Cost and Time Overruns in Western Australian Government Projects: Procurement Decision-Making Antecedents

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ABSTRACT Cost and time overruns in public-sector construction projects are a noteworthy issue in Western Australia, often stemming from pre-contract client decisions' antecedents compounded by a lack of guidance for (lay) stakeholders. This research develops models to assist stakeholders towards identifying/selecting a procurement method that allocates risk appropriately, alongside objective guidance for suitable prequalification criteria. A qualitative research methodology using two developed sets of semi-structured interviews targeted a sample of 21 respected WA industry-practitioners. Response transcripts revealed common themes; findings then informed models for selecting a procurement method that most appropriately allocates risks, leading to the development of additional models to structure prequalification processes in construct-only procurement, by aligning prequalification criteria with respective project circumstances. The developed guidance flowchart models have been validated and enhanced through follow-up validatory industrial appraisal. This research provides a contribution to the existing body of knowledge related to procurement methods, contractor selection, and optimisation of pre-contract decisions for use by inexperienced stakeholders, towards the mitigation of cost/time overruns in public sector jobs.

KEYWORDS: Construction; time/cost-overruns; procurement; decision-making
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INTRODUCTION

Cost and time overruns have long been an issue in Western Australian (WA) public capital works projects, as well as throughout Australia (Whyte, 2015). Historical studies identify an accumulation of creep increase in both cost and time, where findings of cost overruns of upwards of 20% on transport infrastructure projects are oft argued and debated (Flyvbjerg *et al.*, 2003; Caffieri *et al.*, 2018; Liu *et al*, 2016). As a result of such budget and duration issues, WA Government agencies have often faced criticism from the media and general public (Whyte, 2015). WA Public-Sector Commissions identify procurement planning as a significant cause of blowout (Murphy, 2012).

This paper identifies two key decisions administered by public sector clients within the procurement process namely: the selection of an appropriate procurement method; and, the identification of prequalification criteria to aid contractor selection. Identifying a procurement method that is fit-for-project is integral to achieving key project objectives (Hampton *et al.*, 2012), as it sets out the allocation of risks between parties. Western Australian infrastructure providers historically seemed to choose a familiar delivery method, primarily to avoid uncertainty, without apparent consideration of other, potentially more appropriate methods (Caffieri *et al.*, 2018). Procurement links explicitly to another factor of success of a project, that of selection of a contractor capable of managing the risk extending from a tendering method. Prequalification, if structured appropriately for specific project settings, is argued as able to maximise the chance of receiving the best possible tenders for the job, however this process is often perceived as somewhat ad hoc and fragmented.

Once parties are contractually bound, cost-control measures align development viability estimations, with capital-cost expenditures through asset cradle-to-cradle life-cycle cost analyses of operation and maintenance across net-present values and time-values. This work sees pre-contract decisions as key.

This research pre-empts contractual relations and addresses explicitly the two critical decisions (of procurement method and, prequalification selection criteria) by developing frameworks to aid review processes, for inexperienced client/stakeholders lacking familiarity and knowledge with procurement. A qualitative, semi-structured interview research method across 21 industry experts (civil engineers and tender process managers with direct experience in contractor selection, and government personnel involved with procurement policies) provided a basis for the guidance frameworks developed here.

PUBLIC SECTOR CAPITAL WORKS

Cost and Time Overruns

Table 1 describes a random sample of oft-referenced literature publications (termed a-k), alongside respective key variables (enumerated as 1-14) argued to impact cost and time negatively. Columns highlight (identify) variables effecting project cost and duration, such as clients' tendering processes, contractors' tendering processes, risk allocation, and procurement method, albeit the papers present limited measurable causation. Current literature has no universal consensus of a main cause of cost & time blowout, with no single dominant variable identified.

Table 1. Variables (1-14) linked to cost & time overruns in a sample of papers (a-k)

	Variables													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sample Publication Review	Contractors Tendering	Risk Allocation	Clients Tendering	Strategic Misrepresentation	Poor Results Review	Poor Estimation	Management	Procurement Method	Time/ Budget Constraints	Rework Onsite	Implementation Phase	Size of Project	Optimism Bias	Design Scope Change
(a)	X	X	X											
(b)		X			X				X					X
(c)			X											
(d)			X	X			X						X	X
(e)			X			X	X	X						
(f)											X	X		
(g)				X			X	X	X	X				
(h)						X				X				
(i)		X	X			X	X							X
(j)				X	X									
(k)				X			X						X	

This work extends and enhances current literature variables (above) via a localised reflection of structured pre-contract decisions and respective effects on a project's on-site resultant cost and time.

Procurement Method Selection

Western Australian public sector delivery agencies had historically been categorised as uninformed due to a perceived propensity to select familiar, commonly used procurement methods (Love *et al.*, 2008). More recently, alternative procurement methods such as Public-private partnerships (PPPs) and Managing Contracting options have been adopted to varying degrees of success; there remains however, need for a more structured framework toward selection of an appropriate procurement approach that sets out the allocation of risk in a way that is more relevant to the project and the respective client (Liu *et al.*, 2016).

The range of procurement routes available in Western Australia, described by the local Centre for Excellence and Innovation in Infrastructure Delivery (CEIID, 2010), allows recognition of a broad spectrum of alternatives, namely: Traditional Construct Only, Design and Construct, Construction Management, Management Contracting, Early Contractor Involvement, Alliance, and an array of PPPs variants.

It is worth recalling that procurement methods set the overarching contractual obligations of parties in a construction contract, and with that, allocate the risk aligned with such obligations. By way of example, some PPPs will allocate the responsibility of project finance, design, construction and maintenance and operation of the completed asset to a private sector contractor; whereas a construct only method will require the contractor to only construct the asset. This allocation of risk plays a significant role in project outcomes (Urquhart & Whyte, 2018) and so the selection of a procurement method that allocates risk appropriately is essential to achieving positive project outcomes. Traditional risk allocation theory argues that risk be allocated to the party that is best able to manage the risk (Uher & Davenport, 2009). Excess loading of risk to a contractor may ultimately, some argue, result in a client paying more via contingencies' claims; however, clients who retain risk, but who are unequipped to manage unrealised risks, will often also face cost overruns (Xiao *et al.*, 2012). Alternatively, clients can choose a collaborative and cooperative approach to risk allocation through methods such as alliances, in order to manage risks that cannot be foreseen or quantified ahead of time. For some, this can lead to a faster and more cost-efficient resolution of actualised risks when used effectively (Awad *et al.*, 2013; Abdullah *et al.*, 2021).

There have been a number of methods put forward by industry and academia (Urquhart & Whyte, 2020; Hatush & Skitmore 1997) to guide the process of selecting a procurement method, however, these are often unwieldy for inexperienced clients as they require a pre-existing knowledge of the procurement methods available and thence a somewhat qualified review. It is argued therefore that there is a misalignment between selection methods, and the factors that affect procurement decision. This research seeks to fill this gap in knowledge by creating a tool that less-experienced clients can use to select an appropriate procurement method that will allocate risk appropriately, in a way that is specific to the local Western Australian market.

Contractor Prequalification and Selection

Numerical studies analysing prequalification criteria from a numerical perspective (detailed throughout the section below) are somewhat inflexible in that they seek to rank the criteria into static hierarchies that seldom change to suit differing environments. This study echoes work arguing that emphasis be placed upon an acknowledgement of varying project conditions (Urquhart & Whyte, 2018), and builds on the following studies.

A study conducted by Hatush & Skitmore (1997) collated, expected bid price influence of 20 specific contractor aspects with 90% confidence intervals across interviewee responses. The values were obtained via a Delphi study conducted with a sample of eight experienced construction personnel. Key influencers argued that experience and financial stability is generally of importance, with length of time in business and safety of lesser importance.

Similarly, Rao & Kumar (2016) ordered the relative importance of 15 prequalification criteria, condensed using a fuzzy set based numerical model to achieve the overall score of each criterion, also revealing an emphasis on experience and financial stability. Following the same theme, Eadie *et al.* (2012) conducted a study regarding the relative importance of six prequalification criteria obtained using Relative Importance Index (RII) formulae. Forty-one industry practitioners were queried using a prequalification questionnaire. Once again, across the six variables, experience and financial stability are observed to have a high relative importance. Of note, historical findings show 'environmental aspects' sustainability as least important (Eadie *et al.*, 2012), if mentioned at all, as a consideration in selection criteria rankings.

It is recognised that, while certain prequalification criteria have been identified and discussed, nominal recommendations are made across literature for variable project conditions' factors.

METHODOLOGY

Semi-structured interviews occurred in two sets, providing reducible data: in the first instance, current methods of procurement model selection; and in the second instance, formulating criteria for contractor prequalification. These two processes sought optimised mitigation of cost overruns in public works projects. Interviews were recorded, then transcribed verbatim. Two expert-groupings were chosen for the two sets of interviews, to cover respective specific knowledge areas.

In order to inform the semi-structured interviews, two preliminary flow charts were developed based on the findings of the literature review; the first regarding procurement method selection, the second targeting prequalification criteria selection; in other words, literature review identified key factors that would determine an initial decision-making flowchart, with these logic-flow stages then tested for relevancy via semi-structured interviews. The interview questions related directly to areas in the preliminary flow charts, with responses' collation enabling development, modification and validation.

The analysis of data was carried out, under three overarching steps (Creswell, 2014):

- Prepare and organise data for analysis, defining speakers and questions within transcripts;
- Reduce data coding in NVivo 12, then condense themes into primary & secondary nodes;
- Represent information in figures, tables and flowcharts. The analysis then streamlined in accordance with the main aims of this paper, namely developing a tool for navigating procurement decisions.

After analysis of the data and adaption of preliminary logic-flows, the revised flowcharts were then re-sent to selected participants for review and revision. Select participants validated the edited flowcharts to confirm responses were relevant, and the tool arising was accurate.

The validated final flowcharts are presented below as *Recommended developed guidance flowcharts*.

DISCUSSION OF RESULTS

Extending discussion above, in total 21 interviews (11 for procurement method selection, 10 for prequalification criteria) were undertaken with construction practitioners in WA. Participants were chosen based on their expertise and knowledge within the industry, in particular, specialist knowledge relating to the topic of the interview. Interviewees had significant industry experience, with 8 having over 30 years' experience in the industry, as demonstrated by Table 2.

Table 2. Respondent Sample Details

Industry Experience (years)	Selected Expert-Practitioner	
	Procurement Method Expert	Prequalification Expert
0-9	2	1
10-19	2	4
20-29	4	-
30+	3	5
Total	**11**	**10**

Interviewee role was noted to assess if and how this affected responses; respondents identified as: contractors, with both private and public sector clients, project management consultants, and design consultants. This allowed a range of responses that reflected the requirements and desires of multiple parties for an objective overarching perspective.

Table 3. Factors Influencing Procurement Decisions

Decision Factor	Procurement Method Selection	Prequalification Criteria
Project Complexity	X	X
Scale	X	X
Public-sector finance availability	X	
Design risk	X	
Design sensitivity	X	
Client experience	X	
Risk understanding and quantifiability	X	X
Maintenance complexity	X	
Operational complexity	X	
Client construction quality requirements	X	
Asset capacity to create revenue	X	
Desired allocation of asset revenue	X	
Construction complexity	X	X
Number of bidders predicted		X
Completeness of design documentation		X
Contractor availability within market		X
Routineness for client		X
Routineness for potential contractors		X
Project time and budget pressure		X
Public pressure groups' awareness		X
Financial complexity		X
Environmental drivers		X
Environmental/*sustainability* compliancy		X

As shown in Table 3, it is noted that decision factors for procurement method selection and prequalification criteria selection, overlap to some extent, but consider different aspects of varying project conditions. Prequalification decisions focus upon largely on lump-sum procurement. From

this observation, it is argued that different project conditions be considered throughout the multi-stepped phases of contractor selection staging.

Procurement Method Selection

A dominant overarching factor identified throughout the interviews regarding procurement method selection, was the appropriate allocation of risk, namely risk related to design, finance, construction, maintenance, and operation. Participants here perceive that private-sector contractors (particularly large, high-value contractors) in Western Australia are generally more skilled and capable at managing complex risk, when compared to many public sector clients. Respondents here (from all sectors) suggest that a lion's share of risk be placed within a contractors' remit, in lieu of a public sector client.

Whilst participants acknowledged that this would, in most cases, mean greater (upfront) contract-sums, project-costs and increased contractor contingency costs, they also argued that this would ensure less unexpected site-works' blow-outs. Findings show perceived value in utilising relational contracting methods such as alliancing, and early contractor involvement that embrace joint risk allocation, and respective general conditions of contract GCC clauses that share risk, towards faster and more cost- efficient, collaborative dispute resolution. Alliancing approaches are argued as effective for large, complex projects, where risks are not/cannot-be completely understood prior to commencement.

Figure 1 recommends a developed 'Procurement Method Flowchart', able to guide a client in their options' selection, given the range of factors of procurement choices as follows: ***C**onstruct-**O**nly; **C**onstruction-**M**anagement; **D**esign-&-**C**onstruct; **D**esign-**B**uild-&-**M**aintain; **E**arly-**C**ontractor-**I**nvolvement; **M**anaging-**C**ontractin; **A**lliance; **D**esign-**B**uild-**O**perate-**M**aintain; **D**esign-**B**uild-**F**inance-**M**aintain; **B**uild-**O**wn-**O**perate-**T**ransfer*.

Contractor Prequalification

Contractor prequalification remains important and necessary if a project is being tendered out to market, where the works require specific complex competencies, albeit low-value, low-risk works, or extra work packages of existing contracts, need less prequalification. Respondents to this work, find that contractors have a subjective gauge of their own capability, so prequalification is required for objective comparison.

Clients must define projects as standard or non-standard at the outset. According to interviewees, a 'standard' project is one that occurs under normal market conditions with sufficient design documentation and is core business for the client. Attributes for 'non-standard' project situations include 'low contractor availability' and 'a market saturated with contractors', adding difficulty to the prequalification process. Indeed, in-depth consideration of 'occupational health and safety', currently front-of-mind globally, somewhat sits as a 'non-standard' definition for respective contractor selection.

Respondents argued that the complexity of projects be given much structured emphasis and be defined early. This work's developed flowchart hierarchy, places the 'project complexity' cross-road variable, above 'project time/budget' (Figure 2, prequalification flowchart recommendation).

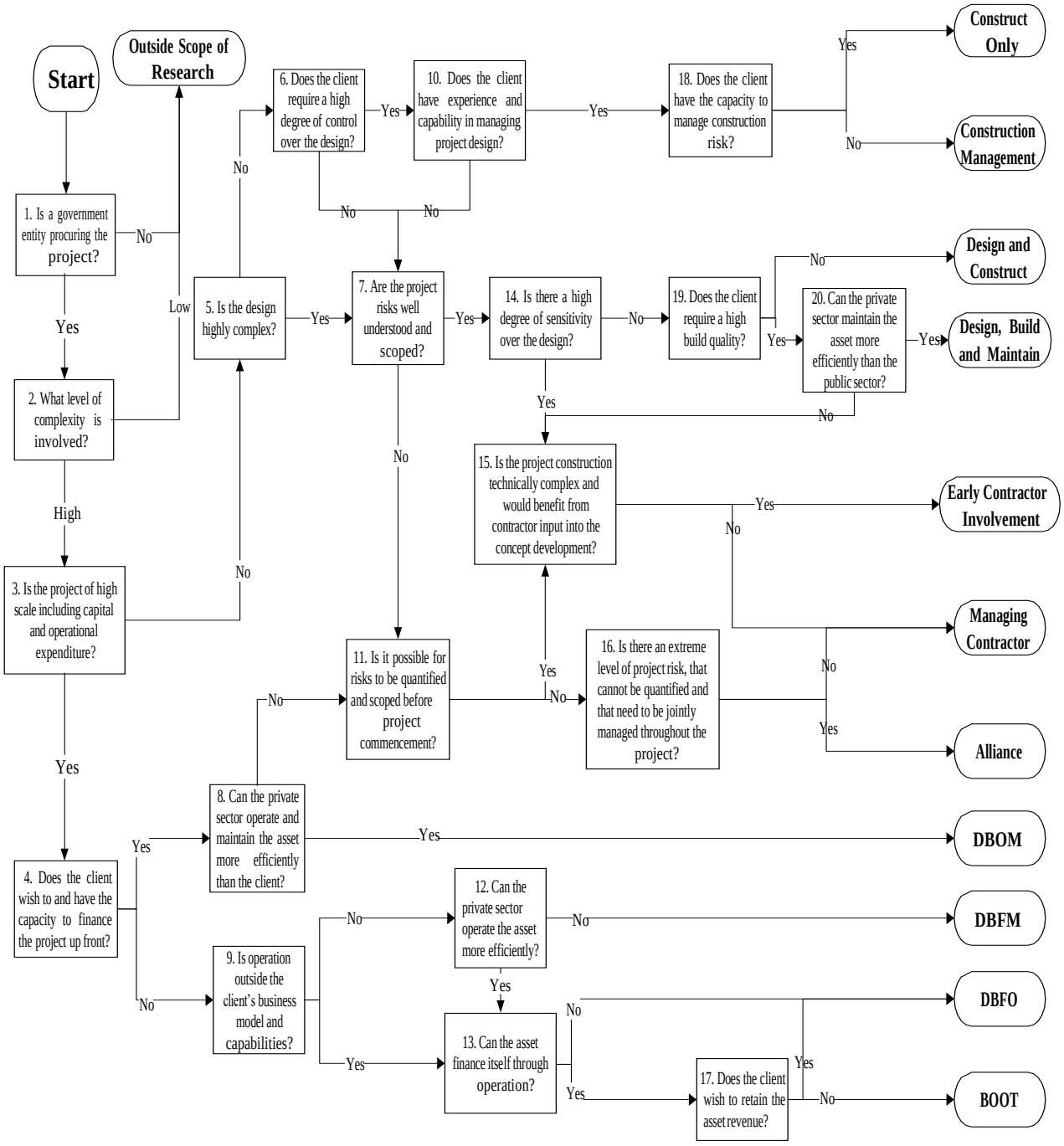

Figure 1. Procurement Method Flowchart

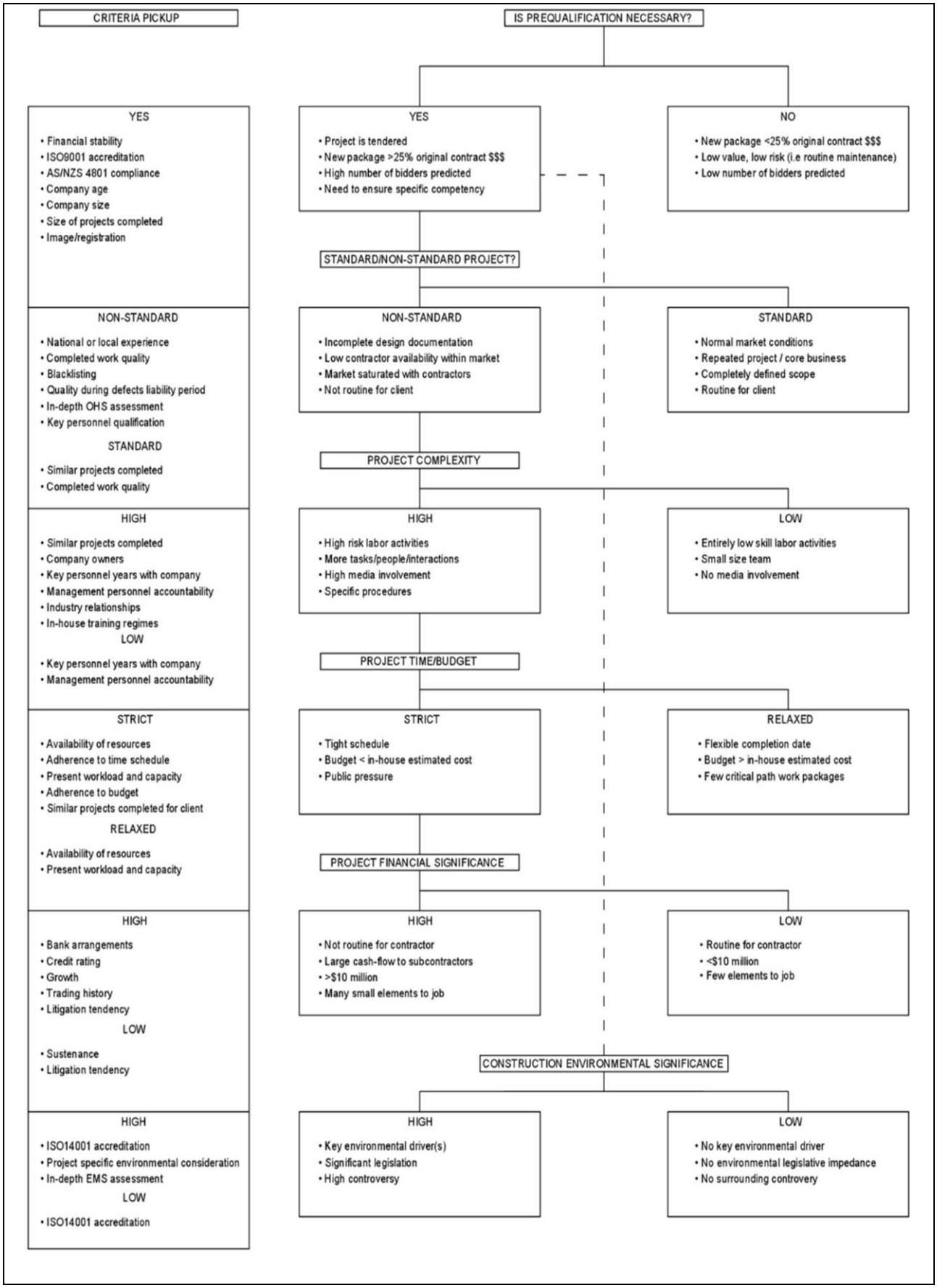

Figure 2. Contractor Prequalification Criteria Flowchart

Thirty-percent of respondents suggest that a financially significant project of $10M can help determine selection. 70% of experts however argue that a more appropriate criteria-variable is the financial assessment of contractors, where cash flow, not the sum of the project is important; relatedly arguing that, if a job is complex with many sub-contractor (cash flow) elements then selection must recognise this. Project Financial significance is noted here as requiring less emphasis in selection criteria.

Environmental/sustainability Risk/OHS is deemed independent of all other project conditions. Specific environmental credentials' consideration of contractors bidding for work can be a key driver, particularly given recent highly publicised Aboriginal heritage damage, latterly across WA. Tenderers increasingly require to provide confidence that they have the ability to manage environmental impact assessments appropriately.

For illustrative purposes, Figure 3 presents default (NVivo 12's) terms' weightings of word frequency query function, showing respondents' key reflections in size ratios of selection criteria

Figure 3. Transcript weighting of Contractor prequalification terms

Figure 2 summarises the data-set towards a developed 'Prequalification Flowchart', able to guide a client in their selection-criteria towards a structured contractor-prequalification process. Such flowchart guidance to less experienced clients is argued to assist selection-criteria towards a structured contractor pre-qualification process. A further body of work is developing similarly styled contractor preselection flowcharts for other project delivery methods; notwithstanding this, Figure 2 is deemed to be of use now by novice client-representatives as a framework for typical internal contractor preselection approaches.

CONCLUSION

Mitigation of financial risk for client and contracting organisations within the public sector, requires more objective and structured tendering guidance. Theories regarding the cause of cost blowout explored in the literature above, find no universal consensus on the causes, albeit factors such as contractor tendering, risk allocation, client tender processes, and procurement method, play a large part - this work notes as key: selection of an appropriate procurement method; and, selection of suitable prequalification criteria.

A qualitative methodology was used to address these two areas of interest through semi-structured interviews with 21 industry representatives from varying fields with a broad range of experience within procurement; interview questionnaires used for data collection were tied directly into a hypothesised framework for two optimised procurement processes, developed from

secondary research. Data was systematically analysed to evolve the resulting guidance frameworks (see Figure 1 and Figure 2 for clarity).

This paper identifies a snapshot for a Western Australian scenario, regarding the allocation of risk through an appropriate procurement model. Small-scale analyses limitations' notwithstanding, sophistication limitations of public utility/delivery agencies responsible for significant capital works (if compared to larger contractors capable of complex project delivery) perceived by the experts consulted here would transfer complex risks to a contractor, rather than to a client's team to manage such unknowns.

Clients responsible for procuring projects with risks that cannot be understood prior to tender, may benefit from relationship contracting such as Alliancing or an Early Contractor Involvement model.

Examination of contractor prequalification factors, allowed development of a flowchart that defines and aligns project conditions and input parameters, with selection criteria (Figure 2). Such definitions include: whether prequalification is necessary for a project; if a job is standard or non-standard; project complexity; financial significance; environmental significance as high or low; and, if the project time/ budget is set or open to scope change. These project conditions are structured within a flowchart (Figure 1), and allocated prequalification assessment criteria (Figure 2).

A primary purpose of this work is to provide structures to mitigate cost blowout arising from the procurement stage of public works; the flowcharts below can act as tools to define a project or understand project conditions better. The structured flowcharts described below are presented as a deliverable-tool to inexperienced (client-rep) engineers to enhance their professional skill-base, across helping choose appropriate procurement models, and assist with prequalification processes within the public sector.

RECOMMENDATION: DEVELOPED GUIDANCE FLOWCHARTS

The following flow-charts (Figure 1 and Figure 2) were developed initially from secondary research, then evolved and validated as a result of quantitative analyses of primary research, aggregated responses of industry experts. The tools below are intended to provide guidance to inexperienced stakeholders faced with the complex challenge of selecting a procurement method and prequalification criteria. They present structured guidance for pre-contract decisions in public works projects. The flowchart frameworks were re-reviewed by industry experts; this feedback allowed iteration and verification and validation of the tools.

The Procurement Method Selection flowchart shown in Figure 1, guides users through 20 'yes or no' questions in order to arrive at a recommended procurement method. To use the Contractor Prequalification Criteria flowchart shown in Figure 2, for construct-only public works projects, the user begins at the top of the page and works their way down through each crossroad, which requires them to define the project progressively. Users refer to the 'Criteria Pickup' column on the right-hand side, and align the corresponding prequalification criteria. Both flowcharts presented here seek to assist less experienced practitioners to make objective, informed, structured choices related to both *Procurement Method Selection* (Figure 1), and *Contractor Prequalification* (Figure 2).

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