ARC Value in Operations

Innovative procurement theories to optimise educational outcomes per total cost of school facilities

RESEARCH PROJECT REPORT

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This report is dedicated to the memory of Noel Christie.

Noel was instrumental in the successful application of the research project to the Australian Research Council. Before his passing in 2017, Noel greatly contributed to the project as one of the Partner Organisations.

Noel Christie, a true gentlemen and scholar in the field of education facilities.

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Executive Summary

Funded by an Australian Research Council (ARC) Linkage grant between December 2016 to June 2022, the ARC Value in Operations research project radically advances the body of procurement knowledge by developing a novel suite of whole-of-life procurement decision-making theories, models, and tools for the delivery of schools.[1]

The application of this body of procurement knowledge by public and private school operators is designed to advance educational outcomes in relation to the total cost of the built environment for the school. This is vital to Australia's future prosperity given a growing population. The project's success in developing the body of procurement knowledge to deliver new schools with significantly improved value is validated using a new approach measuring the contribution of schools' facilities to educational outcomes, while accounting for their total production costs and transaction costs i.e., "Value Rating Tool".

The six education departments in this research project operate over 6,000 schools and Goss (2022) considers that well over 400 new schools will be needed to accommodate 650,000 more students by 2026. The Value Rating Tool and other theories, models and tools developed and applied in this project meet an acute need for meaningful guidance in effectively and efficiently spending capital and recurrent funding in schools.

The research project is a collaboration of significant scale, comprising three universities – Queensland University of Technology (QUT), University New South Wales (UNSW) and the University of Melbourne (UoM) and 17 partner organisations. Project partners are Infrastructure Australia; four state departments of Treasury and/or Finance (NSW, QLD, VIC, and WA); six state and territory departments of education (ACT, NSW, QLD, SA, VIC, and WA); and six private sector organisations representing the full spectrum of school delivery (GRC Quantity Surveyors; Bickerton Masters Architecture; Capella Capital; Lendlease Building; Lidunian Partners; and Spotless Services).

A Project Advisory Committee including executives and senior managers from the partner organisations was established to act as an advisory panel for the project. The combined expertise and experience of these panel members enabled the receipt of informed advice, stakeholder perspectives, and reviews of the functions and operations of the research. In particular, the Project Advisory Committee meetings provided a forum where the research team could present progress reports and test the development of new theories, model and tools. Project Advisory Committee meetings were held typically on two occasions in each year of the project. There was a total of 12 Project Advisory Committee meetings.[2] The

1 The research project was supported under Australian Research Council's Linkage Projects funding scheme (project number LP160100259).

2 In addition to these Project Advisory meetings, meetings were held with groups of partner organisations i.e., 17 meetings were held with the group of education partners, 3 meetings were held with the group of Infrastructure Australia and treasury partners, and 3 meetings with the group of industry partners. The research team also held numerous meetings with individual partners including numerous presentations.

final Project Advisory Committee meeting to finalise this research project report for public dissemination, was held on 3 June 2022.[3]

In addition, the Project Research Team including senior university-based members of the project oversaw the implementation of the research that incorporated the project management plan and program, including ethics approval and compliance and maintenance of the project's website (https://research.qut.edu.au/arcvio/). The Project Research Team was led by Associate Professor Adrian Bridge (QUT) who chaired fifty (50) project research team meetings attended by the project's Chief Investigators and the project's Research Associate. The last of these meetings to finalise the draft of this research project report was held on 27 May 2022.

The project research team members participating at the final project research team meeting and responsible for the month-to-month implementation of the grant comprised:

- Associate Professor Adrian Bridge – Project Lead Chief Investigator (QUT)
- Professor Jill Franz – Chief Investigator (QUT)
- Associate Professor Peter Verhoeven – Chief Investigator (QUT)
- Associate Professor Riza Sunindijo – Chief Investigator (UNSW)
- Professor Lihai Zhang – Chief Investigator (UoM)
- Dr Linda Carroli – Research Associate (QUT).

Other members of the project research team at the time of the final project research team meeting comprised:

- Adjunct Professor Martin Skitmore – Chief Investigator (QUT)
- Associate Professor Vaughan Coffey – Chief Investigator (QUT).

Original members of the project research team included the following researchers that withdrew from their project research team position during the project:

- Adjunct Associate Professor Hilary Hughes (formerly a Chief Investigator when an Associate Professor at QUT)
- Professor Martin Loosemore (formerly a Chief Investigator when at UNSW)
- Nora Kinnunen (formally the project's Research Associate when at QUT).

The research team for each study is given in the report on each study in Sections 1 to 5 including Higher Degree Researchers and Research Assistants, and those members of the project research team that withdrew from the project.[4]

3 The views expressed in this research project report represent those of the research project team participating at the final project research team meeting but do not necessarily represent the views of any of the partner organisations.

4 Please contact Professor Lihai Zhang at UoM (lihzhang@unimelb.edu.au) for details on a study applying reliability-based optimisation analysis related to procurement of infrastructure.

Conclusions and Recommendations

Value Rating Study and Tool

This study aimed to develop a Value Rating Tool to assess value for money in infrastructure assets.

The key finding from this study is as follows:

- This study developed a fully implementable Value Rating Tool, which can be used to observe the school's built environment contribution to educational outcomes and their whole-life cost.

The Value Rating Tool is the most comprehensive post-completion review and benchmarking tool, as far as the research team are aware.

The Value Rating Tool was developed in school setting. The Value Rating Tool can be applied to primary and secondary schools including schools incorporating trends in delivery e.g., vertical schools and modular school buildings.

The Value Rating Tool can be adapted to apply to a wide range of social and economic infrastructure e.g., hospitals and roads.

More broadly, the Value Rating Tool can also play a key role upstream in Strategic Asset Management Planning and a key role downstream in guiding either a proposed increase in expenditure or a proposed reduction in expenditure in existing of infrastructure assets – by previewing the effect of the future spending or saving on value for money.

The Value Rating Tool has the potential to promote a paradigm shift in the practice of design e.g., Architecture and Engineering, as well as the practice of cost management e.g., Quantity Surveying and Cost Engineering. That is, instead of design following a cost plan or an estimate of cost following a design, the Value Rating Tool synchronises changes in design and costs because it previews the outcome of a change in design and cost before committing to this change.

Regarding infrastructure assets generally (including schools), it is recommended:

1. Federal Departments of Finance and Infrastructure, with support from Infrastructure Australia, fund a user guide for the Value Rating Tool, along with funding updates to the user guide as and when the Value Rating Tool is adapted to further social and economic infrastructure sectors.
2. State and Territory treasury departments and agencies consider funding the implementation of the Value Rating Tool to other sectors e.g., health and transport infrastructure.
3. The Value Rating Tool's user guide is considered for implementation by all Australian jurisdictions in its review (benchmarking) mode and preview (future spending) mode and in Strategic Asset Management Planning. This includes education departments consideration of the implementation of the Value Rating Tool, promptly, in trends in delivering schools e.g., vertical schools and modular school buildings.

Real Options Study and Model

This study developed and empirically tested a new integrated framework (or Real Options Model) comprising a combination of behavioural economics (or the economics of hold-up i.e., transaction cost economics) and real options theory on the governance of one of the most frequently occurring significant changes in an availability-type Public-Private Partnership (PPP) school contract i.e., staging changes.

The finding from this study is as follows:

- A defer-type real option is illustrated as a viable and attractive alternative to negotiating, post contract, a settlement sum with a PPP Company to defer the opening of a school/s. This type of real option provides the means for government not just to economise on the cost of a post-contract settlement but also to avoid the cost of hold-up, which could be a significant cost beyond the PPP Company's base cost associated with the deferment.

From a practical perspective, the Real Options Model developed in this study can be used to guide identifying viable real options to significantly improve the flexibility of PPPs and advance value for money delivered by PPPs.

It is recommended:

1. Federal Departments of Finance and Infrastructure, with support from Infrastructure Australia, fund the transformation of the Real Options Model into a fully implementable Real Options Tool via a user guide.
2. State and Territory treasury departments and agencies consider applying the Real Options Tool's user guide to defer real options, accelerate real options, and switch real options in availability-type PPPs.

Free Design Study

This study aimed to investigate the interrelationship of school design and procurement and its combined effect on student wellbeing and educational outcomes.

This study focused on schools delivered via different procurement methods i.e., PPP, Design and Construct (D&C) and Design-Bid-Build (DBB). It also compared the implications for procurement regarding: (i) free versus prescriptive design approaches; and (ii) timing of action – before or after schools had opened.

The findings from this study comprise:

- With yet unopened schools, the budget similarly impacts design across PPP and D&C/DBB schools.
- With yet unopened schools, prescriptive design impacts procurement similarly across PPP and D&C/DBB schools.
- With already opened schools, procurement impacts design and school operation in different ways across PPP and D&C/DBB schools.

Regardless of the procurement mode, the implications of the study's findings reveal the need for more future focused budgets, aspirational design briefs and design autonomy to drive innovation as well as stronger linkage of design, procurement, and educational goals. Education outcomes would also benefit from broadening of the procurement priorities to accommodate 21st century educational goals and whole-life costs.

The study points to the need to consider the various procurement methods and their potential to impact the school and its environmental, organisational and social alignment in different ways.

Most significantly, this study found that it is not just the design or the procurement process pre-opening of the school that informs school facility performance. Rather, design and procurement together post-opening of the school, as experienced by principals, teachers and students, impacts school performance in terms of broader educational goals and outcomes extending to the whole student and their wellbeing. PPP principals report that after the first few years of working-out issues between schools, consortium and education department, principals can focus on educational services and prefer being principals of PPP schools where someone else has responsibilities for facilities. The more school principals can 'hand-over' the responsibility of the facilities to the consortium, the more likely satisfaction will occur. It also depends on the effectiveness of the consortium to maintain the facility and build relationships with the school. While Principals of non-PPP schools value autonomy, they emphasis that they have not been trained in facility management and maintenance, and that this become problematic as buildings progress in years in operations and need more maintenance.

The study highlights how stakeholder involvement is interdependent and, as such, how stakeholders have a mutual responsibility as carriers of educational vision and, consequently, a collaborative role to play in meeting and further informing the expectations of 21st century educational goals through the design, delivery, and operation of 'innovative learning environments' (ILEs).

It is recommended:

1. Education departments consider prioritising aspirational goals and user participatory processes in brief development, design, procurement and operation of schools.
2. Education departments and schools consider the actual lived experience of teaching in schools and the interrelationship of the social and physical environment in terms of impacting wellbeing and educational outcomes; advocating for principal autonomy and teacher involvement in school design and its operation; and in supporting teachers in the transition to ILEs.
3. The local community and Parent & Friends groups are encouraged to recognise the role of the school environment in preparing students for the 21st century and correspondingly advocate for changes that facilitate this.
4. Architects and designers adopt a design process and create designs that are future-oriented, user-inclusive, pedagogically aligned, evidence-based, and that encompass the whole school environment including outdoor environments and its urban context.
5. Contractors including various suppliers, such as furniture suppliers, develop their awareness of the educational value of high-quality school design.

Stakeholder Study

This study provided the groundwork for future research on developing guidelines on more effective levels of design involvement amongst stakeholders across alternative modes of procurement.

The findings from this study comprise:

- The level of involvement of the school principals and teachers is appreciably different in Stage 1 delivery (initial campus buildings to opening of school including their operations and maintenance) in PPP schools, in contrast to Stage 1 delivery in non-PPP schools i.e., principals and teachers have a low level of involvement in operations and maintenance in Stage 1 delivery of PPP schools, while principals and teachers have a high-level of involvement in operations and maintenance in Stage 1 delivery of non-PPP schools. The lower level of involvement by principals and teachers in operations and maintenance in Stage 1 delivery of PPP schools is a relative strength of PPPs, when principals in non-PPP schools report a strong desire to see more involvement of facility management to assist with operations and maintenance.

- The level of involvement of school principals and teachers is also appreciably different in Stage 2 delivery (buildings post-opening of school) in PPP schools, in contrast to Stage 2 delivery in non-PPP schools i.e., principals and teachers have a low level of involvement in all phases of Stage 2 delivery including a low level of involvement in design phases and Operations and Maintenance in Stage 2 delivery of PPP schools, while principals and teachers have a high level of involvement in Schematic Design, Detailed Design and Tender Documentation and Operations and Maintenance in Stage 2 delivery in non-PPP schools.
- Respondents broadly consider that value for money could be improved by including more involvement of principals and teachers in the design phases in Stage 1 and Stage 2 delivery in both PPP and non-PPP schools.
- Architect and Quantity Surveyor respondents consider that value for money could also be improved by Architects and Quantity Surveyors having more involvement in the design phases in Stage 1 and Stage 2 delivery of both PPP and non-PPP schools.
- Time pressures, as well as capital and recurrent costs restrictions are observed as root causes and barriers to increasing in the level of involvement of school personnel, Architects and Quantity Surveyors in design in both PPP and non-PPP schools and to increasing the level of involvement of facility management provided to school personnel in operations and maintenance in non-PPP schools.

It is recommended:

1. Future research be undertaken to strengthen the findings and their generalisability via a larger scale study using the method developed in this study. As part of larger study, schools with very high Value Ratings and schools with very low Value Ratings can be selected to identify optimal levels of stakeholder involvement.

Procurement Decision Study and Tool

The key finding from this study is as follows:

- This study showed how to apply the Procurement Decision Tool to a school, as a further illustration of the application of the Procurement Decision Tool in a sector other than health and road sectors.

The Procurement Decision Tool identifies the best value for money approach to two key infrastructure procurement decisions. These are contract packaging (the size and number of contracts) and their contract terms (using competitive and/or collaborative contracting). To achieve this, the Tool employs state-of-the-art microeconomic theory that was developed to address these two procurement decisions specifically and systematically. Neither competition nor collaboration are virtues on their own. Rather, it is the Procurement Decision Tool's strategic deployment and mixing of these approaches to contracting that is the key to optimising value for money, i.e., competition *and* collaboration leads to maximising cooperation.

The Procurement Decision Tool is a world-first; it is the only procurement decision-making tool based on state-of-the-art microeconomic theories and which has been successfully empirically tested. The significance of this becomes self-evident, given that value for money is an economic concept and requires an economic response. In brief, the Tool can be expected to deliver the following important benefits:

- Significant cost and time savings
- Appreciable improvements in transparency, accountability, consistency, and reliability in procurement decision-making, and
- More efficient deployment of private investment and finance.

The Procurement Decision Tool is estimated to double the chance of more effective procurement decision-making in contrast to current procurement decision-making practice (Bridge and Bianchi, 2014).

Regarding infrastructure assets generally (including schools), it is recommended:

1. Infrastructure Australia adopt the Procurement Decision Tool as the "Procurement Decision-Making Tool" to which Infrastructure Australia refers in its Infrastructure Plan 2021 (Recommendation 3.2b.1).
2. State and Territory governments consider the use of the Procurement Decision Tool in business case when seeking federal government funding in their new infrastructure projects, as well as using the Procurement Decision Tool in business case when they are the sole funders of their projects.

Regarding school infrastructure, it is recommended:

3. State and Territory governments consider implementing the Procurement Decision Tool to any trends in delivery, and promptly as these trends emerge, e.g., vertical schools and modular buildings.

Looking Across All Findings

To the extent the agency wishes to seek to improve performance across both PPP and non-PPP delivery, then the key likely source of this performance improvement lies in the nature and extent of stakeholder involvement. There is broad agreement amongst all the interviewees in the Stakeholder Study that value for money could be improved by more involvement of school personnel in Stage 1 in both PPP and non-PPPs delivery. While the non-PPP schools studied exhibit higher levels of involvement of school personnel in design phases in Stage 2 (buildings delivered post-opening of school), both the PPP and non-PPP schools studied have low levels of involvement of school personnel in design phases in Stage 1.

To facilitate and help crystallise the benefits of more involvement of school personnel in Stage 1 in both PPP and non-PPP delivery, the education department would likely need to develop the design further than a schematic design (around 30% complete) and closer to developed design (around 60% complete) before inviting D&C tenders. In doing so, the education department would need to trade-off time, and given the opening date of the new school is fixed, then this additional time and an earlier start on design would need to be achieved via forward planning.

Although the Procurement Decision Tool closely matched the actual D&C procurement in the non-PPP school in Section 5, the Procurement Decision Tool does not prescribe the exact level of design to be completed prior to inviting tenders. Rather, the Procurement Decision Tool relies on the concept of the Optimal Design Level for the Client to complete prior to signing contract/s (including substantial construction works). The Optimal Design Level represents a design that is sufficiently robust such that it is unlikely to change and clearly imparts the Client's requirements. Therefore, this Optimal Design Level is not universal. It will depend on the Client's circumstances, though not reaching full working drawings. The important point is that the design progresses right up to but, ideally, not a single detail further than what is required to achieve the Optimal Design Level. And so, a developed design would still be within the scope of an optimal design predicted by the Procurement Decision Tool vis-à-vis the non-PPP school in Section 5.

One of the recommendations associated with the Value Rating Tool and Procurement Decision Tool concerns State and Territory governments applying these two tools to trends in delivery, e.g., vertical schools and modular buildings. It's important that the performance and whole-life cost of these trends be assessed in a timely way. It's also important to assess different approaches taken to procurement to emergent trends e.g., to ensure thin markets or a single-select manufacturer of modular components and elements are procured in a way to mitigate likely high prices associated with market power and to avoid eroding the value and benefits of modular construction. This procurement may include the use of nomination of modular manufacturers to a Main Contractor to maintain competition associated with the on-site works, including groundworks, fit-out and landscaping.

Section 1

Value Rating Study and Tool

1.1 Introduction

The International Transport Forum (ITF) at the OECD have cited and endorsed the Value Rating Tool as one of their two recommended "ways forward" (ITF, 2018: 108-109).[5] More recently, Infrastructure Australia have taken a significant step forward in recognising the need to improve value for money in operations by recommending the development of a Value Rating Tool i.e., Recommendation #8.1.3 in Infrastructure Australia's 2021 Australian Infrastructure Plan (Infrastructure Australia, 2021: 102).

This study aimed to develop an implementable Value Rating Tool, which can be used to observe the the school's built environment contribution to educational outcomes and their whole-life cost. In other words, the Value Rating Tool assesses value for money of infrastructure assets, as depicted in Box 1.1.

Box 1.1: At a Glance: Value Rating Tool

What	Benefits	Opportunities
Evidence-based Value-for-Money assessment	Post-completion review and benchmarking	Customisable for all infrastructure classes
Multi-tiered weighted scorecard of performance	Previews VfM turning points to use renewal spending to maximise performance lift	Integration with Strategic Asset Management Planning
Aggregates all finance, design, construction, operations and maintenance costs	Feedback best practice into procurement of new facilities	Future proofing of facilities

5 The second "way forward" recommended by the ITF at the OECD is the Procurement Decision Tool in Section 6.

1.2 Value Rating and Value for Money

The Value Rating Tool captures value for money with respect to whole-life production and transaction costs (both internal and external) and benefits, or performance (judged by users, in terms of the built asset's contribution to the core business outcomes) within the footprint of the built asset and with respect to only those costs and performance affected by finance, design, construction, operations and maintenance (FDCOM) decisions.

In an educational facility setting, this approach to capturing value for money is indicated in Figure 1.1.

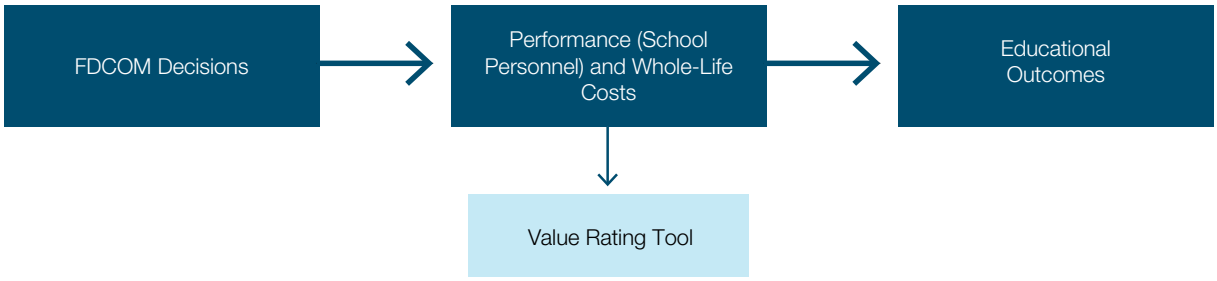

Figure 1.1: Value Rating Tool and Value for Money

The Value Rating is expressed in Box 1.2.

Box 1.2: Value Rating

$/m² per mean performance point

The penultimate step in developing the Value Rating can be expressed graphically as shown in Figure 1.2.

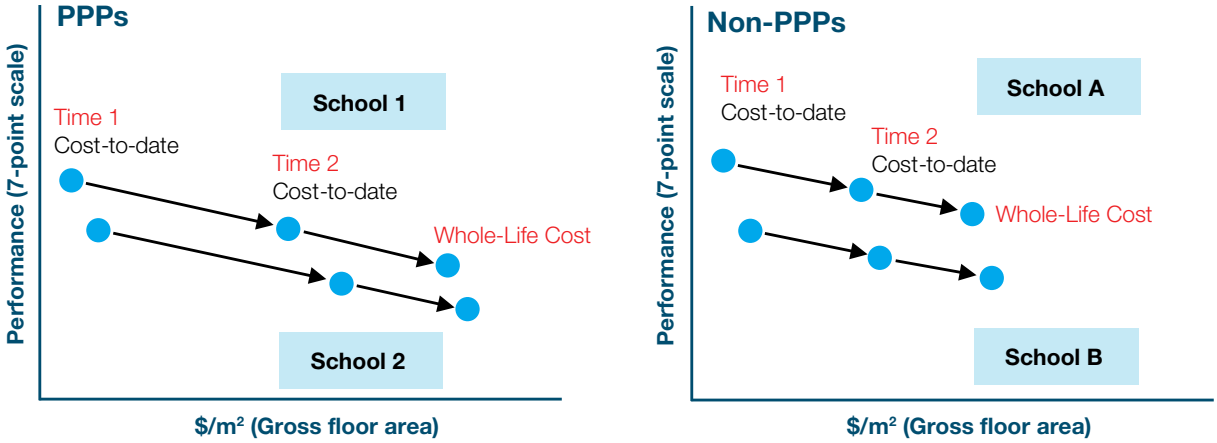

Figure 1.2: Graphical Expression of Value Rating

The hypothetical Figure 1.2 shows that in *Time 1* (e.g., one year since the school opened and in operations) and in *Time 2* (e.g., two years since the school opened and in operations) PPP School 1 is delivering superior value for money relative to PPP School 2, and non-PPP School A is delivering superior value for money relative to non-PPP School B. In whole-life terms (across a life in operations common to

both the PPP schools and non-PPP schools) in the hypothetical Figure 1.2, the non-PPP schools A and B are both delivering superior value for money relative to the PPP Schools 1 and 2.

Having established the data on the *x*-axis and *y*-axis of Figure 1.2, the mean of the performance scores is calculated and then the whole-life cost (in today's money) per m^2 (gross floor area) is divided by the mean performance score to give the Value Rating, or *$(whole-life cost in today's money)/m^2(gross floor area) per mean performance point*.[6]

1.3 Method

The study comprised a small sample and total of 38 primary schools (20 PPP schools and 18 non-PPP primary schools) in metropolitan locations delivered by government education agencies across five jurisdictions in Australia.

Data on whole-life costs was provided by the education agency for each school. Around 95% of all internal and external cost data was provided by the education agency i.e., ascertained costs. The remaining approximately 5% of costs was estimated by the research team.

Data on the performance of the schools was collected in interviews held at the schools with the Principal and a senior teacher from each school. The performance score comprises the direct and indirect contribution to education outcomes made by all teaching and non-teaching spaces and all the operations and maintenance activities in the school. The school's built environment directly contributes to educational outcomes when it physically assists teachers, the Principal and all other school personnel perform their role. The school's built environment indirectly contributes to educational outcomes when it assists in attracting and retaining students, teachers, the Principal and all other school personnel. This measure of performance approximately captures the concept of wellbeing in a school setting (Hughes, *et al.*, 2019).

1.4 Findings

1.4.1 Summary

The key finding of this study is summarised in Box 1.3.

Box 1.3: Value Rating Study and Tool Key Finding

- This study developed a fully implementable Value Rating Tool, which can be used to observe the school's built environment contribution to educational outcomes and their whole-life cost.

In other words, the Value Rating Tool assesses value for money of infrastructure assets and is the most comprehensive post-completion review and benchmarking tool, as far as the research team are aware.

6 The Gross Floor Area (GFA) approximates to GFA defined by The Australian Institute of Quantity Surveyors (2000).

1.4.2 An Example Application

1.4.2.1 Value Rating

An example application in this section illustrates the procedure of developing a Value Rating for a school and outlines the nature and extent of cost and performance data collected.

The example application is a non-PPP school that opened between 2007-2011 yielding a Value Rating of *$951/m^2 per mean performance point.*

For ease of exposition, the procedure to develop a Value Rating for this example application school is presented in reverse chronological order.

Figure 1.3 shows the graphical expression of the Value Rating for the example application school.

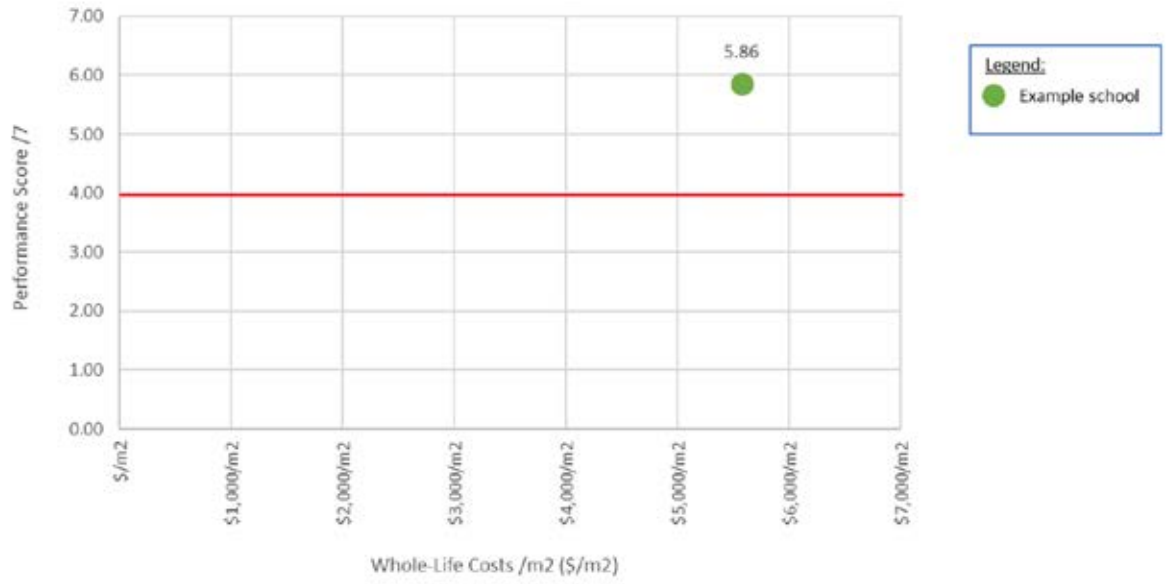

Figure 1.3: Graphical Expression of the Performance Score and Whole-life Costs

The study was a static study with one measurement of performance and one measure of whole-life costs taken between 2017-2018. Hence, the mean performance score is the same as the one measure of performance i.e., 5.86.

The whole-life cost (i.e., $5,570 in today's money, or 2021 dollars and location adjusted) per m^2 (gross floor area) is divided by the mean performance score (i.e., 5.86) to give the Value Rating, i.e., of *$951/m^2 per mean performance point*, as shown in Figure 1.4.

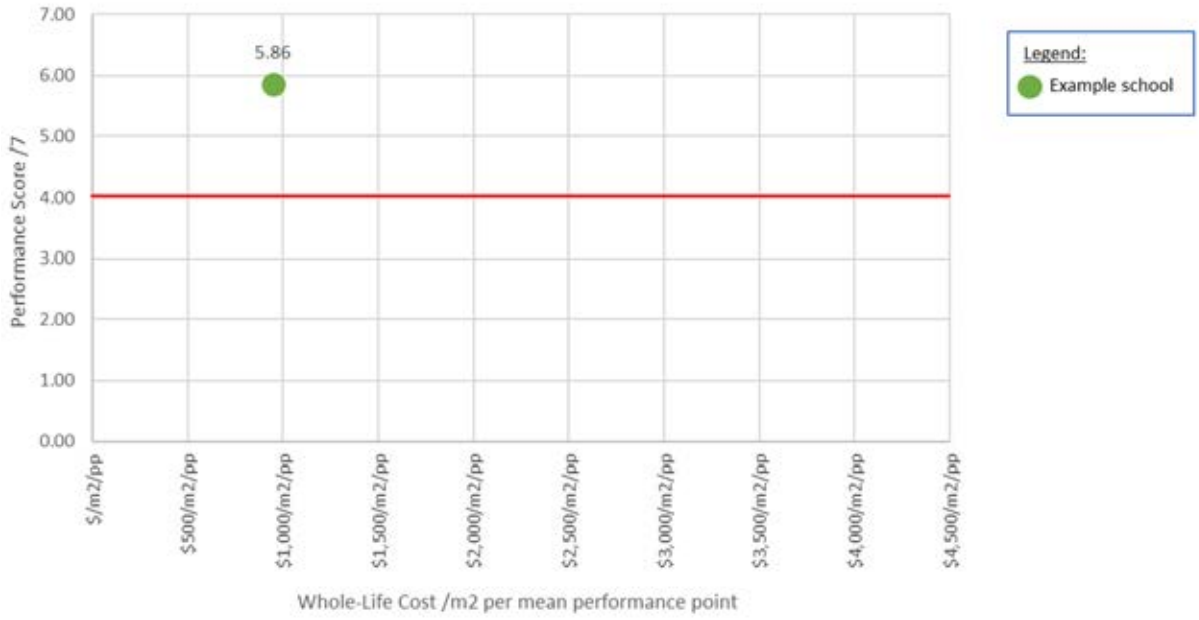

Figure 1.4: Graphical Expression of the Value Rating

The Performance Score of 5.86 is a weighted measure of the physical and aesthetic functioning of the contribution of all teaching and non-teaching spaces, both internal and external spaces, and all operations and maintenance activities to the education outcomes of the school, expressed as a number between 1.00 and 7.00. The Performance Score combines ratings given by a senior Teacher and the Principal to spaces and operations and maintenance activities with respect to how satisfied they are vis-à-vis the contribution of spaces and activities to educational outcomes, relative to a middle of the range space and the educational outcomes sought by the school. The range is from 1 (extremely dissatisfied i.e., the space or activity greatly falls short of fit-for-purpose) to 7 (being extremely satisfied i.e., the space or activity is fit-for-purpose and is an outstanding exemplar space or activity). A rating of 4 is the mid-point and represents the point at which the respondent is barely satisfied with the space or activity. Performance data was collected from the school's Principal and Teacher in a cross-sectional sample in 2018. These ratings are collated, and a series of weightings derived from cost and spatial data, are applied to the ratings to calculate the Performance Score.

The whole-life cost per m^2 (gross floor area/GFA) for the school is calculated using whole-life costs in 2021 dollars assessed over 30 years in operations, again in cross-sectional data collected between 2017 and 2018. The gross floor area used is approximatively the gross floor area (GFA) as defined by The Australian Institute of Quantity Surveyors (2000).

The GFA comprised all internal (enclosed) and external (unenclosed) covered teaching and non-teaching spaces, and in terms of those spaces common to all schools in the sample. Some spaces were excluded from the GFA since they are disproportionately large and less costly, e.g., ovals, playgrounds, carparks, uncovered walkways and grounds. Costs are location adjusted to account for differences between jurisdictions in cost of labour, plant and equipment, and materials.

1.4.2.2 Whole-Life Costs

Figure 1.5 shows the accumulation of costs over 30 years in operation.

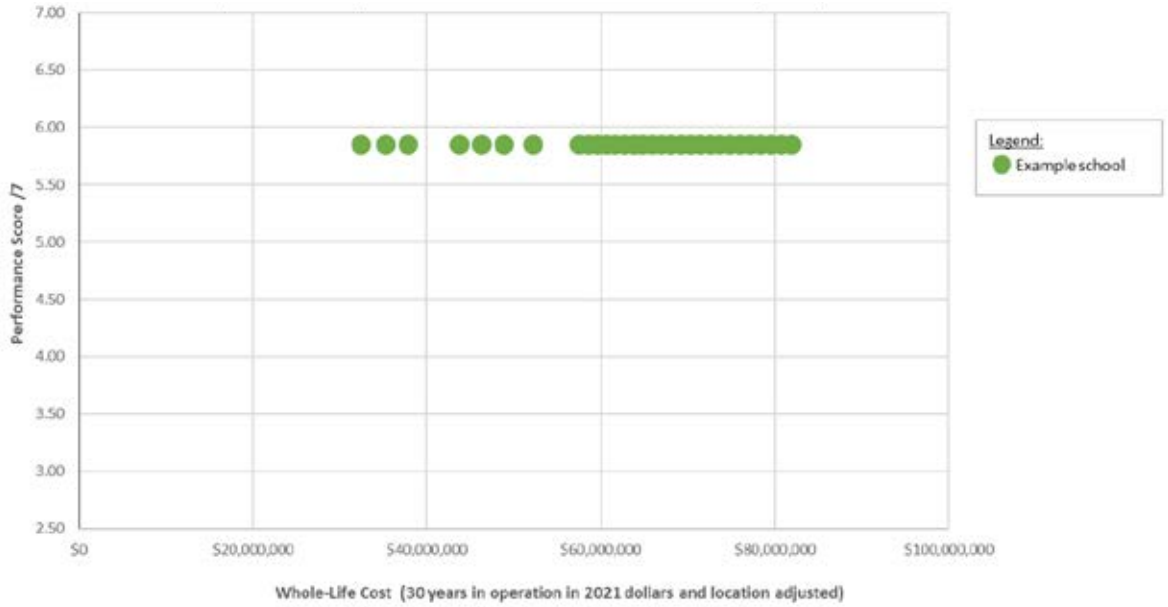

Figure 1.5: Cumulative Whole-Life Costs

Figure 1.5 shows a limitation of the research method, concerning performance. Because the study was a static/cross-sectional study incorporating one measurement of performance in 2018, the line or *Value Path* in Figure 1.5 is horizontal, i.e., it is assumed that performance is constant in the time prior to the assessment of performance and constant in the period after the assessment of performance to the end of the 30-year assessment term. However, with multiple and regular measurements of performance e.g., 12 monthly assessments, the Value Path is expected to be downward sloping from left to right and displaying a lift in performance in the first assessment taken after a significant capital spending in operations.

The first nine data points in Figure 1.5 represent 'costs-to-date', i.e., accumulated costs each year from 2009 (including the year in which the school was constructed and the first year of operations) to 2017. The subsequent 21 data points are estimated costs to the year 2038 to give total cost for 30 years in operation. The 30-year timeline was chosen for the application of this tool as it corresponds to the duration of a typical PPP contract in Australia.

Table 1.1 shows the calculation of whole-life costs over 30 years in operation, which is adjusted for location, building inflation and time-value-of-money.

Table 1.1: Whole-life Costs Across 30 Years in Operations (Location, Building Inflation and Time-Value-Money Adjusted)

					Inflation Adjusted				
Year	**Date**	**Cost for the year ($)**	**Accumulated cost ($)**	**Construct'n Inflation 3.5%**	**Cost for the year ($)**	**Cost for the year Today's Money ($)**	**Accumulated cost Today's Money ($)**	**Perform Score (/7)**	**Risk-free rate**
1	2009	$20,329,716	$20,329,716	$0	$20,329,716	$32,379,930	$32,379,930	5.86	3.96 %
2	2010	$1,523,752	$21,853,468	$0	$1,523,752	$2,819,839	$35,199,769	5.86	5.76 %
3	2011	$1,541,108	$23,394,576	$0	$1,541,108	$2,632,435	$37,832,204	5.86	5.50 %
4	2012	$4,162,806	$27,557,382	$0	$4,162,806	$5,840,904	$43,673,108	5.86	3.84 %
5	2013	$1,961,847	$29,519,229	$0	$1,961,847	$2,563,477	$46,236,585	5.86	3.40 %
6	2014	$1,941,763	$31,460,992	$0	$1,941,763	$2,555,228	$48,791,813	5.86	4.00 %
7	2015	$2,925,366	$34,386,358	$0	$2,925,366	$3,378,650	$52,170,463	5.86	2.43 %
8	2016	$4,652,040	$39,038,398	$0	$4,652,040	$5,307,149	$57,477,612	5.86	2.67 %
9	2017	$927,812	$39,966,210	$0	$927,812	$1,033,354	$58,510,966	5.86	2.73 %
10	2018	$915,161	$40,881,371	$32,031	$947,192	$1,029,005	$59,539,970	5.86	2.80 %
11	2019	$915,161	$41,796,533	$65,182	$980,344	$1,024,755	$60,564,725	5.86	2.24 %
12	2020	$915,161	$42,711,694	$99,494	$1,014,656	$1,035,355	$61,600,080	5.86	2.04 %
13	2021	$915,161	$43,626,855	$135,007	$1,050,169	$1,050,169	$62,650,248	5.86	1.68 %
14	2022	$915,161	$44,542,016	$171,763	$1,086,924	$1,058,803	$63,709,051	5.86	2.66 %
15	2023	$915,161	$45,457,178	$209,806	$1,124,967	$1,067,508	$64,776,559	5.86	2.66 %
16	2024	$915,161	$46,372,339	$249,179	$1,164,341	$1,076,284	$65,852,843	5.86	2.66 %
17	2025	$915,161	$47,287,500	$289,931	$1,205,093	$1,085,133	$66,937,977	5.86	2.66 %
18	2026	$915,161	$48,202,661	$332,110	$1,247,271	$1,094,055	$68,032,031	5.86	2.66 %
19	2027	$915,161	$49,117,823	$375,764	$1,290,925	$1,103,050	$69,135,081	5.86	2.66 %
20	2028	$915,161	$50,032,984	$420,946	$1,336,108	$1,112,119	$70,247,200	5.86	2.66 %
21	2029	$915,161	$50,948,145	$467,710	$1,382,871	$1,121,262	$71,368,462	5.86	2.66 %
22	2030	$915,161	$51,863,306	$516,111	$1,431,272	$1,130,481	$72,498,942	5.86	2.66 %
23	2031	$915,161	$52,778,468	$566,205	$1,481,367	$1,139,775	$73,638,717	5.86	2.66 %
24	2032	$915,161	$53,693,629	$618,053	$1,533,214	$1,149,146	$74,787,863	5.86	2.66 %
25	2033	$915,161	$54,608,790	$671,716	$1,586,877	$1,158,594	$75,946,457	5.86	2.66 %
26	2034	$915,161	$55,523,951	$727,256	$1,642,418	$1,168,119	$77,114,576	5.86	2.66 %
27	2035	$915,161	$56,439,113	$784,741	$1,699,902	$1,177,723	$78,292,299	5.86	2.66 %
28	2036	$915,161	$57,354,274	$844,237	$1,759,399	$1,187,406	$79,479,705	5.86	2.66 %
29	2037	$915,161	$58,269,435	$905,816	$1,820,978	$1,197,168	$80,676,874	5.86	2.66 %
30	2038	$915,161	$59,184,596	$969,551	$1,884,712	$1,207,011	$81,883,885	5.86	2.66 %
Present value (PV) 2021			$59,184,596			$81,883,885	$81,883,885		
						Area at 2017	Cost/m2		
						14,702m^2	$5,570/m^2		

To calculate whole-life costs to 30 years, the costs are adjusted for the time-value-of-money and into 2021 dollars using the risk-free rate (10-year bond) i.e., costs are compounded up to 2021 dollars and subsequent costs are discounted back to 2021 dollars.

From and including 2018, the annual recurring cost is in the sum of $915,161. This recurring cost is based on costs in 2017 dollars, which have been location adjusted. First, non-recurring construction costs in 2017 and planned maintenance costs are deleted from the costs, so that the residual cost comprises the annual cost of emergency and routine/basic day-to-day maintenance only. Next, planned life cycle maintenance costs (planned repairs and replacement costs) are added, based on the school's asset condition schedule that is used to calculate an annual cost/m^2 rate and applied to the gross floor area.

Building inflation is applied to the annual recurring cost from 2018 onwards. Building inflation at the rate of 3.5% is applied i.e., the 30-year long-term average annual inflation for buildings.

The method for calculating whole-life costs for PPP schools is the similar, except the PPP schools differ in their calculation of the inflation adjusted cost for each year. In the PPP schools, inflation according to CPI is applied only to the operations and maintenance costs within the regular service payments, excluding design and construction costs and the PPP Company's overheads, profits and other costs in the regular service payments.

With regards to adjusting for location, costs to and including 2017 (in dollars of the day) are shown in Figure 1.6 and their location adjustment is shown in Figure 1.7.

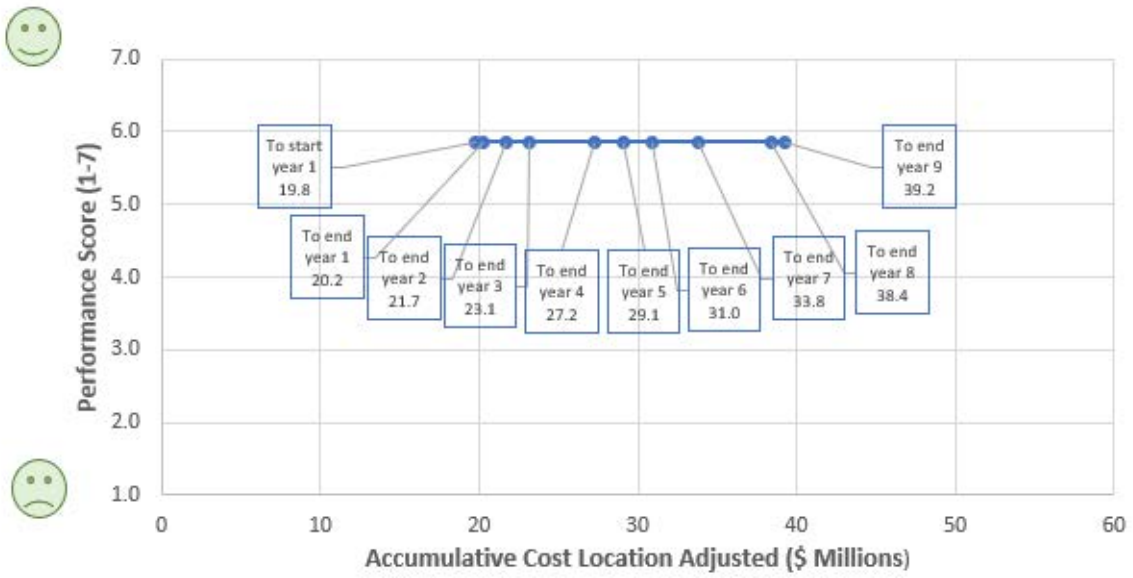

Figure 1.6: Pre-Location Adjusted Costs

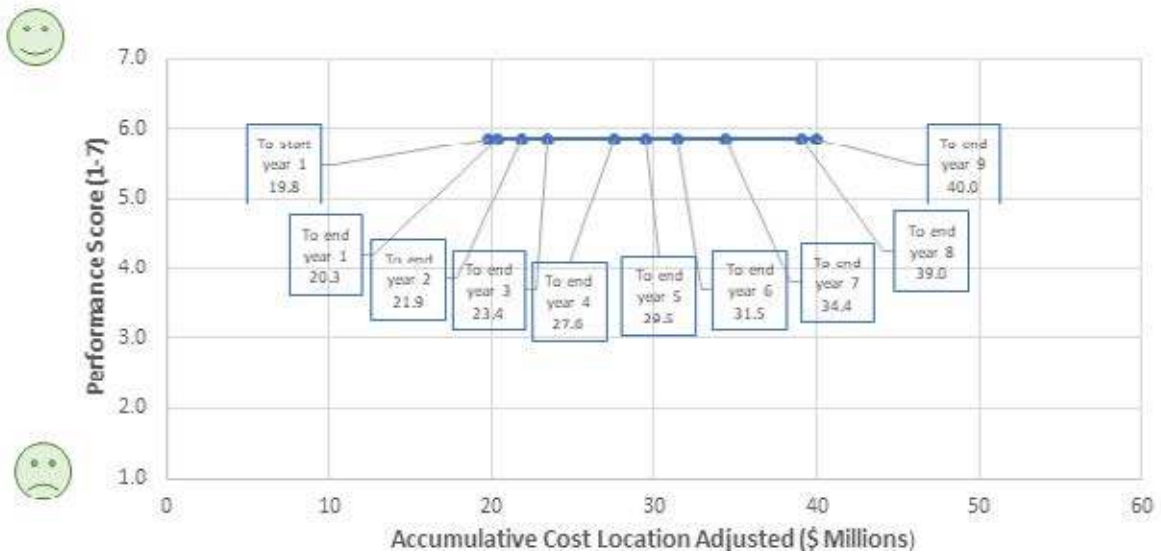

Figure 1.7: Post-Location Adjusted Costs

Internal and external construction costs are adjusted using Rider Levett Bucknell (RLB) cost relativity index (2021). The index is calculated for the period spanning the construction years of all sampled schools in the focal jurisdiction and then averaged. Design, operations and maintenance costs are adjusted using the Australian Bureau of Statistics (ABS) average weekly earnings data (2021). Design, operations and maintenance costs are considered less material-intense and more labour-intense so more sensitive to labour costs. The index is calculated for the period spanning years in operation of all the sampled schools in the jurisdiction and then averaged. Construction and design, operations and maintenance costs are adjusted for location in each jurisdiction except the jurisdiction that is used as the reference jurisdiction.

Table 1.2 summarises all internal and external costs (in dollars of the day) for the school for each year from construction year 2008 to 2017. These costs encompass all costs associated with delivering the whole school facilities, including all teaching and non-teaching internal spaces, and external spaces such as carparks, ovals, walkways, playgrounds and school grounds, and across all activities spanning pre-opening and operational phase of the school.

Table 1.2: Internal and External costs (Dollars of the Day) to 2017

Year #	To end of Construction Year	To end of Year 1	To end of Year 2	To end of Year 3	To end of Year 4	To end of Year 5	To end of Year 6	To end of Year 7	To end of Year 8	To end of Year 9	Total ($)
Total Floor area at end of year (m2)	7612	7612	8262	8262	10172	11052	11862	12012	14702	14702	
Internal Costs $ (excl GST)											
Pre Design		$2,616	$2,616	$2,616	$2,616	$2,616	$2,616	$2,616	$2,616	$2,616	$23,548
Design		$749	$749	$749	$749	$749	$749	$749	$749	$749	$6,741
Construction		$1,498	$1,498	$1,498	$1,498	$1,498	$1,498	$1,498	$1,498	$1,498	$13,481
Operations (excluding cleaning)		$3,643	$3,643	$3,643	$3,643	$3,643	$3,643	$3,643	$3,643	$3,643	$32,791
Operations: School based staff		$174,349	$160,087	$171,907	$183,289	$187,445	$198,102	$201,476	$204,206	$182,648	$1,663,509
Operations - Cleaning: Non skilled cleaning staff		$187,249	$192,860	$198,639	$205,713	$213,097	$219,681	$223,544	$237,078	$274,026	$1,951,884
Maintenance		$4,271	$4,271	$4,271	$4,271	$4,271	$4,271	$4,271	$4,271	$4,271	$38,435
Monitor, review and develop policy		$6,507	$6,507	$6,507	$6,507	$6,507	$6,507	$6,507	$6,507	$6,507	$58,561
External Costs $ (excl GST)											
Pre Design	$172,628		$17,000								$189,628
Design	$181,409		$170,000				$5,603				$357,012
Construction	$19,404,246	$14,388	$793,022	$951,687	$3,533,275	$1,284,681	$962,913	$2,180,026	$3,836,000	$112,239	$33,072,477
Operations (excl cleaning)		$74,568	$80,327	$98,215	$117,095	$118,193	$137,896	$144,824	$131,022	$138,707	$1,040,847
Operations - Cleaning											$0
Maintenance		$1,250	$10,723	$36,516	$34,866	$64,607	$290,463	$74,151	$134,590	$111,099	$758,263
Monitor, review and develop policy											$0
Total cost $ (excl GST)	$19,758,283	$471,088	$1,443,303	$1,476,248	$4,093,522	$1,887,307	$1,833,942	$2,843,305	$4,562,180	$838,003	**$39,207,178**
Accumulative cost $ (excl GST)	**$19,758,283**	**$20,229,371**	**$21,672,673**	**$23,148,921**	**$27,242,443**	**$29,129,750**	**$30,963,691**	**$33,806,996**	**$38,369,176**	**$39,207,178**	
Total Cost per floor area $/m2	2595.68	2657.56	2623.18	2801.85	2678.18	2635.70	2610.33	2814.44	2609.79	2666.79	

All internal and external costs are categorised in Table 1.2 according to the following activities:

1. Predesign - including strategy, feasibility, compliance, planning
2. Design - including any design activity upstream and associated with the subsequent downstream implementation of construction, operations and maintenance (including architectural, engineering consultants)
3. Construction - including building contractor, plant and equipment and project management involved in new works
4. Operations – including helpdesk services; graffiti removal; pest control; school office (janitor/ caretaker) including general duties, recording and delivering duties, day-to-day cleaning duties and ad-hoc/ basic maintenance; security services; utility management; and waste management
5. Cleaning - including scheduled and routine cleaning; planned periodic and project cleaning; unplanned cleaning
6. Maintenance - including any routine and specialist reactive breakdown/emergency maintenance; preventative maintenance; and planned repairs and replacement maintenance
7. Monitoring, reviewing and development of policy and procedures

The internal costs include costs for education infrastructure department staff (calculated using the total full-time equivalent education infrastructure department staff, the type of staff and the approximate annual salary, including on-costs) that are substantially (around 90% or more) involved in delivering non-PPPs.

In the case of a PPP school the education department staff would be substantially (around 90% or more) involved with PPP schools. Staff that work across both PPP and non-PPP schools and do not work either substantially on non-PPP schools or substantially on PPP schools are excluded.

Internal costs are apportioned per school on annual basis i.e., the total annual internal cost of an activity is divided by the number of non-PPP schools in the jurisdiction to give the per-annum sum for each activity shown in each of the internal cost rows in Table 1.2. In the case of a PPP school, the total annual internal cost of an activity is divided by the number of PPP schools in the jurisdiction.

The total external costs summarised in Table 1.2 include:

1. Education department reported external costs. These costs are external to the education department to deliver the school (within the boundaries of the site). This includes costs that are more obviously affected by the type of procurement approach, and include costs arising from consultants, contractors and others external provides to the education department. These costs exclude, utility costs to establish the service up to the perimeter of the site and preliminary/enabling works contracts.
2. External costs reported at school level. These costs are paid for at the school level so are not included in the education department reported cost data e.g., grounds person. School staff costs are estimated based on the average salary including on-costs for a typical education department staff member across all jurisdictions in the study.
3. Other external costs. These costs included funding via federal (e.g., the Building Education Revolution project) and education department grants (outside the mainstream funding reported by the education department). These costs also include fundraising and grants provided by the school's parents and community.

The total floor area is approximatively the gross floor area (GFA) as defined by The Australian Institute of Quantity Surveyors (2000). This GFA comprises all internal/enclosed covered areas and all external/unenclosed covered areas.

The costs for PPP schools are calculated similarly, except external costs are reported via Regular Service Payments (RSPs). For PPP contracts where the RSPs are provided as a total for all schools in the contract, the costs are allocated per school according to the GFA of the school as a proportion of the total GFA for all the schools in the contract. For PPP contracts in which the RSPs are provided per school, this cost is taken directly from the data provided by the education department.

Table 1.3 shows the confidence in the cost data using three categories of confidence.

Table 1.3: Cost Data Confidence

Known items & costs (costs provided by ED i.e., ascertained costs)	Certain item exists, 80% confidence that cost is +/-20%	Likely item exists, 80% confidence that cost is +/-20%	Total cost
$35,962,973			
	$1,209,830		
	$68,802		
		$0	
		$30,574	
	$1,935,000		
$35,962,973	$3,213,632	$30,574	
			$ 39,207,178
91.7%	8.2%	0.1%	

Regarding the total costs in this example school, approximately 92% of items are known, or ascertained costs i.e., actual costs provided by education department.

1.4.2.3 Performance

As mentioned, the performance score comprises the direct and indirect contribution to education outcomes made by all teaching and non-teaching spaces and all operations and maintenance activities in the school. The school's built environment directly contributes to educational outcomes when it physically assists teachers, the Principal and all other school personnel to perform their role. The school's built environment indirectly contributes to educational outcomes when it assists in attracting and retaining students, teachers, the Principal and all other school personnel. This measure of performance approximately captures the concept of wellbeing in a school setting (Hughes, *et al.*, 2019).

The performance score is derived from satisfaction ratings given by the Principal and a senior Teacher in the school to the spaces and activities as shown in Table 1.4.

Table 1.4: Performance Score Participants

Space categories and activities:	Direct contribution	Indirect contribution
Teaching spaces: 1. Internal 2. External covered including covered sports and assembly areas 3. External uncovered, including playgrounds and sports courts 4. Ovals	Teacher	Principal
Non-teaching spaces: 5. Internal 6. External covered, including walkways, verandas, assembly areas 7. External uncovered, including carparks, walkways 8. Grounds, including landscaped areas	Principal	Principal
Operations activities: - Cleaning - Other	Principal	Principal
Maintenance activities - Internal spaces - External spaces	Principal	Principal

The performance of the school facilities is assessed using separate instruments for the Teacher and the Principal.

The Teacher's instrument collects data on the performance of the teaching spaces in relation to the direct contribution of the spaces on supporting teaching activities. In rating each space, the Teacher is asked how satisfied they are that the teaching space "*supports the school's vision, mission and curriculum themes and consequently helps develop students' attributes and outcomes sought by the school*" and relative a middle-of-the-range space. The use of middle-of-the-range spaces is designed to reduce bias in the Teacher's response.

The response format for the 7-point scale in the Teacher's instrument is shown in Table 1.5 and an example of a middle-of-the-range space (a senior primary school classroom) is shown in Figure 1.8.

Table 1.5: Teacher Response and Scale on Direct Contribution of Teaching Spaces

Descriptor	Score
Extremely satisfied i.e. is an outstanding/exemplar space (greatly exceeds the 'middle-of-the-range space') and greatly contributes to the school's vision, mission and curriculum themes	7
Very satisfied i.e. is among the best of its kind of space (comfortably exceeds the 'middle-of-the-range space') and makes an appreciable positive contribution to the school's vision, mission and curriculum themes	6
Satisfied i.e. is fit for purpose (about the same as the 'middle-of-the-range space') and sufficiently facilitates the school's vision, mission and curriculum themes	5
Unsure i.e. might not be fit for purpose (might be inferior to the 'middle-of-the-range space') and some doubt whether the space may actually be detracting from the school's vision, mission and curriculum themes	4
Dissatisfied e.g. space not fit for purpose with minor issues (falls a short of the 'middle-of-the-range space') and is detracting from the school's vision, mission and curriculum themes	3
Very dissatisfied i.e. space is comfortably falls short of being fit for purpose with major issues (falls comfortably short of the 'middle-of-the-range space') and is appreciably detracting from the school's vision, mission and curriculum themes	2
Extremely dissatisfied i.e. space or activity greatly falls short of being fit for purpose (greatly falls short of the 'middle-of-the-range space') and is substantially inappropriate to the school's vision, mission and curriculum themes	1

Figure 1.8: Example of Middle-of the-Range Space (for a Senior Primary School Classroom)

The Principal's instrument collects data on the performance of the spaces and the operating and maintenance activities in relation to the direct contribution and the indirect contribution to educational outcomes made by the spaces and activities.

The first part of the Principal's instrument, addresses the direct effect of non-teaching spaces and the operations and maintenance activities on the delivery of teaching services. In rating the direct effect of each non-teaching space and activity, the Principal is asked how satisfied they are that the non-teaching space or operations activity or maintenance activity *"helps organise the delivery of teaching services in the school?"*.

The response format for the 7-point scale for the direct contribution of non-teaching spaces and the operations and maintenance activities in the Principal's instrument is shown in Table 1.6.

Table 1.6: Principal Response and Scale on Direct Contribution of Non-Teaching Spaces and Operations and Maintenance Activities

Descriptor	Score
Extremely satisfied i.e. is an outstanding/exemplar space or activity and greatly contributes to organising the delivery of teaching services	7
Very satisfied i.e. is among best space or activity in comparable schools and makes an appreciable positive contribution to organising the delivery of teaching services	6
Satisfied i.e. is fit for purpose and sufficiently facilitates organising the delivery of teaching services	5
Unsure i.e. might not be fit for purpose and some doubt whether the space or activity may actually be detracting from organising the delivery of teaching services	4
Dissatisfied e.g. space or activity not fit for purpose with minor issues that are detracting from organising the delivery of teaching services	3
Very dissatisfied i.e. space or activity comfortably falling short of being fit for purpose with major issues that are appreciably detracting from organising the delivery of teaching services	2
Extremely dissatisfied i.e. space or activity greatly falls short of being fit for purpose and is substantially inappropriate that make organising the delivery of teaching services extremely difficult	1

The second part of the Principal's instrument, addresses the indirect effect of both teaching and non-teaching spaces, and the operations and maintenance activities on attracting and retaining students and staff. In rating the indirect effect of each space and activity, the Principal is asked how satisfied they are that each space or operations activity or maintenance activity '*helps attract and retain the kind of students and teaching staff and non-teaching staff sought at the school?"*.

The response format for the 7-point scale for the indirect contribution of the non-teaching spaces and the operations and maintenance activities in the Principal's instrument is shown in Table 1.7.

Table 1.7: Principal Response and Scale on Indirect Contribution of Teaching and Non-Teaching Spaces and Operations and Maintenance Activities

Descriptor	Score
Extremely satisfied i.e. is an outstanding/exemplar space or activity and greatly contributes to attracting and retaining students and school personnel	7
Very satisfied i.e. is among best space or activity in comparable schools and makes an appreciable positive contribution to attracting and retaining students and school personnel	6
Satisfied i.e. is fit for purpose and sufficiently attracts and retains students and school personnel	5
Unsure i.e. might not be fit for purpose and some doubt whether the space or activity may actually be detracting from attracting and retaining students and school personnel	4
Dissatisfied e.g. space or activity not fit for purpose with minor issues that are detracting from attracting and retaining students and school personnel	3
Very dissatisfied i.e. space or activity comfortably falling short of being fit for purpose with major issues that are appreciably detracting from attracting and retaining students and school personnel	2
Extremely dissatisfied i.e. space or activity greatly falls short of being fit for purpose and is substantially inappropriate that are putting-off students and school personnel from joining the school and causing students and school personnel to leave the school	1

Further questions in the Principal's instrument collect data on the school-based staff costs and external costs that are incurred at the school level and not captured in the education department provided cost data.

Additionally, the Principal is asked to assess the relative importance that the direct role played by the school facilities in contrast to the indirect role played by facilities.

The source of spatial information required to measure areas includes spatial schedules from education department verified against and expanded on with *Nearmap* imagery across construction year and years in operation.[7]

Spatial data is obtained in the form of functional area schedules which detailed the type of space (e.g., junior classroom), the number of spaces and their total area. Spatial data also details any stages of construction for each space. The spatial data provided represents the plan of the school at the pre-procurement stage and not the actual situation in the reference year, therefore, the spatial data is cross-referenced with 2017 aerial data available online, using *Nearmap*, to provide an accurate picture of the school facilities. Spatial data is further confirmed during the interview at the school during which time a walkthrough of the school with the Principal or Business Manager is conducted.

A series of weightings is applied to Teacher and Principal's ratings of space functions, operations activities and maintenance activities to calculate a range of component performance scores and the overall performance score for the school. The weightings are used to account for the difference in size of the spaces, the cost of their construction (for example, the small costs per m^2 of construction of oval space in contrast to costs per m^2 to construct internal teaching space), operations and maintenance, and the level of direct and indirect contribution of the space and activities. Figure 1.9 and Box 1.4 outlines the nature and sequence of the application of the weightings.

7 *Nearmap* was accessed at: https://www.nearmap.com/au/en

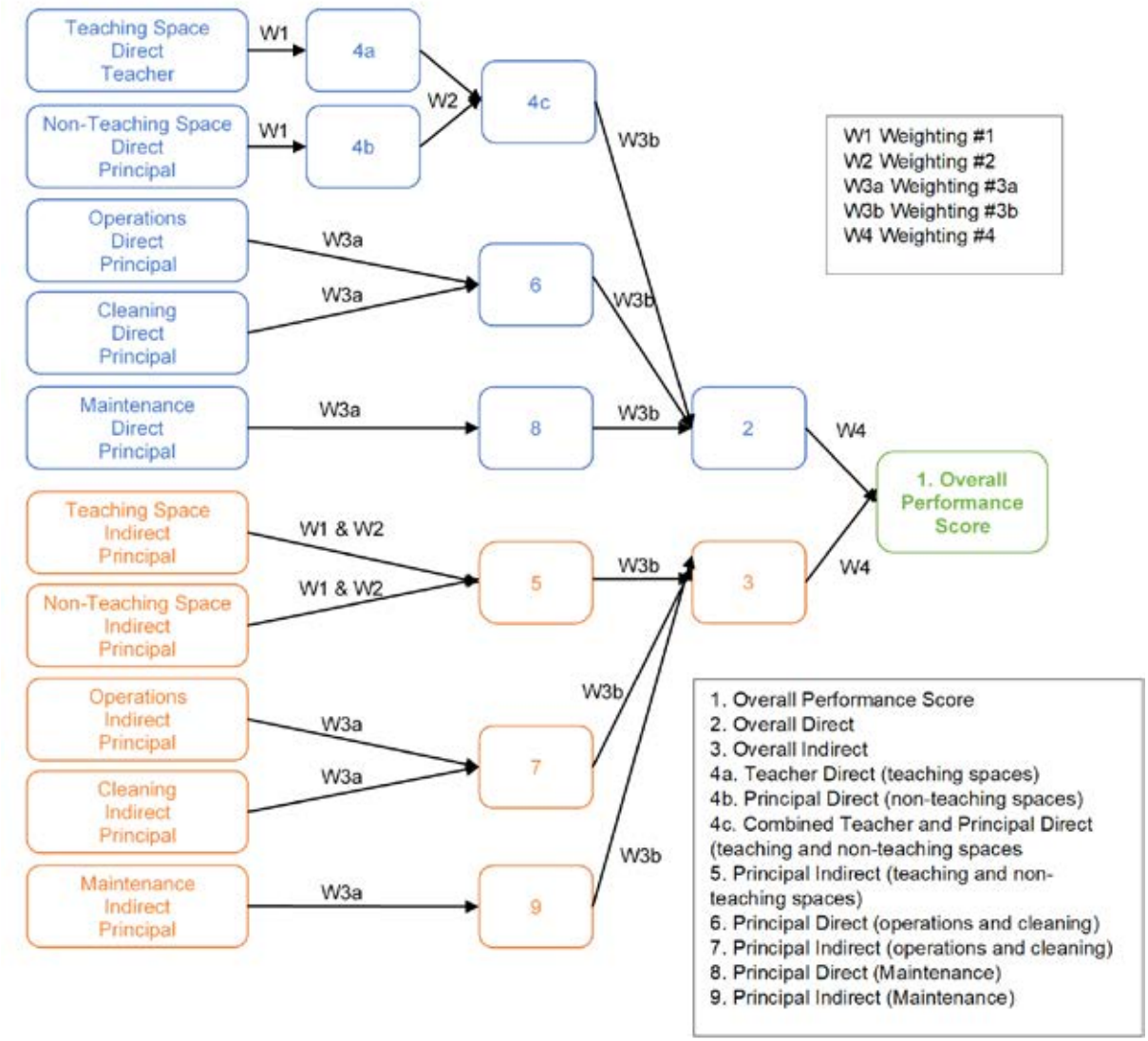

Figure 1.9: Schematic of Performance Score Weighting System

Box 1.4: Brief Description of Performance Score Weighting System

- Weighting #1: Each Teacher and Principal rating of spaces is weighted according to the area of the space as a proportion of the total space of that type.
- Weighting #2: Applied after Weighting #1, the scores are aggregated into space type and weighted according to the average proportion of their construction cost.
- Weighting #3a: Applied in two parts to operations, cleaning and maintenance activities:
  - Part 1. To operations activities (and their subsets) and cleaning activities based on the cost of these activities as a proportion of the total cost of operations plus cleaning activities; and
  - Part 2. To internal and external maintenance activities based on the cost of these activities as a proportion of the total cost of maintenance activities.
- Weighting #3b: Applied in three parts after Weighing #1, 2 and 3a, providing a total weighted performance - for 1. construction (including pre-design, design, construct and monitoring and reviewing) activities of the teaching and non-teaching spaces; 2. operations and cleaning activities; and 3. maintenance activities – according to the proportion of their costs from the total cost of all activities.
- Weighting #4: The final weighting is applied to the Overall Direct and Overall Indirect partial performance scores to give the Overall Performance Score, according to the Principal's assessment of the relative importance of the direct contribution of school facilities and indirect contributions of school facilities.

Table 1.8 summarises the overall performance score and component performance scores for the example application school.

Table 1.8: Overall Performance Score and Component Performance Scores

Activity:	Teacher Direct (/7)	Principal Direct (/7)	Principal Indirect (/7)	Overall Performance Score (/7)
Teaching spaces	5.014		6.099	
Non-teaching spaces		6.056		
Operations and Cleaning		6.292	6.584	
Maintenance		6.000	7.000	
Total (/7)	5.014	6.083	6.175	5.855

1.5 Discussion

1.5.1 Advancing the Value Rating Tool

As mentioned, this study is based on a small sample. The Value Rating Tool represents the whole-life costs at a point in time. When calculating the Value Rating in operations, whole-life costs comprise a mix of actual/historical costs and estimated/future costs. It is recommended the Value Rating be calculated on a larger sample of assets and on a regular basis (say 12 monthly measurements) and throughout the life of assets and beyond 30 years. This approach will allow the estimate of future costs in non-PPPs to be updated to reflect any emergent significant refurbishment required because of any lack of maintenance in prior years. Meanwhile, this approach will also allow for anticipated benefits of the remaining useful life of PPPs, in terms of both performance and overall lower whole-life costs, to be assessed.

There is the opportunity to explore the relationship between the condition of the asset and the performance score derived from responses made by principals and teachers. It is expected that there would be a clear match between a focal space receiving a good performance score (i.e., over 4.00 out of 7.00) and a good condition of the focal space. However, it does not follow that there would always be a clear match between performance score asset condition because the performance captures among other things, how much the focal space is fit for purpose – i.e., how much the space is contributing (direct and indirectly) to delivering teaching services vis-à-vis the particular education outcomes sought in the focal school and, in terms of teaching space, relative to a middle-of-the-range space. Hence, it could be that a space is in an excellent condition but receives a poor performance score (i.e., below 4.00 out of 7.00) because it is lacking in terms of fitness of purpose.

1.5.2 Advancing Theory

Existing research on investigating the effects of procurement and facilities on educational outcomes tends to focus only on academic outcomes, largely ignoring more general and transferable educational outcomes (Barrett, Zhang, Moffatt & Kobbacy, 2013). Existing research also tends to focus on internal teaching spaces. Moreover, existing research on investigating the effects of procurement and facilities on educational outcomes attempts to either correlate different facilities with educational outcomes or isolate the effect of the facilities on educational outcomes. Among the research that seeks to correlate facilities with educational outcomes, the effects of teachers and other key factors on educational outcomes are typically held as constants in statistical analysis and as an attempt to assess the contribution of facilities to educational outcomes (Barrett *et al.,* 2013; Bowen *et al.,* 2008). In so doing, this work greatly overplays the direct contribution made by facilities to educational outcomes when the teacher, student and other factors explain the substantial variation in educational outcomes (Leckie, *et al*., 2010). To isolate the effect of facilities on educational outcomes would require a rigorous experimental design that controls for all the key factors, including the effect of time, that act as ingredients into an educational outcome. Byers *et al*. (2018) reviews work of this kind and sheds a very dim light on its reliability and validity.

In addition, research on Post-Occupancy Evaluation (POE), while avoiding the issue of holding the effects of teacher and other key variables constant, focuses on user satisfaction and only accounts for the direct effects of the school's built environment and facilities, ignoring indirect effects on attracting and retaining teaching personnel and students (Nawawi & Khalil, 2008; Neill & Etheridge, 2008). There is a widespread perceived lack of value from conducting a POE (Roberts, *et al.*, 2019).

There is a dearth of research that accounts for the whole-of-life production costs (finance, design, construction, operations and maintenance costs) of individual schools and a complete absence of research that surfaces and delineates transaction costs that are also significantly affected by procurement (Orgill 2011).

The better news is that when assessing value for money, there is no need to isolate facilities from other factors that act as ingredients into an educational outcome. Instead, value for money is a relative concept, which involves the comparison of goods and services with similar goods and services. The Value Rating Tool adopts this relative concept and captures the contribution of facilities to all educational outcomes specified as relevant by the Principal of the focal school. The Value Rating Tool also assesses not just the direct contribution of all internal and external spaces (across all teaching and non-teaching spaces) and all operations and maintenance activities but also the indirect contribution of all spaces and all operations and maintenance activities on attracting and retaining students, teachers, the Principal and all school personnel i.e., the contribution of the facilities to wellbeing.

1.5.3 Advancing Practice

The Value Rating Tool delivers the most comprehensive post-completion review and benchmarking tool, to the knowledge of the research team. The ability to observe value for money delivered by different modes of procurement, and not just within a jurisdiction but also across jurisdictions, can immediately begin to drive improvements in the whole-life costs and performance of both existing and new facilities, when the results of the Value Rating Tool feedback into future finance, design, construction, operations and maintenance (FDCOM) decisions, as depicted in Figure 1.10.

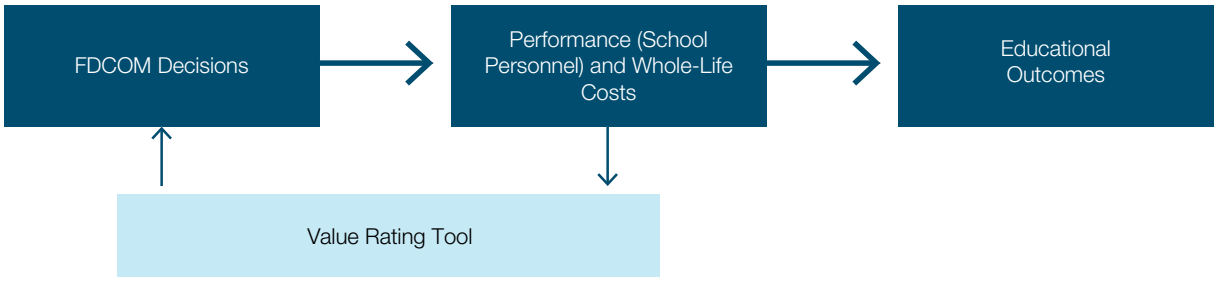

Figure 1.10: Value Rating Tool and Future Decision-Making

The Value Rating Tool was developed in school setting. The Value Rating Tool can be applied to primary and secondary schools including schools incorporating trends in delivery e.g., vertical schools and modular school buildings.

The Value Rating Tool can be adapted to apply to a wide range of social and economic infrastructure e.g., hospitals and roads.

More broadly, the Value Rating Tool can play a role upstream in Strategic Asset Management Planning (see Publication #3 in Section 1.6) and a role downstream in guiding either a future reduction in expenditure or a proposed increase in expenditure in an existing school, by previewing future saving or spending options to ensure performance (post change in expenditure) is in the blue area in Figure 1.11. This ensures the change in expenditure results in value for money.

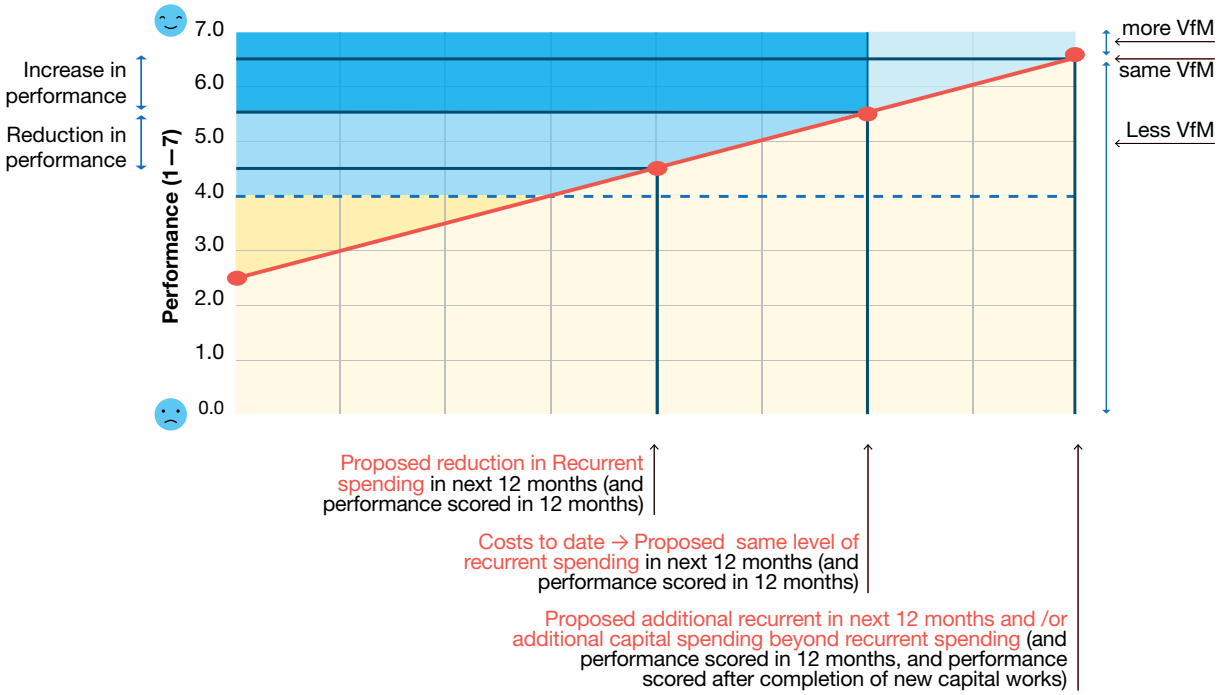

Figure 1.11: Value Rating Tool in Preview Mode

The Value Rating Tool has the potential to promote a paradigm shift in the practice of design e.g., Architecture and Engineering, as well as the practice of cost management e.g., Quantity Surveying and Cost Engineering. That is, instead of design following a cost plan, or an estimate of cost following a design, the Value Rating Tool synchronises changes in design and costs i.e., the outcome of a change in design and cost is known before committing to this change.

1.6 Publications

The following papers directly arising from the Value Rating Study and Tool are upcoming and anticipated to be accepted for publication in 2022:

- Kinnunen, N., *et al*. (2022): Working Title: *The Value Rating Tool: An Empirical Study of the Delivery of Australian Schools*

  This publication includes more detail on the method of data collection including more details on sampling and an assessment of the level of confidence associated with the data collected. Detail is also given on the analysis of performance scores and whole-life costs across PPP and non-PPP schools, including a full presentation of the thematic analysis, to demonstrate the Value Rating Tool's capability on observing any effect of procurement on the contribution of the school's built environment to educational outcomes and their whole-life cost. The analysis of performance scores and whole-life costs across PPP and non-PPP schools will also show any variation in whole-life costs and performance within PPP schools and any variation in whole-life costs and performance within non-PPP schools. Additionally, this publication more fully explains the Value Rating's weighting system and its design parameters including more justification of assumptions made concerning rate of interest used in discounting and compounding calculations, inflation and adjustments for differential design, construction, operation and maintenance costs across different jurisdictions in Australia.
- Kinnunen, N., *et al*. (2022): Working Title: *The Value Rating Tool: Advancing Theory and Practice in the Delivery of Built Infrastructure*

This publication provides more explanation on the way the Value Rating Tool adopts the relative concept of value for money and captures the contribution of facilities to all educational outcomes specified as relevant by the Principal of the focal school. It also explains further how the Value Rating Tool assesses not just the direct contribution of all internal and external spaces (all teaching and non-teaching spaces) and all operations and maintenance activities but also the indirect contribution of all spaces and all operations and maintenance activities to attracting and retaining students, teachers, the Principal and all school personnel i.e., the contribution of the facilities to wellbeing.

Additionally, this publication explains how the Value Rating Tool can guide both a future reduction in expenditure and a proposed increase in expenditure in an existing school to deliver value for money.

Finally, this paper provides a further illustration of developing a Value Rating. This time, the application example is a PPP school (in contrast to a non-PPP school).

- Carroli, L., *et al.* (2022): Working Title: *Innovation in Infrastructure Performance Management: A Case Study of the Role of the Value Rating Tool in Strategic Asset Management Planning in Queensland Government*

  This publication investigates the relationship between the Value Rating Tool (VRT), Post Occupancy Evaluation (POE) and Strategic Asset Management Planning (SAMP). It is based on a case study of Queensland Government policy with reference to the SAMP framework and guidelines introduced in 2020. It compares how the POE and VRT address the priorities of SAMP and value for money. More specifically, this publication addresses the following research questions:

  1. How do POE, SAMP and the VRT address value for money?
  2. How do POE and the VRT compare?
  3. How do POE and the VRT support the decision making, priorities and provisions of the SAMP Framework?

1.7 Value Rating Study and Tool Research Team

At the final project research team meeting, the Value Rating Study and Tool research team comprised:

- Study's lead-Chief Investigator: Associate Professor Adrian Bridge (QUT).
- Other Chief Investigators:
  - Associate Professor Peter Verhoeven (QUT)
  - Professor Jill Franz (QUT)
  - Associate Professor Riza Sunindijo (UNSW)
  - Professor Lihai Zhang (UoM)
  - Adjunct Professor Martin Skitmore (QUT)
  - Associate Professor Vaughan Coffey (QUT).
- Research Associate: Dr Linda Carroli (QUT).

Original members of the Value Rating Study and Tool research team included the following researchers that withdrew during the project:

- Adjunct Associate Professor Hilary Hughes (formerly a Chief Investigator when an Associate Professor at QUT)
- Professor Martin Loosemore (formerly a Chief Investigator when at UNSW)
- Nora Kinnunen (formally the Value Rating Study and Tool research team's Research Associate when at QUT).

The research team for the Value Rating Study and Tool included the following Research Assistants:

- Nora Kinnunen (QUT)
- Adjunct Associate Professor Hilary Hughes (QUT)
- Dr Dianne Smith (QUT)
- Dr Eveline Mussi (UNSW)
- Dr Nilupa Herath (UoM)
- Dr Mayuri Wijayasundara (UoM)
- Dr Philip Christopher (UoM).

Section 2

Real Options Study and Model

2.1 Introduction

PPP transactions are declining across the globe, and one of the frequently cited reasons for this decline is a perception by government that PPP are not delivering value for money due, in large measure, to concerns about the inflexibility of PPPs – whose long-term contracts are not suited to dealing with change, particularly at a time of unprecedented technical and social change (Moseley, 2020). Relatedly, in the 2021 Infrastructure Plan (Recommendation 8.2.2), Infrastructure Australia call for existing PPP guidelines and models to be updated (Infrastructure Australia: 538). Colacino considers, "Australia once led the world in infrastructure procurement thanks largely to the PPP model, but it's now time for PPP 2.0." (Colacino, 2021, as cited in Skatssoon, 2021).

Real Options provide a way to introduce more flexibility into PPP and to help address concerns regarding PPPs delivering value for money. While real options are applied in a wide range of infrastructure sectors, there is an absence of empirical studies applying real options in educational infrastructure. There is also an absence, in any infrastructure sector, of real options applied to availability-type PPP (AT-PPPs) of the kind found in those PPPs in the Value Rating study. More fundamentally, across the entire Real Options literature, there does not exist a tested theoretical framework (that integrates behavioural economics and real options) to assist managers to identify opportunities to create real options.

This study aimed to develop and test a new integrated framework (or Real Options Model) comprising the combination of behavioural economics (or the economics of hold-up i.e., transaction cost economics) and real options theory on the governance of one of the most frequently occurring significant changes in an AT-PPP school contract i.e., staging changes.

Typically, government will internalise and retain the risk of a staging change and compensate the PPP Company, when changing the terms of the AT-PPP contract – with respect to the agreed staging plan. In this situation, government is not in a strong bargaining position to agree a settlement sum for the change given the high switching costs associated with the alternative approach of omitting from the PPP contract the school/s associated with the staging change and delivering this school/s separately. Given the government's weak bargaining position, the PPP Co may behave in a negative opportunistic way to appropriate super-profit on the government's proposal to vary the terms of the contract. In other words, the PPP Co may choose to hold-up government. Should the PPP Co decide to hold-up government in this situation, then this is not an ideal outcome for either party in the long-run – assuming both parties wish to see more PPP transactions. As a further alternative to agreeing a settlement sum for the PPP Co to accommodate the staging change or omitting the school/s associated with staging change and

delivering them separately, the government could choose to exercise a real option to deliver the staging change. This real option would be priced up-front as part of the PPP bid and the government would pay a premium for this real option as part of the PPP contract sum. In this third alternative, government now transfers the risk of a defined staging change and the PPP Co now prices and internalises the risk of the defined staging change.

The typical, or conventional, approach taken by government to a staging change in one or more schools in a PPP contract and the real option alternative approach are depicted in Figure 2.1.

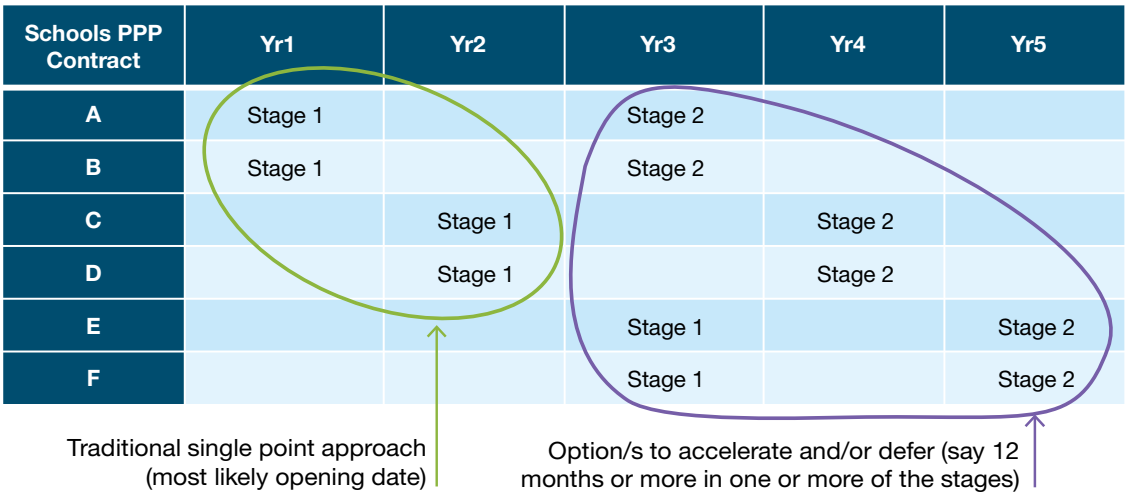

Figure 2.1: Conventional and/or Real Options Approach to Staging Change/s

The Real Options Model's key features, benefits and opportunities are highlighted in Box 2.1.

Box 2.1: At a Glance: Real Options Model

What	Benefits	Opportunities
Extends real options analysis by adapting the techniques developed for financial options to 'real-life' decisions	Achieving higher economic value by anticipating the changes that are likely to occur over the life of a facility	Integrating tool to identify where and when opportunities create real options
First time application of real options theory to availability-type PPPs	Outcomes flow back into the finalised full design for a new school	Application to procurement decision making and contracting
Develops a model on how real options analysis can be used in an availability-type PPP	Improves flexibility to efficiently make changes during the facility's operation	Divides future into risks that can be priced by market and uncertainty that needs a collaborative approach

2.2 Real Options

An option is a right, but not an obligation, to exercise some future action at a specific cost and it was Myers (1977) who popularised the term real options by bringing the theory of financial options within the scope of strategic decision-making (Trigeorgis and Reuer, 2017). Martins et al. (2013) summarise different types of real options as follows:

- Defer
- Staged investment
- Alter opening scale
- Abandon
- Switch
- Growth, and
- Combinations of the above types of options.

In this study, the application of the defer real option type, within a staging change in one of the PPP school contracts in the Value Rating study is investigated. The theoretical lens through this which this case is examined is Transaction Costs Economics (TCE) and Real Options Theory (ROT). Roemer (2004) compares these to theories and concludes they are complementary because of their contrasting approaches to uncertainty. TCE accounts for those risks within the control of the buyer and disturbances emanating from the buyer that concern variations to the planned scope of works and/or planned method to deliver the works, and which creates behavioural uncertainty on the part of the supplier in terms of hold-up by the supplier. This can be resolved, or at least mitigated, through the mechanisms within the existing contract. In contrast, ROT focuses on those risks outside the control of the buyer and disturbances emerging from outside of the contract that may cause the buyer to seek to vary the terms of the contract. While seeking to vary the contract terms will also prompt behavioural uncertainty on the part of the supplier and possibly hold-up by the supplier, this time the mechanisms within the contract (in the absence of a real option/s) are not applicable in terms of resolving or mitigating the disturbances from outside the contract.

The hypothesis developed to test the integration of TCE and ROT, as a new integrated framework (or Real Options Model) on the governance of one of the most frequently occurring significant changes in an AT-PPP school contract i.e., staging changes, is given as follows:

> *Real Options are more likely to be viable (i.e., provide net savings for the buyer and provide net gains, on average, for the supplier), where the buyer has made significant transaction specific investments and faces high switching costs and hold-up associated with external disturbances (outside the control of the buyer) – whose risks of occurrence are determinable.*

2.3 Method

2.3.1 Three Alternatives Ways to Deferring Opening of a School

The method used in this study to test the hypothesis comprised an estimate of the costs incurred for Alternative A (remain/stay with PPP Company via ex post negotiation) and an estimate of the costs for a counterfactual Alternative B (omit school from PPP Company and switch delivery of school to different contractor/s), along with a combination of an estimate costs and Monte Carlo simulation of a second counterfactual, i.e., Alternative C (remain/stay with PPP Company via ex ante priced real option), as summarised in Figure 2.2.

Alternative A. Remain/Stay with PPP Company
- Negotiate/finalize the cost of the change to staging ex post/with an existing PPP Company

Alternative B. Leave/Switch from PPP Company to different contractor/s
- Omit the work in an existing PPP contract that is affected by the staging change
  - Negotiate the cost of this omission ex post with the existing PPP Company
  - Establish and agree/finalize the cost of this work with new contractor/s

Alternative C. Remain/Stay with PPP Company
- Exercise a real option to change to staging that was agreed and priced ex ante/as part of the contract sum with the existing PPP Company

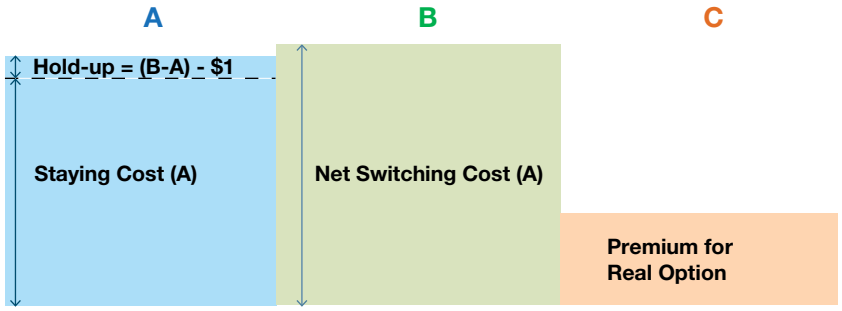

Figure 2.2: Alternative Ways to Defer Opening of a School

The deferred opening case study is a school in one of the PPP contracts in the Value Rating study. The opening of this case study school (i.e., Stage 1) was deferred from January 2017 to January 2019. Estimates of costs for changes in design, construction, operations and maintenance associated with Alternative A and B were established based on costs provided in the Value Rating study along with expert opinion. Costs for changes to finance associated with Alternative A and B were established using expert opinion.

2.3.2 Alternative A (remain/stay with PPP Company via ex post negotiation)

Given the government decided to delay the opening of the school, the financing cost to the PPP Company is a function of the net cash flows exchanged between the PPP Company and the counterparty in the swap contract (the 'bank').

2.3.3 Counterfactual Alternative B (omit school from PPP Company and switch delivery of school to different contractor/s)

If the contract for the school is cancelled, the PPP Company would need to cancel the swap facility.

2.3.4 Counterfactual Alternative C (remain/stay with PPP Company via ex ante priced real option)

In estimating the value of the real option, we assume that the PPP Company has hedged interest rate risk by taking out a swap facility for the full loan amount. In the swap facility, the variable rate paid is swapped for the fixed rate. The fixed rate paid is when the swap facility is fairly-priced, i.e., when the present value of the sum of the expected variable rate payments equals the present value of the sum of the fixed rate payments. The expectations on future rates (forward rates) are taken as of December 2013 when the PPP contract was signed. The swap facility for the loan commitments commences in January 2016 for the duration of the loan. After modelling of forward rates (based on swap parameters selected for this study) the swap fixed rate is estimated to be approximately 4.1%, which is consistent with the low credit risk exposure.

To compute the value of the real option for a 'two-year delay in school opening', the cost of the delay to the PPP Company, as well as the likelihood of the government exercising their right to exercise the option, i.e., delay, needs to be considered. It is assumed that the government considers this option in January 2016 and decides to delay the school opening when there are less than 50 students anticipated to be enrolled in the school. The probability of a delay is computed using 10,000 Monte Carlo simulations and is based on publicly available population projections and demographics for the case study school and other parameters for this modelling. The simulation results show that the estimated probability of a delay is near 39%, which is economically highly significant making the real option valuable.

To the PPP Company, the cost of delaying the school for two-years comprises administrative costs and financing related costs directly linked to the swap facility. For the two-year delay period there will be no payments forthcoming from the government in respect of the case study school, nevertheless the PPP company will still be obliged to fulfill their obligations with respect to the swap facility.

2.4 Findings

2.4.1 Summary

The finding from this study is given in Box 2.2.

Box 2.2: Real Options Study and Model Finding

A defer-type real option is illustrated as a viable and attractive alternative to negotiating, post contract, a settlement sum with a PPP Company to defer the opening of a school/s. This type of real option provides the means for government not just to economise on the cost of a post contract settlement but also to avoid the cost of hold-up, which could be a significant cost beyond the PPP Company base cost associated with the deferment.

2.4.2 Alterative Ways to Defer the Opening of a School

The incurred costs of Alternative A to deliver a deferred opening to a school are shown in Tables 2.1, and the estimate of the order of likely costs for the two counterfactual alternatives are shown in Tables 2.2 and 2.3.

Table 2.1: Alternative A Costs

Item	Approximate Estimate of Incurred Cost
Changes to Finance	• For 2017-2018, the variable rate was less than the fixed swap rate resulting in a net cost of financing of $1.24 million to the PPP company. • Estimated cost of administration of $0.23 million • Sub-Total = Realised cost to the PPP company over the two-year period of **$1.47 million**
Design and Construction Costs	• Escalation costs for 2 years in the order of **$150,000** • Because the deferred staging occurred among other schools delivered in 2019, the loss of discount on bulk purchase of materials and returning design manager and construction manager are ignored
Operations and Maintenance	• Because the regular service payments increase/accumulate each time one of the schools is opened in the contract, there are no savings to be considered associated with the deferral.
Government's Personnel	• Around 2 weeks salary (including on-costs) for Treasury and Agency's PPP Contracts Manager = **$15,000**
Government's consultants	• Around 2 weeks for Quantity Surveyor and round 2 weeks for Contracts Lawyer = **$20,000**
PPP Co Personnel	• Quantity Surveyor, Contracts Lawyer, and Finance **$40,000**
Wider/core business	• As there only a small number of students enrolled for the original opening date in January 2017, these would have been absorbed into other schools and so assume no costs associated with the core business arising from the deferral
Total Approximate Estimate of Incurred Costs	**$1.7million**

Table 2.2: Alternative B Net Costs

Item	Estimate of Order of Likely Costs (and Savings)
Changes to Finance	• The cancellation cost is the value of the swap facility as of January 2017. Based on the forward rates as of January 2017, the swap (= present value of the fixed cash flows – present value of the floating cash flows) is estimated to be valued at approximately **$5.53 million**, which is net compensation to the swap counterparty for expected loss of revenue.
Design, Construction Operations and Maintenance Costs (omission of school from PPP Contract)	• Omission of the school from the PPP contract: These savings would exclude overhead and profit – assuming the PPP Company retains/is eligible to be paid lost overheads and profit as damages for government breach of contract): Approximate whole-life savings **($100 million)**
Design, Construction Operations and Maintenance costs (switch to new contractor/s)	• Contractor/s' Design and Construction and Operations and Maintenance in delivering the school (including government operations and maintenance staff): Approximate whole-life cost **$105 million**
Government's Personnel (vis-à-vis omission of school from PPP Contract)	• Around 2 weeks salary (including on-costs) for Treasury and Agency's PPP Contracts Manager = **$15,000**
Government's consultants (vis-à-vis omission of school from PPP Contract)	• Around 2 weeks for Quantity Surveyor and round 2 weeks for Contracts Lawyer = **$20,000**
Government's personnel and consultants (vis-à-vis omission of school from PPP Contract)	• Agency's procurement staff and consultants (including Contract Lawyer; Architect, Engineers; Quantity Surveyor: Approximately **$95,000**
PPP Co Personnel	• Quantity Surveyor, Contracts Lawyer, and Finance **$40,000**
Wider/core business	• As there only a small number of students enrolled for the original opening date in January 2017, these would have been absorbed into other schools and so assume no costs associated with the core business arising from the deferral
Total Estimate of Order of Likely Net Costs	**$10.7million**

Table 2.3: Alternative C Costs

Item	Estimate of Order of Likely Costs
Price for Real Option	• Based on December 2013 projections of the forward rates for 2017-2019, the present value of the expected financing cost to the PPP Company is approximately $1.64 million. Remaining administrative costs (including the PPP Company's bidding cost and time to model and price the real option) are estimated at $0.23 million. To estimate the price of the real option, the estimated probability of a delay in the opening of the school is multiplied with the projected cost of the delay to the PPP company. This gives an estimated final price for the real option of (0.38 * $1.87) **= $0.71 million**
Government's Personnel	• Around 1 week salary (including on-costs) for Treasury to internally model reasonable price of real option (i.e., work involved in this study) PPP Contracts Manager = **$3,000**
Government's consultants	• Around 1 week for Contracts Lawyer to draft bespoke terms for real options = **$5,000**
Wider/core business	• As there only a small number of students enrolled for the original opening date in January 2017, these would have been absorbed into other schools and so assume no costs associated with the core business arising from the deferral
Total Estimate of Order of Likely Costs	**$720,000**

The above results support the hypothesis i.e., the cost of the real option (Alternative C) is much less than the cost (excluding any hold-up) in Alternative A. And because the cost of Alternative A is much less than the cost of Alternative B, then the government faces the prospect of having to concede a significant hold-up cost on top of and additional to the $1.7million cost of Alternative A (shown in Table 2.1).

More precisely, if the government agreed a settlement sum of more than around $1.7 million for the deferred opening of the school in this study, then based on this estimate of the cost for Alternative A, government would have conceded a hold-up cost component as part of the settlement sum.

This makes the real option in Alternative C even more viable and attractive. As it provides the means for government not just to economise on the cost of Alternative A but also to avoid the cost of hold-up, which could be a significant cost beyond the base cost of Alternative A.

2.5 Discussion

This study makes a significant contribution to knowledge by extending the scope of TCE and ROT to AT-PPPs and developing a new integration of these theories into a predictive model that can be used to guide identifying viable real options.

The study also contributes to method in its assessment of the TCE variables by switching costs in terms of TCE's Asset Specificity variable and the probability of developing an incorrect assessment of student enrolment (including Monte Carlo simulation) in terms of TCE's Uncertainty variable. Additionally, the study develops a practical way to calculate the cost of changes to finance – both deferring finance and cancelling finance.

From a practical perspective, the model developed in this study can improve flexibility and value for money in PPPs.

2.6 Publications

The following paper directly arising from the Real Options Study and Model is upcoming and anticipated to be accepted for publication in 2022:

- Lee, Y.S, Verhoeven, P., Bridge, A., & Rose, T. (2022): Working Title: *The governance of staging in an availability Public Private Partnership: An empirical test of a new integrative framework of transaction costs economics and real options.*

This publication includes more detail on all the sub-sections in Section 2 of this report. In particular, more detail on the integration of TCE and ROT, and more detail on the calculation the costs for changes to finance in Alternative A and Alternative B, as well as more detail on the calculation of the real option cost in Alternative C, including the Swap parameters and the Monte Carlo parameters, in the case study of the school whose opening was deferred by two years.

This paper will also discuss a further scenario in which government accepts the cost of changes to finance in Alternative A and Alternative B, in the same case study school.

2.7 Real Options Study and Model's Research Team

At the final project research team meeting, the Real Options study and model's research team comprised:

- Study's lead-Chief Investigator and PhD Principal Supervisor: Associate Professor Adrian Bridge (QUT)
- Other Chief Investigator and PhD Associate Supervisor: Associate Professor Peter Verhoeven (QUT)
- PhD Principal Supervisor Designate (from July 2022): Associate Professor Tim Rose (QUT)
- PhD and study's principal researcher: Yun Soon Lee.

2.8 Acknowledgments

The Real Options Study and Model's research team, gratefully acknowledge assistance provided by Tony Avsec (GRC Quantity Surveyors) in estimating the construction costs associated with deferring the school in Alternative A and B and assistance provided by Terence Carroll (Capella Capital) in estimating the costs of changes to finance associated with deferring the school in Alternative A and B.

Section 3

Free Design Study

3.1 Introduction

Despite growing evidence of the impact of school facilities on wellbeing and educational outcomes, limited attention has been given to understanding this impact in relation to the interrelationship of design and procurement and their combined effect on student wellbeing and educational outcomes. The Free Design study addressed these omissions. This study focused on the interrelationship of school design and procurement and its combined effect on student wellbeing and educational outcomes through a case study involving six Australian state schools delivered via public-private partnership (PPP) and 'design & construct' (D&C) and 'design, bid, build' (DBB) procurement methods.

The Free Design study aimed to:

1. Identify stakeholder perspectives on the design/procurement relationship pre-opening across PPPs and D&C schools and DBB schools
2. Understand the perceived impact of design on procurement in PPPs and D&C and DBB schools, and
3. Examine the experience pre-and post-opening of school of how procurement impacts design and lived experience in PPPs and D&C and DBB schools.

The study sought to highlight similarities and differences in the procurement approaches by exploring the design and procurement relationship pre-opening of the schools and post-opening of the schools. It was especially interesting to explore how teachers and principals understood the impact of the facilities and procurement on educational outcomes extending to the student's wellbeing, as depicted in Box 3.1.[8]

8 This section draws heavily from Rolfe, Franz & Bridge (2022) and Rolfe (2019).

Box 3.1: At a Glance: Free Design Study

What	Benefits	Opportunities
Addresses gap in understanding the role of design and user expectations in learning contexts	Education departments experience budgetary and time constraints	Enhanced procurement flexibility to include the needs of local school communities
New understanding of relationships in school design and procurement approaches and educational goals	A school, as a product of procurement and design, can impact human development and wellbeing goals	Recognition of design decisions as impacting student wellbeing and learning
Aims to lift performance in any mode of procurement through design process	Prescriptive design guidelines constrain alignment with educational goals and stakeholder engagement	Strategic involvement of school principals, teachers and students in design process

3.2 Method

3.2.1 Case Studies

The research is based on qualitative case studies that enabled in-depth exploration of the design and procurement of six Australian government schools procured through PPP or D&C and DBB modes of procurement. Data collection involved interviews with architects, education department officers, school principals and teachers. The data were analysed thematically using techniques aligned with Grounded Theory.

Of the total of six schools involved in the study, three schools were primary schools, and three schools were secondary schools in metropolitan areas (A-F in order of participation) (as summarised in Appendix A). More precisely, all the schools are located on the outskirts of a capital city in Australia where suburban development has occurred. All of the schools studied were opened within the last 15 years and are rated at varying levels on the Index of Community Socio-Educational Advantage (ICSEA) average of 1000 with the scale starting at 500 for schools with students with very disadvantaged backgrounds to 1300 for schools with students of privileged backgrounds (ACARA, 2020: 1).

The interviews were completed over a three-year period. For schools A and B, nine interviews were conducted (three participants from each school, a department of education representative, and two architects). For schools C to F interviews were undertaken with two participants from each school, an interview with a school business manager, and online interviews with another department of education representative, and two architects.

3.2.2 Recruitment and data collection

The participants in this study were selected because of their direct relationship with the design, procurement, delivery, and operation of the case school facilities or similar. Data were collected primarily through interviews with the participants. Walkthrough observations of each school were also undertaken by the researcher to provide physical context to the interview responses. This was further supplemented with information from school websites. This secondary data supported authentication of participant responses and the overall credibility and confirmability of the study (Lincoln & Guba, 1985).

3.2.3 Data Analysis

Individual case reports were prepared for each school following in-depth analysis of the interview data collected for each case informed by walkthrough and other contextual data. Three levels of analysis were undertaken using approaches informed by Braun & Clarke (2006) and Constructivist Grounded Theory (Charmaz, 2014). In a process of cross-case analysis exploring differences and commonalities (Miles, Huberman and Saldana, 2014), coding was undertaken at a more advanced level where outcomes were constantly compared to other case data and codes. A summary of the similarities and differences across the six schools is given in Appendix A.

3.3 Findings

3.3.1 Summary

The findings demonstrate that design and procurement together impact wellbeing and educational outcomes as experienced by principals and teachers, and summarised in Box 3.2.

Box 3.2: Free Design Study Findings

- Pre-opening of schools, budget impacts design similarly for procurement across the PPP and D&C/DBB schools.
- Pre-opening of schools, prescriptive design impacts procurement similarly across the PPPs and D&C/DBB schools.
- Post-opening of schools, procurement impacts design and school operation in different ways across the PPP and D&C/DBB schools.

3.3.2 Pre-opening of schools, budget impacts design similarly for procurement across the PPP and D&C/DBB schools

Various aspects relating to budget were found to impact school design from participant perspectives and this was similar for PPP and D&C/DBB case schools. In summary, such aspects derived from interviews included:

- Reduced government funding for new schools leading to the education department tightening controls on budget estimation and allocation.
- Cost driven design processes compromising educational goals for contemporary, exemplary school design. While the education department in this study cited the aim of PPP schools to be contemporary and an exemplary design for the department, architects noted decisions for the design of schools were based on cost efficiencies rather than using the PPP approach to be innovative or context specific. As with PPP procurement, in D&C schools cost becomes the driving factor of design decisions.
- Perception of architect led innovation as being unaffordable resulting in a prescriptive standardised design process.
- Spending justification requirements limiting the construction of new schools to current rather than predicted enrolment numbers.
- Cost driven design contributing to shortfalls in infrastructure for some schools such as for shade structures, technology, and multipurpose courts. Regardless of how the school was procured, in general, cost restrictions placed responsibility on schools to fundraise for shortfalls of some items not provided in building contracts; items such as design technology equipment, multipurpose courts or outdoor shade structures. While this is the case in the D&C/DBB schools, the difficulty for some PPP schools, which receive minimal additional funding for maintenance – beyond maintenance funded as part of consortium contract, is that contractually any item purchased by the school needs to be cleaned and maintained by the school rather than the consortium unless negotiated otherwise.

3.3.3 Pre-opening of schools, prescriptive design impacts procurement similarly across the PPPs and D&C/DBB schools

The research found that restrictive design and lack of design autonomy are common across all procurement methods for this education department. Though evidence of quality of spaces and innovated learning were found (see Appendix A), restrictive design and lack of design autonomy were likely creating a lack of readiness or willingness for innovation and restricting the potential for innovation. Regardless of the procurement method, the research found evidence of:

- The use of prescriptive design that also restricted architect autonomy and scope. Prescriptive design approach and the resulting uniform outcome was understood to be central to ensuring equity across schools as well as public accountability. Prescriptive design approaches involve the use of standardised templates.
- Formulaic, and as such inflexible, space allocations that that did not completely consider local community or curriculum needs. According to some school principals from PPP and D&C/DBB schools, strict space allocations and design standards were not only constraining the design process but also the potential of schools to support programs and curricula that the education department was urging schools to put in place.
- Provision of furniture, technology, and equipment in stage 1 of each school that did not necessarily align with curriculum or educational goals. Interviewees reported that design restrictions were limiting the provision of spaces, furniture, and equipment to enable and support schools to meet educational outcomes of “collaborative entrepreneurs and design thinkers” (PPP school principal).
- Homogenous built outcomes with similarities in form, material, and spatial configuration mentioned in interviews and verified through walk-throughs. It was reported that some of the design guidelines contradicted policy statements regarding innovation and aspirations.
- Limited user engagement in design.

3.3.4 Post-opening of schools, procurement impacts design and school operation in different ways across the PPP and D&C/DBB schools

The different PPP procurement approaches had different impacts on the lived experience of the operation and maintenance of schools as well as any further design undertaken after the schools opened. In analysing the interview data, relationships were perceived as paramount to successful operation, maintenance, and subsequent facility building or upgrades. Relationships involved:

- People (school, consortium, education department)
- Process (of design and/or procurement)
- Place (school facilities and campus).

PPP as a procurement approach impacted lived experience. including relationships and levels of communication. The nature of PPP as an upfront design of two stages at a fixed cost meant the design team were less likely to incorporate school principal requests for design change unless they were cost neutral. The school principals report varying degrees of involvement in the design process of subsequent building phases with varying levels of innovation.

An advantage discussed by stakeholders of PPP schools was the guarantee of maintenance for the length of the contract (30 years) so that the schools would be returned to the department in 'as new' condition at the end of that time. However, considerable time was spent managing relationships and conflict between (1) facility management (offsite) and (2) facility officers and cleaners (onsite). PPP principals report that after the first few years of working-out issues between schools, consortium and education department, principals can focus on educational services and prefer being principals of PPP schools where someone else has responsibilities of facilities. The more school principals can 'hand-over' the responsibility of the facilities to the consortium, the more likely satisfaction will occur. It also depends on the effectiveness of the consortium to maintain the facility and build relationships with the school.

Meanwhile, Principals of non-PPP schools value autonomy and agility in making decisions regarding changes to school facilities, they emphasis that they have not been trained in facility management and maintenance, and that this becomes problematic as buildings progress in years in operations and need more maintenance.

Generally, it was found that the school facilities were understood to meet some of the requirements for contemporary learning. While there were some innovative learning spaces to suit 21st century education goals, the principal for PPP school C felt there was much more that could be done to support attainment of 21st century educational goals.

3.4 Discussion

This research is the first to link school design and procurement and educational goals and their mis/alignment through the experience of principals and teachers to the design/procurement process pre-opening of schools and its combined experience post-opening of schools. It explicitly considers wellbeing in relation to educational goals and outcomes and associated design/procurement implications across both primary and secondary schools.

The findings show a relationship between the degree to which budget is constrained and cost driven (as opposed to educationally driven), and the tendency for this to drive a prescriptive rather than aspirational design approach. Prescriptive design impacts procurement similarly across PPP and D&C/DBB schools. To mitigate financial risks, the education department implemented a prescriptive, formulaic design

process across the board for the PPP and D&C/DBB case schools. This approach has accentuated other risks where 21st century educational goals may be undermined and jeopardised.

Teachers and principals from across the PPP and D&C/DBB case schools report challenges in relation to: accommodating increasing student enrolments; formulaic design sometimes restricting flexible responses to local community and curricula needs and goals; furniture, technology, and equipment that do not always align with broader educational goals; homogenous design that can psychologically and existentially impact wellbeing as well as shortfalls in infrastructure such as shade structures, multipurpose sports courts and open natural environments that can affect wellbeing at a basic physiological level. The designed outcome particularly when the school initially opens does not always reflect core tenets of design quality or the aspirational goals for driving transformational change in the 21st century.

In post-opening of schools this study revealed differences in the impact of procurement across PPP and D&C/DBB schools and it is in terms of social and organisational relationships that it is most evident. In PPPs, it was revealed that school culture was impacted by not having full access initially to facility officers and cleaners as needed to provide an adaptive, agile and inspirational learning environment. However, other principals noted there were overall net benefits in not having to manage maintenance and cleaning once a working relationship with the consortium was established.

3.5 Publications

The following paper directly arising from this Free Design Study is published:

- Rolfe, A., Franz, J., & Bridge, A. (2022). The combined impact of school design and procurement on student wellbeing and educational outcomes. *Facilities*. *40*(7/8): 533-550.

The following thesis directly arising from this Free Design Study is unpublished:

- Rolfe, A. (2019). *School Design and Procurement and Educational Goals: A Qualitative Case Study of Two Australian Schools* (Master of Philosophy Dissertation, Queensland University of Technology).

3.6 Free Design Study's Research Team

At the final project research team meeting, the Free Design Study research team comprised:

- Study's lead-Chief Investigator and MPhil Associate Supervisor: Professor Jill Franz (QUT)
- Other Chief Investigator: Associate Professor Adrian Bridge (QUT)
- MPhil Associate Supervisor: Associate Professor Jill Willis (QUT)
- MPhil and study's principal researcher: Annie Rolfe

The original members of the Free Design Study research team included several members that withdrew during the project, comprising:

- Adjunct Associate Professor Hilary Hughes (formerly a Chief Investigator and MPhil Principal Supervisor when an Associate Professor at QUT)

Section 4

Stakeholder Study

4.1 Introduction

In their first recommendation, the House of References Standing Committee on Infrastructure, Transport and Cities calls for better planning and coordination of the infrastructure pipeline, including consideration given to the effectiveness of stakeholder engagement prior to project commitments being made (House of Representatives Committees Standing Committee, 2022: xix).

The study aimed to investigate more effective levels of design involvement amongst stakeholders across alternative modes of procurement (PPP and non-PPP) in the whole-life delivery of schools i.e., from design of design guidelines to operations and maintenance.

In other words, the study sought to provide the groundwork for future research on developing guidelines on more effective levels of design involvement amongst stakeholders across alternative modes of procurement, as depicted in Box 4.1.

Box 4.1: At a Glance: Stakeholder Study

What	Benefits	Opportunities
Whole-life perspective on stakeholder involvement in design and delivery of schools	Understanding of current practice in stakeholder involvement across design, construction, operations and maintenance stages	Guiding stakeholder involvement and commons organisations across whole-life
Relating commons governance to current stakeholder involvement practice	Enhancing effectiveness of stakeholder involvement in the design and delivery process	Development of governance models and tools
Identify the levels of centralisation and decentralisation in governance structures and stakeholder involvement	Improvements in governance and stakeholder involvement	Relating stakeholder involvement to value for money

4.2 Method

The method comprised eight interviews with key stakeholders in the delivery of PPP and non-PPP schools.

With regards to the delivery of PPP schools, the following interviews were held:

- A Principal at a PPP school that opened between January 2015 to January 2017 inclusive
- A government Procurement and Contracts Manager who responded to the questions in terms of a typical school among the schools in the PPP contracts in their jurisdiction that opened between January 2007 to January 2011 inclusive and between January 2015 to January 2017 inclusive
- An Architect working for a PPP Company on a PPP contract who responded to the questions in terms of a typical school among the schools in this PPP contract that opened between January 2007 to January 2011 inclusive
- An Architect working for a PPP Company on a PPP contract who responded to the questions in terms of a typical school among the schools in this PPP contract that opened between January 2015 to January 2017 inclusive.

In terms of the delivery of non-PPP schools, the following interviews were held:

- Two Principals, each at a non-PPP school that opened between January 2007 to January 2011
- A government Procurement and Contracts Manager who responded to the questions in terms of a typical school among the schools in the PPP contracts in their jurisdiction that opened between January 2007 to January 2011 inclusive
- A Quantity Surveyor who responded to the questions in terms of a typical school among the schools in the PPP contracts in their jurisdiction that opened between January 2007 to January 2011 inclusive.

The same questions were asked about two stages in delivery, i.e., Stage 1 (buildings up to the opening of case study school and delivery following the opening of the school of the initial buildings) and Stage 2 (design and delivery of any subsequent significant building or refurbishment project after the school had opened)

The questions targeted the following phases of delivery:

- Design Guidelines (DG)
- Design Brief (DB)
- Schematic Design (SD)
- Detailed Design and Specification of Operations and Maintenance (DD)
- Tender Documentation (TD)
- Construction (C)
- Operations (O)
- Maintenance (M).

The questions concerned the interviewees views about the following stakeholders:

- Principal (P)
- Teachers (T)
- Students and Parents and Wider School Community (S)
- Education Department (Ed)
- Architect – in PPP and in non-PPP delivery (A)
- Quantity Surveyor – in PPP and in non-PPP delivery (QS)
- Main Contractor – in PPP and in non-PPP delivery (MC)
- Facility Manager – in PPP and in non-PPP delivery (FM)
- Treasury – in PPP and in non-PPP delivery (Ty)
- Financier – in PPP (F).

The questions are shown in Box 4.2.

Box 4.2: Questions

1. The interviewee's level of involvement in the delivery of the school/s across the various phases.
2. The interviewee's perception of the level of other stakeholders' involvement in the delivery the school/s across the various phases.
3. The interviewee's view on the benefits in terms of higher performance and/or lower cost, of their involvement delivery of the school/s across the various phases.
4. The interviewee's view on the benefits in terms of higher performance and/or lower cost of other stakeholders' involvement in the delivery the school/s across the various phases.
5. The interviewee's view on the potential for higher performance and/or lower cost from more or less involvement of the various stakeholders across the different phases of the study school/s delivery.
6. The interviewee's view on the barriers preventing more or less involvement of the other various stakeholders across the different phases of the study school/s delivery (where the interviewee indicated they consider more or less involvement of certain stakeholders would be beneficial in Question 5)
7. The interviewees view on the drawbacks in terms of reducing performance and/or increasing cost of their involvement delivery of the school/s across the various phases
8. The interviewee's view on the drawbacks in terms of reducing performance and/or increasing cost of other stakeholders' involvement in the delivery the school/s across the various phases

Regarding Questions 1 and 2, the interviewee responded using 12-point scale as shows in Table 4.1.

Table 4.1: Response for Questions 1 and 2 (Adapted from "A Ladder of Stakeholder Management and Engagement", Friedman and Miles, 2006: 162)

Level of Involvement	Engagement	Stakeholder Response
Forming or agreeing to decisions	Majority representation of stakeholders in decision-making process	**12. Stakeholder Control**
	Stakeholders have increased power/autonomy to form design decisions	**11. Delegated power**
	Joint decision-making process	**10. Partnership**
	Stakeholders have some decision-making power	**9. Collaboration**
Having an influence on decisions	Stakeholders are more involved and have an influence on design decisions	**8. Involvement**
		7. Negotiation
Being heard before a decision	Stakeholders are consulted with around design decisions	**6. Consultation**
	Stakeholders can hear and be heard but have no assurance of being heeded for design decisions	**5. Being heard**
Knowledge about decisions	Stakeholders are informed/ educated about the new school/ new building but have no say.	**4. Educated**
		3. Informed
	Stakeholders are aware of new school/ new building planned but not intentionally informed	**2. Aware**
	Stakeholders are unaware of new school/building planned	**1.Unaware**

4.3 Findings

4.3.1 Summary

The findings demonstrate the groundwork for future research on developing guidelines on more effective levels of design involvement amongst stakeholders across alternative modes of procurement, as summarised in Box 4.3.

Box 4.3: Stakeholder Study Findings

- • The level of involvement of the school Principal and Teachers is appreciably different in Stage 1 delivery (initial campus buildings to opening of school including their operations and maintenance) in PPP schools, in contrast to Stage 1 delivery in non-PPP schools i.e., Principal and Teachers have a low level involvement in operations and maintenance in Stage 1 delivery of PPP schools, while Principal and Teachers have a high level of involvement in operations and maintenance in Stage 1 delivery of non-PPP schools. The lower level of involvement by principals and teachers in operations and maintenance in Stage 1 delivery of PPP schools is a relative strength of PPPs, when principals in non-PPP schools report a strong desire to see more involvement of facility management to assist with operations and maintenance.
- • The level of involvement of the school Principal and Teachers is also appreciably different in Stage 2 delivery (buildings post-opening of school) in PPP schools, in contrast to Stage 2 delivery in non-PPP schools i.e., Principal and Teachers have a low level of involvement in all phases of Stage 2 delivery including a low level of involvement in design phases and Operations and Maintenance in Stage 2 delivery of PPP schools, while Principal and Teachers have a high level of involvement in Scheme Design, Detailed Design and Tender Documentation and Operations and Maintenance in Stage 2 delivery in non-PPP schools.
- Mostly all respondents consider that value for money could be improved by including more involvement of the Principal and Teachers in the design phases in Stage 1 and Stage 2 delivery in both PPP and non-PPP schools.
- Architect and Quantity Surveyor respondents consider that value for money could also be improved by Architects and Quantity Surveyors having more involvement in the design phases in Stage 1 and Stage 2 delivery of both PPP and non-PPP schools.
- Principals report the strong desire to see more involvement of facility management to assist with operations and maintenance in non-PPP schools.
- Time pressures, as well as capital and recurrent costs restrictions are observed as the root causes and barriers to increasing in the level of involvement of school personnel, Architects and Quantity Surveyors in design in both PPP and non-PPP schools and to increasing the level of involvement of facility management provided to Principals in operations and maintenance in non-PPP schools.

4.3.2 Level of involvement of stakeholders across whole-life delivery of PPP and non-PPP schools

Similar answers were provided by the two Architects working for a PPP Company on different PPP contracts and similar answers were provided by the two Principals at the non-PPP schools. The results from the two Architects working for a PPP Company on a PPP were aggregated and the results from the two Principals at the non-PPP schools were also aggregated.

A summary of the interviewee's responses to Questions 1 and 2 are shows in Table 4.2. In this table, a high level of involvement represents a score of 7 to 12 on the 12-point scale in Table 4.1 and a low level of involvement represents a score of 1 to 6 on the 12-point scale in table 4.1.

Table 4.2: Level of involvement of stakeholders

Interviewee	Influence PPP Phases Stage 1 High (≥7) Low (≤6)	Influence Non-PPP Phases Stage 1 High (≥7) Low (≤6)	Influence PPP Phases Stage 2 High (≥7) Low (≤6)	Influence Non-PPP Phases Stage 2 High (≥7) Low (≤6)
1 Principal (Self)	P: All Low	P: O/M	P: All Low	P: SD/DD/TD/O/M
2 Principal (Others)	T: All Low S: All Low Ed: DG/DB/SD/DD/TD/C/O/M A: SD/DD/TD/C QS: SD/DD/TD/C MC: SD/DD/TD FM: All Low Ty: DG F: DG/DB/SD/DD/TD/C/O/M	T: O/M S: T: All Low Ed: DG/DB A: SD/DD/TD/C QS: SD/DD/TD/C MC: SD/DD/TD/C FM: O/M Ty: DG	T: All Low S: All Low Ed: DG/DB/SD/DD/TD/C/O/M A: SD/DD/TD/C QS: SD/DD/TD/C MC: SD/DD/TD FM: All Low Ty: DG F: DG/DB/SD/DD/TD/C/O/M	T: O/M S: All Low Ed: DG/DB A: SD/DD/TD/C QS: SD/DD/TD/C MC: SD/DD/TD/C FM: O/M Ty: DG
3 Government (Self)	Ed: DB/SD/DD/T/O/M	Ed: SD/DD/TD	Ed: DD/T/O/M	Ed: SD
4 Government (Others)	P: All Low T: All Low S: All Low A: DG/DB/SD/TD/C QS: DG/DB/SD/TD/C/O/M MC: DG/DB/SD/TD/C/O/M FM: DG/DB/SD/TD/C/O/M Ty: All Low F: All Low	P: O/M T: O/M S: All Low A: SD/TD QS: DG/DB/SD/TD MC: TD/C FM: O/M Ty: All Low	P: All Low T: All Low S: All Low A: DG/DB/SD/TD QS: DG/DB/SD/TD MC: DG/DB/SD/TD FM: All Low Ty: All Low F: All Low	P: O T: O S: All Low A: SD/DD QS: SD MC: C FM: O/M Ty: All Low
5 Architect (PPP – Self)	A: C		A: C	
6 Architect (PPP – Others)	P: All Low T: All Low S: All Low Ed: DG/DB/DD/O/M QS: DB/SD/C MC: DB/SD/DD/TD/C/O/M FM: O/M Ty: DB/SD/DD/TD/C/M F: SD/DD		P: All Low T: All Low S: All Low Ed: DG QS: DG/DB/SD MC: DG/DB/SD/DD/TD/C/O/M FM: DB/O/M Ty: All Low F: SD/DD	
7 Quantity Surveyor (Non-PPP) – Self		QS: C		QS: C
8 Quantity Surveyor (Non-PPP) – Others		P: O/M T: O/M S: All Low Ed: DG/DB/SD/O A: DB/SD MC: DD/TD/C/O FM: M Ty: All Low		P: O/M T: O/M S: All Low Ed: DG/DB/SD/O A: DB/SD MC: DD/TD/C/O FM: M Ty: All Low

Table 4.2 highlights likely important patterns on the level of stakeholder involvement across the delivery of the first stage of the school campus and second stage of the same school campus, including as follows:

- The level of involvement of stakeholders is broadly the same across Stage 1 and Stage 2 delivery stages in the PPP schools and level of involvement of stakeholders is broadly the same across Stage 1 and Stage 2 delivery non-PPP schools
- The level of involvement of the school Principal and Teachers is appreciably different in Stage 1 delivery of PPP schools – in contrast to Stage 1 delivery of non-PPP schools i.e., Principal and Teachers have a low level of involvement in operations and maintenance in Stage 1 delivery of PPP schools, while Principal and Teachers have a high level of involvement in operations and maintenance in Stage 1 delivery of PPP schools. The lower level of involvement by principals and teachers in operations and maintenance in Stage 1 delivery of PPP schools is a relative strength of PPPs, when principals in non-PPP schools report a strong desire to see more involvement of facility management to assist with operations and maintenance.
- The level of involvement of the school Principal and Teachers is also appreciably different in Stage 2 delivery of PPP schools – in contrast to Stage 2 delivery of non-PPP schools i.e., Principal and Teachers have a low level of involvement in all phases of delivery including a low level of involvement in design phases and Operations and Maintenance in Stage 2 delivery of PPP schools, while Principal and Teachers have a high level of involvement in Scheme Design, Detailed Design and Tender Documentation and Operations and Maintenance in Stage 2 delivery of PPP schools.
- There is stark contrast in the perceptions of the level of involvement of Architects and Quantity Surveyors. The Architect respondents consider Architects only have a high level of influence on decisions in the Construction phases of Stage 1 and Stage 2 delivery in PPP schools and the Quantity Surveyor respondent also considers Quantity Surveyors only have a high level influence on decisions in the Construction phases of Stage 1 and Stage 2 delivery, this time in non-PPP schools. In contrast, the Principal respondents and the government respondents all consider that Architects and Quantity Surveyors to have a high level of influence on decisions in the design phases in Stage 1 and Stage 2 delivery of both PPP and non-PPP schools.

4.3.3 Changing level of involvement of stakeholders across whole-life delivery of PPP and non-PPP schools

Regarding responses to Questions 3, 4 and 5, a broad consensus is observed among all the respondents that value for money could be improved by including more involvement of the Principal and Teachers in the design phases of in Stage 1 and Stage 2 delivery of both PPP and non-PPP schools.

There is also a clear pattern of the Architect respondents and Quantity Surveyor respondent advising they consider that value for money could also be improved by Architects and Quantity Surveyors having more involvement from the design of the design guidelines through tender documents in Stage 1 and Stage 2 delivery of both PPP and non-PPP schools.

Another clear message in the answers to Questions 3, 4 and 5 given by the Principals in the non-PPP schools is the desire of these Principals to see more involvement of facility management expertise to assist with operations and maintenance.

However, respondents demonstrate their awareness of the barriers to changing the level of involvement of stakeholders (in their answers to Question 6). These barriers connect with the answers given to Questions 7 and 8 concerning the drawbacks associated with the level of stakeholder involvement summarised in Table 4.2. Box 4.4 shows some of the sentiments from stakeholders on barriers to changing the level of involvement.

Box 4.4: Barriers to changing the level of involvement of stakeholders

Barriers to more involvement of the Principal and Teachers in the design in PPPs and non-PPPs

- Working off templates and constrained by a budget for the school design.
- Principals not having the design knowledge to give input.
- Teachers, parents and students in early stages – too many people involved can be complicated.
- Principals, teachers and students don't understand the design process and may make design decisions which would not suit future Principals preferences.
- Possible barrier to involvement may be that the process of identifying compromises and interpreting the compromises into a workable design between stakeholders is time consuming or difficult.
- Lengthy process of focus groups, working groups for consultation.
- Perception that the project could be derailed if things are pushed that are personal preference.
- Concern about cost blow outs and individual views that may not be department views.
- Having to manage expectations if there is a process of feedback.
- Time-consuming for Principal, who struggle to attend the meetings.
- Teacher input is individual so what works for one school may not for another.
- Education department to minimise capital costs i.e. reduce stakeholder involvement thought to help reduce capital costs.
- Political pressure of timeline makes collaboration with community difficult to deliver by a certain date and a push to get schools built.
- Timeframes for delivery are restricted, reducing community involvement in early stages.
- Cost driven design decisions. Lack of discussion with treasury about cost, focus on lowest cost.

Barriers to more involvement of Architects and Quantity Surveyors in the design in PPPs and non-PPPs

- Architect not wanting to overstep the mark, to go over them to the education department, since they are the client.
- Builder having more say on design decisions to ensure budget was maintained and buildability was ensured.
- Design is cost driven.

Barriers to more involvement of facility management in operations and maintenance in non-PPPs

- FM need to be the right person to understand what is a school, how a school is run and what is priority.
- Education department to minimise costs i.e., reduced Facility Manager involvement thought to help reduce costs.
- Time pressure due to a systematic and procedural problem.

It seems clear from the answers given to Questions 6, 7 and 8, illustrated in Box 4.4, that time pressures, as well as capital and recurrent costs restrictions are the root cause of the low level of influence of school personnel, Architects and Quantity Surveyors in design phases in both PPP and non-PPP schools, as well as the root cause of the reported lack of assistance given to Principals in non-PPPs in operations and maintenance. Correspondingly, these root causes are barriers to increasing in the level of involvement of school personnel, Architects and Quantity Surveyors in design in both PPP and non-PPP schools and the level of involvement of facility management expertise provided to Principals in operations and maintenance in non-PPP schools.

4.4 Discussion

This study provides the basis for future research, which can strengthen the findings and generalisability of the results in this study by undertaking a larger scale study using the method developed in this study. As part of larger study, schools with very high Value Ratings and schools with very low Value Ratings can be selected to seek to identify the optimal levels of stakeholder involvement.

4.5 Publications

The following paper directly arising from the Stakeholder Study is upcoming and anticipated to be accepted for publication in 2022:

- Carroli, L., *et al*. (2022): Working Title: *Stakeholder Involvement in Delivery of Australian Schools: An Empirical Study*

This publication includes more detail on all aspects of this section, including a full thematic analysis of all comments made by respondents and discussion of the balance of centralisation versus decentralisation in terms of observed practice and commons theory.

4.6 Stakeholder Study's Research Team

At the final project research team meeting, the Stakeholder Study's research team comprised:

- Study's lead-Chief Investigator: Associate Professor Adrian Bridge (QUT).
- Other Chief Investigators:
  - Professor Jill Franz (QUT)
  - Associate Professor Riza Sunindijo (UNSW)
- Research Associate: Dr Linda Carroli (QUT)

The original members of the Stakeholder Study's research team included researchers that withdrew during the project, namely:

- Adjunct Associate Professor Hilary Hughes (formerly a Chief Investigator when an Associate Professor at QUT)
- Professor Martin Loosemore (formerly a Chief Investigator when at UNSW)
- Nora Kinnunen (formally the Stakeholder Study's research team's Research Associate when at QUT)

The research team for the Stakeholder Study included the following Research Assistants:

- Nora Kinnunen (QUT)
- Annie Rolfe (QUT)

4.7 Acknowledgments

The Stakeholder Study Research Team gratefully acknowledges Shirley Jancetic (formerly a Higher Degree Researcher when at UNSW) for completing the initial literature review in this study.

Section 5

Procurement Decision Study and Tool

5.1 Introduction

The Procurement Decision Tool (the Tool) identifies, the best value for money approach to two key infrastructure procurement decisions. These are contract packaging (the size and number of contracts) and their contract terms (using competitive and/or collaborative contracting). To achieve this, the Tool employs state-of-the-art microeconomic theory that was developed to address these two procurement decisions specifically and systematically. The Tool was successfully trialled on Australian major public sector health and road projects as part of an Australian Research Council grant and in collaboration with Infrastructure Australia and Austroads.[9] The Tool was also successfully piloted internationally on major public sector road projects in collaboration with the OECD. [10]

It is expected that the Tool will deliver significant time and/or whole-life cost savings – in contrast to contract packaging and contract terms established using current procurement decision-making practice. The Tool will also enhance the objectivity, transparency, accountability, reliability, and consistency of infrastructure procurement decision-making. Beyond these microeconomic benefits, the Tool will improve the planning of portfolios of projects, including improving the planning and pipelines of projects, to nurture and deepen markets and to advance productivity.

The Tool's key features, benefits and opportunities are highlighted in Box 5.1.

In their 2021 infrastructure plan, Infrastructure Australia take a significant step forward in recommending that a new procurement decision-making tool is required to replace current procurement-decision making practice (Infrastructure Australia, 2021:63).[11]

This study aimed to apply the Procurement Decision Tool to a school, as a further illustration of the application of the Procurement Decision Tool in a sector other than health and road sectors.

9 The application of the Procurement Decision Study Tool to a school in this study applies the Procurement Decision Tool as per Austroads (2020) and Infrastructure Australia's Draft Procurement Decision Tool User Guide (Bridge, 2022).

10 The OECD funded the involvement of Associate Professor Bridge and QUT in the OECD's piloting of the Tool on major roads in Norway (OECD, 2021). This OECD project was led by Dr Dejan Makovsek. This project helped strengthen the Tool and led to formation of OECD's version of the Tool i.e., "STEPS" (Support Tool for Effective Procurement Strategy).

11 See the need for a new procurement decision-making tool recommended by Infrastructure Australian in Recommendation 3.2b.1 in Infrastructure Australia's 2021 Infrastructure Plan, which concerns reducing risk and improving value for money by using common and best practice commercial arrangements, standard contract forms and delivery approaches to infrastructure.

Box 5.1: At a Glance: Procurement Decision Tool

What	Benefits	Opportunities
Procurement Decision Tool determines efficient bundling (contract packaging) and contract terms	Enhances objectivity, transparency, risk management and accountability in project procurement	Customisable for all significant Capex and Opex projects that involve bespoke design
Applies state-of-the-art economic theory to bundling and contracts	Overall time and cost savings	Infrastructure planning and pipeline estimated to cost
Successful trialled in two major Australian public sector projects	Can be applied in review mode to test decisions or in guidance mode on a new project	Integration with procurement systems and processes

5.2 Procurement Decision

The Tool employs state-of-the-art microeconomic theory that has been integrated and empirically tested to identify the most efficient size and number of contracts within a project and the most efficient use of competitive and/or collaborative terms across each of these contract/s. This microeconomic theory is summarised in the Figure 5.1.

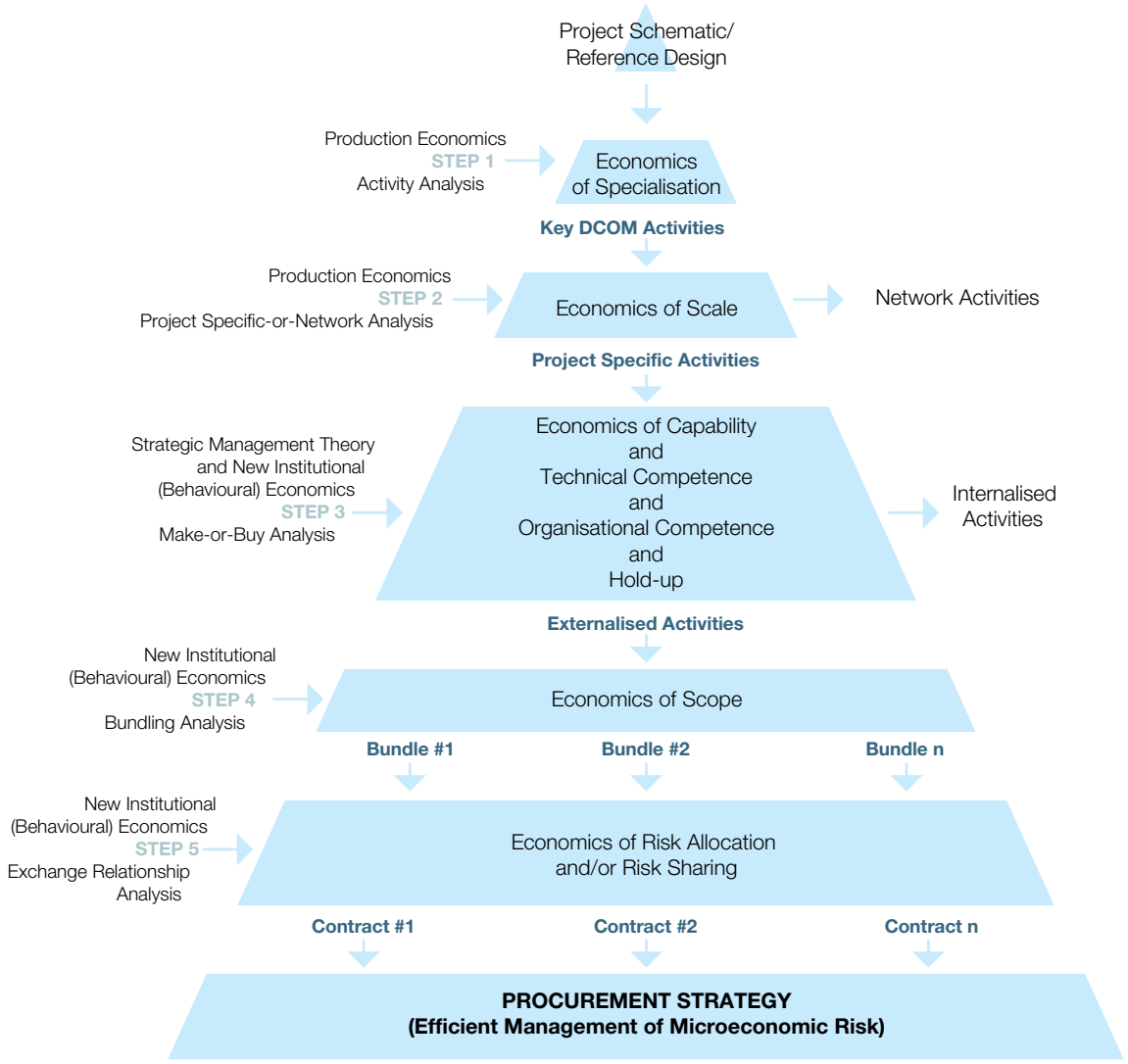

Figure 5.1: Microeconomics in the Tool (Source: Austroads, 2020)

As indicated in Figure 5.1, across the five steps in the Tool various schools of economic thought are combined to develop the most efficient procurement strategy for the project vis-à-vis the Client's project performance attributes. This procurement strategy amounts to the efficient management of microeconomic risk in the externalisation of key design, construction, operations and maintenance (DCOM) activities arising from the project schematic, or reference design.

While efficient collaborative and/or competitive contracting terms (Step 5) and efficient contract packaging (Step 4) is central to the efficient management of microeconomic risk, these steps rely on the partition of those activities that are more efficiently internalised and those activities that are more efficiently externalised, as well as the identification of different kinds (or categories) of risks associated with externalised activities (Step 3). The risk analysis in Step 3 depends on focusing on project-specific activity and excluding from the analysis those network activities in the new project that are both recurring and like already occurring activities in an existing network of infrastructure operated by the client (Step 2). Meanwhile, Step 2 can only effectively commence once key DCOM activities have been identified (Step 1). The Tool's sequential decision-making procedure across its five steps is summarised in Figure 5.2.

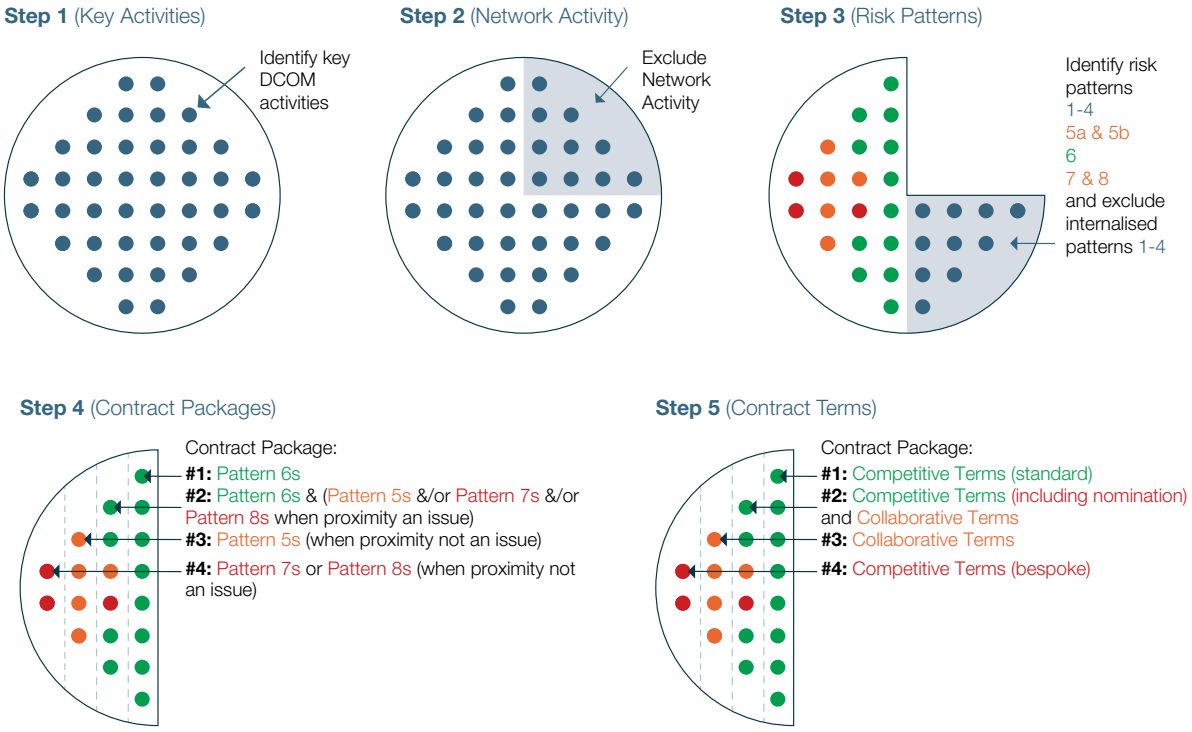

Figure 5.2: Sequential Decision-Making Procedure

The effectiveness of the decision at each step of the Tool is dependent on the effectiveness of the prior decisions. This process is analogous to a steeplechase in which runners need to successfully clear each hurdle to reach the finish line. In the case of procurement decision-making, we can add to this analogy by envisioning the hurdles decreasing in height and difficulty as runners proceed. In other words, the ineffective application of the initial steps in the Tool will have a bigger negative effect on efficiency and value for money than the ineffective application of the latter steps. This is pertinent to appreciating the potential of the Tool to deliver superior value for money in comparison to current procurement decision-making practice because much of the content in the first three steps in the Tool is missing in current procurement decision-making practice.

5.3 Method

The Tool can be applied in three different modes. First, it can be used in business case to guide contract packaging and contract terms in projects whose procurement decision is yet to be made i.e., preview mode. Second, it can be applied to evaluate existing procurement decisions i.e., in current mode (in projects whose design has commenced but whose main construction and/or installation works are yet to start). Third, it can be applied in review mode (in projects whose main construction and/or installation works are complete). The Tool is applied to one of the schools in the Value Rating Study that is in operations and constructed prior to application of the Tool. This means the Tool is applied in its review mode.

The Tool is applied is to the first stage of buildings and grounds delivered to the opening of one of the non-PPP schools in the Value Rating Study i.e., the non-PPP school that is used in Section 1 to show the procedure to develop a Value Rating.

Beyond details available to the research team on the selected non-PPP school from the Value Rating Study, secondary sources of data were collected concerning this school selected. All this data was analysed in this study using the expertise within the study's research team and within staff at QUT, which includes extensive experience in the delivery of government primary schools.

5.4 Findings

5.4.1 Summary

The key finding of this study is shown in Box 5.2.

Box 5.2: Procurement Decision Study and Tool Finding

- This study showed how to apply the Procurement Decision Tool to a school, as a further illustration of the application of the Procurement Decision Tool in a sector other than health and road sectors.

5.4.2 Step 1. Activity Analysis

Key Design, Construction, Operations and Maintenance (DCOM) activities comprise distinct knowledge and skill including the inherent management and supervision of the physical output of the activity that is sold as a good or service. These technologically bounded activities approximate to the highest level of specialised good or service offered by market firms.

The output from Step 1 is a shortlist of DCOM activities, as depicted in Figure 5.3.

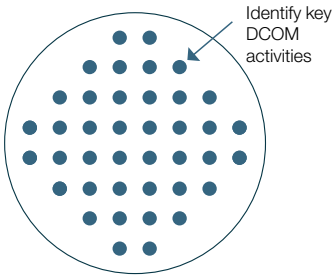

Figure 5.3: Step 1. Short-List of DCOM Activities

This project was divided into the main buildings, initial works and external works to first stage of buildings and grounds delivered to the opening of the selected school. The Australian Cost Management Manual (ACMM) – Volume 1 (2000) and Volume 2 (2001) was used to help identify activities in the following building elements in each of the main buildings, initial works and external works, as follows:

- Substructure
- Superstructure (columns; upper floors; staircases; roof; external walls; windows; external doors; internal walls; internal screens & borrowed lights; internal doors)
- Finishes (wall finishes; floor finishes; ceiling finishes)
- Furniture; fittings/fixings and equipment

- Services (sanitary fixtures; sanitary plumbing; water supply; gas service; space heating; ventilation; evaporative cooling; air conditioning; fire protection; electric, light and power, communications, transportation systems; special services)
- Centralised energy systems
- Site works (site preparation; roads, footpaths and paved areas, boundary walls, fencing, gates, outbuildings and covered ways; landscaping)
- External Services (stormwater draining; sewer drainage; water supply; external gas; fire protection; electric light and power; communications; and special services).

Having identified DCOM activities in the above building elements within each of the main buildings, initial works and external works in the project and having written-up the longlist of activities in each of these parts of the project, the similar activities within each of the parts of the project were initially grouped to create shortlists of activities.

These shortlists were able to be collated into four shortlists (i.e., Design shortlist; Construction shortlist; Operations shortlist; and Maintenance shortlist) in terms of the DCOM activities across all the campus buildings, initial and external works – because of the homogeneity of conditions surrounding the construction, operations and maintenance of the campus and the relatively short construction program i.e., less than 12 months. In total, there were 113 DCOM activities across the shortlists of activities listed in Appendix B.

5.4.3 Step 2. Project Specific-or-Network Analysis

Project Specific Activities generated by the new project are either one-off activities or recurrent activities. These new one-off activities or new recurrent activities are appreciably different to any existing recurrent activities in a current network operated by the Client and these new activities create the potential to deliver efficiency gains through economies of scope. In contrast, new Network Activities generated by new project are new recurrent activities that are like existing recurrent activities in a current network operated by the Client. This time, these new recurrent activities create the potential to deliver efficiency gains though economies of scale when they are procured with similar existing recurrent activities in a current network operated by the Client.

In summary, the output from Step 2 comprises each shortlist of activities divided into Project Specific Activities and Network Activities. Network activities are then excluded from subsequent analysis in the Tool, as depicted in Figure 5.4.

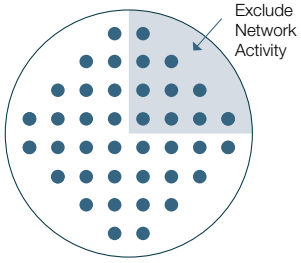

Figure 5.4: Step 2. Project Specific Activities and Network Activities

The activity of designing/planning for maintenance of the buildings and external works, mostly all operations activities (or “Soft” Facility Management/FM e.g., cleaning) and mostly all maintenance activities (or “Hard” Facility Management/FM) were considered to meet the definition for Network Activity. Therefore, design and construction of the buildings, initial works and external works, some “Soft” FM and some “Hard” FM activities were deemed Project Specific Activity.

Design and construction activities did not meet the definition for Network Activity because of their one-off/non-recurring nature. Some "Soft" and "Hard" FM while recurrent, did not meet the definition for Network Activity because of their immediacy and site specificity. This is summarised in Table 5.1.

Table 5.1: Project Specific Activities and Network Activities

Project Specific Activities (to be analysed in Steps 3-5)	Network Activities (to be excluded from subsequent analysis in Steps 3-5)
• Design of construction • Construction • *Ad hoc*/immediate response "Soft" FM and *Ad hoc*/immediate response/basic "Hard" FM	• Design (specification) of maintenance • Operations ("Soft" FM) – including Routine (day-to-day) Cleaning and Pest Control and Waste Management • Routine and Planned maintenance ("Hard" FM) of building fabric and carpark fabric and building services and external works

5.4.4 Step 3. Risk (Make-or-Buy) Analysis

The output from Step 3 comprises the identification of Project Specific activities that are more efficiently internalised (Risk Patterns 1 to 4) and Project Specific activities that are more efficiently externalised (Risk Patterns 5 to 8). Project Specific activities that are more efficiently internalised (Risk Patterns 1 to 4) are excluded from subsequent analysis in the Tool.

Four out of the five Risk Patterns associated with the Project Specific activities that are more efficiently externalised, reflect microeconomic risks that could lead to a lack of competition and high to very high prices (Risk Patterns 7 and 8) or high switching costs, which could lead to hold-up and costly variations (Risk Patterns 5a and 5b). These risks need to be treated (in the next two steps of the Tool) to avoid high prices and to avoid costly variations.

With regards to the remaining Risk Pattern 6, this is associated with externalised Project Specific activities that carry a low risk of high prices and costly variations. Low-Risk Pattern 6 activities do not require any treatment and can be bundled and efficiently transferred to suppliers using standard contracting terms.

The nine Risk Patterns and the output from Step 3 is depicted in depicted in Figure 5.5.

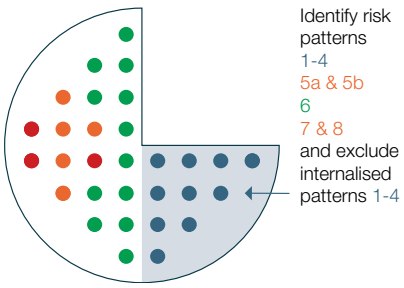

Figure 5.5: Step 3. Internalised and Externalised Risk Patterns

A Risk Pattern for the Project Specific was assigned by using the assessed level (i.e., High, Moderate or Low) for each of the three dimensions of High Prices and for each of the three dimensions of Costly Variations and was matched with the closest Risk Pattern in Appendix C. The following Risk Patterns were identified:

1. Pattern 4s
    a. Immediate response (ad hoc and basic) operations
    b. Immediate response (ad hoc and basic) maintenance of all the building and carpark and external works
2. Pattern 5bs
    a. Outline design of all construction activities including outline design of the buildings and carpark fabric and all services and initial works and external works
3. Pattern 6
    a. Developed detail design and construction of all project specific activities.

Design of construction was ungrouped and divided into two sub-activities i.e., outline design of construction and detailed design of construction. This outline design represents the Optimal Design Level for the Client to complete prior to signing contract/s (including substantial construction works). The Optimal Design Level represents a design that is sufficiently robust such that it is unlikely to change and clearly imparts the Client's requirements. This Optimal Design Level is, therefore, not universal, it will depend on the Client's circumstances. Clients procuring simple structures perhaps a simple carriageway or an industrial building may find a functional specification and schematic sufficient. Whereas, a client procuring a complex and high-profile facility such as a headquarter building may need to progress the design to some point between developed design and full working drawings – though not reaching full working drawings. The important point is that the design progresses right up to but, ideally, not a single detail further than what is required to achieve the Optimal Design Level.

The ungrouping of the design of construction activity's initial grouping in Step 1 was needed because part of the initial activity (outline design) was assessed as "High" on the Unpredictability dimension and part of the initial activity (detailed design) was assessed as "Low" on the Unpredictability dimension of Costly Variations. Operations and Maintenance was also ungrouped and divided into two sub-activities i.e., immediate response (*ad hoc and basic)* operations and maintenance and routine (day-to-day) and planned operations and maintenance. The ungrouping of the activity's initial grouping in Step 1 was needed because part of the initial activity (immediate response/ ad hoc and basic operations and maintenance) was assessed as "High" on the Unpredictability dimension and part of the initial activity (routine day-to-day and planned operations and maintenance) was assessed as "Low" on the Unpredictability dimension of Costly Variations.

An example of one of the Pattern 6 activities is shown in Table 5.2.

Table 5.2: Construction of Sheet Metal/Cladded Roof (Pattern 6 Activity)

Market Structure	High Prices		Switching Costs	Costly Variations			Activity
Complementarity	Rarity	Costly to Imitate	Sunk Costs and/or Timeliness	Unpredictability	Frequency	→ Risk Pattern →	Internalise or Externalise
High	High	High	Low or High	Low or High	High	1	Internalise
High	High	Low	Low or High	Low or High	High	2	Internalise
High	Low	Low	Low or High	Low or High	High	3	Internalise
Moderate	Low	Low	High	High	High	4	Internalise
Moderate	**Low**	**Low**	**High**	**High**	**Moderate or Low**	**5a**	Externalise: Treat risks of very costly variations
Low	Low	Low	High	High	Low	5b	Externalise: Treat risks of costly variations
Low	Low	Low	Low or High	Low	Low	6	Externalise: Low risks of costly variations and low risks of high prices
Low	High	Low	Low or High	Low or High	Low	7	Externalise: Treat risks of high prices
Low	High	High	Low or High	Low or High	Low	8	Externalise: Treat risks of very high prices

The validity of matching each Project Specific Activity with one of the Risk Patterns in Appendix C was checked, when it found that, in each Project Specific Activity, only one of nine rows/nine Risk Patterns in Appendix C appeared as fully ticked/shaded. This is a check on the theoretical logic underpinning Risk Patterns in Appendix C.

Project Specific Activities assigned an internalised Risk Pattern 1 through 4 would have been more efficiently internalised, and so they are excluded from subsequent analysis in the next two steps of the Tool.

All other Project Specific Activities were assigned externalised Risk Patterns. The Risk Pattern 7 and 8 activities need to be treated to avoid risks of High Prices. The Risk Pattern 5b activities also need to be treated but this time to avoid Costly Variations. Risks of High Prices and Costly Variations are low in all other Pattern 6 activities. Low-Risk Pattern 6 activities do not require any treatment, they can be bundled and efficiently transferred to suppliers using standard contracting terms.

In the next Step 4 only the externalised Project Specific activities i.e., Project Specific activities assigned with Risk Patterns 5b and 6 are analysed.

5.4.5 Step 4. Contract Packaging (Bundling) Analysis

The Tool maximises the benefits of bundling and minimises the costs of bundling, to advance value for money.

The output from Step 4 comprises bundles, or contact packages, of externalised Project Specific activities comprising five Risk Patterns 5a; 5b; 6; 7; and 8.

In doing so, bundling is used to treat four of five externalised Project Specific activities that carry microeconomic risks that could lead to a lack of competition and high to very high prices (Risk Patterns 7 and 8) or high switching costs, which could lead to hold-up and Costly Variations (Risk Patterns 5a and 5b). The remaining Risk Pattern 6 is associated with externalised Project Specific activities that carry a low risk of High Prices and Costly Variations. Low-Risk Pattern 6 activities do not require any treatment and can be bundled and efficiently transferred to suppliers using standard contracting terms. Step 4 is depicted in Figure 5.6.

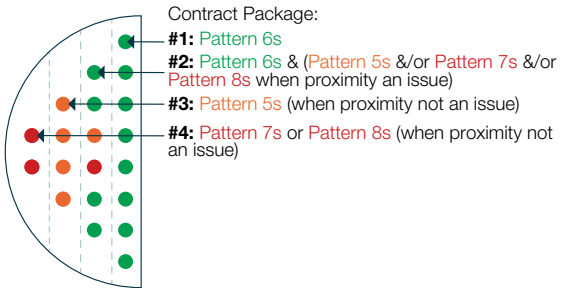

Figure 5.6: Step 4. Contract Packages

Only Risk Patterns 5b and 6 were identified and so there is no need to review any High-Risk Pattern 7s (to check whether the size of these activities had led to a High-Risk Pattern 7) and there are no proximity issues associated with the High-Risk Patterns 5b and so these outline design activities are treated by using a separate bundle, or contract packages. The remaining Low-Risk Pattern 6 detailed design and construction activities are bundled.

The Risk Pattern at the level of each of these two bundles was reassessed to check that a new High-Risk Pattern 7 and/or new High-Risk Pattern 8 has not arisen because of its size. This was not the case, because the size of each of these bundles would likely still attract a sufficient supply (5 or more market firms) capable of delivering each bundle.

While the second bundle comprised Low-Risk Pattern 6 activities, this bundle did not offer a strong potential for efficiencies in whole-life costs and/or strong potential for quality (functionality) innovations, and so this bundle is not market sounded for private finance.

In summary, two bundles, or contract packages, of externalised Project Specific activities are identified:

1. **Bundle #1.** High-Risk Pattern 5b i.e., the outline design of the school
2. **Bundle #2.** Low-Risk Pattern 6 activities i.e., detailed design of the school road and construction of the school.

5.4.6 Step 5. Collaborative-or-Competitive Contracting (Exchange Relationship) Analysis

Each contract used to procure each bundle of activities requires the Client to identify the most efficient exchange relationship with the counterparty market firm/supplier at the head of the supply chain of each bundle of activities. The exchange relationship is a continuum from relational exchange (collaborative

contracting) to arm's length or discrete exchange (competitive contracting). Competitive contracting becomes more extreme (and further away from collaborative contracting) when it includes bespoke contracts and/or costly-to-write credible threats concerning performance (e.g., a substantial performance bond). Credible threats are designed to pre-empt a strong balance of power held by suppliers in thin markets. Credible threats are costly to write in respect of the costs of drafting bespoke contract terms and in terms of their effect on pricing by suppliers.

The output from Step 5, and the Tool, are contact packages of externalised Project Specific activities with assigned contracting terms i.e., competitive (standard competitive or bespoke competitive) or collaborative or standard competitive (with some bespoke competitive terms and/or some collaborative terms), as depicted in Figure 5.7.

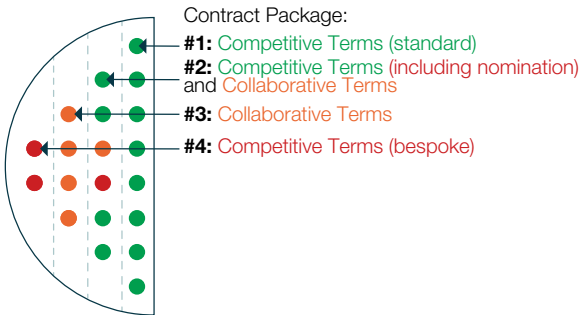

Figure 5.7: Step 5. Contract Packages and Contract Terms

Table 5.3 is used to assign an exchange relationship to each of the two bundles.

Table 5.3: Exchange relationship continuum

Market Structure	High Prices		Switching Costs	Costly Variations			Bundle
Complementarity	Rarity	Costly to Imitate	Sunk Costs and/or Timeliness	Unpredictability	Frequency →	Risk Pattern →	Exchange Relationship
Moderate	Low	Low	High	High	Moderate or Low	5a (Very High Risk)	Collaborative Contracting
Low	Low	Low	High	High	Low	5b (High Risk)	Collaborative Contracting
Low	Low	Low	Low or High	Low	Low	6 (Low Risk)	Standard Competitive Contracting
Low	High	Low	Low or High	Low or High	Low	7 (High Risk)	Bespoke Competitive Contracting
Low	High	High	Low or High	Low or High	Low	8 (Very High Risk)	Bespoke Competitive Contracting

The use of Table 5.3 led to two contract packages, as follows:

1. Collaborative contracting assigned to bundle/s of High-Risk Pattern 5b activities
2. Standard Competitive contracting assigned to bundle/s of Low-Risk Pattern 6 activities.

Additionally, it was considered that all elements of the work e.g., quantities of materials and/or prices of resources were reasonably predictable at the time of tender.

Where practicable, the Tool recommends selecting a standard contract to reflect the exchange relationship assigned to each bundle, or contract package. For example, the New Engineering Contract (NEC), "is a family of contracts that facilities the implementation of sound project management and procurement principles and practices, as well as defining legal relationships" (NEC, 2022). [12]

Using NEC as an example standard contract led to the following output:

1. **Contract #1 (using Collaborative contracting).** Scope of the works: High-Risk Pattern 5b i.e., the outline design of the school:
   a. NEC Professional Services Contract.
      i. This one contract to a consortium of designers. If the market does not respond favorably to this approach (at least 5 consortia expressing an interest) then multiple Professional Services Contracts are used and linked using X12 – Multiparty Collaboration. A range of reimbursement and target payment options are used through the process of developing the outline design including Client's brief and value engineering workshop/s. As mentioned, the important point is that the design progresses right up to but, ideally, not a single detail further than what is required to achieve the Optimal Design Level. In the case of the selected school, Optimal Design Level is likely to be at least schematic design, but not full design.
2. **Contract #2 (using Standard Competitive contracting**). Scope of the works: Low-Risk Pattern 6 activities i.e., detailed design of the school and construction of the school.
   a. NEC ECC including:
      i. Main Payment Option (Priced contract with activity schedule)
      ii. Secondary Option X15 – Contractor's design.

12 A website comprising case studies of NEC applications including school projects can be found at: https://www.neccontract.com/projects.

5.5 Discussion

The procurement strategy recommended by the Procurement Decision Tool closely matched actual procurement, as shown in Table 5.4.

Table 5.4: Comparison of procurement

Tool's recommended procurement strategy recommended	Actual procurement
Professional Services for outline design	Professional Services for schematic design and outline speciation and geotechnical details as tender documentation
Single detailed design and construction contract (including initial works and external works) with priced activity schedule	Single detailed design and construction Contract (including initial works and external works) i.e., AS 4300 (with modifications for government client and priced trade packages)
Routine and Planned Operations and Maintenance procured as part of the Client's existing network	Routine and Planned Operations and Maintenance procured as part of the Client's existing network
Immediate response/*ad hoc* and basic "Soft" FM and immediate/*ad hoc* and basic response/basic "Hard" FM procured as part of the Client's existing network	Two school-based personnel (grounds workers/ caretakers) procured as part of the Client's existing network

The Procurement Decision Tool identifies the best value for money approach to two key infrastructure procurement decisions. These are contract packaging (the size and number of contracts) and their contract terms (using competitive and/or collaborative contracting). To achieve this, the Tool employs state-of-the-art microeconomic theory that was developed to address these two procurement decisions specifically and systematically. Neither competition nor collaboration are virtues on their own. Rather, it is the Procurement Decision Tool's strategic deployment and mixing of these approaches to contracting that is the key to optimising value for money, i.e., competition and collaboration leads to maximising cooperation.

The Procurement Decision Tool is a world-first; it is the only procurement decision-making tool based on state-of-the-art microeconomic theories and which has been successfully empirically tested. The significance of this becomes self-evident, given that value for money is an economic concept and requires an economic response. In brief, the Tool can be expected to deliver the following important benefits:

- Significant cost and time savings,
- Appreciable improvements in transparency, accountability, consistency, and reliability in procurement decision-making, and
- More efficient deployment of private investment and finance.

The Procurement Decision Tool is estimated to double the chance of more effective procurement decision-making in contrast to current procurement decision-making practice (Bridge and Bianchi, 2014).

5.6 Publications

The following paper directly arising from the Procurement Decision Study and Tool is upcoming and anticipated to be accepted for publication in 2022:

- Bridge, A.J, Carroli, L., Kinnunen, N. & Gray, J. (2022): Working Title: *The Procurement Decision Tool: An Empirical Study of the Delivery of an Australian School.*

This publication includes more detail on all the sub-sections in Section 5 of this report.

5.7 Procurement Decision Study and Tool Research Team

At the final project research team meeting, the Procurement Decision Study and Tool researcher was the:

- Study's lead-Chief Investigator: Associate Professor Adrian Bridge (QUT).

5.8 Acknowledgments

The Procurement Decision Study and Tool researcher, would like to acknowledge the important contributions made by the following persons and organisations:

- Emeritus Professor Clem Tisdell, School of Economics, The University of Queensland, Australia provided significant support and guidance to Associate Professor Bridge during his PhD in which the approach to integrating various state-of-the-art microeconomic theories in Step 3 and in Step 5 of the Tool was developed and empirically tested.[13]
- Australian Research Council (Linkage Projects grant ID: LP0989743) funded the PhD study by Dr Pauline Teo in which all the steps in the Tool were developed and tested. Strong support and encouragement from Danny Graham (NSW Treasury) and Glenn Maguire (VIC DTF) in the process of developing and submitting the grant, along with assistance provided by Stephen Hogan in developing the Tool in the PhD study is gratefully acknowledged.[14]
- Austroads funded the trial of the Tool on Toowoomba Second Range Crossing (TSRC) and have kindly given their permission for content from the report arising from the trial application of the Tool on TSRC to be used in this Research Project Report. [15] The leadership and foresight shown by Ross Guppy (Transport Infrastructure Program Manager at Austroads) in facilitating Austroads supporting the application of the Tool on TSRC is greatly appreciated.
- Infrastructure Australia (IA) funded the trial of the Tool on the Gold Coast University Hospital and the production of this user guide. The key role played by Peter Colacino is recognised. Beyond IA, the following persons also provided valuable assistance in completing this trial application and user guide: Jason Wishart (Queensland Treasury); Gavin Ross (Queensland Treasury); Don Glynn (Queensland Health); Robert Phillips (retired, formerly Queensland Department of Project Services); Tony Avsec; Steven Evans; Dr Dejan Makovsek; Klaus Grewe; Dr Linda Carroli; and Nora Kinnunen.

13 Associate Professor Bridge's PhD Thesis is available at: https://eprints.qut.edu.au/17214/

14 Dr Teo's PhD Thesis is available at: https://eprints.qut.edu.au/72914/

15 The report of the application of Tool on TSRC and a webinar on this application are available at: https://austroads.com.au/publications/project-delivery/web-r624-20

- OECD funded the involvement of Associate Professor Bridge and QUT in the OECD's piloting of the Tool on major roads in Norway. This OECD project was led by Dr Dejan Makovsek. This project helped strengthen the Tool and led to formation of OECD's version of the Tool i.e., "STEPS" (Support Tool for Effective Procurement Strategy). Assistance given to Associate Professor Bridge, in his involvement in OECD's application of the Tool, by Associate Professor Dr Tim Rose, Dr Farshad Rezvani, Gerald (Mango) Murphy PSM and Dr Linda Carroli is also gratefully acknowledged. [16]
- Further assistance provided in this study by Dr Linda Carroli (QUT) and Nora Kinnunen (QUT) is gratefully acknowledged.
- Assistance provided by Jason Gray (QUT) in developing the shortlist of DCOM activities – based on Mr Gray's extensive experience of project managing the delivery of government primary schools, is gratefully acknowledged.

16 The report on the application of STEPS on the Norwegian roads, along with a webinar on this application and a brochure on STEPS are available at: https://www.oecd.org/publications/procurement-strategy-in-major-infrastructure-projects-38996343-en.htm#:~:text=The%20OECD%20has%20trialled%20a%20new%20evidence-%20based,effectiveness%20of%20public%20procurement%20of%20infrastructure%20and%20beyond; and https://www.youtube.com/watch?v=Gs8lucvC7DE; and https://www.oecd.org/gov/public-procurement/STEPS-brochure-april-22.pdf

Appendix A

Similarities and Differences Across Six Schools in Free Design Study

Table A.1: Similarities Across Six Schools in Free Design Study

	School A D&C (Stage 1) DBB (subsequent buildings)	School B PPP	School C PPP	School D PPP	School E D&C (Stage 1) DBB (subsequent buildings)	School F D&C (Stage 1) DBB (subsequent buildings)
Agency	Autonomous decision making to prioritise maintenance and future building.	Lack of autonomy – facilities management occurs through logging jobs on system - automates job priority.	Need to seek permission for any changes from consortium - even to change GPO position. Process is much faster now.	Need to seek permision from consortium - pinboards, new gardens. Have learnt to preempt questions from consortiums for speedier approvals. No longer concerned with day to day maintenance - involved in facility planning at a strategic level.	Autonomous decision making for changes to facilities and involved in design meetings however limited ability to change design.	Autonomous decision making and active involvement in masterplanning for large numbers of future enrolments.
Spaces to support Melbourne Declaration development/ wellbeing (walkthrough observations and interviews)	• Spaces for retreat, socialisation, and for enabling personalisation & ownership with school principal active in design process. • Library was well resourced and evidenced school culture. • New outdoor area for retreat and/or socialisation with natural materials and trees for shade.	• Limited spaces for safe retreat, shaded areas, personalisation & ownership. • Diversity in learning spaces and modern equipment. Library had minimal artwork and resources. • Outdoor areas have little shade and minimal tables and chairs. • No dedicated outdoor area for retreat. Some areas that are not easily supervised.	• High quality of some green spaces but lacking green spaces to accommodate large numbers of students. • New innovation learning space and refurbishment of communal learning space to support online learning and vocational entrepreneurship. • School hall not large enough for whole school assembly – more challenging to promote school culture and belonging.	• Lacking adequate green spaces and outdoor areas for student numbers. • Wanting to put up basketball hoops for general play but proved too many rules and regulations. •Collaborative classrooms. •Shaded areas with established trees. but some outdoor areas without shade	• Lacking green outdoor spaces and play spaces for physical, emotional and psychological health and wellbeing. • School has too many students for the space. • Outdoor nature scapes evident and planned to increase quality of play spaces. • unior classrooms are ground level with flow to outdoors.	Green areas for students are lacking established trees and plantings. Learning areas have been refurbished quite soon after opening to be more engaging for learners.

Table A.2: Differences Across Six Schools in Free Design Study

	School A D&C (Stage 1) DBB (subsequent buildings)	School B PPP	School C PPP	School D PPP	School E D&C (Stage 1) DBB (subsequent buildings)	School F D&C (Stage 1) DBB (subsequent buildings)
Educational Goals	Student development and engagement in diverse programs. Focus on student wellbeing and collaborative learning.	Building personal capability through diverse programs. Every student gaining what they need in terms of wellbeing.	Meeting students' development and wellbeing needs. Focus on developing culture, spirit and community to improve quality of student experience	Broader academic and social outcomes. Focus on whole child and wellbeing needs. Building social and emotional connections.	Broader range of general capabilities beyond literacy and numeracy. Focus on mental health, wellbeing and social skills. caring for others, we care for self, care for school environment	Wellbeing and welfare. Creating community. Helping students achieve the best they can achieve. Meeting students basic needs before learning.
Constraining Design	Strict area allocations prevented some design requests for learning spaces	Design for bundle of schools limited individual school changes. Used outdated design standards.	Formulaic approach' to design of schools using 'old design standards'	Archaic design' approach that is outdated	Designing to square meterage rate for general learning areas with no thought to location rather than designing to be site specific and designing for learning and wellbeing needs.	Standard design outcome using design guidelines that are 'obsolete'

Appendix B

Shortlists of Activities in Selected School in Procurement Decision Study and Tool

Table B.1: Shortlist of *Design* Activities (Based on ACMM, 2000 and 2001)

Campus Buildings, Initial Works and External Works (*Design*)		
1 Architectural Design	3 Mechanical Design	15 Maintenance Design (plan/ specification of routine and programmed maintenance)
2 Structural Engineering Design	4 Electrical Design	
	5 Hydraulics Design	
	6 Drainage Design	
	7 Geometric Design (carpark)	
	8 Pavement Design (carpark)	
	9 Landscaping Design	
	10 Lighting Design	
	11 Fire Protection Design	
	12 Communications Design	
	13 Audio Visual Design	
	14 Acoustics Design	

Table B.2: Shortlist of *Construction* Activities (Based on ACMM, 2000 and 2001)

Campus Buildings, Initial Works and External Works (*Construction*)		
16 Site Clearance	32 Metal Framed Roof	51 Fitments (including Loose and Fixed Furniture)
17 Reduced Level Excavation	33 Sheet Metal Roof Covering	52 Special Equipment
18 Utilities Connections	34 Sheet Metal Cladding External Walls	53 Sanitary Fixtures
19 External Drainage	35 Brickwork External Walls	54 Sanitary Plumbing
20 External Sewage	36 Blockwork External Walls	55 Water Supply
21 External Water Supply	37 Fiberboard External Walls	56 Gas Service
22 External Gas	38 Aluminum Windows	57 Ventilation
23 External Fire Protection	39 Timber Cored Doors	58 Air Conditioning
24 External Communications	40 Metal Cored Doors	59 Fire Protection
25 Strip foundations	41 Metal Frames to Doors	60 Electric Light and Power
26 Ground Slabs	42 Hardware to Doors	61 Communications (including Voice and Data)
27 Reinforced Concrete Columns	43 Metal Studding Internal Walls	62 Footpaths, Paved and Parking Areas
28 Insitu Slab Upper Floors	44 Plasterboard including Paintwork Wall Finishes	63 Boundary Walls, Fencing and Gates
29 Portal Frames	45 Vinyl Wall Finishes	64 Outbuildings
30 Staircases including Landings, Tread and Rises Finishes	46 Vinyl Floor Finishes	65 Covered Ways
31 Balustrades and Wall Handrails	47 Ceramic Tiles Floor Finishes	66 Landscaping
	48 Carpet Floor Finishes	
	49 Plasterboard Ceiling Finishes	
	50 False Ceiling Finishes	

Table B.3: Shortlist of *Operations* Activities (Based on ACMM 2000 and 2001)

Campus Buildings, Initial Works and External Works (*Operations*)
67 Cleaning
68 Pest Control
69 Waste Management
70 Security

Table B.4: Shortlist of *Maintenance* Activities (Based on ACMM, 2000 and 2001)

Campus Buildings, Initial Works and External Works (*Maintenance*)		
71 External Drainage	89 Hardware to Doors	104 Ventilation
72 External Sewage	90 Metal Studding Internal Walls	105 Air Conditioning
73 External Water Supply	91 Plasterboard including Paintwork Wall Finishes	106 Fire Protection
74 External Gas	92 Vinyl Wall Finishes	107 Electric Light and Power
75 External Fire Protection	93 Vinyl Floor Finishes	108 Communications (including Voice and Data)
76 External Light and Power	94 Ceramic Tiles Floor Finishes	109 Footpaths and Paved and Parking Areas
77 External Communications	95 Carpet Floor Finishes	110 Boundary Wals, Fencing and Gates
78 Staircases including Landings, Tread and Rises Finishes	96 Plasterboard Ceiling Finishes	111 Outbuildings
79 Balustrades and Wall Handrails	97 False Ceiling Finishes	112 Covered Ways
80 Metal Framed Roof	98 Fitments (including Loose and Fixed Furniture)	113 Landscaping
81 Sheet Metal Roof Covering	99 Special Equipment	
82 Sheet Metal Cladding External Walls	100 Sanitary Fixtures	
83 Brickwork External Walls	101 Sanitary Plumbing	
84 Blockwork External Walls	102 Water Supply	
85 Fiberboard External Walls	103 Gas Service	
86 Aluminum Windows		
87 Metal Cored Doors		
88 Metal Frames to Doors		

Appendix C

Risk (Make-or-Buy) Analysis in Selected School in Procurement Decision Study and Tool

The Microeconomic risks of high prices and costly variations are shown as nine risk patterns in Table C.1.

Table C.1: Microeconomic risks of high prices and costly variations: Risk patterns

Market Structure	High Prices		Switching Costs	Costly Variations			Activity
Complementarity	**Rarity**	**Costly to Imitate**	**Sunk Costs and/or Timeliness**	**Unpredictability**	**Frequency**	**Risk Pattern**	**Internalise or Externalise**
High	High	High	Low or High	Low or High	High	1	Internalise
High	High	Low	Low or High	Low or High	High	2	Internalise
High	Low	Low	Low or High	Low or High	High	3	Internalise
Moderate	Low	Low	High	High	High	4	Internalise
Moderate	**Low**	**Low**	**High**	**High**	**Moderate or Low**	**5a**	**Externalise: Treat risks of very costly variations**
Low	Low	Low	High	High	Low	5b	Externalise: Treat risks of costly variations
Low	Low	Low	Low or High	Low	Low	6	Externalise: Low risks of costly variations and low risks of high prices
Low	High	Low	Low or High	Low or High	Low	7	Externalise: Treat risks of high prices
Low	High	High	Low or High	Low or High	Low	8	Externalise: Treat risks of very high prices

The question, response format and approach to assessing their answers to establish the level (i.e., High or Low) of the three columns (or dimensions) of High Prices and the three dimensions of Costly for each activity are as follows:

a. Questions on the three dimensions of **High Prices (HP)**
   - Dimension 1. **Complementarity**:
     - **Question HP1a.** Did the Client have the in-house *capability* (*breadth* of knowledge and skills, amongst permanent/ongoing staff, *excluding* temporary/casual staff, as well as other resources) to deliver the management and implementation of the activity across the entire project?
       - Answer:
         - "Yes (Capable)" or
         - "No (Not Capable)
     - **Question HP1b.** Did the Client have the in-house *capacity* (*depth* of knowledge and skills amongst permanent/ongoing staff, *excluding* temporary/casual staff, as well as other resources) to deliver the management and implementation activity across the entire project?
       - Answer:
         - "Yes (Capacity)" or
         - "No (No Capacity)"
     - **Question HP1c.** If the answer to Question HP1a is "No", then did, or could, the Client have the in-house *capability* (*breadth* of knowledge and skills, amongst permanent/ongoing staff, *including* up to 20% additional staff employed on a temporary/casual basis, as well as other resources) to deliver the management and implementation of the activity across the entire project?
       - Answer:
         - "Yes (Capable)" or
         - "No (Not Capable)"
     - **Question HP1d.** If the answer to Question HP1b is "No", then did, or could, the Client have the in-house *capacity* (*depth* of knowledge and skills amongst permanent/ongoing staff, *including* up to 20% additional staff employed on a temporary/casual basis, as well as other resources) to deliver the management and implementation activity across the entire project?
       - Answer:
         - "Yes (Capacity)" or
         - "No (No Capacity)"
     - **Assessment**
       - *High* = "Yes" to Q1a and "Yes" to HPQ1b
       - *Moderate* = "Yes" to HPQ1c and "Yes" to HPQ1d
       - *Low* = "No" to either HPQ1a, HPQ1b, HPQ1c or HPQ1d
   - Dimension 2. **Rarity**
     - **Question HP2a**. How much was there likely to be a sufficient supply (5 or more market firms) capable of delivering the activity across the entire project *and* likely to have the capacity and interest to express an interest/apply for qualification to deliver the activity (when the activity is part of the typical size and type of contract that these market firms are thought to prefer)?

       The User of the Tool selects the geographical tier/s i.e., local and/or national and/or international that the Client's choses to apply to the project.

- Answer:
  - “Yes (Sufficient/5 or more - locally)” or “No (Insufficient/4 or less)”
  - “Yes (Sufficient/5 or more - nationally)” or “No (Insufficient/4 or less)”
  - “Yes (Sufficient/5 or more - internationally)” or “No (Insufficient/4 or less)”

- **Question HP2b.** If the answer is “Yes” to any of the three geographical tiers, then was there anything about the project that would likely have given a significant competitive advantage to any of those market firms – vis-à-vis the activity and which would have effectively reduced your choice of supply of the activity to 4 or less market firms?

  - Answer:
    - “Yes (Reduced Supply/4 or less - locally)” or “No (Reduced Supply/4 or less - locally)”
    - “Yes (Reduced Supply /4 or less - nationally)” or “No (Reduced Supply/4 or less - nationally)”
    - “Yes (Reduced Supply/4 or less - internationally)” or “No (Reduced Supply/4 or less - internationally)”

- **Assessment**

  - *High* = “No” to each of the geographical tiers in HPQ2a
  - *Low* = “Yes” to one or more of the geographical tiers in HPQ2a i.e., across one or more of the geographical tiers there are 5 firms or more and this number is not reduced to 4 or less firms because of a “Yes” answer to any of the geographical tiers in HPQ2b

- Dimension 3. **Costly to Imitate**

- **Question HP3.** If the answer is “Yes” to one or more of the geographical tiers in Q2a i.e., across one or more of the geographical tiers there are 5 firms or more and this number *is* reduced to 4 or less firms because of a “Yes” answer to any of the geographical tiers in Q2b**,** then how difficult would it have been for other rival market firms to develop and match this competitive advantage – within the project’s timeline to increase the supply to 5 or more firms?

  - o Answer:
    - “Yes (Difficult)” or
    - “No (Not Difficult)”

- **Assessment**

  - *High* = “Yes” to HPQ3
  - *Low* = “No” to HPQ3

b. Questions on the three dimensions of **Costly Variations (CV)**

- Dimension 1. **Sunk Costs and/or Timely Delivery**

- **Question CV1a.** How much would a Supplier of the activity i.e., firm specialising in the either the design, construction, operations or maintenance of the activity, upon award of a contract to deliver the activity – as part of the typical size and type of contract that these market firms are thought to prefer, need to customise its existing knowledge and/or skills and/or other internal resources to deliver the entire activity within project?

  For example, customisation could involve adaption to standard hardware or software but which the supplier cannot use in other projects with different clients. In other words, this question captures how much unique investment is made by the Client and the Supplier to deliver the activity and, in turn, how much the Client then becomes dependent the Supplier and which can drive costs for Client to switch from the existing Supplier to a new Supplier. These costs comprise disestablishment costs including any damages payable to the existing Supplier because of the contract break and re-establishment costs including re-investment costs

associated with the new Supplier and the time taken by the new Supplier to regain the level of productivity achieved by the existing Supplier.

- Answer:
  - "Yes (Significant Customisation i.e., ≥ 20% of the Supplier's total time and cost required to deliver the activity)" or
  - "No (Insignificant Customisation i.e., ≤ 20% of the Supplier's total time and cost required to deliver the activity)"

- **Question CV1b.** At the start of the activity was there any flexibility to extend the period initially allowed for the activity in the project?

  The start of the activity means:

  - the start of design in the activity – if it is a design activity; or
  - the start of construction/installation in the activity – if it is a construction activity; or
  - the start operations in the activity – if it is an operations activity; or
  - the start of the maintenance in the activity – if it is a maintenance activity.

  This question captures broader switching costs associated with costs to the Client's core business and/or reputation should the project end-date be delayed.

  For example, if design and construction activities are on the critical-path they may have little or no flexibility. If the activity has some float-time (i.e., at least 20% or of the original timeline for the activity), then the answer would be "Some Flexibility".

  In some operations and maintenance activities there may be both some flexibility and little or no flexibility e.g., inspections may allow some flexibility but statutory requirements including health and safety requirements may not allow any flexibility. In these cases, the activity would need to be divided into sub-activities based on technical requirements i.e., a sub-activity that requires an urgent response and a sub-activity that allow a non-urgent response, to allow a clear "Yes" or "No" answer on this question. This process of sub-dividing activities is explained below in Procedure #7 in this step.

  - Answer:
    - "Yes (Some or A Lot of Flexibility)"
    - "No (Little or No Flexibility)"

- **Assessment**

  - *High* = "Yes" to CVQ1a or "Yes" to CVQ1b
  - *Low* = "No" to CVQ1a and "No" to CVQ1b

- Dimension 2. **Unpredictability**

  - **Question CV2a.** Is the Client's requirements (scope and/or specification) likely to change and materially disrupt the scope of work and/or the supplier's planned method of delivery?

    These changes include both client-initiated change and changes arising because of inadequate project documentation and both kinds of client changes could trigger the unexpected involvement of third parties.

    - Answer:
      - "Yes (Appreciable Client's Requirements changes and disruption)"
      - "No (Negligible Client's Requirements changes)"

  - **Question CV2b.** Are third parties, whose involvement is expected at the start of the activity, likely to change and materially disrupt the scope of work and/or the supplier's planned method of delivery?

- Answer:
  - "Yes (Appreciable Third-Party involvement and disruption)"
  - "No (Negligible Third-Party involvement)"

- **Question CV2c.** Are environment changes likely to change and materially disrupt the scope of work and/or the supplier's planned method of delivery?

  - Answer:
    - "Yes (Appreciable environmental changes and disruption)"
    - "No (Negligible environmental changes)"
      Environmental changes include factors completely beyond the control of the Client and suppliers, including changes to demand for the Client's good or service being facilitated by the project, changes to technology, changes to health and safety requirements and climate change. Except for an epidemic or pandemic, environment changes are more likely to apply to O&M activities (as opposed to D&C activities) because of the prolonged period of O&M from their commencement at the end of construction/installation to rehabilitation/major refurbishment. For example, a typical health service plan incorporating tends in demographics and clinical services requirements might cover a 10-year planning horizon. As O&M will continue well beyond these kinds of planning horizon, the answer to CV2c in respect of O&M activities could turn to "Yes" at some point in the future delivery of O&M.
      If so, O&M activities would again need to be divided into sub-activities to allow a clear "Yes" or "No" answer on this question. This time, sub-dividing the activity is based on time i.e., a sub-activity that reflects the period of years after initial construction/installation that is *unaffected* by environmental changes and a sub-activity that reflects the period of years after initial construction/installation (until rehabilitation or major refurbishment) that is *affected* by environmental changes.

- **Assessment**

  - *High* = "Yes" to CVQ2a or "Yes" to CVQ2b or "Yes" to CVQ2c
  - *Low* = "No" to CVQ2a and "No" to CVQ2b and "No" to CVQ2c

- Dimension #3. **Frequency**

  - **Question CV3a.** What was the total amount and value of work for the activity across all the Client's projects and any network being designed or being constructed or being operated or being maintained by the Client *relative* to the scale and turnover of the activity being designed or being constructed or being operated or being maintained by leading national or international market firms specialising in the activity?

    The total amount and value of work for the activity in this question is assessed very approximately in the Quarter in which the procurement decision was made and compared with the scale and turnover of the activity by leading national or international market firms in the same Quarter.

    The potential for the Client to efficiently internalise the activity is based on achieving *economies of scale* similar or superior to individual leading market firms specialising in the activity. Hence, if the Client's total amount and value of work for the activity falls between one of the tiers of suppliers, then the next highest tier will likely be more efficient in delivering the activity because it has superior economies of scale, and when the lower tiers of market firms are likely not suited to delivering bundles of the activity associated with the Client's total amount and value of work for the activity.

The User of the Tool identifies approximate tiers of market firms delivering the activity. Tiers of firms are identified by partitioning those firms whose pricing decisions are affected by the other firms in the same tier (see reference in Footnote #6).

For example, if there were three tiers of leading market firms:

- Answer:
  - More (≥20%); or Same; or Less (≤20%) than the largest Tier (1) leading market firms
  - More (≥20%); or Same; or Less (≤20%) than the mid-Tier (2) leading market firms
  - More (≥20%); or Same; or Less (≤20%) than the smallest-Tier (3) leading market firms

- Dimension #3. **Frequency**
  - **Question CV3b.** How confident would the Client have been in forecasting, beyond the focal Quarter in Question CV3a, a continuous flow of the total amount and value of work for the activity in Question CV3b?
    - Answer:
      - Confident over 5 years from the focal Quarter; or
      - Confident for 3 to 5 years from the focal Quarter; or
      - Confident 1 to 3 years from the focal Quarter; or
      - Confident 1 to 12 months from the focal Quarter; or
      - Not Confident for any period from the focal Quarter
  - **Assessment**
    - *High* = More (≥20%) than the largest Tier and confident over 5 years from the focal Quarter
    - *Moderate* = Same as any tier and confident for over 3 years from the focal Quarter
    - *Low* = Less than Tier 3; More than Tier 3 but less than Tier 2; More than Tier 2 but less than Tier 1 and either not confident or confident for any period from the focal Quarter

It was necessary to subdivide the design activity in the project into two sub-activities. Because the initial outline part design was assessed as high the first two dimensions of Costly Variations, while the remaining developed/detailed was only assessed as high on the first dimension of Costly Variations.

Operations and Maintenance was also ungrouped and divided into two sub-activities i.e., immediate response (*ad hoc and basic*) operations and maintenance and routine (day-to-day) and planned operations and maintenance. The ungrouping of the activity's initial grouping in Step 1 was needed because part of the initial activity (immediate response/ ad hoc and basic operations and maintenance) was assessed as "High" on the Unpredictability dimension and part of the initial activity (routine day-to-day and planned operations and maintenance) was assessed as "Low" on the Unpredictability dimension of Costly Variations.

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