ABSTRACT

From a decade the growth story of India has taken many folds, with infrastructure been at spotlight. Infrastructure has always been a backbone for a developing economy, and road infrastructure enjoys a special spot in it. Developed roads are the key to the all-round development as they act as arteries to the economic heart. As National Highways (NH) constitute only 2% of all road network and carries 40% of all road traffic, and the projects undertaken are significantly stalled. Hence an immediate upgradation in the technology is need of hour.

This paper suggests the implementation of Building Information Modeling (BIM) for a road infrastructure project. BIM has been used in India but majorly in vertical construction\(^1\). BIM has shown a potential to be utilized in horizontal construction covering all the aspects from pre-project planning to execution. A comprehensive analysis shows upgrading the existing technology to BIM for project planning and implementation will save project delivery time vis-à-vis other resources will be optimized.

Keywords: Building Information Modeling (BIM), Road Infrastructure,

\(^1\) In India there is 92% utilization of BIM in architecture.

Notes: As per Make in India programme, government is planning to increase the length of National Highways from 92,850 Km in 2013-14 to 100000 Km by the end of 2017, for such an abrupt increase, we definitely need an upgraded technology for project implementation.

References: The implementation of BIM in UK by Transport Industries, By F Fernando G Banuelos Blanco Oetal and Scope of BIM in India By J. Vinoth Kumar & Mukherjee.
1. INTRODUCTION

A preeminent civilization is a result of its technological encroachment from its predecessor. The story of technical encroachment is evident from as early as Bronze Age, when the actual benefit of wheel was realized. Since then, in one way or other technology has advanced and is persistent.

Industries have completely revolutionized by emerging technologies and the functioning of such industries then, has remodeled in an efficient way; industrial revolution is a very instance of such phenomenon.

Project management has also evolved through many hurdles. The story started when Henry Gantt introduced the Gantt chart which proved to be an efficient tool for planning and controlling of the projects. The project management was five management functions which laid a foundation of modern project and program management, and hence the story of project management started.

Many tools have been evolved such PRINCE, Critical Chain Project Management (CCPM) and Lean Project Management etc. and still new principles are being introduced for the betterment.

Building Information Modeling (BIM) is such a step towards the advancement of the project management. BIM has been extensively used in vertical construction but its real potential has been undermined, but in recent times researchers have been trying to use BIM in horizontal construction as well.

BIM holistically documents the project throughout its lifecycle from design, construction planning, scheduling, monitoring till operation and maintenance phase.

This paper has identified the bottlenecks in the road project management, and tries to solve the problem through BIM. The problem in the project management has first been identified and then through BIM lens these problems has been viewed and suggestions have been made to introduce the BIM throughout the lifecycle.

The study identifies several points vital to a successful completion of the project across the lifecycle. These points include the daily reporting of the work, a proper monitoring system (both financial and physical monitoring) of the project. Several number of scope changes and a poor project closeout could also severely affect the schedule.

The respondents have agreed that an ineffective planning is the cause of most of the schedule overruns. Moreover, several scope changes have also affected the project schedule to a greater extent.
Conflicts between the different works (for example during excavation if the level of the underground pipe exceeds to that of subbase) have stalled the project, as the conflict resolution process is very tedious and time consuming.

This paper ends with the conclusion that introducing BIM at the suggested phases (shown in the proper flow charts) can not only lead to a timely completion of the project, but also save a handsome amount 7-8 months in the estimated duration of completing the project.

2. Literature Study

Emergence of Public Private Partnership (PPP) in infrastructure sector has brought new trends with specific roles of stakeholders. India stands out 2nd with 41,10,000 km across the world after USA with 65,06,000 km. Addition of 9% target growth i.e. 10,000 kms in 12th FY Plan is the key outline to be achieved by NHAI. However It has witnessed deceleration from 11th FY Plan, as projects are facing delay from 4 months to 37 months resulting in further suspension in allocation of projects. However, the percentage change in length up gradation has been dynamic with decreasing by 3 percent. Project completion in scheduled time and cost has been identified as one of the inefficiencies in project implementation which results in 20% to 25% delay.

Indian infrastructure projects are encountering hurdles which are more prevalent in execution and closing phase thus giving signals to enhancement in project management approach. Inefficacious scope change management impacts schedule the most. Improper site investigations and geographical surprises lead to generate further disputes between contractor and client raising a stretch of months delay. Scope change management is observed insufficient in project management framework of organizations. Also project monitoring is critical for decision making, as it provides required information at right time, impacting control over scheduled plan. Large infrastructure projects involve multiple agencies and integration management between them becomes critical for successful delivery of project.

The major causes of construction delays in transportation infrastructure projects are mainly Land Acquisition, Environmental Impact of the project, financial closure, and change orders by the client, poor site management and supervision by contractor. As delays are found more frequent in feasibility and early planning stage indicates lack of detailing in DPR. Stated "In a roads project, a temple was adjacent to the site of a proposed flyover. This aspect was overlooked in the DPR phase. The flyover got built, and subsequently erased due to local pressure, wasting INR 21 cr in the process". Amongst the identified risks of Indian BOT road projects, (i) traffic revenue risk; (ii) delay in land acquisition; (iii) demand risk; (iv) delay in financial closure; (v) completion risk; (vi) cost overrun risk; (vii) debt servicing risk; and (viii) political risk has been further analysed in various
risk model and found critical relationship with the probability of occurrence.

**BIM in project management**

Management research says that Indian construction industry lacks practice of project management capacity and use of Information and Communications Technology (ICT) broadly. E-tool is a growing tool in the field of project management, enables easy exchange of accessible information throughout the life cycle of a project. Mainly it consists of Project management system, e-procurement system, content management system, communication system, document management system, computer aided design system, works estimation system, measurement system, quality management system, performance monitoring and evaluation system, decision support system, grievance Redressal system, scope management system, risk information management system. Evidently found use of Construction Monitoring System in case of 'Karnataka State Highway Improvement Programme', showing strong results of project monitoring, transparency of data and resource planning. E-tool facilitates in project management system for successful delivery avoiding project schedule overrun and cost.

Prospective of BIM is explored in AEC industry for better integration of information across all the levels for enhancing decision making. Use of model as supporting planning, execution and project tracking allows construction industry to overcome inefficiencies has been the major attention. BIM as a business transformer has been extensively described, focusing on vision, leadership and integration management. BIM is one of the model centric system which enables flow of information in all the levels and commands over the operation of project.

The Norwegian Public Roads Administration (NPRA) has been benefited immensely with BIM tool and proved its multidisciplinary assistance to clients’ expectations. The collaborative procedure has been discussed in tabular matrix form for understanding of BIM goals, highlighting periodic coordination, and iteration. Finland research team has explored information modeling and established a systematic change in the working environment of complete project life cycle. By applying in a pilot project further reinforce the guidelines and specifications of BIM. The use of BIM in site management has added value to information sharing, evaluating the traditional electronic communication medium amongst client and contractor. Information model supporting the verbal communication is the major understanding found.

3. **Methodology**

At inception the study started with the identification of the loopholes in the current project management approach developed by the project managers of the leading construction
firms in India. Both primary and secondary data was documented for the study.

Secondary data is gathered from the leading construction journals published throughout the country and from the information available on World Wide Web.

Primary data is gathered by interviewing the representative of the both concessionaire and the regulating authority (NHAI) commissioned for a particular project. Several consultants of the same projects has also been interviewed so that all the perspectives could be gathered for a single project.

A mixture of telephonic interview, personal interview and questionnaire has been used to collect the data. Majority of the data has been collected by telephonic interview and some personally. Some preferred to answer the questionnaire.

The data has been collected from across the country. The under implementation projects commissioned by National Highway Authority of India (NHAI) were identified first and then the respective representative of the concessionaire has been introduced. This interview gives the potential loopholes in the project management approach from the contractor side; like poor coordination, lack of proper information sharing platform, poor conflict management and much more.

Our interview with the Project director of the concerned project highlighted the loopholes in the management approach labored by the regulating agency. Then finally the consultants perspective has been scrutinized, this gave a holistic view of the management paralysis throughout the lifecycle of the project.

On other hand; a comprehensive study for the benefits of the BIM in ACE industry depicts that the BIM has been underutilized. BIM could prove a powerful tool to manage a massive infra project if utilized to its full extent. BIM with its benefits of serving a tool which provides a better visualization and a proper integration and coordination of the project could serve the infra industry as well.

Finally, the identified loopholes in the project management has been inspected using BIM as a project management tool and the conclusion has been given.

4. Result

The investigation has been framed up according to the identified reasons of scope change management, coordination issues, conflicts, poor monitoring and updating work. Discussion on various parameters are focussed and held responsible for project delays. Findings from discussion of 10 different projects indicate real time improvement to be added in existing road project management. As according to Indian
project management code, a project is divided in four phases namely initiating phase, planning phase, execution phase and closeout phase, so as the questions has been structured up. The interaction oriented study was the source of information as also to get the glimpse of current drawbacks facing by the Indian construction industry. The questions were not only pivoted around the causes but also to know the impact. Investigations show that there is lack of attention given in DPR, based on which client finalizes cost estimates and take decisions of concession period.

The survey results has identified certain loopholes in the current project management approach, these loopholes are widely spread throughout the project life cycle.

The study suggests that the road infra projects are huge in nature, they involve a large number of stakeholders and huge investments are required. Hence it becomes important that these projects are completed on time. Moreover with the uncertain economic conditions of our nation if these projects are not completed on time the escalated prices of the construction material would abruptly increase the project cost.

Since there are number of stakeholders involved in such a huge projects, there must be a proper information sharing platform. The information must be properly circulated, and the communication must be rapid and effective. But we found out that in almost all the projects the communication medium is not up-to-date, still the conventional method (of letters) are being used for the communication moreover the use of election medium for communication is rare to see.

With multiple scope change very frequent in such a huge infra project; communication paralysis could affect the project schedule. Such an ineffective communication system could affect the project schedule from some weeks to months.

Our study suggests that the conventional methodology for the communication has to be dropped out and a new improved and fast technology must be introduced.
The next critical parameter of our study is **Daily Reporting Mechanism**; the daily reporting of work is done in conventional method. All day’s work is reported in a sheet which is then at the day’s end is updated to their planning software system. This kind of reporting only provides a numerical progress of the work to the planners, there is no visual representation of the work in such mechanism and apparently the updating of project is just a numbered progress not a visual one.

Now the regulatory bodies like National Highway Authority of India (NHAI) also monitors the project. Instead of daily monitoring the monitor on weekly or monthly basis and that too the standard of monitoring is kilometers of road constructed in a week or month respectively. This monitoring also does not provide a real time progress of the project. **Around 70% of our respondents angered that these monitoring agencies should monitor the concessionaire’s work on daily basis.**

Apart from physical monitoring of the project, the financial monitoring of the project is also essential. The results show that there is a lack of financial monitoring on the concessionaire; this many a times could overrun the proposed budget of the project.

Further our study highlights the most important aspect of project management and that is **coordination issues.** 95% of our respondents feel that poor coordination is a major cause of schedule overrun.

Coordination is one thing which affects project schedule the most. There must exist a harmony between the stakeholders of the project, and project manager is responsible to bring such harmony. But because of large number of stakeholders with a different role to play and since there exists communication paralysis and...
lack of transparency, the coordination of job becomes hard-hitting. And because of poor coordination, conflicts become frequent during the execution which stalls the project for months.

<table>
<thead>
<tr>
<th>INITIATING PHASE</th>
<th>PLANNING PHASE</th>
<th>EXECUTION PHASE</th>
<th>PROJECT CLOSEOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF STAKEHOLDERS IN THE PROJECT</td>
<td>SCOPE CHANGE MANAGEMENT</td>
<td>DAILY REPORTING</td>
<td><em>INITIAL DPR IS SELF SUFFICIENT BUT SCOPE CHANGE AFTER DPR CANNOT BE DENIED.</em></td>
</tr>
<tr>
<td>INTENSITY OF DPR</td>
<td>COMMUNICATION METHOD ADOPTED AMONGST STAKEHOLDERS</td>
<td>COORDINATION ISSUES</td>
<td><em>MULTIPLE NUMBER OF STAKEHOLDERS DISTORTS PROJECT INFORMATION MAJORLY &quot;STATET&quot;</em></td>
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</table>

**Figure-1** Shows the potential problems throughout the project lifecycle which could cause schedule overrun.

<table>
<thead>
<tr>
<th>PROJECT CLOSEOUT</th>
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<tbody>
<tr>
<td></td>
<td>DAILY REPORTING</td>
<td>COORDINATION ISSUES</td>
<td><em>CONTRACTOR KEEPS TRACK OF WORK WITHOUT DRAWING</em></td>
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<td></td>
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<td><em>MONTHLY REPORTING BY PER KM ANALYSIS</em></td>
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<td><em>UPDATING OF WORK WITH FINANCING AGENCIES</em></td>
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<td><em>COORDINATION ISSUES WHEN PROJECT GOES BEYOND THE LIMITS OF LUNCH</em></td>
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**Figure-2** Shows gives a deep view of the problems discussed in Figure-1.
Now, when the identified problems are analyzed viewing Building Information Modeling (BIM) as a potential tool to resolve these problems, astonishing results were obtained.

BIM which has proved its potential in Architecture, Construction and Engineering (ACE) industry, shows a big promise in Infrastructure too. With its benefits of 3-D visualization and a collaborating tool, BIM could be used throughout the infra project lifecycle.

Here is how the utilization of BIM could help in strengthening the project management approach for an Infra project.

A. Communication Issue

As discussed earlier communication paralysis could be a major cause for project delay, but if we adopt BIM as a management tool the problem seems to vanish away. By implementing BIM we will connect all the stakeholders together to a central BIM database model. This BIM data base model will constitute all the drawings, plans, schedules, cost sheets etc. If one stakeholder wants to communicate to another, instead of conventional method of letters the communication will be on BIM database. This could provide a platform for information sharing and will provide a transparency in the system. This would reduce the information asymmetry.

B. Daily Reporting and Monitoring
together

The daily reporting could be easily done on BIM. The day to day work must be updated to the BIM database. Since we will use high-tech software like Autodesk Infraworks 360, Autodesk Naviswoks, Autocad Civil 3D the day-to-day progress can be simulated and a proper visualization of the progress can be witnessed. This would ease the updating the schedule as per actual progress.

C. Coordination Issues

Since all the stakeholders will be connected to the BIM database model (as shows in figure-3) the coordination asymmetry would be minimized. All the important decisions like scope change could be taken on central BIM server; this will have in clash detection of any thus avoiding the clashes between the different works.

Figure-3 Shows a BIM database model shoeing how different stakeholders are connected to a central database
Figure-4 Shows how information sharing is done in BIM database model and how different stakeholders are also informed about the scope change, so if there is any clash it could be detected at the very stage and thus lot of time is saved.

5. Conclusion

As we have seen that if we introduce BIM as a project management tool, it could save a lot of time just by improving some small aspects of the project management. But there are certain rules which is to applied while implementing BIM,

1. BIM must be holistically implemented across all the phases of the project. This would increase the impact of BIM. Many of our respondents feel that a poor planning results in schedule overrun. Hence it becomes essential to introduce BIM from tendering phase itself.

2. Since BIM is just integration of different software, some of common software must be used like Miscrosoft Projects, Autocad Civil 3D & some more software could be used like Infraworks 360.

3. BIM must not be use just as a 3D representation tool, 4D and 5D models must be prepared. In 4D schedule is attached to the model and in 5D cost is also attached. Even Operation and Maintenance schedule must also be introduced in the model which gives a brief information of maintenance schedule of the road constructed.

4. BIM must be used in designing, as some advanced software provides a better designing approach; such software must be exploited more like Infraworks 360.

5. Even the Detailed Project Report (DPR) must be prepared using BIM software; this gives a better view of project. The software gives us a freedom to simulate the project before actually starting the construction; this would give us an idea of how the road will work even in worst traffic conditions.

6. The better visualization of the project (3-D visualization) would be easier to understand. 98 % of our respondents agreed to switch to 3 D drawings if given a choice,
Initiating Phase

Need of Project
  ↓
  Feasibility
  ↓
Scope Identified
  ↓
Call for bids
  ↓
Contract is awarded (Concessionaire is appointed)
  ↓
Stakeholders are identified

NIIAI  Concessionaire  Financing agency  Consultants  Other regulating bodies

EPC Contractor

Figure-5 Shows the critical chart, in which the BIM must be implemented.
Planning Phase

Planning and Designing of the works

Planning
- Set milestones
- Set monthly targets
- Set weekly targets
- Set daily targets

Designing
- Topographical Study
- Ground Surveys and Studies
- Designing of the works

Execution Phase

Monitoring and Updating of the works

Monitoring/Controlling of mechanism
- Daily reporting of work
- Weekly reporting
- Monthly reporting
- Financial monitoring of the project

Updating work
- Updating schedule as per current progress

Closeout Phase

- Phase-end review
- Initial trial of the product
Figure-6 Shows the critical chart, in which the BIM must be implemented.

References


[12] MOSPI

[13] www.nhai.org projects under implementation


