Strategic option assessment – an alternative approach to multi-criteria analysis for transport / land use corridors

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Abstract: Multi-criteria analysis (MCA) and benefit-cost analysis (BCA) are established techniques for evaluating alternative transport and land use scenarios. They each have their own strengths and weaknesses. The MCA is usually applied to a strategic-level, rapid assessment of alternative options while the BCA is most often used to develop a robust, detailed business case for a particular project.

In the conduct of an MCA there is an emphasis on the judgement of decision-makers (and stakeholders) in establishing strategic objectives and criteria and linking these to option evaluation. While providing clear links to the objectives, it is often difficult to incorporate rigorous, quantitative analysis within its framework. Evaluation criteria are rarely independent and can tend to overemphasise the benefits of an option rather than its costs.

A BCA enables policymakers to assess whether a policy initiative or project will provide a net community benefit, taking into account that the (limited) resources deployed in implementing the initiative or project have alternative productive uses. The BCA carefully compares total costs and benefits. However, a BCA does not explicitly account for the broader policy objectives of decision-makers and is less concerned with the distribution of benefits.

This paper presents a “middle” approach referred to as a strategic option assessment (SOA). It introduces elements of the MCA approach to the quantitative framework of a basic BCA. The relative importance of different strategic criteria are considered through differential weighting of the cost and benefit components of each option. Consideration is given to the spatial and temporal distribution of benefits and alternative policy emphases are considered through adjusting BCA parameters. The net result is a clear, transparent, rigorous method for assessing options against established policy objectives.

1. Introduction

Given the rapid growth of Australia’s major cities, a host of new infrastructure projects are being proposed. Federal and state governments are committing significant funding to infrastructure projects, but there is a need to ensure resources are wisely invested, particularly for competing transport projects which often have deep and long lasting social and economic impacts. Governments need rapid evaluation tools to determine which potential projects are worthy of more detailed investigation before significant resources are committed.

Multi-criteria analysis (MCA) and benefit-cost analysis (BCA) are established techniques for evaluating alternative transport projects. They each have their own strengths and weaknesses. The MCA is usually applied to a strategic-level, rapid assessment of alternative options while the BCA is most often used to develop a robust, detailed business case for a particular project.

The Strategic Opportunity Assessment (SOA) framework suggested within this paper presents a “middle” approach, able to incorporate different viewpoints within a robust, evidence-based process. The SOA framework has potential applications outside public transport corridors, for example, road transport options (and other infrastructure projects), but this paper focuses on its application to the challenges being faced daily by strategic and transport planners to develop and evaluate options which address growth challenges and provide opportunities in established and new transport corridors.

2. Project evaluation processes

Transport project evaluation processes in Australian jurisdictions are typically applied at the sub-corridor level – once a preferred project is nominated or identified. The process by which the preferred project is chosen is often not clear.

At the project level the National Guidelines for Transport System Management (NGTSM) recommend a 3-level appraisal process with corresponding business case development (see Douglas and Brooker, 2013) including:

1) Strategic Merit Test (Strategic Business Case) in which all proposed initiatives (to achieve the project objectives) are evaluated
2) Rapid appraisal (Outline or Preliminary Business Case) of a filtered list of options
3) Detailed Appraisal (Full Business Case) of short-listed options to determine the best initiative(s)

Most jurisdictions adopt this type of approach or a variation of it, though there is surprisingly little readily available documentation on the adopted processes in each state. In NSW, the three-step process ties in with the Treasury Gateway Review system for capital business cases (see NSW Treasury 2008). Transport for NSW (2013) has released guidelines for economic appraisal of transport investment and initiatives, which outlines the process in line with the Treasury guidelines. However, there is no definitive or uniform process for strategic level project development and evaluation at the subregional or broad corridor level in Australia. In general, the approach at this level involves:

- the identification of transport corridors for protection (both road and rail) within strategic planning documents (e.g. Western Australian Planning Commission 2014, Transport for NSW 2012), particularly in transport master plans or metropolitan strategies, and
- the development of plans for specific modes, regions or precincts, or alternatively undertaking studies for specific corridors to identify the appropriate mode and alignment for the corridor.

These plans or studies often lead into a linear NGTSM type process as outlined above, which involves BCA-based rapid and detailed business case appraisals, which may be preceded by an MCA (perhaps following or as part of a Strategic Merit Test).

In NSW for example, Transport for NSW has prepared the NSW Long Term Transport Master Plan (LTTMP) as well as a number of modal strategies for Sydney, including Sydney's Light Rail Future and Sydney's Bus Future. According to Transport for NSW (2014) these documents identify a number of corridors to be considered for upgrading to bus rapid transit or light rail within Western Sydney to connect or pass through Parramatta. Parramatta Council advocated for a light rail network focussed on Parramatta and the Government announced a Parramatta Light Rail project. A shortlist of four corridors was announced and these are currently the subject of more detailed investigations. However, there was no public or explicit process for the corridor shortlisting.

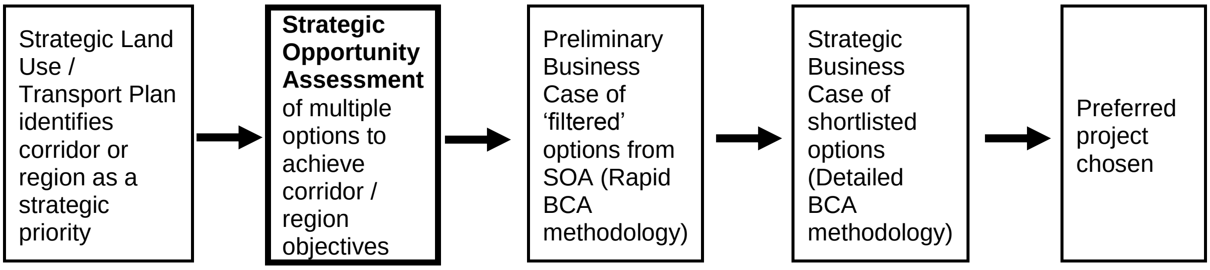
There appears to have been a more comprehensive approach in the UK for the Crossrail project in London. According to Crossrail (2015), the project was arguably born through the release of the 1974 London Rail Study. However various delays, particularly due to the recession in the 1990s, meant that the project did not gain significant momentum until 2000. It was identified within *Transport 2010*, the ten year transport plan for the UK (Crossrail 2015). The Strategic Rail Authority then undertook a London East-West Study which recommended that the Crossrail scheme be resurrected. The London Crossrail project appraisal firstly involved an MCA of five shortlisted corridors, which allowed a judgement to be made as to whether the project should be progressed and which corridor options were optimal (Meeks et. al. 2002). The appraisal framework within the MCA was linked closely to the transport strategy aims identified by the UK Government within the then 1998 Transport White Paper (Meeks et. al. 2002). A business case process was then undertaken based on the national guidance published by the UK Department for Transport.

Douglas and Brooker (2013) have prepared a review of Transport Project Appraisal in NSW and they include the following conclusion.

> [Cost benefit analysis] has been of little use in developing long term plans or influencing decisions on large scale projects. Recent large projects have been announced as 'happening' by Government before CBAs have been completed or as in some recent examples even started. For these projects, CBA has become an exercise in retrospective justification with all the ensuing biases and cynicism that such a process entails [.…] it may instead be wiser to recast the problem at a higher planning level.

'Recasting the problem at a higher planning level' requires a means to undertake rapid but evidence-based appraisals of potential projects at a corridor, or even subregional level. It is suggested in this paper that an SOA would be appropriate for this task.

The full project evaluation process therefore might be as follows.



In this process the corridor or region's 'fit' against a Strategic Merit test is 'assumed' by its inclusion in the Plan and the SOA step replaces what could be undertaken by a less rigorous MCA (though even this rarely occurs).

3. Existing project evaluation techniques

Multi-criteria analysis (MCA) is an evaluation method used to assess infrastructure projects at a strategic level, prior to undertaking a Benefit-Cost Analysis (BCA). The MCA allows various options to be narrowed down prior to undertaking the detailed BCA. These techniques, and their strengths and weaknesses are detailed below. This provides the context for highlighting the potential advantages of the Strategic Opportunity Assessments (SOA) approach outlined in this paper.

Multi-criteria analysis

Strengths

The MCA involves establishing criteria against which options are rated. The criteria can be 'weighted' to account for their relative importance. Each option is ultimately scored, and can be compared to other options, based on the sum of its performance against the weighted criteria.

A key strength of an MCA is that it is flexible. An MCA can be applied to both the identification of high level strategic transport corridors across a metropolitan area, as well as for comparison of specific routes for a transport project. The objectives and criteria identified for the assessment can be easily altered and amended throughout the process if they are considered to be inappropriate or irrelevant.

An MCA is also flexible in its ability to deal with non-quantifiable costs or benefits which are typically not incorporated into a BCA, such as some environmental consequences or wider economic benefits including 'second round' impacts of investments in transport infrastructure (Department for Communities and Local Government 2009). These less easily quantifiable costs or benefits can be scored for each option based on a judgement made by the analyst. This process assists in highlighting where information may be further required to substantiate a benefit or cost in the preparation of a business case (Australian Transport Council 2006).

In the case of transport corridors, an MCA allows for the direct comparison of multiple options and routes. It is a rapid process which provides an "efficient means to filter proposals before considerable resources are spent on development" (Australian Transport Council 2006, p.15). Whilst conducting BCA for all transport corridor options would be too time consuming, an MCA needs to be rigorous enough to ensure that the appropriate options are taken forward for more detailed analysis and assessment.

The MCA can be readily linked to government policies and goals through the identification of objectives and criteria for assessment which relate to these policies and goals. This allows for projects or transport corridors to be assessed against the delivery of these government policies. A BCA does not necessarily have the same ability to do this.

An MCA is "a tool for appraisal of different alternatives, when several points of view and priorities are taken into account to produce a common output" (Tsamboulas 2007, p. 12). This highlights that an MCA can be used to reflect stakeholder views and perspectives unlike a BCA which is a technical, quantitative exercise. Stakeholders can provide input through the identification of the project objectives and framework, as well as the scoring and weighting process. The development of weights allows for the incorporation of different viewpoints. The relative importance of impacts is acknowledged through the weightings process. This is considered to be important because it is not realistic for all impacts to be considered to be equally important (Bureau of Transport Economics 1999).

Limitations

There are a number of limitations associated with the MCA process, which are also related to its strengths as described above:

- There may be conflicting objectives, or there may be overlap between objectives which can result in double counting. An example of this would be adopting “reducing congestion” and “reducing environmental externalities” as two separate objectives.
- The process may not be sufficiently robust with an insufficient evidence base.
- The MCA process may be considered to be too subjective and there may be difficulty in determining suitable weights (Bureau of Transport Economics 1999).
- MCAs are often criticised for a lack of transparency and accountability in reaching a decision (Sayers et al 2003, p. 96).
  Insufficient trade-off between benefits and costs. Typically, most of the strategic objectives within the MCA are focused on benefits rather than costs which can result in a bias towards more expensive options or “gold plating”.

Benefit-cost analysis

Strengths

A BCA is a tool used to evaluate the potential socio-economic impacts of public investment choices (Damart and Roy. 2009, p. 200) to allow governments to make informed decisions. ‘It enables policy makers to assess whether a policy initiative or project will provide a net community benefit, taking into account that the (limited) resources deployed in implementing the initiative or project have alternative productive uses’ (Spiller and Deng 2013, p.1). Costs and benefits are expressed in monetary terms, where possible, which allows for direct comparison. The typical indicators used to evaluate projects in BCA are Net Present Value (NPV, which measures the current day value of the margin of benefits over costs), Benefit Cost Ratio (BCR, which is the ratio of benefits to costs with projects expected to rate at least above 1) and Internal Rate of Return (IRR which measures the percentage return on the invested ‘costs’).

The BCA is a robust process and when conducted correctly should avoid double counting. It can be used to compare different options against ‘doing nothing’ or ‘business as usual’, and because it is about identifying the optimal use of public resources, can compare different investments which are not easily comparable within an MCA (for example a hospital versus a rail line).

Limitations

The BCA can be considered to be inflexible, particularly for non-tradable benefits or costs which are not easily quantifiable (Spiller and Deng 2013) or where data is not easily available. It generally does not take account of interactions between different impacts and cumulative impacts (Department for Communities and Local Government 2009) which may be better addressed through an MCA. The process can be time-consuming, particularly the process of collating data and calculating each benefit and cost.

Conventional BCAs tend to heavily ‘discount the future’. This can be problematic for major infrastructure projects which have the potential to reshape the city (Spiller and Deng 2013). Relatedly, BCAs typically apply a common discount rate across all items which ignores that some benefits may effectively increase in value over time (environmental or biodiversity values, for example).

BCAs are focused on economic efficiency and less so on strategic objectives. A BCA measures overall (state or national) welfare or community wide impacts and therefore it is often criticised for overlooking equity impacts both spatially or on different income groups (Spiller and Deng 2013). However, equity may be addressed through an adjusted BCA.

Adjusted BCA

The notion behind the adjusted (or distributional) BCA is the consideration of equity, for example in terms of the distribution of benefits and costs by income level or by region (Bureau of Transport Economics 1999). The BCA is adjusted by re-weighting or incorporating non-efficiency objectives (Australian Transport Council 2006). There is limited understanding of the process and implementation and therefore it has not been widely adopted in Australia. This is also due to a general bias among economists against mixing BCA with moral judgements (Bureau of Transport Economics 1999) and a likely reluctance of governments to implement an untested process.

According to the ATC guidelines (Australian Transport Council 2006), BCAs can be adjusted by:

- replacing some market-based values with nominated values.
- multiplying some benefits and costs by weights.
- inserting subjectively determined monetary values for benefits and costs normally omitted because valuation is not possible.
- applying a distributional multiplier to the benefits.

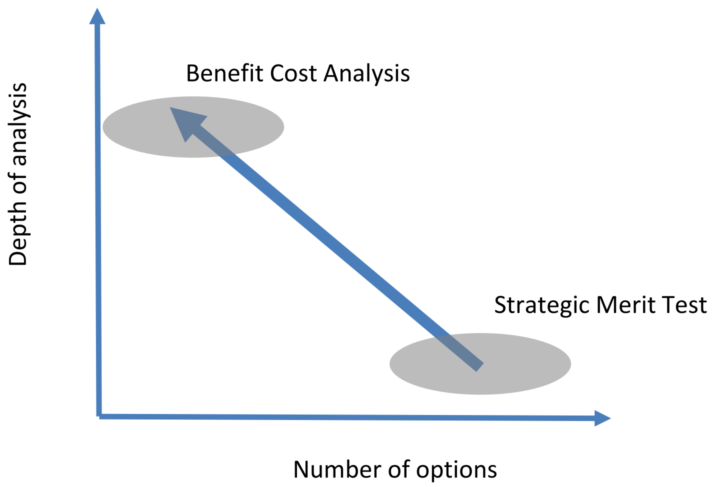
The SOA proposed within this paper is an extension of the adjusted BCA idea, however is more closely aligned with the MCA, maintaining strong links to strategic policies and objectives.

Comparing the MCA and BCA processes highlights a conflict between consistency and flexibility. 'A balance is needed between these two attributes, with respect both to the criteria to be adopted during the evaluation and to the best method of ranking the options' (Sayers et al 2003, p. 96). The proposed SOA framework seeks to balance these two attributes by developing a method which is both consistent and flexible.

Option evaluation paradigm

As land use – transport projects move through different stages of evaluation, the number of options considered typically decreases and the depth and accuracy of evaluation increases – this is shown in the figure below.

Figure 1: Option evaluation paradigm



The Strategic Merit Test (SMT) involves a preliminary level of analysis applied over a large number of options, particularly focused on whether proposals reflect 'jurisdictional objectives, policies and strategies' (ATC 2006, p.15). Later in the evaluation path, the BCA process warrants more detailed analysis for a smaller number of options.

The question arises as to how much time (and money) is spent on the SMT stage versus the more detailed BCA stage. There is also a parallel question on how much time is devoted to developing the evaluation tools versus applying them. There is a risk that too much of the overall budget allocated to the assessment process is spent on developing models and evaluation tools, with limited resources spent on the application and interpretation of results from such tools.

The key requirement, then, at the strategic stage of option evaluation is the development of a set of rapid evaluation tools that can be applied across a range of options. It is important that the time spent evaluating options is constrained as little as possible by the development and application of the evaluation framework. Stakeholders at this stage require decision support in a time-critical fashion. Ideally, options could be developed and evaluated within an extended workshop environment.

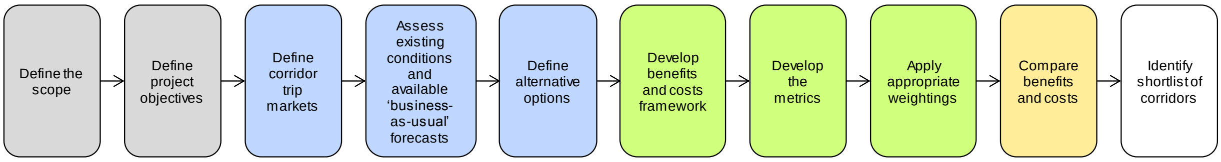
Rapid evaluation techniques can include benchmarking against existing transport and land use - with respect to, for example, land use density, transport service attributes and project costing. The objective should be to perform an assessment of a single land use -transport option in, at most, a few minutes in contrast to running detailed travel models which can take many hours per scenario. The fast run times allow application of the evaluation to a large number of options while also allowing for sensitivity testing on variables and different weights, as discussed later in this paper.

The SOA framework presented in this paper is an example of a rapid evaluation technique that provides strong, evidence-based support to decisions regarding shortlisting of candidate projects.

4. Strategic Options Assessment framework

The SOA framework and steps described in this paper, for the evaluation of options within a set of defined land use-transport corridors, are summarised in Figure 2. As with an MCA, a SOA would feed into the full business case and BCA, where the corridors shortlisted by the SOA would be assessed comprehensively.

Figure 2: Overview of Framework



Having made the decision based on policy settings and high level strategic objectives to undertake the project, the following process would be undertaken. Elements of the SOA process are illustrated using a hypothetical example. The example is based on a high level objective to support Liverpool as a regional city in Sydney through stronger transport connections with surrounding centres. The data and findings are illustrative only.

Define the scope

- Clearly define the geographic extent of the corridor(s);
- Identify the set of options including
    - infrastructure alternatives;
    - do nothing and do minimum scenarios;
    - demand management measures
- Identify the role the corridor might have within the regional transport network - does the corridor provide an opportunity for improved regional travel or is it mostly about supporting activity within the corridor itself?

- Define the evaluation time period (e.g. weekday morning peak period) and the forecast years – at least two years should be chosen to capture short and long term outcomes
- What is the reference or Do Minimum case?

Define project objectives

- Perform a review of relevant strategic planning documents to compile a set of goals, policies and targets
- Distil a set of clear objectives that are applicable to the particular land use-transport corridors

Example: Liverpool transport corridors - relevant strategic objectives

The following strategic objectives may be identified based on a review of *A Plan for Growing Sydney* (Department of Planning and Environment 2014) and *NSW Long Term Transport Master Plan* (Transport for NSW 2012):

- Grow Liverpool as a regional city centre supporting its surrounding communities including the South West Growth Centre (refer to Department of Planning and Environment 2014, p. 49)
- Maximise opportunities to increase economic activity and jobs growth in the Bankstown to Liverpool corridor (refer to Department of Planning and Environment 2014, p.41)
- Support the revitalisation of Liverpool through better transport hubs and improved connections (refer to Transport for NSW 2012, p. 30)
- Increase capacity on the East Hills Line to support the Liverpool to Sydney Airport corridor: (refer to Transport for NSW 2012, p. 153)
- Promote mode shift to public transport in Liverpool (refer to Transport for NSW 2012, p. 202).

Define corridor trip markets

- Identify the key trip markets for the corridor with particular consideration of internal and external markets:
    - internal trips are those with either an origin or destination or both within the corridor
    - external trips are those that pass through the corridor as part of the regional transport network
- Identify existing and future potential activity centres within the corridor which serve as key generators of trips.

Ultimately alternative options will be evaluated based on their ability to deliver benefits to existing and future users. The trip markets define these users. Breaking down the total trip market (total set of users) will also be of use later in applying differential weighting, for example, the extent that projects are targeting improvements for users making short internal trips against improving regional access for longer distance trips.

Example: Liverpool corridor trip markets

In relation to a potential corridor between Liverpool and Bankstown (via Bankstown Airport-Milperra), the internal trips would include Liverpool to Bankstown, Liverpool to Bankstown Airport-Milperra, Liverpool to Chipping Norton and Liverpool to Condell Park. The main external trip would be Liverpool to the Sydney CBD. The existing activity centres within this corridor include Liverpool, Bankstown and Bankstown Airport-Milperra (with the potential for growth and expansion through urban renewal). There is potential for future activity centres at Chipping Norton and Condell Park within this corridor.

Assess existing conditions and available 'business-as-usual' forecasts

- Compile data on existing land use (population and employment distribution) and travel patterns (e.g. Census journey-to-work data)

- Develop key land use metrics to be used in the evaluation process such as forecast change in population and jobs; socioeconomic characteristics etc.
- Summarise existing transport services - for public transport, identify the underlying structure of services including key interchanges and nodes, and network structure

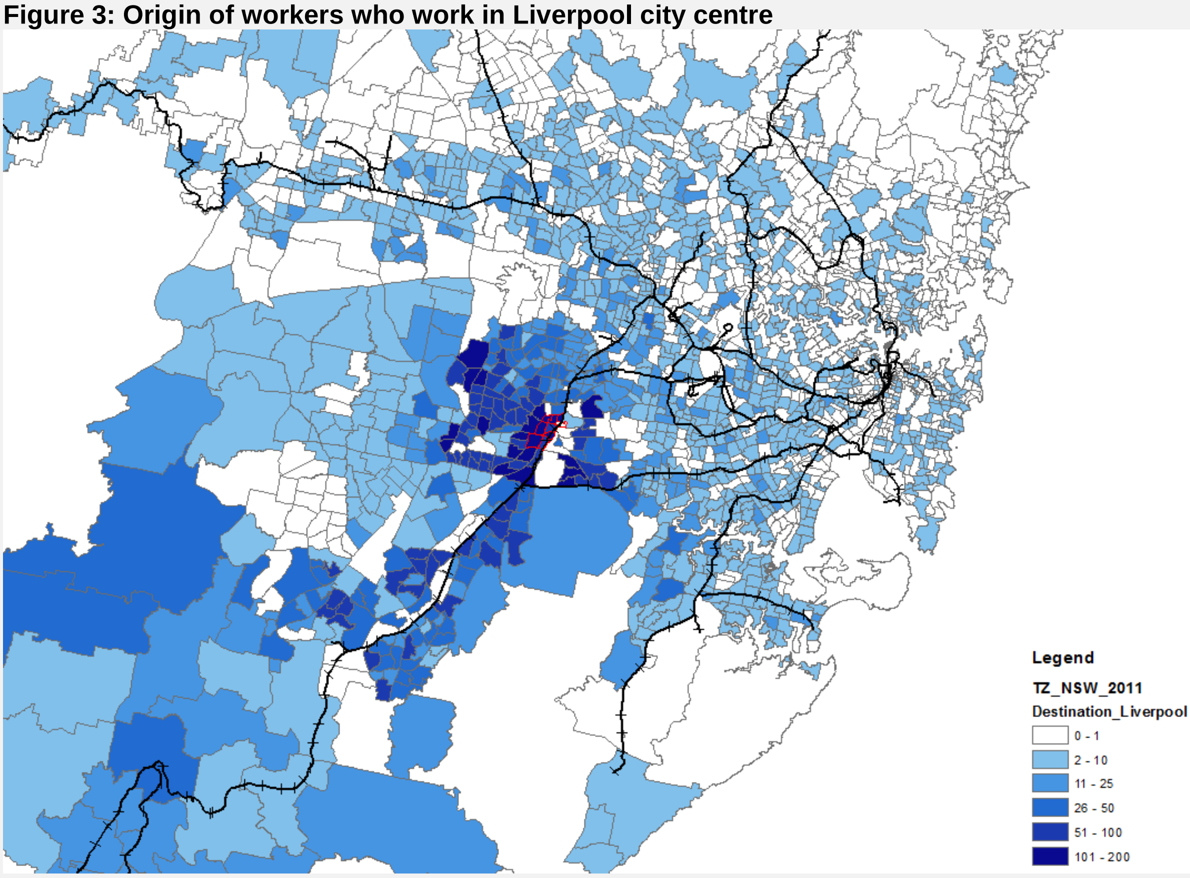
This analysis is used to establish the base against which future options are assessed. The performance of future options is really about their ability to deliver improvements over existing travel and land use patterns (or 'business as usual' future patterns). The emphasis here is on readily available data; most would be sourced online through Census portals, state government agencies and service operators. Geographic Information Systems (GIS) software can be used to identify hotspots (employment clusters, urban renewal opportunities, disadvantaged areas, transport bottlenecks) which may benefit from transport improvements.

Example: Liverpool transport corridors, example of relevant data/mapping

Analysis of existing population and employment distribution as well as journey to work patterns has been undertaken for the Liverpool transport corridors example project. Figure 4 below illustrates the origin of workers who work in Liverpool city centre, highlighting that majority of workers travel from the immediate surrounding areas and south west.

This is relevant as it helps to develop an understanding of the spatial aspects of travel to Liverpool. It informs development of project options particularly ones that target existing workers. Overlaying alternative options on these kind of maps provides a good graphic depiction of the relationship between the option and existing trip patterns. This is not to say that all options should target existing trips – some options will want to influence future trips as well. Other mapping, such as showing where future population growth occurs, would also be useful.

Figure 3: Origin of workers who work in Liverpool city centre



In terms of Option 3, the existing transport network is primarily bus routes with the M90 Liverpool to Bankstown bus servicing the majority of this corridor.

Define alternative options

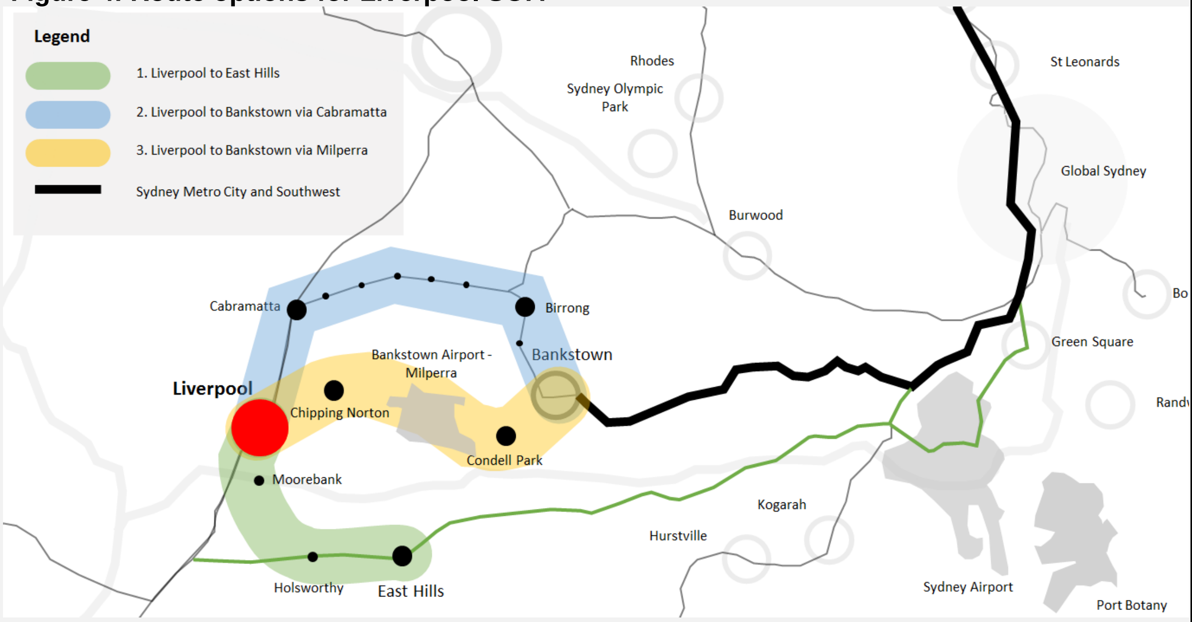
- Define the broad set of "strategic" route alignments within the corridor with particular attention paid to the relationship with existing and future activity centres
- Avoid the temptation to focus on engineering alignments at this stage; focus here is on the underlying function of the alignment less than its form
- Define option service attributes - mode, station locations, service speeds and frequency; rely on generic service offerings within the context of target service attributes in existing network plans; for example, most cities have a strategic network plan that will define different levels of transit service provision; in Sydney the LTTMP defines a hierarchy of three public transport networks (mass, intermediate and local transit).
- Define the level of network integration within the corridor (e.g. integrated feeder and trunk services vs separated feeder / trunk) and also external connections

Example: Liverpool transport options

As an example, three route options have been identified here to support Liverpool as a regional city.

1. Liverpool to East Hills (Y Link). This corridor reflects the formerly proposed Y Link, creating a more direct link between Liverpool and East Hills and Sydney Airport. This might be proposed as a heavy rail ‘spur’ or extension.
2. Liverpool to Bankstown via Cabramatta and Birrong. This corridor allows for the upgrading and conversion of the existing rail line to metro line to allow for the continuation of the proposed Sydney Metro City and Southwest from Bankstown to Liverpool.
3. Liverpool to Bankstown via Bankstown Airport-Milperra. This corridor allows for the continuation of the proposed Sydney Metro City and Southwest from Bankstown to Liverpool with a new extension via Bankstown Airport-Milperra (through the enterprise corridor identified within *A Plan for Growing Sydney* (Department of Planning and Environment 2014). The service frequency is likely to be in line within what is proposed for this service (a train every 4 minutes during peak and every 10 minutes off peak). Three new railway stations are possible as part of this option: Chipping Norton, Bankstown Airport-Milperra and Condell Park.

Figure 4: Route options for Liverpool SOA



Develop benefits and cost framework

- Review a generic long list of option benefits and costs used for a conventional BCA process (for example refer to Australian Transport Council 2006, p. 53) and select which benefits and costs are to be included in the current evaluation process.
- Distinguish between user benefits (existing and future), and system and economic benefits
- Identify cost components for consideration in the evaluation - e.g. capital costs, property acquisition, operating costs etc.

Example: Liverpool transport corridors, benefits, costs and metrics

For the Liverpool transport corridors project, a possible range of benefits and costs, including proposed metrics for the quantification of each benefit and cost, have been identified below.

Benefits

- Savings in travel costs for passengers (metric: estimating travel costs and user benefits as detailed below).
- Decrease in growth of congestion (metric: change in mode share as detailed below in other benefits).
- Improved business to business connections, for example, Liverpool to Bankstown or Liverpool to the Sydney CBD (metric: strategic level wider economic benefits as detailed below in other benefits).
- Increase in residential development potential around new station locations, for example at Chipping Norton, Bankstown Airport-Milperra and Condell Park (metric: evaluation of base case capacity and potential growth using techniques developed by SGS Economics and Planning; this can be quantified by using proxy techniques as used in a BCA such as land values).

Costs

- Investment costs, for example land acquisition, construction costs, planning and design (metric: estimated construction and other costs).
- Impact on existing rail network and lines such as connections, movement of trains and frequencies (metric: strategic level wider economic benefits as detailed below in other benefits, increasing travel times where appropriate to measure cost).

Develop the metrics

Following the development of the benefits and costs framework, the metrics are then developed and benefits and costs are calculated. The total benefits and costs (ultimately identified as dollar values) are then totalled. Outlined below are tools for the evaluation of some of the metrics identified above.

Estimating travel costs and user benefits

A core aspect of the SOA process is the development of a simple, desktop tool for the estimation of user benefits across the full range of options without use of a detailed transport model. There are many aspects of traditional four-step models that limit their use for rapid option evaluation including long preparation and run times, and lack of flexibility in how land use and transport are modelled.

An alternative, rapid evaluation tool might be developed as follows.

Estimating travel costs:

- Develop a long list of potential station locations across all options
- Specify the format of generalised cost equations including travel cost components and the weights applied to the different cost components
- Using distances between zones and stations, build estimates of average access time taking into account network integration; distinguish between walk and bus/car access
- Build a table of station-to-station travel times including average wait time, in-vehicle time, transfers
- Build zone-to-zone generalised travel cost estimates as a combination of:
    - Origin zone to origin station (access component)
    - Origin station to destination station (main component)
    - Destination station to destination zone (egress component)
    - For external trips, develop generalised cost estimates for end-to-end travel through the corridor
- Estimate the size of the external customer market – ie the number of trips that might use the corridor for cross-regional travel

Example: Liverpool transport corridor options, illustration of travel times for Option 3 origin and destinations

The following tables provide an illustration of how travel costs could be built using the above techniques. Calculations are shown for a small sample of trips within the Liverpool to Bankstown (via Bankstown Airport-Milperra) corridor.

The station-to-station travel times were built from existing and future service attributes; service interval and run time between stations (refer to Table 1).

Table 1: Station-to-station travel costs (sample)

Origin Station	Dest'n Station	Service Interval	Wait Time	In-vehicle Time	Travel Cost
		min	*min*	*min*	*min*
Existing bus					
Chipping Norton	Liverpool	20	10.0	10.0	28.0
Bankstown Airport	Liverpool	20	10.0	20.0	41.0
Condell Park	Liverpool	20	10.0	30.0	54.0
Bankstown	Liverpool	20	10.0	40.0	67.0
Future rail					
Chipping Norton	Liverpool	10	5.0	4.0	11.5
Bankstown Airport	Liverpool	10	5.0	8.0	15.5
Condell Park	Liverpool	10	5.0	16.0	23.5
Bankstown	Liverpool	10	5.0	20.0	27.5
Weights	Bus		1.5	1.3	
	Rail		1.5	1.0	

The access costs have been built from each study area zone to the closest station (refer to Table 2).

Table 2: Access costs (sample)

Origin Zone	Origin Station	Access Mode	Access Wait	Access Time	Access Cost
			min	*min*	*min*
Chipping Norton	Chipping Norton	Bus	10.0	5.0	21.5
Milperra	Bankstown Airport	Walk		10.0	13.0
Condell Park	Condell Park	Walk		10.0	13.0
Bankstown	Bankstown	Walk		10.0	13.0

The access, mainline and egress costs are combined to give zone-to-zone travel costs (refer to Table 3).

Table 3: Zone-to-zone travel costs (sample)

Origin Zone	Dest'n Zone	Origin Station	Dest'n Station	Access cost	Main cost	Egress cost	Total Cost
				min	*min*	*min*	*min*
Existing bus							
Chipping Norton	Liverpool CBD	Chipping Norton	Liverpool	21.5	28.0	5.0	54.5
Milperra	Liverpool CBD	Bankstown Airport	Liverpool	13.0	41.0	5.0	59.0
Condell Park	Liverpool CBD	Condell Park	Liverpool	13.0	54.0	5.0	72.0
Bankstown	Liverpool CBD	Bankstown	Liverpool	13.0	67.0	5.0	85.0
Future rail							
Chipping Norton	Liverpool CBD	Chipping Norton	Liverpool	21.5	11.5	5.0	38.0
Milperra	Liverpool CBD	Bankstown Airport	Liverpool	13.0	15.5	5.0	33.5
Condell Park	Liverpool CBD	Condell Park	Liverpool	13.0	23.5	5.0	41.5
Bankstown	Liverpool CBD	Bankstown	Liverpool	13.0	27.5	5.0	45.5

Estimating user benefits:

Development of the above desktop tool provides a robust, transparent platform for estimating user benefits for different options. Broadly, the user benefit of an option is the sum of individual zone-to-zone benefits which, in turn, are equal to the trip demand multiplied by the difference between the existing situation and future options, in travel cost (i.e. travel time multiplied by a dollar factor, as specified by agencies such as Austroads and discussed by the Victoria Transport Policy Institute (2013). Benefits would be estimated for existing and future demand.

Future trip demand between a pair of zones can be estimated here by “growing” existing demand in line with forecast growth in zone population and employment (which could be boosted by transport investment induced renewal). This avoids the need to run each scenario through four-step models that perform detailed calculations with respect to trip generation and redistribution.

Other benefits

Reductions in car trips could be estimated through applying a simple assumed elasticity of demand with respect to public transport cost. For example, a 10% reduction in public transport cost might be assumed to lead to a 5% reduction in car demand (cross elasticity of -0.5). This reduction in car demand could then be multiplied by assumed zone-to-zone car distances and times to get an estimate of reduced car vehicle kilometres and hours (also able to be converted into dollar values using published sources).

Strategic-level wider economic benefits (WEBs) could be estimated by assessing travel time and labour productivity improvements associated with the proposed transport corridor (refer to method within SGS Economics and Planning 2012).

Apply appropriate weightings

The preceding section outlines a simplified methodology that is consistent with conventional user benefit calculations for business cases. Of interest in the context of this paper is how this framework might be used to look at distributional benefits and costs to align with the objectives identified early in the process (which would typically be the focus of an MCA process).

The weighting of benefits is discussed here in the context of temporal and spatial aspects. The weightings can be applied at the disaggregated zone-to-zone level or at an aggregated level. Ultimately, weighted benefits and costs are aggregated to give total weighted benefits and costs.

Temporal weighting

The weighting method described here provides the opportunity to place more or less emphasis on future benefits versus existing benefits. The MCA process often needs to consider whether the infrastructure project is primarily focused on serving existing demand or providing the opportunity to influence and shape future demand, particularly with respect to future land-use.

Within the context of the SOA methodology, the trade-off between existing and future demand can be explicitly catered for through appropriate weighting of estimated existing and future user benefits. This approach also allows for the fact that conventional economic analysis applies discount rates in a way that diminishes future benefits when brought back to a net present value. (reflecting that ‘ a dollar now is valued more highly than a dollar in the future’ and uncertainty and risks that a future dollar may not eventuate) For example, using a discount rate of 7.5% per annum over a 20 year valuation period reduces the future user benefits to a value of just 21% of existing user benefits where adopting a lower rate of, say, 4 percent per annum results in only a 44 percent devaluation.

The use of very low or even negative discount rates is sometimes suggested for projects with social and environmental objectives focussed on the future (for example Harrison 2010; Flurbaey and Zuber 2012). It would not add significantly to the complexity of the SOA model to adopt a discounted cash flow framework and choose variable discount rates for different benefits, including lower ones for those which are future oriented. The choice of reduced discount rate will be somewhat subjective but so are other ‘weightings’ approaches.

Spatial weighting

Many MCA criteria can be addressed through appropriate spatial weighting of user benefits. Weightings can be applied either by origin zone, destination zone or origin-destination zone pairs. Weightings could be applied to centre-to-centre trips, for example. Census data, being available at a spatial level, provides the opportunity to weight user benefits by certain socioeconomic or other population-based characteristics.

On the other side of the equation, employment related statistics, such as employment floorspace or GDP, can be applied to destination zones to take into account benefits in an economic sense. Established techniques for estimating wider economic benefits are just an example of applying spatial weights to travel time improvements.

Returning to the theme of integrated land-use transport corridors, weightings can be developed to apply more emphasis to travel time improvements that support identified land use outcomes. For example, travel time improvements from identified renewal areas can be given more emphasis over travel time improvements to existing areas.

The ATC Guidelines suggest that within an adjusted BCA process some benefits or costs be multiplied by weights, i.e. greater than 1 to give greater weight and less than 1 for less weight. For instance, travel time savings for origins or corridors with a demonstrated social disadvantage might be given a greater weight where addressing the inequality of transport access is an objective, or the corridor which best connects nominated strategic centres might be weighted more highly than others.

The ATC Guidelines also suggest a method for how a 'distributional multiplier' might be applied, acknowledging that "the estimation process will inevitably involve judgement" (ATC 2008 p.82). The steps include:

- Calculating the percentage of benefits (already calculated if using the SOA framework) accruing to each (spatial) group or entity, including the share that accrue outside the area or corridor of interest
- Identifying the weightings (greater than or less than 1) to be used for each spatial group or entity (this may be relatively subjective but should be based on a strategic or policy logic)
- Multiplying the weightings by the share of benefits accruing to each group and summing the results, this figure being the 'distributional multiplier' that would apply to that particular benefit.

Table 4 provides an example of typical MCA criteria that might be used for evaluation of a land use – transport corridor and the potential treatment within the SOA process.

Table 4: Linkages to MCA

MCA criterion	Potential treatment within SOA process
Support growth in regional centres	Apply weighting to user benefits with origin or destination in regional centres.
Increase economic productivity	Calculate Wider Economic Benefits of enhanced agglomeration economies and apply appropriate weightings
Support urban renewal	Apply weighting to future benefits with origin or destination in identified renewal areas
Serve expected demand growth	Apply weighting to future versus existing benefits
Improve regional connections	Apply weighting to through trips versus internal trips
Reduce car use	Apply weighting to benefits associated with reduced car use
Minimise property acquisition	Apply weighting to property acquisition component of costs
Minimise construction risk	Apply weighting to estimated construction contingency costs.

Example: Liverpool transport corridors, weightings

Given the overall strategic objective to strengthen Liverpool as a regional city, strengthening its employment role is of particular importance, particularly in the longer term. Consequently, to better recognise future benefits related to employment, a lower discount rate might be applied to the 'business to business connectivity' (or WEBS) benefit line item in the evaluation of each option, if a discounted cash flow analysis framework is utilised. Alternatively, a simple higher weighting might be applied to this line item, e.g. 1.2 or 1.3, where other benefits may not be weighted.

In terms of the ATC suggested approach, and if social equity was an objective, benefits attributed to travel zones with a lower socio-economic index might be rated higher than others

Cost weighting

Weightings can also be applied to cost estimates although not to the same level of detail as that for benefits. For example, costs could be broken down into capital costs, property acquisition costs, operating costs, and other costs with different weightings applied to each. There is also the opportunity to apply appropriate weightings to construction risk which is particularly important at the early stage of option evaluation where not all of the construction challenges are known.

Compare benefits and costs

Ultimately, making an appropriate trade-off between benefits and costs it is a crucial aspect of rigorous option evaluation. The conventional BCA framework is focused very much on reducing costs and benefits to the same net present value through monetising cost and benefit streams.

In the SOA process described here, where the emphasis is on comparing options, there is less need to reduce benefits and costs to the same level. Rather, we are interested in the relative weighted benefit-cost performance of options.

One method is to rank options with regards to weighted estimated benefits and costs. The option with the highest weighted cost is awarded a rating of one, the other options are rated as a proportion of the highest weighted cost (refer to Table 4). Similarly, options are awarded ratings for weighted benefits.

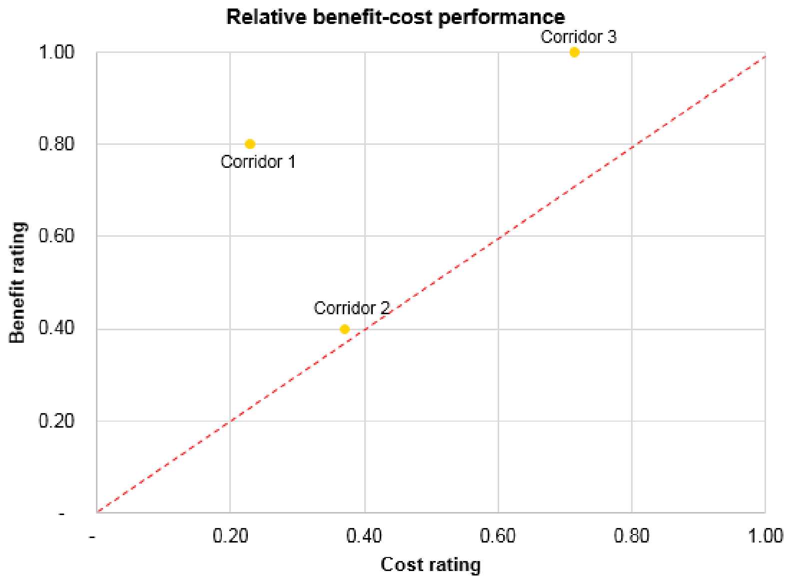
Example: Liverpool transport corridors, comparison of weighted costs and benefits
Once the calculations and weightings have been completed, each of the options might end up with the weighted and rating costs and benefits shown in Table 6 (note: these are hypothetical for illustration only).

Table 5: Illustrative weighted benefits and costs of Liverpool corridor options

Option	Weighted Cost $m	Weighted Benefit $m	Rating Cost	Rating Benefit
1	400	800	0.23	0.80
2	650	400	0.37	0.40
3	1,750	1,000	1.00	1.00
Max	1,750	1,000	1.00	1.00

Plotting the relative performance of options against costs and benefits provides an easy way of comparing options (refer to Figure 4). Options above the diagonal line perform relatively better with respect to benefits and coststo those below the line. The further the option is away from the diagonal line the better it performs with respect to benefits versus costs. A final, overall performance rating could be assigned to each option based on the ratio of the benefit to cost ranking. This serves as a general indicator of the extent to which the options deliver benefits in proportion to costs.

Figure 5: Relative benefit-cost performance



5. Conclusion

Table 6 compares the three methodologies, highlighting how the SOA sits between the MCA and BCA. The SOA proposes a clear, transparent, rigorous method for assessing options against strategic policy objectives.

Table 6: Comparison of evaluation methods

	MCA	SOA	BCA
Flexible	✓✓	✓	
Direct comparison of different infrastructure investments			✓
Rapid process	✓✓	✓	
Incorporate the views of various stakeholders	✓	✓	
Link to government policies	✓	✓	
Objective comparison		✓	✓✓

Because it relies on an evidence base focussing on benefits and costs, but also introduces strategic or policy objectives, the SOA framework provides the prospect of more rigorous and transparent decisions in relation to major projects **at the corridor or options stage.** It provides a “middle” approach introducing elements of the MCA approach to the quantitative framework of a basic BCA. Since a BCA involves the monetisation of all benefits and costs (where information is available), the SOA better ensures that the shortlisted corridors which are taken forward are options which can be appropriately assessed under the BCA framework.

The authors of this paper have been involved in projects where elements of the SOA framework have been applied, but the work is so far not publicly available. Needless to say, the SOA approach requires a wider embrace from governments and decision makers, and further application and testing, to refine its elements and confirm its utility. Multiple use and application will be necessary before it is likely to be recommended as part of accepted project processes by transport agencies, Infrastructure Australia and state treasuries for example.

While this paper has focussed on SOA’s possible application to transport projects it would be suited to other projects where alternative options are possible and with a spatial dimension, or which have the prospect of impacting on the distribution of economic activity (e.g. education investment pathways, electricity network planning). It is unlikely to be of use in situations where the options are between a physical project and a ‘soft’ or demand management alternative. This is because the latter alternatives are typically not aiming to influence economic geography, in fact they may be explicitly about suppressing movement or changes in spatial relationships; it is not a like for like comparison.

This paper is not a commentary on **how** current project evaluation methods are used and applied by Australian governments and infrastructure agencies, but it may be that the SOA framework – in addition to the other advantages outlined here – provides an alternative for greater transparency and rigour in decisions related to major strategic projects, with the accompanying prospect of greater public acceptance of these decisions.

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