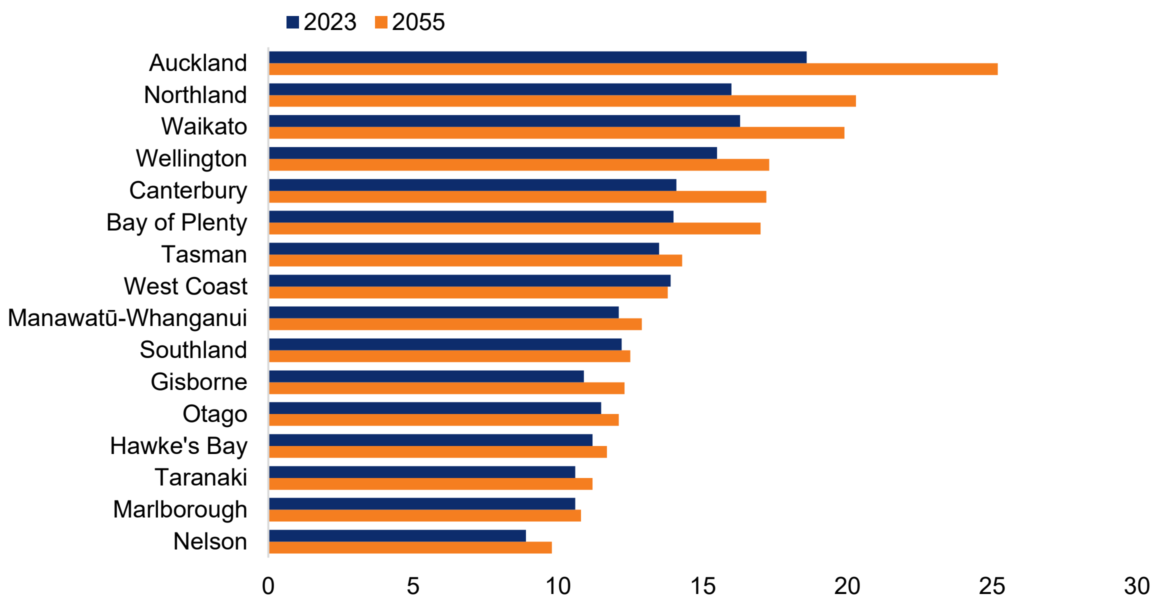
Overall, the results from the national 2055 scenario are not unexpected: increased population leading to increased road use, and correspondingly, increased travel time due to congestion.

Relative to 2023, in the 2055 scenario mean travel times increased in all regions, except for on the West Coast where population is forecast to decline. Auckland had the largest increase, with travel average travel times increasing from 18.6 to 25.2 minutes.

32 Stats NZ, 2022a; Stats NZ 2022b; Stats NZ, 2021b; Stats NZ, 2021c.
33 Bösch et al., 2018.

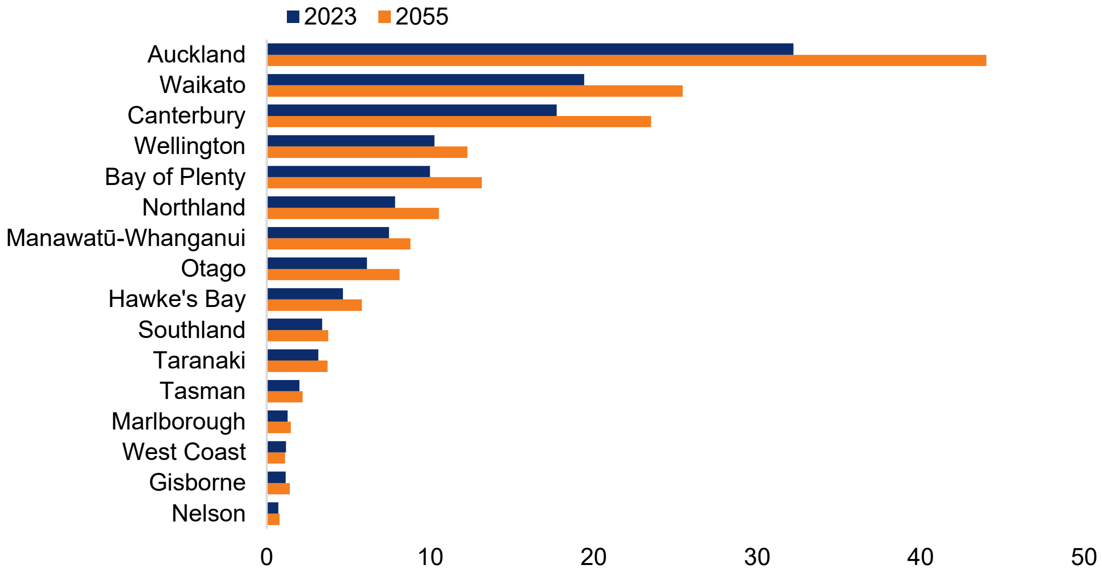
The increases in travel times are driven by Monty agents taking both longer and slower trips (on average). Between 2023 and 2055 the national mean speed per trip (across all modes but excluding freight) decreased from 37.48 km/h to 30.92 km/h, while the average trip length increased slightly from 9.66km to 10.03km. This suggests that significant population growth without corresponding changes to the transport network would lead to people travelling greater distances due to urban sprawl and/or travelling slower due to more congestion.

Figure 13: Mean trip travel time by region in 2023 and 2055 scenarios



Non-freight vehicle kilometres travelled increases in almost all regions, except for on the West Coast. In particular Otago, the Bay of Plenty, Auckland, Canterbury, Waikato and Northland all have increases in vehicle kilometres travelled of over 30%. On the West Coast the population is forecast to decrease, driving decreasing travel in the region.

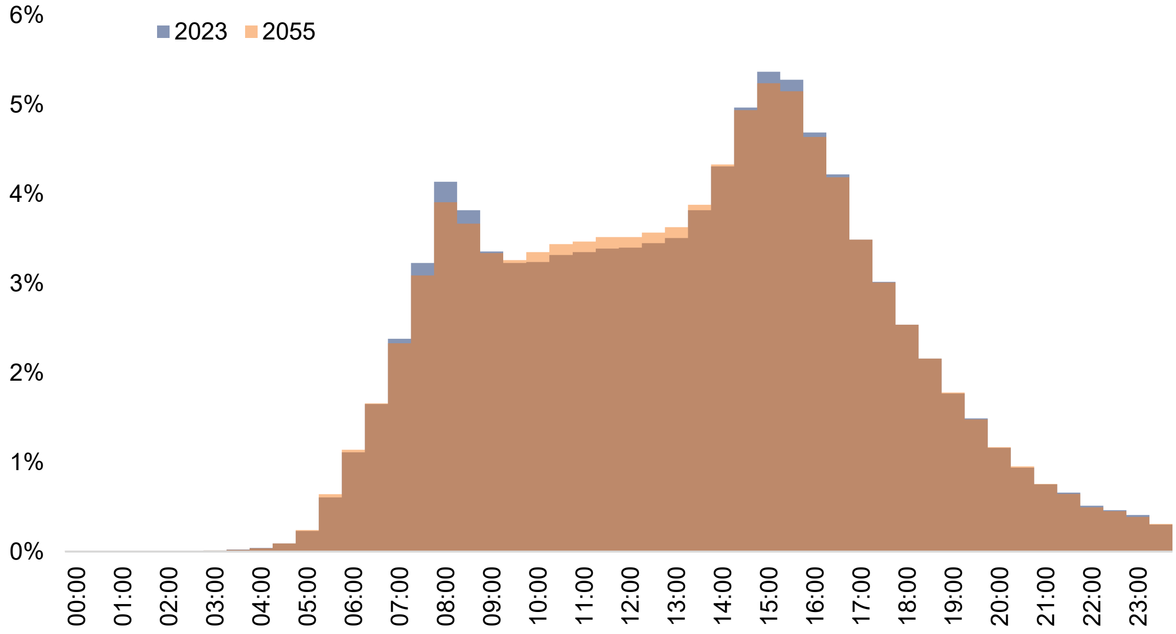
Figure 14: Non-freight vehicle kilometres travelled by region in 2023 and 2055 scenarios



Looking at the times of day that agents begin their trips, we see that in 2023 there are stronger peaks in the morning and afternoon, whereas in 2055 there is a higher proportion of inter-peak travel. This is demonstrated in Figure 15, which shows an overlay of 2055 trips by departure time on top of 2023 trips. Figure shows more travel between 9.00am and 2.00pm in 2055 than in 2023.

The 2055 inter-peak departure time increase may be due to network saturation (increased congestion) during the morning peak and afternoon peak. Another factor could be demographic changes. The 2055 population has a smaller percentage of school-aged people, resulting in a smaller percentage of education trips (which tend to happen around the peaks).

Figure 15: Proportion of total trips by departure time in 2023 and 2055 scenarios



How might this change in our case study?

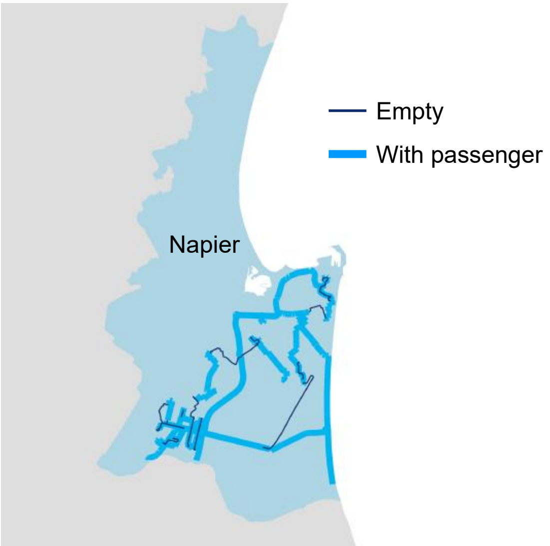
For our illustrative Napier 'robotaxi' scenario, the population is created in the same way as in the 2055 national scenario, but filtered to only people and freight agents who start or end their trips in Napier. This allows us to see how the travel behaviour of the same trips, done by the same agents, compares when robotaxis are introduced and private car travel is not available as a mode.

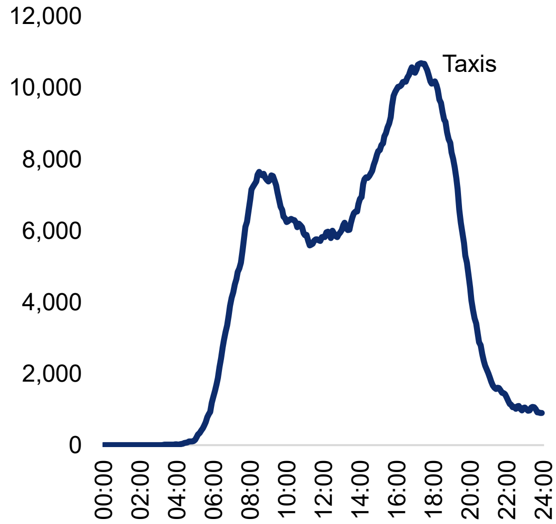
The network is the same as in the 2055 national scenario, but filtered to the Napier City Council area. Car and car passenger are not available as a mode to anyone. The cars are replaced by a fleet of 1500 autonomous taxis, which are available to anyone (regardless of age or car availability). Freight continues to be transported by regular trucks.

The simulation has 1500 taxis serving 10 percent of the population, which is equivalent to 15,000 taxis serving the entire population of Napier. The scheme works as follows:

- In the scenario agents need to wait for the robotaxis to arrive to pick them up.
- The self-driving cars are used for private trips and have a capacity of one passenger, but will be able to serve multiple agents over the course of the simulation.
- The taxis are simulated driving on the network both when they are transporting agents and when they are empty – travelling between requests (Figure 16).

Figures 16 and 17: An example taxi itinerary; Number of taxis in use by time of day in Napier





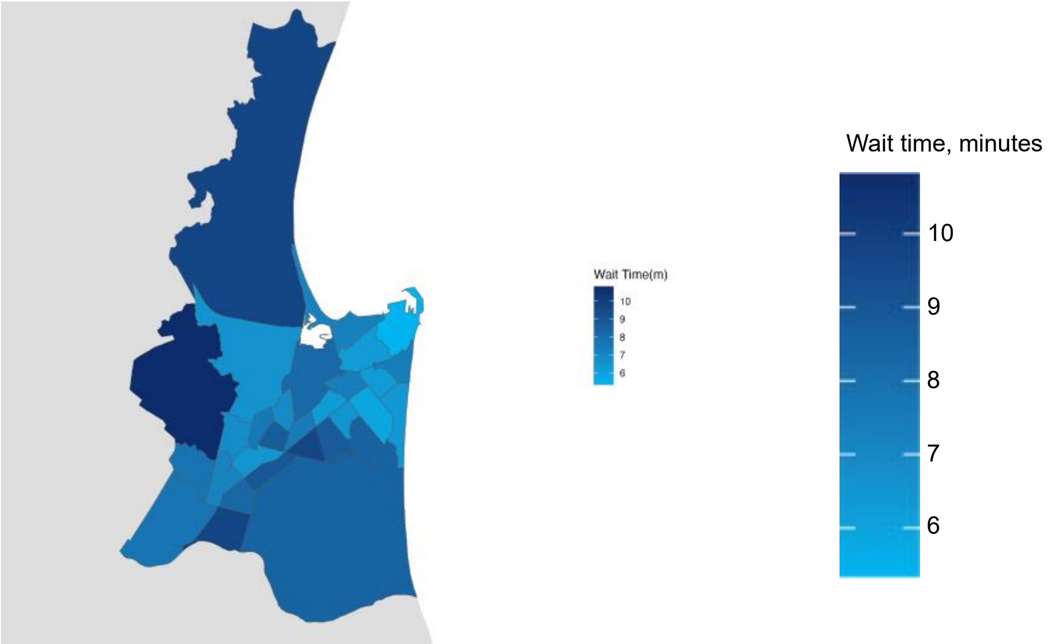
Based on these scheme parameters, daily usage peaks at around 5:30 pm with 10,700 taxis in operation.

As this is a 10 percent simulation, we could say that Napier's 2055 demand may be able to be served by 10,000 taxis. However, the waiting time may become too high if we have only just enough taxis to cover the demand. The optimal number of taxis may require a certain number of redundant taxis to reduce wait times.

Based on the scenario outputs, throughout the day the median wait time for a taxi was eight minutes - but some agents experience very long wait times of up to 50 minutes.[34] Some of this is driven by the location of the pickup point, with pickups closer to Napier CBD having lower median wait times.

34 In the simulation Monty agents have a maximum desirable wait time of 30 minutes. This creates a soft cap on taxi wait times by penalising agents if they wait longer.

Figure 18: Median taxi wait times based on trip start location



Overall, this led to two interesting findings. First, that the use of robotaxis could lead to slightly fewer vehicle trips in Napier as, due to wait times, some agents choose to use active travel options such as biking or walking. This is demonstrated in Figure 19.

Second, due to the need for robotaxis to move "between jobs," the expected vehicle kilometres travelled will increase by about 35%, and this will likely mean greater network volumes in most parts of the transport network (more congestion). In both the scenarios the number of trips that agents take contributing to vehicle kilometres travelled (i.e. car driver trips or robotaxi trips) is almost the same. However, the robotaxis also travel empty (with no agent as a passenger). Figure 20 shows the increase in vehicle kilometres travelled, and Figure 21 shows which parts of the Napier road network are most impacted by increased congestion (with line thickness and colour indicating the change in congestion).

Figures 19 and 20: Mode share of Napier trips; vehicle kilometres travelled in Napier on the simulated day

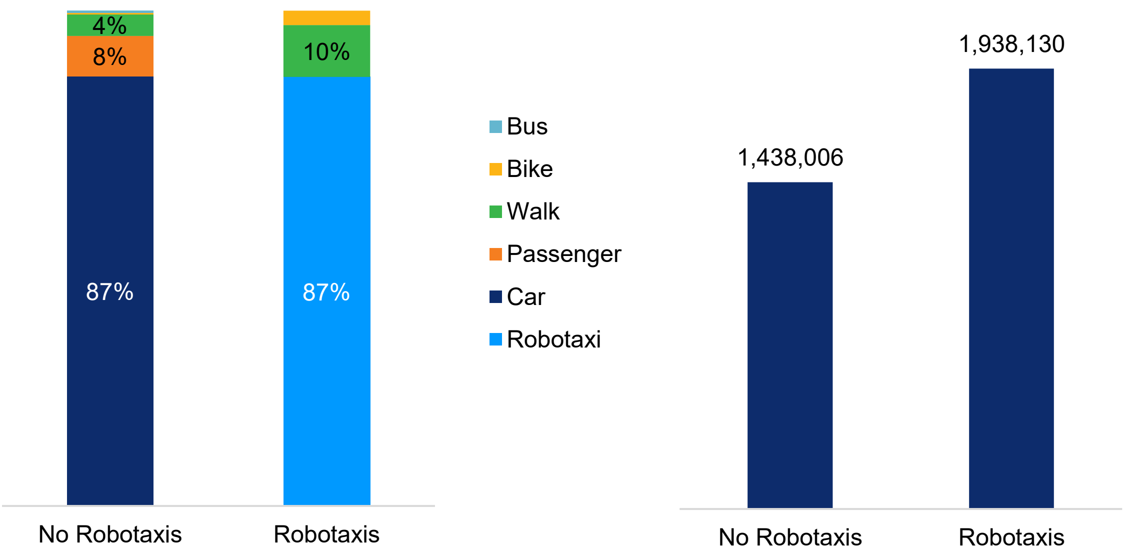
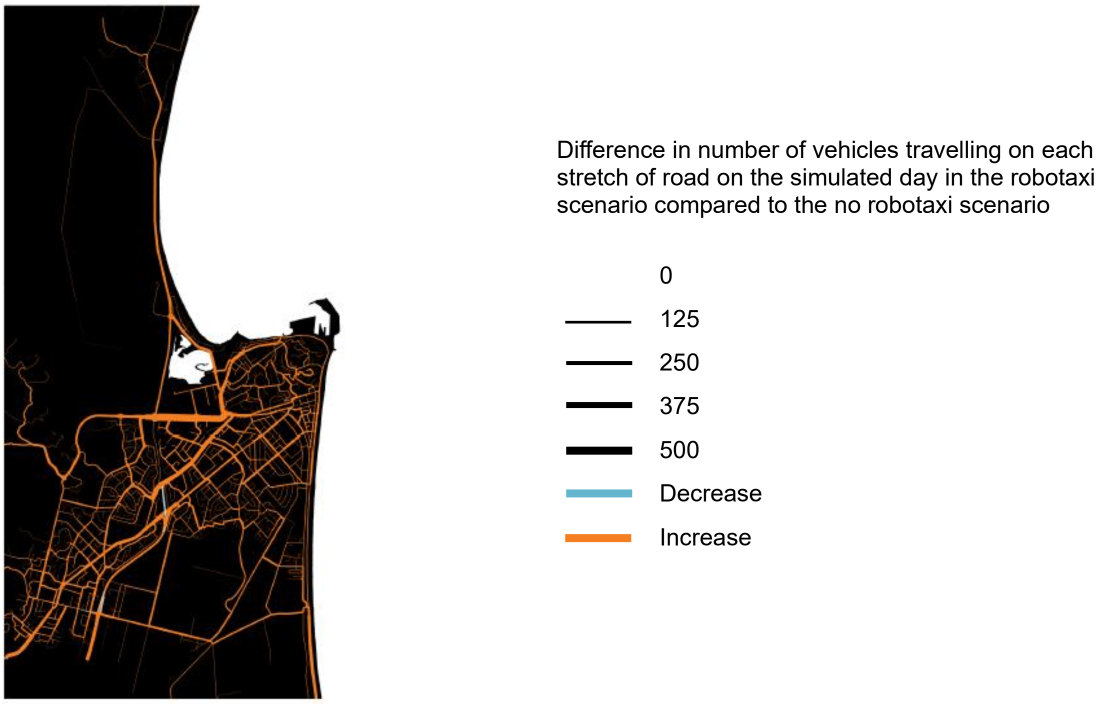


Figure 21: Difference in link volumes on the network



V: Next steps

Our analysis has some limitations…

There are two key sets of limitations to the analysis we've undertaken in this Briefing: those driven by assumptions in Monty, and those driven by assumptions in our chosen scenarios.

The assumptions that we apply to all Monty modelling could benefit from the following changes:

- Extension of our ability to handle more behavioural variables that influence agent activity. For example, in some cases income or type of private vehicles influences agent behaviour.
- Improvement in land-use forecasting: the generation of new locations for homes, businesses, workplaces, schools and the network infrastructure needed to serve them.

Our two 2055 scenarios are primarily illustrative, meaning that our findings are unlikely to materialise. However, they still offer interesting insights about the future. Specific limitations to the 2055 national scenario include that:

- The future population is built from Stats NZ median projections. These projections are based on current trends, are subject to revision and are known to underestimate immigration. StatsNZ has begun to address the matter and are in the process of revising their forecasts upwards. The effect of this will likely be increases in effects associated with the number of network users.
- Our model is based on the current transport network and transport policy and does not include all the improvements (including new capacity and tools like demand management) that could be available in 2055.
- We have assumed that freight will scale linearly with population growth, which does not account for the possibility of future events that significantly change the nature of freight demand.

Additional 'robotaxi' scenario insights could be obtained by extending the work to include:

- Consideration of network efficiency gained from replacing privately owned vehicles with robotaxis (i.e. removal of parking), or explicitly modelling changes in land use.
- Other schemes allowing shared robotaxis or a different number of robotaxis. Only one robotaxi scheme was modelled (15,000 single occupancy taxis), and we expect others will yield different results.

Further, the trends we observe in the Napier scenario may not be applicable to the rest of the country. It would be interesting to run a nationwide experiment with robotaxis, along with the other extensions.

But we are confident that agent-based modelling can be a useful long-term insights tool

This Briefing has explored what our Monty model can tell us about current and future demand and behaviour within the transport system.

This approach has shown strong potential to offer valuable long-term insights by simulating the actions and interactions of agents within the transport system. It can help to:

- Model different scenarios which incorporate a multitude of different assumptions to gain insight into possible outcomes.
- Learn about possible behaviour in the transport system, by observing how Monty agents respond to different incentives.
- Test policy outcomes in advance.

Long-term Insights Briefings are not intended to advocate for any particular policy interventions or future pathways. However, in the future, the Ministry will explore how Monty can support our policy work to:

- Analyse the impact of various policy interventions on New Zealand's transport system, including:
  - changes to roading, rail, active and public transport infrastructure,
  - different public transport services/schedules,
  - removing roads (e.g. due to weather events), and
  - changing speed limits.
- Assess how different population scenarios affect travel demand and how different demographic groups are affected by each intervention.
- Incorporate different pricing mechanisms in the model, allowing us to examine how Monty agents change their behaviour depending on different transport costs.
- Assess how transport evolves with shifts in activity patterns, such as an increase in remote work, different land-use scenarios, or shocks like the COVID-19 pandemic.

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