A Causal Model of Dwindling Bidder Size in Government Procurement Auctions – A Case Study

Sidhartha S. Padhi[1]* and Pratap K. J. Mohapatra[1]

ABSTRACT

Assigning the work contract to the bidders in government procurement auction is influenced by many factors directly and indirectly. Therefore, there is a need to study the cause and effect relationships among the processes in government procurement auction. This paper attempts to develop a dynamic model of factors and their relationships in order to explain the phenomena of dwindling bidder size. We have considered factors like number of bidders, bid price qualification level, bid period, work content, and collusion among the bidders to develop a system dynamics model. We suggest that allowable profit margin and work content should be properly designed to get a reasonable number of bidders.

***Keywords**:* Government procurement auction; System dynamics; Bid period; Bid price; Collusion

1. Introduction

Government departments and agencies purchase a huge variety of goods and services from the private sector through Tender (RFQ, NIT)/Auction. It is often observed that number of bidders participating in auctions shows a declining trend leading to high values of winning bid price (Gupta, 2002; Lunander, 2002; Iimi, 2006).The current paper attempts to develop a dynamic model of factors and their relationships in order to explain the phenomena of dwindling bidder size. Getting a work contract by competing through RFQ (Request for Quotation) is not of much interest for many bidders due to its marginal efficiency in earning profits. In addition, there is no competition among the bidders which leads to lack of motivation in participating in bidding process. This is because the bidders are not allowed to make profits on work contract. So, there is a dying interest of participation in the bidding process which leads to loss to the government.

Many large government systems find it difficult to develop a strategy for efficient procurement of items. The government as a buyer needs to know how this purchasing is done, whom to contact and, importantly, how to find the efficient way of submitting a competitive tender and setting the reserve price to earn maximum revenue. In government, items for roads and bridges, buildings, irrigation and rural works, among others, are purchased through tenders or quotations. *Procurement Auction* is a market mechanism in which an object, service, or set of objects are being purchased, rather than sold, to the auctioneer. The auction provides a specific set of rules that will govern the purchase to the submitter of the lowest bid. The specific mechanisms of the auction include first and second price auctions, and *English and Dutch auctions.* The government often uses procurement auctions. In this paper we have tried to capture the

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mental image of bidders to make our causal model to explain the relationships among the different factors of government procurement process.

2. Reference Mode

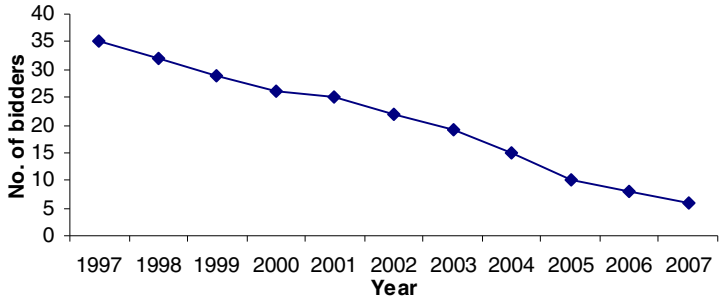

Figure 1: Bidder size variation over the years

When we plot the number of bidder participation over the last 11 years in Pradhan Mantri Gram Sadak Yojna (PMGSY) and national gram sadak program we got a graph like above (Graph-1). This shows that the number of bidders over the years decreases for different causes to define those hidden causes we have tried to make a causal model of the system.

3. Literature Review

After the literature review, we found that auction theorists put more effort on designing an auction that generates maximum revenue (Janssen, 2004). However in some cases it is very difficult to change or modify the auction mechanism. These types of auctions are mostly seen in government or semi-government organizations. In these organizations many factors like; tendering procedure, bidding period, splitting of work content, and allowable profit margin influences the auction procedure. This multiplied with the averseness of the government officials for a change of the age-old mechanism makes a redesign of the government auction mechanism difficult. In such an environment it is a better strategy to reengineer the traditional auction mechanism considering all those factors that influences in profit generation (Ong, 2005).

Table 1: Factors influence the procurement out come

Factors	Authors
No of bidders participating	Phlips (1996); Iimi (2006); Lunander (2002); Gupta (2002)
Bid price	Topcu (2004); Klemperer (1999)
Actual profit margin	Lai *et al*. (2004)
Average profit margin earned by the winner	Lai *et al*. (2004)
collusion	Phlips,(1996); Marshall and Marx (2006)
Reserve price	Menezes and Ryan (2005)
Estimated cost	Patil (2006)
Work content	Dutta (2003)
Task complexity	Bajari and Summers (2002)
Allowable profit margin	Bierman and Fernabdez (2005)

Going through literature and asking to the export we come across different factors that directly or indirectly influence the auction outcomes (Tble-1).

4. Causal Model of the Government Procurement Auction

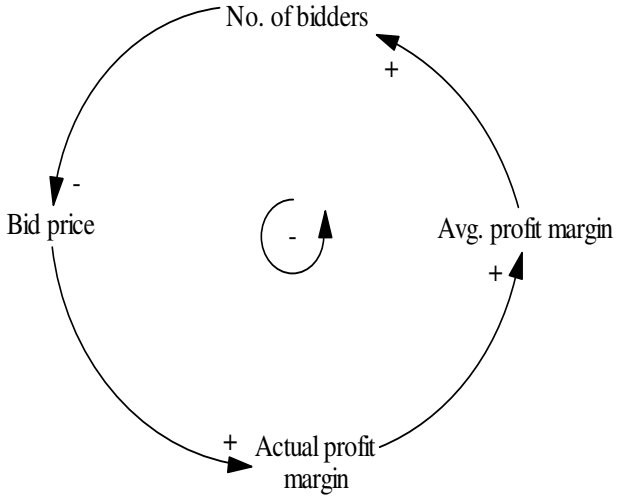

Figure 1: Causal loop considering bid price

Number of bidders participating in an auction is assumed to depend on bid price. Higher the number of bidders lowers the winning bid price. Actual profit margin depends on the winning bid price higher the bid price higher will be the profit margin so higher the average profit margin (Figure 1).

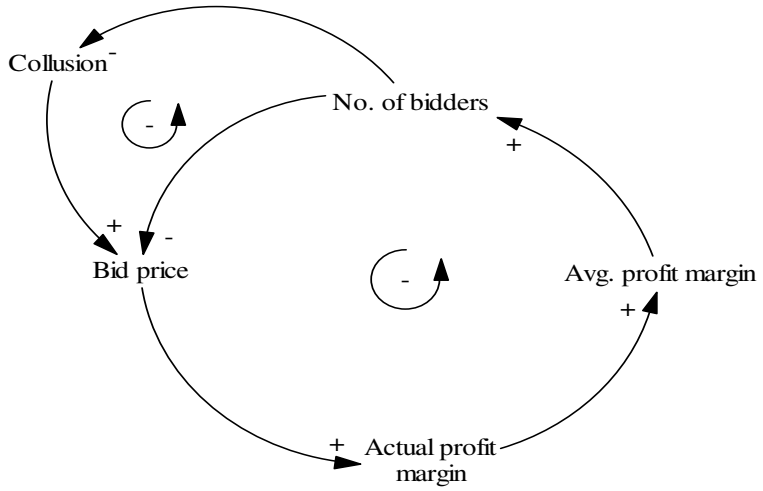

Figure 2: Causal loop considering bid price and collusion

In Figure 2, Number of bidders participating in an auction is assumed to depend on collusion that is, as the number of collusive bidders increases, it directly affects the number of biding participant in the auction. Bid price in terms depend on size of participating bidders and collusion (Gupta, 2002).

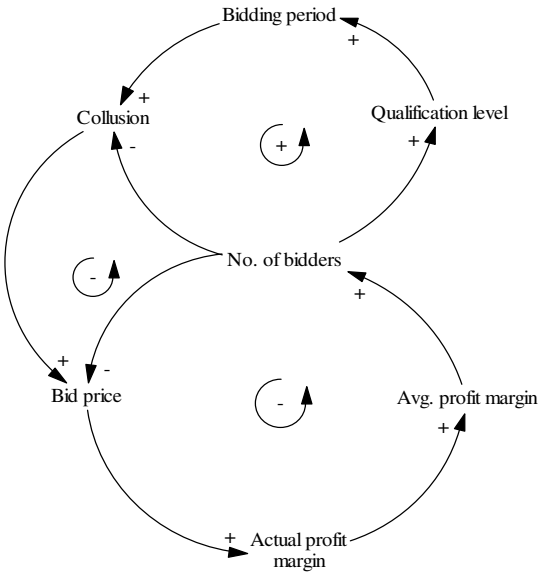

Figure 3: Causal loop considering different auction related factors

Next we consider that the collusion among the bidders rise when the bidding period allowed is high. It is further assume that the government raises the minimum qualification level of the intending bidders in order to achieve better service level. Usually a higher minimum qualification level is associated with higher bidding period (Figure 3).

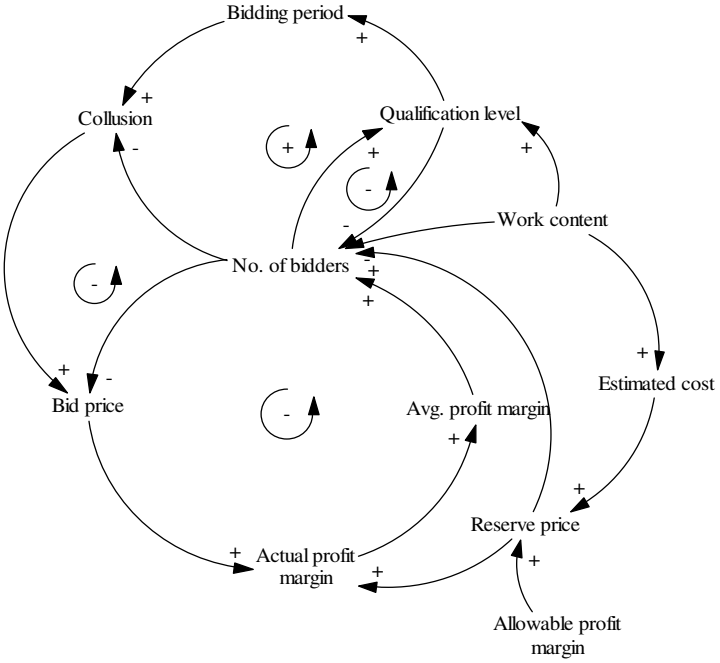

Figure 4: Causal model of the government procurement auction

Finally we can draw (Figure 4) the causal model considering all the influential factors. When reserve price increases, the number of bidders increases. Similarly increase in work content increases the estimated cost, which in turn increases the reserve price. When reserve price increases, the allowable profit increases which leads to increase in average profit margin earned by the winner. This results in an increase in the number of bidder in the next round of auction (repeated procurement auction). However, when collusion takes place, the numbers of bidders decrease, leading to an increase in the bid price.

5. The System Dynamics Model

Figure 5 shows a stock-flow diagram of the procurement process prevailing in many government departments.

Stock Variable:	Number of Bidders
Flow Variables:	Bidder Increase Rate
	Bidder Decrease Rate

The model defines thirty auxiliary variables and eight parameters. Of these, three are auction-related parameters, one smoothing parameter, and two parameters related to bidder growth. The model defines seven table functions to define the structural relationships between various variables. Fig. 6 through Fig. 8 show table functions for three important structural relationships defined in the model.

Appendix gives the complete model listing.

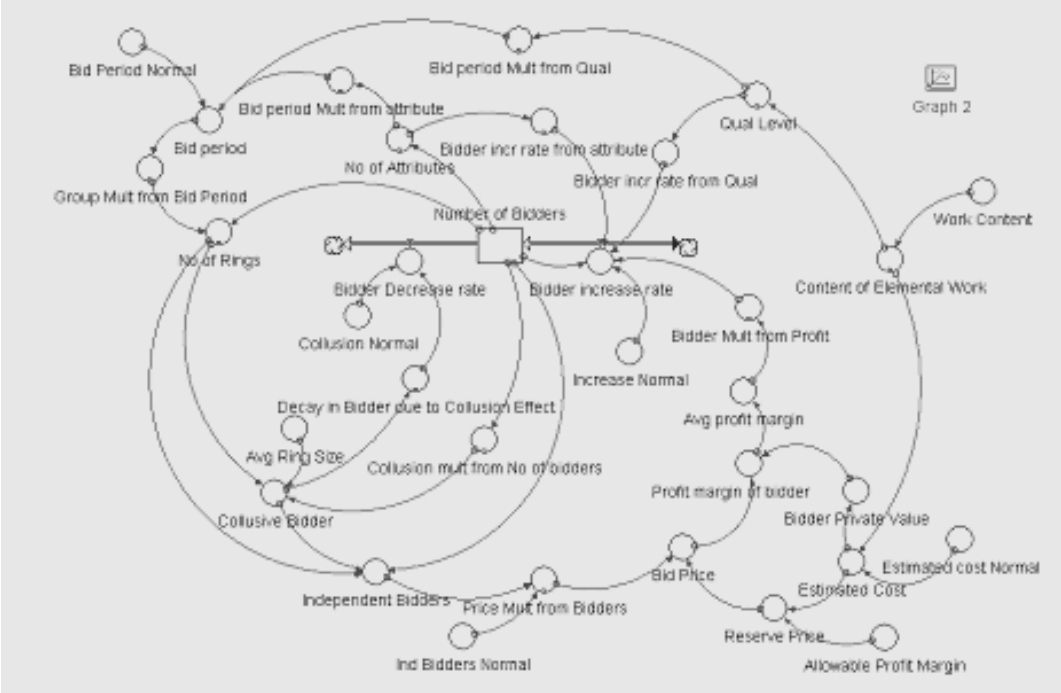

Figure 5: Stock flow diagram of the government procurement auction

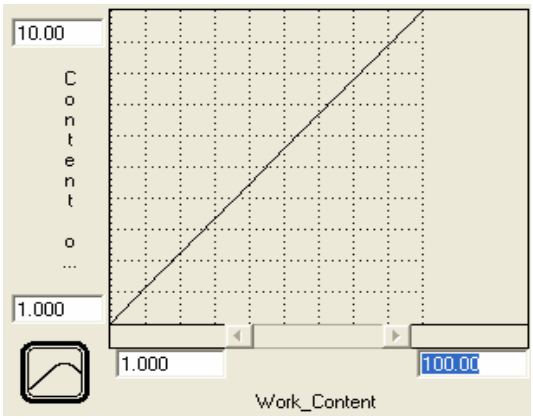

Figure 6: Content of Elemental Work vs. Total Work Content

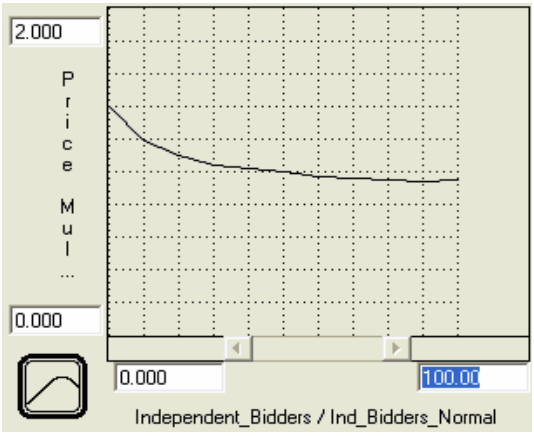

Figure 7: Price Multiplier from Bidders vs. (Independent Bidders/ Independent Bidder Normal)

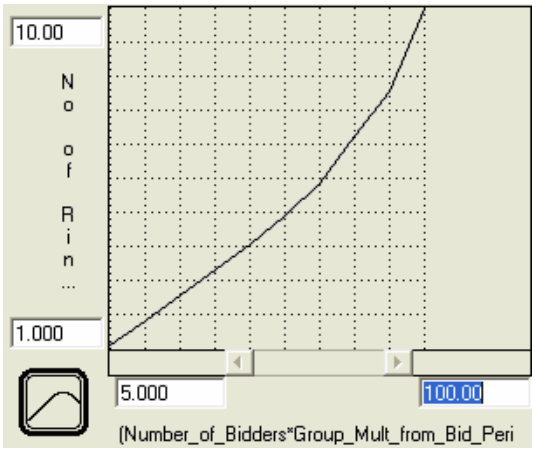

Figure 8: Number of rings vs. (Number of Bidders * Group Multiplier from Bid period)

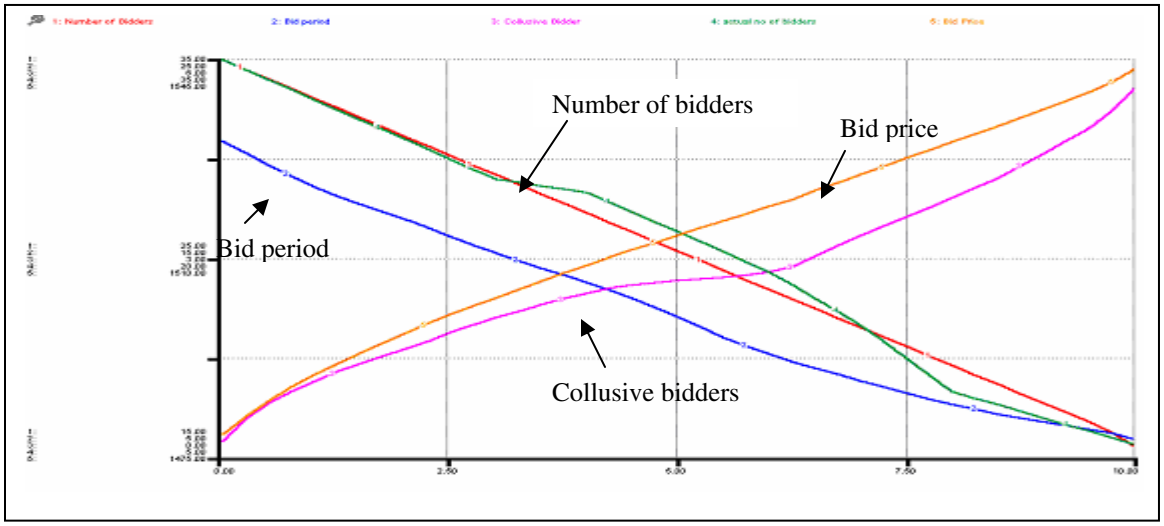

Figure 9: Simulated result considering number of bidders, number of collusive bidders and bid price in government procurement auction

5. The Model Simulation

For the purpose of simulation, we used the following parameter and initial values:
Number of bidders: 35
Bid period normal: 21 days
Work content: 100 kilometers
Allowable profit margin: 12% of estimated cost
Average ring size: 5
Collusion normal: 20
Bidder increase normal: 10
The model was simulated using STELLA. The solution interval, DT, was taken as 0.25 day and the model was simulated for 3,650 days.

Discussion

From the simulated result we found out that when number of bidder decreases bid price ;increases and also collusive bidder increases.

6. Concluding Remarks

This is the beginning of the study and we will add other features to test our model in near future and try to integrate the factors that influence the electronic procurement auction and try to test different policy and options to increase the profit for the government.

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Appendix

Number_of_Bidders (t) = Number_of_Bidders (t - dt) + (Bidder_increase_rate - Bidder_Decrease_rate) * dt
INIT Number_of_Bidders = 35

Inflows:
Bidder_increase_rate =
Number_of_Bidders*Increase_Normal*Bidder_incr_rate_from_attribute*Bidder_incr_rate_from_Qual*Bidder_Mult_from_Profit

Outflows:
Bidder_Decrease_rate = (Decay_in_Bidder_due_to_Collusion_Effect*Collusion_Normal)
Allowable_Profit_Margin = 0.12
Avg_profit_margin = SMTH3 (Profit_margin_of_bidder, 2)
Avg_Ring_Size = 5
Bidder_Private_Value = Estimated_Cost
Bid_period = Bid_period_Mult_from_attribute*Bid_period_Mult_from_Qual*Bid_Period_Normal
Bid_Period_Normal = 21
Bid_Price = Reserve_Price*Price_Mult_from_Bidders
Collusion_Normal = 20
Collusive_Bidder = Avg_Ring_Size*No_of_Rings*Collusion_mult_from_No_of_bidders
Estimated_Cost = Estimated_cost_Normal*Content_of_Elemental_Work
Estimated_cost_Normal = 100
Increase_Normal = 10
Independent_Bidders = (Number_of_Bidders - Collusive_Bidder)+ (No_of_Rings)
Ind_Bidders_Normal = 30
Profit_margin_of_bidder = Bid_Price-Bidder_Private_Value
Reserve_Price = Estimated_Cost * (1 + Allowable_Profit_Margin)
Work_Content = 100