APPLICATION OF PROJECT MONITORING TOOLS FROM OWNER'S PERSPECTIVE

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ABSTRACT

Completing a Construction Project on time and in allocated budget is the basic need of any Owner of the facility. For this the most important factor affecting is the monitoring tools that has been used to monitor the progress of the project. There are many tools available for monitor the progress of the project. The use of these project monitoring tools usually depends upon the type of the contract (i.e, BOT contract, Lump-sum and so on). The study was carried out by conducting interviews with the Agencies and Firms that owns the facility regarding the tools used for monitoring the progress. And then the analysis is done based on the outcome of the interview carried.

Keywords: BOT, Contract, Item Rate, Lump-Sum, Owner's Perspective, PM Tools, Project Monitoring Tools

1. INTRODUCTION

The construction industry has been growing like anything these days and the number of projects that has been executed daily is increasing day by day. But construction industry now-a-days is facing severe problem of poor project management resulting in huge amount of cost overrun and delay in completion of the project. This needs serious attention for improving the management of project as projects are rarely completed in time and in allocated budgets.

Every project has some costs associated with it in the form of direct and indirect costs. It is very important to keep a check on these costs as the increase in costs will have an impact on the future of the project. And this is done by project monitoring of the project. Project monitoring is the process of collecting, recording, and reporting information concerning project performance that project manager and others wish to know. Monitoring involves watching the progress of the project against time, resources and performance schedule during execution of the project and identifying lagging areas requiring timely attention and action whereas project controlling uses data from monitor activity to bring actual performance to planned performance (Andrew F. T and Sachin Paul, 2013).

On the other hand cost control is a process where construction costs of the project are managed through the best methods and techniques so that project gets completed in given time and under budgeted cost. One of the aims of cost control is to construct at the cheapest possible costs consistent with the project objectives. Ultimately the decision of the manager that something should be done differently and the translation of that decision into practice are the actions to achieve control (Harris and McCaffer 2002).

Both the contractor and the Owner tries to minimize the cost by monitoring and control project, but while doing so their perspective is different and the tools which they use for project monitoring are also different. Adapting a project monitoring tools for the Owner depends upon the type of the contract i.e., item rate contract and lump

sum contract. There are various costs incurred to the Owner during different phases of the construction right from the planning stage to execution stage but the Owner cannot monitor the progress of the project asclosely as the contractor and also the data which contractor may be having after monitoring of the project may not be shared with the Owner fully and hence it becomes difficult for the Owner to monitor the project.

The aim of this study is to find out various project monitoring tools which Owner should use depending on the type of the contract so that the project progress can be monitored properly and the project can be completed before time and with the allocated budget.

2. PROJECT MONITORING TOOLS

Once it is decided to go for contracting and the type of contract is decided then the tenders are floated. Interested contractor then submits bids for the contract. These bids are then evaluated and the contract is awarded to the suitable contractor. The construction phase of the project then begin, it becomes necessary to monitor the project in order to take corrective actions or controlling of the project so as to complete the project in stipulated time and budgeted cost. The projects considered for the study are: 8 lane carriageway from PeddaAmberpet to Shamsabad for BOT Contract, GayathriNiwas (a residential building) for Turn-key Contract, Navi Mumbai Metro Rail Project for Lump-sum Contract, Casa Buena (a residential building) for Item-Rate contract.

There are various tools available for monitoring the progress of project. These tools have been classified in different categories depending upon how they convey the information to the receiver. They are graphical tools, meetings, reports and photographs. We will be looking for only graphical tools as the other tools i.e, meetings, reports and photographs are common for all types of contract. They are further explained below:

2.1. Graphical Tools

Graphical tools as the name suggests is the graphical representation that helps to understand the progress of the project just by looking at the graphs. They are the graphs generated by input of data obtained from site in relevant software such as MS Project, Open Proj, and MS Excel Templates etc. Following are the graphical tools that are used commonly:

2.1.1. Tracking Gantt Chart

Tracking Gantt chart can be developed using various software such MS Excel, Ms Project, Open Proj etc. Fig.1 shows a sample of Tracking Gantt chart for a factory project. The dataentered here is the planned start and finish date for each of the activity and also actual start and finish dates. This is shown in the Fig. 1. Therefore for each activity we have here 2 bars, the upper bar represents the actual start and finish of the activity while the lower bar represents the planned start and finish dates of the activity. For the following example, the date on which the status of the project is to be known is 18th September 2013. In the Fig.1 the highlighted activity is “Excavation” the planned start and finish date are 13th September and 19th September i.e. it requires 6 days to complete this activity. But the actual start date of the activity 12th September and till 18th September the activity was just 75% complete.

Similar track can be kept for other activities and thus for any day the status of the project can be seen just by looking at the Tracking Gantt chart. The percentage of the work entered depends upon the person who is recording the data. Usually the actual performed work is compared with the total work to be performed and then the % work completed is found. This may vary from person to person and depends upon the perspective of the person.

2.1.2. Earned Value Analysis

Earned Value is a program management technique that uses "work in progress" to indicate what will happen to work in the future. EVA uses cost as the common measure of project cost and schedule performance.

EVA uses the following project parameters to evaluate project performance:

- Planned Value
- Actual Value
- Earned Value

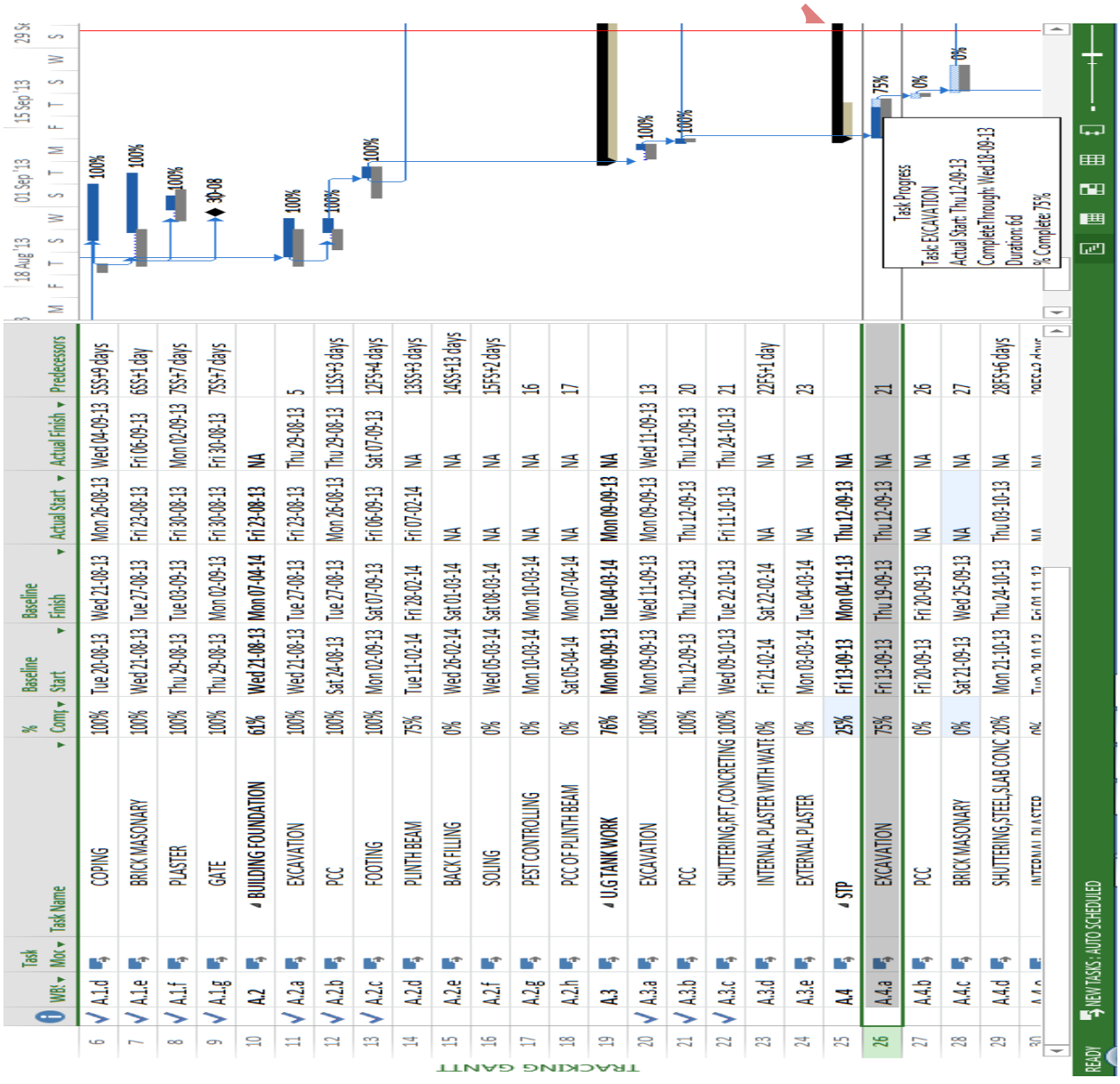

Fig.1. Tracking Gantt chart of Industrial Shed Project

The Case Study of Residential Project has been taken, using the information of an actual project its cost and scheduling. The Built-up Area of residential building is 120 sq.m. The data required for Earned Value

Analysis is planned start and finish dates, planned cost, actual start and finished dates, planned duration and actual duration to complete the activity and actual cost and percentage of work complete on a specified date.

After entering the data required, Earned Value Analysis curve can be generated for this example we can see that the earned, planned and actual cost does not vary much. Scheduled variance and cost variance can be found out which shows for particular activity weather it started on time (for start variance) and finished on time (for end variance) along with costs for each activity. Fig.2. shows graphical representation of the Earned Value Analysis Chart.

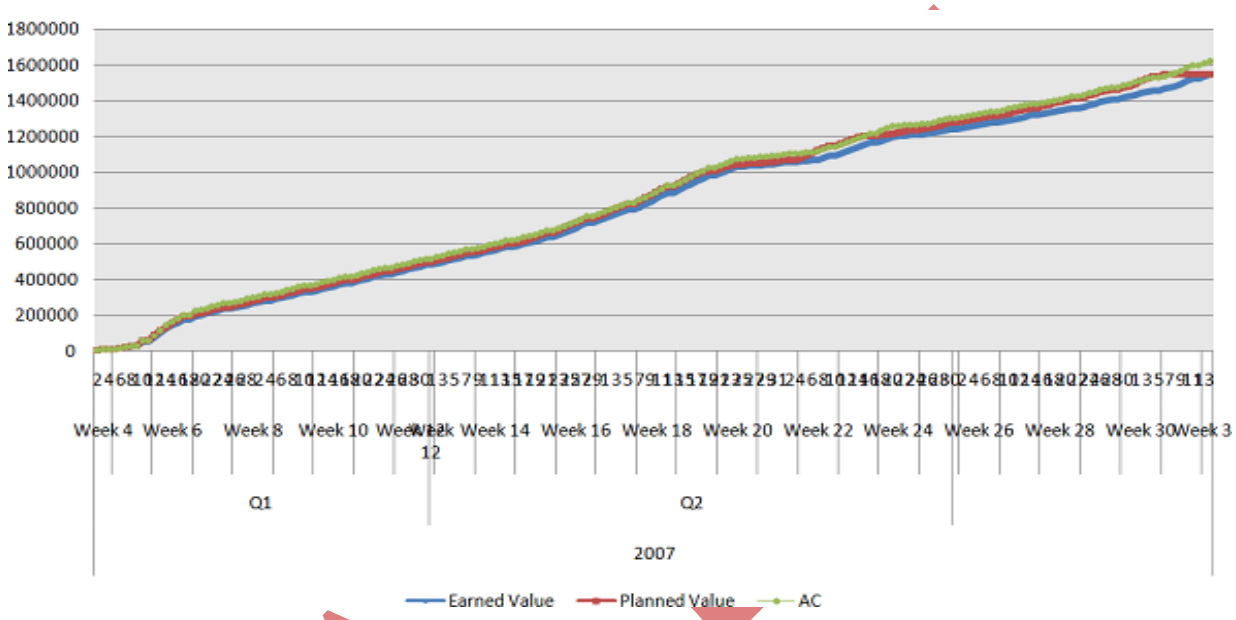

Fig.2. Graphical presentation of Earned Value Analysis

2.1.3. Strip Charts

Strip Charts is an excel template showing the status of the work and can be used for nature of the work can be repetitive or linear. The status of the work can be found out just by watching the colour of the activity. Following is the example of the strip chart used to monitor the metro bridge. The Table.1 shows pier 1, 2, 3, and 4. For each pier they are further divided into activities such as RCC design, work order, excavation, erection for reinforcement, etc. The data required for this is planned date and actual date required for the specific activity. Consider Pier 1, for this the planned date for RCC design is 21st March 2013 and the actual date at which the RCC design was available is also 21st March 2013 so the boxes are green representing that this activity was carried on time. Further the planned completion date of erection of reinforcement for Pier 1 is 30th April 2013 but it was actually completed on 01st May 2013 so the colour of the box is yellow showing there is delay in completing the activity but it was not that much. Similarly, the planned date for completing the construction of the pier is 20th June 2013 but instead of this the pier was completed on 30th June 2013 and so is the red colour of the box which shows that there was considerable delay for the specific activity. At the end there is a column for remark and that displays the current status of the milestone. For Pier 1 the remark is completed with considerable delay similarly for Pier 2 it is completed earlier than planned or on time. And for Pier 3 and Pier 4 the status of the project as of now is that there is a delay because the work order has not been given.

Table. 1. Strip Chart

STRIP CHART								
Activity	RCC design	Work Order	Excavation	Erection of Reinforcement	Foundation	Pier	Pier Cap	Remarks
	21-03-2013	05-04-2013	10-04-2013	30-04-2013	20-05-2013	20-06-2013	20-07-2013	
Pier 1	21-03-2013	02-04-2013	08-04-2013	01-05-2013	25-05-2013	30-06-2013	30-07-2013	Completed
	25-03-2013	10-04-2013	15-04-2013	04-05-2013	24-05-2013	24-06-2013	24-07-2013	
Pier 2	29-03-2013	14-04-2013	16-04-2013	04-05-2013	22-05-2013	23-06-203	22-07-2013	Completed
	21-04-2013	05-05-213	10-05-2013	30-05-2013	20-06-2013	20-07-2013	20-08-2013	
Pier 3	21-04-2013							Delay in Giving Work Order
	25-04-2013	10-05-2013	15-05-2013	04-06-2013	24-06-2013	24-07-2013	24-08-2013	Delay in Giving
Pier 4	01-05-2013							Work Order

2.1.4. Work Programme Chart

This is a tool which displays the progress of the milestone of a project. This is usually used by relatively small PMC firms. Fig.3 shows the tabular representation of the Work Programme Chart for a residential project.

In this tool the input data is the planned and actual date of start and finish for any milestone along with planned and actual duration required to achieve the milestone. This is very simple tool for monitoring and it is usually prepared at the end of the month.

Sr. No.	ACTIVITIES	TARGET			ACTUAL		
		FROM	TO	NO OF DAYS	FROM	TO	NO OF DAYS
1	Raft Slab - Part - III (Shopping) with Retaining Wall	23-Nov-10	3-Dec-10	11 Days	23-Nov-10	3-Dec-10	11 Days
2	Lower Ground Floor Slab Part - II	30-Nov-10	8-Dec-10	9 Days	3-Dec-10	12-Dec-10	10 Days
3	Upper Ground Floor Slab	9-Dec-10	14-Dec-10	6 Days	10-Dec-10	20-Dec-10	11 Days
4	Water Proofing U.G. Tank and Lift Pit	15-Feb-11	15-Mar-11	30 Days			
5	Grid Slab (Ramp)	10-Mar-11	30-Mar-11	20 Days			
6	1st Floor Slab	15-Dec-10	31-Dec-10	17 Days	21-Dec-10	14-Jan-11	25 Days
7	2nd Floor Slab	15-Jan-11	30-Jan-11	16 Days	15-Jan-11	30-Jan-11	16 Days
8	3rd Floor Slab	31-Jan-11	13-Feb-11	14 Days	31-Jan-11	12-Feb-11	13 Days
9	4th Floor Slab	14-Feb-11	27-Feb-11	14 Days	13-Feb-11	1-Mar-11	16 Days
10	5th Floor Slab	28-Feb-11	13-Mar-11	14 Days	2-Mar-11	13-Mar-11	12 Days
11	6th Floor Slab	14-Mar-11	27-Mar-11	14 Days	14-Mar-11	26-Mar-11	13 Days
12	7th Floor Slab	28-Mar-11	10-Apr-11	14 Days	27-Mar-11	6-Apr-11	11 Days
13	8th Floor Slab	11-Apr-11	25-Apr-11	15 Days	7-Apr-11	16-Apr-11	10 Days
14	9th Floor Slab	26-Apr-11	10-May-11	15 Days	17-Apr-11	30-Apr-11	14 Days
15	10th Floor Slab	11-May-11	25-May-11	15 Days	2-May-11	11-May-11	10 Days
16	11th Floor Slab	26-May-11	9-Jun-11	15 Days	12-May-11	24-May-11	13 Days
17	12th Floor Slab	10-Jun-11	24-Jun-11	15 Days	25-May-11	8-Jun-11	15 Days
18	13th Floor Slab	25-Jun-11	9-Jul-11	15 Days	9-Jun-11	23-Jun-11	15 Days
19	14th Floor Slab	10-Jul-11	24-Jul-11	15 Days	24-Jun-11	5-Jul-11	12 Days
20	15th Floor Slab	25-Jul-11	11-Aug-11	18 Days	6-Jul-11	19-Jul-11	14 Days
21	16th Floor Slab	12-Aug-11	29-Aug-11	18 Days	20-Jul-11	1-Aug-11	13 Days
22	17th Floor Slab	30-Aug-11	16-Sep-11	18 Days	2-Aug-11	20-Aug-11	19 Days
23	18th Floor Slab	17-Sep-11	4-Oct-11	18 Days	21-Aug-11	9-Sep-11	20 Days
24	Terrace Floor Slab	5-Oct-11	22-Oct-11	18 Days	10-Sep-11	9-Oct-11	30 Days
25	Lift M/C Room & OH Tank	23-Oct-11	21-Nov-11	30 Days	10-Oct-11	27-Dec-11	79 Days
26	Elevation AboveTerrace	22-Nov-11	21-Dec-11	30 Days	28-Dec-11	26-Jan-12	30 Days
27	Electrical Works	10-Dec-10	15-Dec-11	360 Days	10-Dec-10		
28	Brick Works	1-Apr-11	30-Nov-11	244 Days	21-Mar-11		

Fig.3.Work Programme Chart

2.1.5. Milestone Chart

The milestone chart is portrayed on a project time line. It displays only the key project milestones. These milestones are typically associated with some major element of project risk, such as passing a test or gaining approval from a regulatory agency. Each milestone is represented by a diamond or triangle. These milestones normally become major reporting points to senior management. Large complex projects may have hundreds or even thousands of tasks. Senior management usually does not want to receive status reports at that level of detail, yet they want something more than just a "tollgate" review at the end of a phase. The milestones provide interim reporting points. Also, when planning a complex project, task leaders can become overwhelmed with all the tasks they must do. Having a focused sub-project for each milestone gives those task leaders a framework for planning and tracking project activities. The Milestone Chart is the schedule reporting format that is generally used on Full-Scale and Complex projects.

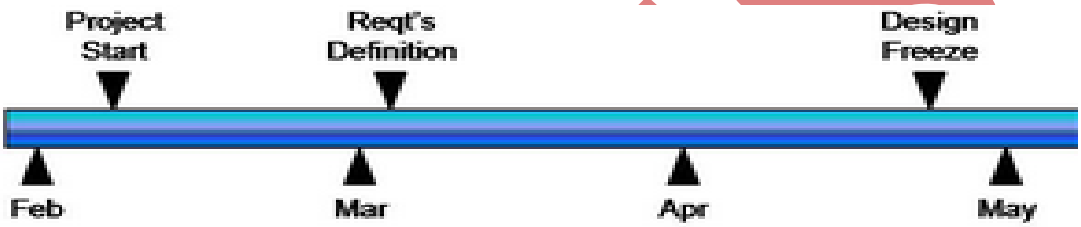

Fig.4. Milestone Charted along Timeline

2.1.6. Burn-down Chart

A burn down chart is a graphical representation of work left to do versus time. The outstanding work (or backlog) is often on the vertical axis, with time along the horizontal.

That is, it is a run chart of outstanding work. It is useful for predicting when all of the work will be completed. Burn down charts can be applied to any project containing measurable progress over time.

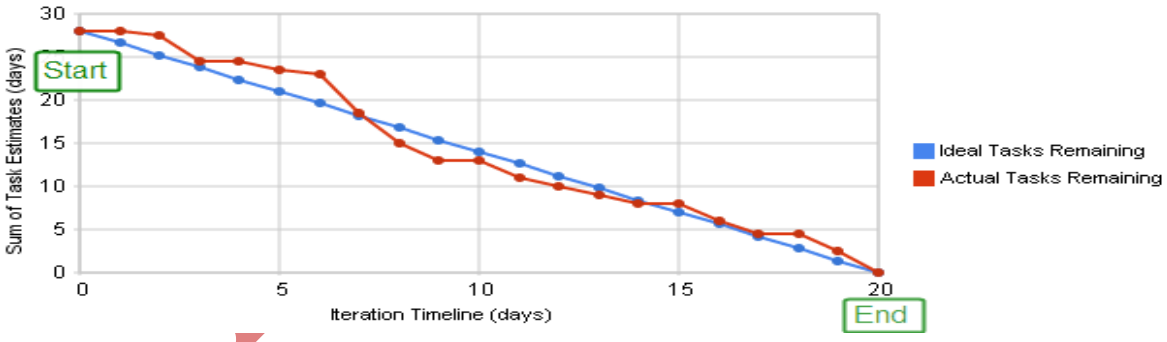

Fig.5. Burn Down Chart

3. ANALYSIS OF PROJECT MONITORING OF TOOLS

3.1. Present scenario in construction industry

Project monitoring tools mentioned in the previous chapter are tools that are generally used for monitoring the project. But the use of specific tool depends upon the interest of the Owner or the PMC agency. According to the interview had with some PMC agencies and Owners we can compare the graphical tools as shown in Table.2.

Table.2.Comparison of Graphical tools

Earned Value Analysis	Tracking Gantt Chart	Strip Chart	Burn-down Chart	Milestone Chart	Work Programme Chart
Tracks the project in terms of work, time and money.	Tracks the project in terms of work only.	Tracks the Project in terms of time only.	Tracks the project in terms of work only.	Tracks the project in terms of work only.	Tracks the project in terms only.
Can be used for both repetitive and linear nature of projects.	Can be used with project of repetitive nature only.	Can be used for both repetitive and linear nature of projects.	Can be used with project of repetitive nature only.	Can be used for both repetitive and linear nature project.	Can be used with project of repetitive nature only.
Early detection of problems.	No such predictions.	No such predictions.	No such predictions.	No such predictions.	No such predictions.
Can predict what will be the status of the project on its planned finish date.	No such predictions.	No such predictions.	No such predictions.	No such predictions.	No such predictions.

3.2. Analysis of compatibility of Tools

For an Owner, the Degree of Control for a project is directly proportional to the risk shared by the Owner for the particular project. This is so, because if the risk shared by the Owner is high then he should have higher Degree of Control so as to minimize the risk. Following is the Fig which gives the idea about of Degree of Control for both Owner and Contractor for various types of contract.

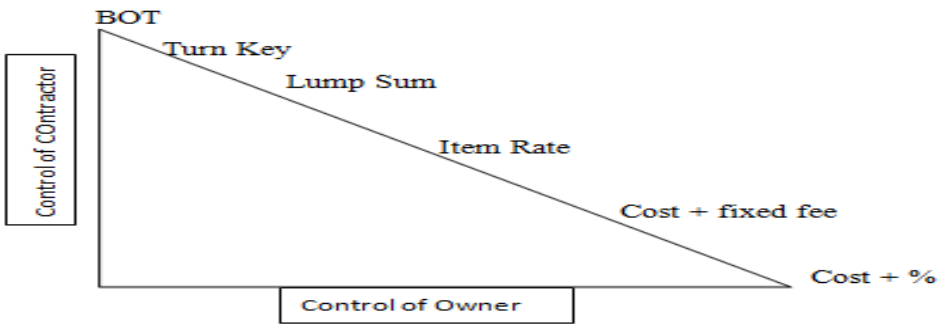

Fig.6. Diagrammatic Representation of Degree of Control of Owner and Contractor for types of Contract

From the above fig we can see that the Degree of Control for Owner is minimum for BOT contract and maximum for Cost+% contract. Similarly for a Contractor it is maximum for BOT contract and minimum for Cost+% contract.

3.2.1. For BOT Contract

Build–operate–transfer (BOT) is a form of project financing, wherein a private entity receives a concession from the private or public sector to finance, design, construct, and operate a facility stated in the concession contract.

BOT finds extensive application in the infrastructure projects and in public–private partnership. In the BOT framework a third party, for example the public agency, delegates to a private sector entity (Contractor) to design and build infrastructure and to operate and maintain these facilities for a certain period. During this period it is the responsibility of the private party to raise the finance and it can retain the revenues generated and is the Owner of the facility. The facility will be then transferred to the public administration at the end of the concession agreement, without any remuneration of the private entity involved.

Here we can say that the maximum part of the risk is on the Contractor side while there is least for the Owner. The risk for the Owner is that the contractor can ask for extension in payback period and also the Owner has to look that the facility is provided for public use as early as possible. Normally for every project a PMC agency is appointed by the Owner who monitors the progress of the project and keeps updating the Owner. The tools used by the monitoring are usually depends upon the PMC or Owner.

But from the Fig.6. one can see that the Degree of Control for Owner is least for BOT project and that for contractor it is maximum. This means that Contractor has to see that the project gets completed on time as he is the investing for the project and not the Owner. Owner only has to look for weather the project is on track and there is no considerable delay as it will make contractor to ask for extension of pay-back period.

Thus the data required for Owner to keep the track of the project can be obtained from the reports, meetings and milestone chart. These tools are enough for Owner to know the progress of the project and also to know reasons for the delay.

3.2.2. Turn Key and Lump-sum Contract

Turn-key is a contract wherein the contractor is entitled to design, construct, commission and hand over the project to the Owner. For this type of contract the contractor becomes the Owner until the facility is completed and transferred. During this period the contractor is paid in lump-sum amounts by the Owner as earlier decided in different stages. This is similar to the Lump-sum Contract but the main difference here is, in lump-sum contract the Ownership is not transferred to the contractor and it is different from BOT contract in the way that the financing for the project is done by the Owner, also the contractor does not operate the facility after completion and hence do not generate revenue from the facility. Unlike BOT contract the facility is transferred to the Owner at a cost in turn-key contract.

Lump-sum Contract is a contract where the value of the contract is fixed and contractor is paid in lump-sum amount as agreed upon for the amount of work performed i.e. the amount to be paid depends upon the percentage of the work. It is similar to Turn-key contract except the Ownership is not transferred to the contractor and remains with the Owner itself. Thus the Owner has to look for all the permissions from the Governing agencies required to carry the work.

Thus the risk associated for Turn-key type of contract is more for contractor than the Owner and hence the Degree of Control for Owner is less. Similar is with the Lump-sum contract. But the Owner's Degree of Control

associated with turn-key is slightly less than compared to Lump-sum contract. So the tools used to monitor progress of the project by Owner are same. So for these types of contract the Owner has to know how much percentage of the work has been performed so as to make the payment accordingly to the contractor. Thus Owner can use any one graphical tool such as strip chart, tracking Gantt chart, earned value analysis along with reports and meetings. Photographs are also used to monitor the project. Use of strip chart is only restricted for project of linear nature e.g. bridge, flyover, road projects. Strip chart is currently used for Mumbai Metro and Navi Mumbai Metro Project. If the nature of the project is of repetitive then tracking Gantt chart proves to be useful than strip chart. Tracking Gantt chart proves to be useless for linear projects. Earned Value Analysis can be used but most of the time it provides more information than needed which is not required at all. Also according to the industry personal Earned Value Analysis is carried out for projects for which time and cost are of essence e.g. Hydro Projects, Military projects, Airports etc.

3.2.3. Item rate, cost plus fixed fee and cost plus percentage

In item rate contract, the project is divided into small items and these items are then specified in Bill of Quantity. When the tenders are floated, contractor bids by specifying rates against each item. The bidding amount also include contingencies. The quantities are usually estimated and there are chances for variation. Thus the contract price may be increased or decreased depending upon the variation but mostly the contract price increases. Thus the risks associated with the Owner are more than that of contractor, in fact the risk associated with the contractor is very much less compared to the Owner. In this type of contract the Ownership is not transferred to the contractor at any stage.

In cost plus fixed fee contract and cost plus percentage contract, the contractor is paid the cost incurred to do the work along with incentive. This incentive can be fixed as in case of cost plus fixed fee or percentage of cost of the project as in-case of cost plus percentage contract. In cost plus fixed fee, the Owner pays the contractor the cost incurred and the fee is fixed which is predetermined. It remains same even though the cost of contract varies. But in case of cost plus percentage contract the Owner pays according to the cost of contract that is if the cost increases then he pays more percentage to the contractor. The risk associated with the Owner is almost same and is higher than the contractor and hence the degree of control required for Owner is more than contractor.

Tools required for above types of contract should provide Owner with detailed information regarding the progress of the project. Here also the Owner can use any of the above graphical tools from strip chart, earned value analysis, tracking Gantt chart along with milestone chart or work programme chart. Meetings and reports are the common tools. Photographs also provide sufficient information of project progress. In these types contract the nature of the work can be repetitive or linear. So depending upon the nature of the work strip chart or tracking Gantt chart should be used.

4. CONCLUSION

All the Agencies/Firms with which the interviews were carried out, all of them had there set of tools and some have developed there proprietor tools. They use these tools for all types of contract and the nature of the project also affects the selection of the specific tools used.

The use of tools usually depends on both the contract type (this is supported by the degree of control) and the nature of the work. For BOT projects having work of repetitive as well as linear nature, tools such as milestone charts, meetings, reports and photographs can be used where the Owner has very less risks as compared to

contractor. For BOT contract one can also use any graphical tools but it is usually not required as milestone chart provides with sufficient information about the progress of the project. For Turn-key, Lump-sum, Item-rate, cost plus fixed fee and cost plus percentage contracts one can use any one graphical tools from strip charts, earned value analysis and tracking Gantt chart along with milestone chart. This is so because the Owner has to pay the contractor and he should know the progress of the work in detail in order to make the payment accordingly. Along with the mentioned graphical tools meeting, reports and photographs can be used. Among Strip chart, Earned Value analysisand Tracking Gantt chart, for works such as repetitive nature earned value analysis and tracking Gantt chart and for work of linear nature strip chart along with earned value analysis can be used.

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