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Guidance for transport planning and policymaking in the face of an uncertain future

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ABSTRACT

Uncertainty of outcome is widely recognised as a concern facing decision-makers and their advisors. In a number of spheres of policy, it appears uncertainty has intensified in the face of globalisation, economic instability, climate change, technological innovation and changing consumer preferences. How can planners and policymakers plan for an uncertain future? There is growing interest in, and use of, techniques that can help decision-making processes where deep uncertainty is involved. This paper is based upon one of the most recent international examples of a foresight exercise employed to examine uncertainty – specifically that which concerns uncertainty over the nature and extent of future demand for car travel. The principal focus of the paper is on the insights and guidance this examination of uncertainty brings forth for transport planning and policymaking. To accommodate deep uncertainty requires a flexible and open approach in terms of how policy and investment possibilities are formulated and judged. The paper argues for a focus upon the *Triple Access System* of spatial proximity, physical mobility and digital connectivity as a framework for policy and investment decisions that can harness flexibility and resilience. Uncertainty becomes an opportunity for decision-makers with the realisation that they are shaping the future rather than (only) responding to a predicted future. The paper outlines two forms of policymaking pathway: *regime-compliant* (in which adherence to trends and the nature of the world we have known pushes policy) and *regime-testing* (in which the nature of the world as we have known it is brought into question and vision pulls policy decisions). Stronger orientation towards regime-testing to assist in managing an uncertain future is advocated.

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1. Introduction

Proclamations about the future (even where provenance or authenticity may be questioned) can subsequently gain historical prominence for their fallibility: “*This ‘telephone’ has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us.*” (Western Union internal memo, 1876); “*Heavier than air flying machines are impossible.*” (Lord Kelvin, President of the Royal Society, 1895); and “*The actual building of roads devoted to motor cars is not for the near future, in spite of many rumours to that effect.*” (Harper’s Weekly, 1902). The future is uncertain. This is a truism. However, in the face of a globalising society and the tempo of socio-technical change, its poignancy is as great today as it has ever been.

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Herein lies the difficulty for planners and policymakers. The essence of planning, as a profession, is to plan for the future – going beyond only prediction with a goal of creating a better future (Myers and Kitsuse, 2000). Yet conventional tools employed to try and understand uncertainty and the future state are rooted in prediction based on the current understanding of cause and effect relationships. Forecasting, for example, has been a tool often employed to assist strategic decision-making. While forecasting itself can seek to accommodate uncertainty through providing a range of forward projections, it has a reputation for being based upon historical trends and relationships leading to extrapolation. Forecasts tend to conceal uncertainty, with their quantifications giving an air of authority and precision. Yet we are seeing some contemporary demonstrations of their fallibility. Six forecasts (from different sources) of future oil prices running from 2011/12 to 2017/18 were collated in relation to the Scottish Independence Referendum in 2014 (Lyons et al., 2014: 16). Six-year change in price ranged across the forecasts from +30% to –10%. The range itself signals significant uncertainty but this was underlined when the price of crude oil plummeted in the second half of 2014 (and has since fallen further). This has been in the face of increased production in the United States, declining demand from developing economies and continued production from other oil producing nations.

Drawing upon an analysis of 210 projects across 14 countries, Flyvbjerg et al. found that “forecasters generally do a poor job of estimating the demand for transportation infrastructure projects” (Flyvbjerg et al., 2006: 1). Further demonstration of traditional tools’ limitations or fallibility comes from national forecasts for road traffic volumes, which are noted for an unwavering projection of growth (albeit of varying magnitude). Collations of official forecasts reveal repeated upward projection in spite of recent actual trend data to the contrary.¹ The phenomenon of ‘peak car’ has emerged, which refers to a decade long period in several developed economies of long-run growth in car travel having halted or even reversed (Goodwin and Van Dender, 2013). Professional opinion is divided over whether car travel (per capita annual distance travelled or total distance travelled) in the future will remain largely unchanged, will resume its trend of growth or will go into decline (Lyons and Goodwin, 2014). Uncertainty regarding the future for car travel can be cause for significant concern. However, uncertainty can be seen as an opportunity rather than a threat if greater recognition and acceptance is given to the obligation on transport policymakers to play a part in shaping future society, rather than only having a more reactive approach that responds to trends.

In the face of uncertainty, there is a growing body of literature concerning the value of scenario planning (Davidson, 2014). Scenario planning produces a number of divergent plausible future scenarios from which to then consider the implications for present-day policymaking. This paper offers an examination of the challenges, imperatives and opportunities for transport planning and policymaking in the face of an uncertain future. It considers approaches to looking to the future with a focus upon a recent strategic project by the New Zealand Ministry of Transport, involving scenario planning. The paper does not set out in detail the scenario planning exercise and the accompanying work within the project (though this is summarised). It instead focuses its attention upon the insights resulting from the project. The paper highlights different approaches to policymaking and investment decisions and makes the case for moving away from a ‘regime-compliant’ approach towards a ‘regime-testing’ approach. The paper is structured to address the following insights in sequence:

- We are confronting *change* which, because of our limited understanding of cause and effect, is *uncertain*. There is uncertainty concerning what *people* in future will want to do and what *technology* in future will enable us to do.
- Examining the future for car travel indicates a range of future demand scenarios from significant increase to significant decrease in vehicle kilometres travelled.
- To accommodate uncertain change we need *flexibility* both in our thinking but also in the design of systems and infrastructure.
- Change comes about and flexibility is enabled by the fact that it is *accessibility* not mobility that is at the heart of economic and social welfare. Being able to reach people, goods, services and opportunities is affected by our transport, land-use and telecommunications systems, referred to in this paper as the *Triple Access System*.
- There are different *policymaking pathways*. A policymaking pathway is a series of elements of approach that contributes to determination of a policy or investment decision. This is distinct from a policy path (policy actions to be taken, and when to take them). Policymakers have a responsibility to consider the type of pathway best suited to evolving the transport system. They may find it useful to consider the wider *Triple Access System* in support of a better future in the face of uncertainty.

2. Change and uncertainty

Predictions of future change are often based on our *experiences* of past change: looking back over time to observe what has changed (and how quickly) informs our attempts at foresight. Seidl and van Aaken (2009) label this reliance on past experiences as our ‘cultural-cognitive limitations of perception’ (see also Chia, 2004; Narayanan and Fahey, 2004; Banister and Hickman, 2013). Experience of past change reminds us that the rate and nature of change across multiple drivers can vary. It can be sudden and unexpected (e.g. natural disaster) or so slow that from day to day or year to year one is oblivious to its accumulation over time (e.g. ageing or change in land use). The accumulation of change can establish or reinforce the way of the world as we know it, or reflect a gradual and ultimately profound transition towards a new ‘regime’.

¹ <http://transportationist.org/2014/12/03/extrapolations-in-traffic-vs-reality/>.

2.1. Deep uncertainty

Our level of *understanding* of change, i.e. of cause and effect, determines the extent of our ability to anticipate future change (Walker et al., 2010). Walker et al. (2003, 2010) (see also Marchau et al. (2013)) offer a taxonomy of four different levels of uncertainty and suggest analytical tools best suited to each level. The levels are labelled as follows (Walker et al., 2010): Level 1 – ‘A clear enough future’; Level 2 – ‘Alternative futures (with probabilities)’; Level 3 – ‘A multiplicity of plausible futures’; and Level 4 – ‘Unknown future’. Level 4 is also referred to as ‘deep uncertainty’. Many Level 1 and 2 uncertainties are well managed through current analysis and scientific techniques, as these uncertainties result from a lack of information; improved information gathering and use of stochastic processes and statistical analysis can reduce uncertainty (Walker et al., 2010; McDaniel and Driebe, 2005). However, many of the important policy problems currently faced by transport policymakers are characterised by higher levels of uncertainty, which cannot be addressed by gathering more information (Walker et al., 2010). Deep uncertainty occurs when parties to a decision do not know and/or do not agree on the best model for relating actions to consequences or the likelihood of future events (Lempert et al., 2003, 2013; Walker et al., 2003, 2010; Cox, 2012). We suggest, after Walker and colleagues, that current transport demand forecasting and strategic policy-making tools are not sufficient for the change and uncertainty we currently face in the 21st Century; car travel in particular is in a period of deep uncertainty.

2.2. Uncertainty in car travel

New Zealand’s land transport programme has a current expenditure target for the next ten years of \$38.7bn (NZD), including \$10bn (NZD) to expand the road network and improve its quality and capacity. Yet such investment plans are in the face of a country, like several others, that has experienced a decade-long interruption to a long-run trend of growth in car travel. The peak car phenomenon has caused government transport ministries to pause for thought, struggling to make sense of a number of different factors including: a declining share of young people holding driving licences; volatile energy prices; the nature and pace of economic recovery; demographic change; urban renaissance; climate change; the effects of the digital age on how we connect and transact; and the prospects for technological innovations such as driverless cars.

Change in car use has, until recently, been considered a lower level uncertainty. Up to around 2000, car use could be described as something that would ‘inevitably’ rise and keep on rising. However, this has now changed (Stokes, 2013). The post-2000 economic downturn is seen by some as the principal factor at work (see Goodwin, 2011, 2012), suggesting that change in car use can continue to be explained and therefore handled as a lower level uncertainty for the future. However, the degree of ‘coupling’ between the level of economic activity and the level of road traffic has been changing over time, for a number of countries. In New Zealand, for example, the proportional change between 1990 and 2001 was very similar for both economic growth and road traffic growth. Meanwhile from 2001 to 2013, economic growth has been nearly three times the rate of traffic growth (Lyons et al., 2014). This weakening relationship is known as ‘decoupling’ (SACTRA, 1999; Banister and Stead, 2002; Gray et al., 2006). It is not to imply that an important link does not remain, but that its importance may be diminishing and that other factors could be at play including: economic drivers (price, income, productivity); technological effects (smart phones, wearable devices, the internet); and social trends (demographics, consumer preference, location of population). Our understanding of the interplay of such factors remains limited, signifying deep uncertainty. A number of commentators are convinced that we need to look beyond economic conditions to address future mobility (Goodwin and Van Dender, 2013; Stokes, 2013; Kuhnimhof et al., 2013; Delbosch and Currie, 2013).

2.3. Regime transition

Deep uncertainty suggests we may be experiencing a fundamental evolution in the way society operates, known as a regime transition. Geels (2012) considers long-term socio-technical change in terms of the notion of regimes and transitions from one regime to another. A regime encapsulates the way of the world as we know it and within which the various actors engage. It is an “alignment of existing technologies, regulations, user patterns, infrastructures, and cultural discourses” (Geels, 2012: 473). Transition management is a possible approach to bringing about desirable transition from one regime to another, for example in relation to sustainability goals (Loorbach, 2007). Regime transition may also appear as something slowly thrust upon us. History reveals how incumbent regimes can evolve and endure, but then be subject to niche developments that disrupt and destabilise the regime leading to transition to a new regime. For example, Geels has examined the transition from sailing ships to steam ships over a fifty year period and from horse-drawn carriages to motor cars over a forty year period (Geels, 2001). Broadly speaking, the 20th Century has, in many developed economies, been defined by the ‘automobility regime’ (Geels et al., 2012; Dudley, 2014). This has deepened over a period of decades in terms of: levels of car ownership and use; a growing dominance in the built environment of transport infrastructure; and strong symbolic attachment to, and dependence upon, the car.

A particular feature of the automobility regime has been the observed coupling between economic activity and road traffic activity, alongside the long-run trend in traffic growth. The phenomena of decoupling and peak car in the latter part of the 20th Century and the early years of the 21st Century respectively (in tandem with a rapid growth in society’s digital connectivity) may be symptoms of a regime transition taking place in society in the face of an advancing digital age (Lyons, 2015). We suggest that uncertainty of change in periods of regime stability is low (corresponding to Walker’s Levels 1

and 2). Meanwhile in times of regime instability and potential transition, deep uncertainty exists – and this calls for alternative decision-making support and approaches. Deep uncertainty with possible regime transition encompasses significant unknowns concerning people and their behaviours and the unknowns of technological advance.

2.4. Changing demographics and behaviours

The literature examining the peak car phenomenon highlights that aggregate examination of travel demand masks a diversity of travel behaviours for population sub-groups, defined in a number of ways (socially, economically, demographically and spatially) (e.g. [Le Vine and Jones, 2012](#)). [Headicar \(2013\)](#) emphasises the significance of locational distribution of populations, notably between urban and rural, in terms of the consequences for patterns of travel and levels of demand. Efforts continue to better understand why aggregate demand for car travel has seen an interruption to its long-run trend of growth ([Grimal et al., 2013](#)). It is clear that in looking at future change, we need to take into account: how many people will comprise the travelling population; the socio-demographic composition of this population; and where the population is located spatially ([Kuhnimhof et al., 2013](#); [Grimal et al., 2013](#); [Dejoux et al., 2010](#); [Delbosc and Currie, 2013](#); [Headicar, 2013](#)). Particular attention has been drawn to the mobility of young adults. [Kuhnimhof et al. \(2013\)](#) consider the young adult group important because of its pronounced contribution to the recent flattening of car travel. The question as to how the newly established behaviour patterns amongst young adults will persist as this group ages is also key for future development. The nature, extent and consequences of people's adoption of the technologies of the digital age is also recognised as potentially significant to changing car travel, but poorly understood ([Delbosc and Currie, 2013](#); [Le Vine and Jones, 2012](#)).

2.5. Technological advance and inherent uncertainty

Human ingenuity has seen some remarkable technological advances through history. Indeed it is argued that technological advance is exponential. [Kurzweil \(2001\)](#) has described this as the Law of Accelerating Returns in which positive feedback enables the next stage of evolution to capitalise on that of the past. Technology ability, conceptually, is speculated to become a million times greater in 20 years' time and a billion times greater in 30 years' time ([The Emerging Future, 2012](#)). Such considerations have given rise to the notion of the Singularity ([Vinge, 1993](#); [Chalmers, 2010](#)) which refers to a point where machine intelligence exceeds human intelligence. Paralleled by this blurring of science fiction and science fact has been the notion that technological advances can keep pace with or outstrip the pressures placed on the earth's finite resources by economic and population growth – growth which would otherwise have to reach its limits ([Meadows et al., 1972](#)). This notion is known as technological optimism ([Krier and Gillette, 1985](#)). Optimism should not, however, be confused with inevitability. Regardless of the pace of technological advance, there is significant uncertainty regarding the form it will take, the nature of innovation, and the way in which technology will influence practices and the form of society.

Our fascination with technological advance, coupled with technological optimism, can cloud our ability to make sense of particular technological possibilities in terms of the extent to which they may become transformative and mainstream, and over what timescale. There are prominent contemporary examples of this in transport: electric and hydrogen powered vehicles, and – most recently – self-driving cars. All of these have enjoyed or are enjoying the 'hype' of speculation about their future prospects. Prototypes and early models to market can fuel a sense of inevitability. Gartner's Hype Cycle ([Linden and Fenn, 2003](#)) is a means of depicting early progression of an emerging technology. This serves to highlight how the media hype technology, raising visibility of the technology over time towards a 'peak of inflated expectations'. This is then typically followed by negative hype with declining visibility as problems emerge and credibility is questioned such that a 'trough of disillusionment' is reached. Perseverance sees a more measured 'revival' of fortunes over a (longer) time period along a 'slope of enlightenment' that reaches a 'plateau of productivity', marking the start of mainstream adoption. A hype cycle's shape is likely to be context dependent and hence vary a lot in form ([van Lente et al., 2013](#)).

The cycle also depicts the expectations of users. This is distinct from the purchasing behaviour of users ([Jun, 2012](#)). The latter is embodied in a consumer behaviour model of five stages: "(1) problem awareness, (2) information search, (3) evaluation of alternatives, (4) decision to purchase, and (5) actions following purchase" ([Jun, 2012: 85](#)). One of the challenges for potentially transformative technologies, which look to modify such a mainstream product as the motor car, is whether or not they "underperform in the performance attributes most valued by mainstream customers" ([Bergek et al., 2013: 1212](#)). Such underperformance has plagued the prospects of both hydrogen and electric cars in relation to driving range and costs ([Bergek et al., 2013](#); [Bakker, 2010](#)). Incumbent firms struggle with this; prospective new entrants who might otherwise bring 'discontinuous innovation' to the marketplace struggle even more. Incumbent firms have, instead, found greater promise in hybrid-electric power-trains that can more readily offer key performance advantages ([Bergek et al., 2013](#)). [Bartl \(2015\)](#) suggests self-driving cars are at the early technology trigger stage of the hype cycle that precedes the peak of inflated expectations.

Technological uncertainty for transport is further exacerbated by the fact that technological advances that ultimately affect use of the transport system are not confined to transport technologies. Non-transport technologies that affect social and business practices and processes of production and consumption can also affect patterns, and levels, of people and goods movement ([Hubers and Lyons, 2013](#)). Examples of such technologies include refrigeration, credit cards, electricity, fast food, broadband, wireless networks and 3-D printing.

In summary, changes observed in car travel may be attributed to changes in demographics and behaviours, allied with dramatic technological advances over recent years. Digital technologies in particular are now commonplace across many societies and the proliferation of their use is changing, or is changed by, social behaviours. The speed of development and adoption of some technologies has been startling. It remains significantly uncertain how new technologies will permeate society, and the effects this may have, not only on transport but many other spheres. This socio-technical uncertainty contributes significantly to the deep uncertainty facing the future of transport. This calls for novel and resilient frameworks for planning and policymaking. In order to inform and consider such frameworks later in the paper, we next turn to an approach to examining uncertainty.

3. Examining the future for car travel through scenario planning

Diverse quantitative and qualitative techniques have been employed across a number of domains when examining future uncertainty and possibility. Quantitative techniques can include model sensitivity analysis (e.g. Briggs et al., 2012), stochastic modelling (e.g. Maqsood et al., 2005), Monte Carlo simulations (e.g. Spinney and Watkins, 1996) and Bayesian Networks (e.g. Das, 1999). Qualitative techniques include Delphi (e.g. Sourani and Sohail, 2014), roadmapping (e.g. Phaal et al., 2012), backcasting (e.g. Akerman and Höjer, 2006 and Geurs and van Wee, 2004b) and scenario planning (e.g. Hickman et al., 2012 and Hickman et al., 2014). Quantitative and qualitative techniques can also be used in combination (e.g. Song et al., 2015).

Recognising that it faces deep uncertainty, the New Zealand Ministry of Transport in 2014 undertook a major piece of strategic work centred upon the use of scenario planning. This technique was selected because of its ability to help: demonstrate how divergent, plausible futures can emerge; avoid 'group think' and foster 'contrarian thinking'; and challenge conventional wisdom (Roxburgh, 2009). The work had, as its focal question: *How could or should our transport system evolve in order to support mobility in the future?* (Lyons et al., 2014). A number of elements accompanied and informed the scenario planning exercise itself. These included: expert debate concerning the phenomenon of peak car; examination of the history of the motor car; and consideration of a plausible regime transition to a world beyond 'automobility'.

The scenario planning exercise involved a wide cross-section of expertise and stakeholders in the identification of key drivers of change and critical uncertainties for a time horizon of 2042. Collaborative workshops elicited a wide range of drivers that could shape the way society operates, categorised as Social, Technological, Economic, Environmental and Political (STEEP). Subsequent workshops reviewed and shortlisted these drivers according to how certain they were and how important they were to the focal question. Informed by this, candidate pairs of 'critical uncertainties' to define a two-by-two scenario matrix were put forward. These were tested against criteria that included: exclusivity with other drivers; factors the Ministry of Transport had little control over; and factors that had resonance with national and international debate over major issues facing society. Final selection of the preferred pair of critical uncertainties was also guided by two key unknowns: what society will *want* to do in the future and what society will be *able to afford* to do in the future.

The critical uncertainties chosen to frame the scenarios were:

- (i) *Accessibility preference*. This was identified as a critical uncertainty concerning the role of technology and whether society would prefer to access people, goods, services and opportunities by virtual means or by physical means.
- (ii) *Relative cost of energy*. This critical uncertainty concerns the cost of not only fuel and electricity, but all energy that goes into goods production and operation. The relative cost of energy can act as a constraint or a freedom, influencing what people will be able to do.

Four plausible and divergent scenarios were developed for future transport and society in New Zealand (Fig. 1).

The project developed a narrative for each scenario, reflective of key drivers of change. It also outlined plausible paths from the present to each of these 2042 futures (see NZ MoT (2014) for a detailed account of the scenarios and related paths). Alongside the narratives for these different worlds, a simple structural model was developed to estimate quantifications of levels of car travel in 2042 for the different scenarios. The scenarios can be summarised as follows (with change in total car traffic (vehicle distance travelled) in 2042 compared to 2014 shown in brackets):

- *Co-operative and close* (↓ 3%) – While people value face-to-face contact, high energy costs have forced them to adapt and focus upon proximity. New Zealanders persevered through challenges by simplifying their lifestyles. They value strong communities, resourcefulness and simplicity.
- *Travellers' paradise* (↑ 35%) – New Zealand is awash with cheap energy, which powers rapid growth. Citizens prefer to connect with one another face-to-face as digital life feels less authentic. People support network pricing to ensure they have the transport system they need. They value individual liberties, privacy and self-reliance.
- *Digital decadence* (↓ 25%) – People enjoy a vast array of experiences and services anywhere, anytime via their digital interfaces. Many people now feel more comfortable in digital worlds than in their own skins. They value openness, collaboration and innovation.
- *Global locals* (↓ 53%) – In response to rising energy costs, society invested in energy-efficient technologies and virtual interfaces. Society has moved from car dependence to virtual confidence and reliance. People value adaptability, efficiency and ingenuity.

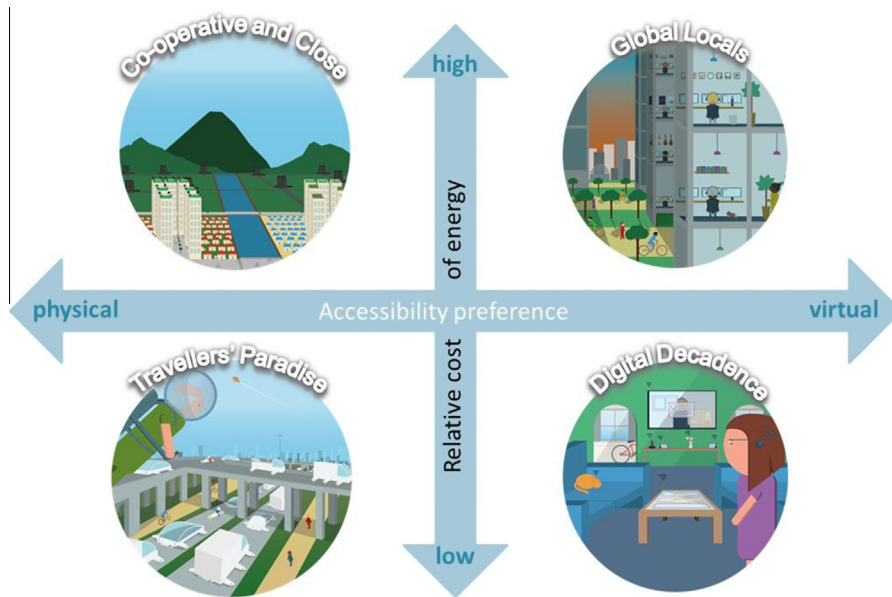


Fig. 1. Plausible future scenarios for New Zealand in 2042.

The preceding four scenarios demonstrate a spectrum of possibility with regards to the interplay of accessibility preference and relative cost of energy. Yet these are not the only four possibilities for the future. As with any such scenario planning exercise, the purpose is not to assert that a particular set of scenarios precludes the existence of many others, nor that one scenario is preferred over another. However, the set is intended to be pertinent to the focal question and bring uncertainty to the fore. In the face of it being plausible that very different futures might emerge, how should planners, policymakers and other stakeholders determine a desirable course of evolution for the transport system? The remaining sections of the paper address this, drawing upon the project's findings and conclusions (Lyons et al., 2014) and developing these further through addressing wider literatures.

4. The flexibility of thinking and design

Policymakers and their advisors employ a range of analytical tools intended to inform, especially in relation to investment decisions. Commonly recognised approaches concern the use of transport modelling (to estimate future travel demand and travel time savings) and appraisal – economic, environmental or multi-criteria (with economic appraisal focused upon estimating the costs and benefits of an investment over a period of many years into the future). Preceding such analytical tools is a degree of examination of the investment options that would fulfil the policy objective in question. An important question surrounding decision-making is the extent to which the information produced from the analytical tools is used to guide a decision, as distinct from information being sought that can justify a decision (i.e. information as ammunition (Owens, 2005)).

4.1. Flexibility of thinking

Decision-making takes place in a wider context of professional debate and public opinion concerning the issues and possibilities at hand. With these points in mind, there is a need – highlighted through the Ministry of Transport work – to acknowledge the range of different preconceptions that are held by the actors involved in the process of examining the future and informing and making decisions that help shape it. Such preconceptions have previously also been referred to as 'frames' (see Schon and Rein, 1995). This builds upon the 'futures cone' taxonomy (see Bland and Westlake, 2013). Individuals and organisations, including the authors of this paper, may align with one or more of the following outlooks:

- *predicted* – an extrapolated outlook for the future (e.g. growth in transport demand) giving a (misguided) sense of confidence;
- *presumed* – an outlook for the future on a basis of probability and instinct but without proof (e.g. the emergence of electric and self-driving cars);

- *practical* – an outlook for the future that aligns best with immediate interests and imperatives (e.g. the need for expanded transport infrastructure to support economic recovery, or the need to show a degree of alignment with the thinking of the client in order to protect future business prospects);
- *plausible* – an outlook for one or more future possibilities whose potential emergence cannot be denied based on current knowledge (e.g. the demise of the motor age); and
- *preferred* – an outlook for the future that is desirable (so therefore value laden – e.g. growth in aviation to support global business, or growth in cycling and walking to support healthy urban environments).

What is of concern is that while such preconceptions are present, they may not be consciously acknowledged by those who hold them, and are rarely declared to others. Myers and Kitsuse (2000) offer a critical reflection – effectively spanning such outlooks – on the state of planning, which still seems subject to similar concerns some 15 years later. Concerns include: the risk of regression towards prediction in place of vision; complicit support of practical outlooks; and little confidence in articulating plausibility in the absence of ‘hard’ data. Vanston and Vanston (2004) provide important consideration of how those involved in forecasting are subject to inevitable biases in the course of making expert judgements and assumptions that shape the outcomes.

By exposing and encouraging a realisation of the outlooks that are at play, it is possible to introduce greater flexibility of thinking and open-mindedness when engaging with the matter of uncertainty. Without doing so, we fail to diminish the prospect that the power of particular actors and their outlooks will drive or distort knowledge (Owens, 2005). We should instead aspire to shared outlooks, strengthening knowledge to enable more robust decisions. This is especially important in circumstances of complex decision environments involving uncertainty. In these environments it is found that individuals become subject to multiple decision-making biases as part of an heuristic approach to dealing with uncertainty. For an excellent exposition of such biases see Carter and Kaufmann (2007). Biases include: *bandwagon effect* (falling in line with beliefs or actions of others); *confirmation* (only focusing on information that supports a position rather than that which might refute it); *escalation* (extending a previous unsatisfactory approach allowing sunk costs to influence decisions); and *imaginability* (probability correlated to ease of being able to imagine outcomes).

As Hammond et al. (1998) note, while such ‘hidden traps’ in decision-making exist, by becoming more alert to them we are better able to compensate for them. What is perhaps especially frustrating is that such observations are not new (see Evans, 1982). A failure to account for uncertainty – and indeed to establish the degree of uncertainty faced – can be a determinant of policy failure (Walker et al., 2010). Marchau et al. (2013) highlight a tendency for transport futures analysis to adopt approaches that better suit modest uncertainty rather than the deep(er) uncertainty actually faced. If we consider that uncertainty has deepened, then our exploration of the future and the design of policy measures and investments must be more flexible.

4.2. Flexibility of design

It is apparent from the literature that researchers are growing increasingly alert to the uncertainties that transport policy faces, and are engaged in examining alternative policymaking approaches that build in greater flexibility than traditional approaches. It may be that flexibility of thinking is hampered by a lack of flexibility in our current approaches to policy measures, to investment options and in turn to the design of new transport schemes. As Hamarat et al. (2012) observe with reference to de Neufville and Scholtes (2011), “[a]daptivity and flexibility are of great importance under deep uncertainty and should be taken into consideration in policy design” (Hamarat et al., 2012: 1). Several emerging frameworks, that incorporate flexibility through policy design, include the application of Real Options Analysis (ROA), Adaptive Policymaking and Dynamic Adaptive Policy Pathways. ROA appears to be receiving growing (academic) attention and indeed has seen some level of application, even if not formally under this heading (Treasury, 2009).

ROA is a “framework to address decision-making in a world of uncertainty” (Miller and Park, 2002: 140). Akin to options in the finance sector, real options concern physical infrastructure. In both cases, an option represents securing a right (as opposed to an obligation) to be able to do something at a later date, or under given circumstances (de Neufville, 2003). “A ‘real option’ is a decision taken today that makes it possible for policy makers to take a particular action in the future” (BITRE, 2014: 13). For infrastructure development, this means building flexibility in at the design stage which provides the means, should it ever be needed, to accommodate a possible but uncertain later development that a less flexible design would be unable to. Building in flexibility will typically introduce greater cost than not doing so. However, the dividend – should the uncertain later development arise – could be significant. Zhao et al. (2004) refer to the example of a parking facility where ROA is used to consider the merits of designing the structure to be strong enough to accommodate vertical expansion (i.e. building additional floors) should future demand exceed projections. De Neufville (2003) refers to the example of a river bridge built to be able to carry trains in future – not needed at the time but providing the ‘right’ to later be able to do so (as indeed proved to be the case). Further illustrative examples and examination of ROA are available (e.g. Treasury, 2009; Grimes, 2011; Ofgem, 2012; de Neufville, 2003; ACIL Allen Consulting, 2014). Conventional economic appraisal of design options allied to assumed future conditions would disadvantage such flexibility. ROA accounts for the value of the flexibility in the face of uncertainty. This can mean that a more expensive solution is judged, on balance, a better investment.

ROA is a routeway to mitigating against costly lock-in (Foxon, 2007), and turning future uncertainty into financial opportunity. It can involve three phases (de Neufville, 2003): (i) the examination of areas of uncertainty of most relevance;

(ii) consideration of design options that could be implemented to build in flexibility; and (iii) the ongoing monitoring of how the uncertainties unfold over time to inform and ultimately trigger exercising the opportunity to take advantage of the built in flexibility. There is a need, in evolving our future transport system, to beware of a reliance on standard cost-benefit analysis. Its static nature has been a cause for concern – in circumstances of uncertainty – amongst academics and practitioners for some 20 years (Ofgem, 2012). It should, however, be noted that ROA can become complex if used as a quantitative tool since assumptions are still called for in second-guessing possible future circumstances in which flexibility yields value (Grimes, 2011). In this respect, it can be suggested that ROA might fall prey to heuristics and decision biases (as discussed earlier) in its application in decision-making. What follows, is the case for (also) using ROA as a framework for a qualitative approach. This can combine with scenario planning to help decision-makers explore how to bring uncertainty and flexibility together (Miller and Waller, 2003; Alessandri et al., 2004). In this way we start to move our thinking away from the ‘predict and provide’ approach to a more adaptive approach that may hold better prospects of negotiating uncertainty and avoiding the worst outcomes, namely ‘policy failure’ (Marchau et al., 2010).

Allied to the thinking behind ROA, Walker et al. (2001) proposed the notion of Adaptive Policymaking (APM) that would allow “policymakers to cope with the uncertainties that confront them by creating policies that respond to changes over time and that make explicit provision for learning” (Walker et al., 2001: 282). It is only in recent years that, following attention from academia, practical applications of APM are being explored, such as in the Dutch Adaptive Delta Management strategy (Ministry of Infrastructure and Environment, 2014). Van der Pas et al. (2012) explored (through workshop activity with domain experts, policymakers and stakeholder representatives) reasons why further practical examples of APM are limited (see also Marchau et al., 2010). Their findings suggest that a more adaptive approach to policymaking faces serious inertia in moving away from established approaches, as well as political difficulties associated with using and explaining the use of APM.

Dynamic Adaptive Policy Pathways (DAPP) is a further extension of APM and has been receiving academic interest in recent years. DAPP provides a framework for connecting short term targets with long-term goals, with decision points informed by monitoring of deep uncertainties. Haasnoot et al. (2013) present an application of DAPP for long-term water management of the Rhine Delta in the Netherlands. Their findings suggest DAPP stimulates planners to incorporate flexibility and adaptation at the design stage of projects that allows corrective actions over the life of their plans.

Recognising an imperative for flexibility in thinking and design leads to the need to determine a focus for its application. A framework is required in order to help guide decision making processes in transport. Such a framework we believe arises from planning for accessibility rather than (only) mobility.

5. Planning for accessibility

Through the two key considerations of what society will wish to do and what society will be able to do in future, the Ministry of Transport work underlined a fundamental tenet of (transport) planning; namely the development of the built environment as a means of making people, goods, services and opportunities (more) accessible to one another (Farrington, 2007). The evolution of transport systems has been driven by the pursuit of improved accessibility, not least because this is a key enabler of economic activity. In this sense, physical mobility is a means to an end – but not the *only* means. Land use planning has long been recognised as another determinant of accessibility (in concert with transport planning). Greater spatial proximity lessens the need for physical (motorised) mobility to transcend distance. As the digital age advances (Lyons, 2015), a further means has become more prominent – namely digital connectivity. These three elements make up what we refer to as the Triple Access System. The existence and interconnectedness of these three elements is not new but the degree of maturity of digital connectivity is now such that its contribution to accessibility has become much more pronounced.

5.1. The Triple Access System

Drawing upon the four scenarios from the Ministry of Transport work, we articulate the notion of the Triple Access System (TAS – Fig. 2). This recognises that today’s society and its future are significantly defined by our land use, transport and telecommunications systems that are the enablers of economic and social activities (with their associated resource requirements and associated negative externalities). There are two and three-way interactions between the three elements and their use, with the latter reflecting enduring aspects of the human condition:

- *Spatial proximity* – we are social beings that need physical intimacy and collective comfort and security.
- *Physical mobility* – we are mobile biological beings that need sustenance and are able and required to go forth and seek it out, gather it, store it and share it.
- *Communication* – we are imaginative and communicative beings who exchange ideas in order to flourish and survive.

As each sub-system of the TAS and its use continues to evolve, there is much research that takes place in an effort to understand the relationships and cause and effect. For a comprehensive recent review of how transport and land use affect accessibility in cities including the notion of *accessibility pathways*, see Rode et al., 2014. Less understood is the net effect of the multiple inter-relations between telecommunications and transport (for authoritative reviews see Mokhtarian, 2003 and

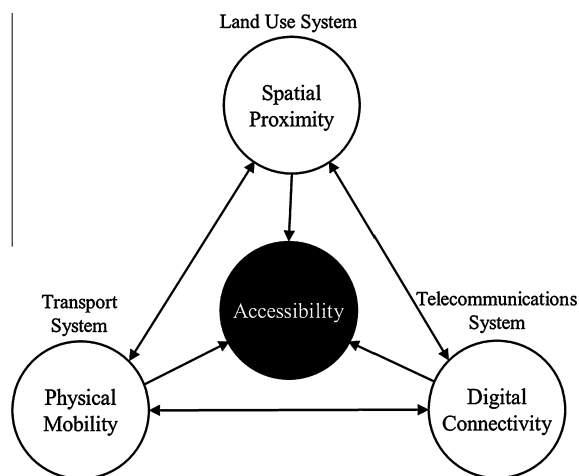


Fig. 2. Triple Access System.

Mokhtarian, 2009). Perhaps least understood is the relationship between land use and telecommunications (though see Page and Phillips, 2003, for a case study examination of Jersey City), albeit that notions of ‘smart cities’ are attracting much interest (e.g. Maeng and Nedović-Budić, 2008). There appears to be very little examination of the *three-way* interaction of the TAS, certainly in relation to empirical insight (for an early critical exploration see Marvin, 1997). Comprehensive understanding, let alone modelling, of the TAS remains elusive. This is because of the complexity of the interactions involved and the dynamic nature of the TAS, both in terms of its physical components and their use. Telecommunications (a more recent force to be reckoned with as part of the TAS) has appeared relatively ignored by researchers and policymakers “[d]espite the fact that telecommunications networks are central to modern urban life” (Moss et al., 2006: 235).

A particular focus on the transport system and land use system components of the TAS in the past has fundamentally contributed to the development and layout of cities. Planners and policymakers’ decisions on how to evolve the built environment contribute fundamentally to defining paths of society’s spatial and behavioural identity. Rode et al. (2014), for example, contrast the path of urban sprawl (strongly linked to widespread use of the car and “widely demonstrated to be excessively wasteful and unproductive” (Rode et al., 2014: 37)) with that of compact urban development (focused upon the importance of proximity and efficient collective transport modes). In the absence of the proliferation of telecommunication systems, many cities developed to reflect the dominance of the transport and land-use elements of the TAS. Hickman et al. (2014) use the example of Auckland where an embedded automobility system creates its own inertia, developing a culture that appears to support car-oriented lifestyles. The challenge for planners and policymakers now is to account for how the telecommunications system and its use exert new – and possibly quite profound – influences on physical mobility and spatial proximity.

Uncertainty about future demand for transport derives from uncertainty about the scale and makeup of future access. However, we suggest what follows is an important *opportunity* – and indeed imperative – to focus upon the TAS, through the lens of (qualitative) ROA, as a means of embedding flexibility into the built environment. There is critical uncertainty concerning society’s future balance of preference between physical and virtual accessibility (Fig. 1), and the affordability of different forms of access. This is accompanied by the fact that the evolving composition of the built environment, and the capacity it provides for access itself, influence demand. However, this crucially underlines that users of the built environment are adaptable – they are capable, over time, of configuring their activities to the capacity and forms of access available. There is a need therefore to refrain from a ‘predict and provide’ approach. Inherent in this is the notion of the self-fulfilling prophecy – the very act of catering for a predicted future can help bring that future about. In this context, any notion of the prediction being ‘accurate’ is illusory.

5.2. Explore, decide and provide

It is therefore not a matter of predicting the future but more consciously shaping the future in a way that resurrects an important quality of planning itself, namely to explore the question of how to develop a *better* future. We suggest that this moves us from ‘predict and provide’ to ‘decide and provide’ (see also Dales, 2013). The TAS, if designed appropriately and viewed as a whole rather than only in terms of its component parts, can embody resilience and flexibility. This is crucial in the face of uncertainty over what society will want to do and what it will be able to afford to do. Hence we should undertake to *decide* on a policy path that *provides* an evolution of the TAS and which builds in options so that along that path, as more information becomes available, adjustments can be made. Much planning debate would clearly be called for in order to

produce candidate policy paths. As a simple illustration, the following long term objectives, alongside existing policy targets, could set the policy framework for the TAS (either at city, regional or national scale):

- (i) maintain at 2015 levels (with the option to reduce) the overall land take of surface transport (with further options for changed use of land take between modes and in relation to improved operating efficiency and carrying capacity within modes);
- (ii) increase by x per cent annually (with the option to accelerate), the population density of urban areas;
- (iii) increase by y per cent annually (with the option to accelerate), the proportion of population with access to superfast broadband (with the option to raise the threshold definition of 'superfast').

Accessibility in practice is a complex phenomenon to measure and understand. It relates to location of activities, temporal considerations and the needs and opportunities of the individuals or organisations concerned (Geurs and van Wee, 2004a). Yet its complexity should not be a signal for reversion to more partial examination of its system components and over reliance on quantitative tools ill-equipped to deal with complexity and uncertainty. Expert input is called for, but the TAS should remain the focus of forward planning for economic, social and environmental wellbeing. In relation to the two critical uncertainties examined by the Ministry of Transport's work, two important influences that feed into the TAS are those of technology and people. Technological inventiveness continues to abound in ways that has the *potential* to affect the means and experience of both physical travel and digital connectivity. A key question is which concepts and inventions will translate into innovation and widespread uptake so as to be transformative? Better understanding the characteristics and preferences of existing generations and exploring plausible characteristics and preferences of future generations is likely to assist in managing this uncertainty.

6. Responsibility for the policymaking pathway

As Marchau et al. (2010) note, "although uncertainty has attracted a great deal of interest in transport policy and planning since the 1990s, the ways it can or should be taken into account in policymaking are still developing" (Marchau et al., 2010: 941). In our view, the imperatives for policymakers to handle uncertainty have grown. However, change in the policymaking approach is unlikely to be rapid. We conclude our paper in this section by setting out two different *policymaking pathways* which we believe may assist in guiding this evolution. The distinction between a policymaking pathway (a *process* for making a policy) and a policy path (policy actions to be taken, and when to take them) should be noted. The two policymaking pathways are depicted in Fig. 3. This is intended to capture, in simplified form, the key considerations within the paper as a whole.

The first of these we refer to as the *regime-compliant pathway*. This pathway is characterised by an (implicit) reliance on the way of the world as we have known it, in relation to transport, continuing. This way of the world has been described by Geels et al. (2012) as the regime of automobility. Motorised mobility has been encouraged, and the motor car in particular has come to dominate with both functional and symbolic significance. The longevity and intensity of automobility varies by country and over time. Nevertheless, the regime-compliant pathway is geared towards evolution of the regime rather than transition from it. Concealed uncertainty, through reliance on trends and historical cause–effect relationships, is used to push policy decisions towards a legitimate outcome. The second pathway is the *regime-testing pathway*. This pathway is characterised by embracing uncertainty and indeed deep uncertainty, i.e. it is plausible that the incumbent regime is significantly weakening and that signs of regime transition are emerging. Such plausibility does not preclude a continuation of the incumbent regime. However, it guards against both a *reliance* upon this regime and against policy failure. The second pathway also engenders a proactive stance in terms of not only responding to uncertainty, but treating it as an opportunity to shape the future.

The setting out of two contrasting policymaking pathways is not to imply that only two pathways exist, or in fact that they are in reality linear in nature. Nor are the two pathways polar opposites on a spectrum of policymaking approaches. We suggest that an array of different pathways exists in practice (including ones which may combine elements of those depicted). Reflecting the messages of Scott and Baehler (2010), while the proposed step-wise pathways fit the 'rational comprehensive' approach to policy, we also propose that the two pathways are treated more as a flexible learning aid rather than as strict algorithms for practical application. Fig. 3 is intended as illustrative rather than exhaustive in this respect – for example reference to ROA does not preclude alternative techniques such as DAPP. As a learning aid, the imperative is nevertheless to be mindful of the need to strongly question what sort of pathway is appropriate in practice for the circumstances we face.

Referring to the taxonomy of four different levels of uncertainty by Walker et al. (2010), we can suggest that a regime-testing pathway would be better suited to Level 3 and Level 4 (deep) uncertainty. Meanwhile, a regime-compliant pathway is more suited to Level 1 and Level 2 uncertainty. Current practices are, broadly speaking, more strongly aligned with a regime-compliant approach. We recognise that considerable inertia would in practice apply to any realignment towards regime-testing. Such inertia will relate to: systematised thinking across a multiplicity of actors; vested interest (psychological, financial, political) in the regime; resource limitations in terms of new thinking and supporting tools (especially in times of austerity); and the requirements for and importance of public consultation and engagement. It is

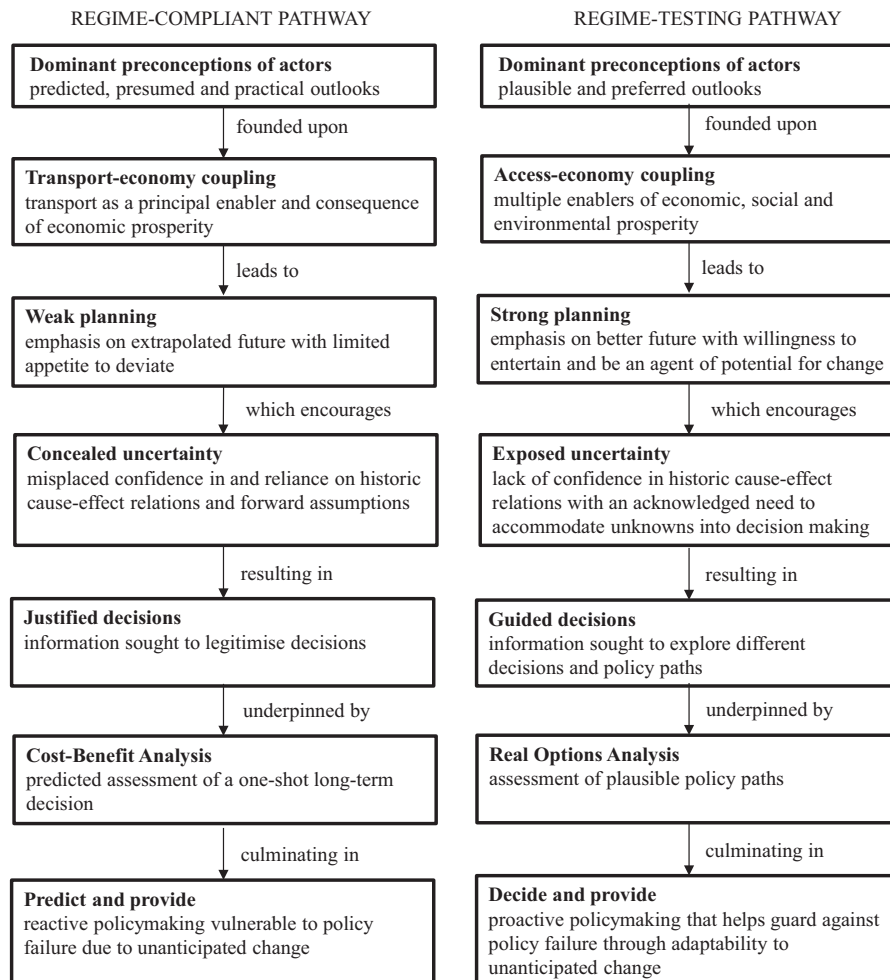


Fig. 3. Policymaking pathways.

ultimately in the hands of policymakers themselves to subscribe to a given policymaking pathway or to commit to adapting from one policymaking pathway towards another.

There are some signs that attention is indeed being given to how policymaking pathways should potentially change based on insights for New Zealand and the United Kingdom. In New Zealand, the Ministry of Transport work has helped challenge mindsets through the approach taken to its ongoing Strategic Policy Programme. The work has been and continues to be presented by the Ministry and discussed with several other agencies within and beyond the transport sector. Indeed, in December 2015 a Select Committee inquiry was announced into the Future of New Zealand's Mobility. In the United Kingdom, the Department for Transport (DfT) has been specifically examining the factors affecting future travel demand in an effort to engage with the uncertainty associated with the peak car phenomenon. In its 2014 Road Investment Strategy (DfT, 2014), while there are many traits associated with regime-compliance, there is also an explicit consideration of uncertainty to a greater extent in the road traffic forecast scenarios than previously seen.

This paper has sought to examine transport planning and policymaking in the face of an uncertain future. There are big challenges to be faced ahead but also important opportunities to address those challenges and even capitalise upon them. Turning challenge into opportunity will depend upon the approach we take. How much, and how rapidly, we are willing and able to change the nature of our current approach to policymaking, in a way that becomes more compatible with the uncertainty we face, is unclear. However, willingness to entertain such change is an important first condition. It is hoped that the insights offered by this paper will help encourage and inform that willingness.

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