A Selection and Prioritization Framework
for Public Projects

Keith Amos
Alireza Abbasi
Director of Postgraduate Studies and Coordinator of Project Management Programs
University of New South Wales, Canberra, Australia

Abstract: The aim of this research is to develop and propose a framework to supplement existing government frameworks for the selection and prioritization of large public capital projects. The effectiveness of the existing Australian frameworks is tested against three large public projects. Case study analysis indicated Optimism Bias and Focalism were cognitive traits that influenced key decision-making along with legislative structures. The result of the analysis showed the proposed framework is capable of mitigating risks of improper project selection through criterion analysis of quantitative and qualitative measures. However empirical analysis is required to further test assumptions.

Keywords: Project Selection; Optimism Bias; Capital Investment Appraisal Method; Cost-Benefit Analysis; Multi-Criteria Decision Analysis.

1. Introduction

Various documents provided for and commissioned by the government and private sector entities have indicated a number of possible issues with how large public projects are selected, prioritized and funded (McFadden, 1975). For instance, Terrill and Batrouney (2017) recognized "over the past 15 years, 32 percent of transport infrastructure projects valued at $20 million or more were announced before a funding commitment had been made", and that these prematurely funded projects accounted for 74 percent of cost overruns.

In Australia, Infrastructure Australia (IA) is tasked with overseeing large capital investments greater than $100 million at the federal level, whilst each state and territory has its own regulatory project and infrastructure framework in place to manage and oversee project approvals and prioritisations. All these frameworks attempt to capture and articulate similar aspects including the use of capital investment appraisal measures, whilst ensuring the methods and processes used to identify viable public projects that are aligned with government policies and representative of value for money (VFM). Though it is asserted here that these frameworks can still be manipulated through the political process either through conscious or unconscious bias, leading to inefficient project approvals and prioritization outcomes (Terrill & Batrouney, 2017). This leads to the assertion that if there are so many governance arrangements in place, there must be another aspect that influences and contributes to the recognized project assessment, selection, and prioritization inefficiencies.

Capital investment appraisal methods used in infrastructure assessments such as those used by IA are believed by some to have inherent shortcomings and failures. Some measures such as Net Present Value (NPV) and Internal Rate of Return (IRR) are assumed to undervalue long term benefits (Ashford, Dyson, & Hodges, 1988). Given these flaws, it is no surprise that many organizations adopt combinations of appraisal measures in their project selection analysis (Drury & Tayles, 1997). Even the widely used Cost-Benefit Analysis (CBA) method has flaws and inefficiencies. It is considered to involve the systematic and analytical process of comparing and evaluating identified benefits and costs to determine the desirability of a project (Quah & Haldane, 2007). It, however, is limited in its ability to compare project priorities where the completed metric analysis is not clearly indicating a single preferred outcome. It also has a tendency to ignore project interdependencies and complex relationship interactions (Cordier, Pérez Agúndez, O'Connor, Rochette, & Hecq, 2011). The result of this is that CBA in itself does not tell us or indicate whether a project or program of work is popular or bitterly controversial, nor whether it is fundable, or how it should rank in terms of strategic government objectives.

It is being suggested here that Optimism Bias (OB) is one key element that exerts influence and contributes to project inefficiencies (Kutsch, Maylor, Weyer, & Lupson, 2011). A distinction needs to be made between OB and strategic misrepresentation though. Whilst both may be viewed by outside commentators as influencing decisions, strategic misrepresentation is intentional and relates to approvers and managers deliberately and strategically overestimating benefits and underestimating costs, whereas OB is a form of self-deception with no intentional or malice overtones (Flyvbjerg, Glenting, & Rønnest, 2004). OB has also been defined as the difference between a person's expectation and the actual outcomes that follow (Sharot, 2011). A contributing element to the self-deception interpretation of OB, is the focal theory which is described as the tendency for people or decision-makers to give too much weight and attention to one particular piece of information when making judgments, forecasts or determinations (Baumeister & Vohs, 2007). By focusing too heavily on one element or aspect (the focal event or hypothesis), people tend to neglect and ignore the other primary considerations, which leads to illusional and inaccurate judgments and determinations.

The risks associated with the perceived inefficient governance frameworks and potential biases is that resultant projects may be approved and prioritized based on inconsistent and incongruent information and data, leading to concerns over the attainment of VFM on key public infrastructure and capital projects. This perceived governance gap facilitates major capital projects and programs being approved without sufficient and robust due diligence even with ex-ante and ex-post analysis and planning occurring (Ramjerdi & Fearnley, 2014).

In order to fill this perceived gap, this research aims to develop and propose a framework for the selection and prioritization of large public capital projects across multiple disciplines and industries, as a means to mitigate the mentioned risks associated with poor public project selection and prioritisations processes. Therefore, this research attempts to address the following research question: How should complex public projects be assessed and selected as viable and value for money whilst being aligned with government policies?

In answering the above research question the following sub-questions will be investigated:

- What economic and financial mechanisms and metrics are in place to ensure public projects are measurable and fit for purpose?; and are these metrics, if any, consistently applied within Government policy and expectations?

- What are the key cognitive traits, if any, that influence key decision-makers in their project selection and prioritization formulations?

To address these questions, this research reviews three recent large Australian public projects (i.e., Capital Metro, WestConnex and NBN Co.) to ascertain whether the financial analysis was conducted in accordance with the academic understanding and what cognitive traits impacted key approval decisions. It is anticipated that the framework will be tested on international public capital projects at a later stage pending the findings of this research

2. Methodology
2.1. Capital Investment Appraisal and Financial and economic decision support measures

Throughout the world, there are a number of well documented and recognized Capital Investment appraisal measures used to aide in decisions for large capital projects. These include Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) (Barfod & Salling, 2015)and Wider Economic Benefits (WEBs). These measures are not mutually exclusive to any industry or sector. These measures are explained in more detail below.

- NPV, is the difference between the present value of benefits and costs. The difference between the two reflects the worth in monetary terms of the project or proposal. The key decision criterion for this measure is where the NPV > 0, the project has intrinsic value and is worth pursuing. A weakness of NPV is its reliance on estimated cash flows, which can be easily manipulated as well as the reliance on estimated interest rates which can be difficult to predict for an extended period (Nugus, 2006).

- BCR, is essentially the ratio of PV of benefits to the PV of costs. The key decision point when utilizing this measure is that where a BCR >1, a project has intrinsic worth and is worth pursuing. There are some disadvantages of relying solely on BCR for decision purposes, which include: its ability to be manipulated due to its reliance on costs and benefits; and it is not time-sensitive, i.e. does not take into consideration the length or duration of projects in the analysis (Satyasai, 2009). The literature surrounding financial and economic investment methods states that if multiple projects are to be assessed with only one to be selected, then the project with the highest BCR would give the highest return for monies expended and as such should be selected over the other proposals (Wedley, Choo, & Schoner, 2001). This implies BCR should be used as the primary decision criterion mechanism within CBA before the utilization of other identified criteria. This interpretation is supported by various government assessment frameworks; for instance, the United Kingdom suggests, when ranking a set of projects with substantial capital spending, the BCR including whole life costs should be used (Treasury, 2014,The Green Book: Appraisal and evaluation in central government), whilst Australian frameworks suggest for ranking project proposals, options should be assessed on the basis of the BCR than NPV (List, 2018, Assessment Framework).

- IRR, is referred to as the discount rate or percentage that corresponds to the present value of benefits equaling the present value of costs. The key decision criterion for this measure

is where the IRR > Discount Rate (i.e. an IRR is being provided of 9% against a Government approved discount rate 7%, then this decision criterion has been satisfied. However, if the IRR produced is equal to 6%, and the Government approved the discount rate is 7%, them the decision criterion hasn't been met so the project shouldn't proceed), the project has intrinsic value and is worth pursuing. There are disadvantages to using IRR for a sole decision measure which includes its inability to consider the length and size of projects which can lead to erroneous rankings of mutually exclusive projects (Satyasai, 2009).

- Wider Economic Benefits (WEBs) or Wider Economic Impacts (WEIs), refers to improvements in economic welfare that are acknowledged but are not able to be typically captured or measured through traditional cost-benefit methods. They can be interpreted as resulting from market imperfections: that is, prices of goods and services differing from costs to society as a whole (Transport and Infrastructure Council, 2016). WEBs are generally captured and presented within BCR and NPV assumptions, they are generally not presented as separate calculated measures. A notable weakness of WEBs is the inability to identify if the benefits not captured as part of traditional methods such as BCR, NPV and IRR truly lead to economic growth (Vickerman, 2000).

All these individual capital investment measures can be consolidated for efficiency into a single financial comparison model known as Cost Benefits Analysis (CBA). Whilst CBA has a useful purpose, its limitations are also well documented as previously covered. The following statement identifies those limitations (Mackie, Worsley, & Eliasson, 2014, p. 5):

> "…CBA typically needs to be viewed as a framework of monetised and non-monetised impacts which, however, leads to difficulties with the value for money metric. Secondly, there are completeness issues. The cost-benefit analysis does not tell us whether a scheme is popular or bitterly controversial nor whether it is fundable. Above all, CBA does not map on to all the higher order strategic objectives of the government".

An approach is known as Multi-Criteria Decision Analysis (MCDA) or Multi-Criteria Analysis (MCA) attempts to fill the void created by the CBA limitations, by incorporating multi-facets to project evaluation that CBA alone cannot accomplish. MCDA methods are adopted to support decision making in cases where conflicting economic, environmental, societal and technical, and aesthetic objectives are involved. In essence, MCDA aims at bringing together qualitative and quantitative information and data for multiple complex criteria to support decision making.

- Analytical Hierarchy Process (AHP)

The AHP, developed by Saaty in 1971 - 1975, is a general theory of measurement that derives ratio scales from both discrete and continuous paired comparisons (Saaty, 1987). It essentially integrates criteria importance and alternative preference measures into a single overall score for ranking identified alternative decisions and project outcomes (Lee & Kozar, 2006). The major characteristic of the AHP method is the use of pair-wise comparisons, which are used both to weight coefficients and compare alternatives with relative ease. It is scalable and can easily adjust in size to accommodate decision-making problems due to its hierarchical structure (Velasquez & Hester, 2013). A noted disadvantage of AHP is that pair-wise comparison can also be subject to

inconsistencies in judgment and ranking criteria and it doesn't allow grading of one criterion in isolation, but in the only comparison with the rest of the criteria, without identifying weaknesses and strength (Velasquez & Hester, 2013).

- Simple Additive Weighting (SAW)

The SAW value function is established based on a simple addition of scores that represent the goal achievement under each criterion, multiplied by the particular weights. There are several advantages of using SAW which includes its ability to compensate among criteria, it is intuitive to decision-makers and its calculations are simple and can be performed without the help of complex computer programs. However, its disadvantages include: the estimates yielded by SAW do not always reflect the real situation, results may not appear logical, with the values of one particular criterion largely differing from those of other criteria (Velasquez & Hester, 2013).

2.2. Optimism Bias (OB) Theory

Traditional OB in project selection and prioritisations, relates to managers and decision-makers adopting project forecasts to reflect their own heuristic expectations. They do this unintentionally due to internal biases, by inflating projected benefits and reducing forecasted costs (Meyer, 2014). The ramifications of such forecast misrepresentations, being adopted and presented for project approvals, is that wrong projects may be inadvertently approved when compared to other projects where fewer heuristics influences were exercised on cost and benefit development (Flyvbjerg et al., 2004). Various methods have been developed attempting to mitigate the misrepresentational risk, such as the production of Reference Class Forecasting (RCF) methods (Love, Ahiaga-Dagbui, Welde, & Odeck, 2017), which is used to make forecasts based on actual performance in a similar reference class or project (Salling & Leleur, 2015). Essentially using actual information from previous similar projects in scale and scope and utilizing this data to base forecasted information upon, thereby mitigating the risk of OB and strategic misrepresentation (Flyvbjerg, 2013). Analysis of RCF is reasonably mature with plenty of research having been conducted on its impacts and consequence's in project selection. However very little research has been conducted on the impacts of political OB.

Political OB relates to the manner in which political players influence selection outcomes based on their own heuristic opinions on what they believe constituents really desire, whilst attaining benefits for themselves, thereby ignoring tangible and credible evidence in their project selection decisions. They essentially inadvertently attempt to maximize their own utility in line with their interests rather than that of the constituents (Flyvbjerg et al., 2004). It is this form of OB that is believed to exert its self-more frequently in the selection and prioritization of public projects and is being considered and researched herewith aims of supplementing the existing literature (Flyvbjerg, 2013). Our proposed framework (CBA-QQ)

This research proposes and develops a framework, we call CBA-QQ (Cost-Benefit Analysis using both the Quantitative and Qualitative aspects), for mitigating risks generally associated with project selection and is not bound by a specific industry or sector projects. The CBA-QQ framework can be applied to any industry or sector and takes into consideration traditional capital investment appraisal measures and OB influences through RCF. The proposed framework will also include a "decision conference" component, which is essentially aimed at getting the key stakeholders to agree on a path forward through a common understanding of the problem being encountered (Barfod & Salling, 2015). The framework is intended to supplement existing

frameworks, to added greater assurances that Value for Money (VFM) of public funds is being achieved.

2.3. Criteria determination

The CBA-QQ framework includes a minimal project acceptance criteria which should reflect organizational goals and their strategic targets, though others could be included as required. We recommend the following minimum general core criteria including recognized capital investment appraisal methods, and two qualitative (Key decision criteria) aspects for project acceptance and further consideration:

- Capital Investment Appraisal Measures
  The measure must meet the minimum acceptance criteria

Note. Given the complexity and uncertainty in some large capital projects, a Rough Order Magnitude (ROM) analysis is acceptable to allow progression for consideration.

- Key decision criteria
  Policy alignment: Aligned or broadly aligned (score => 6)
  Approval progress: Business Case under review (score => 2.5)

  Policy alignment refers to the level of congruence that a particular initiative has in relation to the relevant government jurisdiction's or organizations objectives and strategic values (Ewusi-Mensah & Przasnyski, 1991). In achieving this congruence the proposed framework utilizes the taxonomy offered by Marsden and Reardon (2017) which aims at identifying the underpinning policy arrangements. The elements of this taxonomy includes: 'goals' which are the absolute ends that underpin policymaking; 'objectives' which operationalize goals; 'settings' that specify the requirements to operationalize the objectives; 'instrument logics' refers to the actions that guide and enact the policy; 'mechanism' which refers to the instruments to implement the objectives; and finally 'calibrations' which relates to the manner in which an instrument is operationalized. It should be noted that policy can change over time, as such when a project prioritization process has begun and a policy shift occurs, the prioritization and selection process should be reset.

  Project proposals are scored on their corresponding alignment with each of the identified taxonomy elements. The proposed framework assigns a score of 0 for 'not aligned', 1 for 'broadly aligned' and 2 for 'aligned' to each policy element. The overall scores are summed with a net score of 0 reflecting the project proposal has no alignment with strategic policy, a net score of 6 represents broad alignment whilst a score of 12 represents alignment with policy. The scale of 0-12 is represented to recognize the extent to which the proposed project adheres to government principles and policies, noting there can be a wide-ranging adherence to the principles that need to be measured and considered (Cheung, Mirzaei, & Leeder, 2010).

  Approval progress refers to the level of oversight that has been conducted on particular initiatives (Bhuiyan & Thomson, 1999). The approval progress is adopted from Hensher, Ho, and Mulley (2015) in which several gated approval processes were implemented to

provide a standardized project mechanism to ascertain the stages of project development. There are four sequential stages in this process: 1) 'business evaluation' which is where the business case is tested for robustness; 2) 'preliminary scope' involves the development of a more detailed scope statement; 3) 'project definition' involves the development of the final project plans, and 4) 'execution' involves carrying out the project. Each of these stages involves the following sequential elements, initiation, planning, control, execution and closure.

The proposed framework assigns a 0.5 score to each element of each stage beginning with 0 for 'no work undertaken', through to 10 for 'completion' of the 'execution' element within the 'execution' stage.

This approach recognizes that complex projects through government do not simply receive one checkpoint before proceeding to development, rather multiple checkpoints occur to test the project proposal for fitness for purpose characteristics (Bhuiyan & Thomson, 1999).

Note. Whilst IA recommends WEBs currently be excluded in Australian proposals, it is viewed here that WEBs are an important part of realizing a project's true worth, and as such is considered a requirement for inclusion of this framework.

AHP

The implementation of AHP in the proposed framework is linked with the intent of identifying all the key identified decision assessment criteria and having the key stakeholders agree on the comparative importance of each criterion against each other (pairwise comparison). The purpose of doing this is to ensure a clear distinction of what criteria are deemed as the most important from the perspective of the collective stakeholder group. Doing so ensures the criteria outcomes receive the required level of support to avoid conflicts based on the eventual project selection or attractiveness ranking.

The CBA-QQ framework prioritizes project decision criteria for inclusion in the AHP module as follows: relevant capital investment appraisal methods appropriate to the project such as, though not exhaustive: (1) BCR, (2) NPV, (3) IRR, (4) Policy alignment, and (5) Approval progress. The comparative importance criteria are based on identified strengths and weaknesses of each criterion in our CBA and in line with best practice utilized by various international jurisdictions. The most appropriate and relevant Capital Investment Measures should be used, with irrelevant ones excluded from the process.

Data capture

Data capture is required to allow the detailed information to be compared and analyzed. Both qualitative and quantitative aspects need to be captured with no requirement for a consistent unit of measure, as the MCDA will convert data into normalized factors. It is a requirement though that a numerical scale is used to represent the qualitative results.

The data capture component covers all the forecasts for the relevant project, it also expects RCF or another form of modeling to have taken place to ensure data integrity and act as a mitigation strategy from standard OB impacts. The data captured in the actual forecasted data relating to the relevant capital Investment appraisal method calculations.

MCDA (SAW)

The role of the MCDA in this framework is to essentially convert the criteria importance established through the AHP pairwise comparison mechanism and the information attained through the captured data, into a clear identifiable ranking or level of attractiveness through the utilization of the Simple Additive Weighting (SAW) technique.

Ranking / Attractiveness

Once all the data has been normalized through the MCDA component and summed, the overall net scores will be compared. The proposal or option with the highest cumulative score is intrinsically the highest ranked or most attractive proposal. In testing the proposed framework, if any of the proposed criteria are not achieved, it is determined that the project should not be selected or proceeded with, in its presented form. If multiple projects meet the approved criteria, the normalized weighted average allows for a suitable ranking to be relied upon to determine preferred options for project progression and selection. If there is concern over project forecasts and expenditures, it is recommended to also undertake the analysis on the sensitivity tests to gauge their impacts. Further forensic analysis can be conducted on the individual criteria outcomes so as to ascertain where aspects and criteria, on which proposals were found, to be comparatively weaker than others being considered.

3. Applying the proposed framework to three Case Studies

In order to test our proposed CBA-QQ framework, two recent major public projects in Australia have been analyzed: (1) Capital Metro Light Rail project undertaken by the Australian Capital Territory (ACT) Government; (2) the WestConnex project undertaken by the New South Wales (NSW) Government and (3) the National Broadband Network (NBN) project undertaken by the Australian Federal Government. First, we analyze the three cases to assess and find out whether the intrinsic capital investment appraisal measures adopted were applied in-line with existing approaches. Following the initial analysis and identification of the key quantitative metrics, the three case studies are further analyzed on whether cognitive considerations such as OB were evidenced in the decision-making processes and impacted the decisions. Finally, all case studies are assessed using the CBA-QQ framework, to determine if the framework would have impacted or altered the decisions attained.

3.1. Case Study 1: Capital Metro Light Rail project

In April 2012, the ACT Government commissioned a report titled "City to Gungahlin transit corridor" concept design report (City to Gungahlin transit corridor: concept design report (April 2012) : report / URS; prepared for ACT Government Environment and Sustainable Development, 2012) which provided independent analysis on two options to service the "City to Gungahlin Corridor" (Northern Corridor), a Bus Rapid Transit (BRT) proposal and a Light Rail Transit (LRT) proposal. This report did not provide a solution preference, and simply listed financial and economic indicators and performance information on both proposals.

Table 1 shows the economic and financial indicators for the 2012 submission (ACT Government, 2012) against both BRT and LRT proposals had a BCR >1, NPV > 0, and IRR > 7% ('the Government approved discount rate of 7%'), and therefore, were technically viable and representative of VFM. However, a simple comparison between the two proposals, highlights the

BRT had a higher intrinsic worth on face value in each indicator, suggesting the BRT should have been the preferred project.

In late 2012, a decision was made to pursue the LRT over the BRT irrespective of metric indicators and independent evaluations. It is suggested here that political OB, and focalism were key influences in the political decision to pursue the LRT option over the BRT in view of overwhelming economic and financial indicators. This assertion is supported by the 02 November 2012 Parliamentary agreement between the ACT Greens and ALP (Gallagher & Rattenbury, 2012) which resulted in the ALP committing to the LRT as part of their reforms for the ACT through a Private Public Partnership (PPP) arrangement.

In committing to the LRT the holistic economic and financial analysis seemed to have been ignored in the project selection and ranking, it appears that the ALP was overly optimistic that the LRT would, in fact, provide greater intrinsic benefits to the ACT economy and constituents than the BRT proposal would have. The ALP government seemed to be suffering political myopia by constantly promoting the unrealized WEBs inclusive metrics of the LRT in its 2012 submission over the superior BRT indicators; in doing so they were ignoring all other tangible financial and economic metrics. The 2012 submission noted total benefits for the LRT was $534.9 million as opposed to the BRT total benefits of $491.8 million, the submission ignored the fact the LRT cost considerably more to develop at $469.8 compared to the BRT at $215.3 million. This assertion was also observed by the ACT Auditor-General who believed that the calculation of WEBs (including land use benefits) needs to be treated with caution.

Methodologies for the calculation of WEBs are continuously evolving, but have not yet reached a stage where they are widely and uniformly accepted in Australia, their calculation is generally hampered by the lack of necessary base data (ACT Auditor General's Office, 2016). Interestingly, irrespective of the perceived potential for OB, our framework supports this policy action through the policy alignment criteria.

Using the 2012 submission data in the general CBA-QQ framework guidelines presented in Section 3, as shown in **Table 1**, both the BRT and LRT options meet the criteria for consideration and progression. This, however, does not justify either project as the best option. To determine the attractiveness or ranking of either proposal, the 2012 submission data are tested using the entire CBA-QQ framework processes.

Table 1. Guidelines for consideration and progression

CRITERIA \ OPTIONS	BRT		LRT	
NPV	243.3	✓	10.8	✓
BCR	1.98	✓	1.02	✓
IRR	14.60%	✓	7.20%	✓
APPROVAL	Business Case under review (2.5)	✓	Business Case under review (2.5)	✓
POLICY	Aligned (12)	✓	Aligned (12)	✓
DECISION	Progress	✓	Progress	✓

Steps 1 to 3 demonstrate how to utilize and undertake the proposed framework in detail, as worked through using case study 1.

Step 1.
Identify a clear priority level scale on which the identified criteria will be assessed. The scale adopted for the priority levels ranges from much more important at a score of 10 through to much less important with a score of 0.1, with equal value reflective of a score of 1.

Step 2.
Next, a comparison matrix is developed to include the criteria being compared. **Table 2** shows for the first row that BCR is more important than NPV by having a score of 5, whilst BCR is much more important than Approvals with a score of 10. The weight average (W/A) is calculate in the first column as the BCR/Sum (1/1.60=0.63), NPV/Sum (0.2/1.60 = 0.13) etc. The Relative weight (R/W) is calculated as the BCR/Sum (2.48/5 = 0.50), NPV/sum (1.35/5 = 0.27) etc.

Table 2. Criteria Comparison Matrix

CRITERIA	BCR	W/A	NPV	W/A	IRR	W/A	APPL.	W/A	POL.	W/A	W/A SUM	R/W
BCR	1	0.63	5	0.78	5	0.45	10	0.31	10	0.31	2.48	0.50
NPV	0.2	0.13	1	0.16	5	0.45	10	0.31	5	0.31	1.35	0.27
IRR	0.2	0.13	0.2	0.03	1	0.09	10	0.31	5	0.31	0.87	0.17
APPL.	0.1	0.06	0.1	0.02	0.1	0.01	1	0.03	5	0.03	0.15	0.03
POL.	0.1	0.06	0.1	0.02	0.1	0.01	1	0.03	1	0.03	0.15	0.03
SUM	1.60	1	6.40	1	11.20	1.00	32	1.00	32	1.00	5.00	1.00

Step 3.
The next set of steps involves the use of the MCDA (SAW) techniques as a means of normalizing the scores for each option against each criterion. The net average (NA) is calculated by utilizing the RCF or modeled forecasted outcomes and dividing the lowest score by the highest score. For example, NA for the BCR component for LRT and BRT are as follows: LRT / BRT (1.02/1.98 = 0.34), BRT/BRT (1.98/1.98 = 1)

For the relative score (RS), we need to multiply the NA by the R/W sum for each component. That is completed as follows for BCR of LRT: 0.34 * 0.50 = 0.17. We then need to sum all the RS for all the proposals, then rank the proposals from highest to lowest, with the proposal with the highest net score being the most attractive proposal.

Utilizing the entire CBA-QQ framework, it is clearly evidenced that the preferred proposal or most attractiveness proposal is in fact the BRT proposal with an overall RS score of 0.97 compared to a LRT RS score of 0.27. It should be acknowledged that the policy alignment portion of the CBA-QQ framework, specifically 'mechanism' which refers to the instruments to implement the objectives would not have mitigated the risk of the LRT being pursued as the mechanism was the support attained from the ACT Greens. The AHP allowed for the quantitative and qualitative

aspects to be ranked prior to the proposal being assessed and as such would have mitigated the OB influences of ignoring evidence on the most attractive and viable financial option.

3.2. Case Study 2: WestConnex

The NSW Government adopted the WestConnex strategy in the 2012 State Infrastructure Strategy and the NSW Long Term Transport Master Plan, with the subsequent business case being approved by the NSW Government in August 2013. To achieve the WestConnex outcomes the NSW Government completed a business case in 2013 and later a revised version in 2015 including updated estimates and assumptions, with economic appraisal components; which was conducted by (KPGM, 2015).

Acknowledging the economic and financial indicator development and interpretations were correctly applied by decision-makers, there were other cognitive factors present in project funding and prioritization. In an ANAO report (Australian National Audit, 2017a), it was noted that both the Federal Coalition and ALP had announced committed funding of $1.5 billion and $1.8 billion respectively to the project. These commitments were made prior to NSW finalizing their July 2013 WestConnex business case. For federal funding on projects above $100 m, the Federal Government requires IA to evaluate the associated business case. This Governance mechanism did not occur prior to the Federal Government making their financial commitments. Further to this, in May 2014 the Commonwealth government made a $500 m advance payment for WestConnex that subsequently led to the project being approved (Australian National Audit, 2017a) without documented analysis that statutory criteria had been met.

Applying the general CBA-QQ framework to this case study, we can identify that the WestConnex project should not have received commitment funding at the time it did. The framework indicated the project needed to have the business case approved or being reviewed before it should have received the committed funding, therefore no further analysis is required on the proposed framework to identify its alignment. Noting no review had been endorsed before approving funding the 'business evaluation' in the approval process would have mitigated the project receiving premature funding. This is because the business case hadn't been tested for robustness and as such would have also mitigated the OB influences as a consequence.

Through a detailed analysis of the three case studies, it is viewed that major public infrastructure projects are generally exercising a high degree of fidelity in their project analysis, identification, selection and prioritization processes. This is evidenced through the clear use and application of capital investment appraisal measures such as BCR, NPV and IRR within their respective business cases and submissions. Analysis of all case studies also indicated instances of possible political optimism bias (OB) influencing both project outcomes and decision criteria points as well as legislative structures playing a role in the process. This assertion is based on the fact that established capital investment appraisal measures, in the Capital Metro proposal indicated that the BRT should have been selected as the most attractive proposal, considering a higher intrinsic BCR, NPV and IRR than the LRT proposal, and therefore pursued accordingly. There is also no clear evidence or detailed rationale as to why the established financial criteria were ignored in favor of a financially inferior proposal (i.e. LRT). This lack of rationale, accompanied by the parliamentary agreement that coincided with the endorsement of the LRT as the preferred proposal, strongly indicates other exogenous influences on the proposal impacted the decision-making process.

The WestConnex proposal also indicated a strong presence of political OB due to the fact funding was committed during an election campaign prior to any business case being fully developed. Selecting a project without due diligence via a business case review would strongly indicate other factors were present in influencing the selection process. As part of the analysis, it was determined that political OB associated with the emergent election was the factor that resulted in the WestConnex funding being committed. Also, noting the Australian federal legislative system is bicameral, it appears to have played a role in ensuring some analysis and debate occurred surrounding the pros and cons of committing the advance payment. Even though the advance payment was made, the bicameral system in this instance appeared to have performed its function as designed and allowed for robust discussion. Had the CBA-QQ framework been utilized alongside existing review measures it is hypothesized that the framework would have prevented the commitment of the advance payment.

In establishing the NBN Co., the RFP process appeared to be rushed and lacking design clarity and evaluation criteria certainty. Also given the major industry participant (Telstra) also failed to comply with the conditions of participation of the tender and the recognition by the panel that no other viable tender was presented, along with the weighting and influence the ACCC had on the RFP outcome, it is not surprising the RFP process ended in the way it did. Given the CBA-QQ framework would have required the design and evaluation criteria to be fully agreed prior to the RFP process beginning as part of the AHP criteria, it is conceivable to hypothesize that the outcome may have been more orderly and structured and possibly leading to a different broadband model or outcome had it been applied. However, no matter the detailed or rigorous nature of a process, if a participant to an evaluation process fails to understand their mandatory participation requirements, then the same result will occur in respect of that participant. Noting the GFC was occurring at the time of the NBN creation and implementation, it is not clear but asserted that the Government expedited the NBN creation to further stimulate the Australian economy, which could have potentially and directly benefit constituents. The stimulus intent is considered the focal event indicating the presence of political OB, this is supported by the fact no CBA or business case was developed or approved in support of the NBN at the time of creation. Utilizing the CBA-QQ model to test the Mark II process, it is clear that the framework would have prevented a rushed decision to implement NBN. Co.

The approval gates associated with the CBA-QQ framework would have recognized no financials were completed meeting the mandatory criteria and that no business case was developed and approved or being approved therefore failing the project definition element of the approval criteria. Sufficient approval through the legislature for a commitment of funding had not occurred. With these aspects not occurring, the framework would have prevented the NBN implementation at that time, irrespective of the political and financial climate and alignment with Government policy and intent. It should be understood that the CBA-QQ framework is not intended to stop governments and policymakers from making decisions for the benefit of the country and its peoples, the intent of the framework is to ensure that decisions made are robust and approved through appropriate mechanisms prior to the commitment of funding or other committed obligations.

3.3. Case Study 3: National Broadband Network

The National Broadband Network (NBN) under the newly elected ALP Government, undertook two initial policy iterations, these were termed Mark I and Mark II by Bills Scales AO in his 2014 NBN Audit (Scales, 2014).

Mark I was pursued and characterized by a lack of clarity on the design framework and the importance of the objectives and selection criteria. The RFP required participants to provide proposals on a FTTN and/or FTTP rather than FTTN only and was undertaken as a single-stage process whilst maintaining an aggressive timeframe by allowing only 15 weeks from RFP release to close of submissions and an eight-week panel evaluation timeframe. The panel in its evaluation encountered unsolicited commentary from the Australian Competition and Consumer Commission (ACCC), that the Fibre to the Node (FTTN) was not a stepping stone to Fibre to the Premises (FTTP). The ACCC advice was sought as it is considered under the context of the RFP process, as a specialist advisor (Scales, 2014). This advice appears to have been instrumental in ensuring Mark I was abandoned, as the panel did not fully test this assertion with industry experts before abandoning Mark I and pursuing Mark II. It is at this stage Mark I was essentially terminated, with Mark II already in its infancy. Reviewing the Mark 1 process it is clear the lack of clarity and detailed understanding of requirements led to the closure of the RFP process. It is also not possible to test the entire RFP process through the CBA-QQ framework as it was stopped prior to any analysis of financials and the development of a business case for progression. However, if the CBA-QQ framework had been adopted from the start of the RFP process it is likely Mark I may have provided a different outcome. This assertion is based on the AHP requirement within the CBA-QQ framework which explicitly requires all assessment decision criteria be agreed to by key stakeholders before the process begins.

As Mark II was being developed, the 2009 Global Financial Crisis (GFC) was in full swing and impacting international economies. The Australian federal government was also issuing stimulus packages known as 'nation-building' initiatives to keep the Australian economy flowing and out of possible recession (Beltrán, 2014), of which the NBN was one such initiative. The desire to continue to stimulate the Australian economy may have been a contributing factor and focal event in creating the NBN Co. in the absence of full analysis and clear political oversight. Similar to Mark I, as no CBA or approved business case had been developed to justify the creation of NBN Co at the time of its implementation, it is asserted that political OB influenced and led to the creation of NBN Co. with the intent to stimulate the economy and attain political capital being the OB focal events. The CBA was eventually completed in 2014 rather than as part of the evaluation stage, after continued concern over the network structure and cost viability (Vertigan, Deans, Ergas, & Shaw, 2014).

As Australia was trying to navigate the GFC, the Strategic Priorities and Budget Committee of Cabinet (SPBC) was the key group of Government that had the initial oversight provision of the initial development of the NBN Model rather than the Cabinet of Government. The SPBC is a formal Cabinet committee that establishes the government's fiscal strategy and policy priorities at the beginning of each budget cycle (Webb, 2010). The fact that NBN Co. was created without either house of Parliament able to vote on its creation, whilst seemingly incongruent with the CBA-QQ framework. The Framework actually supports this initiative via the 'instrument logics' aspect of the Alignment criteria which refers to the actions that guide and enact the policy. The SPBC is the logic instrument and as such complies with the Alignment aspect. As no funding had been

sought at the creation stage, the legislative structure at that stage did not feature beyond the general debate in Parliament. Without sufficient robust debate through the bicameral systems and supportive business case, it is asserted that if the framework were adopted alongside existing practice, it would have prevented the formation of NBN Mark II. This assertion is based on the fact no business case was developed of analysis undertaken, thereof failing the project definition phase of the approval criteria.

As detailed for Mark I, had the CBA-QQ framework been applied to the analysis prior to formal implementation of NBN Co. via Mark II, it would have prevented the creation of NBN Co at that time and in that iteration. The prevention would have occurred due to the lack of financial and economic analysis and a reviewed business case The CBA-QQ framework requires all the criteria to be achieved for project progression, with a piecemeal approach being unacceptable.

4. Conclusion

This research aimed to identify how complex public projects are selected and assessed as value for money (VFM) whilst also being aligned with government policies. In identifying those aspects, the analysis was undertaken on three large public projects so as to substantiate what economic and financial indicators are utilized; as well as what cognitive influences, if any, are applied within decision formulations. A framework that we call CBA-QQ was therefore developed to test whether it would have mitigated the risks identified in project selection and prioritization. The CBA-QQ framework utilizes quantitative measures such as capital investment appraisal measures and qualitative measures such as *policy alignment* and *approvals* to mitigate influences associated with political OB and focalism in decision making. Traditional OB mitigation strategies such as RCF focus on reducing the impacts of decision-makers inflating forecasted benefits and reducing forecasted costs, but do not mitigate decision-makers' impacts on overall decision outcomes that are incongruent with the qualitative metrics. The CBA-QQ isn't intended to replace existing frameworks, rather its intent is to supplement and aide decision making by adding a further layer of assurance over public projects that will commit public funds.

Furthermore, both the Capital Metro and WestConnex projects which were reviewed indicated a strong understanding and alignment with the existing economic and financial criteria requirements which included the utilization of BCR, NPV and IRR as key decision criteria, therefore there were no concerns surrounding the financial metric criteria utilisations. However, concerning cognitive influences, the Capital Metro proposal focused too heavily on the application of the WEBs component as the focal point for progressing the LRT option over the BRT. This resulted in a decision to pursue the LRT which present weaker overall economic results. The WestConnex project also indicated key focal OB events that lead to the project receiving funding prior to a business case being finalized. As the federal government was entering an election campaign, it appeared as though the focal events were the potential benefits, WestConnex could have contributed to the local constituents as well as at the election for both political parties. Analysis of both case studies determined financial alignment with expectations, however also strong indications of political OB influencing the decision-making processes.

The NBN project through Mark I was characterized by a lack of design and evaluation clarity, which appears to have contributed to the eventual failure of the associated RFP. Utilisation of the CBA-QQ framework may have altered the outcome had it been employed. This assertion is based on the fact that the CBA-QQ framework requires through its AHP criteria, a firm and agreed set

of criteria to be established prior to a project assessment occurring. Though given no financial or economic assessment was undertaken, a complete analysis of the financial impacts can't be completed. Through the Mark II variant process, international economies were managing their response to the GFC. Australia was not immune from the GFC and was also implementing economic measures to avoid negative outcomes. These measures were known as nation-building initiatives, the NBN was one of these identified initiatives. It is asserted that political OB was a driving factor in leading to the creation of NBN Co. This assertion is based on the analysis that no CBA was undertaken or the development of a business case prior to the approval. Then the beneficial constituent outcomes associated with the NBN creation must be the focal aspects leading to its creation and resultantly led to political OB associated with approving the NBN.

The CBA-QQ framework was utilized to ascertain whether it would have mitigated both the quantitative and qualitative risks associated with both project proposals and selections. Analysis from the framework testing, strongly indicated that the CBA-QQ framework would have effectively mitigated risks associated with any incorrect application of quantitative data and the cognitive impacts associated with political OB. Further empirical testing is required to ascertain whether the CBA-QQ framework has greater project proposal selection and attractiveness identification utility. Testing should also include the CEP model to ascertain aspects that may be integrated into the CBA-QQ framework to enhance its overall functionality.

On a final note, the major limitation of this paper is the ability to attain access to critical information in a timely manner. Given nature and security implications of some capital projects, request for information through Freedom of Information (FOI) may need to be made.

References

ACT Auditor General's Office. (2016). *Initiation of the Light Rail Project / ACT Audit Office*. [Canberra]: Publishing Services, Shared Services, Commerce and Works Directorate, ACT Government.

ACT Government. (2012). *City to Gungahlin Transit Corridor Infrastructure Australia Project Submission*.

Ashford, R. W., Dyson, R. G., & Hodges, S. D. (1988). The Capital-Investment Appraisal of New Technology: Problems, Misconceptions and Research Directions. *The Journal of the Operational Research Society, 39*(7), 637-642. doi:10.2307/2582185

Australian National Audit, O. (2017a). *The approval and administration of Commonwealth funding for the WestConnex project : Department of Infrastructure and Regional Development, Infrastructure Australia / Australian National Audit Office*. Barton, ACT: Australian National Audit Office.

Barfod, M. B., & Salling, K. B. (2015). A new composite decision support framework for strategic and sustainable transport appraisals. *Transportation Research. Part A: Policy & Practice, 72*, 1-15. doi:10.1016/j.tra.2014.12.001

Baumeister, R. F., & Vohs, K. D. (2007). *Encyclopedia of social psychology* (Vol. 1): Sage.

Beltrán, F. (2014). Fibre-to-the-home, high-speed and national broadband plans: Tales from Down Under. *Telecommunications Policy, 38*(8), 715-729. doi:https://doi.org/10.1016/j.telpol.2013.08.006

Bhuiyan, N., & Thomson, V. (1999). The use of continuous approval methods in defence acquisition projects. *International Journal of Project Management, 17*(2), 121-130. doi:https://doi.org/10.1016/S0263-7863(98)00011-8

Cheung, K. K., Mirzaei, M., & Leeder, S. (2010). Health policy analysis: a tool to evaluate in policy documents the alignment between policy statements and intended outcomes. *Australian Health Review, 34*(4), 405-413. doi:https://doi.org/10.1071/AH09767

City to Gungahlin transit corridor : concept design report (April 2012). (2012). Retrieved from [Canberra:

City to Gungahlin transit corridor : concept design report (April 2012) : report / URS; prepared for ACT Government Environment and Sustainable Development. (2012). [Canberra: Environment and Sustainable Development.

Cordier, M., Pérez Agúndez, J. A., O'Connor, M., Rochette, S., & Hecq, W. (2011). Quantification of interdependencies between economic systems and ecosystem services: An input–output model applied to the Seine estuary. *Ecological Economics, 70*(9), 1660-1671. doi:https://doi.org/10.1016/j.ecolecon.2011.04.009

Drury, C., & Tayles, M. (1997). The misapplication of capital investment appraisal techniques. *Management Decision, 35*(2), 86-93.

Ewusi-Mensah, K., & Przasnyski, Z. H. (1991). On Information Systems Project Abandonment: An Exploratory Study of Organizational Practices. *MIS Quarterly, 15*(1), 67-86. doi:10.2307/249437

Flyvbjerg, B. (2013). From Nobel prize to project management: getting risks right. *arXiv preprint arXiv:1302.3642.*

Flyvbjerg, B., Glenting, C., & Rønnest, A. K. (2004). Procedures for dealing with optimism bias in transport planning.

Gallagher, K., & Rattenbury, S. (2012). *Parliamentary Agreement for the 8th Legislative Assembly for the Australian Capital Territory.*

Hensher, D. A., Ho, C., & Mulley, C. (2015). Identifying resident preferences for bus-based and rail-based investments as a complementary buy in perspective to inform project planning prioritisation. *Journal of Transport Geography, 46*, 1-9.

KPGM. (2015). *WestConnex Full Scheme: Economic Appraisal.* Retrieved from

Kutsch, E., Maylor, H., Weyer, B., & Lupson, J. (2011). Performers, trackers, lemmings and the lost: Sustained false optimism in forecasting project outcomes — Evidence from a quasi-experiment. *International Journal of Project Management, 29*(8), 1070-1081. doi:https://doi.org/10.1016/j.ijproman.2011.01.010

Lee, Y., & Kozar, K. A. (2006). Investigating the effect of website quality on e-business success: An analytic hierarchy process (AHP) approach. *Decision Support Systems, 42*(3), 1383-1401. doi:https://doi.org/10.1016/j.dss.2005.11.005

List, I. P. (2018). Assessment Framework.

Love, P. E. D., Ahiaga-Dagbui, D., Welde, M., & Odeck, J. (2017). Light rail transit cost performance: Opportunities for future-proofing. *Transportation Research Part A: Policy and Practice, 100*, 27-39. doi:https://doi.org/10.1016/j.tra.2017.04.002

Mackie, P., Worsley, T., & Eliasson, J. (2014). Transport appraisal revisited. *Research in Transportation Economics, 47*, 3-18.

Marsden, G., & Reardon, L. (2017). Questions of governance: Rethinking the study of transportation policy. *Transportation Research Part A: Policy and Practice, 101*, 238-251.

McFadden, D. (1975). The Revealed Preferences of a Government Bureaucracy: Theory. *The Bell Journal of Economics, 6*(2), 401-416. doi:10.2307/3003236

Meyer, W. G. (2014). The effect of optimism bias on the decision to terminate failing projects. *Project Management Journal, 45*(4), 7-20.

Nugus, S. (2006). *CIMA Learning System Fundamentals of Business Maths*: Elsevier.

Quah, E., & Haldane, J. (2007). *Cost-benefit analysis*: Routledge.

Ramjerdi, F., & Fearnley, N. (2014). Risk and irreversibility of transport interventions. *Transportation Research Part A: Policy and Practice, 60*, 31-39. doi:https://doi.org/10.1016/j.tra.2013.10.014

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical Modelling, 9*(3), 161-176. doi:https://doi.org/10.1016/0270-0255(87)90473-8

Salling, K. B., & Leleur, S. (2015). Accounting for the inaccuracies in demand forecasts and construction cost estimations in transport project evaluation. *Transport Policy, 38*, 8-18. doi:https://doi.org/10.1016/j.tranpol.2014.11.006

Satyasai, K. (2009). Application of modified internal rate of return method for watershed evaluation. *Agric. Econ. Res. Rev, 22*, 401-406.

Scales, B. (2014). *Independent audit : NBN public policy processes : April 2008 - May 2010 / Bill Scales AO*. [Canberra, Australian Capital Territory]: [Parliament of Australia].

Sharot, T. (2011). The optimism bias. *Current biology, 21*(23), R941-R945.

Terrill, M., & Batrouney, H. (2017). etting infrastructure right, one project at a time. *Australian Financial Review*.

Transport and Infrastructure Council. (2016). *Australian Transport Assessment and Planning Guidlines - T3 Wider Economic Benefits*. Retrieved from Canberra, Australia:

Treasury, H. M. s. (2014). The Green Book: Appraisal and evaluation in central government. 2003. *TSO: London*.

Velasquez, M., & Hester, P. T. (2013). An analysis of multi-criteria decision making methods. *International Journal of Operations Research, 10*(2), 56-66.

Vertigan, M., Deans, A., Ergas, E., & Shaw, T. (2014). Independent cost-benefit analysis of broadband and review of regulation–Volume II–The costs and benefits of high-speed broadband. *Vertigan Report, August*.

Vickerman, R. (2000). Evaluation methodologies for transport projects in the United Kingdom. *Transport Policy, 7*(1), 7-16. doi:https://doi.org/10.1016/S0967-070X(00)00009-3

Webb, R. (2010). *The Commonwealth budget : process and presentation (updated April 2010) / Richard Webb*. [Canberra]: Parliament of Australia, Dept. of Parliamentary Services, Parliamentary Library.

Wedley, W. C., Choo, E. U., & Schoner, B. (2001). Magnitude adjustment for AHP benefit/cost ratios. *European Journal of Operational Research, 133*(2), 342-351. doi:https://doi.org/10.1016/S0377-2217(00)00302-7

About Authors

Keith Amos a student at the School of Engineering and IT at University of New South Wales (UNSW) at Canberra. He has also several years of project management experience at Australian Government.
Keith has over 20 years experience in the Public and Private sectors in a range of professions including Accounting, Project Management and Procurement/Contract Management. He is a certified Practicing Project Professional and a Certified Practicing Accountant and would like to acknowledge the support of his wife Kavita and two young children Zara and Aryan for the support through his study and professional career. Keith would also like to acknowledge and thank his mentor and Alireza Abbasi for the guidance and inspiration provided through his studies.

Dr. Alireza Abbasi is Director of Postgraduate Studies and Coordinator of Project Management programs in the University of New South Wales (UNSW) at Canberra. He obtained his PhD in Project Management from the University of Sydney in 2012 before joining the School of Engineering and Information Technology (SEIT) at UNSW Canberra. He also holds a graduate certificate in University Learning and Teaching from UNSW Sydney. His research and teaching interests include project management, management science, information systems management and network science. He has written a book, three book chapters and over 60 technical journal and conference papers. Dr Abbasi has had several appointments and been involved in different projects in IT/Software, Oil, Education and R&D sectors. He is an active member of several professional bodies including Australian Institute of Project Management (AIPM), Project Management Institute (PMI), and Australian and New Zealand Academy of Management (ANZAM).