Statistical Analysis of Construction Projects using Artificial Intelligence with the Help of Primavera

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Abstract— The timely completion of any construction project is no doubt one among the most vital aspects for any project manager. The involvement of numerous different type and nature of works, and hundreds or many times thousands of numbers of activities make it a very sophisticated job to perform. Since most of the activities are interrelated, the importance of every single activity is to be understood well. It is therefore very important to consider all the possible factors that would directly or indirectly affect the progress of the project. In this study, two construction projects of high repute were analyzed that are being presently built in Bhopal. A questionnaire was formulated and personal interviews were conducted with the senior engineers and managers of both the projects. The survey was conducted by means of direct interactions to get realistic and explained responses. The responses were recorded and analyzed statistically and the following major problems were identified that were responsible for late completion of project - late approval of material samples, slow decision making, delayed approval & revision of drawings, change orders in the design during the course of work, poor communication and coordination, excessive mistakes & discrepancies in good for construction drawings provided by the consultant, poor communication & coordination between parties and lack of use of latest planning tools like MS-Project and Primavera.

Keywords: Construction Projects, Artificial Intelligence, Primavera

I. INTRODUCTION

India is becoming increasingly noticed in the international arena for its infrastructure development. The country's inherent infrastructure deficit, coupled with growth-oriented measures by the Government and increased private capex, drives the activities in the infrastructure many folds. Construction projects involve varying manpower and their duration can range from a few weeks to more than five years. Each one of them is „unique" and „temporary" in nature, and so is the management involved. Here, the term „unique" means that every project is different in some way from other projects, and the term „temporary" means that every project has a definite beginning and an end. Project Management is the application of knowledge, skills, tools and techniques to a broad range of activities to meet the requirements of a particular project. Project management aims to achieve the stated goals of the project leading to completed facility, by virtue of planning, executing and controlling time, funds, and human & technical resources. The planning essentially consists of setting objectives, identifying resources and forming strategy. Executing consists of allocation of resources, guiding execution, coordinating efforts and motivating the staff. Controlling consists of measuring achievement goals, reporting and resolving problems. The planning, executing and controlling are performed on a continuous basis till the goals of the project are realized. The performance of any project is mainly analyzed based upon the so-called "iron triangle" of time, cost and quality, which have been the most important metrics of construction project performance, especially for the selection of appropriate procurement methods (El Wardani et al., 2006). The duration of the project is one of the three key indicators of performance for any construction project. The time duration in a project alone has the capacity to affect the budget and even quality. There are numerous factors that contribute in affecting the duration of activities, they are very clearly figured out in previous research works as mentioned in the next chapter of literature review. The study includes specific analysis of two construction projects of high repute being presently built at a same location in Bhopal. First is the Construction of 72 NGO Quarters (Say Project A) and the second project is Construction of 240 Constable Quarters (Say Project B) both projects in Bhopal, Madhya Pradesh with MP Police Housing and Infrastructure Development Corporation Ltd., Bhopal as the client.

Project A: C/o 72 NGO Quarters

Project B: C/o 240 Constable Quarters

Both buildings being constructed are residential buildings having similar nature of activities involved in construction. Following are some major activities that are common for both projects:

1) G+5 storeyed structures
2) Ground conditions are same for both projects.
3) Isolated footing in foundation has been provided in both projects.
4) Framed structure.
5) Only ready-mix concrete (RMC) has been used at both works.
6) The project cost of each project is nearly same.
7) Both projects are located in well developed areas of Bhopal, so the work conditions at site are same.
8) For both projects, the MPPWD Specifications are adopted as the technical standards for work.

II. LITERATURE REVIEW

Greeshma B Suresh and Dr. S. Kanchana in 2015 said that any project is said to be successful when it is completed in desired time and cost. The Construction industry of India is an important indicator of the development, as it creates investment opportunities across various related sectors. Construction delays can be minimized only when the causes are identified. Time is one of the major considerations throughout project management life cycle and can be regarded as one of the most important parameters of a project and the driving force of project success.

Ar. Meena V. and K. Suresh Babu in 2015 agreed that time delay is one of the biggest problems facing in many construction buildings in India. Completing projects on time is the key factor of the project, but the construction process is subject to many variables and unpredictable factors, which result from many sources such as availability of resources, external factors, performance of parties and type of building. If there is a delay in project it leads to loss of productivity, increased cost, contract termination and disputes between contractor and owner.

P.M.Pethkar, Prof. B.V.Birajdar (2015) enlisted the following reasons of delay in projects : Effective planning and scheduling, Proper site management and supervision, Changes in design during construction being demanded by owners, Timely availability of construction materials, Efficiency of sub-contractors, Proper inspection and testing by consultants, Lack of qualified and experienced workers, Change orders added or deleted from the original scope of work, Timely deliveries of site, approval of design documents and progress payments, Quick decision making by owner, and Effective communication between client, consultant, contractor and sub-contractors.

Rahul Kolhe, Milind Darade (2014) found that delay is a critical function in construction projects. In general, the time delay and the cost of the project gets increased simultaneously. Their studies figured out time overrun and cost overrun as the most frequent effects of delays which significantly affect the entire construction project. Also, there are loss and expense claims arising from delay and fluctuation claims during the delay period which have significant effects on cost overrun.

Aditi Dinakar in 2014 interestingly found that almost all parties‟ involved in a construction project hold nearly equal responsibility for the delays.

Kang Sik Wei in 2010 figured out the top ten most important factors that contributed to the causes of delays include: late in revising and approving design documents, delays in sub-contractors work, poor communication and coordination, change orders by client during construction, inadequate contractor's work, delay in approving major changes in the scope of work, shortage of labors, ineffective planning and scheduling of project, conflicts in subcontractors schedule in execution of project, and mistakes and discrepancies in design documents.

Gould & Joyce in 2009 said that the beginning of a project, when the amount of money spent in the project is at its low point, the possibilities of influencing the design and the direction of the project is at its highest.

K.N. Jha and K.C. Iyer in 2006 said that the repercussions and consequences of poor quality can be a loss in productivity; additional expenditure by way of rework and repair; loss of reputation, leading to loss in market share; and eventually being put out of business. This study was conducted to identify and evaluate various factors affecting the quality performance of construction projects. The results of the study prove to be closer to Juran's philosophy that middle management (project manager and his team in this case) play a more important role in most stages of the project, although the top management's role becomes more significant in further enhancing the level of quality when the existing level is already high.

III. METHODOLOGY

The primary objective of this research work is to identify the problems associated with the timely completion of construction projects, and to suggest methods to overcome such problems in real time.

The literature reviews although clearly figures out the main reasons responsible for timely completion of a project, but the outcomes have not been cross-checked with projects in real time. The analysis will start on the basis of the identified factors responsible for timely completion of construction projects with the help of research works done in the past. A questionnaire will be formulated to conduct personal interviews with the senior engineers and managers of Project A and B. The questionnaire will consist of four sections namely Respondent's Profile, Factors Affecting Completion Time, Consequences of Construction Delays and Ways to Complete Work Within Scheduled Time. A rating scale from 0 to 4 will be provided for recording the responses, the value of which will be analyzed using statistical techniques. The survey will be conducted by means of direct interactions to get realistic and explained responses.

With the help of the personal interviews, the identified factors will be co-related to the actual conditions of work specifically for the concerned projects of the respondents. Since the status of both the projects is completely opposite in terms of time duration, it will therefore give a very clear idea of the differences between the approach used to execute the projects by their respective managers and engineers. The responses shall be recorded and

analyzed statistically which will ultimately figure out the much realistic factors responsible for successful completion of projects within the desired time-frame.

The identified factors after the interviews, will be inculcated in a fresh project management plan using Primavera P6. The factors that may affect the timely completion of any activity will be assigned to the respective activity id that will keep the responsible person alert in advance about the possible risks or issues of involved with that activity.

IV. RESULT ANALYSIS

The data collected from both projects has been analyzed using the Relative Importance Index method, to statistically state the intensity of each question asked.

Relative Importance Index (RII): Kometa et al (1994) used the Relative Importance Index method to determine the relative importance of the various causes and effects of delays. The same method is going to adopted in this study within various groups (i.e. clients, consultants or contractors). The five-point scale ranged from 0 (not answered/not contributing) to 4 (very highly contributing) will be adopted and will be transformed to relative importance indices (RII) for each factor as follows:

$$RII = \frac{\sum W}{A*N} \quad (0 \leq RII \leq 1)$$

Where:

W – is the weight given to each factor by the respondents and ranges from 1 to 4,

A – is the highest weight (i.e. 4 in this case) and;

N – is the total number of respondents.

The RII value had a range from 0 to 4 (0 not inclusive), higher the value of RII, more contributing was the factor of delays. The RII was used to rank (R) the different causes. These rankings made it possible to cross-compare the relative importance of the factors as perceived by the two groups of respondents (i.e. clients and contractors). Each individual causes RII perceived by all respondents should be used to assess the general and overall rankings in order to give an overall picture of the causes of construction delays in Indian construction industry.

V. CONCLUSION

According to the results collected by Interactive Data Collection conducted, it was known that the tentative completion cost of Project A went up by 8.61% in comparison to the original estimated cost. This drastic increase in cost was caused due to several mis conducts on part of all the stakeholders of the work. Whereas there is a saving of 5.17% in tentative completion cost of Project B as compared to the estimated cost, which itself speaks about the efficiently managed project.

Further, after interpreting the received data through statistical analysis, following conclusions can be made:

1) On part of the client/owner of the project, following problems have been identified: late approval of material samples, slow decision making, delayed approval and revision of drawings, change orders in the design during the course of work and poor communication and coordination. These problems must be taken care of seriously to avoid undesirable delays.
2) Consultants were also held responsible in this analysis for causing delay. Delay in providing the design documents, and excessive mistakes and discrepancies in good for construction drawings were the key issues for the execution team that should not happen in order to achieve uninterrupted progress.
3) Poor communication and coordination between the parties involved in the project, lack of proper planning and coordination, difficulties in financing the project and utilization of proper planning tools like MS Project, Primavera etc were found to be the major aspects on part of the contractor that obstructed the timely completion of work.
4) The progress of the project gets affected when the construction materials are not procured on time and when specially required materials and building components are manufactured late.
5) Shortage of labourers at site is yet another issue that was raised by the site engineers which needs to be rectified in order to finish work on time.

Further, the respondents expressed following problems-cum-suggestions that should be seriously worked out to avoid unnecessary construction delays:

1) Approval of specialized agencies for work took too much time.
2) Timely payment from client against running bill was yet another issue of concern.
3) Communication channels were too long, this posed to be a problem for day to day needs.
4) Unpredictable financial recoveries/penalties imposed by the client on account of milestones, part-rates etc causing financial strain on the contractor, was another issue.
5) The contractor on a project also gave a suggestion that Mobilization Advance given to them should be made interest free as it unnecessarily increases financial strains on the contractor.
6) It was expressed very strongly that the decision takers for any project must be available at site so that issues can be resolved without losing any time.

Lack of project specific experience of the Government Officials was held responsible for their slow speed of decision making.

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