Decision Support Tools in City Planning: Bridging the gap between numerologists and conversationalists

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Abstract: Decisions taken on transport infrastructure and urban form often rely upon conventional urban models and their interface with Cost-Benefit Analysis. Such positivist methods typically conceal the full complexity and uncertainty of how large projects can transform cities. Recent years have seen the emergence of new, more participatory planning Decision Support Tools (DST), designed to guide broader discussion and facilitate more open and inclusive dialogue between planners and communities. However, the effectiveness of such tools, in informing different political discussions and in ultimately influencing policy outcomes remains poorly understood. This is particularly as participant attention often reverts to system outputs at the expense of discussions of broader goals or strategies. DSTs may also lack ready interoperability with formal project evaluation processes (such as the Infrastructure Australia Assessment Framework), limiting their usefulness in translating future visions into project definition. Drawing on experiences from research and professional practice, in Australia and internationally, we consider the potential for traditional urban travel demand models and DST to be combined within a more complementary process of planning, evaluating, and selecting urban infrastructure projects. In doing so, we highlight the challenge of designing planning processes with flexibility and robustness to handle highly uncertain urban futures, and contemplate how the integration of knowledge between modellers, DST developers, planning agencies, and urban publics could better inform the future course of Australian cities.

Key words: *Infrastructure planning; strategic planning; Decision Support Tools; business cases; land use transport integration.*

Introduction

"A good decision is based on knowledge and not on numbers."
- Plato

Planning in cities and regions has always required contemplation of diverse and typically conflicting objectives - within communities, and between communities - particularly in the allocation of public resources for infrastructure. This allocation has a long and chequered history, layered in promises, pork-barreling, political interference, failed and successful partnerships, and spatial partisanship. Australian scholars have reflected on the emergence of infrastructure-driven planning processes (Dodson, 2009), and the 'panic' of infrastructure planning in this country (Legacy, 2017), while asking prescient questions about the sometimes antagonistic manner in which divisive transport infrastructure projects have been progressed (Legacy et al., 2017). As examples of poor infrastructure project selection and management amount globally, there is a clear need for improved governance, and an increasing recognition of the need to reframe "stakeholders" as critical actors who must participate directly in decision-making across the entire project life cycle, integrating different forms of knowledge, insight, and critical reasoning (Di Maddaloni and Davis, 2017, Glasbergen and Driessen, 2005).

The allocation of funding for transport planning projects remains an opaque and seemingly haphazard process, even though governments have formalised many of the processes through which projects are planned. The formalisation of standards of Cost Benefit Analysis (CBA), and the sustained employment of travel demand modelling tools, has supported an application of 'rational' economic forecasts for infrastructure development proposals. In order to compare projects, frameworks and rules for consistent appraisal are needed (Mackie et al., 2014). CBAs in Australia are commonly completed by consultants (Denham and Dodson, 2018) in line with guidelines and specified values provided in the Australian Transport Assessment and Planning (ATAP) guidelines (published by the Federal Department of

Infrastructure, Regional Development and Cities). The Infrastructure Australia Framework requires proponents to complete a 'Business Case' at Stage 3, central to which is an Economic Appraisal (CBA) incorporating distributional and sensitivity analysis to select a preferred project option (Infrastructure Australia, 2018, pp. 30-33).

Conventionally, in the case of transportation infrastructure, models which represent urban development and travel demand feed inputs to CBA to derive a Benefit-Cost Ratio (BCR). A BCR above 1 implies a positive return on expenditure, indicating that a proposal may be of value, with initiatives with higher BCR values likely to result in higher returns (Eliasson et al., 2015). The BCR is a numerical reference point intended to support consistent decision-making by agencies who advise government (Hickman and Dean 2018). Projects often have BCRs calculated for a number of potential options in order to select a preferred option, though some comparatively less attractive options may be contrived by proponents seeking to promote a preferred project case. The use of travel demand models for input values to CBA also tends to cement methods of passive demand forecasting, instead of proactive planning of transport network supply, which can be paired with strategic land use planning to meet broader objectives (see Curtis 2011).

The relative ambiguity of how projects truly are selected remains a feature of infrastructure planning in Australia. The degree to which apparently objective CBA contributes to infrastructure decision-making in Australia has been fundamentally questioned (Denham and Dodson, 2018), since governments often have significant electoral incentives to fund infrastructure based on the distribution of perceived benefits to constituent and stakeholder groups (Cadot et al., 2006). Forecasts and assessments are prone to many potentially significant errors and oversights (Mackie and Preston, 1998), because proponents have an incentive to overstate benefits and understate costs in order to maximise the resulting BCR (Flyvbjerg, 2009). Business cases reporting CBAs have often been wholly or partly concealed from the public under the guise of commercial confidentiality (Jacks and Lucas, 2019), often with the stated reason that disclosure of expected costs might result in higher construction prices bid by tenderers. Perhaps most significantly, the ultimate executive power of government politicians in project selection creates and depends on a degree of procedural ambiguity to the public.

The manner in which governments attempt to fund large public works has seen significant changes over recent decades. Neoliberal governance has eroded the resourcing, roles, and knowledge-base of many public sector agencies, and consolidated sources of revenue under the control of treasuries. Weak economic conditions in many states, particularly in Western Australia, have seen a necessary enthusiasm for Infrastructure Australia funding for a wide range of public works projects. Many states have also established equivalent infrastructure funding agencies to enact a similar purpose, seeking 'efficiency' in public spending. Simultaneously, there has been renewed interest in privately-funded infrastructure, which may be seen to be a 'safe' asset class, with particular appeal in a low interest-rate context (O'Neill 2017). The need to find alternative funds, or seek more hotly contested funds, is challenging infrastructure agencies, especially for projects aimed at achieving benefits which may be difficult to quantify in monetary terms. This further incentivises enthusiastic CBA calculations.

In this multi-actor context, decisions that will drastically re-shape Australian cities appear increasingly to be at the mercy of a network of powerful and potentially hidden actors and institutions, made at significant distance from the communities most directly impacted by such projects. This raises questions for the practice of planning infrastructure for the public interest. However, the political mobilisation of public interest and stakeholder groups against many proposals has demonstrated the relative danger of approaches that exclude genuine public participation in project definition and selection (Legacy et al., 2017). Achieving significant progress towards sustainability will also require a departure from current incrementalist, path-dependent infrastructure development processes (see Curtis and Low 2012), towards decisions which consciously support drastic progression in the manner in which cities are shaped (Malekpour et al., 2015). With this in mind, critical analysis of the current approach and potential alternatives is timely.

Approach

This paper draws upon the experience of the authors as both academic researchers and practising planning practitioners. Collectively, we have worked across Australian states and in cities internationally, developing and testing Decision Support Tools (DSTs), and working within professional planning practice. This paper synthesises our experiences in the development of DSTs, in strategic

planning processes, and in the development of business cases (including submissions for consideration by Infrastructure Australia.)

The remainder of this paper is structured as follows. Firstly, we explore the concept of uncertainty in planning, within project life cycles, and how this relates to current CBA practice. Secondly, we turn to the international literature on DSTs, and the challenges of applying them in planning practice. We close the paper with reflection upon how both the effective use of CBA and DSTs depends upon broader reforms to the way in which infrastructure in Australia is planned.

Uncertainty in Project Planning

Projects are planned in the context of significant uncertainty (Giezen et al., 2015). Drawing on the literature on project uncertainty (see Aktinson et. al., 2006, Ward and Chapman 2003), we contend that there are three major forms of uncertainty in the context of planning public infrastructure:

1. Firstly, there are ***basic uncertainties about the specific conditions*** that may be faced by a project - for instance, there are uncertainties that may relate to cost variability, physical conditions, human and environmental heritage, and the unexpected influence of stakeholders. These uncertainties may be politicised by actors seeking to prioritise or constrain projects (Taylor et al., 2009). These uncertainties are typically considered as risks, which proponents attempt to manage through formal project risk management processes. Often, techniques such as sensitivity analysis and Monte Carlo simulation are used to specifically model these *known unknowns* in project planning, including sometimes in CBAs (Mackie et al., 2014). This is the case in the IA Assessment Framework (2018, pp. 31-32), in which sensitivity testing is the primary mechanism to address such uncertainties.

2. Secondly, large infrastructure projects catalyse ***immense long-term changes within cities which are inherently uncertain***. Many instances of CBA over-state direct project benefits, which may not be achieved following project completion (Flyvbjerg, 2009), often due to complex land use and transport demand dynamics. For transportation infrastructure, many long-term benefits (often termed "Wider Economic Benefits") may be significant, but challenging to forecast in a manner which is rigorous and compelling (Vickerman, 2008). This is also the case for environmental sustainability and climate change mitigation benefits, which are entangled within uncertainty about the full severity and specific timing of changes in the earth's climatic systems (see Schwanen et. al. 2011).

   Major new route projects may catalyse significant change in land use structures, depending also on the integration of planning decisions (Adler, 1988). The life-cycle of such infrastructure projects, which may be extremely durable and essentially permanent, is well beyond the typical 30-year time horizon that may be contemplated in a business case. Many such long-term benefits are typically the stated motivation and political justification for infrastructure projects, though it is practically impossible to assess the full scope of benefits, especially as future contextual conditions change.

   Over the short term, management of this uncertainty is typically attempted through project benefits management processes. The IA Framework addresses this through calculation of BCRs with and without Wider Economic Benefits (2018, pp. 32), and through Post-Completion Reviews (pp. 38-41). While many major projects are eventually evaluated as individual case studies by academics, there remains a lack of consistent, long-term rigorous ex-post evaluation of projects in Australia (BITRE, 2018). Mandated post-completion reviews may also be of insufficient scope to meaningfully assess wider structural effects. Considering the longer term through which these outcomes are realised, we have a poor understanding of, and capacity to accurately forecast, these *unknown unknowns*.

3. Lastly, there is ***uncertainty about the nature, framing, and inherent biases of information available and not available*** to planners, actors, and other stakeholders throughout all planning processes (Forester, 1982). Projects are planned in environments of contested facts and values, in which the information available may be filtered, distorted, framed, and supressed (Pickrell, 1992). Even for practitioners developing business cases and CBAs, collating the full set of available data and evidence to support the proposal is a surpassingly difficult, time-consuming, and expensive task. The completion of business cases by consultants (Denham

and Dodson, 2018), the final investment decision is made at the ministerial level, and the suppression of key details in business cases even if published also sustains this uncertainty. This uncomfortable reality limits the degree to which all but the most closely involved actors in many planning decisions may be aware and informed of the nature of the previous two forms of project uncertainty. Simultaneously, it may also reflect political executives' attempts to antagonise and obfuscate the planning process by deliberately generating uncertainty where this is seen to facilitate the implementation of controversial projects and planning outcomes (Legacy et al, 2017). This overarching uncertainty may essentially make information that should be known either unknown or unknowable; it could be characterised as a category of *'post-truth unknowns'*.

Cost Benefit Analysis: The Construction of Certainty?

The primary aim of CBA is to rigorously evaluate proposals in a manner which optimises the efficiency of public expenditure. CBA is a key tool for mitigating the politicisation of public spending, especially where political decisions would result in ineffective or wasteful use of funds (Priemus et al., 2008). However, many forms and practices of quantitative modelling and forecasting have been much criticised for their accuracy, validity, and implications in the effective practices of planning (see Flyvbjerg et al., 2005, Lee, 1973, Wachs, 1989). Proponents may have significant incentive to manipulate forecasts, transport models, land use scenarios, and other inputs to CBA calculations (Kain, 1990, Flyvbjerg, 2009).

CBA often reflects a utilitarian perspective on ethics (van Wee, 2012), and embeds values in a manner which subverts the opportunity for democratic deliberation and discursive exploration of the full opportunities and costs that projects might realise (Spash, 1997). CBA requires the monetisation of events and outcomes which lack market prices, which thus necessitates inherent value judgments, such as the estimation of the value of human life or a unit of air pollution (Hickman and Dean, 2018). Arguably, CBA places a monetary value on travel time in a manner that over-states the actual benefit of projects for the public, and in a way that which produces perverse incentives to plan for high-speed long-distance vehicle travel (Metz, 2008), directly countering many basic long-term strategic planning objectives.

CBA often does not incorporate any analysis of the distributive effects of benefits (van Wee, 2012), especially considering socio-demographic inequities, which should be central to transport network planning (Scheurer et al., 2017). Conventional CBA practice also discounts future benefits, which runs counter to principles of intergenerational equity (Lind, 1995), and the notion of planning as an endeavor primarily concerned with improvements in future conditions. A procedural emphasis on CBA may engender low levels of trust among stakeholders and the public (Beukers et al., 2012). Without the opportunity for meaningful public participation and dialogue, the sole use of CBA as a decision-making instrument poses significant risk of poor decision-making (Damart and Roy, 2009).

The role of CBA and other analysis in actual decision-making may be varied. Sager and Ravlum (2005) detail the selective use of ex ante project analyses among the Norwegian National Assembly's Standing Committee on Transport and Communications. They find decision-makers:

- Treated some results as irrelevant, even when they aligned with political viewpoints;
- Collected large volumes of often irrelevant information, potentially to signal "a commitment to means-ends rationality" (pp. 55);
- Insisted upon more analysis when existing analysis did not align with their own viewpoint;
- Made decisions first, and then sought justifying information later; and
- Struggled with inherent political value and judgement rationality trade-offs, which cannot entirely be informed by professional planners.

Hence, even if and when CBA itself is rigorous, evidence-based, encompassing the full known set of benefits and costs, its use to inform effective project-selection remains subject to bias at the political level. Nonetheless, there remains a perception in the academic literature and in practice that CBA remains essentially the only formal method through which the potential utility of a project can be consistently compared, especially when considering relative value between investments across highly

divergent spatial or sectoral contexts. Thus, there is a need to consider the other instruments which can be used through decision-making for public works infrastructure.

Problems of Integration and Continuity in Decisions

A major critique of CBA is that it offers limited guidance for significant project decisions beyond the decision to fund the nominated project option or project scope. Projects may be funded at an early stage of definition, without a detailed understanding of specific conditions which influence design[1]. As infrastructure projects move through the project life cycle, decisions relating to scope and quality are crucial to achieving intended benefits (Winch et. al., 1998). The importance of decisions *within* project design and delivery may often be overlooked, in terms of both cost overruns and in the achievement of benefits (Love et al., 2015).

During project delivery, quality attributes of infrastructure may be eroded through value engineering. This is especially the case for integrated land use transport developments, which hinge upon successful intermodal integration and delivery of amenity to support high-value urban development (Curtis et al., 2016, McLeod and Curtis, 2018). Similarly, studies to reduce technical uncertainty and develop project definition are often undertaken in a way that disconnects them from major decisions about project viability and progression. For example, an Environmental Impact Assessment may have scope only to consider the implications of the specifically designed proposal, with no remit to vary the nature of the project beyond the imposition of minor conditions (Soria-Lara et al., 2015). Some have called for greater integration of long-term, life-cycle environmental effects of infrastructure through CBA (see Tricker (2007) and Hickman and Dean (2018). However, it is difficult to see how this might be operationalised within rigid assessment frameworks, especially where the long-term uncertainty of projects (our second type of uncertainty) is the defining characteristic of the project's planning context.

For these reasons, it is broadly acknowledged that CBA needs to be complemented by other decision-making techniques. Multi-Criteria Analysis (MCA) - also referred to as Multi-Criteria Decision Analysis (MCDA) – is a structured decision-making process which is widely used to substitute or complement CBA, especially for minor decisions (Shiftan et al., 2002). Key advantages of MCA is that it more directly addresses objectives and values, it may be utilised within participatory approaches, and it enables rapid "what-if" scenario evaluation through the relatively simple adjustments of values, weightings, and scores (Massam, 1988, Keeney, 1982). The Infrastructure Australia framework itself incorporates the potential use of MCA in preliminary stages of option selection (Stage 2 of the current framework), before a "comprehensive" economic CBA appraisal is undertaken in Stage 3. Use of MCA in other jurisdictions appears to have improved the manner in which project selection is transparent, and contemplates clearly defined objectives in the decision-making process (Novak et al., 2015).

Decision Support Tools and Planning Process

Decision Support Tools (DSTs) have significant potential for supporting planning dialogue and decision-making, through interactive conceptualisation of potential futures. DSTs often utilise visualisation technologies, and can be paired with facilitation methods and technique such as backcasting (Curtis et al., 2017). The use of DSTs can facilitate interdisciplinary learning (Goodspeed, 2013), though it is important that such tools support, rather than dominate, discussions about city futures (Pelzer and Geertman, 2014). They can be used both in structured MCA processes, and in many other forms of structured and unstructured deliberation.

DSTs are often designed to incorporate knowledge in a range of disciplines and as such enable a planning and policy-making dialogue that transcends the single-disciplinary 'silo culture' that has traditionally dominated the flow of information between practitioners and decision-makers. However, the uptake of DSTs in planning practice has been slow, not least because of these added complexities. Perhaps fallaciously, due to their many limitations (Pettit et al, 2018), conventional tools such as CBA or predictive transport models widely continue to be regarded as providing greater objectivity in their output than the more discursive DSTs (Geertman, 2017).

Thus, for DSTs there is a challenge of overcoming an inherent disconnect between tool developers and users. This disconnect originates from differing perspectives on the planning process between the two

[1] In Australia, a design developed to 15% of the expected detail is usually drafted for the purpose of informing investment decisions. A cost estimate at P90 (estimated 90% confidence) is typically derived from this design.

groups: while tool developers (mostly researchers and consultants) are primarily concerned with a tool's academic rigour and presentation, tool users (mostly practitioners) primarily ask for a sense of simplicity in a tool's output and its broad communicability, including to decision-makers with limited planning expertise (te Brommelstroet et al, 2016). The key qualities sought here are referred to as the utility of a tool ("is it constructed to help answer the salient planning questions?") and its useability ("can practitioners engage with its procedures and content easily and with satisfaction?") (see te Brommelstroet et al, 2016; Pelzer, 2017; Russo et al, 2018; Wulfhorst et al, 2017).

DSTs that achieve these qualities are often the outcome of an iterative process of co-evolution involving tool designers and tool users; Russo et al (2018) describe 'participatory design' in this context, while te Brömmelstroet (2017) and Champlin et al (2018) describe this evolution as one of 'negotiated knowledge' (see also Amara et al, 2004 and Gudmundsson, 2011). They also highlight the critical role of facilitators and narrators in a collaborative application process to enable a shared learning experience for both tool designers (further enhancing a tool's agility, adaptability, and responsiveness in subsequent iterations) and tool users (deepening their understanding of the thinking that informs the tool's development and how it is relevant to practical planning challenges).

Common to these experiences with the use of DSTs in planning practice is a departure from the perceived authority of 'numerical' knowledge as a primary input for policy decisions (important as quantitative indicators are). In place is a recognition that the complexity and inevitable interdisciplinarity of planning tasks requires a more 'conversational' (or discursive) approach, in order to arrive at robust decisions and a relative consensus among well-informed stakeholders.

The use of DSTs as an inherently collaborative way of planning can facilitate critical decisions about long-term structural uncertainty of different planning options. The adds significant richness to analysis, especially where modelling or CBA cannot readily quantify or represent such potential futures. The use of DSTs in informing integrated land use and infrastructure planning in Australia has a relatively rich recent history, especially in experimentation and in exemplar discursive planning exercises (see Legacy et al., 2014). Though to date, there has been limited application of a participatory approach to infrastructure project planning through an entire project life cycle. In this sense, DSTs likely hold new potential to address issues of uncertainty in the long-term effects of infrastructure in cities, especially in comparison to conventional CBA. However, one-off use of DSTs is not likely to address uncertainty around the validity and legitimacy of available project information (our third type of uncertainty).

An Alternative Approach?

Planning must inevitably contend with conflicting facts, values, and politics – planning cannot be limited to positivist and technocratic analysis, since meaningful planning decisions always exist within a political context (Swanstrom, 1987). For this reason, the *rationale* and *reasoning* for planning objectives are central to how both the public and politicians actually think about infrastructure proposals. A key principle is that the rationale and reasoning of politicians and the public are transparent and aligned, which cannot readily be resolved through use of CBA alone. CBA may be necessary and most effective for filtering proposals which provide a limited basic public interest return (Eliasson et al., 2015). Mouter et al. (2013) suggest the 'subtle' use of CBA as a such a filter; evidence from practice suggests this may already be the case (Sager and Ravlum, 2005). While CBA may enforce a technical rationality in planning infrastructure, there is clearly a lack of strategic rationality in the dis-integration of land use and infrastructure planning in Australia (Dodson, 2009, Legacy et al. 2017, McLeod and Curtis, 2018). This lack of consistent strategic decision-making is often also evident in the incremental, but significant, project definition decisions which inevitably follow project selection. Planning actors, stakeholders, and the community are frequently excluded in the crucial points at which project decisions are made, resulting in the coarse, path-dependent simplification of strategic objectives into poorly-considered project deliverable requirements.

We contend that there is a need to re-frame the process by which infrastructure proposals in Australia are considered by facilitating ongoing use and development of DSTs as a central aspect of better practice. We assert that the process of business case development should incorporate a wider process of CBA and public deliberation using DST. Undertaken together, this will provide opportunities to consider highly divergent future scenarios (addressing our second type of uncertainty), enable public engagement and confidence in the planning process, and enhance its resilience against abuse by antagonistic players in positions of power (addressing the third type of uncertainty). In undertaking these

together, the existing CBA process may benefit from options and knowledge synthesised through the deliberative use of DSTs, and vice versa.

Essential to this would be reform of planning to more closely re-link processes of strategic long-term regional/metropolitan planning; infrastructure project planning; project evaluation and selection; and project decisions through delivery in a way which continually invites and integrates public participation and scrutiny at each step. Public engagement integrated throughout the infrastructure planning process is critical to addressing uncertainty, particularly that which relates to the potential of divergent conditions into the future (our second type of uncertainty), and the accuracy and availability of project-related information (our third type of uncertainty). Requiring collaborative planning at project milestones, supported through the application of techniques of DST and CBA, may thus be a way of addressing the issues outlined in this paper. This is likely to depend on the capacity for governments and planning agencies in Australia to implement new modes of sustained, deep transparency and collaboration. Opening up the range of planning objectives through the definition and selection of projects will be critical for more dynamic and responsive planning in an era of accelerating change. Planning infrastructure *with* the public raises the prospect of re-uniting the gap between strategic and project planning (see Albrechts, 2004, Legacy et al., 2012) in a way which can ultimately better serve public interests.

Conclusion

Governments worldwide are challenged by designing and implementing planning processes to support effective decision-making for public infrastructure projects. Recent practice in Australia has been characterised by relative opacity, antagonism among stakeholders, and the partisan politicisation of large projects. The Australian public is largely excluded from most of the key decisions which occur prior to the announcement of project funding, and many project decisions after. We contend that Australian planning practice has insufficiently grappled with forms of uncertainty beyond the known unknowns of basic project risks, while simultaneously excluding many public interests from their rightful roles in shaping our cities.

While there remains a need to undertake an honest and transparent CBA process, there is also a need in Australia for planners to more systematically integrate deliberative decision-making through the entire process of planning and developing public infrastructure. To date, a focus on standards, specifications and requirements on project appraisal, such as in the Infrastructure Australia framework, engenders a narrow focus on technical validity and the "comparability" of CBA, rather than a raison d'être for actually doing planning.

Decision Support Tools are a key implement in embracing divergent public interest planning objectives, and they must play a role in exploring uncertainty around the very long-term structural implications of infrastructure and planning decisions, and in building knowledge and capacity with a wider array of relevant stakeholders. They may not, however, fully address public uncertainty around the availability and accuracy of information relating to projects. This third, over-arching uncertainty can only be addressed through a much broader reorientation around *doing* planning with the public, in a manner which embraces transparency, open dialogue, and legitimate power-sharing between actors at all levels. Public participation in developing business cases would be a key part of this.

Greater focus on the design and performance of the *processes* in which both CBA and other DSTs may be deployed is needed. A more discursive planning approach, based around inherently transparent planning, can ensure greater rigour in planning input, greater quality in planning output, and better support decisions across the full life cycle of planning infrastructure. Both planners and elected officials in Australia must critically consider the state of current practice, and continue the conversation on how we can open up informed public participation in the shaping of our cities and their infrastructures in the interest of better decision-making.

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