



Propose a Robust Spinal Model to Predict Time and Cost Claim in PE Project

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Abstract:

Accurate project cost and time estimation in the initial stage of PE project plays a key role for project success and for mitigation of disputes. Total project cost (TPM) management and Time requirement of pipeline projects in India has become more important because those projects increasingly rise in quantity with the urbanization and population growth. This topic presents the application of Robust Spinal Model (RSM) in managing TPC and required Time of pipeline projects. The proposed decision-making model would be a useful tool to effectively and efficiently assist pipeline project planners and managers to become more knowledgeable and effective in their decision-making. Here in this project study our focus is on the contractor, Domestic and Commercial sectors of an Organization.

Keywords: PE Project, TPM, RSM, TPC, Population Growth...etc

I. INTRODUCTION

As we can see that many companies were developing and similarly competing with each other perhaps they have to be fast to cope up with others but there are some circumstances due to which many of the industries are having the problem related to the timely completion of project and the cost overrun of project. I have followed certain no of research paper related to the time and cost management in construction industries in that the researcher given a possible solution to the industries for respective problems. From different research paper I have found out different time and cost management techniques which I mentioned here for the reference of my future study likely Critical Path Method (CPM), PERT, Gantt chart, tools and techniques for cost estimating, cost management techniques, cost reduction techniques, project cost management elements etc. The no of project industries can calculating the required time period for completion of the project on the base of their experience only and most of the time it is random period of time based on some assumptions .Here in the industry for laying of the pipeline the project managers can deciding time by considering the factors like How many km of line have to lay, How many teams contractors have.. etc [1] The main aspect considered during the evaluation of cost of project the planning department will go through the detailed study of the no of factors, like How many km Of line Have to be lay, The location of the project site, Schedule of rates of each components, They have previous knowledge of the cost analysis, fixed cost, variable cost, Cost of labors, cost of employees, how many cost has to pay to the government to get permission for excavation and for laying the pipeline etc and so on. Often a Project Manager is evaluated on his or her ability to complete a project within budget. The costs include estimated cost, actual cost and variability. Contingency cost takes into account influence of weather, suppliers and design allowances.[2] It is important that every individual associated with projects and especially, project management understand the basic notion that the reason why a project is conceived, planned and executed is to

serve a final customer or user of the project's outcomes. A project without any end ownership is not sensible. (Martin, 1976, Pruitt, 1999) At the same time however, projects are becoming more complex. The risks involved in project planning and design are also higher. Organizations can save money and resources by utilizing various simulation models to determine the effectiveness of the project. (Doloi and Jaafari, 2002) Planning is necessary for all projects. Simulating project needs at every stage of the project life cycle can help decision makers view the changes or modifications that might be needed in a plans. Research indicates that many of the problems experienced in projects are of a "management, organizational or behavioral nature" and rarely due to inadequacies in technique or skill. This is especially true of software related projects. (Hartman and Ashrafi, 2002) "Identify the variables for integrated Cost and Schedule control in terms of reducing required work load. Potential variables including project delivery system, Contract type, level of outsourcing, degree of specialization, progress measurement methods, budget format, management detail, vertical integration and so on can be identified", according to Iris Tommelein, Editor, Youngsoo Jung (2005). According to the Director (Contract), Military Engineering Services, Ahmadabad (2006), "the total cost management of construction projects is possible only when all the players in the field i.e. the client, the contractor, the architect, the design engineer, the quantity surveyor and the site engineer / project manager are conscious of cost management of project and perform their functions effectively. A lapse on the part of any single component will result in delay of project and increase in cost". Michael Bommer, Rence DeLaPorte and James Higgins (2002) say that "the skunk works project management teams was able to deliver the projects on time and particularly within budget by

- (i) Adhering to clear focus on their mission
- (ii) Including extensive up front planning efforts
- (ii) Critically analyzing customer needs
- (iv) Leveraging project overlaps

- (v) Involving suppliers early
- (vi) Empowering the team and
- (vii) Breaking rules.

Objective of this project work is Find out problems related to time and cost overrun during PE project., Study the hidden barrier which remain untouched in scenario of time and cost. Reduce cost of the project indulging the execution process. Optimize time for project in organization to enhance productivity. At the present numbers of the companies are giving contracts rather than doing they own, to make their work done. Scenario in the project industries is that project time and cost overrun takes place, due to this the company suffers very badly. In gas distribution Industries the project of PE and Steel pipeline laying getting delayed and cost of project is much more than the actual required cost because of the contractors work policy, because of this companies are not able to maximize their net profit. The contractors are not having a schedule of project plan for entire project period. The cost required for the project is higher because of the sub-contracting which is done by contractors. Due to sub contracting profit is share by contractor and sub-contractor and because of this quality work cannot happen. To avoid this respected company should have to use the different tools and technique to calculate real cost estimations for the project and have to adopt a monitoring technique for quality check. The study of this project will help to the planners and project managers of industries working on the pipeline laying project for making decisions of cost and time of project. The different techniques discussed in this paper relative to time management like Gantt chart, milestone diagram, CPM, PERT will give a better decision making knowledge to the project planners. Rather than this the solutions given to the problem occurs in domestic and Industrial and Commercial connection, after implementing this model in the industries then they will able to get required time period of proposed project. Definitely the research gives a strong model to project time evaluation than the present conventional methods of time evaluation used by the industry. The cost evaluation techniques explained in the research paper have a broader reason to adopt them for the cost evaluation as it will maximize the net profit of the industries and minimize the cost of the project. The paper also helps to avoid the sub contracting tendency in the project industries as we know that in sub contracting only 15 to 20 percent of the project cost was earned by the parent contractor. So that by implementing this model in the industries then they will be beneficial in both the ways.[3] The PE and Steel project process can be divided into three important phases, i.e. project conception, project design and project execution. Usually, the vast majority of project delays occur during the 'execution' phase, where many unforeseen factors are always. In execution, delay could be defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for the delivery of a project. It is a project slipping over its planned schedule and this is a common problem in projects. To the Industry, delay means loss of revenue. In some cases, delay causes higher overhead costs to the contractor because of longer work period, higher material costs through inflation, and due to labour cost increases. Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. The sources are the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations, and the completion of a project within the specified time is rare (Assaf, 2006)

II. RESEARCH METHODOLOGY

Spinal model is the tool that helpless experienced estimators to integrate such effects. Like human brain, neural networks learn from experiences, generalize from previous examples to new ones and abstract essential characteristics from inputs containing irrelevant data. The major objective of this study is to develop a NN- based model for estimating TPC and Time of PE and Steel projects in conceptual design phase. The purpose of this research project is to develop a model to enhance the decision-making process for the selection of projects and contractor for the project. The proposed decision-making model would be a useful tool to effectively and efficiently assist pipeline project planners and managers to become more knowledgeable and effective in their decision-making.[6] The most of the time and cost related factors were identified through survey from the professional working in the company. This survey will be made through different aspect of the project to different professionals. These professionals include engineers, contractors and clients. Moreover, all of the professionals are selected based on their experience. The collected data were analyzed through relative importance index method. These analyses include ranking the different causes according to relative important indices.

- Find the areas where time and cost overrun occurs
- Study the reasons for time and cost overrun of project
- Collect a suggestion to control the cost and time management from experience researcher and project managers.
- Identify the important cost and time management tools and techniques
- Study of this tools and techniques in accordance with the companies problems.
- Accept this tools and techniques as per their relative importance index.
- Suggesting this tools and techniques to the company for control the cost and time in a pipeline project

III. PROBLEM ANALYSIS AND INTERPRETATION

The project mainly concentrated on the basic points of commercial and domestic sector due to which project time and cost overrun happens and also studied briefly the influence of contractors work policy on the progress of PE project.

Here in this project I focused on the following points and studied with respective circumstances Of Time and Cost management as per the convenience;

1. Industrial and Commercial segment
2. Domestic Segment

1. INDUSTRIAL AND COMMERCIAL SEGMENT

Our objectives are,

- To study the reasons of delay in I & C conversion projects.
- To suggest proper solutions for the faced problems.

There are two main reasons for the delaying work

1. Delayed due to customer end reasons
2. Delayed due to company end reason

1.1 DELAYED DUE TO CUSTOMER END REASON

In many of the cases the industrial and commercial customers don't finish their down streaming work even after company has completed the up streaming work up to MRS inlet. Due to this the forecasted profit of MGL has frozen down.

1.2 DELAYED DUE TO COMPANY END REASON

Here in this study we have to focus particularly on the reasons for the delaying of conversion from MGL end. We have listed out the number of problems technical as well as managerial which are mainly responsible for the conversion delay.

- ✓ Delayed due to documentation
- ✓ Local political issues
- ✓ Absence of Liaisoning
- ✓ Lack of interaction between different departments
- ✓ Unavailability of equipment and manpower with contractor
- ✓ Sub-contracting
- ✓ Lack of proper communication between customer and concern company authorities
- ✓ Variation in testing methods of MRS
- ✓ Contractors issues- lonely fish

Delayed Due to Documentation:

For getting the permission from Municipals corporation takes more time for example in many cases we observed that for getting NOC from CFO takes a much more time than required one which result in the delayed of conversion. As per our study government of Maharashtra is not supporting well to the MGL, if we see towards Gujarat state their government supporting well to the Gujarat gas.

Absence of Liaisoning:

company should appoint the third party Liaisoning person because when the problem arises in the laying of pipeline then it will be more impact full that rather than company representative third party liaisoner talk to them and it will be beneficiary to make work to be done. As we observed Due to lack of Liaisoning the huge amount invested by company is now in frozen state and no profit is generated from that. Company should keep some fund for Liaisoning it will be very helpful to complete conversion of the many customers who are in the waiting queue.

Local Political Issues:

As project in the Phase of laying PE or steel pipeline there are the many hurdles which company come across. Among this one highlighted one is the local political leaders are forcing us to stop the work for their self interest even after MGL has all the necessary permissions related to the work. For this case also the third party Liaisoning is good option.

Lack of interaction between different departments:

Before the registration of any Industrial and Commercial Customer it should be studied that how much time it should take to give him a connection. All the parameters should be studied before the registration like customer is at how much distance away from charged line?, Should it feasible to complete a conversion before a promised date?, there should be the proper conversion between marketing department and project department.

Unavailability of equipment and manpower with contractor:

While bidding, every contractor shows on the paper that, they have all the required equipment and total number of working teams as per company's requirement. But in actual practice none of them are having all equipment and man power. In case where that particular equipment is required like Dewatering pump, Compressor, generator etc contractors managing the situation by asking it to other contractor which will be time consuming.

Lack of proper communication between customer and concern MGL authorities:

As we experienced after having an interaction with commercial customers they are not satisfied with way company's works. They are having a list of complaints about MGL work. In some no. of cases customers are waiting for the connection more than the double of the promised time period, it can be minimized by the good communication between customer and our authority. If the respected authorities of company have a proper interaction with the customers then it will help to work done timely and it increased goodwill of company.

Variation in testing methods of MRS:

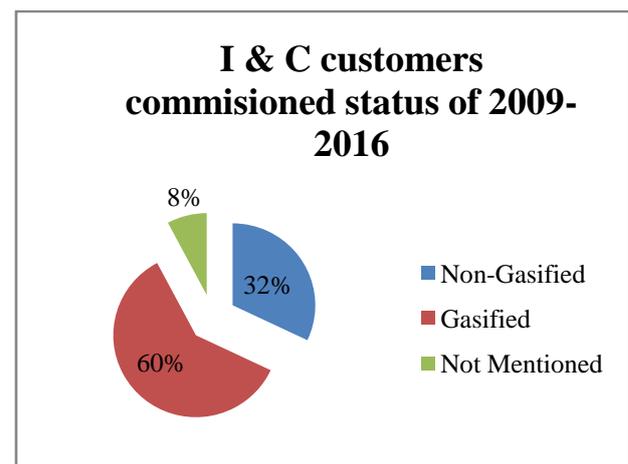
MRS manufacturing industries from where company getting MRS are testing the MRS by the analogous method while after installing the MRS at site, Operation and Maintenance team of company testing it Digitally due to this the error occurs and if it will out of the permissible error range then it will delay the conversion.

Contractor's issue- lonely fish

As we were known about the sub-contracting, this is also a big reason behind delaying in works as they knows that they are the only one whom we are going to offer work, so they became lazy and not willing to work. company could keep watch on their every activity using different tools and techniques.

REMEDIES

- Company should keep bank guarantee from authorized contractor who are laying down streaming work.
 - Considering I & C, we have to change the management, the down streaming work is done by the 3rd party whereas the up streaming work is followed by company, and within this gamble loss occurs to customers as in his delaying of work leads to dissatisfaction of customers.
 - If company allow the down streaming worker itself to install the MRS then it will be beneficial to reduce time. More over this authority must be provided by company itself, to avoid the complication.
 - Company don't have any down streaming data in system or SAP to identify which contractor did work at particular site. If someone required it after some days or years then we have to look for the whole file & junk to find which contractor or worker did those locations, it consumes lot of time.
 - Unavailability of materials towards contractors.
 - Lack of plumbers or workers.
- Company should train their own workers or plumbers.
- No alternative work allowed before finishing the work/ one site at a time.



As, pictorial representation shows, 40% of customers are still awaiting for gas. It's a dead investment which didn't generate any revenue, so here we focused on those non gasified customers and their reasons.

1.2. DOMESTIC SEGMENT

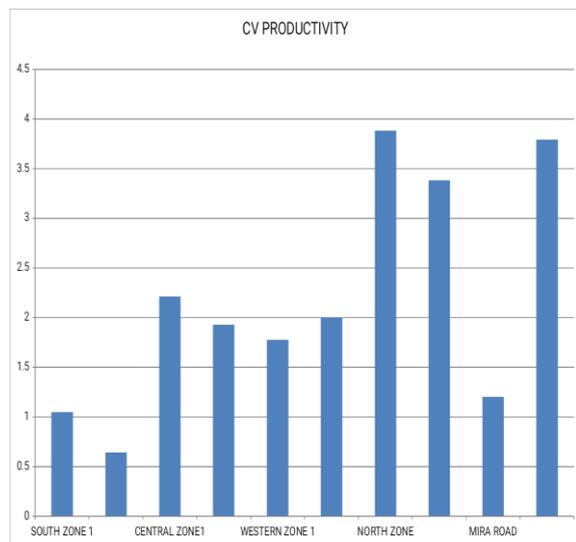
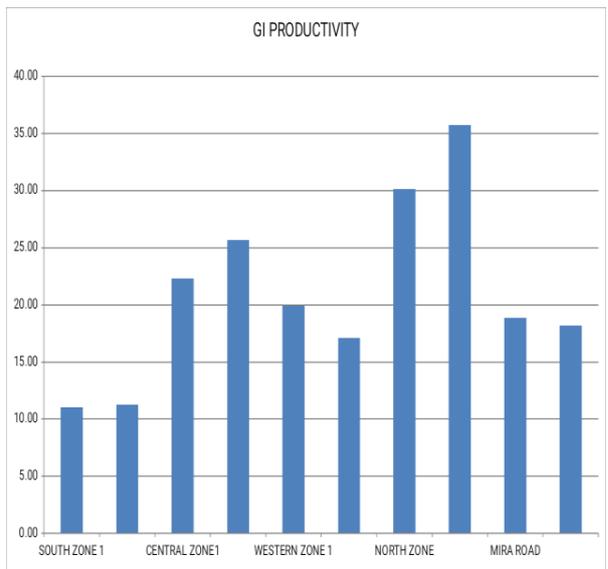
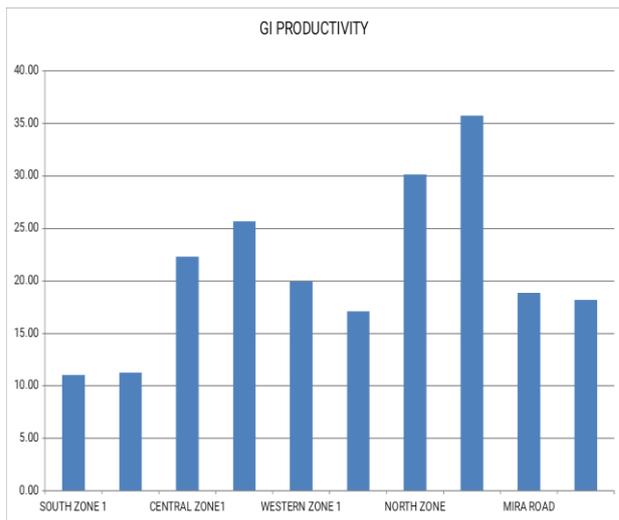
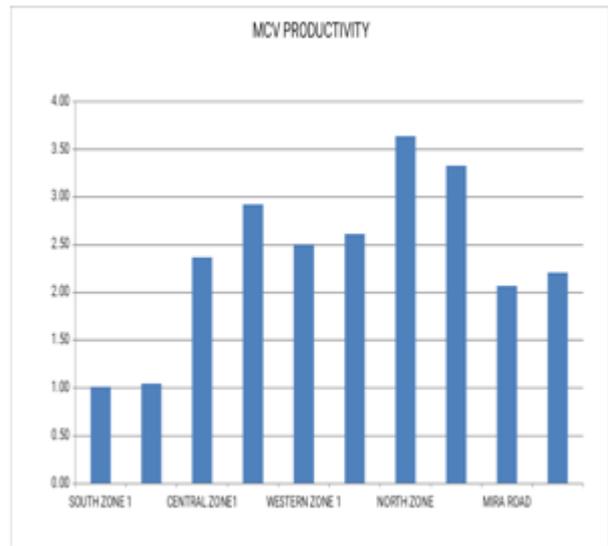
Here in the domestic segment we focused on the GI work. In the Domestic segment progress of work can be measured mainly on the basis of plumber performance. As we discussed earlier plumber is supposed to do 4 MCV and 4 CV per day, but most of the time he fails to meet the standard figure thus we have face delaying projects. Further we have demonstrated some activities and there outcomes goes in such a way. Plumbers play crucial role in achieving Last Mile Connectivity. Unless they do GI & MCV, conversions planned would not be achieved. In this context, plumber productivity becomes a vital issue in some of the industries. The plumber's output can be measured in terms of total MCV's they do on a given day (i.e. MCV per day). While it gives a fair idea about their productivity in general, but it doesn't reflect GI pipeline laid in a day, Building complexity and other factors productivity concerned with increasing measurable output at given constrained input factors. Our study basically focused finding the causes that affect plumber productivity and workable suggestions to improve it.

11.2.1 PRESENT PERFORMANCE

We access the Total Physical Performance data for all project zones which gives idea of MCV's done, GI pipe laid, Conversions done for the period 1 sept 2015-15 aug 2016. We have assumed normal available working days for the plumber across each zone are to be 22 days. We calculated three performance indicators namely MCV per day, GI laid per day and conversion efficiency. The objective behind this experiment is to observe the inter-zonal performance patterns and identify the causes behind variances. Productivity in general is defined as units of output per labor hours or units of output per shift. company, physical performance parameters are -

- (1) MCV installed
- (2) Conversions Achieved

It has input factors namely (1) Planning activity, (2) labor hours (plumbers), (3) Material availability, (4) Equipment



It is evident from the results that there are significant inter-zonal differences in performance output which varies from 1 MCVs per day per DRS in south zone to 4 MCVs per day per DRS in north zone and GI laid varying from 11 meters per day per DRS to 35.72 meters per day per DRS. While plumber productivity certainly is one of the factors behind these differences, there are several other factors which also affect overall performances which are distinct for each zone. One may also argue that the differences are directly attributed to more manpower deployment i.e. contractors employing more

plumber teams in a zone to achieve maximum physical progress availability.

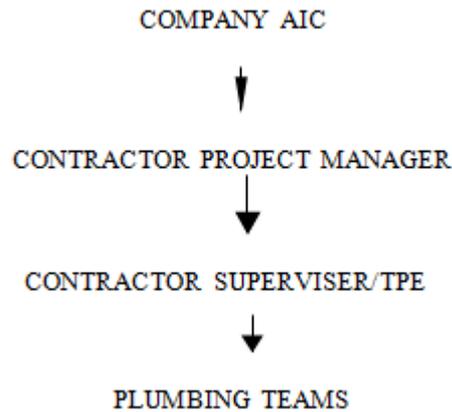
FOLLOWING POINTS ARE OBSERVED IN OUR VISITS

Material Specification; Material available on site is not as per specification of required material. For example, the heavy pipes are used for threaded riser which causes the extra efforts for threading on pipes. It makes wastage of plumber's energy and time thereby resulting in less productivity. WAH Online; while it is commonly agreed that Present WAH system is a welcome change to improve performance but still there are several issues, network connectivity being prominent in them. Some areas lacks strong network which makes delay in sending the permit request. It is also observed that after request is sent from tab, AIC don't get update of permit request. Till such time plumber has to wait to carry out the work with required equipment which causes wastage of time. Deployment of teams; Some areas have less number of GI teams deployed than ideally required which henceforth results in non achievement of targets . Customer confrontation Due to lack of GI teams, current GI team has to resolve the customer complaints which are ideally not expected from them; which results in loss of MCV / CV /GI for that particular day. Plumber has lost his productive time due to interruption of customer. The work rate gets reduced due to excessive pressure of customers. Payment Discipline; Lack of timely payment is the major problem faced by GI teams. Their salary time is not periodic or fixed. Hence plumber start doing work without taking any interest, the work rate is reduced, they start coming late at work and also remain absent frequently. Some sites are closed most of time due to unavailability of material. It causes the dissatisfaction to plumber who has to remain idle for day. Material Transportation; Plumber loses his productive time while handling the material from contractor store to working sites. Team co-ordination; Poor team co-ordination is main reason which reduced the work rate. The sites start late due to one of member of team. It is found that the members remain absent without assigning replacement person. It is also observed that the supervisor is not taking responsibility from contractor side to work, he remain dependent on TPI. It is also found that the AIC have to instruct GI team frequently for minor problems like Tab, MJC upload etc. This shows that there is no active person from contractor side who can resolve such minor problems. Poor performance is shown on system due to failure in MJC in time though the work is going on. Unnecessarily AIC has to make decision to stop work to force them to complete MJC upload activity. It is also observed that the equipment is shared between GI teams which make the GI team dependent on each other. This situation causes the missing of equipment and equipment is not available on site whenever required which again makes the productive loss. It is also observe that the working hours are not maintained regularly due to lateness of one of team member, customer is not available or site is not available for work. Due to various reasons the working hours at sites are not same every day. Due to wrong information given by marketing team which causes the over expectation such as they forces the plumber to do work which is not under the scope of plumber as per rule and plumber also not ready to take risk. This makes work get stopped for long time. GI team, especially plumber gets fear to do work on site which causes reduction in his work performance. Work rate is reduced due to shifted kitchens. Plumber has to put extra work.

1.3. REMEDIES TO REDUCE TIME AND COST

1.3.1 DILIGENT GI PLANNING

The higher level planning for GI is done by MGL AIC & then the plan is further percolated to contractor project manager. The typical cycle is as follows:



The monthly plan which is sent to P.M who is supposed to chalk out a plan for his teams spanning over month but this seldom happens and due to inadequate planning measures, sites are often not cleared for work or no task is assigned to his teams thus we waste our labor hours. We have also seen a trend where PM further delegate his responsibility to supervisors while also expecting from him to discharge his normal duty

1.3.2 EXPECTED PLANING FROM CONTRACTORS PROJECT MANAGER

The way of planning is expected from contractor project manager. Planning is such a aspect which is not given a adequate attention. A micro plan based on general plan should be prepared by contractor involving his supervisors, plumbing teams, & safety officers. It should be realistic & in sync with the resources available with him. AIC should be kept informed on every development as well as in any discrepancies in plan. Either project manager himself or Supervisor (not assigned to any site) should thoroughly survey prospective GI Sites and record the following:

1. Quantum of work to be done
2. Rough GI Survey (Riser)
3. Society approval/ customer interaction
4. Time estimation to complete the work
5. Possible difficulties in execution.

This exercise should be completed at the earliest in preceding or current month. After preliminary survey, priority should be decided and accordingly teams are to be deployed for execution. AIC should also depute his senior/experienced TPE to accompany contractor P.M./Supervisor for above task.

1.3.3 PAYMENT STRUCTURE REVAMP

Most of the plumbers have reported to us that they receive around 60-70 Rs. Per meter of GI work. Most of them were satisfied with the rate per meter they receive but their only issue was late payment / deductions by contractors etc. The majority of the plumbers come from Orissa, West Bengal, UP and Bihar; and since they have dependents on them, it is only wise to instill a mechanism which can guarantee them timely payment for their works. In order to keep them motivated, which is also directly affects their productivity; we recommend a clause in the contract itself to make payment to plumber compulsory before final billing. We would also want to draw

to your attention regarding the fact that plumbers get almost uniform rates regardless of complexities of their work. Some zones especially Kalyan-Dombivali, Ambernath, Thane have simple building structure and are convenient for speedy GI work while that is not the case for other zones e.g. South zone. There should be a comprehensive relook to methodology of calculating SOR for GI.

1.3.4 MANPOWER DEPLOYMENT

In our current system, contractors can bid for more than one project area and he can win the bids for different zones. In such situations, he deploys a common pool of manpower especially plumbing teams and technicians and adjusts his teams in all his areas. While this strategy may seem appropriate for contractor but in the end company suffers from this approach. AIC should intimate his contractor regarding the work plan and GI fronts available to be executed and prepare a manpower planning chart duly involving inputs from contractor project manager by taking in writing from them at the time of resource mobilization and suitably incorporating a penalty clause for non compliance.

1.3.5 PLUMBER DATABASE

It is also a workable option to have a pan Mumbai plumber database to be created by company having all the details viz, name, address, contact, experience, current occupation, experience with company as a contingency plan so that we can direct contractors to hire them in case of shortage in any particular project area.

1.3.6 ROLE OF TPE

Keep seminars for TPEs as per zone to give information of planned target and corresponding work progress. Give them information related to company work, so they can feel the improvement in their knowledge and will get satisfaction of learning new things. Most of TPEs have knowledge of their site only. They are not aware of the future plans of company. This makes the improvement in self-confidence and able to perform well. Present situation of TPEs is dominated by MGL and Contractors. He is key person who knows the way on which work is going on. He has some authority for handling the contractor. Also, He should be responsible for that site work.

1.3.7 INCENTIVIZE BEST PERFORMERS

Do monthly evolution of particular team performance and provide best performance prize monthly to encourage them. So everyone will be serious for their work. Also, make communication with poor performers also.

1.3.8 INVENTORY MANAGEMENT & DOCUMENTATION

There must be one active member from contractor side who can take care of material inventory management and capable to solve the site problems. His main responsibility will be to ensure plumber do only productive work rather wasting his time to handling material from store to site. It is observed that contractor do not complete most of documentation work, TPEs are doing their work. Hence it is suggested that so as to TPE get involve in their productive work.

1.3.9 FEW OTHER SOLUTIONS

It is necessary to made verification of availability of set of equipment to each GI team. If the sets of equipment are shared between GI teams, then they will dependent on each other which hampers the work. GI team members must give training on how to handle the customer. Many of the times team

members are hesitate to talk to customers or give false commitments or creates quarrel with customer. Many times plumber fails due to customer bourdon. It is very necessary to arrange meetings with customer of concern region or authorities of society where project fails to obey time commitment. Company must discuss with them, so as to get correct status of work. Hence, customer burden gets reduced which can feel by team. The MJC and WAH permits are dependent on network strength. Current WAH permit process gets too much time due to network. Yes, it is best process only when network issue get solved using portable Wi-Fi. One suggestion we have got is that AIC did not get alert of permit request; team has to make calls for intimation of same. It also observes that some sites MJCs are pending to upload on system or contractor submit it late on system. Hence, it is very necessary to adopt practice to upload MJC as soon as conversion over. It is necessary to do contractors work evolution with respect to safety, quality points and work performance, team performance. It must refer while giving contract to next year. Improve communication between the marketing and project department. So as to avoid customer dissatisfaction ensuring that customer get right information. There must not be any misunderstanding to customer which can hamper the future work. Plumber must carry material, tools, equipment at kitchen from store room through some kit. The advantage of kit is that plumber can easily guess whether all tools are available or not.

IV. CONCLUSION

After studying commercial and domestic sections the project turn towards conclusion as reaching towards the objective and goal of the project. The project has been studied at different level and different places according to the circumstances. The results which we faced are conveying the reduction of time and project cost. As if to increase plumber productivity, while indulging of technical and non technical aspects which ruined comparatively faster as it was. The project has been discussed with the Manager of Project Department and even management convinced with the recommendations which tends to reduce time and cost of project. The factors considered in the commercial and domestic project likely Liaisoning, some political issues, technical drawbacks and some managerial aspects in commercial segment and the plumber productivity in case of the domestic project are likely the Spinal cord for the progress of project. The solutions given for the above problems occurring during the project funder the different circumstances are use to reduce time and cost in projects then the achieved result is become the framework of model to predict time and cost claims in PE project. This is a long term project if properly implemented in the future will have a positive impact on the company.

V. REFERENCES

- [1]. "Request for quotation, Tender document of MGL, Laying of MP/LP pipeline, GI installation, Gas meter, for providing Piped Natural Gas to domestic & Non domestic customers in Mumbai Area".
- [2]. www.mahanagargas.com
- [3]. https://en.wikipedia.org/wiki/Mahanagar_Gas
- [4]. Chidambaram Ramanathan, SP Narayanan and Arazi B Idrus, (Universiti Teknologi Petronas, Malaysia), Construction

[5].Shanmuganathan N1, Dr. G.Baskar2,” EFFECTIVE COST AND TIME MANAGEMENT TECHNIQUES IN CONSTRUCTION INDUSTRY”, Shanmuganathan N et al., International Journal of Advanced Engineering Technology, Int J Adv Engg Tech/Vol. VII/Issue II/April-June,2016/743-747.

[6]. Zoran Pučko, Nataša Šuman, Uroš Klanšek,” Building Information Modeling Based Time And Cost Planning In Construction Projects”, DOI 10.5592/otmcj.2014.1.6 Research paper.

[7]. Peter Stelth (MSc), Professor Guy Le Roy (PhD),” Projects’ Analysis through CPM (Critical Path Method)”, School of Doctoral Studies (European Union) Journal

[8]. Hyung KP. 2005. Cash Flow Forecasting Model for General Contractors Using Moving Weights of Cost Categories, Journal of Management in Engineering, Volume 21, No.4, 64-172.

[9]. Pilcher R. 1985. Project Cost Control in Construction, Collins, UK.

[10]. Frisby TN. 1990. Survival in the Construction Business: Checklists for Success, Kingston, Mass, R. S. Means.

[11]. Burke R. 1992. Project Management: Planning and Control, Burke Publishing, New York.