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Effective pre-qualification systems – Are they essential for minimising delays on road projects?

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Abstract: The most significant and pivotal advance in each construction project is to choose the right contractor which is normally done by a pre-qualification system. Pre-qualification of contractor is a course of gathering data and evaluation that decides the contractor's capacity as far as considering assets accessible, management processes and execution information. However, the current prequalification system witnesses many limitations such as contractor selection (CS) based on L1 bidder concept which may compromise with time, cost and quality of project; non-usage of a quantified mathematical model or software for selection of most competent contractor might as well compromise the system. The objective of this paper was to highlight the need of strengthening the existing pre-qualification system used in Indian roads and highway projects. To achieve the above stated objective of the research, the project-specific data were collected from 25 different road and highway projects. The analysis of the collected data showed that there was negative impact in terms of time and cost requirements, which was observed in all the projects even if the contractor was selected using the prequalification system. The main reasons identified for the delays and cost overruns were land acquisition issues, suspension of work during monsoon season and maintenance work of bitumen refineries, claims and disputes between contractor and clients, inefficiency of contractors while dealing with scope change, etc.

Keywords: contractor selection, multi-criteria decision-making, prequalification system, time and cost overruns

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1 Introduction

Choosing the finest construction contractor entails a number of difficult decisions for proprietors and consulting firms in the private as well as public sectors. Pre-qualification of contractors entails the owner evaluating candidate contractors based on a predetermined set of standards to ascertain their suitability for the job should they be granted the construction project. The construction industry encounters many difficulties in project execution such as cost acceleration, time delays, low quality of development, and so forth. The contractor's inefficiency is the primary cause of these setbacks not because the firm is incapable but because of unethical practice that may exist in the tendering process. A right system is expected for choosing the competent contractor for a construction project (Alzober and Yaakub 2014). When a legitimate determination process has been finished, the client can then trust the contractor with the project work.

Many government authorities in India such as the National Highway Authority of India (NHAI), Public Works Department (PWD), Zilla Parishad (ZP), Municipal Corporations, etc. follow competitive bidding process for contractor selection (CS) which is mainly divided into two steps: (i) pre-qualification and (ii) bid evaluation. Around the world, the construction industry experiences delays that stop many ventures, and in some cases, it even causes complete surrender; alongside it is time and cost consuming, which accompanies different results like project failure, decrease of net profits and the deficiency of public certainty, especially on government-subsidised projects (Doraisamy et al. 2015; Zailani et al. 2016). Lo T. Y. et al. (2006) in their research highlighted that construction delay factor, 'exceptional low bid,' was recognised as the third most huge reason for delay, which is practiced even today where L1 bidder is awarded the work amongst all the qualified bidders. There are many flaws existing in the current process of CS such as contract award to L1 bidder, non-standardised contracting process, selection of contractor is highly dependent on decision maker's judgement etc. This study emphasises mainly on time and cost overruns on roads and highway projects due to inadequate pre-qualification process, which in turn sheds light on need of revising the existing pre-qualification process in the Indian competitive bidding system.

2 Literature review

To understand the current CS procedures on construction projects at international contexts, a brief literature review has been conducted. Many specialists and scholars have been considered on the task of conducting an in-depth study and investigation for this subject due to the significance of CS in the construction business. It includes the effects of pre-qualification criteria, numerous methods used and problems encountered with CS and evaluation, etc.

The contractor choice is a vital issue in the construction industry since the contractor plays a fundamental part in the achievement or disappointment of undertakings in this area (Araújo et al. 2015; Rashvand et al. 2015). Prequalification is a methodology to analyse and measure the capability and abilities of contractors to effectively finish an undertaking on the off chance that is given to them (Plebankiewicz 2009; Rashvand et al. 2015). The majority of the seriously offered development contracts in most countries utilise this lowest bid strategy where the contract is awarded to the firm presenting the least bid price (Waara and Bröchner 2006; Ioannou and Awwad 2010; Kolekar and Kanade 2014; Puri and Tiwari 2014; Ibadov 2015; El-khalek et al. 2019). These incorporate nonsensical low offers either inadvertently or intentionally create broad setback cost invade, quality issues and an expanded number of questions. Therefore, to welcome reasonable bidders, it is important to explain and promote proper pre-determined CS criteria so as to avoid construction delays and cost overruns. It is frequently more difficult to obtain, assess and apply evidence to establish expertise in the equally significant pre-qualification domain of managerial ability in effect (Plebankiewicz 2009). Different researchers have used different sets of pre-qualification criteria to evaluate the potential of contractors for the given project such as available bid capacity, total and similar work experience, financial capabilities, equipment and plants available, managerial competency and quality and safety policies. Hatush and Skitmore (1997) have used financial health, technical skills, management effectiveness and overall safety and health performance as selection criteria. Many of the contractors don't analyse the competitive environment using mathematical or statistical methods. The weighted point score method, combined with the quantification of several characteristics, aids in the choice of the best subcontractor (Kapote and Pimplikar 2014). The analytical hierarchy process (AHP) method, which is based on multi-criteria decision-making (MCDM), allows project management teams to identify contractors who are most likely to deliver acceptable results in a selection process that isn't only based on the lowest price (Balubaid and Alamoudi 2015).

3 Methodology

The research instrument used for the study was a questionnaire survey along with field visits for discussion with the field experts to get information with respect to reasons of time and cost overruns. For data collection, a total of 25 road and highway projects were considered from clients such as PWD, ZP and municipal corporations and also from contracting and consultancy firms of Maharashtra State, India. The collected data were incorporated in the formulas suggested by Gransberg et al. (1999) (refer to Table 1). The questionnaire comprised 10 questions relating to project specific parameters and pre-qualification criteria (refer to Table 2). The questionnaires were filled by 25 experienced field professionals working on roads and highway projects in India. As aforementioned, the specific data from these projects, on which prequalification system existed, had been used to quantify the objective project performance criteria, and four project performance measures such as percentage cost growth (CG), number of change orders, percentage increase per change order and percentage time growth were computed (refer to Table 3).

Further, the parametric analysis of the data obtained from Table 3 was done by arranging these data in a descending order in the form of road project's number associated with that respective data (refer to Table 4). The entire dataset consists of 25 projects which were divided into approximately four equal parts ranging from maximum negative impact to minimum negative impact.

Then, the next step done was calculation of frequency of occurrence for each project under different heads of impact level (refer to Table 5) which were required for data normalisation.

As scope and scale of project variables like cost, duration, number of change orders, etc. were different for each project, in order to bring it on a common scale, data normalisation was done in terms of weights calculated as

Tab. 1: Mathematical formulas for the project performance criterion (Gransberg et al. 1999).

Sr. No.	Parameters	Mathematical formulation
1	% CG	$\frac{\text{Final contract amount} - \text{Original contract amount}}{\text{Original contract amount}}$
2	% Increase per change order	$\frac{\text{\% Cost growth}}{\text{Number of change orders}}$
3	% Time growth	$\frac{\left[\text{Days charged} - \left(\text{Total days allowed} + \text{Additional days granted}\right)\right]}{\text{Total days allowed} + \text{Additional days granted}}$

CG, cost growth.

where days charged = actual contract duration, total days allowed = original contract duration and additional days granted = number of days added by change order.

shown in Table 6. As the parameters chosen to analyse the impact were four, the frequency of occurrence was divided by four so as to normalise the data. Amongst the obtained weights (from 0 to 1) for each project, the highest two weights were selected to measure the impact. Figure 1 represents graphically the parametric analysis done considering the variation between the minimum negative project impact and the maximum.

4 Parameters chosen for the study (Gransberg et al. 1999)

As the goal of the research was to find out the cost and time overruns on roads and highway projects due to inappropriate pre-qualification criteria, CG and time growth were the key performance measures for success of any project. Hence, along with the number of change orders which also had impact on project, increased cost per change orders, time growth and CG were the parameters chosen for the study. Table 1 indicates the mathematical formulations for the chosen parameters.

4.1 Cost growth

CG is a commonly used indicator of project success. This characteristic enables the assessment of any influence pre-qualification may have on the project.

4.2 Number of change orders

Simply adding together, the entire number of change orders for each project yields the average total change orders per project. The effect of the original contract's quality on the progress of the project is further defined by this parameter.

4.3 Cost per change order

Cost per change order is nothing more than the arithmetic average price of the actual adjustments made to each project. With the use of this variable, the investigator can get a sense of the scale at which alterations on common projects typically occur.

4.4 Percent increase per change order

Percentage increase for each change is an indicator of incremental CG. A significant percent rise per change order would suggest that CG happens as a scaling factor and would be a good indicator of how well the contract documents were written.

4.5 Time growth

The passage of time relative to the initial contract completion date is known as time growth. Changes in the project's scope typically result in time expansion.

5 Interpretation

What the statistics does demonstrate was that the given projects may experience cost and time escalation due to a non effective pre-qualification mechanism. Amongst the obtained weights for each project (from 0 to 1), the highest two weights were selected to measure the impact. Therefore, the data analysis showed that collectively 64%

Tab. 2: Project-specific parameters considered for analysis; representation of data obtained.

Projects	Project start and end dates	Whether project was tendered	Whether pre- qualification process was conducted	Details of pre-qualification criteria considered						Original contract amount in Rs. Lacs (at the time of awarding of tender)	Final contract amount in Rs. Lacs (at the time of completion)	Number of change orders (change in scope, updations)	Days charged in months (actual contract duration)	Total days allowed in months (original contract duration)	Additional days granted in months (number of days added by change order)
				Technical	Financial	Past experience	Machinery/ equipment/ plants	Staff	Any other						
R1	23/06/2020 to 22/03/2021	Yes	Yes	Y	Y	Y	Y	Y	-	92.83	92.83	0	9	9	0
R2	23/06/2020 to 22/03/2021	Yes	Yes	Y	Y	Y	Y	Y	-	108.4	90	0	12	9	0
R3	17/03/2018 to 15/04/2019	Yes	Yes	Y	Y	Y	Y	Y	-	253	264	5	13	12	1
R4	04/11/2016 to 04/11/2018	Yes	Yes	Y	Y	Y	Y	Y	-	643	673	0	24	24	0
R5	29/10/2019 to 30/11/2020	Yes	Yes	Y	Y	Y	Y	Y	-	160	160	2	13	12	1
R6	07/12/2020 to 03/05/2021	Yes	Yes	Y	Y	Y	Y	Y	-	155	155	1	6	6	0
R7	19/03/2018 to 20/03/2019	Yes	Yes	Y	Y	Y	Y	Y	-	90	94	3	12	12	0
R8	13/04/2018 to 04/03/2019	Yes	Yes	Y	Y	Y	Y	Y	-	85	92	1	11	10	1
R9	18/05/2018 to 22/01/2019	Yes	Yes	Y	Y	Y	Y	Y	-	70	70	0	8	8	0
R10	21/11/2018 to 19/11/2019	Yes	Yes	Y	Y	Y	Y	Y	-	80	80.5	0	12	12	0
R11	02/06/2016 to 08/08/2018	Yes	Yes	Y	Y	Y	Y	Y	-	258	262	1	20	18	0
R12	29/06/2020 to 02/07/2021	Yes	Yes	Y	Y	Y	Y	Y	-	160	161	2	12	12	0
R13	03/03/2016 to 28/03/2018	Yes	Yes	Y	Y	Y	Y	Y	-	717.12	721.12	2	24	18	0
R14	15/10/2018 to 15/01/2020	Yes	Yes	Y	Y	Y	Y	Y	-	734.43	802.51	1	15	15	0

(*Continued*)

Tab. 2: Continued

Projects	Project start and end dates	Whether project was tendered	Whether pre- qualification process was conducted	Details of pre-qualification criteria considered						Original contract amount in Rs. Lacs (at the time of awarding of tender)	Final contract amount in Rs. Lacs (at the time of completion)	Number of change orders (change in scope, updations)	Days charged in months (actual contract duration)	Total days allowed in months (original contract duration)	Additional days granted in months (number of days added by change order)
				Technical	Financial	Past experience	Machinery/ equipment/ plants	Staff	Any other						
R15	15/10/2018 to 15/01/2020	Yes	Yes	Y	Y	Y	Y	Y	-	707.04	788.35	2	15	15	0
R16	01/02/2019 to 01/08/2021	Yes	Yes	Y	Y	Y	Y	Y	-	2,318.12	2,070.08	1	30	24	6
R17	17/10/2016 to 17/04/2017	Yes	Yes	Y	Y	Y	Y	Y	-	58.12	140.62	0	23	6	6
R18	19/12/2013 to 19/12/2014	Yes	Yes	Y	Y	Y	Y	Y	-	138.09	138.09	0	18	12	6
R19	16/10/2017 to 16/04/2019	Yes	Yes	Y	Y	Y	Y	Y	-	911.18	911.18	0	18	18	0
R20	20/11/2018 to 19/11/2019	Yes	Yes	Y	Y	Y	Y	Y	-	774.97	791.99	1	24	12	6
R21	12/02/2019 to 13/11/2019	Yes	Yes	Y	Y	Y	Y	Y	-	711.8	716.82	1	15	9	6
R22	08/03/2019 to 07/03/2020	Yes	Yes	Y	Y	Y	Y	Y	-	1,230.62	1,233.38	0	12	12	0
R23	11/10/2018 to 11/10/2019	Yes	Yes	Y	Y	Y	Y	Y	-	2,730.71	2,749.15	1	15	12	0
R24	05/04/2019 to 04/04/2021	Yes	Yes	Y	Y	Y	Y	Y	-	14,079	15,118	1	36	24	6
R25	08/03/2019 to 08/03/2020	Yes	Yes	Y	Y	Y	Y	Y	-	406.05	406.22	1	12	12	0

Source: Public sector clients, viz. PWD, Municipal Corporation, ZP, etc., contractors and consultant from the state of Maharashtra, India.

PWD, Public Works Department; ZP, Zilla Parishad.

Tab. 3: Computations of four project performance measures.

Project	Percentage CG	Number of change orders	Percentage increase per change order	Percentage time growth
R1	0	0	0	0
R2	−16.974	0	0	33.333
R3	4.348	5	0.870	0
R4	4.666	0	0	0
R5	0	2	0	0
R6	0	1	0	0
R7	4.444	3	1.481	0
R8	8.235	1	8.235	0
R9	0	0	0	0
R10	0.625	0	0	0
R11	1.550	1	1.550	11.111
R12	0.625	2	0.3125	0
R13	0.558	2	0.279	33.333
R14	9.270	1	9.270	0
R15	11.500	2	5.750	0
R16	−10.700	1	−10.700	0
R17	141.948	0	0	91.667
R18	0	0	0	0
R19	0	0	0	0
R20	2.196	1	2.196	33.333
R21	0.705	1	0.705	0
R22	0.224	0	0	0
R23	0.675	1	0.675	25
R24	7.380	1	7.380	20
R25	0.042	1	0.042	0

CG, cost growth.

Tab. 4: Parametric analysis.

Impact level	Percentage CG	Number of change orders	Percentage increase per change order	Percentage time growth
Maximum negative impact	R17	R3	R14	R17
	R15	R7	R8	R2
	R14	R5	R24	R13
	R8	R12	R15	R20
	R24	R13	R20	R23
	R4	R15	R11	R24
	R7	R6	R7	R11
Significant negative impact	R3	R8	R3	R1
	R20	R11	R21	R3
	R11	R14	R23	R4
	R21	R16	R12	R5
	R23	R20	R13	R6
	R10	R21	R25	R7
Reasonable negative impact	R12	R23	R1	R8
	R13	R24	R2	R9
	R22	R25	R4	R10
	R25	R1	R5	R12
	R1	R2	R6	R14
	R5	R4	R9	R15
Minimum negative impact	R6	R9	R10	R16
	R9	R10	R17	R18
	R18	R17	R18	R19
	R19	R18	R19	R21
	R16	R19	R22	R22
	R2	R22	R16	R25

CG, cost growth.

Tab. 5: Frequency of parameters segregated as per impact on project.

Project	Maximum negative impact	Significant negative impact	Reasonable negative impact	Minimum negative impact
R1	0	1	3	0
R2	1	0	2	1
R3	1	3	0	0
R4	1	1	2	0
R5	1	1	2	0
R6	1	1	1	1
R7	3	1	0	0
R8	2	1	1	0
R9	0	0	2	2
R10	0	1	1	2
R11	2	2	0	0
R12	1	2	1	0
R13	2	1	1	0
R14	2	1	1	0
R15	3	0	1	0
R16	0	1	0	3
R17	2	0	0	2
R18	0	0	0	4
R19	0	0	0	4
R20	2	2	0	0
R21	0	3	0	1
R22	0	0	1	3
R23	1	2	1	0
R24	3	0	1	0
R25	0	1	2	1

Tab. 6: Weights of parameters.

Project	Maximum negative impact	Significant negative impact	Reasonable negative impact	Minimum negative impact
R1	0	0.25	0.75	0
R2	0.25	0	0.50	0.25
R3	0.25	0.75	0	0
R4	0.25	0.25	0.50	0
R5	0.25	0.25	0.50	0
R6	0.25	0.25	0.25	0.25
R7	0.75	0.25	0	0
R8	0.50	0.25	0.25	0
R9	0	0	0.50	0.50
R10	0	0.25	0.25	0.50
R11	0.50	0.50	0	0
R12	0.25	0.50	0.25	0
R13	0.50	0.25	0.25	0
R14	0.50	0.25	0.25	0
R15	0.75	0	0.25	0
R16	0	0.25	0	0.75
R17	0.50	0	0	0.50
R18	0	0	0	1
R19	0	0	0	1
R20	0.50	0.50	0	0
R21	0	0.75	0	0.25
R22	0	0	0.25	0.75
R23	0.25	0.50	0.25	0
R24	0.75	0	0.25	0
R25	0	0.25	0.50	0.25

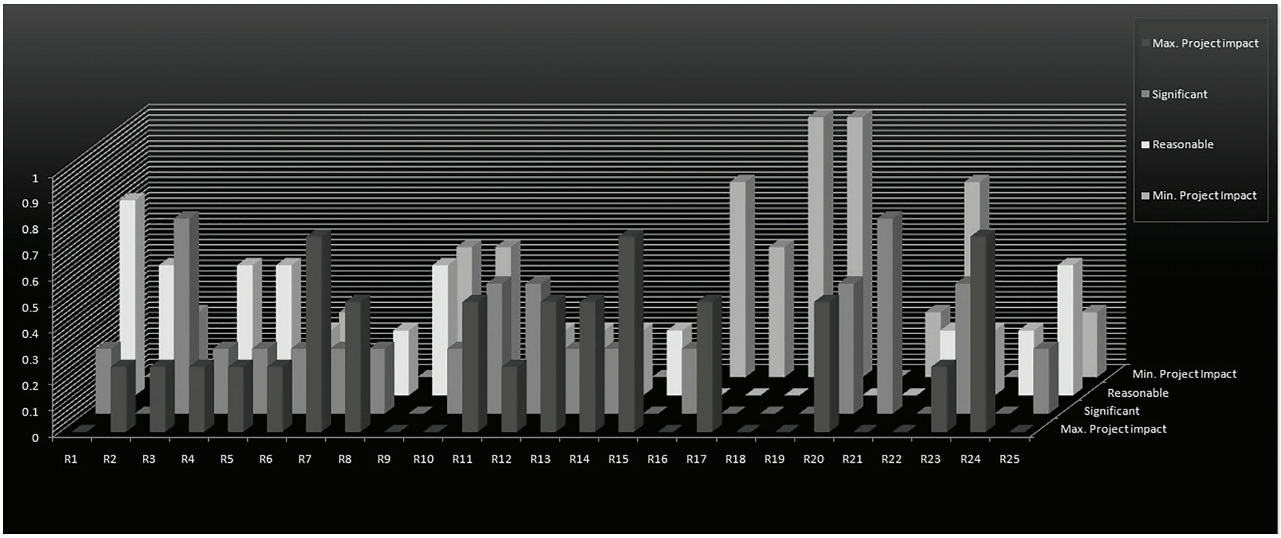

Fig. 1: Parametric analysis of road projects considering weighted project impact.

of roads and highways demonstrates maximum negative impact, 60% of the projects experienced significant negative impact whereas 36% of the projects experienced reasonable negative impact and only 32% of the projects experienced minimum negative impact as shown below. Finally, it may be inferred that collectively all the 25 roads and highway projects have demonstrated CG, increased cost per change order, increased time growth, etc.

a) Maximum negative impact was observed in 64% of roads, i.e., R2, R3, R4, R5, R6, R7, R8, R11, R12, R13, R14, R15, R17, R20, R23 and R24.
b) Significant negative impact was observed in 60% of roads, i.e., R1, R3, R6, R7, R8, R10, R11, R12, R13, R14, R16, R20, R21, R23 and R25.
c) Reasonable negative impact was observed in 36% of roads, i.e., R1, R2, R4, R5, R9, R15, R22, R24 and R25.
d) Minimum negative impact was observed in only 32% of roads, i.e., R9, R10, R16, R17, R18, R19, R21 and R22.

6 Conclusion

The analysis showed the maximum negative impact, such as time and cost overrun, to be more prominent than 64%, whereas 60% of the tasks face a significant negative impact, which indicated that the project delays and cost overrun still remain a part of the concern which ought to be considered seriously for control of project.

This study exhibits the failure of road projects in terms of time and cost overruns even when the projects were granted after the pre-qualification of the contractor. Land acquisition challenges, construction halted during the monsoon and bitumen refinery maintenance, claims and disputes between the contractor and client, ineffectiveness of the contractors while handling scope changes, etc. were the main causes of delays and cost overruns which highlight that the current pre-qualification system executed by different client authorities misses the mark on ability to choose the most competent contractor for the given work indicating the need of revising the existing prequalification process.

Therefore, it is recommended that the contractors be chosen based on project-specific macro-level detailing of prequalification criteria which subsequently should be used to evaluate the bids in the scrutiny process of comparative statement before the work is assigned.

7 Recommendations

The future scientific investigations should be done on innovative contractor prequalification models with stringent criteria such as polychotomous decisions only for selection of the most competent contractor.

Client organisations should consider adding more project-specific and macro-level prequalification criteria where generally conflicts occur such as land acquisition issues, suspension of work during monsoon season and maintenance work of bitumen refineries, claims and disputes between contractor and clients, inefficiency of contractors while dealing with scope change, etc.

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