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Solving Transportation Network Design Problem with MARKOV Traffic Assignment

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Abstract

This research aims at reformulating the continuous network design problem in stochastic system optimum (SSO) bi-level programming. In the lower level, the traffic flow follows a stationary distribution in a Markov chain of driver's day-to-day stochastic route choice adjustment process based on logit model, while the upper level programming is to minimize the expected total travel time of the entire network by optimally determining the link enhancement capacities subject to a fixed budgetary constraint. Considering the nonnegative property of the link flow, it is assumed that the link flows are truncated multivariate normal distributed, then higher order conditional moment of link flow is discussed for the upper objective function. Furthermore, given the non-differentiable property of the objective function, genetic algorithm is implemented to solve this bi-level SSO problem in a small network model with two OD pairs, in which the capacity enhancement on several randomly selected links subset is studied.

Keywords: Network Design, Stochastic Flow, Markov Traffic Assignment, Truncated Multivariate Normal Distribution

1. Introduction

In general, network design problems (NDP) are mainly concerned by two groups: network planners and network users. The continuous network design problem (CNDP) always deals with optimal expansions for the capacities of a traffic network. It has been long recognized that to minimize the system total travel cost is one of the major objectives for transport managers. Meanwhile, from a traveler's perspective, his or her objective is to reduce their own travel cost as much as possible; therefore, the deterministic user equilibrium is widely assumed to model a traveler's rational route choice behavior. Therefore, a bi-level programming formulation has been proposed for the network design problem due to the multiple objectives for formulating CNDP. In a bi-level formulation, the upper level is to minimize the system total cost and the lower level is to solve the corresponding parametric deterministic user equilibrium as a nonlinear complementarily problem, where the parameter could stand for the road capacity expansion.

Public Procurements Rules and Low Bidder

Dilemma in Pakistan

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Abstract

The low bidder dilemma is one of the basic impediments to the procurement of quality goods and services in the public sector. The selection of lowest bidder without checking the technical reasonability of the bid, severely impact the schedule, cost and technical performance (CST) of the projects. Hence the successful project execution becomes an uphill task for the project managers. The Public Procurement Regulation-Pakistan 2004 has provided different options for the cost and quality effective solutions in the procurements of good and services in public sector of Pakistan. In this paper, these options have been discussed and applied to the practical situations, thereby eliminating the trap of low bidder dilemma. The results have shown that if carefully administered, these options can help in procuring the cost and quality effective goods and services.

Keywords: Low Bidder Dilemma, Quality, Goods, Services, Public, Procurement.

1. Introduction

Project is defined as “A unique one time effort bound by cost time and technical performance and has defined objectives to satisfy the customers’ needs” Procurement refers to acquisition of goods and services. The Project Management Institute PMI, has defined projects in a very simple

way as “An endeavor to create a unique product or services” The success of the project lies in its completion within the given time (Schedule), Cost, Quality and scope with an aim to achieve the objectives of customer satisfaction. The Cost, Schedule and Technical performance (CST), of the projects are also referred to as Triple constraints of the projects

Project Management Institute (PMI) in their famous book; Project Management Body of Knowledge (PMBOK) [1] has identified basically nine knowledge areas for the successful project management as identified by

- i. Risk Management
- ii. Time Management
- iii. Scope Management
- iv. Procurement Management
- v. Human Resource Management
- vi. Integration Management
- vii. Quality Management
- viii. Cost Management
- ix. Communication Management.

David I. Cleland and William R.King defined procurement as acquisition of goods and services. Procurement Management is one of the most important knowledge areas for successful Project managers, which include mainly the following activities;

- i. Procurement Planning
- ii. Solicitation Planning
- iii. Source selection
- iv. Contract Administration
- v. Contract closeouts

The open bidding process is usually followed in the procurement process, where the lowest reasonable prices in normally adopted as decision criterion for award. However at times, the low

bidder dilemma makes the procurement process non responsive, sub standard and cumbersome. Krizner has reported that the true spirit of cost and quality effective and time efficient procurements are many times lost by becoming victim of the low bidder dilemma. Hence due care must be exercised to avoid the vicious circle of low bidder dilemma.

V. Leopoulos et al. suggests that project based industries should integrate the "strategy of risk management" during the bidding process in order to invest in bids leading to profitable projects.

William Saxby claims that it may not be rational to bid "honestly" in a lowest price tender. He further elaborates that lowest price selection procedures can be expected to exacerbate the situation because they create a Prisoners' Dilemma between the competing contractors, making it rational to bid at unrealistic profit margins. He has proposed two stage game theory for bidding in construction projects.

Frédéric Boehm and Juanita Olaya argue that a possible strategy in complex contracts with resubmissions is called 'low-balling'. A bidder submits a very low bid just to enter into negotiations with the seller and then make use of his bargaining power in contract negotiations and renewals leading to corruption many tiems.

Lengwiler Y. And Wolfstetter observed that '*corruption cannot work in an open-bid auction simply because it lacks secrecy.*' This is oversimplified and stems from neglecting to consider the whole process. Even open bids have confidential stages or confidential pieces of information. Open auctions may indeed hamper, but not fully eliminate corruption. The pooling of contractor and bidders is a common corrupt practice in the public procuremnst.

The public procurements in Pakistan are mainly regulated by Public Procurement Authority (PPRA) and policy guidelines have been issued under PPRA-Regulations 2004 The basic spirit of the PPRA is to ensure quality procurement of public goods and services through competitive and transparent process. PPRA is continuously monitoring the advertisements, the terms and conditions of the procurement process, the decisions criterion and other related issues in the public procurements. To ensure both quality and cost effectiveness, PPRA has given different procurement options, such single envelop one stage biding, two envelops one stage and two envelops two stage bidding process.

In this paper these various options for the public procurements have been discussed and applied to real case studies in the procurement of goods and services. It has been observed that the options, if carefully exercised can lead to cost and quality effective procurements. The guidelines are even suitable for projects and procurements in private and Non for profit organizations.

2. Significance of Work

The work will help the project managers in the public sector of developing countries to apply various options for the cost and quality effective procurement of goods and services.

3. Low Bidder Dilemma and its Consequences for Organizations

As general financial norm, the lowest bidder is usually selected for the procurement of goods and service both in public and private sectors. The bids quoted by the bidders in some cases are not based on current market information and Government fiscal policies. Again the competition for winning the bids at times, forces the competing firms to quote very low bid which may not be practicable. However the financial rules generally doesn't support to reject this apparently lowest but practically not possible bid. The procurement Manager becomes victim of Low Bidder Dilemma. Timothy J.Havranec has reported that the low bid has negative consequence both for the procuring agency as well as the bidder

3.1 Consequences of Low Bidder Dilemma for the Organizations

- The lowest but impractical bid lead to vicious circle of delays, wastes, more overheads cost and ultimately poor quality. This makes the successful completion of the projects in terms of its cost, scope, time and quality an uphill task.
- The sub standard procurements lead low service life of the goods and services and high lifecycle costs.
- The image of the procuring office is marginalized as the ultimate users are more quality conscious and have generally little or no information about the costs of products and services.

- In projects environment, the low and impractical bids diverts the attentions of the project managers from important tasks to small and minor activities, which ultimately affect the progress.
- The bidders make efforts to minimize his costs and other overheads to complete the procurements within the quoted and approved lowest price and provide sub standard items, which often becomes the source of conflicts. These conflicts lead to litigation and wastage of time and resources of the organization.
- In addition to high life cycle costing of such procurements in terms of maintenance, up keeping and support prices, the execution price also tends to be high due to more supervision costs, rejection and wastages.
- The image of procuring agency severely affects as the lack of quality is viewed as discredit and inefficiency of the agency.

Thus the lowest bidder without rational justification is never turning in the interest of procuring organizations.

3.2 Consequences of Low Bidder Dilemma for the Bidding Firms

According to David I. Cleland, good organizations never indulge in lowest bidder dilemma due to the following reasons;

- Unrealistic low bids reflect the poor credibility of the organizations and contractors as mature and experienced organizations workout their bids after detailed analysis based on market current information.
- The failure to deliver the required quality within time and cost can lead to bad image of the firms. In many cases the regulatory authorities black list, debar the firms.
- Successful completion of projects for the contractor also becomes a Herculean task as profits margins are offset by low and unrealistic bids and the profitability of the firms is severely affected.

- The high costs in terms of imperfect supplies, and rejected works further aggravates the profitability and the projects become sick and redundant.

The lowest but impractical bids are mainly quoted due to lack of sufficient information with the bidder, the non familiarity of the firms with the nature and quality of procurements and sometimes with malicious intentions to supply sub standards goods and services. Mature and stable organizations, therefore workout their bids in a systematic manner. In many cases they have developed standards customized software to workout the bids and refrain from quoting unrealistic bids. However this care provides an opportunity to the inexperienced and typical low bid operating to firm to win the procurements.

To avoid the low bidder dilemma, the procurement process must follow an intelligent and proactive approach of filtering the unrealistic bids. However this process must not scarify the objectives of transparency, quality effectiveness and competition as basic guidelines for procurement and envisaged in the PPRA Rules-2004 of Pakistan.

4. Procurement Methods

Wideman, R.M has discussed a number of procurement methods for the acquisition of goods and services, some of which are given below

4.1 Cost plus methods:

Cost plus percentage

- Cost plus fixed fee
- Cost plus guaranteed maximum and shared saving
- Cost plus incentive
- Cost plus cost sharing

4.2 Fixed Price contracts

- Fixed price or lump sum
- Cost price with re-determination

- Fixed price plus incentive fee.
- Fixed price plus economic price adjustment
- Fixed price with successive targets incentives
- Fixed price for service material and labor at cost.
- Time and material labor hours only.

4.3 *Others methods:*

- Turnkey
- Bonus - Penalty
- Joint venture
- Combination of the above

There are many other procurements methods, however the most commonly used technique in the public procurement is fixed cost methods, where the price for certain specified goods and services are solicited from the bidders. In some cases of civil and infrastructure projects, the base price is worked out on the basis of certain standard estimation manuals and the bidders quote their fixed price for the work including premium in percent above the base price. This is also fixed price contract but the fixed price is arrived on the base of some standard base pricing. [Meredith and Mantel]

5. Major methods proposed for public procurements

PPRA has made an earnest effort to ensure both cost and quality effective procurements in the public sector. The basic principles of procurement as given in the article 4 of the PPRA Regulations-2004, provide the basic spirit for the public procurements as

“Procuring agencies, while engaging in procurements, shall ensure that the procurements are conducted in a fair and transparent manner, the object of procurement brings value for money to the agency and the procurement process is efficient and economical.”

Following three methods have been proposed by PPRA.

5.1 Procedures of open competitive bidding

5.1.1 Single Stage One Envelope Procedure

Each bid shall comprise one single envelope containing, separately, financial proposal and technical proposal (if any). All bids received shall be opened and evaluated in the manner prescribed in the bidding document.

This kind of bidding is usually recommended for routine and repetitive kinds of procurements, where technical parameters of the procurement items are carefully laid down and the specifications are detailed and exhaustive to ensure quality and cost effectiveness. The technical proposal is solicited mainly to compare the specification of the requisite items and those quoted. To discourage the monopolistic trends in the procurements, PPRA requires that the specification of the procurement should be generic and not based on brands. The clause 10 of the PPRA rules states as;

Specifications shall allow the widest possible competition and shall not favour any single contractor or supplier nor put others at a disadvantage. Specifications shall be generic and shall not include references to brand names, model numbers, catalogue numbers or similar classifications. However if the procuring agency is convinced that the use of or a reference to a brand name or a catalogue number is essential to complete an otherwise incomplete specification, such use or reference shall be qualified with the words "or equivalent" .

Single stage one envelope bidding procedure shall ordinarily be the main open competitive bidding procedure used for most of the procurement not involving too many technical parameters and routine procurements.

5.1.2 Single stage Two Envelope Procedure

- The bid shall comprise a single package containing two separate envelopes. Each envelope shall contain separately the financial proposal and the technical proposal.
- First the technical proposal is opened and evaluated on the prescribed criteria given in the Request for Proposal (RFP), without opening the financial proposal. The technical proposal is scored on some quantitative scale already provided to the bidder. Technical

proposals not conforming to the specification or desired level of score are rejected and the financial proposals of qualifying bidders are publicly opened. The financial proposals of the bidders not qualifying the technical parameters of evaluation are returned unaccepted.

- The evaluation ratio of total score for technical and financial proposal may range from 50:50 to 80:20, depending on the nature of procurement, its technical complexity and competitive position in the market. Generally for IT projects a scale of 70:30 is preferred. The financial score of the firm is determined as

$$\left(\frac{\text{Bid quoted by the lowest firm (US\$)}}{\text{Bid quoted for the firm being evaluated}} \right) \times \text{total Score assigned for financial proposal.}$$

The bid of the firm obtaining highest score is selected, which can be both technically feasible and financially viable.

Single stage two envelope bidding procedure is used where the bids are to be evaluated on technical and financial grounds and price is taken into account after technical evaluation. The procurements involving too many technical and specialized parameters are made with this method.

5.2 Two stage bidding procedure

- i. The bidders shall first submit a technical proposal without price according to the required specifications, which is evaluated on the prescribed criteria. The deficient parts of the proposal are discussed with the bidders and they are allowed to re-submit their revised technical proposal after making up the deficient parts. However those bidders not ready to revise their technical proposals may withdraw their proposals at this stage.
- ii. The revised technical proposal and the financial proposal are then opened and evaluated in the manner prescribed above. The bid found to be the lowest evaluated bid shall be accepted, or in other words the bidder getting the highest marks is selected.

Two stage bidding procedure are adopted in large and complex contracts where technically unequal proposals are likely to be encountered and the procuring agency provides an opportunity

to the bidding parties to clarify certain technical parameters of the bids quoted. Two stage procedures are best suited for hiring design and consultancy services.

5.2.1 Two stage - Two Envelope Bidding Procedure

- i. Single envelopes containing two envelopes separately for Technical and Financial proposals are received. The technical proposals are opened and discussed with the bidder with reference to the technical requirements of the procuring agency. Those firms willing to meet the requirements are allowed to revise their proposals. Those bidders not ready to change their technical proposals may be allowed to withdraw their bids.
- ii. The bidders agreeing to revise their technical proposal in the light of detailed discussions may be allowed to submit supplementary financial proposal according to revised requirements.
- iii. The revised technical proposal along with the original financial proposal and supplementary financial proposal are later opened at a date, time and venue announced in advance by the procuring agency.
- iv. The procuring agency shall evaluate the whole proposal in accordance with the evaluation criteria and the bid found to be the lowest evaluated bid shall be accepted.

Two stage two envelope bidding method are used for procurement where alternative technical proposals are possible, such as certain type of machinery or equipment or manufacturing plant

6. Case Study

Use of PPRA-Rules for Procurement of Consultancy Services at Allama Iqbal Open University-Pakistan.

7. Background

Open and Distance Learning provides a unique opportunity to those who cannot afford formal University education due to their socio-economic, socio-cultural and demographic conditions. Pakistan is a developing country with per capita income less than US\$1000 and majority of the

160 million populations belongs to lower middle and poor class. A great majority of these people are placed in the rural areas, where access of education cannot be ascertained through formal education system. Allama Iqbal Open University (www.aiou.edu.pk) was thus established in 1974 at the model of UK Open University. The University during last 30 years has been recognized as a mega national institution providing education to 800,000 students in science, social science and humanities. Presently University offers about 1000 courses and 120 programs from elementary to doctoral levels. The faculty wise student's enrolment and growth trend has been given in Table1.

The average growth rate in enrolment is 15% per annum and University is meeting all of its operating expenses from its won revenue mainly generated from student's fee.

8. Problem

To face the growing challenges to open and Distance Learning (ODL), a mega project “**Strengthening of Allama Iqbal Open University-Pakistan**” has been approved by Government of Pakistan, under Higher Education Commission for cost of US \$ 7 million, to improve the course development, delivery, and assessment and students support services to the students of AIOU. Consultancy services were required from expert ICT firms in the following four areas;

- i. University Information Management System.
- ii. E-Learning Management System
- iii. Data Communications System
- iv. Human Resource Training and Development.

Hence cost and quality effective consultancy services were required for the projects, which can ensure completion of the mega project with the triple constraints of Cost, Schedule and Technical performance (CST). The conceptual model of the ICT project has been shown in Fig.

1

9. Procurement Procedure Adopted for Hiring the Consultancy Service for the projects.

Single Stage Two Envelop Procedure was adopted for procurement of the consultancy services and the following step by step process was followed;

- i. The Expression of Interest (EOI) was published in the national dailies, describing generally the problem and soliciting interest of the interested firms.
- ii. In response of the EOI notice, 12 firms submitted their EOI for participating in the consultancy services.
- iii. The profiles and credentials give by the firms were checked on the basis of following qualitative information and five firms were pre-qualified for the consultancy.
 - a. Type of firm, year of establishment, year of services rendered, organization.
 - b. Certification and registration with different national and international bodies.
 - c. Names and references of clients where ICT projects were completed.
 - d. Names, nature and completion costs of ICT projects completed during last five years.
 - e. Financial soundness with bank references.
 - f. Completion certificates from clients.
 - g. Notarized list of professional, skilled, semi-skilled and administrative staff and profiles as well as list of tools, plants equipment etc.
- iv. Terms of Reference of the four consultancy packages were sent to the pre-qualified firms to submit their Technical Proposal and Financial proposal under two envelop two stage procedures. The weight for Technical and Financial score was given as 70:30.
- v. Following quantitative scale was developed for scoring the technical proposal;
 - a. Consultants Qualification and Experience on similar projects: 20 Marks
 - i. Qualifications (Registration/certification/accreditation) 05 marks
 - ii. Experience in years (one mark per year) 05

iii. History of successful projects completion	05
iv. Relevance of experience to the project.	05
b. Availability of Human and Non-Human Resources.	<u>20 Marks.</u>
i. Teams and its Leader (Knowledge Skills and Attitudes)	05
ii. Financial Soundness (Bank References)	05
iii. Material and equipment	05
iv. Literature/technical data	05
c. Current National and International partners	<u>10 Marks.</u>
i. National partners with proof of JV agreement	05
ii. International partners with proof of agreement	05
d. Quality of work programming and scheduling:	<u>25 Marks</u>
i. Quality of proposed technical solution and work	10
ii. Timelines and targets (Milestones data)	10
iii. Scheduling (Master schedule, WBS)	05
e. Project Support strategy.	<u>15 Marks</u>
i. Methodology	10
ii. Support Services	05
f. Proposal presentation on power point	<u>10 Marks</u>
i. Presentation skills and project knowledge	05
ii. Responses to the Questions and answers	05
	Total 100 Marks.
vi. An advisory committee comprising ICT experts was constituted and the technical proposals were sent to them for their evaluation giving the reasons for awarding different scores.	

vii. Delphi technique was used to arrive at the consensus technical scores for each of the five consultants. Their individual score under each set of consultancy services was finalized.

viii. The financial bids were opened in the presence of the five bidders and their financial score was worked out on the following ratio, the lowest financial bidder getting the maximum 30 marks;

$$(\text{Lowest Bids quoted (\$) / Bid being evaluated }) \times 30$$

ix. The total score of the consultants was worked out as;

$$(\text{Technical Score} \times 0.7) + \text{Financial score.}$$

Consultant obtaining highest score each consultancy was awarded the work package on consensus.

10. Conclusion

Procuring organizations can avoid becoming the victim of lowest bidder dilemma, by using the different bidding option to ensure both quality and cost effective solutions in acquisition of goods and services.

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Vice Chancellor Report Allama Iqbal Open University Islamabad-Pakistan. ([www.aiou.edu..pk](http://www.aiou.edu.pk))

Table1: Faculty wise student enrolment of AIOU(2006)

Faculties	4
Departments (Academic)	35
Research Centres & Institutes	3
Programs Offered	135
Courses produced & Offered	1200
Students Undergraduate	221621
Students (Bachelors & Masters)	363854
Students (M. Phil & Ph. D)	896
Others (Diploma & Certificates)	118331
Total Students Enrolment	704702

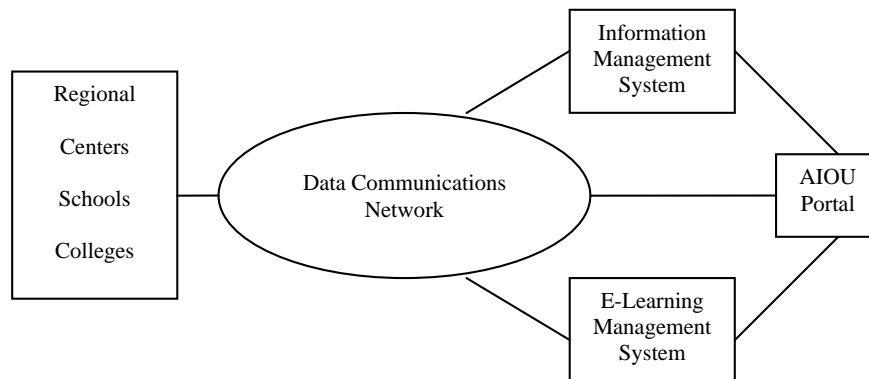


Fig 1: Conceptual Model of the mega Project ‘‘Strengthening of Allama Iqbal Open University’’