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Prequalification in municipal solid waste management public-private partnerships of India

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Abstract

Prequalification (PQ) is a significant process in the selection of private sector for the delivery of civil infrastructure projects. But the extant literature, for the most part, focused on PQ of construction projects. The need for specifying proper PQ requirements, i.e., criteria and their limits in public-private partnership (PPP) infrastructure projects, especially municipal solid waste (MSW) projects is still a lacuna in the body of knowledge of Indian PPPs. To this end, this paper identified PQ criteria using content analysis of the sample of MSW projects. These identified criteria were subjected to regression modelling. These results were compared with the results of well-matured highway sector to draw comparisons with MSW projects. The practical implications are that urban local bodies (ULBs) are but less competent and less uniform in the rationale of setting the PQ criteria and limits for MSW projects. This paper suggests that lowering the technical and financial PQ limits considering the market orientation will help in bringing more competitive bidders into the bidding. Since MSW is in a very nascent stage of application of PPP, the study results could lay directions to discern right limits for right project sizes. This would support the standardization of contracts in MSW sector and enhance the competition between private sector. Extant literature on procurement theory discusses only about criteria of prequalification in construction projects. This study advances the theory of procurement management beyond the criteria to setting the limits of the criteria.

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Keywords

content analysis, India, prequalification, public-private partnerships, regression modelling.

Introduction

Public-private partnership (PPP) mode has been considered as a better procurement model to deliver projects on time and within budget. However, there are cases wherein projects procured through PPP were delivered late and exceeded the estimated project cost. This instigated more attention to the procurement process by the concession granting authorities in shortlisting the bidders who have the requisite technical expertise and right set of experience for undertaking the projects (Morley and Wainscott, 2006). In the early manual issued by the World Bank on concession design, it is argued that the success of concession depends not only on the contractual arrangement in the concession, but also on the methodology adopted for the award of the concession. After a choice of the method of award, the next important process is prequalification (PQ) of the interested bidders (Kerf, Gray and Taylor, 1998). Lo, Krizek and Hadavi (Lo, Krizek and Hadavi, 2002) have stated that PQ plays an important role in the evaluation of the capacity and capability of bidders for a given project. This assumes immense importance because poor design of PQ could have an adverse effect on cost and progress and could breed collusive behaviour and unethical practices in obtaining the contract. In construction projects, prequalification and tendering is one among the stages in which corruption is more prevalent in the developing countries (Owusu, et al., 2019). Often, the criteria adopted in prequalification are criticised to be restrictive and benefit only few firms or not carried out as per the set criteria. On the other hand, rightly set PQ process would yield four fold benefits: adherence to the planned schedule and sequence of construction, timely delivery, lower prices due to competition, and development of local contractors (Lo, Krizek and Hadavi, 2002). These benefits also extend to contain the public procurement costs (Estache and Iimi, 2011). Proper design of the PQ stage is, therefore, one of the key aspects of the procurement process which need to be given due importance before embarking on soliciting proposals from the bidders.

The bidding and award procedures differ across countries and sectors and, thus, contextual empirical research is required for crafting the right prequalification procedures for a given country. For instance, the European Union has established an overarching procurement process with separate procedures for handling different sizes of bidders (EPEC, 2012). This also highlights the fact that the design of the procurement process inherently plays a key role in limiting the number of bidders that will be allowed to participate in the bidding process. The EU procedures of selection also vary in the detail of information required during the tendering process (Carbonara, Costantino and Pellegrino, 2016). In countries like Japan, an objective score, which is a nationwide standardised test called 'Keisin', is used as prequalification for permitting bid entry in public works (Konno, 2014). Thus, the procurement procedures must be designed in terms of the informational aspects beforehand so that the desired number of qualified bidders is allowed to participate in the bidding process.

The current study, therefore, grounds its context and relevance to Indian conditions in the study of PQ in PPPs. PPP projects in national highways sector are counted as one of the sectors, besides the power sector, which has been able to successfully attract private capital investment in India. In fact, transportation sector is being considered as the leading sector of Indian PPP market. The erstwhile 12th Five-Year Plan estimated a total investment of INR 70

billion (GBP 777 billion @ 1 GBP=90 INR) in roads and highways, wherein the private sector investment has increased from 5% in 10th Five-Year plan to 40% in 12th Five-Year Plan (PWC, 2012). The legal and regulatory framework of this sector has stabilized with the inception of regulatory bodies like National Highway Authority of India (NHAI) and development of model concession agreements that helps to streamline the procurement of projects. This sector is also regarded to be a matured sector on account of the vast number of projects being executed and the volume of investment in this sector. In fact, this sector is considered as a benchmark sector in Indian PPP market and development of PPP market for other sector draws procurement documents from highway sector.

On the other hand, urban infrastructure, especially municipal solid waste (MSW) management has started to attract private capital in creating facilities for urban infrastructure service provision. PPP in MSW gained importance relatively lately. Ministry of Housing and Urban Affairs (erstwhile MoUD) had formulated a Waste Management Scheme for Class-I cities/Towns indicating a need of nearly INR 25 million (GBP 0.27 million) and posed to the 12th Finance Commission (operational period of 2005–2010) for devolution of funds to ULBs. PPP was suggested as an integral part of the scheme to leverage funds and add efficiencies. The 12th Finance Commission directed that 50% of the INR 10 billion annual grant-in-aid for ULBs may be allocated towards the development of solid waste management schemes through PPP. The provision of funds for MSW sector has been increased by the Finance Commissions during the last three terms. The 12th Finance Commission provided INR 2.5 billion and this was increased to INR 9.3 billion by the 13th Finance Commission (PWC, 2017).

Research on tendering recommends standardizing prequalification processes, which includes fixing the criteria and understanding the limits (Hughes, et al., 2006). MSW sector is also progressing towards standardization of bid processing and contractual documents. However, these documents are silent on the PQ procedures and criteria. Bidding documents developed for highway sector could act as a reference for development the bidding documents for MSW sector. However, care should be warranted while drawing lessons from highways in developing bidding documents for application in MSW sector. This is because of the difference in the sectorial profiles and maturity levels. In a recent incident, High Court of Cuttack in the state of Odisha, India has asked to reduce the prequalification limits for a project by Cuttack Municipal Corporation. The court directed the ULB to fix reasonable eligibility criteria and, thus, the ULB has reduced limits and issued fresh tenders (Patnaik, 2017). This incident points to a practical encounter of the research gap while the extant literature on procurement theory discusses only about criteria of prequalification. In fact, studies that focus on the PQ of PPP projects, specifically on MSW sector, are in nascent stage. To this need, the current study focuses to buttress the procurement of MSW PPP projects. This study advances the theory of procurement management beyond the criteria to setting the limits of the criteria.

The main objective of this paper is, therefore, to identify and analyse the PQ in case of Indian PPP MSW projects. The paper has been divided into eight sections. The next section presents the literature review on the state of the theory and practice of PQ limits. This is further carried to Section 3, which sets the context of the study for PQ of PPP projects in India. The research design of the current study is presented in section 4. Section 5 presents the identification of PQ criteria for MSW projects. The modelling of identified criteria using bivariate linear regression is presented in section 6. Analysis and discussion are presented in section 7. The paper presents few inferences and concludes by laying practical implications and direction for future research.

Literature review

PQ has a significant impact on contractors' performance across time, cost and quality success (Doloi, 2009). Realizing the importance of PQ in project performance various studies have also been carried out. For instance, Russell and Skibniewski (1988) have asserted, through interviews with construction stakeholders, that PQ is a three-part process concerned with the characteristics of the owner, contractors and the resulting decision. To operationalize it, Xia, Skitmore and Zuo (2012) have developed various factors that should be taken into consideration while designing the PQ process of design-build projects, based on the data set of the United States. Most of the studies have concentrated on projects procured through traditional route while the studies on PQ for projects procured through PPP route, which differs from traditional procurement, is limited. Carbonara, Costantino and Pellegrino (2016) have noted two important reasons that set PPP tendering process different from traditional procurement – (i) parameters used for evaluation need to encompass all the phases of PPP project lifecycle, and (ii) there is a need to ensure much stronger competition to improve the value for money. In the similar lines, De Schepper, Haezendonck and Dooms (2015) have also stated that the PPP procurement process has a strong bearing on various aspects of the projects such as transaction costs, value of money, and lead time for project procurement. Furthermore, Doloi (2009) has stressed the need to bring in enough competition, as it is the key to unlock the value for money achievement in the PPP projects and contribute to stakeholder's satisfaction. The levels of competition in the procurement and the degree of private sector involvement also affects the tendering period which in turn has a direct bearing on the transaction costs (Casady, 2016). Realization of these benefits in PPPs is highly contingent on the proper selection of PQ criteria and the design of the corresponding limits.

The responsibility of PQ design for PPP mode vests in the hands of governments/granting authorities. Potter and Sanvido (1995) have noted that the public sector should be careful in crafting the PQ criteria, limits, and the corresponding selection process to ensure a stable and transparent evaluation procedure. Generally, the government tends to seek bidders with proven track record in similar projects but the participation of bidders with appropriate experience and track record depends on: (i) size and attractiveness of the market to be served, and (ii) sector and the number of established firms currently operating in the market. Given this, before setting the PQ limits, the governments often undertake a preliminary road show to promote the project and based on which the degree of investors' interest is assessed. Kerf, Gray and Taylor. (1998) have stated that such practice will enable the governments in setting the PQ limits appropriately so that a sufficient number of bidders to participate in the bidding process. Estache and Iimi (2011) have emphasized that the selection criteria for PQ normally serve to ensure an objective assessment of the private party interested in bidding for the project. Its main purpose is not only to include the bidders who would be capable of executing the project in a worthwhile manner but also to help in shortlisting and limiting the number of bidders to a manageable size.

The shortlisting and limiting the number of bidders depends on the choice and composition of PQ criteria. But the research focus is different from the industry practices and where the industry seems to depend on the principles of the client organization and their methodologies (Singh and Tiong, 2006). For public projects, more specifically, some governments set PQ limits to restrict the bidders, while others do not specify any PQ requirements (like in case of open procedure). A review of prequalification criteria in infrastructure transactions is presented in Table 1. But, in general, the focus of PQ criteria is mostly on the tangible attributes such

as technical and financial experience and the same are used in most of the countries. Lower limits on these criteria are set by the governments and these limits are used to either screen or rank the bidders. In spite of these general recommendations, the private sector is more inclined towards standardization of PQ criteria, their limits, and the bidding process to aid efficiency, predictability, and approval process of the project (EPEC, 2012). Thus, the intended standardization of PQ limits should not be embarked upon without gathering empirical evidences from the PQ experiences of PPP projects in a given sector. This is because setting unrealistic PQ limits may either lead to participation of incompetent bidders and make the competition very intense or make the project uninviting for the bidders. While extant literature and some bilateral funding agencies have given directives for application, the selection of qualified bidders to participate in the bidding process is not clearly understood in case of Indian MSW projects. The current study, therefore, identifies the PQ criteria, limits, and analyses their behaviour to facilitate the generation of empirical evidences to support the future projects.

Table 1 Prequalification criteria in infrastructure transactions

Sector	Identified PQ Criteria	Countries	Source	PQ Limits
Buildings	Technical ability, Reputation, Financial standing, Management capability, Health and safety	Poland	Plebankiewicz (2010)	No
Buildings	Technical expertise, past success, time in business, work methods and working capital	Australia	Doloi (2009)	No
Highways	Technical and Financial	India	Planning Commission (2009)	No
Mass Transit	Corporate aspects, experience, resources and facilities, workload, support functions.	Hong Kong	Palaneeswaran and Kumaraswamy (2001)	No
Non-sector Specific	Technical capability, Financial capability, Managerial capability, General information, Past performance, and Health and safety records.	Nigeria	Aje (2012)	No

Table 1 continued

Sector	Identified PQ Criteria	Countries	Source	PQ Limits
Non-sector Specific	Keisin (nationwide standardised test of Japan)	Japan	Konno (2014)	No
Non-sector Specific	Technical Capacity, Financial Capacity, Quality assurance, Time performance, Occupational health and safety, Human resource management, Skill formation	Australia	Palaneeswaran and Kumaraswamy (2001)	No
Transport, Natural Gas, Electricity, Water[1]	Technical and Financial	Peru, Argentina, Mexico, Hungary, Argentina, Bolivia	Kerf, Gray and Taylor. (1998)	No
Transportation	Ratings are used to define the maximum value of work that a contractor can bid for a particular project.	USA	Palaneeswaran and Kumaraswamy (2001)	No

PPPs in MSW poses challenges due to the lack of competency with public sector in the procuring/handling the projects (Devkar and Kalidindi, 2013). Unlike other infrastructure sectors such as airports, highways, and ports, there is no central regulatory body that control the procurement of projects. Absence of such body prevents the transfer of knowledge and experience. This has caused variations in the choice of the pre-qualification criteria to some extent and more importantly the limits of those criteria. Moreover, the Ministry of Finance published standardised bidding documents which include Model Request for Qualification (RFQ) for Pre-Qualification of Bidders for PPP Projects. These standardised bidding and contractual documents which are being adopted by project implementation agencies for developing PPP infrastructure projects in sectors such as ports, roads, airports, food storage (silos), and water supply. World Bank also advocates the governments to follow standard model documents to enable the predictability and ease of participation in the bidding process. But these standardised documents are missing for MSW sector. Prequalification system can, thus, act as entry barring agent affecting both the expected competition and the private sector willingness to participate. Furthermore, standardisation of the documents will also promote streamlining the procurement process by allowing faster approval and timely preparation of PPP project bid documents. The study, therefore, attempts to answer the following research questions:

1. What are the prequalification criteria used in PPP MSW projects?
2. How the prequalification limits for the identified criteria vary among the PPP MSW projects?

Prequalification process in India

The procurement phase starts with the notice inviting tenders (NIT). This is followed by Request for Qualification (RFQ) that results in shorting of bidders. Subsequently, Request for Proposal (RFP) results in award of the bidder (Ministry of Finance, 2010). Figure 1 shows the typical process used for procurement of PPP projects in India.

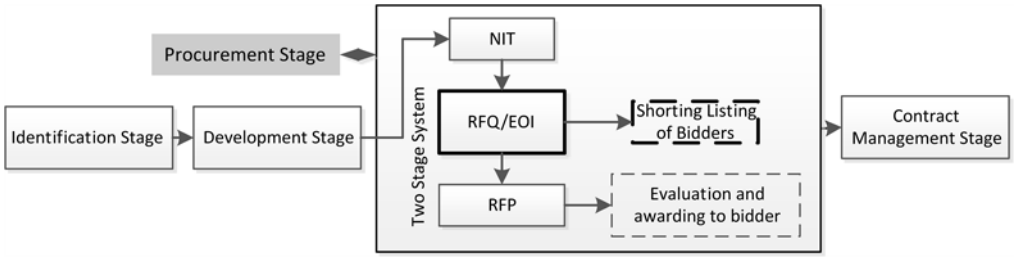

Figure 1 Typical Procurement Process for PPPs in India

The PQ of bidders is normally done to assess the technical capacity and financial strength of the bidders. Planning Commission (2009) suggests that to guide the PQ process of PPP projects, experience has been recommended as a proxy for technical capacity assessment while net-worth could be approximated as a proxy for financial capacity. It also recommends that technical evaluation should precede the bidding stage and restrict the bid stage to financial bids only.

Research Design

The study aims at gaining insights of PQ in India. The research design, therefore, adopted for this study comprised of three sequential stages. In the first stage, classical content analysis was performed as per the procedures suggested by Saldaña (2009). Content analysis is research technique of quantifying and analysing the existence of certain words or concepts within a textual data (Krippendorff, 2004). The data for the analysis of MSW projects was sourced from the PPP Database of India, which hosts the details of all the PPP projects across the sector and states (DEA, 2017). The database hosts the details of 1534 projects valued at a total cost of INR 13.49 trillion (GBP 149 billion). Our interest was limited to the MSW PPP projects executed till 2017. The average cost of the MSW project was INR 121.55 crores (GBP 13.5 million). Out of these, information relating to 27 projects were available and these projects were, then, studied using content analysis by coding the relevant criterion as nodes for identifying the PQ criteria for PPP MSW projects. This resulted in the preliminary list of various criteria used for PQ in PPP MSW projects. Additionally, information relating to PQ limits of the identified criteria were collected from the RFQ/RFP documents of various projects released by the corresponding urban local bodies (ULBs). In the second stage, bivariate regression (also known as linear regression) was carried out to understand the trend of PQ limits of PPP MSW and highway projects. This allows "…to quantify how the average of one variable systematically varies according to the levels of another variable" (Gordon, 2015). Regression analysis was, then, carried out in IBM SPSS Version 20 and Microsoft

Excel (when the data set is small). 27 projects form the data set for PPP MSW projects where 11 projects are integrated MSW projects, 9 projects are processing projects, and 7 projects have a scope of work limited to collection and transportation. On the other hand, the sample for highway projects consists of 258 projects carried between the year 2008 and 2015. The huge difference in the sample size of MSW and highways is because very few MSW projects have been executed in comparison to highway projects in PPP mode. The third stage aimed to gain insights on the logic of setting the different PQ limits. Interviews with five key personnel (as shown in Table 2) of ULBs were also conducted to assess their perceptions and methodological grounding in setting the PQ limits. The interviews focused precisely on two key aspects, minimum limits of various criteria and the reasons for adopting such limits.

Table 2 Interviewee Details

Interviewee	Designation	Years of PPP Experience/Project involved
Interviewee 1	Executive Engineer	8 years (1 project)
Interviewee 2	Transaction Advisor	6 years (4 projects)
Interviewee 3	Project Management Specialist	7 years (2 projects)
Interviewee 4	Transaction Advisor	8 years (3 projects)
Interviewee 5	Officer on Special Duty - Procurement	5 years (2 project)

Results

The results of the identified PQ criteria used in PPP MSW projects are shown in Table 3. It could be observed that technical capacity and financial capacity are the only two parameters used for PQ of PPP MSW projects and highway projects. For the PQ of the private entities, threshold technical capacity and threshold financial capacity were set by the procuring authority as a certain percentage of the estimated project cost.

Table 3 Coded qualification criteria (n=27)

Sl. No.	Criterion	Frequency (%)
1	***Technical Capacity***	
a	Experience in door to door collection of solid waste	44.44
b	Experience in transportation of solid waste	44.44
c	Experience in construction, O&M (operation & maintenance) of transfer station	07.40
d	Experience in design, construction, O&M of sanitary landfill	25.92
e	Experience in design, construction, O&M of processing facilities	51.85
2	***Financial Capacity***	

Table 3 continued

Sl. No.	Criterion	Frequency (%)
a	Annual turnover	55.55
b	Net worth	74.07
c	Net cash accruals	14.81

The technical capacity in case of PPP MSW projects was found to comprise of the following five sub-criteria, and financial capacity has three sub-criteria:

- Technical Capacity: (i) Experience in door to door collection of solid waste, (ii) Experience in transportation of solid waste, (iii) Experience in construction and operation & maintenance (O&M) of transfer station, (iv) Experience in design, construction, operation and maintenance of waste processing facilities, and (v) Experience in design, construction, operation and maintenance of sanitary landfill.
- Financial Capacity: (i) Annual turnover, (ii) Net worth and (iii) Net cash accruals.

The net worth of the private players has been used as the main criteria to measure the financial capacity of the private parties. Net cash accruals statement was also sought from the private players during the RFQ stage. Additionally, in order to estimate the technical capacity, the private party should furnish information about the amount - (a) paid for, or received payments for construction of eligible PPP project (b) and/or commissioned received and paid for execution of eligible PPP projects (c) and/ or collected and appropriated revenues of eligible PPP projects. The sum of the value of payments relating to the above-mentioned category should be more than the threshold technical capacity (Planning Commission, 2014). Management of solid waste can be considered to comprise of a series of interconnected processes such as door-to-door collection, transportation of collected waste to transfer station, management of transfer station, treatment, and disposal. The projects, therefore, are screened based on the experience concerning each process, expressed in tonnes per day. Out of these 8 criteria, 2 criteria namely – 'experience in construction, O&M of transfer station' and 'net cash accruals' are discarded from regression analysis as it has been observed from content analysis of RFQ documents that they are less frequently used. It implies that transfer station experiences are either implicitly considered in other parameters or considered irrelevant. The remaining 6 criteria were subjected to regression analysis.

Regression Model

Regression models are used to identify the relation and the effect between independent variables and the dependent variables. For instance, Lee, Kim and Kim (Lee, Kim and Kim, 2006) used linear regression to find out the relation between the knowledge quality on the reward, top management support, and IT services and found that top management support is negatively affecting the knowledge quality. Casady (2016) determined the effects of project size on tendering length using regression analysis. The general representation of simple bivariate linear regression equation is $y=\beta_0+\beta_1 x$, where β_0 is the intercept and β_1 is the slope. The slope measures how much the dependent variable varies for each one-unit increase in independent variable whereas the intercept indicates the value that is not affected by the independent variable. In our study, there is a clear relation between the pre-qualification limits

and the project cost/ project size as supported by the extant literature and the content analysis presented beforehand. The effect of the independent variable on the dependent variable is the point of interest (refer notes of Table 4) and hence bivariate regression has been opted.

Bivariate regression equations have been developed for technical capacity limits and financial capacity limits for PQ of the two datasets, i.e., MSW projects and Highways. Table 4 presents the regression equations and corresponding coefficients. Theoretically, the variables used in the regression modelling were not collinear. This is because the variables – technical limit and financial limits – are checked for the past projects (ex-ante) and are applied in terms of project cost to the future (ex-post), more precisely, the project in hand.

Table 4 Regression models between project attributes and capacity limits

Variable	Regression Equation	R^2_{adj}	n	Mean
Highways (Average project cost of the sample = INR 1093.88 Cr)				
Technical Capacity	*TCH =108.873 - 0.004 PC*	0.012#	258	104.09
Financial Capacity	*FCH = 21.362 + 0.004 PC*	0.415	258	25.60
MSW (Average project size of the sample = 475 TPD)				
Technical Capacity for Collection	*COL = 288 + 0.63PS*	0.34	11	203.63
Technical Capacity for Transportation	*TRA = 245.27 +0.79PS*	0.36	14	197.50
Technical Capacity for Landfill	*LF= 106.30 + 0.202 PS*	0.13#	11	234.09
Technical Capacity for Processing	*PRO = 85.65a + 0.22 a PS*	0.17#	12	199.07
Financial Capacity for MSW Projects (Average project cost of the regression sample = INR 82.16 Cr)				
Min. Annual Turnover	*MAT= 31.93 + 0.06 a PC*	-0.16#	8	33.8
Min. Net Worth	*MNW = 31.83 + 0.124 PC*	0.268	14	33.45

Notes: TCH, FCH, COL, TRA, LF, PRO, MAT, MSW are the dependent variables while PC and PS are the independent variables.

a represents the items not significant at 10% significance level; # indicates poor R2adj. n represents the data points for the particular regression.

MSW projects: - Project Size in Tonnes per Day (TPD) – PS; Project cost in crore of Indian rupees – PC; Collection limit – COL; Transportation Limit – TRA; Landfill – LF; Processing – PRO; Financial capacity – FCS; Min Annual Turnover – MAT; Min Net worth – MNW;

Highways: - Technical capacity considered as percentage of project cost–TCH; Financial capacity considered as percentage of project cost – FCH (Dolla and Laishram, 2017);

Analysis and Discussion

In the regression equation, the point of interest lies with two coefficients namely regression constant and coefficient of the independent variable. The constant intercept gives the average

PQ limits without the influence of the independent variable. Then, based on the coefficient of independent variable, the increase of the PQ limits is suggested.

TECHNICAL QUALIFICATION

It has been observed that the technical capacity of most of the highway projects is close to 108.873% of the project cost, represented by the coefficient of intercept in the regression equation. Thus, the interpretation of these numbers is that, irrespective of projects cost, 108% of the project cost seems to be the technical capacity. In highway projects, there is not much significant variation in the technical capacity and financial capacity with variation of project cost (represented by the project cost coefficient of 0.004). This is justified in most of the projects adopted by NHAI, the nodal agency for implementation of national highway projects in India, as they have followed the Planning Commission's recommendation to set the technical capacity limit to 100% and financial capacity to 25% of the estimated project cost. Planning Commission (2014) has also specified that the maximum limit should be set as 200% of the estimated project cost.

All the projects, however, have not adopted the specified PQ limits set by the Planning Commission. The proportion of projects that have not adhered to the specified limit is about 23% of the sample. Amongst these projects, the PQ limits of some of the projects have been set as 50% of the prescribed PQ limits. Lower limits were used in case of some of the projects which have adopted the BOT (Toll) model where the private investors recoup their investments with tolls from users. On the other hand, a higher limit of 200% of the prescribed limits was adopted for some of the BOT (Annuity) projects. In case of BOT (Annuity) model, the traffic risk and revenue risk are taken care of by the government and therefore, high technical expertise has been set to limit the number of bidders, as the level of competition is quite high due to the reduced risk exposure to private entities.

With the maturity of the PPP market in India, the number of competent bidders for highway projects has also increased. Implementing agency, therefore, has further modified the minimum net worth based on the project cost. The minimum net worth has been set as 25% of the project cost for a project cost of below INR 20 billion, 50% of the project cost of INR 20-30 billion and 100% for a project cost of above INR 30 billion. The reason for setting a higher limit for high-value projects was to ensure that the project does not get delayed due to the participation of smaller firms in bidding for large projects that are beyond their capacity (Kumar, 2010). This has been a move to facilitate megaprojects, defined as spanning over 400 to 600 km and costing more than INR 50 billion, by bringing in very sound domestic and international companies.

On the other hand, PQ limits set by the ULBs for various PPP MSW projects do seem to reflect a different scenario from that of highways sector. Different limits for technical and financial expertise have been set for implementing projects relating to different phases of the solid waste process life cycle. It could be noted from the constant intercepts of regression equations that the trend indicates that higher PQ standard has been set for collection at about 288 TPD while for processing the limit has been set around 85 TPD. The minimum PQ limit set for the criterion 'technical capacity for collection' varies in the range of 9-80% of the project cost. The regression coefficient of 'project size' (PS) indicates that with the increase in project size by 1 TPD, the PQ limit for collection gets increased by 0.63 TPD. This might be a condition imposed by the implementing agencies to ensure that the prequalified private sector entity has the experience of handling collection of at least one project of size not less than half

the current project size. The mean of the sample for PQ limits for expertise in the collection is around 200 TPD. The mean PQ limit is lower than regression constant (i.e., 288 TPD). This might be an indication that the implementing agencies are assertive about the availability of enough expertise for handling projects of 200 TPD. The operational aspects of MSW projects are not repetitive but depend on various conditions like geographical location, and life style of people. It makes the experience of private sector different from the variation of the project size. So, after taking 200 TPD as benchmark, the technical limit for collection should be further increased by 50% of every additional increase of the project size and this would help in screening bidders with sufficient experience for the project.

The coefficient of the constant for the criterion 'technical capacity for transportation' in the regression equation is 245 TPD. This indicates that the minimum transportation expectation from the private sector is in the range of about 250 TPD whereas the sample mean is 197 TPD. This might suggest that if the bidder company (either new or local contractor) experience is less than 250 TPD in collection or transportation, the company will find difficulty in getting a new concession. Furthermore, the regression coefficient indicates that for an increase in 'project size' by one unit (1 TPD), the technical capacity limit for transportation also gets increased by 0.79 unit. This limit for transportation, set by the ULB, could be interpreted as the practice of factoring 80% of the project size into the transportation technical limit, beyond 250 TPD. However, this has been relaxed in some project like ISWM Agra where the bidder company expertise in other sectors of infrastructure is also taken into consideration. Respondent 1 opined that "…for old infrastructure sectors, number of private parties are predictable. Hence, a fixed guideline of PQ can be followed. But, MSW is a new concept, and there are less established bidders. Earlier, qualification was sought in term of the experience in other sectors and financial strength. Unless the success rate in MSW projects increases with the participation of a greater number of private parties, fixed guidelines cannot be followed". As it was also noted by Xia, Skitmore and Zuo (2012) that experience in similar projects is one of the prime aspects in PQ of the contractors. Projects in Lucknow and Bhopal have also adopted PQ based on the experience in implementation of infrastructure projects. In case of the Bhopal MSW project, PQ was done based on the experience in power sector experience as the supply chain and operation can be considered to be close to characteristics of waste to energy project taken up as part of MSW project.

The regression constant of landfill indicates that irrespective of project size, the ULBs tend to set a minimum PQ limit of 106.30 TPD for the technical capacity of disposal through the landfill. Also, from the regression coefficient, it can be noted that with the increase in project size by 1 TPD, the PQ limit for landfill also gets increased by 0.20 TPD. The mean of the sample for PQ limit of experience in management of landfill is around 234 TPD, and this value is significantly different from the intercept value. In this vein, respondent 4 surprising noted that "the operation of the sanitary landfill is independent of the capacity of the project." He justified his reasoning by referring to a project he handled, where, irrespective of the project size, ability to handle sanitary landfill itself was considered sufficient without any consideration of the size of landfill operated by them in the past. Also, this has been the case for the project at Berhampur of Orissa for which it was stated that the bidders should have experience of doing at least one integrated project. However, no conclusive insights can be drawn to reconcile the significant difference between regression constant and sample mean of technical capacity of the landfill.

The regression constant of processing indicates that irrespective of project size, the ULBs tend to set a minimum PQ limit of around 85 TPD. Furthermore, from the regression

equation, with increase in project size by 1 TPD, the PQ limit of processing also get increases by 0.22 TPD. Respondent 5 opined that the requirements of the project should be "close to the current project requirements. This means that the project size and its characteristics should be set as the limits for the bidders. He also added that "100% collected waste does not go to processing plant and landfill, so a minimum of 50% of collected waste is reasonable to estimate for treatment and disposal (landfill) of the waste". Hence, even though the analysis does not converge to a single statistic, the regression constant suggests that processing varies around 100 TPD. As these values are contextual to the values obtained from studies carried out for preparing the detailed project report, such field data dictates the PQ limits in case of processing. Furthermore, increase in project size above 100 TPD should be accounted for by increasing the technical capacity of processing by around 20%.

FINANCIAL QUALIFICATION

The financial capacity coefficient of intercept in highway projects has been observed to be 21.36% of the project cost. Thus, the interpretation of these numbers is that, irrespective of projects cost, 21% of the estimated project cost seems to be the financial capacity of the highway projects. For MSW projects, the average annual turnover of 3 financial years of the sample ranged from 27.37% to 320% of the estimated project cost. The minimum annual turnover of the bidder for PQ has been set based on the estimated project cost as well as the construction period. This is calculated as a ratio of project cost and construction period such that every year the project company will have that many funds during the construction period. This is to ensure that the project runs without financing problems, as recoupment of investments starts after the commercial operation date. In this vein, respondent 4 noted: "if the project fails, the company should be able to compensate the government." The mean annual turnover and net worth of the sample (INR 338 million; GBP 3.75 million) and the intercept of the regression equation (INR 319 million; GBP 3.54 million) is around 37% of the sample mean project cost (INR 821.6 million; GBP 9.12 million). This is higher than both the interview opinions and published literature. For instance, the Central Vigilance Commission (2002) of India has prescribed that the average annual turnover for the three financial years of 30% of the estimated project cost is enough for setting it as the PQ limit. The minimum level of turnover is set at approximately twice/three times the estimated annualized value of the proposed construction project. Also, as per the practices being adopted in Ireland, annual turnover of 30% of the project cost seems to be a reasonable value for setting it as the minimum standards (DPER, 2013). Specifically, the Health Service Executive (HSE) of Ireland has, in light of the prevailing construction market conditions, set the threshold value for the majority of the non-complex projects at, or close to, the lower level, i.e., twice the annualized project value. This measure will ensure that a wider range of contractors will meet this criterion (OGP, 2009).

Similarly, for MSW projects, the average net worth for the past three financial years varies between 20% to 186% of the estimated project cost. Respondent 3, in connection with minimum net worth, opined that "the financing structure in typical projects are expected to have a debt: equity ratio of 70:30. Thus, it is appropriate to set the minimum net worth at 30%". It is usual practice to set leverage ratio high (high debt) for highly risky projects and low leverage ratio for projects with a low-risk profile. This shows that ULBs are interested in ensuring that enough debt investment in the form of net worth is made by the private sector even before initiation of the bidding process. But, four projects to name a few, Ranchi, Dhanbad, Jamshedpur, and Chennai are the ones which have set very aggressive limit of more

than 100% of the project cost as net worth. Instinctively, the reason could be attributed to the following: all these projects are integrated waste management projects, and these projects are taken up in tier 1 and tier 2 cities. Furthermore, these ULBs also have shown their interest to arrest participation of unnecessary participants in the bidding process. The implication of setting a low financial capacity than the current trend would facilitate the companies to participate independently who had been executing in joint ventures with other major companies, thereby promoting local contractors. Another interesting observation on financial capacity is that, in the case of national highways projects, the financial health of NHAI is quite sound and the bidders normally do not take into consideration this aspect. But, in the case of MSW projects, the bidding response depends to a great extent on the financial health of the ULBs. Respondent 2 opined that "if the financial capacity is set high, few bidders will qualify for the work, resulting in a low level of competition thereby affecting the quality of the proposal. Private parties look into the financial health of the municipal corporation before participating in the bidding process". Hence, this should be considered in setting PQ limits because if the ULB has poor financial health, setting high PQ limits would jeopardize the participation of bidders.

Inferences

While the technical capacity of the highway projects is measured in project cost, MSW projects considered project size in TPD. The findings of highway projects could indicate a sort of saturation in the experience gained by the procuring authorities due to centralized governing body coupled with timely rules and regulations. This also could be because significant number of players in the road sector exists and the winning bidder is expected to perform similarly to the project in the past. But PQ limits of MSW are dependent on the field dynamics of MSW supply chain unlike repetitive national highway projects, which can be standardized. The apparent increase in variables of MSW project prequalification in comparison to highway projects could be attributed to sectorial characteristics rather than on the difference in robustness of the assessment. The analysis indicates that both technical and financial limits are over the recommendations of both the interviewed experts and extant literature, suggesting lowering the PQ limits in MSW sector. Based on our study, the minimum PQ (in approximation) for future projects could be in the range of 300 TPD for collection, 250 TPD for transportation, 100 TPD for disposal and 100 TPD for treatment for procuring the project having a size of 500 TPD, around which most of the projects are concentrated in India. For projects of higher size, it is better to consider multiple projects instead of single large project. This would ensure participation of experienced and competent bidders and screen out bidders with less experience that hinder strong competition in the procurement process. On the other hand, there exists inconsistency in the way financial limits are set in MSW projects. This could be due to the dynamics brought by 'viability gap funding' grant offered by the government as an upfront funding support for individual project, thereby introducing flexibility in the financial expectations from the private sector. Even then, financial capacity of INR 300 million (GBP 3.3 million) seems fitting for either annual turnover or net worth or both.

Regarding the deviations in the current practice, the experts' opinion indicates that stakeholders of PPP MSW of India, especially the individual ULBs who are the granting authority of the projects have not gained enough expertise in managing the PQ process. In the similar lines, Russell and Skibniewski (1988) have also stated that owner's experience is one of the factors which affects the execution of the PQ process. When the owners are

one-timers, which is the case with MSW projects, the owner (i.e., ULB) is less aware of the appropriateness of the set PQ limits. Capacity building exercise, therefore, should extend beyond training on bid evaluation process to include managing and designing of the PQ process also. This is important given the new insight from the current study that the level of bidders' participation depends on competency level of ULBs as well.

Another inference from the study is the comparison of PQ with that of contractor selection procedures followed in the traditional and Design-Build procurement. The criteria of PQ are quite simple when compared with the robustness of other procurement systems. The reason for this could be that the granting authorities might have wanted to keep the PQ simple on purpose to facilitate a thorough analysis in the bid proposal stage. Besides, if the sector of interest is in very nascent stage, then these criteria will tend to be basic and minimal in their robustness to shortlist a competitive bidder for RFP stage (Estache and Iimi, 2009). This has been reflected in Indian MSW projects. Nevertheless, PPP PQ has to incorporate other dimensions like past performance related metrics apart from technical and financial assessments in the prequalification process. This is owning to the poor performance of past MSW projects, specifically in the treatment segment. Thus, technical competence must include litigation history. The current prequalification criteria are also missing to have other important aspects such as health and safety concerns, reputation/past performance on quality and time, managerial capability, quality assurance.

Conclusions

Extant literature on procurement theory discusses only about criteria of prequalification in construction industry. This reported study, therefore, attempts to advance knowledgebase on the theory of procurement management of infrastructure projects to PPPs by extending the current focus on identifying the criteria for prequalification to setting the limits of the PQ criteria for MSW projects. And, this has been done by identifying and analysing the PQ limits of PPP MSW projects in India and then comparing it with the national highway PPP projects in India. The findings indicate that the factors governing the prequalification of MSW projects can be grouped under technical and financial aspects which is further divided into six criteria whereas in highway projects the prequalification is based on the broad two categories of financial and technical capacities only. The findings indicate that in case of national highways the prequalification limits converged to a common value whereas, in case of MSW, there is wide variation between the limits being used in procurement of the MSW PPP projects. Prequalification limits used in MSW PPP projects are highly dependent on the project size whereas in the case of highway projects it is less dependent on the project size. This study indicates that there are inconsistencies in the practices being adopted in prequalification in India from the theory. The study suggests that it will be necessary to lower the prequalification limits to support the current state of practice so much that competent bidders would be participating in the tendering process. The inferences drawn from this study could be further validated with larger samples of other developing countries. This would help to overcome the limitations of a sample being small and help to increase the accuracy of the findings.

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