

Article

Creating an Efficient Public–Private Partnership Bundle: An Empirical Study

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Abstract: Public–Private Partnerships have been implemented globally as a key procurement strategy for addressing the issue of funding gaps amidst the immense pressure to deliver new major infrastructure projects. However, in current practice, procurement selection is applied to the entire bundle of project activities. This often leads to unduly large bundles of externalized project activities that create unduly large PPP contracts and attempt to transfer too much risk. To address this gap, this paper presents the development and testing of an implementable model that embodies a range of microeconomic theories—namely, transaction cost and resource-based theories—and property rights theory. This paper presents the first empirical testing of this model based on two road and two health projects, using competition as an independent measure of the validity of the recommended procurement strategy. The results provide compelling evidence that a rigorous application of the model will enable a substantial improvement of existing procurement approaches, such as identifying the most suitable bundle to be procured using a PPP approach.

Keywords: public–private partnerships; major road and health projects; transaction costs; capabilities; competition



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1. Introduction

The Public–Private Partnership (PPP) mode of procurement continues to play a significant role in delivering global infrastructure. The Global Infrastructure Hub [1] forecasts a growing demand for global infrastructure, with an anticipated investment of USD 94 trillion by 2040, which includes a USD 15 trillion financing gap. Notably, China, the US, India, and Japan are expected to contribute over half of this infrastructure expenditure. Despite the significant disruptions caused by the COVID-19 pandemic, the global infrastructure construction output managed to expand in 2020, as governments worldwide actively invested in transport infrastructure and clean energy to stimulate economic activity [2]. The global infrastructure sector is estimated at USD 2.72 trillion in 2024 and is expected to reach USD 3.69 trillion by 2029, growing at a compound annual growth rate of 6.27% during the forecast period (2024–2029) [3]. Given the substantial debt burdens faced by many nations, governments are prioritizing private investment and financing as a crucial strategy for bridging the significant funding gap in developing new public sector infrastructure [4–6].

Despite their popularity amongst governments, due caution is warranted as PPPs are attracting poor public perceptions [7], which are bolstered by PPP audits that have raised serious questions concerning its efficacy. For instance, the National Audit Office (NAO) in the UK found no clear evidence to conclude that PPPs deliver Value for Money (VfM) [8,9]. The European Court of Auditors (ECA) has expressed concerns regarding the economic viability of PPPs and the UK government has abandoned PPP applications [10,11]. Indeed, we should expect inefficient whole-of-life outcomes when governments unduly leverage private finance, where the cost of private finance is higher than the cost of government borrowing, and governments attempt to transfer too much risk to the PPP company. Therefore, it is not surprising to read disparaging reports on PPPs and observe poor perceptions

amongst public stakeholders. Despite this negative press, it is also not surprising to expect PPPs to prevail, given the parlous fiscal state of governments worldwide. Governments are increasingly reaching out to private investment and finance, whilst overstressing their procurement capabilities. The greater transfer of risk to a lesser number of larger contracts can appeal to the government. Meanwhile, governments' motivation to seek private finance may also be influenced by short-term financial "benefits" associated with off-balance sheet treatment and public accounting that falls short of the International Public Sector Accounting Standards Board's IPSAS32 standard [12].

Against this background, a PPP model that determines projects or part/s of projects suited to a PPP delivery will be beneficial to decision-makers. Central to this PPP suitability question are the microeconomics of bundling property rights with respect to design, construction, operations, and maintenance (DCOM) activities that allow the PPP company to demonstrate efficiency gains and offset the cost of project finance [13,14]. Specifically, Teo and Bridge [15] deploy a novel combination of a range of microeconomic theories—namely, transaction cost and resource-based theories and property rights theory, to explain how an efficient bundle of property rights associated with new infrastructure activities can be configured—to determine those projects or part/s of projects better suited to PPP delivery. Teo and Bridge's PPP model is cited by Australia's Productivity Commission in their final report into Public Infrastructure [16]. The model forms the basis of a procurement decision tool developed by Austroads [17] and policy guidance at OECD [18]. The OECD had adopted the model as part of their policy for infrastructure procurement and is now known as STEPS (Support Tool for Effective Procurement Strategy).

Contrary to the Austroads and OECD reports, this paper shows how to determine the viability of a PPP using a truncated approach; that is, to explain the rationale for differentiating between project-specific and network activities, and how to establish PPP or non-PPP after the bundling step. This is distinctly different to the Austroads and OECD reports, which emphasize the identification of the most efficient exchange relationship (i.e., competitive-or-collaborative contracting) to guide the selection of a suitable procurement method. Furthermore, this paper presents the operationalization of the measurement of Transaction Cost Economics (TCE) and Resource-Based Theory (RBT) variables in the context of major infrastructure procurement, which is a key element of the PPP model and missing in the Austroads and OECD reports.

Moreover, Austroads only reported a single case in a single road sector [17] and similarly, OECD reported two cases in a single road sector [18]. In contrast, this research intentionally develops four different cases across two distinct road and health sectors, employing Yin's theoretical and literal replication methods [19], to evaluate the hypothesis posited in this paper. Hence, this paper represents a robust empirical test to establish validity of the procedures in the theoretical model.

This paper serves as a vital component that, together with the Austroads and OECD reports, forms a complete trilogy of studies. It provides the key element that enables a thorough comprehension of the insights presented in the Austroads and OECD reports. This paper aims to present the development of the implementable version of the schematic model, in conjunction with its first empirical test. This research contributes to the literature by differentiating between project-specific and network activities in procurement and the development of the procurement questionnaire that operationalizes the microeconomic theories into measurable constructs that can be readily applied by the government or industry. The paper begins with the PPP framework, followed by the development of the implementable model and corresponding general and specific hypothesis. Next, the design of the case studies and their results are presented, which lead into a discussion of the theoretical and practical implications. Finally, we conclude with significance and further research.

2. PPP Framework

The PPP framework underpinning the implementable model is represented by three parameters to establish an efficient bundle of property rights within a package of DCOM activities. These act as a precursor to identifying projects or part/s of projects that are better suited to PPP delivery. The three parameters are as follows: 1. avoiding high bid prices, 2. avoiding hold up, and 3. emphasizing positive externalities (or benefits) over moral hazard (bundling theory/bundling-related parameter). The 'high price' parameter concerns the issue of the size of externalized activities in a PPP bundle and ensuring sufficient competition amongst PPP bidders. The 'hold up' parameter refers to externalized activities associated with high endogenous-related uncertainty (e.g., variations arising because of a lack of clear specifications in the contract documentation), which are key sources of costly variations to the works. Collectively, the 'high price' and 'hold up' parameters represent potentially externalized activities that can detract from the efficient transfer of risk embodied within a DCOM package of activities. These troublesome activities are a potential source of pre- and post-contract market failure. Consequently, the first two parameters are used as filters to exclude troublesome externalized activities prior to the deployment of the bundling-related parameter that is applied to the residual (or remaining) externalized activities. If amongst the remaining externalized activities there are DCOM activities that have the potential to generate economies of scope, or positive externalities, to displace an inclination to pursue negative investments associated with moral hazard, and if these economies of scope are non-trivial (i.e., the potential quantum of efficiency gains arising from positive externalities are sufficient to offset any higher cost of private finance vis-à-vis public finance), then these activities can be combined into efficient DCOM bundles of property rights, as the basis of market sounding for PPP contracts. The complete development of the PPP framework is detailed in an earlier paper by Teo and Bridge [15].

3. Development of the Implementable Model

3.1. Activity Analysis and Project Specific-or-Network Analysis

A project is broken down into activities using transaction cost logic in Activity Analysis, whereby transaction costs occur across the interface of technologically separable activities. New project activities (either one-off/capital or recurrent works) could potentially enhance efficiency gains through leveraging economies of scope. This refers to the cost advantage achieved when a variety of goods and services are produced together within a single firm or contract, as opposed to being produced separately by multiple firms or contracts [20]. Governments can achieve economies of scope by bundling D and/or C and/or O and/or M activities, when potential synergy or complementarity are displayed. This potential synergy tends to be more significant when the cost of O and M is greater compared to that of D and C. New project activities can be bundled into one or a smaller number of contracts, in which net costs and benefits are superior to those associated with a larger number of contracts [21,22]. However, this can only be achieved when the formulation and/or delivery of these new project activities are complementary and significantly distinct from recurring activities within the extant network. In general, D and C activities are often considerably different from the existing network activities mainly because of its infrequent nature, unique timing, location, and resource immobility [17]. Meanwhile, ongoing O and M activities from the new project may significantly differ from those in the existing network due to differences in the required knowledge and skills. New project activities that are complementary and significantly different from ongoing activities in a network are referred to as project-specific activities.

The new project may also create recurring activities that resemble those in an extant network and are termed as network activities. These network activities have the potential to enhance efficiency gains by leveraging economies of scale. Economies of scale refer to the decreasing average total cost of a single activity or cost function. Therefore, when a new project produces activities that are similar to recurring network activities, the government

can realize efficiency gains by procuring these new project activities with the existing ones (economies of scale). Figure 1 illustrates the procedural steps of the implementable model.

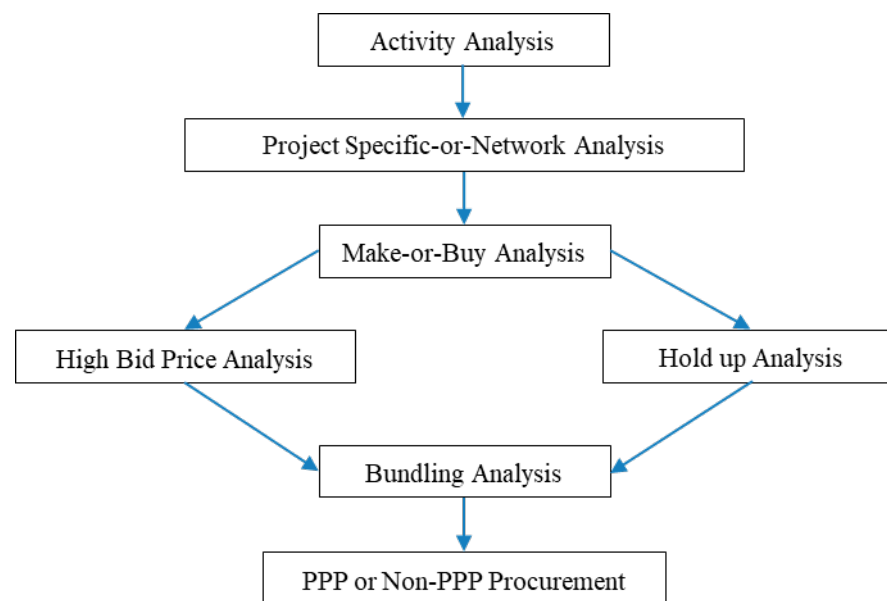


Figure 1. Schematic of implementable model.

3.2. Make-or-Buy Analysis

The integrative framework of vertical integration by Bridge and Tisdell [23] and Bridge [24] (referred as the “framework”) is adopted as the approach to integrating Transaction Cost Economics (TCE), Resource-Based Theory (RBT), and Ronald Coase’s transaction cost thesis (Table 1). Each of these theories has a different emphasis and complementary strengths in relation to the make-or-buy decision: the impact of hold up related to production and organizational uniformity (TCE); internal transaction costs tied to organizational heterogeneity (Coase); and capabilities related to production heterogeneity (RBT) [15]. Indeed, the proponents of these theories have advocated for integrating their respective theories [25–28]. This framework uses the production activity as the unit of analysis. An activity is considered a bundle of resources, which also includes planning and coordination, or organizational resources delivered by the management function. This framework identifies make (i.e., internalized) activities (to be omitted from analysis) and buy (i.e., externalized) activities (the focus of analysis), including two kinds of troublesome externalized activities that are associated with the following: (1) production heterogeneity that can create pre-contract market failure (filtered out in High Bid Price Analysis) and (2) ex-ante homogeneity, ex-post asset specificity and uncertainty, that are likely to create hold up and post-contract market failure (filtered out in Hold Up Analysis).

The framework is based on a conceptualization of the focal firm and its market firms (or suppliers) as a reflected competence and capability spectrum (Table 1). The spectrum envisages both firm-market homogeneity and heterogeneity and comprises four conditions associated with an activity. The four conditions comprise 1. differential capability on production and/or organizational fronts; 2. differential production competence; 3. differential organizational competence (on a platform of similar production); and 4. potential ex-post hold up characteristics of a transaction. As such, the spectrum comprises eight levels (due to the four conditions occurring in both internalized and externalized activities).

Table 1. Integrative framework of vertical integration (Adapted from: Bridge, 2008 [24].)

Level	Dominant Logic	Asset Specificity (TCE)	Uncertainty (TCE)	Frequency (TCE)	Value (RBT)	Rarity (RBT)	Costly to Imitate (RBT)	Mode of Governance
1	Product and/or Organizational Capability (RBT)	+ to +++ (5 to 7)	0 to +++ (1 to 7)	+ to +++ (5 to 7)	+++ (7)	+ to +++ (5 to 7)	+ to +++ (5 to 7)	Internal
2	Production/Technical Competence (RBT)	0 to ++ (1 to 6)	0 to ++ (1 to 6)	+ to +++ (5 to 7)	++ (6)	+ to +++ (5 to 7)	0 (1 to 4)	Internal
3	Organizational Competence (Coase's thesis)	0 to + (1 to 5)	0 (1 to 4)	+ to +++ (5 to 7)	+ (5)	0 (1 to 4)	0 (1 to 4)	Internal
4	Hold up (TCE)	+ to +++ (5 to 7)	+ to +++ (5 to 7)	+ to +++ (5 to 7)	-/+ (4)	0 (1 to 4)	0 (1 to 4)	Internal
5	Hold up (TCE)	+ to +++ (5 to 7)	+ to +++ (5 to 7)	0/+ (4)	-/+ (4)	0 (1 to 4)	0 (1 to 4)	External
6	Organizational Competence (Coase's thesis)	0 to + (1 to 4)	0 (1 to 4)	0 (1 to 4)	- (3)	0 (1 to 4)	0 (1 to 4)	External
7	Production/Technical Competence (RBT)	0 to ++ (1 to 6)	0 to ++ (1 to 6)	0 (1 to 4)	-- (2)	+ to +++ (5 to 7)	0 (1 to 4)	External
8	Product and/or Organizational Capability (RBT)	0 to +++ (1 to 7)	0 to +++ (1 to 7)	0 (1 to 4)	--- (1)	+ to +++ (5 to 7)	+ to +++ (5 to 7)	External

TCE is assigned as the dominant theory at Levels 4 and 5 relating to the condition of ex-post hold up. Coase's thesis is assigned as the dominant theory at Levels 3 and 6 under the conditions of heterogeneity arising from organizational competence. Finally, RBT is assigned as the dominant theory explaining Levels 1, 2, 7, and 8 that represent conditions of heterogeneity due to differential capability across production and/or organizational fronts and differential production competence. The importance of each variable representing these theoretical perspectives is shown using a range of symbols/scores, where +++ (score of 7) is extremely important or exhibits an extremely high incidence in all variables (except the Value variable). The symbol 0 (score of 1 to 4) is negligible or exhibits an extremely low incidence in all variables (except the Value variable). With the Value variable, +++ (score of 7) is extremely positive and --- (score of 1) is extremely negative. A unique pattern of variables is generated for each classification level to capture the dominant theory and, at the same time, reflect the two submissive theories.

A supply chain is broken down into key production activities that are non-trivial and discernible technological boundaries. The values of the variables for each activity are then measured from the viewpoint of the focal firm. The resultant pattern of empirical measurements is then compared with each of the patterns in the eight levels in the framework to select the closest matching level. A theoretical prediction is established in terms of whether internalization (Level 1 to 4 activities) or externalization (Level 5 to 8 activities) is more likely to add value to this firm, including the most efficient allocation of risks amongst the externalized activities (the focus of subsequent analysis). Level 8 activities can create pre-contract market failure (High Bid Price Analysis). Level 5 activities that are likely to create hold up and post-contract market failure (Hold Up Analysis), are filtered out prior to Bundling Analysis. The focus of Bundling Analysis is on the residual or remaining Level 6 and 7 activities. The framework is applied only to project-specific activities.

The model focuses on the externalized project-specific activities and identifies efficient DCOM bundles of property rights as the basis of market sounding for PPP contracts. Next, we refine the general hypothesis to reflect the distinction between project-specific activities (where efficiencies can be derived from economies of scope) and network activities (where efficiencies can be delivered through economies of scale).

3.3. Hypotheses

The general hypothesis is as below:

Following the omission of network activities and internalized project-specific activities (Level 1 to 4), the more that troublesome externalized project-specific activities (Level 5 and 8) are excluded (via the application of the parameters of avoiding hold up and high prices, respectively) from the bundling assessment, the more efficient the subsequent bundle/s of project-specific activities. And should there be one or more DCOM bundles of project-specific activities (one or more of which may form the basis of a PPP), the more likely that government will derive superior VfM from this bundling outcome than bundling (and selecting PPPs) using current theory and practice.

Expressions of Interests (EoI) were identified as a reliable dependent variable (DV) to test the hypothesis, as it is non-tautological in nature and can reflect simultaneously both pre- and post-contract market failure [15]. EoI indicate the level of market interest in the project. EoI in the range of 5 to 8 (inclusive) refers to an optimum range and indicator of the efficacy of the procurement decision [29]. This implies that a procurement strategy that yields four or less EoI, or nine or more EoI, is a strong indicator of sub-optimality in terms of VfM. The model's specific hypothesis is as follows:

Actual competition is expected to be within the optimum range of competition, i.e., five to around eight EoI inclusive, including cases where actual procurement substantially matches the theoretical procurement (PPP or non-PPP) informed by the model. Actual competition is expected to be outside the optimum range of competition, i.e., four or less EoI, or nine or more EoI, in cases where actual procurement and the theoretical procurement (PPP or non-PPP) informed by the model substantially mismatches.

4. Research Design

4.1. Case Study Selection

A multiple case study approach was selected in pursuance of analytical generalization comprising literal and theoretical replication [19]. Literal replication refers to the selection of cases with similar predicted results. Theoretical replication produces contrasting results based on reasons or conditions anticipated from theory. Theoretical replication suggests two types of case studies, i.e., optimal EoI (five to eight inclusive), and suboptimal EoI (outside 5–8 EoI). Literal replication requires the optimal and sub-optimal cases to be repeated. Therefore, two optimal and two sub-optimal cases are required. The Australian public road and health sectors form the source of case studies. In the optimal category, a Road Case 1 (R1) with eight EoI and Health Case 3 (H3) with five EoI were chosen randomly. In the sub-optimal category, projects at the extreme ends of the EoI levels were selected. Health Case 4 (H4) with 15 EoI and Road Case 2 (R2) with two EoI were selected randomly. The case studies are summarized in Table 2.

Table 2. Summary of Selected Cases.

Case Study	R1	R2	H3	H4
Sector	Road	Road	Health	Health
EoI	Optimal EoI (8 EoI)	Sub-optimal (2 EoI)	Optimal (5 EoI)	Sub-optimal (15 EoI)
Capital value	\$50–100 million	\$250–500 million	\$250–500 million	\$250–500 million
Commencement	2009–2010	2004–2005	2006–2007	2007–2008
Actual procurement mode	Traditional Construct only	Alliance	Public–Private Partnership	Managing Contractor
Actual payment terms	Fixed-price lump sum	Guaranteed construction sum with pain-share/gain-share	Fixed monthly payment to year 2035	Target outturn cost with pain-share/gain-share

4.2. Design of Procurement Questionnaire

Unstructured interviews were held with staff from a transport and health state government agency. The aim was to explore the extent of vertical integration within the government by estimating the activity levels in relation to DCOM activities. The discussions contributed to the articulation of the activity levels of the differential capabilities of government and market in road and health procurement. The discussions clarified the boundaries for DCOM activities, which refer to the physical matters that can be adjusted or operated in a controlled way, but not by the core users, e.g., road-users or doctors. For the road sector, services such as emergency response services were not included. For hospitals, clinical and administrative services, e.g., payroll, were not included. Further semi-structured interviews were conducted to test the face validity of make-or-buy questions in the initial procurement questionnaire. Subsequently, the second and third versions were piloted in nine interviews totaling 48 h. The final version was prepared incorporating comments from the piloting of the questionnaire. As the model is designed based on mature PPP markets, it is necessary to make adjustments or adaptations to the model in low-income countries where thin PPP markets are more common.

5. Procurement Questionnaire

5.1. Structure

The first section of the procurement questionnaire provides an overview of the project, and the second section explained the steps of the procurement model and the eight levels of internalization and externalization. Lastly, the standard questions of the RBT and TCE variables were given. Two questions were designed for each variable, except for frequency and value. A seven-point semantic differential scale was used to capture the responses.

By answering the RBT and TCE questions for each activity, an empirical pattern was generated, which is then matched with the theoretical pattern of best fit in the framework. The corresponding activity level reflects the competence and capabilities surrounding the government and the market during the time that the procurement decision was being made.

5.2. Questions

The questions for the RBT variables capture ex-ante competitive advantage and are used to assess the potential for market failure pre-contract. The RBT variables are Value (Capacity); Rarity; and Non-Imitability (Costly-to-imitate):

- **Value:** As a result of feedback from the interviews and mindful of the non-profit nature of public sector works, capacity was developed as a proxy of the public sector organization's valuable resources and refers to the capacity of government to deliver the activity at the time of procurement decision. Capacity is defined in terms of the number of staff employed by the government. The question reflects the constraints on the existing number of full-time staff (in terms of budget and/or numbers), ranging from "beyond capacity" to "within capacity", thus: "In terms of staff employed by state department (including within a sub-agency) to work full-time on the activity in the case study, how much would this have been resisted by capacity constraints (would have exceeded relevant staff salary scales/budget and/or overstretched supervisory staff)?"
- **Rarity:** Barney [25] dimensionalizes the rarity of the resource within an activity in terms of the average level of the resource possessed by competing market firms. Rarity is defined in terms of the extent or number of market firms that possess the resources required, ranging from "possessed by all firms" to "possessed by few firms", thus: "How much was the knowledge and skills required in this activity in the case study possessed by all top-tier specialist local firms capable of delivering the activity?". Rarity is also captured by the level of supply of competing market firms capable of supplying the activity, from "plentiful supply of firms" to "scarce supply of firms", thus: "How much was there a sufficient supply of firms capable of delivering the activity to the case study?"
- **Costly-to-imitate:** Several empirical studies have employed a variety of tangible proxies to measure the non-imitability of tacit skills and knowledge. The results of empirical testing in manufacturing firms indicate that codifiability and teachability are the most significant factors for affecting speed of transfer (or imitability) of capability or knowledge and skills [30]. Codifiability reflects the extent to which knowledge can be articulated in documents and manuals, while teachability relates to the ease with which knowledge can be communicated and learnt by new employees (or in new projects or customization). The questions are designed to determine the level of difficulty of writing and delivering the activity according to the performance brief or manual, and to determine the level of difficulty involved in all top-tier specialist local firms to develop the same knowledge and skills required to deliver the activity. Thus: "How difficult would it have been for a performance brief or manual to be written (that reflects knowledge, policies, and procedures) for this activity in the case study and followed in order to deliver the activity in the case study?", and "How difficult would it have been for all top-tier specialist local firms capable of delivering the activity to develop the same knowledge and skills required to deliver the activity in the case study?" The responses are measured from "extremely straightforward" to "extremely difficult".

The following TCE questions capture the potential for ex-post hold up and are used to assess the potential for market failure post-contract. The TCE variables comprise: Asset Specificity; Uncertainty; and Frequency:

- **Asset specificity** is the most important variable in assessing the potential for hold up. Asset Specificity refers to the extent to which an investment is transaction-specific and cannot be redeployed easily for alternative purposes. The semi-structured interviews revealed that Human Resource Asset specificity and Temporal Asset Specificity were

the most important type of asset specificity creating potential hold up. Human Resource Asset Specificity relates to the time and effort needed to reach full performance or level of customization required by a supplier or firm [31]. Anecdotal evidence from the interviews also revealed that the establishment of tacit knowledge and expertise in the construction industry developed in carrying out the activities requires a significant amount of time and investment. Poppo and Zenger [31] measure Human Asset Specificity in terms of the level of skill assets required to perform the activity, including the level of customization in terms of a set of procedures or functions. Hence, the question is designed to measure the level of investment and/or time needed to acquire new knowledge and/or adapt existing knowledge to deliver the activity, from “minimum investment and/or adaption time” to “substantial investment and/or adaption time”, thus: “How much investment and/or time would be needed to acquire new knowledge (including software/hardware) and/or adapt existing knowledge (including software/hardware) to deliver the activity in the case study; that is, beyond knowledge already possessed by a top-tier specialist local firm with capability to deliver the activity?”;

- Temporal Asset Specificity is associated with the difficulty or cost of replacing the supplier or firm during a project [32]. Given the importance of timing and coordination in the delivery of projects, the delivery of an activity can significantly impact the progress of the project and budget, especially those activities on the program’s critical path, and potentially hold up government due to the cost of switching firms [33]. Although the skills and knowledge required to carry out an activity might be sourced fairly easily in the construction market, it is the difficulty of sourcing an alternative supplier at short notice that creates the potential for hold up. Poppo and Zenger [31] measure Temporal Asset Specificity in terms of how costly it is, in terms of time and resources, to switch suppliers or firms. Therefore, the Temporal Asset Specificity question measures the extent of impact on project timeline and/or budget when government decides to externalize the activity and then decide to replace the firm providing the activity. This is measured from “minimal impact” to “substantial impact”, thus: “At any stage in the delivery of the activity in the case study project, how much negative impact (in terms of effect on the project’s timeline and/or budget) would have been experienced by the state department, if the state department had decided to externalize the activity and replace the firm providing the activity to the case study?”;
- Uncertainty: A high level of Asset Specificity only becomes troublesome when the transaction experiences a disturbance or change in the works. Events driving a disturbance/change that is outside the control of the contractual parties are exogenous. Exogenous events to which probabilities of occurrence cannot be established represent sources of uncertainty, e.g., force majeure. Contrastingly, when the probabilities of occurrence can be established, exogenous events represent sources of risk, e.g., the involvement of third parties in the processing of permits and approvals. Williamson [34] refers to both kinds of events, which are beyond the contractual parties’ control as “primary uncertainty”. Events within the parties’ control can be categorized as endogenous risks. Williamson uses “secondary uncertainty” to reflect a lack of knowledge about project participants and their performance as a source of contractual disturbance [35]. However, Williamson was not explicit about the link between endogenous and exogenous risk. For instance, design including geotechnical information concerning ground conditions can be categorized as endogenous risk. If this design lacks veracity in terms of ground conditions and leads to the involvement of third parties ex-post (because of unexpected requirements for approvals and/or utilities diversion that could have been resolved with more information ex-ante), then this endogenous risk has led to an exogenous disturbance.
- However, at the extremes (and based on the neo-classical assumptions of TCE concerning ex-ante firm and market homogeneity), the situation in TCE is clearer. At one extreme, those events that begin as endogenous risks from the buyer’s perspective can

be efficiently transferred to the supplier (via a fixed price) such that these risks remain endogenous and within the control of the contractual parties. At the other extreme, those events deemed as sources of exogenous uncertainty would be inefficient for the buyer to transfer these risks (via a fixed price) to the supplier. As the probability of exogenous uncertainty occurring is indeterminate, TCE appeals to the production cost logic as part of its wider prescriptions of the firm seeking to minimize the aggregate of production and transaction costs. Given the likelihood of high production costs, TCE considers the buyer should accept the responsibility for these events via a contingency or provisional sum in a contract.

- Between the extremes regarding exogenous risks, TCE concern is on the potential negative effects of hold up by the market, as a result of the firm transferring these risks via a fixed price contract. Instead, TCE prescribes addressing potential hold up either by internalization or through risk-sharing (contingent on the frequency level). When a particular transaction exhibits a high frequency, then the firm can efficiently avoid the potential negative effects of hold up via internalization. Conversely, the likelihood of hold up of a low frequency transaction can be efficiently addressed by sharing risk via a relational exchange.
- This situation concerning exogenous risks reveals a further weakness in TCE, whose micro-analytics focus on exogenous risk at the activity level and, consequently, ignores alternative approaches to addressing exogenous risks and potential hold up at the project level. For instance, a government agency with a restricted jurisdiction over a limited portfolio of government business is practically not able to control demand arising from sociopolitical support or opposition to the new infrastructure. This lack of control can be driven by macroeconomic changes that can be driven by a policy change associated with a change in government that, in turn, can be led by a change in sentiment amongst the voting public and mindful of the full gamut of factors that affect how people vote. Whilst the government agency cannot control demand for the new infrastructure, it can at least estimate demand in the near term (e.g., up to the next election) by developing probabilities associated with alternative demand scenarios. The normative guidance from TCE would be for the buyer (e.g., a government department) to share the risk of disturbances to the project arising from changes in demand (assuming the market enjoys a superior frequency in delivering the activities in the project and, therefore, internalization is inferior to risk-sharing). However, the Real Options literature considers that externalization via a fixed price need not be discounted so quickly, as government could seek to transfer, via an insurance premium, the negative effects on production costs arising from an exogenous risk. This premium paid *ex-ante*/upfront would give options to the government to make decisions in the face of the realized exogenous risk without incurring any hold up costs.
- The Uncertainty questions are designed to measure how much the activity is subject to endogenous and exogenous risks (at the activity level). The questions also capture how the activity is within the control of the parties to the contract, including how much the predictability of the tasks in the activity might be affected by third parties and other exogenous risks. Consistent with TCE, the focus of these questions is not on exogenous risks at the project level, e.g., demand and other macroeconomic factors. The government in this research has chosen to accept these demands and other macroeconomic risks associated with the case studies. However, the questions do implicitly address exogenous sources of uncertainty. This implicit treatment is appropriate, as exogenous uncertainty is not the focus in TCE, which appeals to production cost logic. The buyer accepts the negative effects of this uncertainty *ex-ante* to avoid high prices that outweigh the negative effects of any potential hold up. The first question measures the predictability of each activity, from “extremely straightforward” to “extremely difficult”, thus: “How much were the tasks (types and amount of time) in the activity required in the case study straightforward to predict by

someone with expertise in the activity in major projects?” To corroborate the response to this question, the second question measures unpredictability of each activity, from “extremely low” at 1, to “extremely high” at 7, thus: “How much were the tasks (types and amount of time) in the activity required in the case study likely to be subject to changes caused by unknown factors relating to changes in physical conditions and/or changes because of the state department during the period allowed for the activity in the case study?”:

- Frequency: TCE envisages the frequency dimension in terms of two elements; that is, the extent of a portfolio of “large” and “recurrent” transactions [34], such that higher frequency justifies the costs of internalization. Frequency is deployed in a classical production cost way to capture the division of labor, which is limited by the extent of the market [36]. Future demand or work is needed to justify benefits from investments in learning economies and/or technology to achieve economies of scale. This means that frequency is measured on the focal firm’s side (state government). It is measured in terms of whether these are large and recurrent activities (using the same resources as the focal activity). ‘Large’ is defined as a relative measure of the size of the activity, i.e., greater than the majority of all new similar kinds of activity demanded in the market, or where the buyer represents the substantial demand for the activity, then the buyer’s requirements can be used as the population of the activity. ‘Recurrent’ is defined as how often the activity occurs, i.e., how typical the activity is vis-à-vis the occurrence of other size categories. TCE deems the transaction to frequently occur when it is both large and recurrent.
- The period of time over which the size-related values for the activity are counted corresponds to TCE’s focus on endogenous risk and exogenous risk, i.e., the period which at least estimates can be developed of the frequency of the activity associated with the most likely demand scenarios. The focal period of time for the activity is taken from the commencement of the current government with jurisdiction over delivering the project (that generates the activity) to the next scheduled election. Finally, where the number of values for difficult size categories of the activity cannot be reliably estimated, then the size of the project and its level of occurrence can be used as a proxy for determining the frequency for the activity—on the basis that the size of the activity varies approximately in proportion to the size of the project.
- As such, this question measures frequency at the level of the project: “In the state electoral period surrounding the case study (from commencement of state government term to end of term incorporating the case study procurement decision date), how did the case study compare with the state department’s most frequently occurring or typical new project in terms of capital value and what is the capital value size category of the case study? 1= Case study is not typical and small (\$1–10 million); 2 = Case study is not typical and moderately-sized (\$10–100 million); 3 = Case study is not typical and large (\$100–250 million); 4 = Case study is not typical and an extremely large (>\$250 million); 5 = Case study is typical, and a small to moderately sized project (\$1–100 million); 6 = Case study is typical, and a large project (\$100–250 million); 7 = Case study is typical, and an extremely large project (>\$250 million).”

5.3. Data Collection

Structured interviews were carried out with the project manager of each case study in a total of 110 h. The main contributions from the interviewees were as follows: 1. input into the identification of activities; 2. the partitioning of project-specific and network activities; and 3. answering the measurement questions of the TCE and RBT variables including advice on the supply or competitiveness of the market surrounding each activity. Site plans, construction drawings, contract documents, and programs of work were sourced from the government database and archives. The number of contractors who expressed interest or submitted tenders during the EOI or open tender stages were requested. Refer to the Supplementary Materials for the detailed analysis of each procedure for each case study.

6. Hypothesis Testing

6.1. Road Case 1

The procurement of R1 was based on the traditional approach, with separate fixed-price lump-sum contracts for D and C, whilst O and M were internalized as part of the existing network of activities. The results from make-or-buy analysis indicate that the skills and knowledge for the activities in R1 are readily available in the market. The market is found to be more efficient than the government. No Level 5 and 8 activities were identified, and O and M were identified as network activities. The actual approach is consistent with the model's theoretical approach, except for the bundling of D and C activities. Given the small size of R1, the bundling of D and C will have generated similar levels of competition. Following the specific hypothesis, the actual competition of eight EoI is within the optimal 5–8 EoI inclusive. Therefore, the outcome supports the hypothesis that R1 has been efficiently procured.

6.2. Road Case 2

The design and construction of the tunnels were assessed as Level 8 and 5, respectively. O and M as network activities. The remaining D and C activities were evaluated as Level 6 and 7, and combining into a single bundle would result in Level 8. The model recommends separating D and C into two separate bundles. The D and C of R2 was procured using a single Alliance contract. The model's approach would likely be more efficient than the actual approach because the majority of R2 consisted of comparatively uncomplicated roads and elevated structures (therefore, not a source of exogenous risk), which would be suitable for Tier 2 or 3 civil engineering construction companies. This would have generated more competition as there were more smaller firms than Tier 1 contractors. Bundling all the project-specific activities into a single contract and considering them all as sources of exogenous risk is considered inefficient. The unbundled approach is expected to increase the EoI from 2 to the optimal range of 5–8, therefore supporting the specific hypothesis. This level of bundling is substantially different to the theoretical approach of four separate contracts to the project. Based on the specific hypothesis and given the mismatch in procurement, the actual competition (two EoI) is outside the optimal EoI range as expected.

6.3. Health Case 3

All DCOM activities were assessed as project-specific. Except for the design of helicopter landing (Level 8) and detailed performance specification of O and M (Level 5), the remaining DCOM were assessed as Level 6 and 7. The model proposes to bundle all levels to be market sounded for private finance if did not result in a thin market. Given that the entire H3 was delivered as a PPP across all DCOM activities, this represents a match with the model's theoretical approach of one DCOM bundle as a PPP contract. As expected, the actual competition of five EoI falls within the optimal 5–8 EoI. Therefore, the outcome supports the specific hypothesis that H3 has been efficiently procured.

6.4. Health Case 4

The D and C activities of H4 were procured separately using Managing Contractor. The O and M activities were externalized, except for reactive non-specialist M activities which were carried out by full-time on-site staff. Similar to H3, the bundling analysis led to one DCOM bundle in either a PPP or government-financed contract. The actual procurement is a substantial mismatch to the model's theoretical approach. As expected, the actual competition of 15 EoI falls outside the optimal range. The model's suggestion to bundle DCOM activities is likely to reduce EoI to the optimal range of 5–8. Therefore, this indicates that the model's recommendations are supported.

In summary, all the case studies support the specific hypothesis and model's recommendation (Table 3).

Table 3. Summary of Hypothesis Testing.

Case	Theoretical Procurement	Actual Procurement	Procurement (Match or Mismatch)	Optimum Competition	Actual Competition	Competition (Match or Mismatch)	Hypothesis
R1	Design and construct	Separate design and build contract	Matching	Optimal	Optimal (8 EoI)	Match	Supported
R2	Two design and two construction contracts	Alliance	Mismatch	Potential 5–8 EoI (based on model’s procurement)	Sub-optimal (Low—2 EoI)	Mismatch	Supported
H3	PPP	PPP	Match	Optimal	Optimal (5 EoI)	Match	Supported
H4	PPP	Managing Contracting	Mismatch	Potential 5–8 EoI (based on model’s procurement)	Sub-optimal (High—15 EoI)	Mismatch	Supported

The outcomes provided strong support for the model’s ability to avoid market failure ex-post, and to generate an optimal EoI, e.g., R2 and H4. It represents the model’s predictive strength in deriving a procurement approach in pursuance of VfM in whole life terms. Amongst the 87 major road and health projects surveyed, 57% were in the sub-optimal EoI range. By following the recommended procurement in these sub-optimal projects, it is expected that significant improvements will be seen in VfM in contrast to their actual procurement approach.

7. Discussion

Given the paper’s emphasis on assessing project suitability for PPP, the model culminates at the bundling phase. This step determines the presence of any remaining O and M activities, which are essential to justify a PPP. Consequently, it is unnecessary to extend beyond the bundling phase to ascertain the viability of a PPP bundle within the project. This is unlike the Austroads and OECD reports that go into the exchange relationship analysis (which ranges from competitive to collaborative contracting).

The application of the model is expected to result in different approaches and innovations in procurement, including the size and bundling of PPP projects. For instance, the model may provide recommendations for greater rationalization of procurement across various sectors. For example, it might lead to more opportunities to bundle DCOM in health projects and consider more of these projects as PPPs. On the other hand, roads have comparatively straightforward O and M requirements, and procuring road maintenance on a network basis can result in relative efficiency gains. The model is likely to promote the use of PPPs in roads that are very large and complex, and with a much higher percentage of total cost represented by O and M costs than in routine roads and bridges. The market is afforded advantages by virtue of its specialized knowledge of these complex structures and design innovations capability to reduce whole life costs. An exception might be for the PPP company to take on the demand risk and any inefficiency risks resulting from the delivery and operations of a relatively straightforward road.

Enhancing the rationalization of procurement across sectors may reduce dependence on typical or traditional procurement methods, which often incentivize minimizing capital costs and/or construction time. The model is also expected to enhance greater finesse in the use of Alliancing, ensuring it is applied only to the project components where it can be the most efficient. The model is likely to guide these changes through improvements derived from allowing more time for planning and design development, and the development of full performance specifications to ensure that market contestability can be achieved. The model will also save time and costs to both government and industry by identifying the most suitable bundle to be procured using a PPP approach.

8. Conclusions

This paper serves as a crucial component, completing a trilogy of works alongside Austroads and OECD publications. It acts as the essential missing piece that allows for a more comprehensive understanding of the reports from Austroads and OECD. Moreover, it offers significant theoretical contributions and presents greater validity and reliability compared to the aforementioned reports, and additionally extends the scope to the health sector. The theoretical procurement of the model is tested using four case studies. Hence, the paper is a robust empirical test to establish validity of the procedures in the theoretical model, thereby contributing to theory. A key contribution to theory is the development of the procurement questionnaire that operationalizes the microeconomic theories into measurable constructs in the context of road and health infrastructure projects.

Contrary to current existing practices, the model does not propose a PPP procurement before completing a comprehensive risk and bundling analysis. It does not evaluate risks during the project's early development stage. Instead, the emphasis is on assessing the resources held by the government versus the private sector for each project-specific activity to determine which party is more suited to manage the associated risks. Furthermore, procurement selection in existing practice is typically applied to the whole bundle of project activities, e.g., Australia's Procurement Options Analysis (POA). Different types of risks, including those that the market cannot effectively manage, are bundled into a single contract. This can lead to unduly large bundles of project activities/contracts which attempt to transfer an excessive number of risks. Hence, the POA has essentially embedded market failure into the procurement strategy both pre- and post-contract.

Relying on microeconomics principles, the model remains neutral and is not pre-disposed towards any procurement method, ensuring objectivity in the decision-making process. The model produces a document that can be fully disclosed to the public due to its qualitative (non-monetized) nature and fosters greater accountability and transparency. The questions are developed to obtain known information concerning the market and project objectively and reliably. The model can serve as a supplement to the Public Sector Comparator (PSC) in projects where parts of the PSC are not disclosed due to concerns of confidential commercial information, or completely replace the PSC as the published justification for a PPP. An effective application of the model is likely to yield benefits that extend beyond microeconomic gains (related to the efficient delivery of individual projects). With the prospect of the most acute fiscally constrained environment, post-COVID-19, the application of the model is compelling to ensure that the best VfM is achieved for every new infrastructure project.

9. Limitations and Further Research

The model draws on the full body of contract theory (and RBT) to inform how to procure efficiently. (Contract theory is a specialized area within microeconomics, which focuses on how economic actors construct and develop contractual arrangements [37]. However, the body of theory does not fully acknowledge how procurement design choices are reflected in pre-contract market failures (yielding high bid prices). The key issue relates to the uncertainty (endogenous and exogenous) about the value that bidders are supposed to price (also known as "common value" in auction theory). The bundling of project phases imposes increased requirements on the bidders to gather information, and thereby increases uncertainty. In a PPP, the information requirements increase further to include O and M. The nature of uncertainty in either DC or DCOM context is not only limited to information that could be gathered, but also information about risk. The complexity of the structure to be designed or the temporal distance of activities in a long-term contract may also yield Knightian uncertainty (unknown unknowns).

A rigorous application of the model will enable the improvement of existing approaches, where governments procure full project scopes as PPP without detailed activity analysis. It remains to be seen whether bundling only "the right" activities offsets losses

due to inefficient risk pricing. Further research can be carried out to improve and extend the application of the model to other kinds of infrastructure.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/buildings14072203/s1>, Figure S1. Summary of Activity and network analysis in R1; Figure S2. Summary of Activity and network analysis in R2; Figure S3. Summary of Activity and network analysis in H3; Figure S4. Summary of Activity and network analysis in H4; Table S1. Make-or-Buy Analysis.

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