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An analytical study of critical factors affecting contractor efficiency in construction projects in Indian scenario

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Abstract

Purpose: Recent studies show that lowest bidder technique is mainly used in developing countries such as India to award a contract. It has been demonstrated that the lowest bid is not always the accurate one and can lead to cost overruns and time extensions amongst other problems. The aim of this study was to investigate the critical factors impacting contractor's efficiency in Indian construction projects.

Research approach: A survey was sent to participants of construction projects awarded by the government with the lowest bidder technique in Uttar Pradesh, India. For further research, snowball sampling was used, and structured interviews were conducted amongst experienced managers and engineers of these projects on both client's and contractor's side.

Findings: It was observed that, to a greater extent, the delays were caused due to contractor's opportunistic behaviour. The main findings are that new bidding methodologies are to be tested as they can lead to the choice of a more accurate and realistic bidder. In addition, subjective evaluation components, such as schedule and workforce, should be reflected in contract award methods in addition to the cost criteria. Further studies should be performed on the choice of contract awarding methodology based on the project size and type.

Originality value: The researcher's focus was to analyze the influence of contracting methodologies and factors affecting contractor's performance in lowest bid award project, where this is an area of least focus amongst researchers in the Indian subcontinent.

Keywords: project management, construction industry, contractor performance, construction management

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1 Introduction

The latest and complex modifications in projects and market have compelled the researchers to study the feasibility of project delivery methods used in the construction industry (Palaneeswaran and Kumaraswamy, 2001). Lowest bid award methodology is one of the most popular bidding techniques used for project award. Increased application of lowest bidder technique has promoted inadequacy and unseemliness amongst the submitted bids and resulted in the repetitive occurrence of disputes, cost overruns and time extension (Leśniak, 2015; Setiawan et al., 2015; Suprapto et al., 2015a; Chang, 2017; Yang et al., 2017). As a result, if the Indian government and its subsidiaries as well as privately managed construction organizations have learned a lesson, have adapted to recent advances and invite worthy bidders, yet it is still important to research prequalification criteria and the target of the prequalification and bid assessment forms (Hatush and Skitmore, 1997).

Although in the past few years, in developing countries especially in Uttar Pradesh, India, it is a common observation that construction activities being conducted by government and its subsidiary agencies prefer lowest bidder techniques to award a project for medium-scale projects. The contractor whose bidding price is the lowest will win the bid (Manu et al., 2015; Dražić et al., 2016; Elzomor and Parrish, 2016; Deep et al., 2017a; Dixit et al., 2017). The prequalification and bid assessment methods require the advancement of essential and adequate selection criteria

(Palaneeswaran and Kumaraswamy, 2000). The past two decades have witnessed an enormous improvement in multidimensional aspects of project requirements which prompted to the utilization of different project delivery frameworks (Deep et al., 2017a, 2017e). Interestingly, the prequalification and bid assessment and handling, evaluating and appraisal of criteria are still in its unique frame. In the current scenario, the lowest bidder from the past project is collected in a pool and considered for prequalification in a project, but still lowest bid award is a preferred mechanism to award projects.

2 Theoretical background

The quality of work in the public sector is affected, to a greater extent, by the capability of the contractor (Wong, 2004; Elyamany and Abdelrahman, 2010; Chang, 2016). Researchers have arrived at a consensus that client satisfaction is the vital factor to be considered for contractor's performance measurement "clients are at the core of the process and their needs must be met by the industry" (Latham, 1994; Xiao and Proverbs, 2003). Whether it is arm's length or long term, a client is generally focused on the factors such as budget, time and quality (Heesom et al., 2003; Chang, 2016). The construction industry is considered to be a dynamic and sophisticated; the pertinent reason is it has a direct impact on public (Wong, 2004; Gündüz et al., 2012; Chang, 2015). In addition, major construction projects involve various categories of resources, i.e. human resources, materials and equipment, which require effective planning and allocation by contractors to avoid stereotypes and reap maximum economic benefits (Sarker et al., 2012).

It is a well-established fact for the lowest bid award method that the absence of competition, unreasonable time extensions, trading off quality and acceleration of project costs are the significant issues related to the current approach of conveying projects (Lema, 2006). Inadequate financing of the project by the contracting organization and underestimated procurement of materials, equipment and workforces are prime causes for delays amid the construction stage in the construction industry (Lema, 2006; Oduro-Owusu et al., 2010; Khan et al., 2017c; Singh et al., 2017b).

The construction procedure includes the hierarchical flow of information. Strife and question can hence exist at all levels in the contractual hierarchy amongst client and consultant, client and contractor and contractor and subcontractor. Amongst many reasons for contradictions in the construction project, the project delivery framework chose one of the significant components (Deep et al., 2017e). Henceforth, numerous researchers have stated that construction organizations have learned from their past experiences and made various advancements. Research findings have created modified techniques to address these issues (Safa et al., 2015; Asgari et al., 2016; Aitken and Paton, 2017; Asim et al., 2017b; Deep et al., 2017a, 2017e).

One of these findings, focused normal bidding strategy, has turned into the most favoured approach amongst numerous European nations. Its enactment permitted public sector clients to diminish the unfriendly impacts of abnormally low tenders (ALTs), including unsuitable quality through the need to decrease construction costs (Winch, 2000), savage valuing, out-of-line rivalry that misshapes the market and contrarily influencing alternate bidders (Deep et al., 2017a). Focused normal bidding strategy has turned out to be the most preferred since all the components of the open competitive system are retained on the one hand. Thus, the probability of being awarded a contract to a contractor who submits, either unintentionally or intentionally, an unreasonably low bid will be decreased (Leśniak, 2015; Suprapto et al., 2015a, 2015b; Erdogan et al., 2017). The opposition gives an approach to keep away from extortion and defilement, which are the significant downsides of other transaction-based options.

3 Identification of knowledge gap

There are distinct advantages and disadvantages to the low-bid award framework. Increased competition amongst contractors is a distinct advantage of the procedure. It compels the contractors to decrease quoted costs for carrying out specific work, more often than not through advancement, to guarantee they win bids and keep up their net revenues (Wahaj et al., 2017a). Furthermore, the procedure is beneficial, specifically to the client on account of its straight forwardness, a necessary foundation of the transparency and increased professionalism (Ioannou and Leu, 1993; Ng et al., 2002; Walker et al., 2002; Shehu and Akintoye, 2010; Ishii et al., 2014; Kotula et al., 2015; Naoum and Egbu, 2015; Suprapto et al., 2015b; Jaafar et al., 2016; Wang et al., 2016; Bai et al., 2017). However, the system is not as advantageous in the case of lowest bid award to carry out a particular task that has inherent imperfections (Jekale, 2004; Deep et al., 2017d, 2018).

The framework is entirely focused towards client's requirement which is not a bad idea; since it is more popular with government and its subsidiaries, it tends to increase malpractices and poor quality due to the contractors being sceptical about their profit margins (Deep et al., 2017b, 2017c, 2017e, Mathivathanan et al., 2017; Mishra et al., 2017; Sanderson et al., 2017). The criterion for choosing

the potential bidder is the bid that is reasonably below the client's estimate and serves client's interest well (Deep et al., 2017e). Thus, there is a clear research gap, in the case of developing countries, that the contract awarding framework fails to answer mutual interests of client and contractor relationship resulting in unavoidable risks (Asim et al., 2017a, 2017b; Deep et al., 2017a, 2017b; Khan et al., 2017b; Singh et al., 2017a; Wahaj et al., 2017b). This study aimed to identify the critical factors of contract awarding methodologies that tend to decrease contractors' efficiency in India.

4 Research approach

The work presented in this article is a result of exhaustive independent research conducted for a period of 5 months, i.e. August 2016 to December 2016. The target areas of the research were projects, in which Uttar Pradesh, India, was awarded by using lowest bidder technique. The information of these projects was obtained using Government of India, Right to Information Act, 2005. There were overall 400 major or minor construction projects being conducted throughout the state.

The required number of responses was determined by the following formula (Israel, 1992; Damoah and Akwei, 2017):

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

where n is the required number response, e^2 is the error limit and N is the sample size.

The level of confidence was assumed as 95%, and an error margin of 5% was assumed. A total of 172 responses were required for the assessment of required parameters.

All participants were required to rate their answers on a Likert scale of 1–5. For determining the critical factors that affected the project, we used importance index analysis and ranking and percentile analysis. For further research, snowball sampling was used, and structured interviews were conducted amongst the professionals working in the top level and middle level of hierarchy amongst the project staff on both client's and contractor's side as summarized in Tabs. 2 and 3.

5 Data analysis

An extensive study of literature resulted in the identification of various factors that affected contractor's efficiency shown in the Tab. 1. and relative importance index of each factor was calculated. Furthermore, all these nine categories were divided into 99 different factors.

Tab. 1: Categorization of the factors affecting contractor's efficiency in construction projects.

Sl. no.	Category item	Total no. of category factors
1	Consultant's influence	8
2	Contractor's issues	13
3	Design changes	11
4	Equipment related	7
5	External factors	17
6	Human resources	9
7	Material constraints	9
8	Non-cooperation from principal	19
9	Project complexities	6
	Total	99

Tab. 2: Categorization of participants.

ID	Affiliation of respondents	No. of respondents	Percentage
1	Principal	4	1.45
2	Consultants	20	7.27
3	Managers	44	16.00
4	Engineers	82	29.82
5	Contractors	125	45.46
	Total	275	100

Tab. 3: Working experience of respondents.

Industrial experience	No. of respondents	Percentage
1–5 years	42	15.27
5–10 years	58	21.09
10–0 years	86	31.27
Above 20 years	89	32.37
Total	275	100

5.1 Ranking of delay factors

After calculating overall index (OI) for each delay factor, a ranking of delay factors was carried out by their OI, which is summarized in Appendix 1. It was found that the OI was the highest for factor number 43, "Delay in obtaining permits from municipality" (72.49%), related to the external category. Factor number 63, "Human Resources strikes due to revolutions" (48.82%), related to human resources category, was the lowest amongst all factors. This indicates that factor number 43 is the most influencing

parameter and factor number 63 is the least influencing parameter of construction delay in India. From the list of 99 delay factors, top 20 major delay factors and least 20 delay factors are selected considering the OI factors (Ibironke et al., 2013).

6 Discussion of results

Evidently, all the delay-causing factors originated either from the following: consultant's influence, contractor's issues, design changes, equipment related, external factors, human resources, material constraints, non-cooperation from principal or project complexities (Eriksson, 2010; Wang et al., 2015; Doğan et al., 2016; Sinčić Ćorić et al., 2017). A probable explanation of this is every actor is trying to blame others for delays. Furthermore, it is desirable to compare the strength or importance of each category; thus, a weighted average of each category was calculated to arrive at an unbiased observation. The results are presented in Tab. 4 by using priority rule formula as shown in the following equation:

$$\mathbf{ERII}_{\mathbf{j}}(\%) = \left(\frac{\sum_{n=1}^{n=N} (Pn\ X\ RIIn)}{\sum_{n=1}^{n=N} (Pn)} \right) \quad (2)$$

where $ERII_j$ (%) is the equivalent weighted average percentage of relative importance index per category and $ORII_n$ (%) is the overall weighted average percentage of relative importance index of each factor in a specific category, which is calculated on the basis of total experiences of respondents; n is the number that represents the factor number in the related category (from the first factor of category n=1 to form the last factor of category n=N) and P_n is the priority weight of the studied factor. It is clear that the results of the nine categories are almost consistent, where the categories are ranked from top to bottom as summarized in Tab. 4.

As evident from Tab. 5, summarizing the rank and impact of the grouped factors, there were three most contributing factors to delay for each group: the first important group was consultant's influence (Equivalent average Relative Importance Index (EARII) =64.62%), the most critical factor in this category was "inadequate project management assistance (OI=66.17)". The second important group was contractor's issues having the most significant factor as "inadequate contractor experience (OI=70.23)". The third most important group was design group (design changes) having the most important factor in this category as "misinterpretation of owner's requirements by design engineer (OI=72.03)"; this factor mostly depended on the skill of engineer and designers. The OI and ranks of the each factors are summarized in Appendix 1.

As it can be observed from the abovementioned findings, most of the factors that have been prioritized by the participants are related to the contractor. The reason is as

Tab. 4: Equivalent average relative importance index of category.

Rank	Category item	Equivalent average relative importance index (Eq. 2)
01	Consultant's influence	64.62
02	Contractor's issues	63.82
03	Design changes	62.46
04	Equipment related	62.28
05	External factors	60.28
06	Human resources	60.26
07	Material constraints	60.25
08	Non-cooperation from principal	59.61
09	Project complexities	59.31

Tab. 5: High priority delay factors in each category.

Category no.	Category	ID	Delay factor description	OI%	Overall rank
1	Consultant	6	Inadequate project management assistance	66.17	19
2	Contractor	10	Inadequate contractor experience	70.23	05
3	Design	28	Misinterpretation of owner's requirements by design engineer	72.03	03
4	Equipment	37	Low efficiency of equipment	66.07	21
5	External	43	Delay in obtaining permission	72.30	01
6	Human resources	61	Shortage of human resources	72.30	02
7	Material	67	Damage of sorted materials	66.83	13
8	Owner	78	Delayed payments	67.03	12
9	Project	94	Project ambiguities (project type, project scale, etc.)	67.51	10

OI, overall index.

follows: although a contractor is awarded project on the basis of its low bid, it tends to meet out its finances through time value on money, i.e. by delaying the project (Hatush and Skitmore, 1997; Palaneeswaran and Kumaraswamy, 2000, 2001; Elyamany and Abdelrahman, 2010; Sarker et al., 2012; Leśniak, 2015; Deep et al., 2017e; Asim et al., 2017a, 2017b). The real purpose behind quality imperfections, i.e. in the case of equipment and material, has been due to the inclination of contractors to meet out their cost since they have won the tender with low bids. It is found in the research that the advance according to the timetable of most projects awarded on the responsive lowest bidder award system was weak (Deep et al., 2017e). Competitive lowest bid method has been exceptionally scrutinized for its adverse effect on contractor's profit, disputes/claims, coordination, quality control and project span. Respondents exceedingly valued other option bidding methodologies incorporated into the review for their beneficial outcomes on these characteristics. Most of the respondents favored the use of a competitive system ensuring the work award to bidder whose bid is closest to the average of all bids. (Asim et al., 2017b; Deep et al., 2017a, 2017e; Khan et al., 2017a, 2017c; Singh et al., 2017b; Wahaj et al., 2017a). Amongst the respondents, however, few trusted that the current bidding strategy does not urge contractors to be innovative. The majority of the respondents have consented to the application of competitive system with an arrangement to award contracts to bidders closest to the normal of all bidders and the project cost. All respondents trusted that bidding strategy ought to rely on sort and multifaceted nature of the project. The majority of the members agreed that subjective evaluation components (e.g. timetable, association and workforce) other than cost should be reflected in the contract award. In addition, the majority of the respondents agreed that the choice of the bid evaluation and the contract award methods depend on the type of contract chosen.

7 Conclusion

The method of procurement for the construction project is significant for its success (Shehu and Akintoye, 2010; Kotula et al., 2015; Doğan et al., 2016; Wahaj et al., 2017b), since its essential determinant for the selection of participant that will be responsible for its execution. It was observed that, in Indian scenario, mainly consultant's influence and contractor's influence are the major factors that affect contactor's working efficiency in state-funded construction. Regarding the efficiency of the contractor, it was observed that there is a lack of coordination between consultant and contractor indicating the presence of opportunism. A reason for opportunistic behaviours is the lack of experience of the contractor on a similar type of projects. Next, we observed in this study that there is a lack of project management awareness. In the current state, it is only reduced to planning stage and implementation is low or negligible in execution. Thus, it is vital for a contractor to adopt best practices in project management and for a planner to improve their tendering strategies to ensure on-time delivery of construction projects which will enhance the contractor's efficiency in construction projects.

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Appendix 1: Ranking of delay factors and OI.

Rank	Groups	Factor ID	Cause of delay	OI
1	External	43	Delay in obtaining permission	72.49
2	Human resources	61	Shortage of human resources	72.30
3	Design	28	Misinterpretation of owner's requirements by design engineer	72.03
4	External	48	Sudden failure actions	71.67
5	Contractor	10	Inadequate contractor experience	70.23
6	Human resources	62	Slow mobilization of human resources	69.98
7	Contractor	17	Rework due to errors	69.06
8	Design	27	Mistakes and delays in producing design documents	68.87
9	External	53	Unfavourable weather conditions	68.47
10	Project	94	Project ambiguities (project type, project scale, etc.)	67.51
11	Design	25	Insufficient knowledge	67.31
12	Owner	78	Delayed payments	67.03
13	Material	67	Damage of sorted materials	66.83
14	Owner	85	Slowness in decision-making	66.78
15	Contractor	12	Incompetent project team	66.76
16	Human resources	58	Low motivation and morale of human resources	66.52
17	External	46	Global financial crisis	66.41
18	Contractor	13	Ineffective project planning and scheduling	66.30
19	Consultant	6	Inadequate project management assistance	66.17
20	Project	99	Unfavourable contract clauses	66.15
21	Equipment	37	Low efficiency of equipment	66.07
22	Contractor	16	Poor site management and supervision	66.03
23	External	45	Improper site facilities (water, electricity, etc.)	65.70
24	Owner	83	Lack of motivation	65.49
25	Contractor	18	Unreliable subcontractors	65.33
26	Project	95	Inadequate definition of substantial completion	64.55
27	Contractor	9	Frequent change of subcontractors	64.48
28	Owner	88	Lack of financial planning	64.46
29	Project	97	Conflicts between actors	64.33
30	Equipment	39	Slow mobilization of equipment	64.25
31	Owner	89	Long period between design and time of bidding/tendering	64.09
32	Contractor	15	Communication and coordination failure	63.84
33	Consultant	1	Insufficient experience on similar projects	63.59
34	Contractor	21	Poor financial control on site	63.33
35	Consultant	8	Communication and coordination failure	63.21
36	Contractor	20	Inappropriate contractor's policies	62.95
37	Design	24	Design errors due to negligence	62.89
38	Owner	90	Inappropriate contractual procedure	62.81
39	External	56	Thefts performed on site	62.75
40	Consultant	7	Late in reviewing and approving design documents	62.57
41	Contractor	19	Inadequate site investigation	62.41
42	Owner	86	Suspension of work by owner	62.21
43	External	49	Price fluctuations	62.07
44	Design	26	Delayed approvals	62.04
45	Human resources	64	Unqualified/inadequate experienced human resources	61.72
46	External	52	Unexpected surface and subsurface conditions (soil, water table, etc.)	61.68
47	Material	68	Delay in manufacturing materials	60.96
48	Human resources	65	Human resources injuries on site	60.95
49	Material	73	Shortage of construction materials	60.94
50	External	55	Inappropriate government policies	60.80
51	Design	22	Complexity of project design	60.78
52	Owner	79	Delay in site delivery	60.76
53	Project	96	Ineffective delay penalties	60.72
54	Design	31	Incomplete project design	60.70

(*Continued*)

Rank	Groups	Factor ID	Cause of delay	OI
55	Design	23	Frequent design changes	60.61
56	Contractor	14	Obsolete technology	60.61
57	Owner	82	Lack of knowledge to handle construction projects	60.24
58	Project	98	Original contract duration is short	59.67
59	Consultant	2	Conflict between consultant and design engineer	59.51
60	Equipment	34	Frequent equipment breakdowns	59.43
61	Owner	93	Selecting inappropriate contractors	59.41
62	Equipment	35	Improper equipment	59.13
63	Owner	77	Delay in approving design documents	58.99
64	Owner	81	Lack of capable representative	58.78
65	Contractor	11	Inappropriate construction methods	58.73
66	Human resources	59	Low productivity of human resources	58.71
67	Material	66	Variations in specification	58.56
68	Material	74	Unreliable suppliers	58.55
69	Design	30	Unclear and inadequate details in drawings	58.48
70	Owner	84	Communication and coordination failures	58.34
71	External	40	Accidents during construction	58.15
72	Owner	91	Additional work	57.88
73	Equipment	38	Shortage of equipment	57.88
74	External	54	Inadequate production of raw material in the country	57.87
75	Material	70	Late delivery of materials	57.76
76	Material	69	Escalation of material prices	57.74
77	Owner	92	Bureaucracy in bidding/tendering method	57.42
78	Consultant	3	Delayed approval of changes by consultant	57.37
79	Owner	87	Inadequate planning	57.33
80	Human resources	57	Absenteeism	57.30
81	Material	71	Poor procurement of construction materials	57.23
82	Consultant	4	Delay in inspection and quality tests	57.19
83	External	50	Problem with neighbours	57.10
84	Equipment	33	Equipment allocation problem	57.03
85	Owner	76	Conflicts between joint ownership	56.74
86	External	44	Delay in third-party inspection and certification	56.51
87	Design	32	Defective design made by designers	56.50
88	Owner	80	Improper project feasibility study	55.61
89	External	42	Different tactics patterns for bribes	55.61
90	Material	72	Poor quality of construction materials	55.25
91	Design	29	Lack of application of software	54.88
92	External	47	Time losses due to interruption	54.84
93	External	51	Slow site clearance	53.56
94	Equipment	36	Inadequate modern equipment	53.51
95	External	41	Changes in government regulations and laws	52.44
96	Consultant	5	Inaccurate site investigation	52.43
97	Human resources	60	Personal conflicts amongst human resources	52.08
98	Owner	75	Modifications	51.04
99	Human resources	63	Human resources strike due to revolutions	48.82

OI, overall index.