MATURITY MODEL FOR TRANSPORT SYSTEMS THINKING

THINK PIECE PAPER

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ABSTRACT

How well are we doing at looking at the bigger picture when deciding on transport interventions?

Environmental Sustainability already forms part of New Zealand's Transport Outcomes Framework, but effective decarbonisation requires close collaboration between transport decision makers and the decision makers in other areas of a wider system, such as urban planning and public health. In addition, decarbonisation involves trade-offs and co-benefits not only with respect to other transport outcomes, but also various outcomes of the decision-makers in other parts of the system, thereby exhibiting the typical characteristics of a "Wicked Problem".

We will describe a maturity model to assess how well transport projects, programmes, and organisations are placed to tackle this wicked problem, along with a set of tools that can be used to lift this maturity to achieve better environmental outcomes.

The model considers 5 key determinants of effective transport interventions:

1. **Outcome Metrics**
   Articulating and monitoring suitable leading, current, and lagging outcome metrics.
2. **System Linkages**
   Linkage to decision-making outside of transport for wider system benefits.
3. **Value-chain integration**
   Efficiency of information exchange along the transport intervention value-chain.
4. **Technology**
   Effective use of technology at an appropriate level of risk appetite.
5. **People-Centred Design**
   Iterating towards solutions based on a deep understanding of the people affected and involved.

A simple self-rating exercise will be offered to attendees live, as part of the presentation.

INTRODUCTION

Environmental Sustainability already forms part of New Zealand's Transport Outcomes Framework (MoT, 2020), but effective decarbonisation requires close collaboration between transport decision makers and the decision makers in other areas of a wider system, such as urban planning and public health. In addition, decarbonisation involves trade-offs and co-benefits not only with respect to other transport outcomes, but also various outcomes for the decision-makers in other parts of the system, thereby exhibiting the typical characteristics of a "Wicked Problem" (Rittel & Weber, 1973).

As transport interventions move through phases such as planning, business case, design, procurement, construction, operation, maintenance and end-of-life, they are progressed as projects and/or programmes by different organisations. Each has a responsibility to give effect to transport outcomes, including decarbonisation, but each also has different levels of capability and capacity for tackling this wicked problem. This can result in significant discrepancies between intended and achieved outcomes of transport interventions.

We are proposing 5 key determinants for delivering effective transport interventions in the face of this challenge, applicable at each phase, which can be used as an assessment and diagnostic tool to improve decarbonisation and wider transport outcomes:

1. **Outcome Metrics**
   The ability to articulate and monitor suitable leading, current, and lagging outcome metrics.

2. **System Linkages**
   Effective linkages to relevant decision-makers beyond the transport system (e.g. urban planning, health, economic development, etc) to understand and leverage the dynamics of this wider system.

3. **Value-chain integration**
   The ability to efficiently share information between the phases of the transport intervention.

4. **Technology**
   Effective use of-, and allowance for- technology to deliver transport outcomes, at an appropriate level of risk appetite.

5. **People-Centred Design**
   The ability to iterate towards solutions based on a deep understanding of the people affected and involved in the transport intervention.

The remainder of this paper will cover each of these determinants in turn – describing different levels of maturity, their potential impact on decarbonisation outcomes, tools to raise the maturity levels, and illustrative examples.

MATURITY MODEL APPROACH

We use a maturity model to describe five different levels of capability in each of the key determinants for delivering effective transport interventions. The level descriptions are illustrative only, and kept at a level of abstraction intended to leave them equally applicable to all phases of a transport intervention, while still able to make meaningful distinctions between the maturity of different projects, programmes, and organisations.

The model should apply as much to a transport authority proposing an indicative business case, as to a supplier of a design & construct contract, in identifying opportunities for improved decarbonisation and wider transport outcomes.

Between the project sponsor, project director, and project manager, the level descriptions should facilitate an indicative self-assessment that can be carried out without any further investigation. The earlier in the process that the self-assessment is carried out, the greater the range of options for improved outcomes.

Outcome Metrics

"You get what you measure" - Richard Hamming

The value of outcome metrics may seem obvious, but the quality and application of such metrics varies widely across transport projects. Until a recent update to the investment decision-making framework of Waka Kotahi, including the benefits management approach, the outcome metrics chosen to make an investment decision did not align with the benefits realisation measures, making an assessment of investment decisions fundamentally flawed (Waka Kotahi, 2020).

In terms of decarbonisation, the benefit realisation reviews of transport projects up until 2019/20 also did not include environmental outcomes, instead focusing on travel time savings, journey time reliability, safety, fuel savings, and project costs (Waka Kotahi, n.d.).

A valid question for the maturity assessment is therefore even just to ask whether an environmental outcome metric is included for the current phase of the transport intervention, and whether it is given the appropriate weight and visibility among stakeholders.

The biggest impact on environmental outcomes will typically come in the early phases from the choice of transport intervention (e.g. provision of public transport & active mode options), but design choices, construction sequencing, operational concepts, and maintenance decisions each have an impact on the carbon emissions resulting from the transport intervention.

Outcome metrics can take a long time to register after the actions causing a change take place, so suitable intermediate proxies (output and input metrics) should be defined as needed to guide real-time decisions (e.g. during the operations phase), and may be further enhanced by real-time and predictive reporting. Short-term operating decisions causing disruptions to the public transport network, for instance, may have long-lasting effects on mode choice (and therefore on carbon emissions), so the value of having these metrics available in real time and as input into future predictive models cannot be underestimated.

The table below summarises characteristics that might describe the approach to outcome metrics at different levels of maturity:

Maturity Level	Outcome Metrics
5	Effective reporting on real-time & predictive metrics consistent along the phases of the intervention, with clear outcome owners.
4	Frequent reporting on relevant metrics that connect different intervention phases, visible to key stakeholders, and including leading, current, and lagging metrics.
3	Occasional reporting on metrics that have some relationship with outcomes. Some overlap in process stages.
2	Sparse metrics incompatible between intervention phases. Measured infrequently. Stakeholders not aligned on outcomes
1	Counter-productive metrics or no metrics defined. Outcomes poorly defined. No visibility by stakeholders

Table 1 - Maturity levels for outcome metrics

System Linkages

"Learn how to see. Realize that everything connects to everything else" - Leonardo da Vinci

Transport decisions have wide-reaching impacts on outcomes formally owned by other stakeholders, including on housing affordability, access to employment, injury rates and general health, and, of course, on the environment.

Conversely, other stakeholders may have significant influence over transport outcomes, such as the influence of councils and the media on mode choice, the influence of developers and land owners on route choice, the influence of overseas regulators on the make-up of our vehicle fleet, the influence of police operations on accident rates, etc.

The transport "system" therefore exists within a much wider and interconnected system of different system actors – beyond integrated land use and transport planning. As such, transport interventions should be made with an understanding of these interdependencies, and an assumed responsibility for the resulting system-wide impacts.

Typical decarbonisation strategies for transport include agglomeration, mode shift, and electrification, which involve both co-benefits and trade-offs with other transport- and system-wide outcomes. For example – mode shift is expected to have significant health benefits from active modes and reduced accident rates for public transport users – while agglomeration can have negative impacts on greenspace, crime rates, and poverty.

A mature approach to transport interventions should therefore directly involve a wide range of system actors in two-way conversations at all phases of the intervention - to better understand the inter-relationships and identify ways to share risks and jointly invest in shared outcomes:

Maturity Level	System Linkages
5	Close collaboration between actors in the wider system towards common, overarching goals and shared risk/investment
4	Bilateral collaboration between some system actors towards a common goal, but with discrete means
3	Awareness of other system actors and the interaction between them, with attempts at mitigating externalities
2	Limited awareness of link with other system actors without intention of addressing externalities
1	Lack of awareness of link with other system actors.

Table 2 - Maturity levels for system linkages

An example of an attempt to bring together key stakeholders to develop a common understanding of the challenges and potential solutions for a 30y spatial framework for Tauranga's Te Papa peninsula, including key transport interventions, is reported by Lucca & Krieg (2020). The process included Tauranga City Council, Waka Kotahi, Regional Council, Kāinga Ora, Accessible Properties Limited, Ministry of Housing and Urban Development and mana whenua, to work towards common and integrated outcomes, such as focus areas for regeneration and investment.

Value-chain Integration

The phases of a transport intervention can also be described as a value-chain: from planning to business case, design, procurement, construction, operation, maintenance and end-of-life. As discussed in the section on outcome metrics, each phase has its own contribution towards the project outcomes, but a detailed understanding of the downstream phases is often not available during the earlier phases, so that decisions in earlier phases can result in unintended consequences downstream.

A good example is the choice of grass as a landscape treatment in transport interventions during construction to reduce costs. Not only does this result in much greater whole-of life costs than using native shrubs once maintenance is factored in, but it is also a less efficient carbon sink (Waka Kotahi, 2014).

Between each phase, information of prior work and knowledge of the original intent is also lost in the hand-over process, resulting in sub-optimal outcomes.

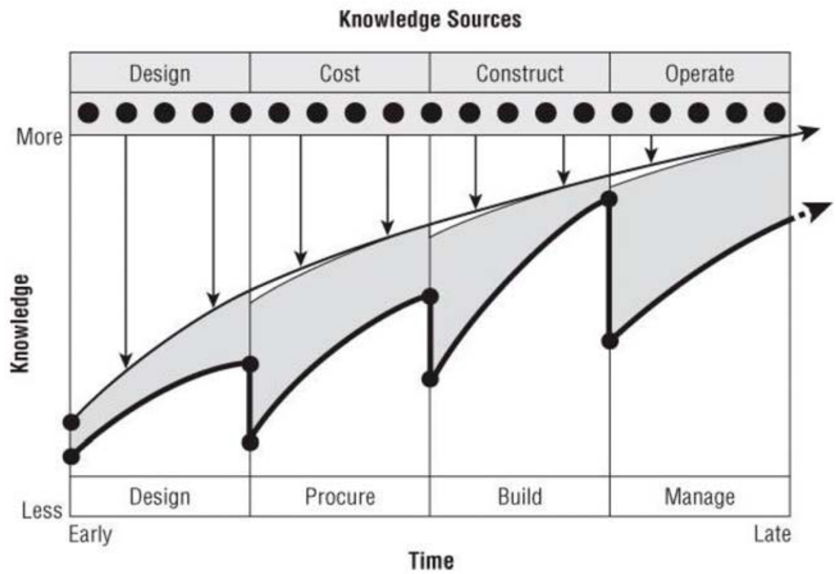

Figure 1 – Potential knowledge loss along value-chain (Zima K., Plebankiewicz E. & Wieczorek D. 2020)

Avoiding unintended consequences and optimising the outcomes from a transport intervention therefore requires good exchange of knowledge and information in both directions along the value-chain. Early phases need to directly involve experienced practitioners of downstream phases to understand the likely implications of planning and design decisions, while later phases can benefit from well documented plans and assumptions developed during earlier phases to ensure outcomes remain aligned, and assumptions can be re-examined over time:

Maturity Level	Value Chain Integration
5	Clear understanding and seamless collaboration along the full value-chain to an agreed vision.
4	Agreement on an overarching vision, with close collaboration between adjacent value-chain actors
3	Understanding of adjacent value-chain actors and their drivers, along with good information exchange.
2	Limited understanding of adjacent value-chain actors.
1	Competition or conflict between adjacent value-chain actors.

Table 3 - Maturity levels for value chain integration

Technology

New Zealand's national transport technology systems are rapidly ageing (Radio NZ, 2020), with mounting technology debt and risks of failure.

Despite this, there are examples of technology being used successfully to improve transport outcomes – such as the introduction of dynamic lanes on Whangaparaoa Road (Auckland Transport, n.d.) as a way to manage peak demand without road widening, and the likely additional demand (and emissions) this would induce.

More can be done to consider technology options alongside traditional transport interventions to deliver transport decarbonisation outcomes – e.g. congestion charging instead of road-building, demand-responsive transport instead of cutting under-performing public transport services, support for e-bike infrastructure instead of car-parks, improved ticketing systems instead of public transport promotion campaigns, etc.

Technology can also play an important part in decarbonising the process of delivering, operating, and maintaining traditional transport infrastructure. Improved digital engineering models allow effective remote collaboration, reducing the need to travel, more accurate and responsive incident detection reduces disruption to public transport users (and preventing unfavourable mode shift), and remote sensing allows more efficient maintenance operations.

In applying technology solutions to transport challenges, a range of new considerations apply that are outside the traditional strengths of transport professionals. Technology should aim to be interoperable, secure, and under-pinned by a balance of privacy and open data principles.

Furthermore, an explicitly stated risk appetite should determine the level of maturity of technology being implemented. A high appetite for risk would allow the trialling of world-first technology in New Zealand, giving us a head-start to enjoy the benefits of successful implementation. The downside would be a greater likelihood of the technology not performing as expected, with potential negative outcomes.

The table below summarises characteristics that might describe the approach to technology enablement at different levels of maturity:

Maturity Level	Technology Enabled
5	Judicious use of interoperable technology of the right maturity, underpinned by sound privacy / security / open data principles
4	Effective technology deployed, but fragmented, and not always underpinned by sound principles
3	Technology-for-technology's sake, often at wrong stage of maturity. Duplication and incompatibility common
2	Mounting technology debt from outdated systems, increasingly costly upkeep.
1	Lack of- or failing- technology. Frequent outages, highly inefficient operation.

Table 4 - Maturity levels for technology enablement

People-Centred Design

Ultimately, the transport system is being operated for- and by- people. Using a people-centred design approach acknowledges this bias, and simultaneously offers solutions to the challenges presented by the other four determinants for delivering effective transport interventions.

There is no universally agreed definition for “people-centred design”, but it belongs in a class of design methodologies, such as design thinking (Plattner H., Meinel C. & Weinberg U. 2009), design sprints (Banfield R., Lombardo C.T., Wax T., 2015), service design (Holmlid, S. and Evenson, S., 2008), and human-centred design (Hargraves, I., 2018) that share the following characteristics:

A. **They simplify complex system dynamics through the lens of the individuals affected.** For example, most citizens are not aware of the complex make-up and inter-relationships of different system actors and value-chain actors, but only experience their combined action on their ever-day lives.

B. **They iteratively develop the problem definition (and thereby, outcome metrics)**. This is based on research and insights into the diversity of people's experience of the problem(s) being addressed, available data, and analogous challenges in other domains.

C. **They harness diversity of thought to generate a large set of potential solutions.** By involving people with different backgrounds, expertise, perspectives and lived experiences, the solution set is not only more diverse, but also provides an insight into the likely buy-in of different people to the potential solutions.

D. **They iteratively prototype and test solutions before implementing at scale.** Narrowing down from the large set of potential solutions to the preferred solutions does not happen through a single-shot process, but involved iteratively forming hypotheses about what the preferred solution might be, prototyping this solution at a smaller scale, simulation, or in the form of a description, and testing this with the people affected by-, and involved in implementing- the solution.

The department of internal affairs has prepared a set of digital service design standards that also easily transferable to non-digital government services, such as transport interventions (Department of Internal Affairs, 2020).

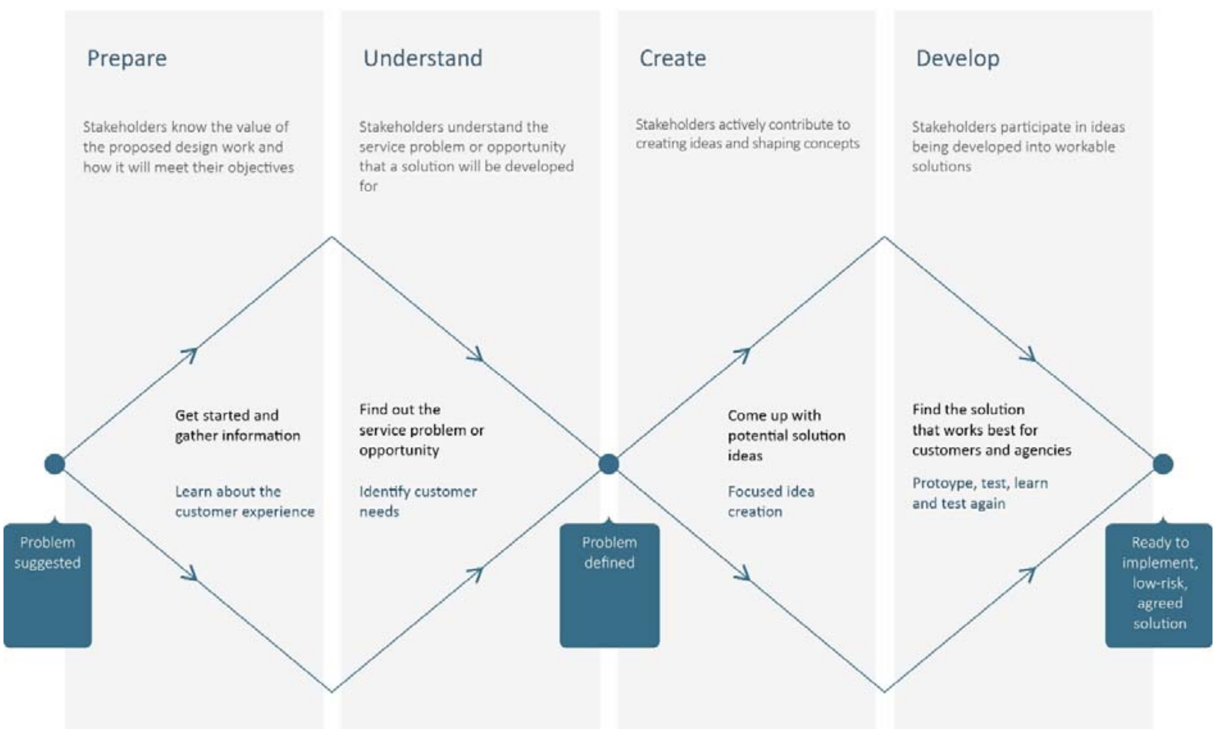

Figure 2 - Service design framework (Department of Internal Affairs, 2020)

The methodology is currently used extensively for the Innovating Streets for People programme by Waka Kotahi, which aims to make a significant contribution to the decarbonisation of the transport system by retrofitting streets to reduce vehicle priority and create more space for people. (Waka Kotahi, 2020).

The table below summarises characteristics that might describe the approach to people-centred design at different levels of maturity:

Maturity Level	People-Centred Design
5	Intervention designed with affected communities using native collaboration frameworks and deep empathy
4	Use of design thinking / service design tools for engaging with the community
3	Affected communities genuinely consulted before making decisions
2	Consultation after the fact or not representative of affected communities
1	No consultation or ineffective communication

Table 5 - Maturity levels for people-centred design

CONCLUSIONS AND RECOMMENDATIONS

We believe that significant advances in the decarbonisation of transport and other transport outcomes are possible, and hope that the key determinants and maturity levels for projects, programmes, and organisations involved in transport interventions described in this paper serve as a useful contribution to the discourse in the field.

The intended use of the maturity model is initially as a self-assessment by project sponsors, directors and managers of transport interventions to highlight areas for further development.

The author welcomes any feedback to refine and evolve this framework.

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