"EFFECT OF EVALUATION OF PRE-CONSTRUCTION PHASE ON A PROJECT"

A Thesis

submitted in partial fulfillment of the requirements for the award of the degree of

Master of Technology

in

Civil Engineering

with specialization in

Construction Technology and Management

under the supervision of

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and

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by

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to

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MAY-2017

CERTIFICATE

This is to certify that the work which is being presented in the thesis titled ***"EFFECT OF EVALUATION OF PRE-CONSTRUCTION PHASE ON A PROJECT"*** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in ***Construction Technology and Management*** and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Dinesh Kumar (Enrolment No. 152613)** during a period from July 2016 to May 2017.

The above statement made is correct to the best of our knowledge.

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ACKNOWLEDGEMENT

First of all, I would like to express my deep gratitude to my project guide Dr. Gyani Jail Singh, (Assistant Professor, Department of Civil Engineering) for providing me an opportunity to work under his supervision and guidance. He has always been my motivation for carrying out the project. Their constant encouragement at every step was a precious asset to us during our work.

I express my deep appreciation and sincere thanks to Dr. Ashok Kumar Gupta, Head of the Civil Engineering Department for providing all kinds of possible help and encouragement during my project work.

I am thankful to the faculty of Department of Civil Engineering, Jaypee University of Information Technology for providing me all facilities required for the work.

I would like to thank my parents for their continuous support and motivation. Finally I would like to thank to all who directly or indirectly helped us in completing this project.

ABSTRACT

The preconstruction phase of a project has a great role in the success of a project. The evaluation of a preconstruction phase in a project helps a project manager or the owner to get the parameters to evaluate the time required, budget required and quality assurance as well of the project. Basically the reduction in the construction project's cost and time is very crucial in the market driven economy of present scenario.

The thesis focuses on the implementation of analysis of preconstruction phase of a project and determining the approach to overcome the problems comes in construction phase of a project and can lead to unsuccessful of a project if pre construction phase is not analyzed properly. "a multi-storey residential building" at Kusumpti, in Shimla has studied in this thesis. In this study preconstruction phase of the building is analyzed with bidding process along with the prequalification process, future estimation of bidders, scheduling and proper planning using MICRO-SOFT PROJECT, MS-EXCEL, Bidding models has been used. To achieve the objectives data of multistory residential building has collected from HP PWD.

Keywords: Bidding process, prequalification process, bidding models, multistory residential building, MS-EXCEL, MICRO-SOFT PROJECT.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEWS

1.1 INTRODUCTION

The preconstruction phase of a project has a great role in the success of a project. The evaluation of a preconstruction phase in a project helps a project manager or the owner to get the parameters to evaluate the time required, budget required and quality assurance as well of the project. Basically the reduction in the construction project's cost and time is very crucial in the market-driven economy of present scenario. The preconstruction phase of a project goes through the various processes including preparation and submission of planning drawing, preparation of building specifications, choice of building materials, detailed technical design, cash flow, preparation of tender document, quality surveying and working schedule of the project. Therefore the evaluation of pre-construction phase of a project takes place with the execution and to full implementation of a project.

In this thesis the effect of evaluation of pre-construction phase on a project is studied in detail and to understand the physical significance of effects of evaluation of pre-construction phase a case study of a multi-storey residential building at kusumpti, Shimla is taken. Thus in this thesis the effect of preconstruction phase is analyzed and implemented on the particular multi-storey residential building taken in consideration. The evaluation of pre-construction phase starts from the tendering stage of a project along with the notice inviting tender of a firm.

The prequalification process of the bidders participating in the particular project has been analyzed in this study before they participate in the bidding process to achieve the right set of bidders only left for the bidding process which have been qualified from pre-qualification stage. Therefore to find the physical parameters to evaluate and implementation of the systematic approach developed "a multi-storey residential" at kusumpti; Shimla is studied in this study. Along with the publication of the Notice inviting tender of a firm the pre-construction phase of a

project begins and thereafter willing contractors are to be asked for the required data for the point of view of evaluation of bidders using the systematic approach developed for the prequalification process to get the right set of contractors to achieve the certain degree of assurance of success of a project. The systematic approach to be developed for the evaluation of the bidders must include the information of the bidders like financial strength of the bidders, work experience in similar class of work, quality of the work done etc. and thereafter the selected set of bidders will be left for the bidding process which have been passed the prequalification process.

The thesis focuses also on the various bidding strategies to be developed to evaluate the future behavior of the bidders. The future estimation of the bidders can be done using the data of the bidders from the capped tenders. In this thesis the various tender document have been collected from the various firms to evaluate the future behavior of the bidders on the basis of the performance of the caped tenders in which they were participated. Thus some bidding models have been studied in this thesis to evaluate the future estimation of the bidders which can be implemented for the future work to reduce with creation degree of assurance of selection of bidders and to thus reduce the risk involved from the selection of right contractor's point of view. Therefore, various economic formulae and scoring parameters have been used in this study to know the future behavior of the bidders. However, proper planning, controlling, monitoring and scheduling are required for the success of a project so various techniques have been used from this purpose in this study. Therefore overall effect of evaluation of pre-construction phase on a project is analyzed and implemented on the case study taken in consideration.

1.2 NEED OF THE STUDY

This work builds a methodology for studying effect of evaluation of preconstruction phase on a project and evaluation of one competitor or a sub-group of competitors in a bidding pattern. Prequalification process is also introduced in this study for the proposed project. The bidding process starts from the prequalification process which takes 7-10 weeks also future estimation of bidders participated in a tender has been done in this thesis. The methodology described in this study has been derived from capped tenders to know the future estimation of the bidders. The future estimation of the bidder participating in a capped tender is done through some models. As the prequalification process is also taken in consideration in this study to thus only prequalified bidders left for the bidding process. In this study prequalified process is done for a case study of

“a multi-storey residential building” and the qualified bidders are analyzed. Further planning and scheduling has also done to evaluate the overall effect preconstruction phase on a project which results in time and cost saving.

1.3 OBJECTIVES OF THE STUDY

1. The project is to imply prequalification process for the bidder precipitating for a tender of “a multi-storey residential building” under PWD at kusumpti, Shimla.
2. Followed by the evaluation criteria of prequalification to develop a systematic approach to find out the qualified bidders.
3. Forecasting the probability of containing a particular score and position among competitor bidders using Friedman’s model and gate’s model using economic scorning formula & various scoring parameters.
4. Lastly measuring overall tender forecast performance of bidder thus can be implying for future works.
5. Determining the systematic approach for proper planning and scheduling of the project and also calculating overall project duration of the project using MICRO SOFT PROJECT and MS-EXCEL.

1.4 PRE- REQUISITES FOR THE STUDY

1. All required details of bidders participating in the tender including financial strength, experience and quality & personal & administration establishment of bidder for the prequalification process.
2. Calculation and measuring of the participated bidders for the tender of a multistoried residential building in MS-EXCEL 2010 followed by the prequalification evaluation criteria.
3. Tender specification document collected from the HP-PWD, HIMUDA, and some private firms.
4. Bidding models having economic scoring and scoring parameters to analyses the tender forecast performance of the various bidders participating in the tenders and are evaluated in MS-EXCEL.

5. MICRO-SOFT PROJECT software used for the proper planning and scheduling of the project and MS-EXCEL is used for calculation of various activities to get the required data.

1.5 SCOPE OF THE STUDY

The thesis is an application of evaluation of pre-construction phase of "a multistory residential building'' located in Shimla (HP) and focuses on finding and developing a systematic approach to find out the qualified bidders and further after submission of the technical & non-technical documents of the qualified bidders evaluation of the lowest bidder. The prequalification process in done using to obtain the qualified bidder on MS EXCEL 2010 the measurement and calculation is done further and are required a number of tender specification documents of the bidders participated in the capped tender. The scoring and position of the various bidders are calculated using bidding model Friedman's model & gate's model. MICRO SOFT PROJECT and MS-EXCEL have been used for proper planning and scheduling of the project.

1.6 LITERATURE REVIEWS

The pre-construction phase analysis of a project plays a vital role in the success of a project. The thesis are mainly focus on pre-qualification of bidders, bidding process, various strategies used to estimate the future estimation of the bidders and proper planning and scheduling techniques to be used in the project before the construction of the project will take place. The inviting firm publishes a notice inviting tender (NIT) through internet, news- paper etc. so the bidding process starts with the notice inviting tender. Thus great relationship exists between theory of auction and competing bidding that is relevant for the construction project.

So to understand the relationship between theory of auction and competing bidding which is relevant for a construction project I studied various papers published in different journals and conferences to familiarize myself with different construction and appropriate techniques used for analysis for pre-construction phase analysis of a project.

1.7 CASE STUDIES

1.7.1 QUICK ABNORMAL-BID-DETECTION METHOD FOR CONSTRUCTION CONTRACT AUCTIONS

In the public and in private sectors as well the competing bids have become the major concern in the construction contract auctions. Consequently various types of models have been developed for the purpose of identifying the bidders potentially involved in the construction contract auctions. But most of the models developed in this field require the complex calculation and extensive information regarding the construction contract auctions which is quite difficult to obtain. In this study a systematic development of a approach is used in which bids are literally categorized in two normal bids and abnormal bids so it aims to recent developments for the purpose of detecting abnormal bids in a construction contract auctions in the capped tenders.

1.7.2 ESTIMATING FUTURE BIDDING PERFORMANCE OF COMPETITOR BIDDERS

The bidding models are in the field of research is in progress since 1950s because the bidding models developed are of quite complex type and the data required is extensive so is quite difficult to collect. In this study a BTFM (Bid tender forecasting model) have been developed in the year of 2012. It is a biding model tool which is easy to use and does not require the complicated calculation and is present a series of graph which enables one to study the bidding competitors using a short historical tender data set of the competing bidders. In this study a software has been developed to study the behavior of the competing bidders in an auction and as it is a computer based programs the calculation required is least but despite the advantage of this model so far it is still mandatory to study all the auction participants as an individual group that means the for a number of competing bidders the behavior of each individual has to be done separately so we cannot use this tool directly for the group or sub-group of competing parties.

1.7.3 SCORING RULES AND COMPETITIVE BEHAVIOR IN BEST-VALUE CONSTRUCTION AUCTIONS

In this study some of the scoring rules have been introduced from the point of view to know the extent to which the engineer can affect the competing bidding behaviors of the participants in construction contract auctions in the best manner where the bid and technical non price criteria

as well of the construction contract auctions are scored according to scoring rules. In this study some case studies from the Spanish construction contract auctions have been taken and analyzed and it has been found that the competing bidders are affected by the auction rules under a variety of the bid scoring rules of construction contract auctions. The parameters which have been used in the scoring rules of construction contract auctions are like the bid score weighting, the formulas developed for bid scoring and the abnormally low bid criteria taken in consideration in the construction contract auctions which is likely to affect the competitiveness of the bidders. Therefore this study provides the balance which is needed to achieve the firm's or owner's desired strategic outcomes in the construction contract auctions.

1.7.4 QUALITY OF TENDER DOCUMENTS

In this the major concern is given on the quality of the tender which is one of the most important stage in the construction procurement which requires the extensive data and the documents of the construction contract auctions are exchanged in this stage of construction contract auctions. But the tender document is always not clear in the practices. Thus this study aims to develop the certain approach to find out the clarity and adequacy of the tender document in any type of construction contract auctions in practices. In this study some case studies have been taken in account from the UK construction firm in which it is found that the a whole tender process for two projects are was in process for 6-7 weeks in each firm which is quite time consuming process so it aims to the quite simpler procedure and simple understanding language of construction contract auction tender documents so that the time can be saved and competing biddings can be make effective with the improvement in the quality of tender documents. Also it has been found from this study that that the poor quality tender documents are responsible for the inaccurate estimates, claims and the disputes on the contracts in the construction contract auctions tenders moreover it is required to have the further research in to the recommendations to favour the improvement of the tender documents.

1.7.5 ESTIMATING FIRST-PRICE AUCTIONS WITH UNKNOWN NUMBER OF BIDDERS

In this paper the consideration of the non-parametric identifications and the estimations of first price auction models have been taken in considerations cross ponding to the bidding models when a number of true number of bidders were not known by the models practically. It aims to develop the non-parametric procedure for the detection and evaluations for covering the distribution of the bids conditioned on the unabsorbed due to some misclassification error so bids are redistributed on the Monte Carlo results showing that the procedure works well in practice. In this study it has been found that the failing to account for the unobservability from the data set of the construction contract auctions can lead to under estimation of the bidder's profit margin as well in the construction contract auctions.

1.7.6 PREQUALIFICATION OF ENGINEERING CONSULTANTS IN PUBLIC PROCUREMENT SYSTEM

In this paper the importance of pre-qualification process in the public procurement system is shown with respect to the engineering consultants in the public procurement system which is suffering from the various arbitrary processes and criteria that cannot effectively shortlist the increasing number of competing bidders in the construction contract auctions. This study aims to develop a prequalification model in the field of construction contract auctions for the purpose of revising the existing regulations and criteria. The researchers in this study conducted the interviews among the experts for the point of view to develop the frame work for the prequalification criteria in the construction contract auctions. As a result of survey conducted it has been observed that the existing guidelines available for the construction contract auctions cannot meet the expectations of the construction industry. A systematic approach has been developed for this purpose known as FAHP (fuzzy analytical hierarchy process) to meet the expectations of the construction industry.

1.7.7 BID COMPENSATION THEORY AND STRATEGIES FOR PROJECT WITH HETEROGENEOUS BIDDERS

This study aims to overcome the problems faced in case of heterogeneous bidders participated in the complex construction contract auctions. In the large-scale projects of complex type projects researchers have been progress to develop the strategy that helps the competing bidders to invest more effort in the project planning and scheduling for the schematic design of the preparation of bids in the construction contract auctions. In the large-scale projects of complex type projects it

has mostly observed that the biding behavior among all the bidders of a particular participant is heterogeneous so game theoretic analysis is applied for the purpose of estimating the strategic interaction among project bidders in the In the large-scale projects of complex type projects. Through this analysis it has been found that under certain conditions the process of inviting the bid compensation can be effectively encourage the best bidder among all or the stronger competing bidders to give more efforts in the early stage of construction project.

1.7.8 DECISION CRITERIA IN CONTRACTOR PREQUALIFICATION

The project owner determines a set of criteria in the prequalification process from the point of view to examine the competence to perform the work if construction project is awarded. Therefore the contractor pre-qualification includes the screening of the competing bidders in a construction project tender to know the ability of bidders to perform the work. In this study a survey was done in which the interviews was taken from the experts and experienced people with the contractor pre-qualifications. Thereafter a generic logical approach has been identified to decision making in the field of prequalification process.

1.7.9 QUALITY-BASED CONTRACTOR RATING MODEL FOR QUALIFICATION AND BIDDING PURPOSES

This study is based on the quality of the contractor participating in the construction project auctions. In this study the contractors are asked for the quality certificate of the work done in the past. The contractors can give the certificate of work finishing work with the quality grades given by the past owners to ensure the quality of work done.in this study a system is developed called quality based performance rating (QBPR) in which the contractor would be rate as per the quality of work he achieved in the past work.

1.7.10 DERIVING OPTIMAL COMPETITION IN INFRASTRUCTURE PROCUREMENT

In the Public Private Partnership (PPP) there are a limited number of the consortiums which are available for the competing bids in the construction project auctions. For the purpose of eliminating this issue this study aims to estimate the optimal numbers of bidders required to ensure the better level of bidding competition in the construction project auctions. In this study the theories of structure-conduct-performance (SCP) including the game theories, auction theories and the cost economics are determined and are used to determine the optimal number of bidders in the construction project auctions.

RESEARCH METHODOLOGY

2.1 INTRODUCTION

The thesis focuses on the analysis of preconstruction phase of “a multistory residential building”. The location of building is at Kusumpti, Shimla. In this thesis various process in the preconstruction phase takes place are analyzed in details. Starting from the notice inviting tender to the selection of contractor including the prequalification process of the contractors participated in the construction project are analyzed in details. The contractors participated in the bidding process are analyzed through the prequalification process thereafter tender documents are issued to the qualified contractors only. The contractors that full filled the prequalification criteria only can quote in the S.O.Q. (schedule of quantity) document issued by the department. The contractors which are qualified get the tender documents after filling the tender document the bids are evaluated and lowest bidder is awarded with the project. In this study I have taken the case study of “a multistory residential building”.

Further future estimation of the bidders are also estimated to know the probability of winning the bids in future on behalf of capped tenders in past in which the contractor is participated. For this purpose thirty tender documents are collected from the various firms of a contractor against an unknown lowest bidder to estimate the probability of winning bids in future on the basis of bid mark decided in the previous projects. The estimation of the typical contractors has been done from the contractor’s perspective using bidding models. The bidding models used in this study are Friedman’s model and gate’s model. Thereafter the project planning and scheduling is done using the software MICRO-SOFT PROJECT and MS-EXCEL.

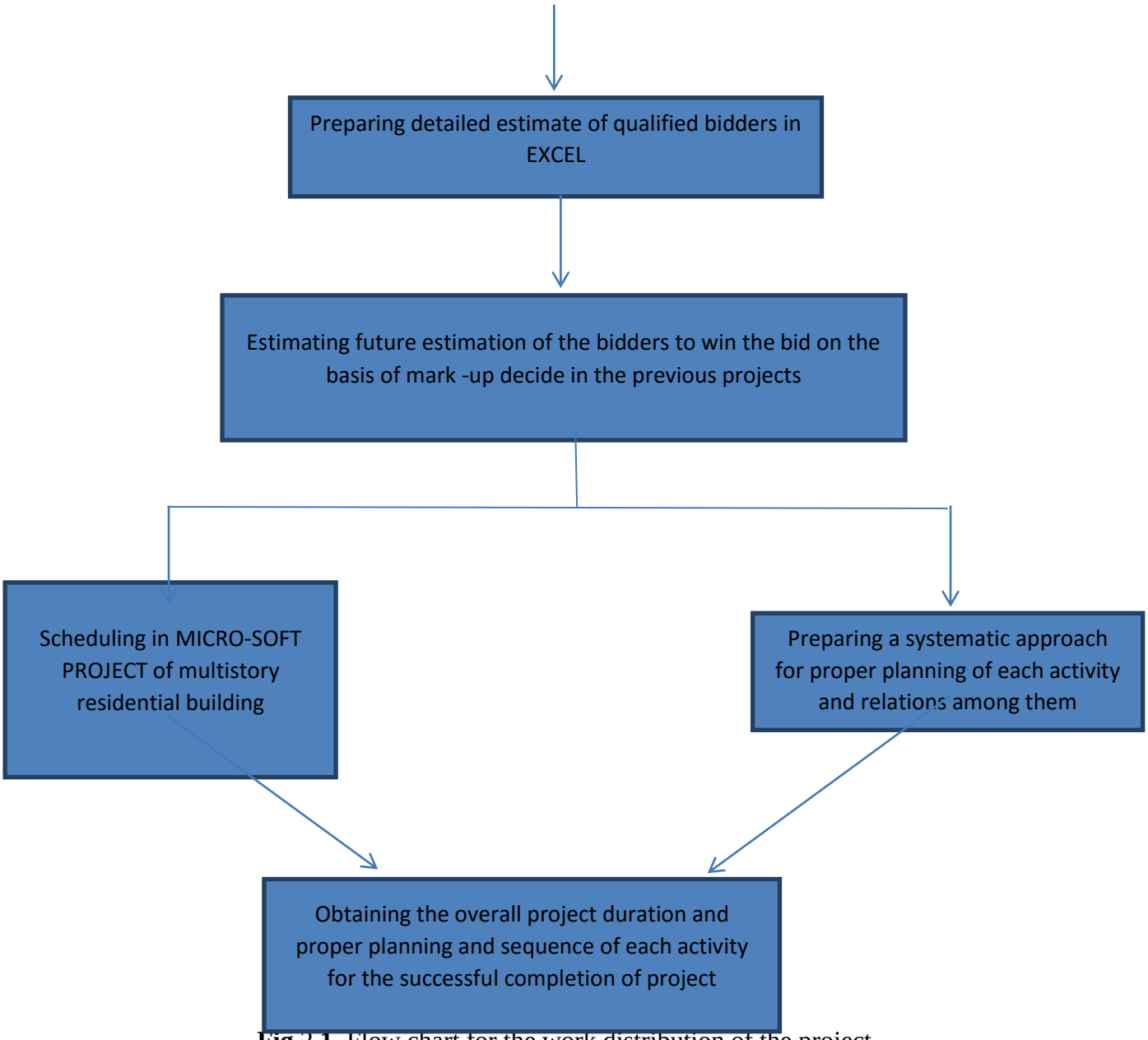


Fig.2.**1.** Flow chart for the work distribution of the project

2.2 WORK DISTRIBUTION

The work distribution of project has been done in two phases. In the first phase bidding process including is covered and in the second phase of the project planning and scheduling of project,

controlling of project using MICRO-SOFT PROJECT has been done in this study. The work distribution is shown by flow chart. Every objective is achieved in the order shown in the flow chart.

2.3 DEVELOPING A SYSTAMATIC APPROACH TO FIND OUT QUALIFIED BIDDERS

The bidders are selected on basis of the criteria of the prequalification process. The prequalification of bidders starts from the notice inviting tender from the firm. The criteria to become a short listed candidate in prequalification process is to score at list 50 percent in each field of evaluation or have to score at list 60 percent marks in aggregate. Therefore here we have developed the approach to select the qualified bidder for the proposed work for which I have taken a case study of a residential multistory building constructing at Kusumpti in Shimla. In the pre- construction phase of building we analyzed the behavior of contractor so developed an approach to select right set of contractors. The financial strength, experience in similar class of work, quality on work, personnel establishment etc. criteria of the bidders are asked from last three consecutive years then the evaluation of the bidders are done on MS-EXCEL.

2.4 EVALUATION OF QUALIFIED BIDDERS

The bidders which have been qualified from the prequalification process can only take part in the tender. Thus the qualified bidders will take part in the tendering process of the project. The bidders quotes rates for each item shown in the S.O.Q. (schedule of quantity) thus amount of all the items are summed up to get the final amount of the bidders. The lowest bidder is then awarded with the project. In this study this methodology has been followed but it’s not necessary all the time that lowest bidders only will be awarded with the project. Owner can negotiate with the second lowest bidder too so if he agrees can we award with the project.

2.5 FUTURE ESTIMATION OF BIDDERS

The bidders can estimate the probability of winning the bids in future on basis of the markup decided by them. In this study a approach is developed to estimate the probability of winning the bids in future on behalf of capped tenders from the contractor’s perspective in the past. The

contractor decides a bid mark to bid for a project in which they add their profit margin. So to decide the markup for the bid in such a manner that the contractor can be the lowest bidder and also the profit margin needs to be keeping in consideration. So to overcome this difficulty of deciding exact bid mark from the contractor's perspective an approach have been developed by making use of some bidding models. Therefore future estimation of winning the bids of typical contractor corresponding to the competing lowest bidders is done in this study so we have collected the tender document of atypical contractor from the capped tenders and the analysis has been done by making use of Friedman's model and gate's model.

2.6 MICRO-SOFT PROJECT

MICRO-SOFT PROJECT s is used to scheduling of the project to know the overall duration and cost of the project. The scheduling of the project has been done from BOQ (Bill of quintiles) of the proposed project. The BOQ of the ''multistory residential building'' have been collected from the HP PWD Shimla.

2.7 DATA COLLECTION

To collect the sufficient and required data the site has been visited and site condition of the building is also known. The data of "multi storey residential building" required to analyses the preconstruction phase analysis have been collected from the HP PWD Shimla. The data required for the future estimation of the bidders are collected from the contractors who has participated in the capped tenders in past in various firms.

CHAPTER 3

BIDDING PROCESS AND FUTURE ESTIMATION OFBIDDERS

3.1 INTRODUCTION

The bidding process starts from the Notice inviting tender (NIT) from the inviting firm of any construction project. The bidding process for the proposed project "pre project phase of a multistory residential building" is selective bidding type in which we will go through the prequalification process as well and the tender document will be issued to the qualified contractors only. Therefore as per the prequalification process the qualified contractors will take part in bidding process and quote their amounts and the lowest bidder will be awarded with the project. The tender is treated as an offer to do the work for a certain amount of money (firm price), or a certain amount of profit. The tender, which is submitted by the competing firms, is generally based on a bill of quantities, a bill of approximate quantities or other specifications which enable the tenders to attain higher levels of accuracy. The bill of quantities is a list of all the materials (and other work such as amount of excavation) of a project which have sufficient detail to obtain a realistic cost, or rate per described item of work/material. The tenders should not only show the unit cost per material/work, but should also if possible, break it down to labor, plant and material costs.

Then future estimation of the bidders are also estimated to know the probability of winning the bids in future on behalf of capped tenders in past in which the contractor is participated. For this purpose thirty tender documents are collected from the various firms of a contractor against an unknown lowest bidder to estimate the probability of winning bids in future on the basis of bid mark decided in the previous projects. The estimation of the typical contractors has been done from the contractor's perspective using bidding models. The bidding models used in this study are Friedman's model and gate's model. Thereafter the project scheduling is done using the software MICRO-SOFT POJECT of the proposed project.

The notice inviting tender for a multistory residential building at Kusumpti, Shimla HP has been shown below. The criteria given in the notice inviting tender are to be full fill to take part in the tender. The terms and conditions are also given in the notice inviting tender prepared by the Executive Engineer, Kusumpti Division HP PWD Shimla on behalf of Governor of H.P.

HIMACHAL PRADESH

PUBLIC WORKS DEPATMENT

NOTICE INVITING TENDER

Sealed item rate tenders are hereby invited by the Executive Engineer, Kusumpti Division HPPWD. Shimla on behalf of Governor of H.P. for the following works from the contractors of appropriate class enlisted with HP.PWD. The tender shall be opened in the presence of the contractors / firms or their representative who wish to be present.

TIME SHEDULE OF TENDER

1. Date and time of receipt of application for tender: on10.10.2016 up to 4.00 P.M.
2. Date and time of issue of tender: on12.10.2016 up to 4.00 P.M.
3. Date and time of receipt of tenders: on 14.10.2016 up to 10.30 A.M.
4. Date and time of opening of tenders: on 14.10.2016 at 11.00 A.M.

The request for issue of tenders should be on the PRESCRIBED APPLICATION FORM which can be obtained from the office of undersigned and tenders will be issued to only those contractors who qualify the criteria after the scrutiny of application forms by the Committee constituted for this purpose.

Sr. no.	**Name of work**	**Estimated Cost (Rs.)**	**Earnest Money**	**Time**	**Cost of form**
1.	Commercial Complex at KZC Shimla 171009.	Rs. 2, 87, 81,039/- only.	Rs. 3, 20,310/- only.	Twenty months	Rs. 315 /-

TERMS & CONDITIONS

1. The earnest money in the shape of National Saving Certificate, Time deposit account in any of the post office in HP / FDR of any Bank duly pledged in favour of Executive Engineer, Kusumpti

Division, HP PWD Shimla, must be accompanied with the application for receipt of tender Form along with cost of tender form. Tender application received without earnest money will summarily be rejected.

2. The contractors / firms should possess the following documents (photo copy to be attached with application for obtaining the tenders documents):

(i) Latest enlistment / renewal orders with application for obtaining the tenders documents.

(ii) Registration under the HP General Sales Tax Act 1968.

(iii) PAN (Permanent Account Number) issued by the Income Tax Department.

3. The Executive Engineer, Kusumpti Division HP PWD, Shimla reserves the right to reject anytender without assigning any reasons(s).

4. The Cess Charges @ 1% will be deducted from the gross amount of work done by theContractor.

5. If 14.10.2016 happens to be holiday the tender shall be opened on next working day at 11:00A.M.

3.3 PREQUALIFCATION PROCESS

To become eligible for short listing, the bidder must secure at least 50% marks in each and 60% marks in aggregate. The bidders are analyzed on basis of criteria of evaluation shown in above table. The complete evaluation of bidders are shown in Microsoft excel and Lowest bidder will be awarded by tender

3.3.1 CRITERIA FOR THE ELIGIBILITY OF THE BIDDERS

Criteria for the eligibility of the bidders are as:

1. The bidder should have satisfactorily completed three works each costing Rs 2.00 Crore (or) two works each costing Rs 3.00 Crore or one work costing Rs 6.00 Crore in building projects during the last five years ending last days of the month March. For this purpose cost of work shall mean gross value of the completed work excluding the cost of materials supplied by client free of cost.

2. The bidders should have had average annual financial turnover of Rs 2.00 Crore on civil/mechanical/electrical construction works during the immediate last three consecutive years.

3. The bidders should have a solvency of Rs 4.00 Crores certified by his bankers.

4.The bidders should have technical and administrative employees for the proper execution of the contract.

5. The bidder’s performance for each work completed in last five years (should be certified by an officer not below the rank of EE).

3.3.2 EVALUATION CRITIRIA OF BIDDERS

Table 3.1. Evaluation criteria of bidders form A, B and C

Sr. no.	FORM	ATTRIBUTE	EVALUATION
1.	FORM –A	Financial strength **(20 marks)** (i) Average annual turnover (16 marks) (ii) Solvency certificate (4 marks)	(i)60% marks for min. eligibility criteria (ii)100% marks for twice the min. eligibility criteria or more In between (i) and (ii) –on pro-rata basis
2.	FORM -B	Experience in similar (20 marks) class of works	(i)60% marks for min. eligibility criteria (ii)100% marks for twice the min. eligibility criteria or more In between (i) and (ii) –on pro-rata basis
3.	FORM C	Performance on works (20 marks) (time over run)	**Score**
		if TOR=(Actual time/Stipulated time) = (i)Without levy of compensation (ii)With levy of compensation (iii)Levy of compensation not	1.00 2.00 3.00 >3.50 20 15 10 10 20 5 0 -5 20 10 0 0

		decided	

Table 3.2. Evaluation criteria of bidders form D

4.	FORM D	Performance of works (Quality)	**(15 marks)**
		(i)Very good	15
		(ii)Good	10
		(iii)Fair	5
		(iv)Poor	0

Table 3.3. Evaluation criteria of bidders form E

Sr. no.	FORM	ATTRIBUTE	EVALUATION
5.	FORM-E	Personnel and Establishment	**(Max. 10 marks)**
		(i)Graduate Engineer (ii)Diploma Holder Engineer (iii)Supervisory/Foreman	3 marks for each 2 marks for each up to max 4 marks 1 mark for each up to max 3 marks

Table 3.4. Evaluation criteria of bidders form F

Sr. no.	*FORM*	ATTRIBUTE	EVALUATION
6.	FORM -F	Plant and Equipment	**(Max. 15 marks)**
		(i)Hopper Mixer	1 mark for each up to max 2 marks
		(ii)Truck/Tippers/Transit Mixer	1 mark for each up to max 2 marks
		(iii)Steel shuttering	2 marks for each 800 sq.m.up to max 4 marks
		(iv)Tower crane	2 marks for each up to max 4 marks
		(v) Building hoist	1 mark for each up to max 2 marks
		(vi) Excavator	1 mark for each up to max 2 marks
		(vii) Batch mix plant	2 marks for each up to max 4 marks
		(viii) Tandem roller	1 mark for each up to max 2 marks
		(ix)Vibration compactor	1 mark for each up to max 2 marks
		(x)Paverfinisher	2 marks for each up to max 4 marks
		(xi)Hot mix plant	2 marks for each up to max 4 marks
		(xii)Special equipment	(Marks to be fixed as per requirement)

3.3.3 DATA SUBMITTED BY BIDDERS

The data submitted by bidders shown below in tabular form and is thus evaluated in MS-EXCEL as per pre-qualification process criteria shown below.

A: Financial Turnover

Table 3.5. Data submitted by bidders form A

Sr. no.	Year1 (amount in Crores) 2012-13	Year2 (amount in Crores) 2013-14	Year 3 (amount in Crores) 2014-15
Bidder 1	2.2	1.90	2.15
Bidder 2	2.2	2.45	2.3
Bidder 3	2.15	2.3	2.6
Bidder 4	1.70	2.2	2.6

B: Solvency Certificate

Table 3.6. Data submitted by bidders form B

Bidders	**Amount (in Crores)**
Bidder 1	4.00
Bidder 2	6.00
Bidder 3	8.00
Bidder 4	5.00

C: Details of all work of similar class during last 5 years: Cost of work (excluding cost of material supply by client free of cost)

Table 3.7. Data submitted by bidders form C

Bidders	Work 1	Work 2	Work 3
Bidder 1	2	3.5	1.9
Bidder 2	3	2.5	2.9
Bidder 3	3.5	1.5	2

Bidder 4	4.5	3.5	-

D: Performance on work-TOR (time over run):

Table 3.8. Data submitted by bidders form D

Bidders	Time over run (actual time/stipulated time)	Remarks
Bidder 1	2	With levy of compensation
Bidder 2	1	Without levy of compensation
Bidder 3	2	levy of compensation not decided
Bidder 4	2	With levy of compensation

E: Performance on work- quality

Table 3.9. Performance on work- quality form E

Bidder 1	Very good
Bidder 2	Good
Bidder 3	Fair
Bidder 4	Very good

F: Personnel and Establishment

Table 3.10. Personnel and Establishment form F

	Graduate engineer	Diploma holder engineer
Bidder 1	1	3
Bidder 2	2	4
Bidder 3	1	3
Bidder 4	1	3

G: Plant and Equipment

Table 3.11. Plant and Equipment form G

P& E	Bidder 1	Bidder 2	Bidder 3	Bidder 4
Batching plant (30cum/hr.)	2	2	1	2
Transit mixer	2	3	1	1
Excavator	1	2	1	1
Dumper	1	2	2	1
Loader	2	1	1	1

EVALUATION OF BIDDERS

Table 3.12. Evaluation of financial strength and solvency

Sr. No. Bidders	Bidders	Form	Marks Obtained	Maximum Marks	Remarks
1.	**A: Financial turnover**				
	Bidder 1		9.85	16	[0.6 +0.4*(2.08-2/2)]* 16 = 9.85
	Bidder 2		10.59	16	[0.6 +0.4*(2.31-2/2)]* 16 = 10.59
	Bidder 3		10.72	16	[0.6 +0.4*(2.35-2/2)]* 16 = 10.72
	Bidder 4		10.11	16	[0.6 +0.4*(2.16-2/2)]* 16 = 10.11
2.	**B: Solvency Certificate**				
	Bidder 1		2.4	4	0.6*4 =2.4
	Bidder 2		3.2	4	[0.6 +0.4*(6-4/4)]* 4 = 3.2
	Bidder 3		2.8	4	[0.6 +0.4*(5-4/4)]* 4 = 2.8
	Bidder 4		4	4	4(twice of double)
3.	**C: Experience in Similar Class of Work**				
	Bidder 1		13.86	20	[0.6 +0.4*(7.4-6/6)]* 20 = 13.86
	Bidder 2		15.2	20	[0.6 +0.4*(8.4-6/6)]* 20 = 15.2
	Bidder 3		20	20	[0.6 +0.4*(7-6/6)]* 20 = 20
	Bidder 4		14.66	20	[0.6 +0.4*(8-6/6)]* 20 = 14.66
4.	**D: Performance on Work (Time Over Run)**				

	Bidder 1		15	20	
	Bidder 2		20	20	
	Bidder 3		5	20	
	Bidder 4		5	20	

Table 3.13. Personnel and Establishment

5.	**E: PERSONNEL AND ESTIBLESHMENT**				
	Bidder 1		6	10	3 Marks for each graduate engg. And 1 mark for each diploma holder
	Bidder 2		10	10	3 Marks for each graduate engg. And 1 mark for each diploma holder
	Bidder 3		6	10	3 Marks for each graduate engg. And 1 mark for each diploma holder
	Bidder 4		6	10	3 Marks for each graduate engg. And 1 mark for each diploma holder

Table 3.14. Plant and equipment

6.	**F: PLANT ND QUIPEMENT**				
	Bidder 1		10	15	2 marks for each up to max 4
	Bidder 2		12	15	1 marks for each up to max 4
	Bidder 3		6	15	1 marks for each up to max 4

	Bidder 4		7	15	1 marks for each up to max 2

Table 3.15. Quality of work

7.	**G. QUALITY OF WORK**				
	Bidder 1		15	15	
	Bidder 2		10	15	
	Bidder 3		5	15	
	Bidder 4		10	15	

4.3.4 OVERALL EVALUATION RESULTS OF ALL THE BIDDERS

Table 3.16. Overall evaluation results of all the bidders

Sr. No.	**Marks obtained**	**Bidder 1**	**Bidder 2**	**Bidder 3**	**Bidder 4**
1	Form- A	9.85	10.59	10.72	10.11
2	Form- B	2.4	3.2	2.8	4
3	Form- C	13.86	15.20	20	14.66
4	Form- D	15	20	5	5
5	Form- E	6	10	6	6
6	Form- F	10	12	6	7
7	Form- G	15	10	5	10
Total Marks	100	**72.11**	**80.99**	***55.52***	***56.77***

Therefore as per prequalification process criteria only bidder 1 and bidder 2 can take part in bidding process. As per pre-qualification process bidders are required to score at list60 percent marks in aggregate or fifty percent marks in each field. Therefore only bidder 1and bidder 2 full filed the criteria of the prequalification process.so they can take part in prequalification process. The names of the bidders and firms have not been show in this study due to confidential data. So only two bidders will take part in the biding process and can quote the rates in the schedule of quantity. Therefore between these bidders the lowest bidder will be awarded with the project. The rates quoted for each item for item rate contract of "a multistory residential building'' has also been shown in this study. The calculations of all the bidders have been shown in appendix in details.

3.4 ESTIMATING FUTURE BIDDING PERFORMANCE OF COMPETITORBIDDERS

The future estimation of the bidders is done to know the probability of winning a bid in a tender and for this purpose the data of thirty projects of the bidders corresponding to a competing lowest bidder has been collected from the various firms. The data collected is analyzed using fried man's model and gate's model. The estimation of the bidders are done on the basis of bid mark-ups decided by the bidder so fried man's model and gate's model has been used in this study. The data collected is evaluated on the MS-EXCEL and thus histogram can be drawn for it so knowing the bidding behavior of the lowest bidder the mark up decided can be evaluated so the exact markup will be known and can be used in future works. Therefore to become the lowest bidder among all the bidders the mark up should be so decided that one can be the lowest bidder and can get the share in the project as well.

3.4.1 EVALUATION OF THE DATA COLLECTED

The data collected from the various firms are evaluated to know the probability of winning the bids in future work. The data collected contains the details of contracts cost including the markup decided by him for the particular project, contractor's total cost exclusive of bid mark, the cost of lowest bid in that particular project. So to calculate the markup decided by the lowest bidder we have calculated the lowest bidder's bid to contractor's cost (B/TC) ratio. Thus calculating the lowest bidder's bid to total cost of contractor the mark percentage of the lowest bidder is

obtained. So depending on the percentage of the lowest bidder's mark up the probability of winning bids can be evaluated.

TABLE 3.17. Evaluations of the data collected for future performance of bidder

Sr. No	Contractor's price (lakh)	Contractor's cost (lakh)	Lowest bid price (lakh)	Lowest bidder's bid to contractor's cost(B/TC)	Mark up percentage of x (in terms of % C's COST) (B/TC-1)*100
1	710	631	521	0.8256735	-17.43264659
2	4017	3625	3494	0.9638621	-3.613793103
3	3500	3340	3101	0.9284431	-7.155688623
4	1432	1269	1114	0.8778566	-12.214342
5	1381	1233	1126	0.9132198	-8.678021087
6	1953	1738	1599	0.920023	-7.997698504
7	575	517	497	0.920023	-7.997698504
8	4714	4272	3670	0.8590824	-14.0917603
9	607	547	496	0.9067642	-9.323583181
10	1201	1071	1044	0.9747899	-2.521008403
11	3046	2721	2701	0.9926498	-0.735023888
12	3180	3052	2961	0.9701835	-2.981651376
13	574	518	508	0.980695	-1.930501931
14	3027	2714	2575	0.9487841	-5.121591746
15	2150	1945	1727	0.8879177	-11.20822622
16	1301	1161	1201	1.0344531	3.445305771

17	3014	2721	2924	1.0746049	2.487562189
18	921	804	824	1.0248756	2.487562189
19	2071	1900	1966	1.0347368	3.473684211
20	1401	2102	2169	1.0318744	3.187440533
21	774	651	682	1.047619	4.761904762
22	3031	2911	2973	1.0212985	2.129852284
23	764	509	587	1.1532417	15.32416503
24	584	401	490	1.2219451	22.19451372
25	654	509	527	1.0353635	3.536345776
26	2965	2702	2782	1.0296077	2.9607698
27	3130	2901	2998	1.0334367	3.343674595
28	694	501	528	1.0538922	5.389221557
29	3390	3041	3390	1.1147649	11.476488
30	1432	1329	1349	1.0150489	1.504890895

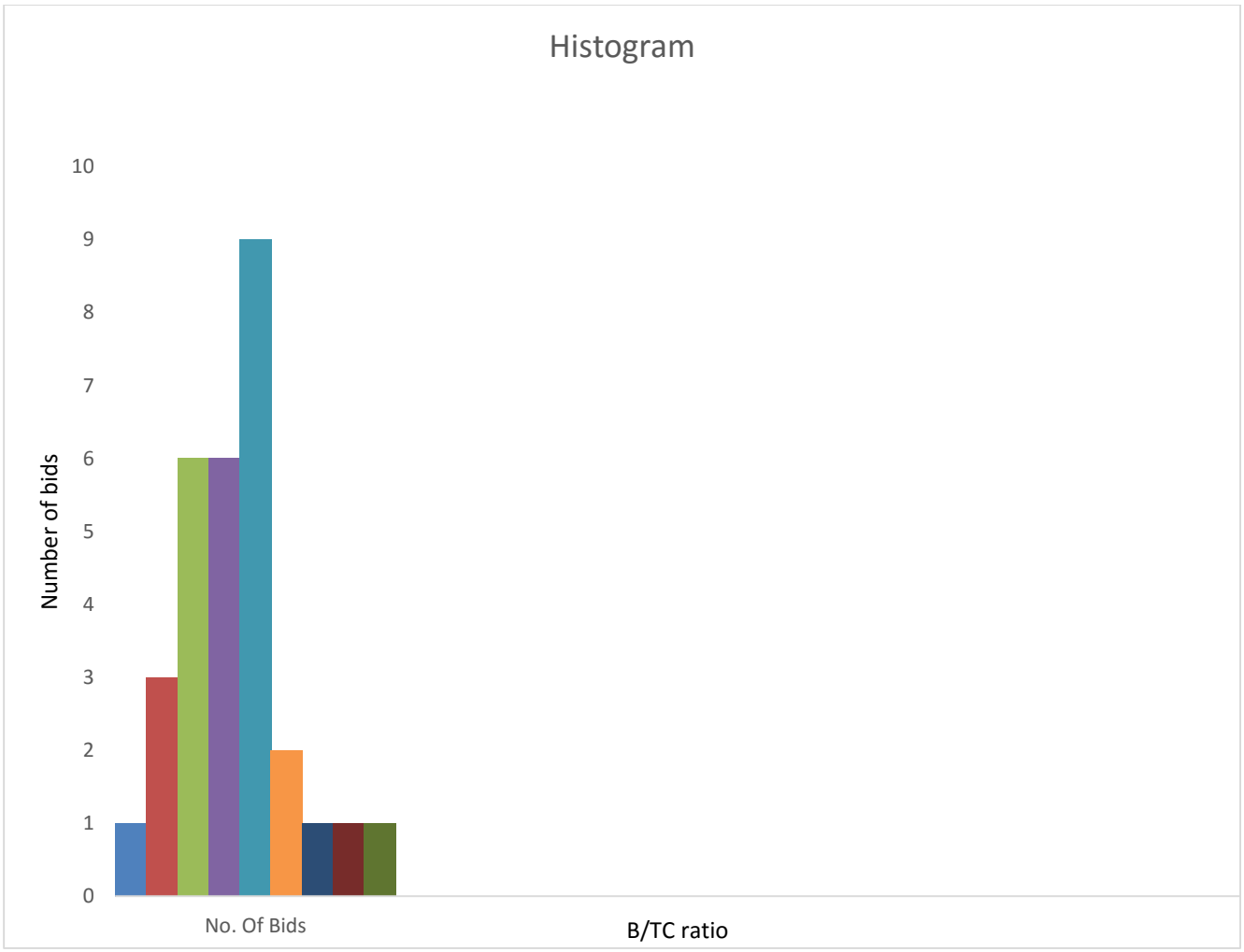


Fig. 3.1. Histogram of data collected

Further by Friedman's model and gate's model the probability of winning bids can be evaluated. For the particular project for given contract sum of the project the mark up amount can be obtained from these models. So the average percentage of markups obtained from both of the models gives the optimum mark up. The optimum markup is thus obtained can be used so that one can be the lowest bidder with his share on contract as well. The data collected are evaluated in MS-EXCEL and is converted in to histogram.

The histogram is obtained from the data collected from the various firms and it has been plotted between B/TC ratio and no. occurrence of bids (Fig. 3.1).

3.4.2 Probability of Beating Lowest Bidder at Markup Percentage Calculated above:

The markup obtained from the above calculation is arranged in the ascending order so that with higher markup decided the probability of winning bids reduces and vice-versa. The probability of winning bids by beating lowest bidders is also done using MS-EXCEL and is shown below in the tabular form.

TABLE 3.18. Probability of beating the lowest bidder at markup percentage

Sr. No.	Contractor's price	contractor's cost	Lowest price B	Lowest bidder's bid to contractor's cost (B/TC)	Mark up % age of lowest bidder (B/TC-1)*100	Probability of beating lowest bidder at given mark up
1.	710	631	521	0.8256735	-17.43264659	(29/30)*100 = 96.66
2.	4714	4272	3670	0.8590824	-14.0917603	(28/30)*100 = 93.34
3.	1432	1269	1112	0.8778566	-12.214342	(27/30)*100 = 90.00
4.	2150	1945	1727	0.8879177	-11.20822622	(26/30)*100 = 86.66
5.	607	547	496	0.9067642	-9.323583181	(25/30)*100= 83.33
6.	1381	1233	1126	0.91322198	-8.678021087	(24/30)*100 = 80.00
7.	1953	1738	1599	0.920023	-7.997698504	(23/30)*100 = 76.66

8.	575	517	497	0.920023	-7.997698504	(22/30)*100 = 73.33
9.	3500	3340	3101	0.9284431	-7.155688623	(21/30)*100 = 70.00
10.	3027	2714	2575	0.9487841	-5.121591746	(20/30)*100 = 66.66
11.	4017	3625	3494	0.9638621	-3.613793103	(19/30)*100 = 63.33
12.	3180	3052	2901	0.9701835	-2.981651376	(18/30)*100 = 60.00
13.	1201	1071	1044	0.9747899	-2.521008403	(17/30)*100 = 56.66
14.	574	518	508	0.980695	-1.930501931	(16/30)*100 = 53.33
15.	3046	2721	2701	0.9926498	-0.735023888	(15/30)*100 = 50.00
16.	1432	1329	1349	1.0150489	1.504890895	(14/30)*100 = 46.66
17.	11301	1161	1201	1.012453	1.54634	(13/30)*100 = 43.33
18.	3031	2911	2973	1.0212985	2.129852284	(12/30)*100 =40.00

19.	921	804	824	1.0746049	2.487562189	(11/30)*100 = 36.66
20.	2965	2702	2782s	1.0248756	2.487562189	(10/30)*100 = 33.33
21.	4102	2102	2169	1.0318744	3.187440533	(9/30)*100 = 30.00
22.	3130	2901	2988	1.0334367	3.343674595	(8/30)*100 = 26.66
23.	1360	1161	1201	1.0344531	3.445305771	(7/30)*100 = 23.33
24.	2071	1900	1966	1.347368	3.473684211	(6/30)*100 = 20.00
25.	654	509	527	1.0353635	3.536345776	(5/30)*100 = 16.66
26.	774	651	682	1.045623	4.7656347	(4/30)*100 =13.33
27.	694	501	528	1.05673	5.387523	(3/30)*100 = 10.00
28.	3390	3041	3390	1.1147649	11.476488	(2/30)*100 = 6.66
29.	764	764	509	1.1532417	15.32416503	(1/30)*100 = 3.33
30.	584	401	490	1.2219451	22.19451372	(0/30)*100 =

						0.00

3.5 Estimation of Probability of Winning Bids Using Gate's Model

Gates' model recognizes that the cost of performing the work random variable at the time the bid is prepared. As per gates, the probability of winning against 'n' known competitors for a given mark-up has been evaluated and shown in the Table 3.19.

Here, Z has calculated using the expression Z = $\frac{x-\mu}{\sigma}$; Also, x =1+$\frac{markup\ \%}{100}$

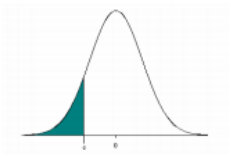
Table 3.19. Estimation of probability of winning bids using gate's model

Sr. No.	Mark Up %	X=1+$\frac{M}{100}$	Z=$\frac{x-\mu}{\sigma}$	Probability from normal distribution curve(y)	Probability of winning bid with one typical contractor P type (1-y)	P_{final}=probability of winning bid with 5 bidders $n\left[\frac{1-Ptyp}{Ptyp}\right]+1$	Expected markup amount Ex (n-1)x P final
1	0%	1	-1.30	0.968	0.9032	0.6570	0.00
2	1%	1.01	-1.17	0.1269	0.8731	0.5791	28955
3	2%	1.02	-1.03	0.1697	0.8403	0.5127	51270
4	3%	1.03	-0.90	0.1841	0.8159	0.4698	70470
5	4%	1.04	-0.76	0.2310	0.7696	0.3996	80275
6	5%	1.05	-.63	0.2613	0.7387	0.3611	90275
7	6%	1.06	-0.49	0.3346	0.6654	0.2895	85350
8	7%	1.07	-0.36	0.3721	0.6279	0.2523	883050
9	8%	1.08	-0.22	0.4102	0.5893	0.2229	891600

Thus, for mark-up percentage of 1%, x would be 1.01 and Z approximately -1.30. similarly, other value of Z can be calculated for different value of x. The probability value corresponding to Z =-1.30 can be read out standard normal distribution chart shown below in figure.3 which is 0.968. thus, probability winning the bid when only single competitor is there = 1-0.968= 0.9032.Since there are five typical competitor, the probability of winning the bid from gate's model is0.6570 Similarly ,the expected value of mark-up amount can be computed at different mark-up percentage.

In the table, the computations for mark-up level up to 6 per cent have been percentage. It may be noted that expected mark-up amount has been increasing initially up to 5 per cent and then started decreasing.so here expected value of markup is obtained at 6 %.

Table of Standard Normal Probabilities for Negative Z-scores



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
-0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Table of Standard Normal Probabilities for Positive Z-scores

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	3.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Fig. 3.2. Normal distribution chart

3.6 ESTIMATION OF PROBABILITY OF WINING BIDS USING FRIED MAN'S MODEL

Friedman's model Friedman attempted to develop in expected value model describing the building situation with probabilistic formulation. He adopted the approach in which the 'value'

that a contract associates with potential profit on a job is synonymous with monetary value of the profit. Probability of winning against a number of unknown competitors for a given mark-up = (Probability of beating one typical competitors)^n

TABLE 3.20. Estimation of probability of winning bids using fried man's model

Mark Up %	X= 1+$\frac{m}{100}$	Z=$\frac{x-\mu}{\sigma}$	Probability from normal distribution curve(y)	Probability of winning bid with one typical contractor P type (1-y)	P_{final}= p(typ)^5	Expected markup amount Ex (n-1)x P final
0%	1	-1.30	0.0968	0.9032	0.6110	0.00
1%	1.01	-1.17	0.1269	0.8731	0.5073	25365.00
2%	1.02	-1.03	0.11597	0.8403	0.4189	41,890.00
3%	1.03	-0.90	0.1841	0.8159	0.3615	49122.5
4%	1.04	-0.76	0.2310	0.7090	0.2689	53780
5%	1.05	-0.63	0.2613	0.7387	0.2179	54975
6%	1.06	-0.49	0.3346	0.6654	0.1304	51120

similarly, Z is calculate using the expression Z =$\frac{x-\mu}{\sigma}$;x =1+$\frac{markup\ \%}{100}$

Similarly, the expected value of mark-up amount can be computed at different mark-up percentage. In the table, the computations for mark-up level up to 4 per cent have been percentage. It may be noted that expected mark-up amount has been increasing initially up to 3per cent and then started decreasing.

3.7 OPTIMUM MARKUP FROM GATE'S MODEL AND FRIEDMAN'S MODEL

From both the models the markup percentage calculated is different. So the optimum markup percentage is required to calculate to be the lowest bidder. Therefore to obtain the optimum markup the average of both the mark ups obtained from both of models gives the optimum markup required. In this study the markup percentage for Friedman's model is 4 percent while from gate's model it is calculated is 6 percent .thus optimum markup obtained is the average of markup obtained from the both models. Thus optimum mark up for this study is 5 percent.

CHAPTER 4

DISCUSSION OF RESULTS OBTAINED FROM BIDDING MODELS

4.1 RESULTS OBTAINED

The present work builds a methology for studying the bidding behavior of the various bidders taking part in a project from the contractor's perspective and from the owner's point of view as well. In this we introduced the prequalification process of bidders which ensures the owner to get the right set of contractors and as we developed the methology from the contractor's perspective as well so he can ensure to estimate the probability of winning bids in future on basis of mark up. So the methology ensures the bidders to decide the mark up such that he can have the sufficient profit margin by selecting an appropriate bid markup and also can be lowest bidder.

4.2 COMPARISON BETWEEN THE MODELS WE USED

In our study we made use of Friedman's model and gates model. From the study it is observed that the Friedman's model is found to be more accurate when cost estimates of different

competitors are nearly same the difference in bid price is mainly due to difference in markup.on the other hand it has been found that gates' model gives the more accurate results when the markups used by bidders are nearly same so the difference in bid price is mainly due to cost estimates only. In this manner gate's model is more optimistic as it assumes that one can still win the bid at high mark up. In our study graphs have been plotted for both fried man's model and gate's model.

4.2.1 GRAPH OBTAINED FROM GATE'S MODEL

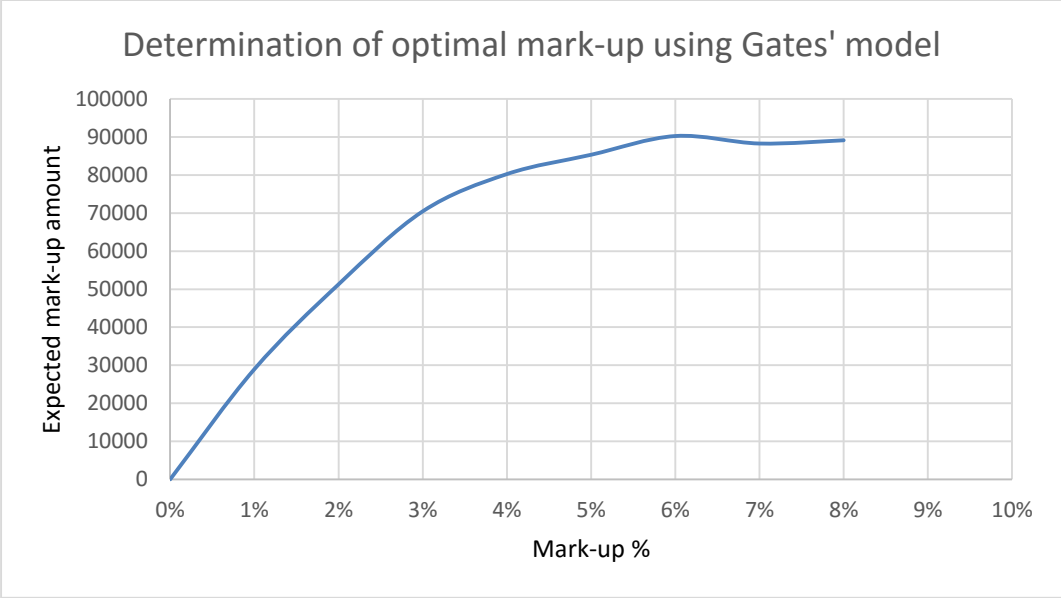


Fig. 4.1. Graph obtained from gate's model

4.2.2 GRAPH OBTAINED FROM FRIED MAN'S MODEL

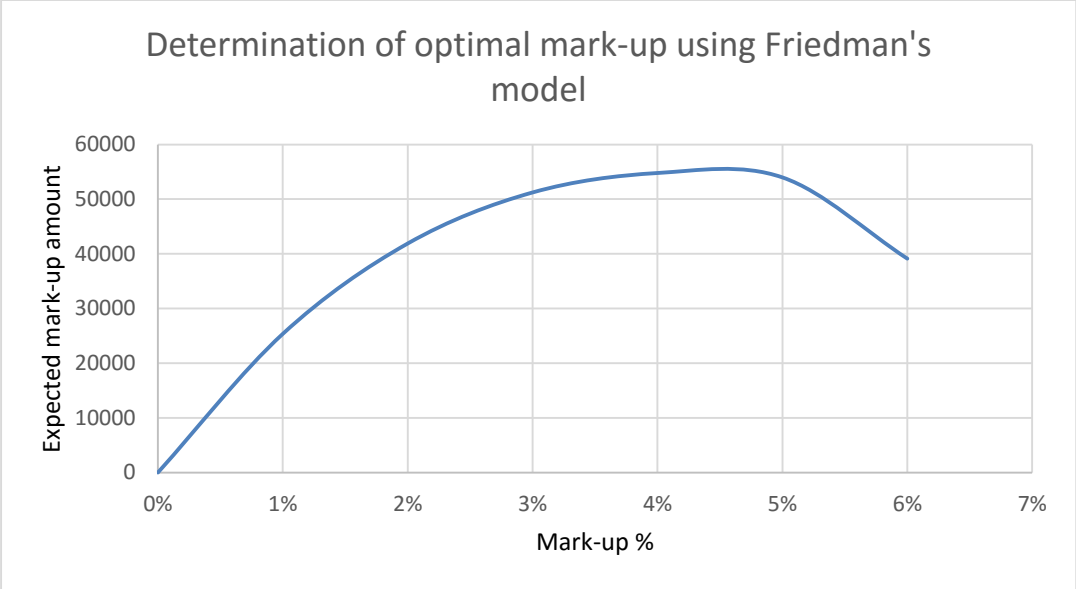


Fig. 4.2. Graph obtained from fried man's model

4.3 CALCULATION OF OPTIMUM MARK UP

With fried man's and gate's model being viewed as pessimistic and optimistic approach respectively a moderate bidding strategy would be assign equal weight to the mark ups obtained using fried man's and gate's models thus consider average of their mark ups to obtained the optimum mark up. Optimum markup= (4+6/2) =5 percent.

Therefore optimum mark up as 5% can be used to be the lowest bidder in this case study what we have considered in this work.

CHAPTER 5

PLANNING AND SCHEDULING OF PROJECT

5.1 INTRODUCTION

The Planning of a project includes the listing of all the activities/tasks involved in the project. Requirement of materials, manpower, machineries and money are determined in the planning phase of a project. Thus Estimates of costs and duration for the various activities are to be prepared in this phase. Thus the objective of project planning is to identify the various activities and to identify the operations require to be performed for the completion of the particular task. Also to produce a time table or proper sequential relationship between the various activities involved in the project, with each activity allocated a start date and finish date. With the assurance that the things necessary to do each activity will be available when will be required during execution of work.

The various steps are required to accomplish such a planning including planning (logic), timing, analysis and scheduling of the each individual activity of the project. The Input for planning is obtained from the estimating departments, project managers, field engineers, contractors. Thus the planning is the base of the whole project and it must be based on clearly defined objectives to be achieved in a particular project. Therefore proper planning, adequate resources are to be available at the right moment and adequate time for each stage in the planning process.

5.2 SEQUENCE OF WORK

Table 5.1. Sequence of work

No.	Sequence of Work (SUBSTRUCTURE)
1	FOOTING
2	Caisson Excavation
3	Drilling Caisson
4	Prefabricated Steel Casing
5	Installation Temporary Steel Casing
6	Remove water from Hole
7	Installation Reinforced Bars
8	Pouring Concrete Work
9	Concrete vibration
10	FOUNDATION
11	Positioning Formwork
12	Prefabricated Reinforcement Bar
13	Installation Reinforcement Bar
14	Pouring concrete
15	Concrete Vibration
16	Curing Process
17	Striping Concrete Formwork
18	GROUND FLOOR BEAM
19	Positioning Formwork

20	Prefabricated Reinforcement Bar
21	Installation Reinforcement Bar and Plumbing
22	Pouring concrete
23	Concrete Vibration
24	Curing Process
25	Striping Concrete Formwork
26	GROUND FLOOR SLAB
27	Cleaning of Slab Form
28	Positioning Formwork
29	Prefabricated Base Reinforcement Concrete (BRC)
30	Installation of Base Reinforcement Concrete (BRC)
31	Pouring Concrete
32	Concrete Vibration
33	Curing Process
34	Striping Concrete Formwork
	SUPER-STRUCTURE
1	GROUND FLOOR COLUMN
2	Prefabricated Steel Cage of Column
3	Installation Steel Cage
4	Column Rebaring
5	Column Plumbing
6	Cleaning of Column Form

7	Positioning Formwork
8	Pouring Concrete
9	Concrete Vibration
10	Curing Process
11	Striping Concrete Formwork
12	STAIRCASE CONSTRUCTION
13	Positioning Formwork
14	Prefabricated Steel Reinforcement Bar
15	Installation Reinforcement Bar
16	Poured Concrete
17	Concrete Vibration
18	Curing Process
19	Striping Concrete Formwork
20	GROUND FLOOR LEVEL WALL CONSTRUCTION
21	Installation of reinforcement bar
22	Mortar mixed
23	Concrete Block Lying
24	ROOF CONSTRUCTION
25	Prefabricated Roof Trusses at Plant
26	Installation of Roof Trusses
27	Installation of Roof Membrane
28	Installation of Roof Covering

	INTERNAL CONSTRUCTION and FINISHES
1	DOOR
2	Prefabricated Doo
3	Installation of Door
4	WINDOW
5	Prefabricated Window
6	Installation of Window
7	PLASTERING
8	Gypsum Mixing
9	Installing the Wall Plaster
10	ROOF CEILING
11	Prefabricated Ceiling
12	Installation of Prefabricated Ceiling
13	PLUMBING
14	GROUND FLOOR COLUMN
15	Prefabricated Pipe for Plumbing
16	Work Installation of pipe
17	Pipe fitting
18	ELECTRICAL WORK
19	Prefabricated Electrical Accessory
20	Wiring Work
21	Installation of Electrical Accessory

22	PAINTING

5.3 DATA COLLECTION

5.3.1 THE COLLECTION OF DATA REQUIRED HAS BEEN DONE IN THREE PHASES

A. Daily progress reports (DPR)

B. Work output of labour

C. Activities with their planned duration

A. Daily progress reports

The daily progress report (DPR) consists of detailed description of the work done, labor and resources required for the work and record of the inventory in a project while planning each and every activity of project individually. Therefore all the DPR starting from the beginning of the project day till now have been collected and used for planning of execution of each activity involved in the project.

B. Work Output of labor

The work out of labor is generally the outrun of the individual person. Therefore the work output is the amount of work done by one person (Labor) in 1 day or the productivity of the labor to execute the particular task in a specified time. The work output of labor is used to calculate durations required for activity based on the available manpower on site for particular task and this is how total project duration can be obtained.

C. Activities with their planned duration

Total activities for construction of the residential project with their planned duration based on work output and man power available on the site. So every activity along with their duration calculated are entered in the micro-soft project for further working.

5.4 DATA ANALYSIS

1. For data analysis each activity of construction of building are directly found from the bill of quantity (BOQ) of the project and noted down and on basis of outrun of manpower available on site duration of each activity is find out which are used in MSP software for working.

2. Practical construction sequence is understood during field training (site visit) and is used in linking of activities in MSP along with provision of necessary lag (Float) in predeceasing and succeeding activities to find out the relationship among various activities of a project depending on the influence of every activity in a project the relationship among them can be made.

3. Resources required for each activity have been allocated in micro-soft project. The resources are so decided that the project duration and budget planned are in the similar sequence as availability of resources may effect both overall project duration and cost of the project.

4. The delay due to some reason are also taken in consideration and their effect on overall project duration and total cost raised is also evaluated.

Therefore Construction planning is a fundamental and challenging activity in management and execution of construction projects as construction on site is full of uncertainty. The construction planning thus includes the selection of technology, the definition of work task, the estimation of required durations and resources of individual task, and identify the inter-relationship among different work tasks involved in a project. A good construction plan is the base for developing proper planning and schedule and the cost required for each and every activity of a project. Developing the construction plan is a critical task in construction project management as rest of execution of work is dependent on the planned schedule. The necessary aspects of construction planning include the generation of required activities, analysis of the implications of these activities and the choice appropriate among various alternatives methods of performing these activities so that all the risk involved can be avoided.

5.5 SCHEDULING OF A RESIDENTIAL BUILDING

5.5.1 INTRODUCTION

The construction project schedule can have different parameters to different people like to the designers, contractors, sub- contractors, suppliers and the owners involved in the construction process of a project. Therefore the construction schedule means the completion date required for phase of the work in the construction project and the schedule may mean the schedule values the contractors submit against which monthly progress payments will be made as well. Thus the schedule may also refer to the process of sequencing and phasing individual activities of the construction project required to complete the project successfully with in stipulated period of time. In this study construction schedule means a graphical presentation, which shows the phasing rate of construction activities with the starting and completion dates are sequential relationship among the various activities in a project so that the work can be carried out in an orderly and effective manner and the overall project requirements can be fill filled to carry out the project in the planned order.

Scheduling is basically the evaluation of the time period required of events in the project that is when and which task will be performed. Therefore Scheduling can be also defined as the detailed plan of the project work tasks with respect to time period. A schedule is also a good communication tool between all the stakeholders of the project. Therefore Schedule gives an overall sense of expected progress of the project however without schedule it is very difficult to explain someone unfamiliar with the project what is going on and what is expected to take place.

5.5.2 PROJECT SCHEDULING STEPS

A project schedule is simply a projected timetable of construction operations made for every event and activity involved in the construction project. There are various steps involved in the preparation of an efficient and workable job schedule for individual work task. Estimation of time required to carry out each network activity and the various relationship thus among all the activities can exist. The various steps are taken as follows:

1. Overall project completion is obtained using the time estimates by computing the time period required for individual activity. Thereafter the Estimation of time intervals is done within which each activity must start and finish satisfying the completion date requirement of the construction project.

2. Estimation of quantities of work for each of the component activity is involved to identify those activities whose expedient execution is crucial to timely project completion by knowing the critical path of the project.

3. Also the crashing of cost may take place in a construction project if the project completion date is not constant with contract or other requirements shorten the project duration at least possible cost by crashing the activities responsible for delay with least increase of cost.

4. The utilization of surplus of float times can be done which the s most activities possess and adjustment of the start and finish times of selected activities is done to minimize resource conflicts and smooth out demands on manpower and equipments in the construction project.

5. A working project schedule that shows anticipated calendar dates for the start and finish of each activity is thus obtained from the micro-soft project.

5.5.3 MANPOWER MANAGEMENT

Manpower management is most important aspect of success of project in construction industry. Manpower is non-pool type of resource it means if manpower is not used in time, they are lost and they have to be paid for it so utilization of manpower on time is crucial in a construction project but other resources like money, materials, and equipments are not lost when they are not used in time. Manpower is an active resource where as other resources are passive as other resources are to be utilized by manpower. Therefore it may be concluded that if the manpower is utilized in a better way other resources can be used effectively and economically thus a serious concern has to be given for utilization of manpower while scheduling the construction project .Unskilled manpower is available in a large number, but skilled manpower is not available large numbers so the assignment of task specified by the skills of manpower and thus accordingly efficiency can be achieved.

5.5.4 MANPOWER PLANNING

Manpower planning has to be done while doing planning of execution of each activity and can be determined from the outrun of manpower .The number of workers required for each activity can be calculated from the standard data (outrun) or from the past experience so that on that basis the number of days required for completing the respective activity can be calculated depending on the amount of work to be done. As it involves a large amount of computations, micro-soft excel and micro-soft project has been used in this study to estimate the total requirement of manpower.

5.5.5 DELAY ANALYSIS

Delay in construction can be defined as an event or a condition that results in finishing the project later than stipulated time period or delay in construction claims as the time during which some part of the construction project has been extended or not executed owing to an unexpected event corresponding to a particular mile stone planned. Delays are common due more complex task and activities and may be various uncertainties may be on the site till the finish of project. There are many reasons for delay in construction project and reasons for delay have been finding out in delay analysis and their effect on overall increase in the duration and cost are evaluated.

Table 5.2. Reasons of delay

Reason for delay	Delay in days	Cost due to delay (Rupees)

Rain	6	46750
Delay in GFC	6	39000
RMC supplier busy schedule	2	7250
Level difference	3	6500
Shortage of labour	2	59250
Shuttering material	1	13500
Shortage of electrician	4	16000
Shortage of material	2	168600
Structural engineering visit	1	7250
Shortage of20mm dia.	1	7000
	28	**Rs. 371100**

5.6 ABOUT MICROSOFT PROJECT

Microsoft Project is a project management software program which is designed to help a project manager in developing a plan, assigning resources to tasks, tracking progress, managing the budget, and analyzing workloads in a construction project. Thus MICRO-SOFT PROJECT is used for scheduling of the project to know the overall duration and cost of the project. The scheduling of the project will be done from BOQ (Bill of quintiles). The BOQ of the ‘’multistory residential building’’ have been collected from the HP. PWD. Department Shimla. Resource definitions (Labour, equipment and materials) can be shared between projects and each resource can have its individual calendar, which defines what days and time is resource present for the specified task of a project.

The micro-soft project creates critical path schedules, and critical chain and event chain methodology of the project resulting of which the relationship among all the activities involved in the project can be find out cross ponding to the critical activities of the project. Schedules can

be resource leveled, and task networks are visualized in a Gantt chart in the micro-soft project and also the critical path obtained can be seen. Additionally Customization of aspects in Microsoft Project such as calendars, views, tables, filters, and fields are stored in an enterprise global which is accessible by all users are available. The durations of the activity have been calculated on the basis of outrun of manpower and the calculation is shown in the appendix.

5.7 SCHEDULING TECHNIQUE USING NETWORK MODELS

With the help of Microsoft Project, it's easily to understand and visualize the flow and network diagram of the project to know the status and progress of each and every activity of the project. One can easily see the Critical Path which is the Longest Path of the Project, Parallel Activities, and Slack which is also called as Total Float of the Activity can be visualized, Relation between activities is understood by networking so that for a project manager it would be easier to take the decision on a particular task of the project.

5.8 REDUCTION IN THE TOTAL DURATION OF THE PROJECT

Microsoft Project gives a clear view to understand the project easily by giving network diagrams and chains to understand the mechanism of every task. Therefore after making proper alteration by using the duration obtained calculated on basis of outrun of manpower and slacks of parallel activity and crushing the parallel activities the duration of the project has been shown in Graphical form in the micro-soft project and can be compared with the duration required by traditional way.. Thus it has been found that duration to complete the project by Microsoft Project is less than the Traditional Method obtained from the data of Case Study taken in consideration in this study.

5.9 EASE OF WORK FOR LABOUR

The ease of labour means By providing all the governmental holidays of India workers so it makes good environment for Labour to work in the organization and the stress can be reduced to the workers to achieve the better outrun. While on other hand, making workers to work for fix timing 9AM to 6PM with one hour of break helps stress free surrounding for workers which makes them willingly work on the field and this aspect helps a lot in proper execution and success of a project.

5.10 DETAILED SCHEDULE OF PROJECT BY MICRO-SOFT PROJECT

The detailed schedule including starting and finishing date of each activity and the duration of each activity has been obtained from the Micro-soft Project. Also the overall project duration of the project has been obtained and the details of each activity obtained refer to the appendix.

CRITICAL PATH OF PROJECT

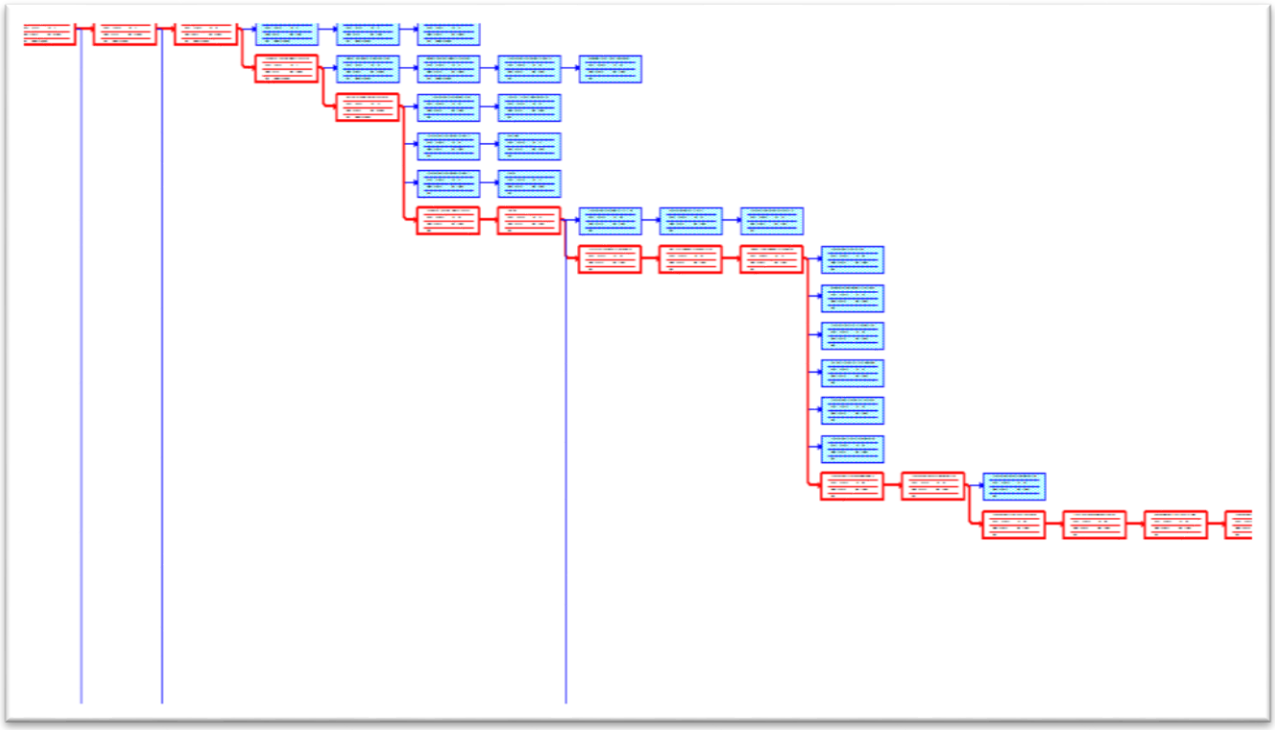


Fig. 5.1.critical path of project

5.11 OUTPUT OBTAINED FROM MICRO-SOFT PROJECT

Table 5.3. output obtained from micro-soft project

Sr.no.	Name of activity	Description of activity
1	Project starting date	3/3/16
2	Project finishing date	9/5/17
3	No. of working hours per day	8
4	Total availability of manpower	34
5	No. of mason	14
6	No. of mazdoor	10
7	No. of bhishti	3
8	No. of carpenter	4
9	No. of welder	3
10	Skilled labour wages as per CPWD	447 ₹/day
11	Semi-Skilled labour wages as per CPWD	407 ₹/day
12	Un-Skilled labour wages as per CPWD	337 ₹/day
13	Total no. of working hours	74,426,97
14	Overall project duration by MSP	552 days
15	Project duration by traditional method	20 Months
16	Reduction in total duration of project	2 months

CONCLUSION AND FUTURE SCOPE

The thesis focuses on the effect of evaluation of pre-construction phase on a project. In this thesis some approaches have been developed to overcome the difficulties in the construction phase. In the construction industry many problems can occur and can lead to delay or extension of project or failure of project. Therefore the appropriate steps are needed to take in the pre-construction phase of a project before the construction phase of takes place.

The main objective of this study is to achieve quality in construction, time saving and budget management. In this thesis a systematic approach is developed for the pre-qualification of the bidders before the bidding process takes place in the construction project to obtain the right set of bidders that have been qualified from the pre-qualification process. The selection of right contraction for a selective and complex type project would reduce the risk involved in the construction project and the quality of construction project can be ensured from the past experiences in similar class of work and quality of work done by him in the construction project that he has executed in the past work. Consequently the case study that I have taken in this thesis the pre-qualification process have been done for “a multi-storey residential building” at kusumpti, Shimla. The four bidders were participated in the pre-qualification of the project and on basis of criteria of the pre-qualification process two bidders have been passed thus only two bidders are left to participate in the bidding process and can quote rates in the tender document of the project issued by department.

Thereafter the future estimation of the bidders also has been studied in this thesis. The various tender documents are collected and analyzed from the various firm for this purpose from the capped tenders and some bidding models have been used for calculating the required data.

Consequently the results obtained from the two bidding models used are compared and optimum results are results from that thus this will help the contractor to become the lowest bidder in such a manner that the sufficient profit from the project is also achieved by deciding the optimum mark up. Therefore this approach can be imply for the future work on basis of data collected from the capped tenders in which he was participated in the past. Therefore the optimum markup thus this is how can be decided and used for the future work as well by deciding the optimum markup.

The appropriate planning and scheduling techniques are used for the effective execution of the work order so that the project would finish in stipulated time period and delay or extension of the project is avoided. The appropriate planning techniques for each activity of the project including working sequence, relationship among all activities, successive activities, and predecessors have been decided properly and the project scheduling is done from the point of view to know the overall project duration with the availability of assumed man powers and other resources decided after site has been visited. Consequently it has been found that the scheduling done by micro-soft project method requires about 18 months for completion of project but by tradition method 20 months are required for project completion.

Therefore in this thesis these are various effects of the evaluation of pre-construction phase on a construction phase of a project.

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