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Using scenarios to address uncertainty in planning for sustainable mobility in small and medium-sized Norwegian cities

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Abstract

It seems hard now to ignore uncertainty over what the future holds. Such uncertainty poses significant challenges for assessing and appraising policy and investment decisions. Correspondingly scenario planning has become the subject of increasing interest internationally as a means to explore uncertainty and in turn support more robust decision making. In this paper we bring together scenario planning alongside more traditional national planning to support more robust planning for sustainable mobility for small and medium-sized Norwegian cities. The paper describes the mapping of key uncertainties influencing mobility, the development of four explorative plausible future scenarios—and in turn how these scenarios can be used as part of transport analysis and appraisal to inform more robust decision making. The purpose of the paper is twofold. First, it provides case study insight into scenario development and planning. Second, it takes the reader on a 'learning by doing' journey through the process of what was done and why, with a sharing of the lessons learned by the study team in the interest of helping others who wish to embark on their own journeys into this important developmental area of transport planning.

Keywords Scenarios, Scenario planning, Uncertainty, Sustainable mobility, Transport planning, Decision making

1 Introduction

This paper takes the reader on a learning journey through the process of creating explorative scenarios about the future, scenarios intended in this case to help in strategic planning decisions on shaping mobility for small and medium-sized Norwegian cities. It highlights decision points where judgement is called for and some of the challenges involved. It goes on to look ahead at what is needed to help support the effectiveness of investment in the face of uncertainty.

Norway with a population of 5.5 million[1] and an area covering 150,000 square miles,[2] has some 100 urban areas that have populations in excess of 5,000, three quarters of which have populations of around 20,000 or less.[3] Compare this with, for example, the UK with a population of 67 million covering 95,000 square miles[4] and with over 150 urban areas that have a population of more than 50,000.[5] This highlights the prevalence and importance of small and medium-sized cities in Norway and the need for developing sustainable transport plans for them.

In tandem, we are entering a period of significant uncertainty, which presents challenges for transport

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[1] https://www.ssb.no/en

[2] https://www.kartverket.no/til-lands/fakta-om-norge

[3] https://www.ssb.no/en/befolkning/folketall/statistikk/tettsteders-befolkning-og-areal

[4] https://en.wikipedia.org/wiki/United_Kingdom

[5] https://www.citypopulation.de/en/uk/cities/ua/

planning. This challenge is noted in the UK Department for Transport's latest National Road Traffic Projections which recognises that: "[t]here is considerable uncertainty around future travel demand, including the extent to which social and behavioural change, emerging technologies, decarbonisation, demographic change and growth in the economy will influence how, when and where we travel" [6].

While the transport sector in Norway is coming off a period of relative stability with continued funding for infrastructure projects,[6] there is, however, an increasing focus on the efficient use of public spending and on achieving sustainability and climate reduction goals.[7]

At the same time, transport planning is evolving to better incorporate uncertainty [15]. Specifically, planning for the future is increasingly turning to scenario development as part of the process [25] to help support development of more robust[8] policies and plans. While scenario development in the transport sector is not new (see for example [29] and [3]), Lyons et al. point to "a growing interest in and use of scenario planning in transport" [25]. They suggest a progression from scenario *development*, as a novel exercise undertaken periodically, to scenario *planning* in which scenarios are (increasingly) being developed and then used as part of the planning and decision-making process.

Foresight studies, including the use of scenarios, have been used sporadically by public agencies in Norway since before the early 2000s [28]. For transport planning there have been several studies conducted over the last ten years looking at for example:

- How certain foresight tools and methods could facilitate more robust planning [16],
- Horizon scanning and/or evaluation of trends and wild cards [19] and [9], and
- Traditional scenario building approach to develop scenarios relevant to future transport in Norway [27].

There has however been no specific guidance on the use of scenarios in transport planning or appraisal. Compare this with the UK, where the Department for Transport has developed a set of seven consistent "off-the-shelf" multi-modal scenarios, called the common analytical scenarios (CAS). These scenarios incorporate critical national level uncertainties and form part of the Uncertainty Toolkit and guidance for modelling and appraisal.

It is within this environment that the work that forms the basis of this paper was commissioned by the Norwegian Public Roads Administration (NPRA) as part of their sectoral responsibility and national goals for achieving more sustainable mobility. The work involved the development of a set of four exploratory future scenarios for small and medium-sized cities in Norway and points to how they might be used in future planning and investment decisions alongside existing models and methods. The purpose of the paper is drawn upon the authors' experiences of scenario development to offer a 'learning by doing and collaborating' exposition to help further support the diffusion of these methods.

The paper provides a brief description of the study methodology, followed by consideration of the specific steps undertaken, including assumptions and decisions made, and the results that were obtained. Following on from this is a discussion section including the lessons learned that may be of benefit to others looking to engage with developing and using scenarios for planning. The last section contains conclusions and suggested further steps that may be taken to progress the use of the scenarios and scenario planning more widely in Norway.

2 Method

This case study involved a tripartite collaborative approach between consultants familiar with transport planning and analysis, experts experienced in the development and application of scenarios (who provided collaborative input, challenge and guidance), and policymakers responsible for nationwide planning in Norway (who played an active role in the co-creation of scenarios and direction on national planning requirements).

Foresight is a collective term for various methods, tools and mindsets that are used in a systematic and holistic way to explore and understand how the future may unfold. The purpose of foresight is not to predict the future, but to open up the possibility of multiple futures to support better and more robust decisions today. Scenario development is one of the most well-known tools in foresight.

There is no definitive approach for developing scenarios or assessing their value, although there are certainly shared themes and techniques between different approaches [25]. We structured our study into five stages (as also shown in Fig. 1):

- Setting the scope and ambition, including qualifying the focal question
- Exploring trends, driving factors and uncertainties

[6] Nasjonal transportplan – Store norske leksikon (snl.no).

[7] Meld. St. 20 (2020–2021) Report to the Storting (white paper)_eng.fm (regjeringen.no)Meld. St. 20 (2020–2021) Report to the Storting (white paper)_eng.fm (regjeringen.no).

[8] Robust here meaning able to stand up to challenge from changing future circumstances.

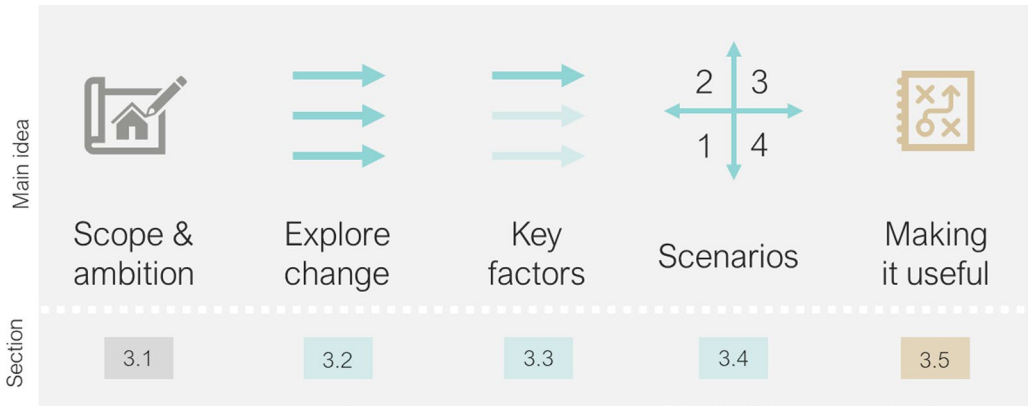

Fig. 1 An overview of the stages in the study. The section number refers to the relevant section in Chapter 3 in this paper, where the details of the task are descried. The colours correspond to those in Fig. 2 below

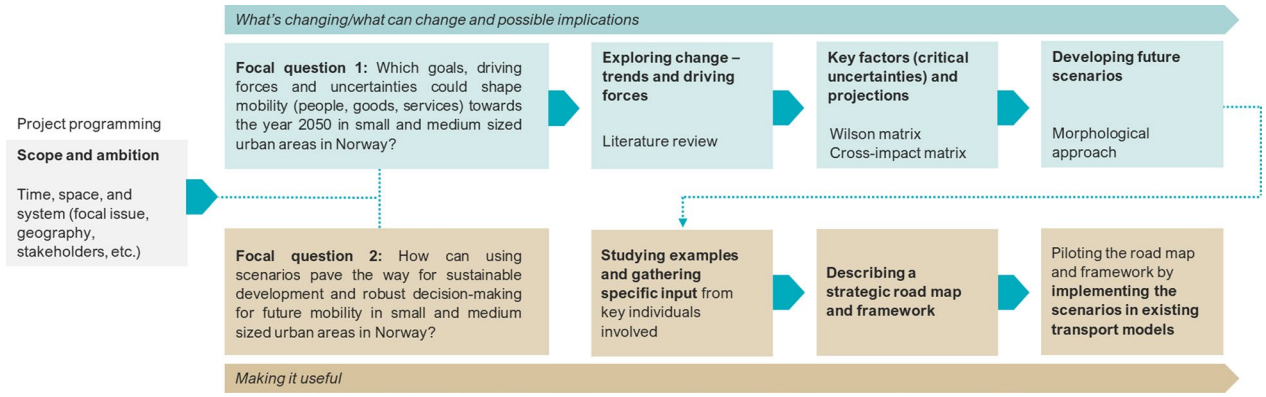

Fig. 2 A more detailed overview of the study journey including focal questions and important methodological choices and input

- Prioritising key factors, reflecting the most critical driving factors and uncertainties, and setting out how they may develop
- Developing scenarios, setting out plausible futures
- Making the work useful to planners.

A more detailed depiction of the study journey, including framing of the focal questions, is shown in Fig. 2.

The specific approach, decisions and findings for each stage are set out in more detail below.

3 Results (and how we got there)

3.1 Setting the scope and ambition

Normally, scenarios portray a world along three dimensions: time, space, and system [25]. The United Nations Development Programme (UNDP) set out the following first step in the scenario development process as follows: Define the focal issue (your focal question or issue you would like to explore) and the scope of analysis—geographical boundaries, time horizon and stakeholders [20].

For our study, the scope was defined partly as a result of the original study brief, as well as through a participatory process together with the NPRA, where we identified the framework for the study.

3.1.1 Type of scenarios

Scenarios articulate what could happen in the future. In this study we developed "exploratory scenarios", that is scenarios that reflect a wide plausible range of future conditions defined by factors exogenous to the decision-maker, i.e. those that are wholly or partially outside the control of the Norwegian Public Roads Administration.

The 'futures cone'[9] invites us to consider a range from probable to plausible to possible to preposterous futures. In this study emphasis was on *plausible* futures, noting that the distinction between 'possible' and 'plausible' is a subjective one, but in the case of this study plausible was understood to reflect what was considered credible by the study group team for the given time horizon. Wildcards

[9] https://thevoroscope.com/2017/02/24/the-futures-cone-use-and-history/

or shocks—such as pandemics or unknown unknowns (so-called black swans), were excluded as potential driving forces for the scenarios—but examples of such events were considered. It was also decided that a set of three to five scenarios would be appropriate to balance representation of a range of future conditions and developments on one hand, against cost and cognitive complexity on the other hand [25].

3.1.2 System

Scenarios are models of the future—simplified representations of real-world possibilities. As such, it is important to understand the system of interest to guide the (qualitative, mental) model development. In this regard, it was agreed that the scenarios should reflect all systems that impact the *future of mobility in small and medium-sized cities.*

3.1.3 Geographic focus

Scenarios can be more or less tailored to specific context and scale. In this study, the geographic focus was Norwegian cities and towns with up to 100,000 inhabitants. This includes around 90 urban areas spread across Norway—with exception of the six largest cities (including the capitol, Oslo). It was important that the scenarios should not be focussed on specific cities, but rather should reflect and be relevant to the diversity of small and medium-sized cities in Norway.

3.1.4 Time horizon

Traditional forecasting can lead us down the path of false precision with indications of very specific traffic levels for a particular year in the future. The time horizon for explorative scenarios is approximate and, while it may tie-in with a horizon for a strategy the scenarios are to inform, it is intended to be indicative of the short, medium or long term. Typically, a time horizon is chosen to reflect being far enough into the future to examine how significantly different pathways could lead to alternative futures. For this study the horizon of 2050 was set by the NPRA. It is emphasised, however, that the time horizon is approximate.

3.1.5 Stakeholder participation

Exploring the future is a product of the knowledge, perspectives, insights and imagination at the disposal of the exercise, which to a significant extent is in the hands of those selected as participants (including the study delivery team). There is then a question of *how many* individuals to involve and to what *extent* they should be involved. After initial input from the client and discussions within the study group, a list of more than 20 potential stakeholders and possible participants for the workshops was identified. The approach to participation was ultimately selective and targeted, balancing both time and resource constraints alongside the need for diverse viewpoints. Of the invited external stakeholders, 15 ended up contributing through workshop participation providing inputs into and review of the scenario development. The list of participants and further details are included in Appendix 2.

3.1.6 Focal questions[10]

In order to help guide the scenarios and study, two focal questions were developed in the scoping phase:

1. Which goals, driving forces and uncertainties could shape mobility (people, goods, services) towards the year 2050 in small and medium sized urban areas in Norway?
2. How can using scenarios pave the way for sustainable development and robust decision-making for future mobility in small and medium sized urban areas in Norway?

These are not alternative questions but sequential ones—the first applies to scenario development, and the second to scenario planning more broadly. Our two focal questions worked both as an 'anchor' (keeping the study from straying too far from the scope and purpose) and as a 'guiding light' (pointing the study in a direction, whilst reminding us of what our goals were).

3.2 Exploring change: trends, driving factors and uncertainties

To explore possible changes in mobility towards 2050, we undertook a targeted literature review aimed at gathering evidence on the first focal question. We reviewed a broad range of reports with a focus on transport and mobility including international literature from both before and after the outbreak of the Covid-19 pandemic.

The literature review incorporated 14 published reports shown in Table 1.

From these reports, we compiled a longlist of some 150 factors that influence transport and travel, representing both exogenous and endogenous factors related to mobility. These were categorised into Political, Economic, Social, Technological, Legal and Environmental (PESTLE) factors. Given the large number of factors we are not able to list them all here, but instead provide some examples of trends and uncertainties mentioned frequently in the reports including: a growing and ageing population, automation and automated vehicles, sharing

[10] Focal questions are often developed as a key part of scenario development to keep the project on the right path and to help focus on the objective.

Table 1 Reports examined for factors that may contribute to future dynamics of change

Title	Authoring body (reference)	Year of publication
Future demand: How could or should our transport system evolve in order to support mobility in the future?	New Zealand Ministry of Transport [23]	2014
Method 21: Early signs and black swans	Jernbaneverket and Statens vegvesen [9]	2014
Travel in Britain in 2035—Future scenarios and their implications for technology innovation	RAND Europe [31]	2016
New Mobility Now	WSP [33]	2017
Foresight 2050—Trends within the Transport Sector toward 2050	Norwegian Transport agencies [19]	2018
Trends in the transportation system—Trafikverket's environmental scanning	The Swedish Transport Administration [14]	2018
Transport sector innovation and societal changes	Institute of Transport Economics, Norwegian Centre for Transport Research [1]	2018
Technology for more sustainable mobility	Norwegian Ministry of Transport [10]	2019
Scenarios for public sector in 2040	Norwegian Ministry of Local Government and Regional Development [18]	2019
Infrastructure Futures Report	Global Infrastructure Hub [13]	2020
Future travel scenarios—adaptive planning to deliver our strategic vision in an uncertain future	Transport for the North, UK [32]	2020
Addressing societal challenges in Norway—Key trends, future scenarios, missions and structural measures	RAND Europe [12]	2021
Future transport in Norway	Oslo Economics (for Norwegian Public Roads Administration)	2021
Future public transport in Norway 2025	Public Transport Norway—the Norwegian Association of Public Transport Authorities [17]	2021

economy, increased effects from climate change, electrification of the transport sector, increased digitalisation and artificial intelligence. Some of these trends are very broad, some are overlapping, some are megatrends, while some are more specific to the transport sector. The process of reducing this general longlist to a more manageable shortlist began with removing or combining factors with strong overlaps. This involved analysis and dialogue between transport planners, foresight experts and policymakers (NPRA) who formed the core study membership. A specific example of how this process unfolded, was for instance that two separately identified factors; (1) rise of AI and automation, and (2) Autonomous driving and new transport modes—was ultimately merged to become 'Prevalence of autonomous transport'.

3.3 Prioritising key factors (critical uncertainties) and their possible development

3.3.1 Moving towards key factors

Shortlisting continued with the aim of moving from a list of potential factors to a shortlist of *key* factors (critical uncertainties), which were:

a. Relevant to the first focal question
b. Clear, concise, unambiguous and easy to understand
c. Highly impactful in terms of transport
d. Highly uncertain.

We were inspired by the 'morphological approach' for scenario development [11, 31], and—for a step-by-step explanation see [25]. This approach moves beyond the 'classic' development of a set of four scenarios based on *two* critical uncertainties, allowing for a *larger number* of critical uncertainties (or factors) across the scenarios. A full morphological approach, incorporating cross-impact, consistency and cluster analysis can be supported using specialised software, such as that from ScMi.[11] However, given the time and resource for the study, we adopted a simplified and explorative (spreadsheet-based) process facilitated through workshops and ad-hoc discussions.

We undertook a 'cross-impact analysis' to quantify which factors were most impactful in the system. The result is an influence matrix—a chart that shows the degree to which factors affect, and/or are affected, by other factors. This information can be used to better understand and quantify the relative impact of each factor to help prioritise a short-list of the variables that are most impactful. For further explanation see [11, 25].

In addition to using the 'cross-impact analysis', we mapped the factors onto an impact-uncertainty matrix—which is normally used to identify critical uncertainties (high impact and high uncertainty) [30]—often referred to as a 'Wilson-matrix' (Fig. 3).

[11] Scenario-Manager™—Scenario Management International.

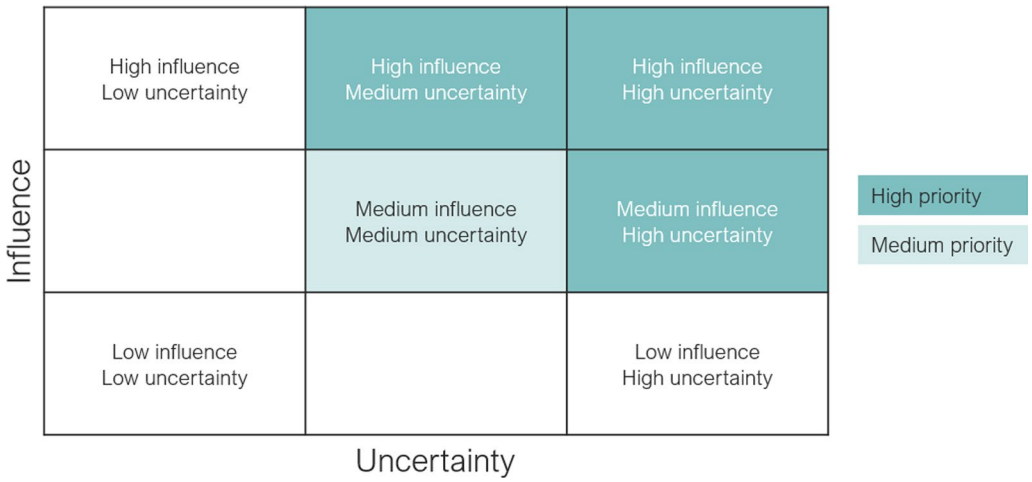

Fig. 3 Example of the Wilson-matrix used in the study. It is important to note that other matrixes might alter the x- and the y-axis and might also refer to 'potential impact', and 'probability' or 'development probability' (see for instance [2])

During the process we collectively moved towards a list of 20 of the most impactful and uncertain factors. This was further reduced to the 14 factors listed in the Appendix 1—before arriving at a prioritised subset of seven critical factors as shown in Table 2. The reduction of factors was done through study team discussions, individual and collective ranking/analysis of factors using both the cross-impact matrix and the 'Wilson-matrix', in addition to discussions with external experts. Projections for how these seven factors could develop over the scenario timeframe were also established (described below and shown in Table 2 as 'possible states').

While some of the factors which did not make the final shortlist are clearly of relevance to how mobility could look towards 2050, we found that the morphological process, helped to structure and prioritise some tough choices. It also helped weed out factors that might be considered relevant, they are not necessarily the real driving forces in the system, but they are instead largely being shaped by other factors. The relationship between a given factor and other factors can be 'active' (meaning the factor influences other factors) and/or 'passive' (meaning the factor is influenced by other factors). The extent of interdependence a factor was considered to have, helped inform factor prioritisation. Some specific examples based on the discussions from the participants working with the cross-impact-analysis/matrix: *Geopolitical stability and collaboration* showed a low passive sum and fairly high active sum, suggesting considered important for influencing other factors but is in turn less influenced. *Composition and diversity of population and workforce*—scored lowest on the active sum, suggesting factor considered less influential to other factors. This factor was part of the medium-list, but was eliminated from the seven key factors. *Attitudes towards consumption, natural resources, and raw materials*—scored high on both passive and active sum, suggesting the factor is considered both highly influenced by other factors, while at the same time being influential in shaping other factors.

Included in the list are also factors that are both within the *influence* of NPRA, as well as factors *outside their control*. In general, the NPRA need to interact and collaborate with municipalities and cities—all of which are

Table 2 Seven key factors and possible future states as the ingredients for creating a set of morphological scenarios

Critical factors (driver of change)	Possible states
Geopolitical relations and co-operation	Unstable–stable
Attitudes towards consumption, conservation of natural resources and raw materials	Ego–eco
Prevalence of autonomous transport	Low–high
Emergence of alternative business models	Incremental–disruptive
Role of government in shaping rules and regulations	Passive–proactive
Changes in production and supply chains	Centralised–decentralised
Desire related to digital accessibility and interaction	Low–high

authorities playing different roles in shaping the society and mobility towards 2050, making the distinction between control and influence complex and somewhat blurred. Two specific examples of this from the subset of potential factors include:

- 'Role of government in shaping rules and regulations' is not entirely within the NPRA's control, as the NPRA need to cooperate with all the other transport agencies in Norway, plus they need to deliver on the overall directions given from the Ministry of Transport.
- 'Prevalence of autonomous transport' is thus not within the NPRA's *control*, but they can *influence* the developments in Norway. This is also hugely influenced by other agencies and (public and private sector) actors, including the technological development elsewhere.

Below we describe the seven critical factors and why they are considered uncertain and impactful (in the context of our first focal question). As will be seen, each factor benefits from such a fuller exposition to help understand its meaning when the factors are deployed in creating the different scenarios.

3.3.2 Geopolitical relations and co-operation (possible states: unstable—stable)

Geopolitics is constantly changing and its (in)stability is a complex phenomenon that exists in an interconnect way at different levels between and within nations. Alliances and war between different countries can affect access to food, energy and goods. They can influence displacement of people, the global and national economy and inequality. The situation in 2022–2024—characterised in particular by the war in Ukraine—is a good example of how external and geopolitical events can both directly and indirectly affect feelings of security, prices, national finances and access to goods even in (small and medium sized) cities in Norway. It also highlights a degree of unpredictability. In addition, geopolitical relations and politics can affect, and be affected by, polarisation in society—which plays out at national, regional and/or local levels. If the period 2025–2050 is characterised by increased polarisation—or alternatively, more cooperation—both could have a major impact on future development for small and medium-sized cities in Norway.

3.3.3 Attitudes towards consumption, conservation of natural resources and raw material (possible states: ego—eco)

Awareness of sustainability and climate change has increased and many countries are now introducing ambitious targets and measures to achieve a reduction in environmental pollution and the use of fossil fuels. In 2023, the EU adopted proposals to make the EU's climate, energy, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55 percent by 2030 (compared to 1990 levels).[12] Norway has also committed to cut its greenhouse gas emissions and aims for the same reduction and timeline.[13] However, it is becoming clear over time that it may not be feasible to reach these targets by 2030 [4]. This highlights that there is still uncertainty related to whether there is sufficient political will to prioritise the climate over profit and make potentially unpopular choices, and whether consumption patterns can be changed enough to reach our climate goals—or whether we end up being (too) passive. The importance of the matter is further highlighted through, for instance, the World Economic Forums annual Global Risk Report, where environmental risks such as extreme weather, pollution, biodiversity loss and ecosystem collapse are listed in the top ten risks for both the short term (two years) and/or longer term (ten years).[14]

Society's attitudes and behaviours around sustainability and the environment could influence consumption levels and practices, which could have a direct impact on natural resources, climate and transport, even within small and medium-sized cities. Sustainability in terms of transport can be achieved in different ways, as is illustrated in the different actions and measures incorporated in the avoid, shift and improve (ASI) framework.[15] Adopting an eco-attitude towards consumption, conservation of natural resources and raw materials, does not automatically mean adopting a completely "avoid-attitude" based from the ASI-framework. In order to make the distinction between the projections ego and eco clearer and easier to understand, 'ego' here refers to "business-as-usual", whilst 'eco' means adopting a conscious and deliberate choice and attitude to avoid certain actions and in general reduce consumption and waste, and highly value the preservation of natural resources (including wildlife and nature). Ego and eco states can also be applied at different levels (locally, nationally and internationally). This factor especially reflects attitudes in Norway while recognising that global climate change itself over time will be influenced by attitudes globally.

[12] https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2030-climate-targets_en

[13] https://www.iea.org/reports/norway-2022/executive-summary

[14] https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2024.pdf

[15] The A-S-I approach entails three pillars: Avoid/Reduce, Shift/Maintain, Improve. See: Sustainable Urban Transport: ASI.

3.3.4 Prevalence of autonomous transport (possible states: low—high)

The development of autonomy, including automated vehicles and automated driving, is stimulated by a number of underlying trends, e.g. digitalisation, technological development (such as artificial intelligence, machine learning, etc.), consumer preferences and provision of infrastructure. Automation and self-driving cars have been identified as one of the most important possible (and highly debated and contested) game changers in terms of social and mobility development. Potential positive effects include increased traffic safety, improved accessibility and more efficient traffic management. However, there are also potential negative effects, unanswered questions and uncertainty of similar significance. These relate to technology development (including the timelines for development and take-up), as well as vehicle ownership and business models for use, legislation, safety, pedestrian-car interaction, transport system efficiency, congestion effects, etc. [21]. This critical factor covers the prevalence of level five (fully autonomous) vehicles in the overall vehicle fleet (for goods/freight and public transport).

In 2024, the NPRA published a national strategy for autonomous road transport, where two very different possibilities for technology take-up by 2050 for autonomous transport in Norway is highlighted (Norwegian Public Roads [26]), ranging from a low take-up (10–20% SAE[16] level 4/5) to a high take-up meaning 90–95% SAE level 4/5 (for public transport, goods/logistics and private cars). This highlights the relevance, possible influence, and uncertainty related to this factor.

Whilst small- and medium-sized cities in Norway may have little direct power over how this factor evolves, it is important for them to understand the potential impacts and develop plans to reach their desired outcomes, through autonomous bus services for example, and to mitigate against potential negative ones.

3.3.5 Emergence of alternative business models (possible states: incremental—disruptive)

The emergence of alternative business models (such as ones relating to cryptocurrency or the circular economy) has the potential to radically change numerous societal aspects (including transport), creating new winners and losers in the business world, and changing the distribution of wealth in (Norwegian) cities. Even though much of the technology needed for implementing shared mobility is already in place or being developed, there is still a lot of uncertainty related to how much shared mobility will change the movement of people and goods—and its subsequent impact on supply and demand both in the short and long term.

A disruptive emergence of new or alternative business models can potentially accelerate development—or a perceived lack of progress (incremental emergence) could slow development and implementation of (for instance) shared mobility down. This variation can in turn lead to different demands and needs related to transport and mobility. The emergence of business models can therefore be linked to peoples' values related to consumption and "how to live their life", including how goods and services are exchanged. As for most of the factors identified and discussed in this paper, emergence of alternative business models has clear links to several of the other factors.

3.3.6 Role of government in shaping rules and regulations (possible states: passive—proactive)

How proactive or reactive the Norwegian authorities deal with shaping rules and regulations for spatial development, mobility, and business, can shape the incentives and solutions available, as well as the barriers and challenges that might emerge. The balance between safe and flexible solutions is challenging to achieve—whilst trying to keep up with rapid technological development and changes in societal requirements. How open the Norwegian state is to private actors, new technology and how well thought out the introduction of systematic changes is in society can have an impact on transport and wider social development. Development of laws and regulations, and the power behind how this is done, may significantly impact how different places in Norway are developed—especially in a world where increased polarisation threatens. The balance between influence from the Norwegian state to the municipalities and between the municipalities to citizens is an important dynamic in assessments of futures in 2050. There is also uncertainty about how coordinated the state and the municipality will be with regard to guidance and introduction of new laws and regulations.

3.3.7 Changes in production and supply chains (possible states: centralised—decentralised)

New technologies could provide different opportunities for production and shipping of goods and materials, for example 3D-printing and new forms of distribution. How centralised or decentralised supply chains operate in the future could affect national economies and distribution channels in Norway and around the world. Alongside the influence of other factors such as geopolitical stability, attitudes towards consumption, sustainability, alternative

[16] The Society of Automotive Engineers (SAE) defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous). See SAE Levels of Driving Automation™ Refined for Clarity and International Audience.

Factors influencing mobility in 2050	Projections	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Geopolitical stability and collaboration	Stable Unstable	Stable	Unstable	Stable	Unstable	Stable	Unstable
Attitudes towards conservation of natural resources, raw materials	Eco Ego	Eco	Ego	Eco	Ego	Ego	Eco
Prevalence of autonomous transport	High Low	High	Low	Low	High	Low	High
Emergence of alternative business models	Disruptive Incremental	Disruptive	Incremental	Disruptive	Incremental	Disruptive	Disruptive
Role of government in shaping rules and regulations	Proactive Passive	Proactive	Passive	Passive	Proactive	Passive	Passive
Changes in the manufacturing supply-chain	De-centralised Centralised	De-centralised	Centralised	De-centralised	Centralised	Centralised	Centralised
Desire for digital accessibility	High Low	High	Low	Low	Low	High	High

Fig. 4 Wireframes forming the basis for the subsequently chosen scenarios (comparing these wireframes to Fig. 5 highlights the changing dynamics which took place during the process, as none of the scenarios shown here are identical to how they finally were formulated)

business models and digitalisation, developments in production and supply chains could potentially radically change freight transport globally, nationally and locally. Specifically for small- and medium-sized cities these technologies could impact where production is located, and its scale, which, in turn, impacts where logistics hubs are placed, the distance goods need to be transported, the types of vehicles that are used for delivering goods, and so on.

3.3.8 Desire related to digital accessibility and interaction (possible states: low—high)

This factor is enormously broad and potentially affects many aspects of daily life. There is little doubt that digitalisation is a megatrend in today's society. The fourth industrial revolution (techno-economic paradigm shift) is underway—where disruptive technologies such as "the internet of things" (IoT), robotics, virtual reality (VR) and artificial intelligence (AI) are changing the way people live and work. How will desire related to digital accessibility and interaction develop as new technology emerges, and how will the preference for in-person interactions possibly change? Availability and introduction of technology alone do not guarantee its adoption. Simply put: to what extent will people engage in activities online as opposed to face to face? Specifically related to transport, this can impact the number of people working from home, where they choose to live and work—and the integration of new technology (AR/VR) to business and social interactions, and thus the desire for travel and the need for both physical and digital infrastructure.

3.4 Developing future scenarios

Morphological scenarios reflect consistent factor projections across the different factors. To keep track of the many different combinations of factor projections and possible scenarios, we developed customised spreadsheets to analyse the different combinations of factors and their projections (what we call the scenario 'wireframes'). Several different combinations of factors and projections were tested and analysed. The wireframes were sense checked based on the following questions:

a. Are all the key factors represented across the wireframes?
b. Are all the possible projections represented across the wireframes?
c. Are each of the wireframes logical and consistent—does the combination of factors and projections make sense?

By 'making sense' here we refer to an element of the morphological analysis where different states and projections are considered to be logically consistent, while others are considered to be less so—or totally inconsistent. In an ideal world such analysis would be done through specialised software.

As mentioned previously, we adopted a simplified and explorative spreadsheet-based approach where this process was done through exploring and mapping different possible combination ('wireframes') in a spreadsheet. The spreadsheet was used as a tool which was combined with group discussions on the combination of factors and projections. Short narratives were written to help test the wireframes, re-evaluating and adjusting the wireframes accordingly. Ultimately a manageable set of wireframes was identified that were as divergent as possible from each other and collectively reflected the different projections across the key factors. Figure 4 shows some of the wireframes that emerged.

As per the framing requirements, the study intended to develop between 3 and 5 scenarios—enough to reflect

a wide range of possible futures, while at the same time being cognitively manageable for users. Fuller narratives were then developed to create depictions of possible 2050 futures for transport and society in Norwegian cities. A small online survey and workshop were undertaken to explore and validate the scenarios with external stakeholders and the NPRA. During the workshop the participants "explored life" in each of the scenarios, prompted by questions such as:

- How did you travel to work today, and what did you see?
- How will this scenario look and feel for your organisation in 2050—and what has changed from today?
- Who will be the 'winners' and 'losers' in this scenario?
- What opportunities, challenges and possible rules/regulations do you see?

The inputs were gathered and collated, followed by study team discussions, where both the 'wireframes' and scenario narratives were further adjusted, before four distinct scenarios were finalised.

The four scenarios reflect four plausible divergent future contexts that could influence planning in pursuit of sustainable transport. While more in-depth narratives for each were created, they can be described in summary form as follows:

(i) Travelling alone—a future in which class and generational differences, alongside differences in working in the physical and digital worlds, lead to a variety of individualistic behaviours and travel needs to the detriment of public transport and shared mobility—but with abundancy in choices for the privileged few.

(ii) A simpler life—extensive changes in priorities and attitudes associated with consumption and environmental sustainability leads to greater focus on living locally and travelling sustainable with tech-innovation not being the main driver of mobility in ways expected by some in the 2020's.

(iii) Together we are stronger—a future in which the primacy of addressing climate change has shaped collaborative and collective change with a prevalence of technology-enabled sustainable mobility and digital substitution for travel.

(iv) Save us from ourselves—a future where small and medium-sized cities are suffering the consequences of increased polarisation, geopolitical unrest and adverse climate change. This has led to floundering efforts to deliver effective and sustainable mobility solutions because investments and focus are on safety and security at the national level.

Figure 5 summarises how the factor projections vary across the scenarios. The top part shows the combinations of factor projections used for each scenario. The spider diagrams in the bottom part also illustrate the projections, but in a different way (where the projections are shown for the two projections levels and across all scenarios). The Figure highlights that the scenarios are divergent and different in their make-up and features.

3.5 Making it useful—using scenarios to test policies

The study then moved on to address the second focal question, concerning how the scenarios might be used in practice within transport planning in Norway. We did this by following three main steps:

A. Studying national and international examples of using foresight and scenarios in transport planning and gathering specific input from key individuals involved.
B. Describing a strategic road map (how use of foresight and scenarios could be increased) and a more practical recipe/framework (how the scenarios should be implemented in day-to-day-practice).
C. Piloting the road map and framework by implementing the scenarios in an existing transport model.

3.5.1 A: Suggested use of foresight and scenarios

Inputs were mainly gathered based on discussions in the workshop held with the NPRA and stakeholders, discussions with external experts, and through studying a targeted group of national and international examples (mainly from the UK) [5, 22, 32].

Based on the inputs, we suggest that scenario development can help with the following main ideas for transport planning in Norway:

- *Fostering participation, dialogue, and co-creation* among stakeholders, for instance with discussions about how the future may develop.
- *Shaping strategies and making strategic choices.* Scenario development can help shape strategies that guide us towards more desirable futures. They can also help to identify future challenges and opportunities and encourage discussion about how to mitigate or encourage these. This relates to for instance the Norwegian National Transport Plan.

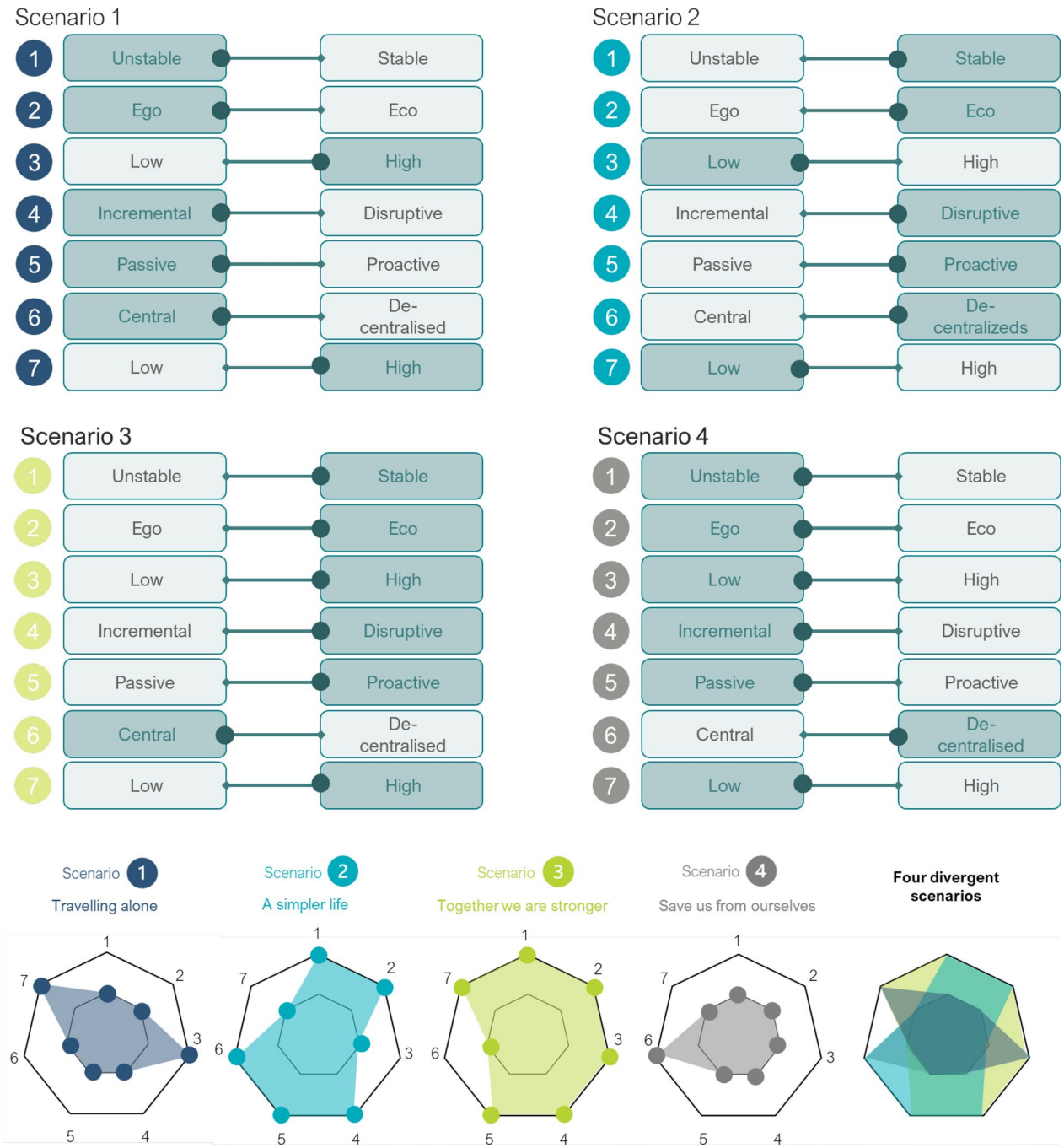

Fig. 5 The four different scenarios visually compared against each other to reflect the differences in projections for the seven factors across the scenarios

- *Stress-testing projects and policy measures.* Scenarios can be used to stress test projects and policy measures, with the aim of choosing projects and policies that are more robust across a wide range of future conditions (rather than being optimal in one central case).

3.5.2 B: Strategic roadmap and suggested framework

A specific framework was developed to show how the scenarios can be used by cities and municipalities. It is suggested that the four scenarios be treated as 'scenarios in common'—inspired by the UK Department for Transport's development of 'Common Analytical

Scenarios' [7]—that can be used across different small and medium-sized cities in Norway. It is recognised that each urban area will have its unique circumstances, and that these should accompany use of the scenarios to help tailor robust investment decisions. This means that while a common framework is provided, a participatory process involving the urban areas concerned is essential in which they actively engage in working with the factors and scenarios—and how this might impact and unfold in their specific geographic context. National support can be provided through horizon scanning and periodic updates to the 'common scenarios' to help ensure that the ongoing dynamics and uncertainties in mobility are being accounted for.

The project team formulated a strategic road map as a supportive tool for the NPRA, highlighting important steps and milestones to facilitate the use of the scenarios, some of them being:

i. Internal communication. Helping to make scenario development an increasingly well-known and accepted method within the NPRA.
ii. External communication. Generating increased attention, understanding and interest in scenario development/planning methodology and foresight among other transport agencies, advisers, mobility actors, municipalities, county councils etc.
iii. Testing and implementation. Applying the prepared scenarios and suggested workflow in specific urban areas with steps to evaluate, iterate and adjust as appropriate.

3.5.3 C: Pilot exercise—implementation of scenarios in transport models

Whilst not a part of the initial study, a pilot exercise was undertaken in the aftermath of the scenario development—where the scenarios were implemented in existing transport models. The end goal of the pilot exercise was to provide valuable insight and a clear direction in terms of bridging the gap between scenario development, scenario planning and evaluation of measures to achieve more sustainable mobility through transport modelling.

The pilot exercise was carried out through a participatory process with two urban areas and the NPRA. An essential part of the exercise related to how existing transport models could be used together with the four scenarios. Three main principles for implementing the four scenarios into the transport models were established:

- User friendly—the model implementations needed to be easy to understand and realistic to implement for users.
- Transparent—the implementations and preconditions needed to be clear and understandable, supporting deeper investigation.
- Level of detail—the method needed to be sufficiently detailed to lend credibility to the process, but at the same time simplified enough to be able to provide indications and findings as part of the pilot exercise.

The validity of transport models can come into question when they are used in new and/or different ways than originally intended, which is why the principles above are important. We also included experienced modellers in the process, both internally and those working within the NPRA—thus making the changes that were made and the results calculated transparent.

With the main principles in mind, adjustments were made in the transport model to create four scenario baselines. The project team actively discussed which, and how much, certain factors in the model could be adjusted to represent the scenarios. After several rounds of calculations, evaluations, adjustments, re-evaluation, and further refinements, an agreed set of adjustments were established for a significant number of factors, including for instance car ownership, demographic data and level-of-service assumptions for different modes. In the scenarios, adjusting these factors reflect different societal behaviours, such as an individualistic society leading to higher car ownership or a community-oriented approach resulting in more walking or cycling. As an example, please see Fig. 6.

Together these adjustments quantify the (exogenous) baseline travel demand for each scenario. A further test, where a road user charging policy was introduced across all scenarios, was conducted for one of the urban areas. The results indicated that whilst road user charging significantly impacted traffic patterns, its effects varied across the four scenarios, demonstrating how scenarios can be used to assess policy robustness against future uncertainties.

Implementing scenarios in transport models requires further testing, validation and adjustments that build upon the work above, but which are beyond the scope of this study.

4 Discussion and lessons learned

4.1 The importance of (shared) mental models

During our study, it has become evident that many within the transport planning field in Norway consider themselves aware of foresight methods and scenarios. However, there does not seem to be a shared understanding

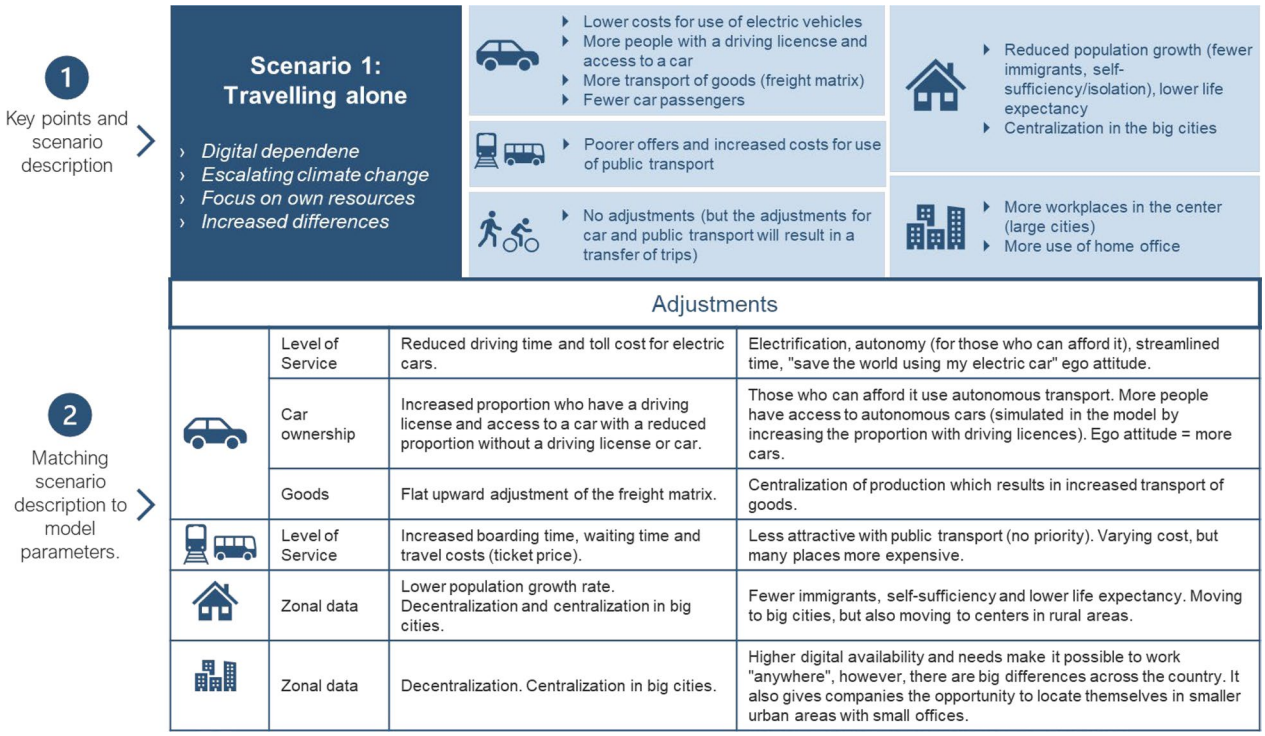

Fig. 6 Illustration (here showing scenario 1) of how we translated the qualitative factors into the quantitative inputs to the transport models

of what 'foresight and scenario development' entails and how and why the use of these methods within urban and transport planning could be beneficial. Some stakeholders also tended to underestimate the complexity and the limitations of existing tools and methods at their disposal when dealing with deep uncertainty and planning for future mobility.

We found it useful, when working with stakeholders in our study, to spend time on getting the 'basics' right and to make sure everyone was starting from the same point of reference (or at least closer to each other than before). This included achieving a clear understanding of how the factors could influence transport in each scenario, which, in our view, can best be accomplished by discussions, co-creating and harnessing views from different stakeholders and experts.

During meetings and workshops, we deliberately challenged participants' "perception of time" and on what could happen towards 2050. Some participants found it difficult to look that far ahead—while others felt that 2050 was too restrictive and wished to look further into the future. We found it useful to frame the time jumps by arguing that the time to 2050 (+28 years), was the same as looking from the time for the start of the study in 2022 and back to 1994 (−28 years), which was the year of the Lillehammer Winter Olympics. Many Norwegians over a certain age can relate to this event because it has become 'ingrained' in the Norwegian culture serving as a kickstart for both major infrastructure development and subsequent sporting achievements. We highlighted some of the innovations and developments that have taken place (or not taken place), during that time. By making this (fairly obvious) connection, we felt that it became easier for participants to open up to and accept the concept of "travelling in time" and easier to reflect on possible changes during the given time horizon.

4.2 Exploring change and establishing key factors

It is easy to be overwhelmed by the number of potential factors affecting the future, especially as they can overlap and be expressed in different (shorthand) ways when looking across the literature. However, the discipline of categorising and refining the factors helps to make sense of this with: (i) overlaps signalling accordance across studies; (ii) the process of reviewing and revising the description of factors building greater confidence concerning what the factors are representing; and these in turn (iii) fostering a sense of ownership for the present study over the refined and shortlisted set of factors.

Most of the factors we identified can be placed in the category of 'well known'. This means that they have been studied and discussed in great detail in both academic research and projects for various clients, including governmental agencies. However, this is not to suggest that

there is not scope for ambiguity related to what they actually entail, in addition to uncertainty and disagreement amongst experts related to degrees of implication, speed of change, local variation/relevance, etc. What some consider plausible, could be well beyond someone else's idea of preposterous. Even though we refrained from including wildcards and black swans in the scenarios, we still found it useful to have sight of them within the literature to help ensure from the study's outset that open-mindedness was promoted within study participation.

It is important to ensure that ambiguity is not confused with uncertainty. It became apparent that if the description of a factor was not clear to the study team members, or the understanding of the description varied between the members, this signalled ambiguity (i.e. uncertainty over meaning as opposed to uncertainty regarding how that factor would play out in future). Undertaking rounds of dialogue and sense-checking between the study team members (transport planners, foresight experts and policymakers) to move beyond ambiguity was time consuming. It proved, however, important to provide supplementary explanation alongside the factor descriptions. An example of this complexity is that artificial intelligence (AI) is specifically mentioned as part of several factors (for instance 'prevalence of autonomous transport' and 'desire related to digital accessibility and interaction'). AI could even warrant a mention as part of other key factors—which further highlights the broadness and complexity of the factors, and that driving forces and trends are not straightforward but rather reflect complex phenomena, overlapping and with cross-impacts.

The process of moving from a longlist to a medium list can be challenging in terms of judging what to leave out and moving beyond the sense of 'we may have missed something'. Yet this is a reminder of perhaps how narrow-minded transport planning in the past may have been in terms of the range of factors accounted for in modelling and analysis to inform decision making. It is also important to recognise that since the future is not 'knowable', the sense we can make over things yet to play out is influenced by what we understand in the present and the signals coming from horizon scanning. This can change (sometimes significantly) over time—for instance with the recent breakthroughs seen in artificial intelligence. Accordingly, what we may determine as factors to retain in one study may change for a similar study at a later time.

Many of the factors identified in the study could be deemed to be outside, or at least on the fringe, of what small- and medium-sized urban cities in Norway can control and influence—and thus are exogenous to the local transport planning system in the urban areas. An important insight was that because the stakeholders perceived they had a low level of influence, many subsequently had trouble 'relating' to the factors and accepting their relevance ('Why are these relevant to this study when we are not able to control and influence them?"). Acceptance and ownership towards the factors and scenarios rose among participants when they were given background and context, a theoretic explanation, a facilitated framework to work within and enough time in meetings/workshops to properly 'dive into' the factors.

4.3 Developing the scenarios using a morphological approach

A morphological approach initially seemed complicated, as well as difficult to communicate and to understand for stakeholders. However, we found it to be a good way to develop a robust framework, which was comprehensive enough downstream to allow for focusing on certain factors when communicating and working with the municipalities or other stakeholders. This relates to the fact that the four scenarios produced were not a product of just two critical uncertainties. Cities, municipalities and stakeholders experience very different challenges and 'pain points' related to mobility. Unless they participate actively in a scenario development process where they determine these uncertainties, the factors and scenarios might be less likely to be "accepted" at face value due to lack of ownership and low perceived relevance to 'their' area. This can be seen as a limitation with using 'common scenarios'—or it alternatively reinforce the importance of common scenarios being worked with by local stakeholders in tailoring their own analysis and planning.

The customised spreadsheets proved effective and a good way to maintain a high degree of control over different factor projection combinations and possibilities. At the same time, we were able to have enough flexibility to adjust and refine the 'wireframes' as we moved along the process. This helped us maintain control over a key question relating back to the framing requirements established during the first phase: *do the wireframes and subsequent scenarios reflect a wide range of plausible futures?*

4.4 Facilitating and planning in the digital age

In this study, all meetings and workshops with the NPRA, stakeholders and international experts were held online. Even though the world has seen a surge in digital meetings and workshops during and after Covid, planning and facilitating (a fully digital process) should still be considered carefully. Meetings and workshops are an essential part of a study relying on involvement of both client and stakeholders, and they provide an excellent window for information moving "both ways" (i.e. to gather input and insight, but at the same time providing information and creating ownership/acceptance). Two lessons from this

process are (i) that a balance needs to be struck between expectations from a meeting or workshop and the effort involved in planning for and facilitating sessions; and (ii) using too many digital platforms (Teams, Excel, Powerpoint, Miro/Mural etc.) simultaneously can risk running into difficulties either with delivery or participant comprehension.

4.5 Comfort in language is important

Using foresight and scenarios within transport planning is an area where we can learn from each other, and where learning happens internationally and nationally. This means collaboration across borders and languages. Norway ranks amongst the highest in the EF English Proficiency Index,[17] however this specific index does not measure how well English is written or spoken—just how well understood it is. According to the British Council, "proficiency can help us to understand someone's ability to communicate effectively in English" in addition to "proficiency can be broken down into smaller components (reading, writing, listening and speaking)".[18] They also highlight that it is normal to experience variation between these components, meaning that one can have a high level of understanding, but a lower level when it comes to speaking (including pronunciation).

Dealing with the future is complex enough as it is—and doing it in a non-native language can complicate the process. Even though most Norwegians in general are comfortable with speaking English in many settings, it became evident to us that a language barrier seemed to be hindering some participants during meetings, witnessed mainly by an increase in engagement when participants were allowed to speak Norwegian. When confronted with this issue several participants agreed that they found it more difficult to think and speak in English ('on their feet') about the complex issues relating to the future. Our solution to this was simply to run parallel sessions where parts of a meeting/workshop were held in Norwegian (for instance group discussions) while other parts were held in English (this could for instance be the main introduction/presentations).

4.6 Making it useful is a balancing act between the qualitative and quantitative

The concept of traditional 'do-nothing-alternatives' is a vital part of traditional transport planning in Norway—and is utilised by most transport agencies, Ministry of Transport, local and regional municipalities, consultants, etc.

For a policy measure or investment to be deemed "fit for the future", it should be considered *robust* ('strong and unlikely to break or fail'[19]), *adaptable* ('able to change in order to suit different conditions'[20]) and *supportive* ('showing agreement and giving encouragement'[21]) towards goals and objectives. Scenario development and implementation of scenarios in transport models should serve as a foundation for discussions on whether a project or policy measure 'makes sense' across several distinct different future situations (where the scenarios represent new baseline scenarios/do-nothing-scenarios). We found this challenging to convey to stakeholders, and we argue that it might be related to a lack of common reference point concerning what scenarios actually are, why they are useful and how they can address robustness and uncertainty. Our experience is that—even when in the midst of a scenario development study—transport planners, transport modellers, stakeholders, and policy makers can be tempted to be drawn towards comparing detailed numbers directly, instead of focusing on whether or not the measures are robust and relevant across different scenarios. This represented an important reminder and lesson for us, and an area we have advised the NPRA to maintain focus on when implementing, adjusting, improving and communicating going forward.

5 Concluding remarks

The study described in this paper has provided valuable insight into possible future(s) of mobility in small- and medium-sized Norwegian cities towards 2050. It helps provide a major step forward within the transport planning field in Norway—contributing to closing the gap between theory and practice related to foresight, the use of scenarios and transport planning.

5.1 Key successes and challenges

Key successes of the study include: (i) focusing on a clear scope and ambition; (ii) drawing upon wider literature to inform and open minds; (iii) adopting a pragmatic and simplified approach to developing morphological exploratory scenarios; (iv) investing time in getting study members and stakeholders 'on the same page'; (v) prioritising co-creation across actors to foster shared understanding, ownership and acceptance; and (vi) combining the use of traditional transport models with scenarios through four distinct 'do-nothing-scenarios' that portrays different futures within a larger scope of possibilities than traditional planning, allowing us to test how different policy measures perform under various future conditions using

[17] EF EPI 2022 – EF English Proficiency Index.

[18] What is the importance of an English proficiency test? | Take IELTS.

[19] ROBUST | English meaning—Cambridge Dictionary.

[20] ADAPTABLE | English meaning—Cambridge Dictionary.

[21] SUPPORTIVE | English meaning—Cambridge Dictionary.

the same model structure and framework for adjusting parameters.

Key challenges faced during the study were: (i) diversity of perceptions and perspectives on foresight creating confusion, friction and resistance; (ii) overcoming the fear of 'we may have missed something' to move on through the scenario development process; (iii) ambiguity being a cause of uncertainty of its own when working with factors; (iv) managing ambitions and expectations of what participatory workshops can achieve; and (v) overcoming the seduction of numbers and encouraging stakeholders to think and develop improved robustness of decision making.

5.2 Moving forward with foresight and scenarios in transport planning

Even though foresight can help manage uncertainties in transport planning, its methods and techniques can be complex and challenging to integrate into existing processes. To truly benefit from foresight, the transport planning sector needs a mental-model-shift. This involves not only adopting new tools, techniques and methodologies, but also fostering an open-minded and inclusive mindset. To help achieve this, we have suggested the following next steps for the NPRA and transport planning in Norway:

- Further testing and calculations should be done to facilitate scenario planning merging with transport modelling.
- The NPRA and other public agencies must ensure sufficient resources and development funds for all parts of further development work within foresight and scenario planning.
- Public governmental agencies in Norway, starting with the NPRA, should focus further on skills development, as well as on strengthening relations and cooperation with international experts and transport agencies.
- An appropriate way of monitoring trends, driving forces and uncertainties must be established. This will form important input for updating the framework and scenarios going forward.
- Foresight consists of multiple methods and techniques and needs to be treated as a toolbox meant to be used together and continually (not a one-time-event). Futures techniques are individually effective, but most powerful when combined [8].

The purpose of foresight and scenarios is perhaps most eloquently encapsulated by John Meynard Keynes: "It's better to be roughly right than precisely wrong".

The further you dive into what the future might hold, acquiring increased awareness and understanding about several possible future outcomes and deep uncertainty along the way, the less certain about one singular future one *should* become. At the same time, acceptance towards viewing uncertainty as an opportunity, rather than merely as a threat and risk to be controlled, should ideally also increase (grow comfortable with uncertainty). This means that the challenges and changes we face pave the way for a new vision-led way of thinking (as set out by [24]: *decide and provide* as opposed to predict and provide (see also [15]). In the decide and provide approach we 'decide' on a preferred future and identify interventions that can help chart a robust course towards that future, through whatever uncertainty lies ahead. We suggest that methods, learnings and insight gathered through the study described in this paper could be used for making further incremental developments within future and foresight expertise worldwide going forward.

By thinking holistically as planners—through combining models, methods and mindset—we can achieve collaborative learning between transport planners, foresight practitioners and policy makers. Together we can help improve the robustness of decision-making and shape more sustainable mobility.

Appendix

Appendix 1: List of factors (trends and driving forces)

The Table 3 shows a shortlist of 14 potential factors including categorisation according to PESTLE:

It is important to note that some drivers fit in multiple categories, as highlighted in the table by listing alternate PESTLE-categories. The main idea is to use the framework to help adopt a wider systems view to identify the different drivers. Other acronymyms/frameworks such as STEEP, PEST, etc. could easily also have been used.

Appendix 2: External stakeholders and participants

Selecting cities and municipalities/county municipalities

Based on the initial geographic focus of the study (Norwegian cities and towns with up to 100,000 inhabitants, which includes around 90 urban areas spread across Norway) we followed the following steps:

1. Initially identified key characteristics of 90 urban areas ranging from geographic location (both region and inland vs. coastal), size (m^2), population size, and density (people/m^2).
2. We wanted to include cities that varied across the different characteristics and include either munici-

Table 3 Shortlist of 14 factors categorised according to PESTLE-framework

	Category	Trend / driving force
P	Political	**Geopolitical stability and cooperation** Degree of policy-alignment between state and local government
E	Economical	**Emergence of alternative business models** (S, T) State (central) government spending on transport infrastructure (P) Cost of travel relative to household income
S	Social	**Attitudes towards consumption, natural resources, and raw materials** (E) Composition and diversity of population and work force Attractiveness of car-free travel options (E)
T	Technological	**Changes in the manufacturing supply-chain** (S) **Desire for digital accessibility** (S) **Prevalence of autonomous transport**
L	Legal	**Role of government in shaping rules and regulations** (P)
E	Environmental	Events related to climate change Decarbonization in transport (T)

The seven key factors are listed in bold. Letters in brackets signalise that factors could potentially fit into other PESTLE-categories

palities or county municipalities which covered different areas of Norway. This meant identifying cities that scored respectively high, medium or low on the different characteristics, and then selecting a set of candidates that covered a wide range.

3. The potential candidate-cities and municipalities were then discussed with the client, adjustments and alterations were made, before a final set of candidates were chosen.

Selecting other stakeholders

We wanted to include a broadness in both people and organisations, and therefore invited interest organisations related to different transport modes (for instance bicycle, Public Transport Norway—the Norwegian Association of Public Transport Authorities, etc.), technology (ITS Norway, SAMS Norway), in addition to national experts who could provide important input to the process. An important factor was also the fact that the focus on the project was also very much on providing support for the NPRA throughout the process, meaning that there was a limit to the number of other possible participants, for instance from other transport agencies.

Number of participants and their affiliation

- Cities and municipalities—5 participants
- County municipalities—3 participants
- NPRA—7 participants
- Stakeholder/interest organisations—4 participants
- External (national) experts—2 participants
- Norconsult—7 participants (both as facilitators and experts)

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Author contributions
All four authors have been involved substantially in co-writing all sections of the paper. Lead writing has been undertaken by the first author.

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Availability of data and materials
Interim analysis (as described in the paper) is not available beyond that included in the paper itself. Full-length versions of the scenarios included in the paper may be requested from the authors.

Declarations

Competing interests
The authors have all been directly involved in the study addressed in the paper and share in a wish to see wider adoption and application of scenario planning in the transport sector. Norconsult and Mott MacDonald are both employee-owned companies and invested in advancing developments in transport planning. The content of the paper has not been affected by any competing interests.

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