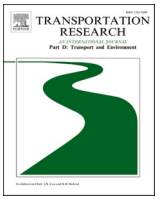
Transportation Research Part D 133 (2024) 104299

Contents lists available at ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd



Governance of automated mobilities transition in Aotearoa New Zealand

Moayad Shammut *, Muhammad Imran

School of People, Environment and Planning, Massey University, New Zealand

ARTICLE INFO

Keywords:
Automated mobilities
Transitions
Governance
Transport policy
Planning
New Zealand

ABSTRACT

This paper explores how political-institutional factors influence the transition towards automated vehicles (AVs) in New Zealand (NZ). Using the lens of 'mobilities paradigm' and analysing policy documents along with interviews data from government officials, the findings reveal the complexity of governing AVs transition due to fragmented responsibility, contested visions, and high interdependency across government agencies. The findings suggest that strong political leadership coupled with infrastructure investments and building regulators' capability are important catalysts of change towards AVs transition in NZ. The paper concludes that the complex governance environment, and the central government action and inaction to set priority for the AVs agenda, may hinder or facilitate a smooth transition towards AVs in NZ. This paper contributes to the mobilities paradigm by enriching our understanding of the political-institutional challenges associated with the emergence of AVs and offers illuminating policy guidance to better inform decision-making around governing the future transition towards AVs.

1. Introduction

The rapid advancement in connected technologies, artificial intelligence (AI) and driving automation over the past decades may lead to a gradual transformation of urban transportation systems (Nikitas et al., 2017; Cugurullo et al., 2023). Among many technologies, automated vehicles (AVs) have been increasingly regarded as highly disruptive technologies of the future with multifaceted implications for cities, economies and people's mobilities (Fagnant & Kockelman, 2015; Clements & Kockelman, 2017). Some researchers argue that AVs deployment may potentially provide safer, environmentally friendly, cost-effective and shared mobility services (Milakis et al., 2017; Faisal et al., 2019; Nikitas et al., 2021), whereas others argue that AVs may bring about new challenges, including in relation to urban sprawl, cybersecurity, privacy, and liability issues (Taeihagh & Lim, 2019; Shammut et al., 2022; Ribeiro Pimenta et al., 2023). Importantly, however, exploiting any potential from AVs may only be attained if they (and any associated risks) have been carefully planned for, regulated, and proactively governed. To that end, this paper aims to address the research question: How may political-institutional factors influence the transition of AVs?

The current literature on the governance of AVs has been explored from various perspectives, including the role and perceptions of planners, preparedness of urban infrastructure, integration into public transport, strategies to govern AV risks, and regulations for urban experimentation (Guerra, 2016; Hopkins & Schwanen, 2019; Legacy et al., 2019; Oldbury & Isaksson, 2021; Grindsted et al., 2021; Aoyama & Alvarez Leon, 2021; Tan & Taeihagh, 2021) A common overarching theme emerging from the literature is that

* Corresponding author.
E-mail address: M.Shammut@massey.ac.nz (M. Shammut).

https://doi.org/10.1016/j.trd.2024.104299
Received 25 September 2023; Received in revised form 10 June 2024; Accepted 15 June 2024
Available online 19 June 2024

transport governance is reaching a 'critical juncture' with regards to the transition towards AVs systems as they could potentially disrupt extant governance regimes. This issue raises a need in the literature to investigate important questions of 'smart mobility governance', such as context, power, politics, and how planning policy decisions get made, shaped, and advanced over time (Marsden & Reardon, 2017; Shammut et al., 2022) to allow greater understanding of how transition towards AVs can be best governed. To address these calls, this research applies a mobilities paradigm (Cresswell, 2010; Sheller & Urry, 2016) to explore the political-institutional factors that may influence the transition towards AVs, taking the case of Aotearoa New Zealand (NZ).

In NZ, the Ministry of Transport (MOT) has shown interest over the past decade in adopting AVs and released a number of policy and White Paper documents exploring the regulatory and infrastructure requirements to adopting AVs in the future (MOT, 2014; 2015). For instance, in 2015–16, MOT released its 'Futures Work Programme' and 'Regulation 25′ documents to understand the regulatory barriers (as well as potential solutions) for AVs transition in NZ. The Minister of Transport at that time also conducted a semi-AV trial on public roads with emphasis on how AVs may improve road safety, and did not propose any regulatory requirements, so as to enable a smoother technology transition. At the local government level, Auckland has been considered a suitable city for AVs adoption (Faisal et al., 2019), whereas Christchurch had already adopted an AVs shuttle at its airport (Christchurch Airport, 2019). Recently however, the Ministry has been leaning towards a 'wait-and-watch' attitude in respect of AVs regulation despite showing initial interest in their adoption (MOT, 2021). To date, there has been no evidence of any discernible debate in the literature that deals directly with the questions of what, how, and who influences the transition towards AVs adoption in NZ. To fill this gap, this paper uses the mobilities approach and aims to explore how political-institutional factors may influence AVs transition in NZ. This paper undertakes document analysis of government policy coupled with interviews with government officials in NZ.

The Society of Automotive Engineers delineates six levels of vehicle automation in its J3016 taxonomy – Level 0 (no driving automation) up to Level 5 (fully automated) (SAE, 2018). This paper focuses on Level 4–5 automation for two reasons. First, the different automation levels will likely require different regulatory responses, so that selecting to focus on specific automation levels helps narrow down the research scope. As such, L1-2 AVs may not present a governance challenge as opposed to higher levels of autonomy. Second, we seek to contribute to literature, and practice, towards an increased understanding of the complexity of governing AVs, and, by extension, to challenge the traditional technocratic narrative that often presents L4-5 AVs as a 'rosy' solution to urban transport challenges. Our paper argues that although L4-5 AVs may have potential implications for society and the environment, governing those implications will be complex and may require substantial reformation of the existing decision-making processes and regulatory arrangements in NZ. Overall, focusing on L4-5 AVs provides an opportunity to understand how driverless AVs transition could disrupt (or be disrupted by) the existing governance environment in NZ.

This paper is organised in five sections. From here, Section 2 conceptualises the governance of AVs transition through the mobilities lens, followed by an outline of the research design in Section 3. The research results are presented in Section 4, and categorised into Strategic, Tactical, Operational and Reflexive activities. Section 5 provides a discussion of key findings. Lastly, Section 6 offers conclusions and highlights the complexity of governing AVs transition in NZ, outlining implications for policy and practice.

2. Conceptualising the governance of automated mobilities transition

The 'new mobilities paradigm' (Sheller & Urry, 2006, 2016) provides insights into a wide range of "social, economic, political practices and infrastructures that all involve various kinds of movement of people, objects, or information" (Urry, 2007, 43). Conceptualising the broader transition towards AVs through the mobilities paradigm may then be divided into four major dimensions, namely, social, governance, technological, and business aspects (see Shammut et al., 2022). This paper focuses on the governance aspect of the transition towards AVs adoption in NZ.

The mobilities paradigm, drawing on theoretical concepts of complexity, offers a fuller appreciation of the behaviour of complex systems that is helpful in analysing how a group of interrelated elements can impact one another, where this group could be an organisation, sector, or even a society. As such, the non-linearity of complex systems contends that small changes may result in major changes to a system. Urry (2004) illustrates how the significant expansion of petrol-based cars was based on a small event that occurred in the past. As such, "petroleum-fuelled cars were established for small-scale, more or less accidental reasons, partly because a petrol-fuelled vehicle was one of only two to complete a 'horseless carriage competition' in Chicago in 1896" (Urry, 2004, p. 31). This incident led to major industry developments such as car manufacturing, car repair and maintenance, highway development, petroleum producers, and petrol stations. Thus, small events occurring in a particular order by the end of the 19th century led to a major change in the 20th century, which later came to be known as 'the century of the car'. This phenomenon is because complex systems are known to be 'open' by nature, in which they constantly evolve and unfold overtime. This (co)evolution means that the complex system is interdependent, interacts, and has feedback loops between itself and the environment in which it is embedded. In the context of AVs, their ripple-effect implications (Milakis et al., 2017) on various transport and non-transport industries (e.g., energy, cybersecurity, privacy, insurance, businesses) show that changes made in one sector can have significant influences on the other sectors. Complex mobility systems are also 'nested' (Büscher et al., 2016) and involve multiple domains and scales, where each of these (sub)systems have their own dynamics: Economic changes happen in the short term, cultures often change more slowly, while changes in technological domains take place somewhere in between. Thus, the introduction of AVs will likely require an interplay of several domains, including the systems of automobility, socio-technical systems, and the systems of information and communication technology (ICT) (Urry, 2004). Therefore, AVs can be conceptualised as an integral component of a wider set of "nested systems within systems, with often contradictory forces at work" (Shammut et al., 2022,p. 420), highlighting the entangled and complex component of AVs introduction. Nonetheless, an analysis of the political-institutional processes that enabled and supported the large-scale development of petrol car dominance in the 20th century, in Urry's example (2003), as well as in the context of AVs, remains largely absent within the mobilities and complexity scholarship (Kemp, 2009; Shammut et al., 2022). This paper attempts to address this

conceptual and empirical gap by pushing the boundaries of the mobilities paradigm to explore how political-institutional factors may influence AVs transition in the future.

In pushing the boundaries of the mobilities paradigm, we first introduce 'mobilities governance', which can be broadly described as the power that controls, manages and shapes movements and behaviour via a series of rules and mandated regulations (Freudendal-Pedersen et al., 2019). In the context of the transportation system, this power tends to be viewed as a "law, calculated and expected obligation" (Cresswell, 2010, p. 169), which includes for instance rules on which side of the road to drive on, speed limits on motorways and near residential areas, as well stipulating appropriate alcohol blood levels while in control of a vehicle, and certainly establishing rules as a comprehensive set of vehicle safety standards (Gudmundsson et al., 2016). In some countries, it is illegal to drive without a fastened seatbelt, a first aid kit or a high visibility jacket (Adey, 2017). As such, from national 'rules of the road' to more local restrictions and nuances, a driver's mobility is disciplined through a host of rules and regulations. However, the notion of automated or 'driverless' mobility, therefore, necessitates disruption to extant governance regimes which often deal with regulating 'human drivers', signalling an important area for further theoretical development.

Governance regimes develop transport legislation and formulate policy, therefore they typically have power and control over setting policy priority and allocation of funding for transport projects, as they often determine 'who gets what, when, where, and how much' to invest in the infrastructure (Flyvbjerg, 2007). Government policy often serves as a statement of intent or aspiration, but "does not provide an indication of whether governments have the capacity to plan new pathways for transport" (Sturup et al., 2012, p. 126). This is because the real capacity of policy to achieve its particular objectives might be restricted or influenced by factors relating (partly) to 'power and politics'. In understanding the influence of power on transport projects, Cardullo and Kitchin (2019) argue that the funding sources have an influence on the power relations in the decision-making process for a funded project. Funders often push a pre-determined agenda, with specifications on how the funding proposals are prepared, and who can make inputs to the project, which contributes directly towards shaping the scope and influencing the direction of transport projects. More recently, the private sector, as major investors in AVs technology, have powers in some jurisdictions to influence government's investment decisions and plans for AVs. In Michigan, United States (US) for instance, the Governor has recently authorised a law that allows the creation of a 40 km connected infrastructure corridor for AVs, which would be made possible by significant investments bankrolled by companies funded by Google (Eggert & Krisher, 2020). Valdez (2023) describes how Uber's 'infrastructural power' prevails in regulatory battles, in which Uber power is developed by becoming an 'infrastructure for society', providing services perceived as necessary and 'as reliable as running water'. Similarly, Rahman (2018) considers Google and Amazon as "the basic infrastructure of modern society" (p. 1641), denoting that these services have become a necessary utility like water or electricity. Expanding the reach of 'tech-giants' (e.g., Uber, Amazon, Google) to more and more users and actors enables them to accumulate more power and therefore become more able to influence regulation (Rahman, 2018; Valdez, 2023). Politics is another factor that influences transport governance and transition. Murphy (2022) shows the influence of politics on the 'making and unmaking' of certain infrastructure projects in Australia, despite public opposition and Ministers' re-announcements of the project. The East-West Link infrastructure project went through vicious cycles of progression and stopping largely due to the 'steering' of political actors who prioritised and deprioritised the project whenever in power. In cycling mobilities as well, Handy and McCann (2010) found that in areas where political will existed, an increase in cycling infrastructure provision was possible. In contrast, Aldred et al (2019) showed a major barrier to building cycling infrastructure in England was the lack of political support, as politicians did not consider cycling as a 'serious' means of transportation. This shows how certain transport infrastructures have become 'instruments of particular political projects' (Rutherford & Coutard, 2014), suggesting that transport governance is dependent on political contexts that shape and reshape them. A transition towards AVs may result in deep structural changes and reconfiguration of the entire transportation system (e.g., legislative, infrastructural, technical as well as social and cultural embeddedness) involving a wide range of actors (e.g., policymakers, regulators, private investors, consultants, civil society), which emphasises the role of power and politics in bringing about momentum for AVs transition (Rutherford & Coutard, 2014; Shammut et al., 2022). Despite the crucial role that politics play in steering transport projects and influencing transitions, the AVs literature tends to largely treat AVs as an 'apolitical artefact' (Stilgoe, 2018). However, Cugurullo et al., (2021,p. 853) contend that further probing is necessary into the network of influential and political actors behind introducing AVs into the transportation system. Marsden and Reardon (2017) highlight the need to get 'behind the mask' of policy and recognise the 'informal networks and sub-systems of actors' which are at play within a policy area. This paper contributes to these debates and aims to explore the influence of political-institutional factors on AVs transition in NZ.

To operationalise the mobilities approach in this paper, and to gain insights into the political-institutional factors influencing AVs transition, the transition process can be understood and guided through four governance cycles – strategic, tactical, operational, and reflexive (Loorbach, 2010). *Strategic activities* aim at establishing the transition arena through vision development, policy and goal formulation with long-term horizons (up to 30 years) with the purpose of affecting change at a societal system level. The involvement of players from the political arena (ideally at ministerial level) is essential to support the transition arena, as will engaging 'frontrunners' (prominent and pioneering actors). Frontrunners are agents with distinct competencies, such as strategists, creative minds, and visionaries. Uncertainty during this stage is elevated, and high-profile actors can influence political and societal discourses. *Tactical initiatives* work on a sub-system or organisational level, with mid-term horizons (5–15 years), and aim at achieving goals within a particular setting rather than a wholesale societal change. Actions involve coalition establishment, negotiations among actors, and agenda development for transition (e.g. rules, regulations). The key focus is to develop networks and coalitions that derive mechanisms for change. *Operational activities* have short-term horizons and aim at initiation and execution of experiments. The focus here is on the mobilisation of actors and the conduct of experiments that should contribute to the transition objectives and in-force future experiments. Actions at this level are high-risk, and are often derived by the ambition, entrepreneurial drive or promise of innovation from engaged and engaging frontrunners. *Reflexive activities* involve assessing, evaluating, and monitoring the actions from the previous transition cycles. The aim is to make adjustments to strategic, tactical and operational activities where necessary, in line with the learning outcome of this reflexive cycle.

These four governance cycles are not sequential but show possible connections and components of the transition process. This analytical approach is helpful in revealing the political-institutional challenges (at strategic, tactical, operational, reflexive levels) associated with AVs transition (Grindsted et al., 2021), providing further insights into the 'messy' reality of AVs governance (Marsden & Reardon, 2017). Overall, the present conceptual framework leads to an engagement with the complexity of governing the transition towards automated mobility futures. In extending the boundaries of the mobilities approach in this conceptual framework, we begin to contribute to the debates on understanding the contextual (political-institutional) factors influencing the AVs transition but also develop an appreciation of who determines its shape and how.

3. Research design

3.1. Case study context

This paper takes the case of NZ to examine the governance of AVs. Several characteristics could make this case worthy of investigation. Historically, NZ has a reputation of being a quick adopter of technology, dating back to as early as 1980′s when NZ was one of the first countries to adopt an electronic payment transfer system (known as EFTPOS[1]) (The Treasury, 2021, p. 142). NZ also has a local AVs Shuttle manufacturing and operating company since 2019 named 'Ohmio'. NZ's transport legislation is also very unique in the sense that it does not legally require a driver presence in a moving vehicle (MOT, 2019a), whereas international laws require that a human driver must be in control at all times (Li et al., 2019). The relatively small population (~5 million) with no State or Federal jurisdiction challenges to navigate (MOT, 2019a) also indicate simpler forms of governance environment to regulate new technologies. AVs research in NZ remains in its infancy, highlighting the salience and added value of this paper to the existing body of knowledge on AVs governance.

This paper adopts a qualitative approach and uses document analysis for government policy documents and thematic analysis for interviews with government officials in NZ. Although a qualitative approach may limit the generalisability of findings, it offers a focussed, in-depth, and more comprehensive understanding of the complex issues embedded in the governance process for AVs as an emerging 'disruptive' technology. Therefore, this paper pursues a qualitative research method to obtain enriched insights into the complex field of AVs governance (and transition) in NZ.

3.2. Document analysis

This paper employed documentary analysis to identify and analyse relevant AV policy documents in NZ. We initiated our search using the following keywords: autonomous, automated, automation, unmanned, driverless, connected, intelligent, technology, infrastructure, transition, (cyber)security, privacy. Based on our knowledge and critical thinking (Milakis et al., 2017; Shammut et al., 2022), we initially considered searching for relevant documents from the following agencies:

(1) NZ ministries (e.g., Ministry of Transport [MOT], Ministry of Health [MoH], Ministry for Environment [MfE], Ministry of Business, Innovation and Employment [MBIE], Ministry of Justice [MoJ], Ministry of Housing and Urban Development [HUD], Aviation Security Service [AveSec], Ministry of Media and Communications, Ministry of Foreign Affairs and Trade [MFAT].

(2) Local government authorities (Auckland Council, Auckland Transport, Wellington City Council, Christchurch City Council (by extension Christchurch Airport), the Local Authority Traffic Institute [Trafinz]).

(3) Crown agencies (e.g., New Zealand Transport Agency [NZTA], The Treasury, Office of the Privacy Commissioner [OPC], the Government Chief Data Steward [GCDS], NZ Police).

(4) Relevant parliamentary offices (e.g., Department of Prime Minister Cabinet [DPMC], Parliamentary Counsel Office [PCO]).

(5) Relevant organisations in the automobile sector (e.g., Ohmio AVs Shuttle company, NZ Automobile Association [AA]).

This search resulted in collecting approximately 250 government reports, policy and consultation documents, politicians' statements, parliamentary inquiries, as well as regulatory agency meeting agendas and corresponding mails. We extended our search to Google to discover the scope of AVs trials conducted in NZ, which we then linked with the development of AVs policy during each government period. Thorough and critical review of these documents was crucial for gaining background and historical insights, tracking policy changes and developments, raising questions and topics to be asked and explored, and confirming key organizations and participants to be interviewed in this research (Dorchey, 2000). In narrowing down our focus, we included documents that relate directly to AVs, including regulatory responses, infrastructure investments, and trials. We also focused on the policy intentions of the conservative National Party-led government (2008–2017) and liberal Labour Party-led government (2017–2023), configurations of government organisations and their potential role in AVs deployment, the different policy instruments used by the government, and how those have resulted in the development of different government strategies to AVs experimentation and future transition (Tan & Taeihagh, 2021). Eventually, 27 documents were included for in-depth analysis. We ensured the inclusion of all necessary and relevant documents to understand AVs governance in NZ and did not face challenges in accessing any documents. However, the possibility exists that our access to certain documentation was restricted because the contents may have contained commercially privileged or politically sensitive information. The triangulation of documentary analysis with primary interview data has strengthened and validated our overall research analysis. In analysing these documents, we reviewed the content of the collected documents through

[1] EFTPOS stands for Electronic Funds Transfer at Point Of Sale.

extensive reading, and where relevant conducted discourse analysis to identify 'storylines' within government policy (Vigar, 2002). Storylines are viewed as narratives or 'modes of arguments' presented in government policy, serving to support a certain policy stance or influence policy direction as well as public perception in relation to transport challenges and solutions (Hajer, 1996). The time frame for this analysis included documents released in the past decade (2012–2023). The year 2012 was selected as it marked the unveiling of Google's driverless car, and the first AVs officially passing a self-driving test in the US (Harris, 2014), a milestone that paved the way for more AVs trials and developments globally, and when a debate began on AVs potential benefits by NZ government. This time frame is also sufficient to identify and understand key developments in AVs policy in NZ (Table 2).

3.3. Interviews

This paper undertook in-depth, semi-structured interviews, recruiting relevant participants in NZ. Our participant selection criteria entailed interviewing people closely involved in the policymaking, regulation and experimentation of AVs. When considering participant recruitment at the local government level, we selected Auckland and Christchurch, as these cities had engaged most deeply at the experimental level with AVs, and their local government strategies showed clear intentions to adopt AVs in the future (AT, 2016; CCC, 2020). We considered Christchurch Airport in our research due to its adoption of an Ohmio shuttle, and the several trials conducted here. We considered what happens in Christchurch Airport important for AVs planning on public roads for two main reasons. First, participants described Christchurch Airport as a 'mini-city', which presents potential scenarios (at a small scale) that would be helpful to understand AVs capabilities and limitations before their large-scale deployment on public roads. Second, as early adopters of an AVs shuttle, it was helpful to gain insights into any challenges regarding AVs regulation and experimentation in NZ when collaborating with regulators.

The participants recruited occupied executive and senior positions across diverse government levels (e.g., chief executives [CEOs], bureaucrats, managers, and team leaders). Interviews with diverse participants enable capturing the "backstage of decision-making, the frustrations, and the tactics and strategies involved in" the governance process (Jiwani & Krawchenko, 2014, p. 58). However, current government participants' perspectives could potentially be biased (as opposed to former ones), as current government officials may have an obligation to adhere to the published government narrative and thus share limited insights or 'backstage' information due the "barriers that limit transparency and openness necessary for political control" (ibid, p.60). To address this limitation, we considered the following steps: First, in the recruitment process, in addition to current government officials, we ensured including former government officials at central level government who are naturally no longer "beholden to their political masters and pressures for secrecy" (Jiwani & Krawchenko, 2014, p.61). Second, to account for potential biases, we recruited two additional key participants from the AVs automobile sector in NZ, who worked closely with government, with expertise in AVs trials and government policy analysis. Third, to further address such biases in our analysis, we challenged all the participants' quoted views by incorporating as many opposing views as possible and whenever relevant. We interviewed 10 participants in total, which ensured sufficient data saturation and triangulation with the secondary data sources used in this research (e.g., see Legacy et al., 2019; Freudendal-Pedersen et al., 2019). Table 1 describes participants organisations and areas of expertise.

We employed thematic analysis to analyse the collected data. This method offers a systematic tool for qualitative analysis which has been used extensively in transportation studies (Gössling et al., 2016; Hafner et al., 2017; Mészáros & Antonson, 2020) producing robust findings. The interviews were recorded where allowed, transcribed, and then coded using NVivo Software. We adopted Braun and Clarke's (2006) six-step approach, which included full transcription of interviews, familiarisation with the data, identification of initial codes, searching for themes, reviewing and redefining themes, and ultimately producing the written output. The key findings (i.e., extracted sub-themes) were linked to the conceptual framework and categorised into tactical, operational, and reflexive overarching themes. To minimise researcher bias, and by following established practice for thematic analysis, the two authors discussed the identified themes and sub-themes while verifying that the codes were consistent throughout the analysis procedure. The use of an initial documentary analysis also helped triangulate the interview data with the official policy documentation to further enhance the validity and reliability of our analysis.

3.4. Overview of transport governance in NZ

This paper takes the case of NZ to examine the governance of AVs. The Ministry of Transport (MOT) is the NZ government's system

Table 1
Participants details.

Participants	Organisation	Area of expertise
Participants 1–4	Central government (Ministry of Transport)	Policymaking, legislation, planning, vision and agenda setting for AVs
Participants 5–6	Crown Agency (NZ Transport Agency)	Future transport regulation, certification, and infrastructure provision for AVs
Participants 7–8	Local authorities (Auckland Transport and Christchurch Airport)	Experimentation and trial of AVs and AVs infrastructure
Participants 9–10	Automobile sector (Ohmio and NZ Automobile Association)	Policy analysts and developers of AVs technology

The Christchurch Airport is owned by 75% the Christchurch City Council and 25% by the NZ Government, hence the tendency to treat it as local authority.

lead on transport in NZ, determining policy, strategy, funding and regulation related to transportation. MOT administers two key Acts that set broad powers – the Land Transport Act 1998 (LTA) and the Land Transport Management Act 2003 (LTMA). MOT remains the most powerful and influential actor in terms of AVs policy-making and direction. Another key actor in terms of AVs regulation is the NZ Transport Agency (NZTA), operating under the LTMA and LTA which determine its roles and provide it with the authority to act. NZTA is a Crown Entity that invests in, manages and regulates access to and use of the land transport network. Testing and certifying AVs lies within the jurisdiction of NZTA, which ensures all safety procedures are met and any hazards or risks are identified. It is also responsible for physical and digital infrastructure readiness assessment and investment for AVs. Other less influential actors include the Ministry of Business, Innovation and Employment (MBIE) which is responsible for different pieces of legislation that could be of relevance to AVs regulation. They include the Fair-Trading Act 1986 which has relevance in terms of the manufacturers' obligations to sell and deploy AVs on public roads, and the Accident Compensation Act which relates to AVs crash liability issues.

Conducting trials for communication frequency standards for AVs requires obtaining a licence clearance from the Radio Spectrum Management (RSM) which falls under MBIE responsibility. The Office of the Privacy Commissioner (OPC) monitors and enforces compliance with the Privacy Act 2020 (PCO 2020), which may require understanding how to accommodate AVs privacy risks and mitigation. At the local government level, local authorities are responsible for road maintenance and trials for AVs and may have technology strategies covering AVs deployment in the future. The governance framework in NZ is generally known to be complex. For a transport project to be approved and funded in Auckland for instance, the project needs to align with the RMA (Resource

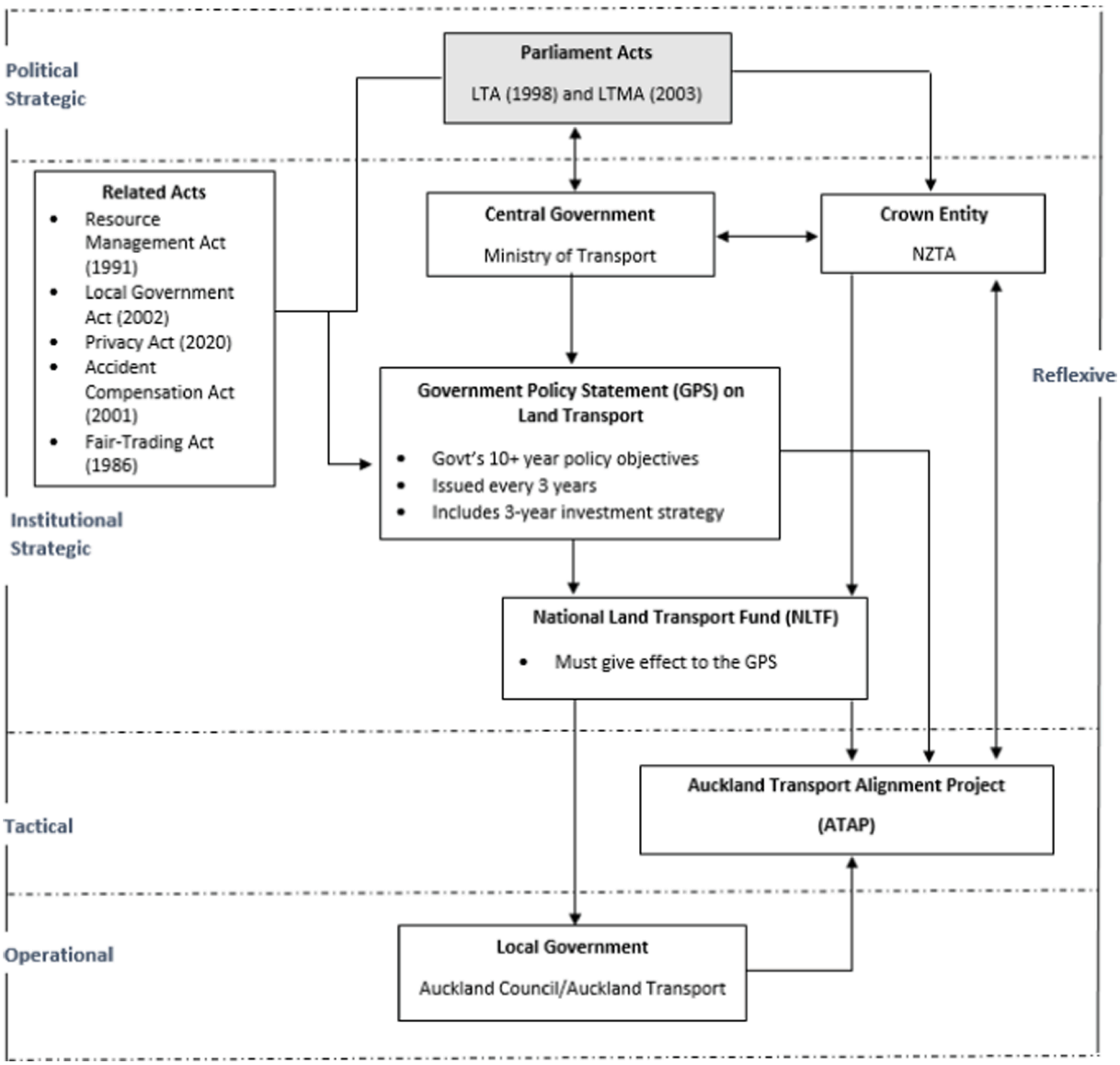


Fig. 1. Transport governance framework in NZ (Source: Authors).

Management Act 1991), LGA (Local Government Act 2002), and LTMA. In 2015, the central government and Auckland Council also joined up to strategically address transport challenges in Auckland through the Auckland Transport Alignment Project (ATAP). The ATAP includes a cross-agency partnership including MOT, NZTA, the Treasury, KiwiRail, Auckland Council, Auckland Transport, and the State Services Commission. The result of the multiple actors, Acts and plans required often brings complexity and fragmentation in decision-making processes and misalignment of investment decisions. Fig. 1 below illustrates a transport planning framework in NZ.

Other jurisdictions like the US and Australia have federal government. In Australia, The Parliament consists of the House of Representatives and the Senate, along with three layers of governments: federal, state, and local government. Each level of government has its own powers and responsibilities, which often creates tensions. Creating laws and implementing AVs usage for instance could be complicated due to the separation of powers and responsibilities and the multi-layer governing system (Veeneman & Mulley, 2018). Another example is the UK which has a multi-tier governance system. The Parliament of the UK of Great Britain and Northern Ireland consists of three parts: The sovereign, the House of Lords, and the House of Commons. Transport governance also generally witnesses some "tensions between the extent to which schemes are local, regional, inter-regional or national in importance" (Marsden & Docherty, 2019., p. 79). However, in NZ, there is one central government with no Federal system, which shows simpler forms of governance though complex relationships and interdependencies do exist between various government departments, as shall be explored in this paper.

Overall, this section presented an overview of transport governance in NZ. The next section presents the findings categorised into strategic, tactical, operational, and reflexive activities.

4. Results

4.1. Strategic – Envisioning and establishing an AVs transition arena

Strategic activities aim at establishing the transition arena through vision development, policy and goal formulation with long-term horizons (up to 30 years) with the purpose of affecting change at a societal system level. To gain insights into the strategic level activities, we reviewed 27 government policy documents of relevance to AVs (e.g. central and local level transport policy, investment policy, business and industry policy, cybersecurity policy, energy policy, and briefing incoming minister documents – see Table 2). This section outlines the strategic level activities, direction and timeline of key policies in relation to establishing AVs transition in NZ.

In 2014, the National Party-led central government released the NZ "Intelligent Transport Systems (ITS) Technology Action Plan (2014–2018)", outlining 42 actions that would help facilitate ITS deployment (MOT, 2014). The Action Plan dedicated one section for AVs focusing primarily on their positive implications for society and the transport sector, while acknowledging that the widespread operation of AVs might raise complex legal challenges. The document covered the government's actions to promote testing AVs in NZ and the need to re-assess current legislation to provide clarity over the legality of trialling AVs in NZ. However, this analysis was specific to the liability of trialling AVs rather than liability for operating on public roads.

In 2016, MOT released the "Regulation 2025: Emerging insights" document which recognised with emphasis the potential paradigm shifts of transportation in NZ (MOT, 2016). The document articulated the drivers of change in regulatory systems to accommodate AVs. It identified three key drivers of regulatory change – change in public perceptions of risks, new regulatory settings, and developing new business models. The document suggested a new regulatory system in addition to the existing regulations. While current regulations cover the physical aspects of transport, the new regulatory regime would cover the 'intelligent' aspect of the automated transport system in the future.

Under the Labour Party-led central government, an "AV Work Program" was drafted in 2019 (MOT, 2019a), outlining the key areas of further research and concerns for AVs in NZ. It acknowledges that the "previous government had a strong focus on AVs"; however, it is currently focusing on reviewing its critical regulatory aspects (ibid, p. 5). The AV Work Program identified four key aspects for its regulatory framework – safety risks, liability, cybersecurity, and economic uncertainty. The AV Work Program seems sceptical about the benefits of AVs including in relation to social and economic outcomes. The document focuses on the risks and uncertainty of AVs, suggesting that the government is no longer prioritising AVs.

The Government Policy Statement (GPS) is the central government's strategy to guide land transport investments over the next 10 years. The GPS 2021 outlines the strategic priorities for investment, including safety, climate change, and freight. However, AVs were not considered as contributing to feeding any of those priorities in that year. GPS tends to focus significantly less on investing in transport technologies compared with the GPS for 2015 and 2018. The current GPS mentioned AVs once, along with low emission vehicles, as potential technologies that the government "expects to take advantage of" (GPS, 2020, p. 30). Overall, the greatest funding from GPS 2021 is allocated towards state highway maintenance and improvements, which is nearly double the funds allocated to public transport infrastructure, while there is significantly limited focus on technology spending and investment.

The 2021 National Infrastructure Plan provides the framework for central government's infrastructure development over the next 30 years across the transport and energy sectors, among others (Treasury, 2022). The plan discusses the need for a robust infrastructure in the face of threats generated by cyber-attacks and the need to resolve regulatory issues around privacy concerns arising from adopting transport technologies in general. Regarding infrastructure investment, remarkably, the document highlighted the need for reforming the transport funding system and included recommendations for MOT to "implement a new, fit-for-purpose transport funding system that is adequate for meeting future transport investment requirements" (Treasury, 2022, p 132). Attempting to achieve these objectives could be through incorporating best practice funding principles and determining how additional funding should be collected if required.

The "Cybersecurity Strategy 2019" was released by the National Security Group (NSG) (DPMC, 2019), aimed at minimising harm and disruption caused by technological advances. The strategy highlighted priority areas of improvement for cybersecurity during

2019–2023 including raising awareness about cybersecurity threats, incentivising the growth of the cybersecurity industry and making a fit-for-purpose law to enable better management and response to cybercrime. The "NZ Information Security Manual" (NZISM, 2018) and Protective Security Requirements (PSR, 2018) also contains standards and guidance related to cybersecurity governance though not AVs-specific.

At the local level, Auckland Transport (AT) released the "AT Technology Strategy 2016" (AT, 2016), outlining the areas of focus and high-level action plans for the strategic vision of Auckland's technology. This includes trialling new and emerging infrastructure sensors, pilot infrastructure for vehicle communications, and enabling sustainable autonomous and electric vehicle trials and implementation. The strategy mentioned AVs six times, particularly when discussing the safety of the future of transport. It stated that AT would draft a "connected and autonomous vehicle strategy" to enable "greater effectiveness, efficiency, resilience and safety in our transport system" (AT, 2016, p. 10). However, no specific strategy has been drafted for AVs as yet, which may suggest a change in priority or lack of funding.

In 2020, the "Auckland Transport Alignment Project 2021–31" (ATAP) was released as an agreed transport programme which provides alignment between central and local government on investment priorities and transport planning in the Auckland region (MOT 2020). ATAP does not include any funding consideration for AVs though a background technology report which entailed a review of AVs' potential implications, known as "Technology Report: Role of emerging technologies" (ATAP, n.d.) was used as an input to the ATAP. The report highlighted the uncertainty of the rate at which AVs will become commercially attractive, and the uncertainty around any potential government intervention to accelerate their deployment. While the report concluded by offering possible government interventions to increase AVs uptake, none of these interventions seem to have been considered, as the government allocated $34 billion of funding towards supporting private electric vehicle (EV) uptake, while no allocation of funding for AVs or their supporting infrastructure was considered.

Overall, the strategic level activities highlight how establishing an AVs transition arena requires substantial considerations for technology innovation trials, smart infrastructure investments, and cybersecurity and regulatory framework responses. It also shows how two different government leaderships have positioned themselves in terms of the vision for future AVs adoption in NZ, which is manifested in their policy direction, long-term goal setting, and investment priorities. Table 2 records key NZ policy developments in relation to AVs.

Table 2
Summary of policy development related to AVs in NZ (Source: Authors).

Policy category	Policy name	Remarks
Briefing to the Incoming Minister (BIM)	BIM 2013	No mention of AVs (MOT, 2013)
	BIM 2014	Promoted AVs and recommended making decisions on infrastructure investment (MOT, 2014)
	BIM 2017	Suggested to increase AVs uptake through funding, trials, and 'marketing' (MOT, 2017)
	BIM 2020	AVs mentioned twice regarding 'risks' and the private sector role as innovation leaders (MOT, 2020)
Transport policy – central government	Intelligent Transport Systems Technology Action Plan (2014–2018)	Dedicated a section on AVs to promote testing in NZ (MOT, 2014)
	Regulation 2025: Emerging insights	Recognised the need for additional AVs regulatory regime covering 'intelligent' aspects (MOT, 2016)
	AV Work Program	Focused on AVs uncertainties with scepticism about any benefits (MOT, 2019)
	Road to Safety Strategy 2020–2030	Focused on transitional risks to AVs (MOT, 2019)
	LTIB: The impact of AVs operating on NZ roads	Thematic focus on AVs challenges, and introduced a 'trolley problem' for the first time (MOT, 2023)
Land transport funding	Government Policy Statement (GPS) 2015	Considered future investments in new (AVs) infrastructure (MOT, 2015).
	GPS 2018	Conveyed more cautiousness in investing in AVs and technologies generally (MOT, 2018).
	GPS 2021	Limited to no focus on AVs technology (MOT, 2021).
	GPS 2024	Considered investment digital infrastructure for increased productivity in the transport system (MOT, 2024).
Infrastructure plan	National Infrastructure Plan 2015	Acknowledged AVs and referred to MOT to help deploy ITS (Treasury, 2015)
	National Infrastructure Plan 2021	Acknowledged drones but not AVs, and highlighted the need for stronger infrastructure against cybersecurity (Treasury, 2021)
Transport policy – local government	AT Technology Strategy 2016	Strongly focused on trialling new infrastructure and communication standards to enable AVs deployment (AT, 2016)
	Suburban Parking Policy	Considered AVs implications to improve parking outcomes (CCC, 2019).
Business and industry	Artificial intelligence shaping NZ future	Balanced review of AVs opportunities and challenges in NZ with future recommendations (MBIE, 2018).
	Investor's Guide to NZ Technology Sector	Highlighted NZ regional strengths as AVs testbeds to attract investors (MBIE, 2019).
	Impact of Covid-19 on NZ Business	Considered exporting Ohmio to South Korea as a significant partnership milestone (MFAT, 2020).
Cybersecurity	Cybersecurity Strategy 2019	Highlighted priority areas for cybersecurity governance though not AV-specific (DPMC, 2019)
Energy and climate change	NZ Energy Efficiency and Conservation Strategy 2017–2022	Strong action plans to increase Evs uptake but no considerations for AVs in almost all other energy strategies (MBIE, 2017)

After reviewing strategic-level activities in this section, empirical contribution was crucial to obtain further insights into tactical, operational, and reflexive activities to gain deeper understanding of the political-institutional factors influencing the transition towards AVs in NZ.

4.2. Tactical – Actors, and forming coalitions

Tactical activities refer to the negotiations between actors, and coalition development, to develop an agenda for AVs transition (e.g. governing rules, regulations). To provide insights into tactical activities, this section introduces the actors involved in the governing process for AVs in NZ. It highlights the complexity of organisational structures in governing AVs in NZ and reveals the challenges in forming coalitions between actors due to high interdependency and potential tensions between different (and within) government agencies.

The NZ Acts of Parliament (i.e., legislation) enable the government to develop regulatory rules allowing AVs certification.~~,~~ Although MOT influence the most significant pieces of legislation (Land Transport Act 1998 and Land Transport Management Act 2003) to enable AVs operation and certification, other government agencies also own relevant pieces of legislation including the Privacy Act 2020 and Accident Compensation Act 2001, which are administered by the Ministry of Justice and the Ministry of Business, Innovation & Employment (MBIE) respectively. Having different Acts of legislation owned by different government agencies means longer timeframes to certify AVs due to having different interest and priority for AVs. Amending legislation for AVs could be further complicated by the fact that (sometimes) they may also need to align with international standards. For the Privacy Act for instance, AVs data privacy regulations not only need to be regulated in line with the NZ national standards, but also need to align with international standards around data privacy such as the European Union General Data Protection Regulation if the AV was imported from that jurisdiction. Table 3 below shows the different levels and roles of government organisations involved in the AVs governing process.

For MOT, there are broadly two kinds of legislation – Acts, and delegated regulations (often called rules). The Land Transport Acts (1998 and 2003) are the primary legislation that allows the Ministry to create the delegated regulations (rules specific for AVs, such as steering wheel, sensors, brakes). These rules are largely generated by MOT along with the Crown Entity NZ Transport Agency (NZTA) and will then be processed by a smaller group of Cabinet members. Though the process of creating a new rules programme would typically involve Cabinet approval, our interview analysis shows that these rules may be created by the simple signature of the Minister of Transport, without giving much weight to Cabinet approval (Participant 2). This is because the Cabinet generally cannot find time to discuss these rules in detail and relies on Ministry personnel consulting with each other and with the public before submission to Cabinet. This factor suggests that creating a new rules program for AVs could be progressed much more quickly and simply if AVs were prioritised by MOT and NZTA. However, having MOT and NZTA agree on new set of rules for AVs, or deciding 'what level of AVs safety specification is acceptable', is challenging:

> *"In terms of [AVs] prioritisation. The Ministry has picked this, but NZTA hasn't. You know, it is not a big thing for them [NZTA], so they have not made any huge efforts. Their overall safety philosophy is not well thought through enough, and then because of that, there are also problems with who is responsible for what… and there are situations where NZTA are quite rude to the Ministry and basically ignoring them."* (Participant 9, 2021)

Participants mentioned that even within one organisation, like NZTA, it could be challenging to have the different departments agree on decisions relating to AVs regulation or investment. Our data analysis reveals potential tensions within NZTA departments (e.g., investment, road building, future transport, and NZTA senior management departments) regarding prioritising AVs regulation. In 2020/2021, the directors of the Future Transport and Public Transport departments within NZTA advocated for an Ohmio AV Shuttle by appearing on a video clip promoted on YouTube, alluding to the fact that the technology is 'here and ready' but the infrastructure and regulation were not fit-for-purpose:

> *"So the point we're trying to make is: the technology is ready but we're not. We need to understand whether we want to invest in AVs or not? Whether we want an AV shuttle part of our transport system? So, what do we need to do? Because the private sector is going: 'we're here with this technology', but the regulation is not fit-for-purpose. The infrastructure is not fit-for-purpose."* (Participant 5, 2021)

Table 3
The levels and roles of different government organisations involved in the AVs governance process (Source: Authors).

	Organisation name	Expected governance role
Central Government	Ministry of Transport	AVs policymaking, investment, legislation (Land Transport Act)
	Ministry of Business, Innovation & Employment	AVs frequency communication standards, legislation (Accident Compensation Act)
	Ministry of Justice	Legislation (Privacy Act)
	Office of Privacy Commissioner	Privacy, data, ethics
	Government Communications Security Bureau	Cybersecurity
Crown Entity	NZ Transport Agency	AVs regulation, certification, infrastructure
	Accident Compensation Corporation	Insurance, liability
	PoliceAVs enforcement on roads	
Local Government	Auckland Transport	AVs trials and funding, local roads maintenance
	Christchurch City Council	

However, NZTA is a big organisation, and it is not necessarily the case that the different departments and units – who are responsible for different aspects like road and public transport – are all interested in AVs. Participants pointed out that "NZTA hasn't decided yet what its vision is for Avs," as senior figures within the organisation have different views (and scepticism) about the benefits of AVs:

> *"There was an interest in parts of NZTA, but it's a big organisation and there are some parts which are dedicated to road building, so whether they're interested in road building [for AVs]? Some parts which are dedicated to public transport, do they have an interest in that [technology]?"* (Participant 3, 2021)
>
> *"It would be fair to say there's also some [organisational] cultural barriers. It's very hard to convince people that they should be especially interested in investing in AVs when we're working in an environment where there is a big push to move people out of the motor vehicles and into public transport and active modes."* (Participant 5, 2021)

This shows how having different organisational cultures and norms within a regulatory agency could form a barrier to a smooth transition towards AVs.

AVs are complex systems which have entangled aspects incorporating the mechanical, electrical and AI functions, which creates "big blind spots" for regulators as they need to understand how AVs systems work and operate safely (Participants 5 and 6, 2021). Due to having regulatory blind spots, the regulatory process between the government and the AVs industry is facilitated through a private sector body known as the Low Volume Vehicle Technical Association, which certifies modified vehicles (e.g. AVs). Currently, any Level 4 AVs operating in NZ would not have a legal certification but instead would be operating under a case-by-case exemption regime. The next section explores the operational activity for AVs transition in NZ.

4.3. Operational – Towards AVs experimentation and implementation

This section covers the operational activity of the transition towards AVs. Operational activities refer to the mobilisation of actors to execute experiments and trials of AVs. These are generally high-risk activities and are often introduced by ambitious frontrunners.

This section highlights the political nature of the experimentation of AVs trials in NZ through the different government leaderships. The centre-right National-led government was in power during the 2011–2017 period whereas the centre-left Labour-led government came into power during 2017–2023. The National-led government focused on economic prosperity, and perceived AVs as a great opportunity to attract economic and employment benefits. On the other hand, the Labour-led government focused on improving safety and social outcomes as well as reducing carbon emissions, and tended to deprioritise AVs and perceived them as a 'risky' technology. This briefly highlights how the different political parties' ideologies may influence the prioritisation of AVs adoption in NZ.

Period 1: Realising the potential for AVs (2011–2017)

In this period, the National-led government began to realise the potential for AVs not only in relation to improved road safety but were also driven by a series of broader economic underlying goals such as attracting investors to test AVs, building knowledge and capability, and creating jobs in NZ, which led MOT to re-structure its departments to establish a new 'Technology Team' dedicated to AVs (Participant 4, 2021). The government's operational activities initially considered the Christchurch earthquake area as a safe and suitable testing zone for AVs to attract international AVs investors, which was something that was not offered anywhere else in the world at the time (Participant 3, 2021). Representatives from MOT visited some AVs testing centres in California to explore their testing setup and discuss how NZ could provide a better testbed for AVs. Christchurch roads could provide a much more interesting technical challenge for AVs compared with California's big empty roads. This led to attracting a number of world-leading AVs companies to test in NZ including Google.

> *"We got quite serious in these conversations, Ministers were involved, and by the time we signed – while we would have been in a position to do it – Google had completely changed its position on automation and they again had a re-structuring, so it didn't happen. But it wasn't fantasy, we were very much in conversation with them about operating."* (Participant 4, 2021)

This was a time where the Minister of Transport led a semi-AV trial and called the Ministry to understand how to regulate AVs. This involved a secondment of foreign expertise to MOT to lead its 'Future Work Programme' in 2014. It also influenced strategic level activities and witnessed the development of several technology and regulatory policies for central and local government, including the 'ITS Technology Action Plan' and 'Regulation 2025′ in 2014 and 2016 respectively. Although Ministers, high-ranking party officials, and leaders of the parliamentary opposition are often presented as the key actors in the operational activities, the political reality is far more complicated. There are 'frontrunners' who engage in this process in the background. MOT CEOs and their senior leadership team are common and powerful 'behind the scenes' actors who select and decide what information or ideas are presented to the Minister. This role enables them to voice their own opinions and beliefs, which could have a significant influence on the Minister's views and decisions, and in some cases 'steer' the Minister into prioritising AVs:

"In my experience, it is not typically the politicians who could come with the grand vision or idea, because they are not typically experts in their field, they are politicians …I ultimately charged one of my senior managers with picking this up [AVs] and then convinced the Minister of Transport that we should actually turn our minds to what we could do, because I could see how we could all benefit from just embracing emerging technologies and innovations around the world … so, a strong focus came from me around 2011–12." (Participant 2, 2021).

This statement illustrates the powerful and significant role frontrunners have in influencing the transition process towards AVs in NZ. The next period (2017–2023) highlights how the Ministry changed its position on AVs regulation and shows a different operational activity stance between the two governments.

Period 2: The disengagement stage (2017–2023).

In this period, the Ministry underwent another re-structuring, terminating the Technology Team department which impacted on not only the strategic level activities but also the operational. Generally, the government's AVs policy work remained quiet during this stage. The Ministry released an AV Work Program and further consultation documents in late 2019 and 2021 respectively. These documents portray the government's position as a 'technology taker', highlighting its intention to put AVs operation on hold:

> *"There are no specific policies currently under development for the deployment and operation of land autonomous vehicles in NZ … NZ is taking a 'wait-and-watch' approach to regulation."* (MoT, 2021, p. 17)

However, participants challenged the current government's position as technology taker, given that Ohmio is a local AVs developer. The government's change in prioritising AVs not only reflected their policy documents but also their engagement with the AVs industry when conducting public experimentation in NZ:

> *"The trial in Christchurch was set up as a joint venture with Christchurch Airport, the University of Canterbury, and with theoretically MOT and NZTA to test AVs technology. But actually, at the time we were setting that up and as it went through, they were totally disengaged from us … I have seen very little evidence of the Ministry or the government actually being prepared to take risks."* (Participant 2, 2021)

This quote shows how the National-led government is going through a disengagement period with AVs experimentation, compared with the previous government. To help explain the change in prioritising AVs experimentation, findings show that in implementation contexts, politicians tend to avoid any controversies arising from the potential malfunctioning of AVs or their involvement in road traffic accidents as the public could become sensitive to such incidents. These potential risks associated with AVs operation hinder current government support for AVs experimentation in NZ according to participants. However, though AVs are associated with risk, several participants referred to the million annual deaths from traffic crashes globally and stated that society has accepted that the benefit of driving outweighs the risk of crashing, arguing that we are already at risk when driving conventional cars even without having AVs on roads. The interview analysis suggests that government would need to understand how the risk of AVs can be mitigated, and then decide what is an acceptable permittable level of risk just as it does now when it is planning the transport system. For instance, risk could be initially managed by allowing only certain AVs use cases (e.g., low-speed shuttles), or operating at certain times (e.g.: 11 pm-4am) and in confined environments.

Overcoming operational challenges was seen by some participants as requiring the intervention of a 'driven figurehead' (i.e., frontrunners). One of the impacts of driven senior officials and their teams within MOT could be firstly to demonstrate to Ministers what is possible, to present their ideas, to have some strategic view about what the opportunities are for improving the transport and regulatory settings for AVs, and then to work closely with politicians to create a set of conditions or an approach to implementing policy or regulatory change that is politically safe and to ultimately social change in terms of AV's exposure and future transition. This, again, highlights the powerful role frontrunners could play in influencing NZ Ministers, generating political will, and informally participating in the wider transition process around AVs operation in the future.

Overall, Section 4.3 explored the governance periods for AVs operational activity in NZ and highlighted how it is influenced by the people, politics, and government priorities of the day. The next section explores the reflexive and final activity for the transition process towards AVs adoption in NZ.

4.4. Reflexive – Evaluating and monitoring AVs transition

Reflexive activities involve assessing, evaluating, and monitoring the actions from the previous transition cycles. Since AVs have not been legally implemented in NZ yet, we identified the factors that are important for evaluating and monitoring AVs policy to enable their safer transition and deployment in the future. This includes regulatory and resource factors.

(a) Regulatory

Regulatory assessment for AVs requires evaluation for vehicle certification, cybersecurity, and the supporting infrastructure. In NZ, the majority of transport-related regulatory rules typically target human drivers (e.g. wearing seatbelts), whereas AVs may be notionally 'driverless', which then requires reconfiguring current regulatory frameworks to reflect this emerging reality. The inclusion of various 'Advanced Driver-Assistance Systems' in AVs presents further challenges to regulators, due to their novelty and evolving sophistication, as in how to certify AVs.

Cybersecurity is a crucial part of the regulatory process for AVs. However, it is currently considered a grey area as to how NZTA could approve or even undertake a risk assessment process for AVs. This is illustrated in the example of trialling the Ohmio shuttle as it was left to the manufacturers to ensure that their vehicle was safe enough without any actual testing by NZTA:

> *"To be able to actually run the trial, we need to do a risk assessment as to what kind of those risks were, and then NZTA at the time approved that risk management plan. But they hadn't actually done any testing of the vehicle to see if the brakes worked or not. They were really relying on Ohmio to actually be confident that they would [work safely], and they did."* (Participant 6, 2021)

This highlights the necessity for regulators to develop a framework to assess technology, cybersecurity (and overall safety) in times of peak technology disruption and uncertainty. Though participants acknowledged that NZ government is lagging behind in terms of cybersecurity standards in the AVs space, one noted that "we need to raise the bar from a regulatory perspective, but I don't think there's any kind of plan to do that at the moment" (Participant 6, 2021). This shows that cybersecurity issues could be dealt with if perhaps there was a vision or policy to drive that regulatory aspect for AVs.

Having adequate infrastructure, both physical and digital, is crucial to facilitate automated driving throughout NZ. However,

participants stated that the infrastructure is not fit-for-purpose. Participants noted that AVs require specific road painting, road signs and sensors under the road, but emphasized that highways and local roads are not always repainted after construction and roadworks, which may 'confuse' AVs if not repainted properly (Participant 5, 2021). Some NZ roads, such as in the capital Wellington, are narrow in nature, which presents further challenges to AVs operation. In the absence of designated lanes exclusively for AVs, operating automated shuttles on narrow, low-speed roads may worsen the existing traffic congestion problem. Though AVs may require significant infrastructure adjustments to the design and implementation of geo-fenced lanes for AVs, little attention has been given to this so far:

> *"If we will look to geo-fence AVs in the future, you'd have to have physical infrastructure and other systems in place … and that's the role NZTA has in terms of planning for that for the future. There's some thought I know, but not too much action to date."* (Participant 6, 2021)

The absence of an integrated digital infrastructure was considered one of the "biggest impediments" to an efficient deployment of AVs according to participants. From a regulatory perspective, the challenge remains to fully understand what the data requirements for AVs are, and how they can best be governed from security and privacy standpoints (Participant 5, 2021). The provision of digital infrastructure could be further delayed until NZ government agencies decide on universally accepted frequency communication standards for AVs, and whether there will be any allocation of government funds for that development, which could be another factor hindering a transition towards AVs.

(b) Resources

This section covers resources evaluation that may enable or hinder AVs transition including investment allocation and capability sufficiency. The policy review in Section 4.1 shows that AVs were given very little to no consideration in the government's investment policy (GPS), though our interview analysis shows that the Ministry was advised to dedicate funding for AVs experimentation in the GPS policy by senior officials in the past:

> *"The government was advised to establish an activity class for trials and demonstrations with technology and other innovations. And the basic thing was that if we put in $50 million a year into a four-billion-dollar fund, over 10 years, that would give us half a billion dollars to invest in trials, demonstrations, or initiatives which is about actually being aggressively pushing things and giving people exposure, but none of that happened."* (Participant 3, 2021)

Despite this, allocating funds for AVs projects and trials was disputed because of the existing demand on current transport infrastructure projects. AVs investment was also complicated by the change of government leadership and political cycles, which could have led to an inevitable short-term focus, as new governments may prioritise different areas of transport infrastructure investment for the next 10 years (through the GPS).

While it is possible for the private sector to lead AVs investments, this has been hindered due to the absence of any regulatory and policy direction for AVs deployment in NZ. Participants doubted that private companies would want to make significant investments in AVs until they understand what the government decides to do around agreed communication standards, arguing that "if there was a government policy to move towards that then there'll be a lot more Investment In that area" (Participant 7, 2021). Another justification for not seeing much private sector investment relates to the lack of both certainty and integrated long-term planning for the deployment of AVs as well as skill challenges at regulatory level:

> *"The industry has not made significant investment in technological innovation because the government as a major customer does not really demand it, and there has been a lack of certainty about a long-term pipeline of work in addition to serious skills and labour shortages."* (Treasury, 2022, p. 142)

Participants commented that the government role in investing in AVs infrastructure is yet to be decided as the technology still needs to mature further to prove that AVs are safe enough, which delays infrastructure and investment policy development. Traditionally, the decision-making criteria for funding transport infrastructure rely largely on cost-benefit analysis (CBA), which could be problematic in the context of AVs as they have not been widely deployed and their 'benefits' are yet to be realised:

> *"It's very hard for an organization like NZTA that's responsible for investing billions of dollars in roading infrastructure and public transport subsidization and all of those kinds of things to make a significant investment in AVs before knowing whether we're going to get any real benefits."* (Participant 5, 2021)

Resource challenges extend beyond funding complexities and involve capability shortages to evaluate whether technology will be sufficiently robust, as well as allocating enough teams and resources to work on AVs. Participants highlighted the need for regulators to have the capability to make assessment of AVs and AI:

> *"Well, how do you check the security of this vehicle? That it will be able to consistently work? And it's not just the AI, it's also the sensing technology and the server technology. That's the big barrier, I think, the capability to make the assessment."* (Participant 3, 2021)

The expertise and capacity to evaluate the security needs of AVs stretch beyond the phases of regulatory and certification approval. Constant surveillance is needed to ensure AVs' safe operation on public roads, a responsibility in which the NZ Police plays a crucial part. However, participants stated that NZ Police currently lack a dedicated 'cybersecurity unit' to consistently monitor, detect or prevent security breaches such as cyberattacks affecting vehicles, drivers, passengers, and their surrounding environment.

5. Discussion

This paper explored how political-institutional factors may influence AVs transition in NZ, drawing on the mobilities paradigm. A summary of key findings is shown in Fig. 2 below and further discussed in this section. Though discussed in four dimensions, it is imperative to note there is a degree of interconnectedness between these dimensions as they do not operate in isolation.

5.1. Strategic – Discourses, perceptions, storylines

Strategic activities aim at establishing the transition arena through vision development and policy formulation to affect change for AVs transition. Policy discourse analysis is used here to analyse AVs-related policy documents released by central government as well as speeches delivered by government officials to help understand the messages conveyed to the public and the position of central government during 2011–2023 on AVs transition arena establishment. The findings highlight how different government discourses shape the direction of policy, and public opinion, around AVs transition in NZ.

First, AVs were promoted by the National-led government (2011–2017) using *paradigm shift* and *economic prosperity* storylines such as improved safety, lower emissions, and business development, which was also reflected in the speeches of government representatives (Beehive, 2015). These storylines led to the development of several policy documents (see Fig. 3) and tended to be more open towards enabling business innovation, arguing that enacting regulation before the technology is deployed is a 'cautious approach' that may hamper innovation. Policy documents suggested ways to 'overcome' transition challenges towards AVs and did not put any additional regulatory expectations on AVs operators so as to support their development. The strategic level activities clearly correlated with, and influenced, operational level activities as the focus of ITS Technology Action Plan on AVs paved the way to the first Christchurch trial of autonomous shuttles in 2016 (Beehive, 2016). These examples show how the National-led government had a desire for technology innovation, which was reflected in their *paradigm shift* storylines.

By contrast, under the current Labour-led government (2017 and onwards), it is clear that AVs have been less prioritised in their policy documents as MOT have adopted a *technology taker* stance, despite having a local AVs developer (Ohmio). Through their policy documents, the current government promotes *technology risks and uncertainty* storylines, which conveys discouraging meanings to the public and businesses to adopt AVs, by using phrases such as AVs may "struggle to co-exist" with conventional vehicles, "perform in a manner that is not in the public interest" and "used as a weapon by terrorists organisations" (MOT 2019a, p. 15). These examples of storylines show the current focus of government on 'presenting' challenges to AVs transition and influencing public perception. This also demonstrates the opposite stances between how the current and previous governments envisioned, perceived and (de)prioritised AVs. Situating our findings in a global context, policy discourses of 'accelerate' and 'uncertainty' were used to influence electric and AVs uptake in various US states (McAslan et al., 2021; Reese, 2016) whereas 'automation race' discourses in the UK led to establishing a Centre on Connected and Autonomous Vehicles (CCAV) to remain leaders in AVs development and future transition (Hopkins & Schwanen, 2018).

Second, our document analysis displays how different NZ governments' perceptions of AVs technology shapes much of their thinking around AVs transition establishment. For instance, '*paradigm shift*' storylines led to greater focus on AVs development through generating more policy work at strategic level, but also at operational level by making connections with AVs testing centres abroad to potentially attract investors to NZ. By contrast, the current Ministry adopts a 'wait-and-watch' stance to AVs policymaking. The Ministry justified this change by arguing that the AVs discourse in NZ was initially driven by a global hype on technology, rather than providing actual benefits to the transportation system. Another reason for not developing AVs policy any further relates to the government's contemporary policy priority focus on climate change, by setting ambitious goals for EVs uptake, which could in some ways

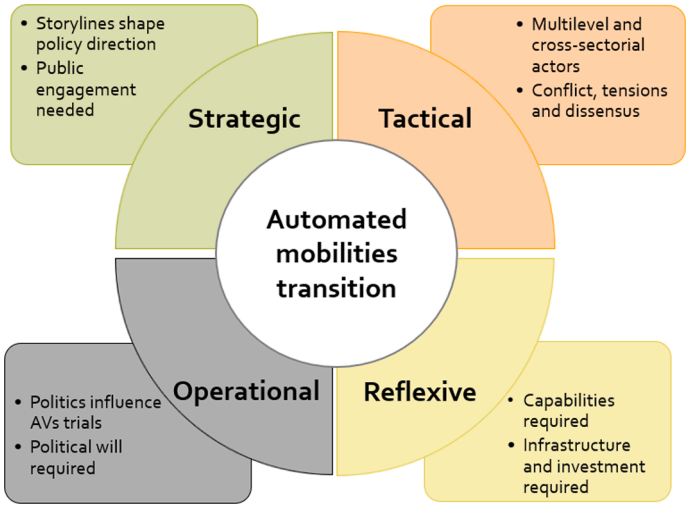


Fig. 2. Summary of key findings.

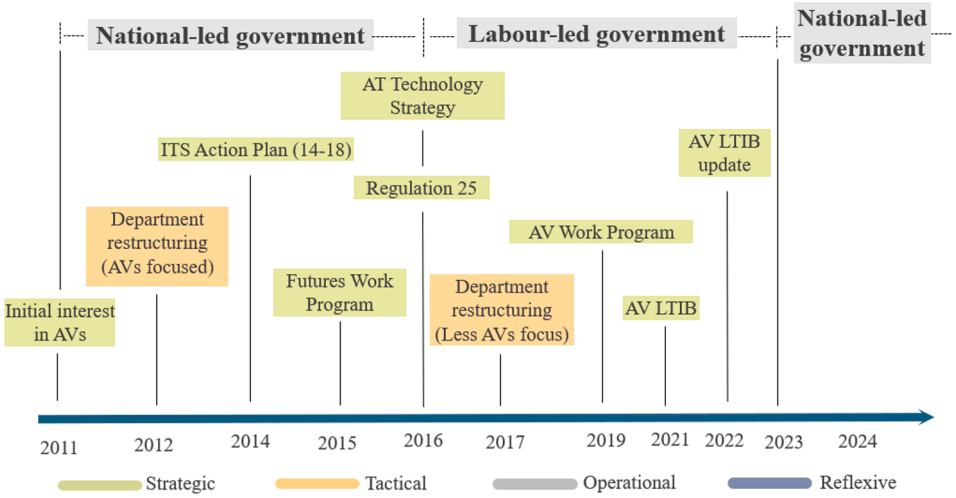


Fig. 3. AVs governance in NZ with key milestones (Source: Authors).

still promote private car ownership, rather than considering a mobility paradigm shift potentially incorporating AVs (e.g. Ohmio) to address some of the transport (first-last mile) challenges. A third reason for disengaging in AVs policymaking is government's notion of 'technology taker', which fundamentally relies on following the development of AVs policy and legislation in other jurisdictions, namely Australia, the United Kingdom, and the European Union. However, this approach may substantially delay AVs strategic planning in NZ, as the majority of the world has yet to establish a clear policy and regulatory framework for AVs, which could also lead to the creation of policy gaps.

In the past, NZ governments who lacked the appetite, strategic leadership or foresight to proactively introduce appropriate policy and legislative change were left in the position of spectators, standing by while the judiciary busily shaped an *ad hoc* policy direction solely through the progression of case law (Memon, 2002). However, in the case of AVs, this could be further problematic, as jurists and Courts may not necessarily have the technical expertise in AVs systems to adequately apportion the liability of AVs crashes, for example (Marchant & Bazzi, 2020). The potential outcome is policy gaps or an institutional 'void', particularly when industry innovation outpaces the government's policy response to such technological challenges. This suggests the need to shift away from the conventional policymaking approach of 'predict and provide', to 'decide and provide' (Lyons & Davidson, 2016), implying that planning for AVs may not necessarily be an issue of predicting the future, but rather more actively and deliberately harnessing and shaping it. This discussion aligns well with some participants' views that "the future is unknown to some extent, but we can actually set our future by making decisions, we can actually determine the direction" (Participant 5, 2021). Overall, the discussion highlights the 'disruption' that AVs technology could have on policymaking, suggesting the need for a radical evolution in traditional policy and governance thinking to effectively respond to such disruptions in the near future.

Third, the content analysis also shows how AVs transition in the context of NZ has been mainly centralised, derived from a top-down approach. However, there is a need for more serious and meaningful forms of public engagement in relation to AVs, where the public have an opportunity to actively participate in this process. Though MOT sought public consultation on AVs in 2021, the extent to which the public were given a say to determine the future of AVs has been limited, because the consultation documents portrayed *technology risks and uncertainty* storylines reflecting government's priorities could have played a role in influencing public opinion on AVs implications. A more inclusive approach is therefore needed in the governance process, echoing a few studies in the literature (Hopkins & Schwanen, 2018; Mehmood & Imran, 2021; McAslan et al., 2021). Arguably though, it is these priorities, perceptions and 'mindset' of government that could present a barrier towards developing an AVs policy and establishing AVs transition in NZ. These perceptions have a direct impact on how the government views the future of transportation system, but also the 'role' it plays in shaping that transition towards AVs in the future.

5.2. *Tactical – Disagreement, conflict, dissensus*

Tactical activities refer to the negotiation and coalition development among actors to develop an agenda for AVs transition (e.g. (governance) rules, regulations). Our findings highlight the complexity of forming coalitions among actors and show how tactical activities in NZ are mainly characterised by disagreement, conflict, and dissensus.

First, AVs transition is an issue of multi-sectorial governance (Hopkins & Schwanen, 2018; Oldbury & Isaksson, 2021). Similarly, our findings provide empirical insights into the complexity of governing AVs in NZ because of the ingrained interdependence and involvement of a wide array of government agencies at central and local levels (e.g. MOT, NZTA, MBIE, Office of the Privacy Commissioner, city councils). Our findings confirm that complex (automated mobility) systems are interdependent, 'nested', and involve multiple domains and scales where each of these (sub)systems has its own dynamics (Urry, 2004; Loorbach, 2010; Büscher et al., 2016). The high level of interdependencies between different NZ government departments may hamper AVs deployment and

future transition, as participants reported significant delays in trailling new communication frequency standards for AVs, as local authorities in Auckland had to obtain a licence clearance approval from MBIE central government (Participant 7, 2021). Globally, similar challenges were reported where the self-drive legislation for AVs passed the US House of Representatives but failed to pass the Senate due to complexities embedded in multi-level governance environments (Latta, 2022).

Second, AVs governance could be further complicated due to complex organisational structures, disagreement, and conflicting priorities between actors in the developed world (e.g. the UK) (Hopkins & Schwanen, 2018; Marsden et al., 2014), whereas issues related to lack of trust as well as lack of important data-sharing between government departments tend to be more apparent in the developing world (Flores & Crompvoets, 2021). In line with the literature, our findings provide clearer examples of how AVs transition in NZ could be stifled due to the possibility of having different institutional norms and conflicting priorities among the responsible organisations. MOT and NZTA are the two most powerful organisations in relation to AVs governance. However, we identified some challenges in the collaboration process for creating a rules program for AVs (regulation). This is due to the presence of differing visions and priorities for AVs, along with contested safety philosophies across these organisations. On some occasions, it is possible for NZTA to ignore (policy directions from) MOT according to participants. We provided further evidence that even within one regulatory organisation such as NZTA, different departments do have different cultures and views on AVs implications and benefits, but it is the higher-level management that controls the organisation's vision for the future of AVs (Participants 5 and 9, 2021). These examples show how having overlapping responsibilities coupled with contested visions among government organisations may create tensions and disputes which may hamper AVs regulation and transition. Clearer and more aggressive examples of dispute were reported between NZTA and Gisborne District Council (Tairāwhiti Roads) which resulted in the dissolution of their partnership in 2019. The main challenge faced was the complex organisational norms and processes present in NZTA and the District Council. The Director of Regional Relationships stated that the efforts of Tairāwhiti Roads staff have been substantial in trying to maintain the partnership, but admitted that, *inter alia,* "the challenges presented by both organisations retaining their own sets of policies, systems and processes were difficult to overcome" (NZTA, 2019, p. 1). In the context of AVs, having fragmented authorities responsible for AVs infrastructure provision, for instance (e.g. highways vs local roads), could have implications on where AVs could drive, and may lead to user accessibility inequity. We argue if these tensions are already occurring in the context of basic road-building (which have been built over the past 80–100 years), then AVs as a disruptive technology could be expected to generate a far more complex array of tensions as AVs may require "a complex policy mix involving new technologies, reformed [organisational] structures and new forms of behaviour" (Marsden et al., 2014, p. 618). Such findings begin to contribute towards understanding the 'messy' realities of governing AVs, by showing how complex automated mobility systems are 'open' (i.e. interact, and have feedback loops, with their surrounding environment) and entangled (Urry, 2004; Loorbach, 2010; Büscher et al., 2016).

5.3. Operational – Frontrunners, politics, priorities

Operational activities refer to the mobilising of actors to execute experiments and trials of AVs. These activities generally carry a high risk and are often initiated by ambitious frontrunners. Our findings highlight how operation activities are influenced by frontrunners, politics, and the priorities of different NZ governments.

First, political government cycles influence operational activity direction and priority settings (Imran & Pearce, 2015; Tan & Taeihagh, 2021; Murphy 2022). Consistent with the literature, we found the direction of operational activities for AVs has been influenced by different NZ governments cycles depending on their political philosophies and priorities. Our findings contribute to the literature by identifying influential individual frontrunners who can influence transition direction and engagement with AVs experimentation. Although Ministers and politicians are often presented as formal actors who engage in the operational activity for AVs, frontrunners (MOT CEOs and their senior leadership team) are common and powerful 'behind the scenes' actors who may influence Ministers' views and decisions into prioritising AVs. This involvement resulted in the then Minister of Transport, Simon Bridges, during his term 2014–2017, to prioritise AVs and push legislative changes accordingly. Participants described how varying CEO leadership could play a role in influencing AVs transition direction as "it depends so much on CEOs and the personalities involved" and "it always becomes below political party representations, and you start to get politics down the operational side of transport regulation" (Participant 9, 2021).

However, the extent to which the Minister could be influenced to accept advice regarding prioritising AVs would also depend largely on the agenda of the political party currently in power, which helps explain how AVs were deprioritised during 2017–22 when the Labour government first came into power. Participants explained that new governments in NZ often have a big agenda to implement, and thus would not be interested in hearing the ideas of the Ministry. On many occasions, the newly elected government wants the Ministry to show it how to implement its own ideas and "sometimes they just want the Ministry to confirm to make the policy changes and they do not want to hear any advice on it" (Participant 3, 2021), impacting operational activity priorities. Our findings show how operational activities are clearly centralised and mainly influenced by Ministers. This is in contrast to Tomor et al.'s (2021) findings that local authorities and Mayors have 'strong' powers to influence decisions and shape smart governance initiatives, in Curitiba (Brazil) and Glascow (Scotland). This has implications for the NZ context to allocate more powers to local authorities (e.g. Christchurch, Auckland) to determine their future with AVs transition.

Second, several case studies (Singapore, Scotland, The Netherlands, and Brazil) underscore how political leadership is a significant factor in facilitating the operational activity and transition towards AVs (Tan & Taeihagh, 2021; Tomor et al., 2021; Cugurullo et al., 2021). Generally, generating political will for AVs in NZ depends on the support of politicians, businesses, and society. Currently, businesses in NZ are pushing for AVs but with little political support as politicians do not see clear benefits from AVs and need to become confident that they have sufficient social support to make a transition towards AVs. However, historically, it is politicians who

affect social change to gradually gain social support for smart initiatives, which reflects the view of some participants regarding the role of both government and politicians in influencing social support for AVs initiatives. Our findings show that the National-led government (2011–2017) took a political leadership role and tried to push for a gradual change around AV's public exposure, and MOT's leadership considered carefully how to give advice to the government and Ministers to make it politically viable for them to go ahead with (legislative and social) change. By contrast, the Labour-led government (2017–2023) appeared to lack that vision of political leadership in the AVs space, which was considered a stronger barrier to AVs transition compared with the regulatory challenges. Participants considered there to be a lack of political leadership on both ministry and political levels, describing the current operational activity for AVs as being 'cautious and conservative'. Generally, affecting long-term change may be challenging for governments knowing that they have limited time in power and would ordinarily be engaged in a constant striving to be re-elected. This nature of democracy and elections often makes governments 'stuck' in a much narrower short-term paradigm, and thus supporting AV-related initiatives that could take 10–15 years to implement often do not have a political milage attached to them.

Overall, while NZ Ministers and politicians represent the official side of operational activities, we identified frontrunners (CEOs and their leadership team within MOT) who could influence Ministers' views and decisions to operationalise AVs implementation. Such actors were found to play a significant role in navigating the political processes, affecting legislative and social change, and paving the way towards AVs transition. Those findings begin to contribute to the transport policy literature by revealing the informal dynamics of influence, steering capacity, and how certain actors hold sway over a transport system (Marsden & Reardon, 2017).

5.4. *Reflexive – Resources, investments, uncertainty*

Reflexive activities involve assessing, evaluating and monitoring the actions from the previous transition cycles. The focus is on resource and regulatory factors, since AVs have not been legally implemented in NZ yet.

First, AVs transition may require significant infrastructure adjustments and investments. Literature shows that constraints on public funding often cause governments to turn to public–private partnerships for investment (Searle & Legacy, 2021; Clements et al., 2022). However, we found that the private sector has refrained from making investments in AVs in NZ due to lack of a government regulatory framework around AVs communication frequency standards and crash liability. This is because the industries being held liable for AVs crashes could undermine their reputation and profits. Not reported in previous studies, our findings reveal NZ-specific circumstances that could constrain investment in AVs infrastructure, including having a small domestic vehicle market with no car manufacturing industry, little R&D focus on AVs, and low population density rendering infrastructure investment for AVs outside main cities not cost-effective.

Generally, NZ central government invests significantly in building more roads than in digital infrastructure, due to the notion that digital infrastructure is short-lived and requires constant upgrading and replacing to stay relevant. Though our interview analysis shows that the government was advised by senior officials to establish an investment activity class for AVs, it was turned down with the justification of having significant demand on the transportation system already, which partly limits government funding for AVs in NZ. However, participants stated if AV shuttles were viewed to serve a similar purpose to light rail (i.e. as a shared mobility model instead of private car model), this could lead to much more public investment in this area. This is because the NZ government's investment criteria depend largely on traditional CBA tools, which currently do not prove to offer considerable benefits for privately owned AVs compared to a shared mobility shuttle model. However, in Stockholm for instance, AV shuttles received government funding and appealed to the creation of 'new possibilities' for the development of public transport (Oldbury & Isaksson, 2021). CBA adopted by the NZ MOT, we argue, is an inadequate tool for assessing AVs impacts. CBA traditionally relies on travel time savings but has been criticised for rarely incorporating environmental and social values (e.g. accessibility) which are often hard to assign a monetary value to (Legacy et al., 2017). AVs could disrupt and further problematise CBA tools since AVs could arguably reconfigure travel time savings by the relocation and retiming of sites of practice (Shammut et al., 2023) which may increase the CBA ratio, while on the other hand AVs social benefits such as increased accessibility cannot be monetised in CBA. This could result in imbalances and inconstancies in CBA ratio. This briefly highlights how AVs transition could require a reformation for current government's investment decision-making tools and criteria.

Internationally, the industry plays a significant role in influencing governance transition for AVs in terms of investment and regulation (Collier et al., 2018; Baumann et al., 2019). In the US for instance, Collier et al. (2018) describes how Uber exercising their power through threats to disinvest and leave the market has been effective in overturning regulations in many US states. In contrast to cited literature, our findings suggest there exists little influence of the local industry to lobby government decisions on AVs investment and regulation, mainly because the AVs market in NZ is still emerging and has yet to establish political and financial influence. In the context of NZ, the greatest influence on AVs transition lies within the central government agencies, particularly MOT (along with NZTA) as the leading government advisors on policy direction and legislative change that would enable the regulation and transition of AVs in the future.

Regulators' capability shortages globally may hinder AVs transition (as reported in Australian, US, and UK case studies) (Curtis et al., 2019; McAslan et al., 2021; Sindi & Woodman, 2021). Similar findings were reported in our study, as regulators were unable to certify and assess the safety of AVs due to having knowledge gaps with regards to the technicality of AVs system as well as the market regulatory environment. However, our findings show that building regulator capability can be achieved through continuous and effective collaboration with AVs manufacturers and operators so as to enhance the understanding of how AVs technology operates. This is something that the previous National-led NZ government had done when senior officials from MOT visited AVs manufacturers and testing centers in the US (2011–2017). Doing so in the future would be helpful to fill the knowledge gaps regarding understanding the AVs regulatory requirements, attracting investors, and paving the way for a safer AVs transition in NZ and beyond.

6. Conclusions

Using the mobilities paradigm, this paper aimed to explore how political-institutional factors may influence AVs transition in NZ. The findings broadly highlight the complexity of governing AVs transition in NZ and suggest that a successful transition will require experimentation and social participation, and involve learnings from users, providers and governments within and across the network. This, nevertheless, will require a reflexive governance environment in which the government and those experiencing technological innovation continue to actively (re)shape the automated mobility system they need whilst minimising the associated risks throughout the transition process. In terms of implications for practice, strong political leadership is needed to act as a catalyst and driver of change in the four governance cycles, with the following features:

- **Strategic:** Initiate policy objectives that are not necessarily 'about transportation', such as a meaningful civic engagement as well as allocating more decision-making powers to local authorities and regulatory agencies (e.g., NZTA) to open a window of opportunity to 'decide and create' the future of AVs in NZ. A combined approach of 'disruptive' and incremental strategic policies will help challenge the status quo of a 'wait-and-watch' approach.
- **Tactical:** Navigate the organisational complexity through establishing a unified body to govern AVs by bringing together representatives from the various government organisations. This could help achieve integrated and cross-sectoral governance of AVs transition.
- **Operational:** Engage 'risk-taking' frontrunners to catalyse AVs transition, identify appropriate timing to generate political will to affect legislative and social change, reduce uncertainty through trials and experimentations, and overcome obstacles related to strategic, tactical and reflexive activities.
- **Reflective:** Invest in 'evolving regulation' through becoming involved in international dialogue on regulation. This approach can achieve better understanding of the global AVs market environment as well as alleviating regulators' capability shortage and attracting investors to enable effective infrastructure development and AVs transition in the future.

In terms of broader implications for urban planning and governance, planners need to recognise how AVs are disrupting traditional investment and decision-making tools, regulatory processes, and how that may lead in turn to the creation of policy gaps. Therefore, conventional ways of policy thinking and planning may need to evolve in such a way that could respond more rapidly and with greater agility to AVs deployment. Another implication that may better position planners for decision-making on AVs transition is to consider engaging with 'frontrunners' as they are the ones who often bring visions, influence Ministers' decisions, and generate political will, so as to steer the direction of AVs policy in a more optimal direction.

Overall, the contribution of this paper is threefold. First, we contribute towards the mobilities paradigm by extending its boundaries to the 'political-institutional' dimension, which has received scarce attention in the mobilities studies. Second, our findings make a unique contribution to the transport governance literature by enriching the understanding of the highly complex and contentious governance landscape surrounding AVs transition. Third, this paper offers a crucial reference to guide decision-makers to identify the areas of influence (i.e. who can affect change, and in which cycle) to facilitate a successful transition towards AVs in the future.

Lastly, this paper stimulates debate on the significant role of political-institutional factors in shaping AVs transitions. Future research may extend this work and focus on the 'reconfiguration' of planning and institutional processes. The scope of such research should examine how to achieve integrated and cross-sectoral governance of AVs within the contexts of fragmented responsibilities among multiple government actors whilst also considering the role of citizen participation in shaping automated mobilities systems. How, and under what conditions, political actors are able to trigger change to overcome the complexity associated with AVs transition could also inspire further research. Continued scholarship along these lines will be critical to establishing a wider and deeper appreciation of the factors influencing the transition of AVs towards desirable outcomes in NZ and beyond.

CRediT authorship contribution statement

Moayad Shammut: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Muhammad Imran:** Writing – review & editing, Validation, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Part of the preliminary findings of this paper was presented in the World Conference on Transportation Research (WCTR), Montréal, Québec, Canada, 17–21 Jul 2023, and the State of Australasian Cities Conference (SOAC), Melbourne, Australia, 1–3 Dec 2021, and partially disseminated in the Transportation Group Roundabout Magazine. We extend our appreciation to all the interviewees for participating in our study. Thanks to the anonymous reviewers, particularly the third reviewer for their constructive comments on an initial draft of this paper. We also thank Engineering New Zealand Transportation Group for assisting with funding this study through the 2021 Tertiary Study Grant.

Appendix A. Glossary of key terms and agencies

Term	Description
AA	NZ-based Automobile Association
AVeSec	Aviation Security Service
AI	Artificial Intelligence
Aotearoa	Indigenous name for New Zealand.
AT	Auckland Transport
ATAP	Auckland Transport Alignment Project
AVs	Automated Vehicles
CBA	Cost-Benefit Analysis
CEO	Chief executive officer
DPMC	Department of Prime Minister Cabinet
EFTPOS	Electronic Funds Transfer at Point Of Sale
EVs	Electric Vehicles
GPS	Government Policy Statement
GCDS	Government Chief Data Steward
ITS	Intelligent Transport System
LVVTA	Low Volume Vehicle Technical Association
MBIE	Ministry of Business, Innovation & Employment
MoH	Ministry of Health
MfE	Ministry for Environment
HUD	Ministry of Housing and Urban Development
MFAT	Ministry of Foreign Affairs and Trade
MOT	Ministry Of Transport
NSG	National Security Group
NZISM	NZ Information Security Manual
NZTA	NZ Transport Agency
Ohmio	NZ-based electric and autonomous shuttle company
OPC	Office of the Privacy Commissioner
PCO	Parliamentary Counsel Office
Tairāwhiti Roads	New collaboration that manages roading assets of the NZTA and Gisborne District Council
Trafinz	Local Authority Traffic Institute

References

Adey, P., 2017. Mobility. Taylor & Francis.

Aldred, R., Watson, T., Lovelace, R., Woodcock, J., 2019. Barriers to investing in cycling: Stakeholder views from England. Transp. Res. A Policy Pract. 128, 149–159. https://doi.org/10.1016/j.tra.2017.11.003.

Aoyama, Y., Alvarez Leon, L.F., 2021. Urban governance and autonomous vehicles. Cities 119, 103410. https://doi.org/10.1016/j.cities.2021.103410.

Beehive. (2015). *Simon Bridges Speech: Opportunities to cut NZ's road transport emissions*. The Beehive. http://www.beehive.govt.nz/speech/opportunities-cut-nz%E2%80%99s-road-transport-emissions.

Beehive. (2016). *Simon Speech: Driverless shuttle to be trialled in New Zealand.* Beehive. https://www.beehive.govt.nz/release/driverless-shuttle-be-trialled-new-zealand.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Büscher, M., Coulton, P., Efstratiou, C., Gellersen, H., & Hemment, D. (2016). Connected, Computed, Collective: Smart Mobilities. In *Mobilities: New Perspectives on Transport and Society* (pp. 157–180). Routledge. https://doi.org/10.4324/9781315595733-12.

Cardullo, P., Kitchin, R., 2019. Smart urbanism and smart citizenship: The neoliberal logic of 'citizen-focused'smart cities in Europe. Environment and Planning c: Politics and Space 37 (5), 813–830.

Christchurch Airport. (2019). *First New Zealand autonomous shuttle debuts at Christchurch Airport.* Christchurch Airport. https://www.christchurchairport.co.nz/about-us/who-we-are/media/2019/first-new-zealand-autonomous-shuttle-debuts-at-christchurch-airport/.

Clements, R., Alizadeh, T., Kamruzzaman, L., Searle, G., Legacy, C., 2022. A systematic literature review of infrastructure governance: cross-sectoral lessons for transformative governance approaches. J. Plan. Lit., 08854122221112317 https://doi.org/10.1177/08854122221112317.

Clements, L.M., Kockelman, K.M., 2017. Economic Effects of Automated Vehicles. Transportation Research Record: Journal of the Transportation Research Board 2606 (1), 106–114. https://doi.org/10.3141/2606-14.

Collier, R.B., Dubal, V.B., Carter, C.L., 2018. Disrupting regulation, regulating disruption: the politics of uber in the United States. Perspect. Polit. 16 (4), 919–937. https://doi.org/10.1017/S1537592718001093.

Cresswell, T., 2010. Towards a politics of mobility. Environment and Planning d: Society and Space 28 (1), 17–31. https://doi.org/10.1068/d11407.

Cugurullo, F., Acheampong, R.A., Gueriau, M., Dusparic, I., 2021. The transition to autonomous cars, the redesign of cities and the future of urban sustainability. Urban Geogr. 42 (6), 833–859. https://doi.org/10.1080/02723638.2020.1746096.

DPMC, 2019. Cybersecurity Strategy 2019. Department of the Prime Minister and Cabinet. Accessed from https://dpmc.govt.nz/sites/default/files/2019-07/Cyber%20Security%20Strategy.pdf.

Eggert, D., Krisher, T., 2020. Michigan plans dedicated road lanes for autonomous vehicles. WPBN. https://upnorthlive.com/news/local/michigan-plans-dedicated-road-lanes-for-autonomous-vehicles.

Fagnant, D.J., Kockelman, K., 2015. Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. Transp. Res. A Policy Pract. 77, 167–181. https://doi.org/10.1016/j.tra.2015.04.003.

Faisal, A., Yigitcanlar, T., Kamruzzaman, Md., Currie, G., 2019. Understanding autonomous vehicles: A systematic literature review on capability, impact, planning and policy. J. Transp. Land Use 12 (1). https://doi.org/10.5198/jtlu.2019.1405.

Flyvbjerg, B., 2007. Policy and planning for large-infrastructure projects: problems, causes, cures. Environ. Plann. B. Plann. Des. 34 (4), 578–597. https://doi.org/10.1068/b32111.

Freudendal-Pedersen, M., Kesselring, S., Servou, E., 2019. What is Smart for the future city? Mobilities and automation. Sustainability 11 (1), 221. https://doi.org/10.3390/su11010221.
Gössling, S., Cohen, S.A., Hares, A., 2016. Inside the black box: EU policy officers' perspectives on transport and climate change mitigation. J. Transp. Geogr. 57, 83–93.
Grindsted, T.S., Christensen, T.H., Freudendal-Pedersen, M., Friis, F., Hartmann-Petersen, K., 2021. The urban governance of autonomous vehicles – In love with AVs or critical sustainability risks to future mobility transitions. Cities, 103504. https://doi.org/10.1016/j.cities.2021.103504.
Gudmundsson, H., Hall, R. P., Marsden, G., & Zietsman, J. (2016). Governance and Decision-Making in Transportation. In H. Gudmundsson, R. P. Hall, G. Marsden, & J. Zietsman (Eds.), *Sustainable Transportation: Indicators, Frameworks, and Performance Management* (pp. 111–136). Springer. https://doi.org/10.1007/978-3-662-46924-8_5.
Guerra, E., 2016. Planning for cars that drive themselves: metropolitan planning organizations, regional transportation plans, and autonomous vehicles. J. Plan. Educ. Res. 36 (2), 210–224. https://doi.org/10.1177/0739456X15613591.
Hafner, R.J., Walker, I., Verplanken, B., 2017. Image, not environmentalism: a qualitative exploration of factors influencing vehicle purchasing decisions. Transp. Res. A Policy Pract. 97, 89–105. https://doi.org/10.1016/j.tra.2017.01.012.
Handy, S., McCann, B., 2010. The regional response to federal funding for bicycle and pedestrian projects: an exploratory study. J. Am. Plann. Assoc. 77 (1), 23–38. https://doi.org/10.1080/01944363.2011.526537.
Imran, M., Pearce, J., 2015. Auckland's first spatial plan: Ambitious aspirations or furthering the status quo? Cities 45, 18–28. https://doi.org/10.1016/j.cities.2015.02.005.
Latta, B., 2022. Federal autonomous vehicle framework is needed for the US to be a leader in AV technology. The Hill. https://thehill.com/driving-into-the-future/3513655-federal-autonomous-vehicle-framework-is-needed-for-the-us-to-be-a-leader-in-av-technology/.
Legacy, C., Curtis, C., Scheurer, J., 2017. Planning transport infrastructure: examining the politics of transport planning in Melbourne, Sydney and Perth. Urban Policy Res. 35 (1), 44–60. https://doi.org/10.1080/08111146.2016.1272448.
Legacy, C., Ashmore, D., Scheurer, J., Stone, J., Curtis, C., 2019. Planning the driverless city. Transp. Rev. 39 (1), 84–102. https://doi.org/10.1080/01441647.2018.1466835.
Li, S., Sui, P.-C., Xiao, J., Chahine, R., 2019. Policy formulation for highly automated vehicles: emerging importance, research frontiers and insights. Transp. Res. A Policy Pract. 124, 573–586. https://doi.org/10.1016/j.tra.2018.05.010.
Loorbach, D., 2010. Transition management for sustainable development: a prescriptive, complexity-based governance framework. Governance 23 (1), 161–183.
Lyons, G., Davidson, C., 2016. Guidance for transport planning and policymaking in the face of an uncertain future. Transp. Res. A Policy Pract. 88, 104–116. https://doi.org/10.1016/j.tra.2016.03.012.
Marsden, G., Reardon, L., 2017. Questions of governance: Rethinking the study of transportation policy. Transp. Res. A Policy Pract. 101, 238–251. https://doi.org/10.1016/j.tra.2017.05.008.
Marsden, G., Ferreira, A., Bache, I., Flinders, M., Bartle, I., 2014. Muddling through with climate change targets: A multi-level governance perspective on the transport sector. Clim. Pol. 14 (5), 617–636. https://doi.org/10.1080/14693062.2014.905823.
Mehmood, A., Imran, M., 2021. Digital social innovation and civic participation: Toward responsible and inclusive transport planning. Eur. Plan. Stud. 29 (10), 1870–1885. https://doi.org/10.1080/09654313.2021.1882946.
Memon, A., 2002. Reinstating the purpose of planning within New Zealand's resource management act. Urban Policy Res. 20 (3), 299–308. https://doi.org/10.1080/0811114022000005924.
Milakis, D., van Arem, B., van Wee, B., 2017. Policy and society related implications of automated driving: A review of literature and directions for future research. J. Intell. Transp. Syst. 21 (4), 324–348. https://doi.org/10.1080/15472450.2017.1291351.
MOT, 2014. Intelligent Transport Systems Technology Action Plan 2014-18. Ministry of Transport. https://www.mcguinnessinstitute.org/wp-content/uploads/2021/04/24d.-Intelligent-Transport-Systems-Action-Plan-2014-2018-Transport-in-the-Digital-Age.pdf.
MOT, 2016. Regulation 2025: Scenarios summary and key findings. Ministry of Transport. https://www.transport.govt.nz/assets/Uploads/Report/Reg-2025-Scenarios-and-Findings.pdf.
MoT, 2017. Briefing to the Incoming Minister. Ministry of Transport. https://www.transport.govt.nz/assets/Uploads/About-us/Corporate/ministry-of-transport-briefing-to-the-incoming-minister-2017.pdf.
MOT, 2021. Government Policy Statement on land transport 2021. Ministry of Transport. Accessed from https://www.transport.govt.nz/area-of-interest/strategy-and-direction/government-policy-statement-on-land-transport-2021/.
Nikitas, A., Kougias, I., Alyavina, E., Njoya Tchouamou, E., 2017. How can autonomous and connected vehicles, electromobility, BRT, hyperloop, shared use mobility and mobility-as-a-service shape transport futures for the context of smart cities? Urban Sci. 1 (4), 36. https://doi.org/10.3390/urbansci1040036.
Nikitas, A., Thomopoulos, N., Milakis, D., 2021. The environmental and resource dimensions of automated transport: a nexus for enabling vehicle automation to support sustainable urban mobility. Annu. Rev. Env. Resour. 46 (1), 167–192. https://doi.org/10.1146/annurev-environ-012220-024657.
NZISM, 2018. The New Zealand Information Security Manual – Part 1. Government communications Security Bureau. https://nzism.gcsb.govt.nz/assets/NZISM/Previous-Versions/NZISM-Part-One-v3.1-October-2018.pdf.
NZTA, 2019. Tairāwhiti Roads partnership to be disestablished. Waka Kotahi NZ Transport Agency. Retrieved from https://www.nzta.govt.nz/media-releases/tairawhiti-roads-partnership-to-be-disestablished/.
Oldbury, K., Isaksson, K., 2021. Governance arrangements shaping driverless shuttles in public transport: The case of Barkarbystaden, Stockholm. Cities 113, 103146. https://doi.org/10.1016/j.cities.2021.103146.
Ribeiro Pimenta, A., Kamruzzaman, Md., Currie, G., 2023. Long-term effects of autonomous vehicles on the built environment: A systematic scoping review towards conceptual frameworks. Transp. Rev. 1–35. https://doi.org/10.1080/01441647.2023.2189325.
Searle, G., Legacy, C., 2021. Locating the public interest in mega infrastructure planning: the case of Sydney's WestConnex. Urban Stud. 58 (4), 826–844.
Shammut, M., Imran, M., Hasan, F., 2022. Conceptualising the adoption of safer autonomous mobilities. Transp. Plan. Technol. 45 (5), 403–426. https://doi.org/10.1080/03081060.2022.2115043.
Shammut, M., Imran, M., Hasan, S.F., 2023. Automated mobilities and society: why do social meanings matter? Cities 132, 104110. https://doi.org/10.1016/j.cities.2022.104110.
Sheller, M., Urry, J., 2006. The new mobilities paradigm. Environ Plan A 38 (2), 207–226.
Sheller, M., Urry, J., 2016. Mobilizing the new mobilities paradigm. Applied Mobilities 1 (1), 10–25. https://doi.org/10.1080/23800127.2016.1151216.
Stilgoe, J., 2018. Machine learning, social learning and the governance of self-driving cars. Soc. Stud. Sci. 48 (1), 25–56. https://doi.org/10.1177/0306312717741687.
Sturup, S., Low, N., Rudner, J., Babb, C., 2012. Institutional barriers and opportunities. Routledge.
Tan, S.Y., Taeihagh, A., 2021. Adaptive governance of autonomous vehicles: Accelerating the adoption of disruptive technologies in Singapore. Gov. Inf. Q., 101546 https://doi.org/10.1016/j.giq.2020.101546.
The Treasury, 2022. New Zealand Infrastructure Strategy 2022-2052. The Treasury. Accessed from https://www.treasury.govt.nz/sites/default/files/2018-03/nip-aug15.pdf.