

COLLABORATIVE WEB BASED CONSTRUCTION INFORMATICS – A LEARNING SCIENCES PERSPECTIVE IN AN INDIAN CONTEXT

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This paper investigates web enabled construction informatics in India. Literature has been studied to derive the characteristics of the system. A web site which seems to be the first of its kind in India has been designed and launched for learning and application of the system. Existing software for data analysis have been proposed as much as possible. A new MS Project add-on application to connect MS Project to the cost database has been developed. Open source software has been used for web based recording and collaboration. Collaboration facilities have allowed the deployment of sophisticated techniques like Monte Carlo simulation and interactive linear programming for time-cost optimization in practical cases. A full learning module consisting of study material, reference and test have been developed for online learning. A project management wiki has been launched for recording user's experience.

1. Introduction

Construction management is a complex task. It requires inputs from varieties of stakeholders namely owners, consultants, suppliers contractors and outside agencies like financial institutions, regulatory authorities etc. The stakeholders are often separated geographically from one another and from the work site.

Projects by definition are unique tasks. Construction projects cost millions and might run for years. It should be adjusted continuously for efficiency. These traits tend to add up for a large amount of paper work which is to be executed in a collaborative manner by the stakeholders. Web enabled service is appropriate in such condition. The advent of web connectivity prompted the project managers to collaborate through internet.

There are number of web sites and IT consultant firms who offer construction informatics service in the developed world. However, construction activities are intimately related to the economic status of a nation and the methodology varies accordingly. The approach and service level of the developed nation may not be appropriate for the developing world.

In India, internet based project management methodology has not yet become popular. One of the major reasons is the absence of a locally tuned methodology.

In this paper an attempt has been made to develop an appropriate methodology for the Indian scenario. The methodology includes development of the construction informatics and applying it to an example work site.t.

2. Literature Survey

Literature has been consulted for studies about the frame work for project management.

Ma and Qin [1] studied information management systems for construction projects in China. They analyzed major aspects and the evaluation criteria for the information management systems. This method can be used to design and evaluate an effective information management system for construction projects.

Tang [2] studied management systems for the construction industry in the United Kingdom. A questionnaire survey was conducted. The study suggested a guideline which focuses on training and staff participation to adopt an integrated system.

Broomfield [3] edited "ISO 9001-2000 Interpretive Guide for the Design and Construction Project Team". He opined that establishing a construction management system is a challenging task. Tables including examples have been published to set up an ISO quality construction management system.

Amor, Betts et al. [4] investigated the application of information technology (IT) in construction over the last 20 years. Data seems to indicate that there is little formal research in the Indian context in this field. They found that visualization and integration between processes and people is the most important area of current research.

Wetherill M, Rezgui Y et al. [5] studied about development of tools for knowledge management in construction in Europe. They felt that it has not yet been properly developed. They found several obstacles like:

1. Knowledge mainly resides in the individuals.
2. Decision intent is often not properly documented.
3. Data is not properly compiled and collated.

They have recommended development of a web based standardized knowledge management system for the construction industry.

Mervi, Veli et al. [6] studied the multidisciplinary aspect of information management in construction. They felt that finding information is not a problem but sorting it into a useful form is a major issue. They felt that construction is an intensively information processing industry due to the uniqueness of each building project. After a similar literature and software system search Guha [7] proposed a scheme for construction management with the properties mentioned as follows:

1. Website establishment for project management.
2. The web operation should be user friendly.
3. Reports should be generated every fortnight.
4. Web enabled systems should be developed.
5. Active participation of users is essential.
6. Document storage facility should be provided.
7. Collaboration facilities should be provided.
8. Standardized formats should be developed.
9. Security controlled access should be provided.
10. Photo album facilities should be provided.

3. Website Proposal

A website christened www.sssolutionsonline.com has been launched. This project management (PMC) website would be used mainly by project stakeholders. The client outlines the requirements based on which consultants deliver drawings and specifications. Suppliers and contractors deliver the product as per drawings and specifications set by consultants. The business model requires substantial collaborations among team members that are managed online. The web managers' role will be to analyze and deliver PMC advice. In addition, the web manager should maintain the system. The requirements of the stakeholders from the proposed PMC web site as proposed by Guha [8] are presented in Fig 1.

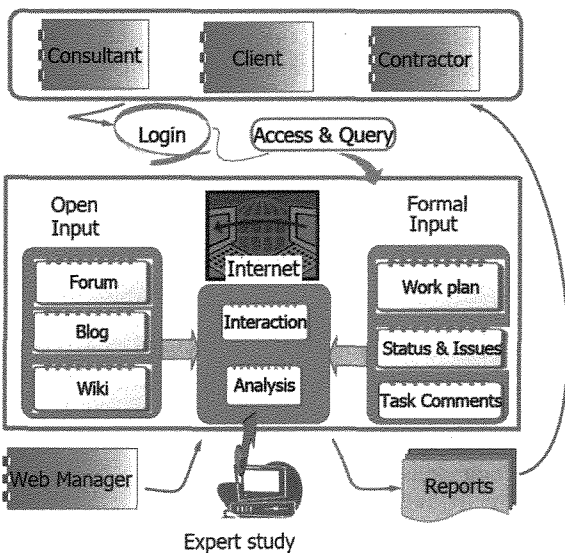


Figure 1: Scheme for the proposed website

The website shall publish reports as presented in Fig 2. Commercial software like Microsoft Project shall be used to generate the reports. The web space shall also be used for collaboration. Open source software has been proposed for collaboration work because source codes would be available for small adjustments.

4. Data Analysis Software

The input data generated in the website is analyzed by varieties of software. The planning for the same are summarized as follows:

1. Open software shall be used wherever possible.
2. Code customization to minimize existing gap.
3. Web enabled databases for online collaboration.
4. Training module to be developed within the site.

The following types of reports shall be generated:

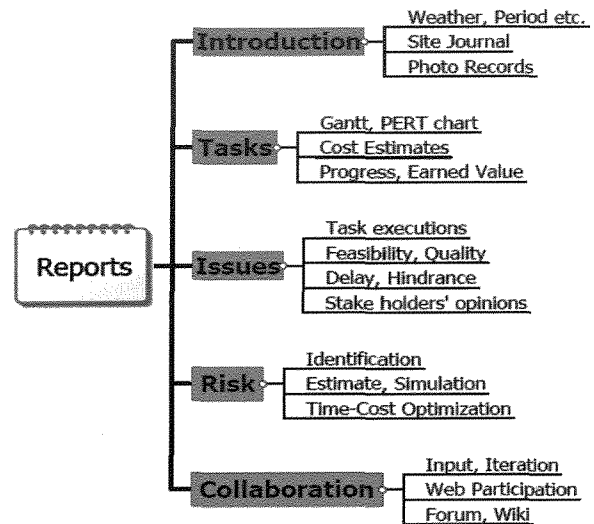


Figure 2: Reports to be published in the website.

Microsoft Project has been taken as the main scheduling software because of its familiarity with the local business community. Moreover, additional open source or otherwise add-ons to MS Project like PERT Chart Expert for primary tracking, WBS Chart for creating Work Breakdown Structure, Project Merlin for assignment lists, Risky Project for simulation and risk analysis etc. have been used.

However, some of the data generated within the website could not be properly processed with the existing software. For instance, costing data cannot be effectively estimated in MS Project scheduling software. Hence, a MS Project add-on christened as REAnalysis [9] has been developed to integrate task scheduling and costing information.

REAnalysis can be used for cost estimating and updating relevant data in MS Project. It executes cost analysis of individual tasks in a manner suitable to the local business practices. Such software was not found in the web survey and hence, the in house product was developed. A screen shot of REAnalysis is provided in Figure 3.

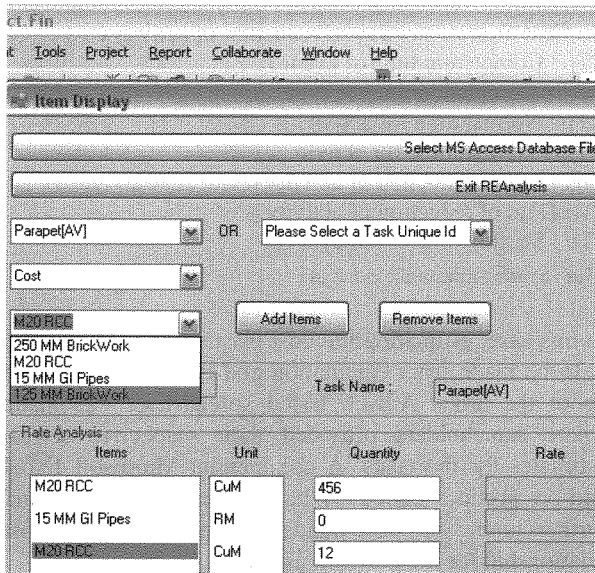


Figure 3: REAnalysis Item Display Screen

Facilities have been provided within the website for collaboration among the stakeholders. Certain open source applications are also used. Since source codes are available minor modifications can be made. Some of the collaboration facilities planned are as follows:

1. Forums for issue wise discussions of stakeholders.
2. Task comments to address daily hindrances.
3. To Do List to track tasks.
4. Editable spreadsheets for stakeholder calculation.

5. Data Analysis Principles

The data has been processed and posted in web site in such a manner that any stakeholder can find usable data with little effort. A PDF volume is published on the website every fortnight. These reports are standardized. Some salient features of these reports may be as follows:

1. Fortnightly volumes are published.
2. Report formats are standardized.
3. Standard formats are adequately explained.
4. Customized Reports for managerial levels.
5. Queries on reports are addressed in the forums.

6. Data Collaboration

The collaboration among stakeholders can be developed as a powerful tool for execution of work and sophisticated management reports. There are several project management techniques that can be practically developed only through collaboration among stakeholders. Two such examples that has been actually done in this web site is presented in the following.

Great Eastern Hotel, Kolkata the oldest hotel in India has been taken up for heritage restoration in 2006. The project is an adaptive heritage work. The project scope could not be reliably estimated before starting of construction. Planning and construction is to be executed simultaneously rather than one after another as in normal construction. Collaboration among stakeholders is of more importance in this case. The project is managed through the facilities of the present web site. The existing database and collaboration facilities have been used to develop a simulation and a real time linear programming optimization study.

7. Simulation Example

Monte Carlos' simulation is an operation research tool which is often used for assessing the risk i.e. the variability of outcome of a project. In a simulation study, randomly selected completion time within the assigned limits for each task is assumed and a probable date of completion is estimated from the Gantt chart. It is assumed that the risk of the actual project shall be the same of the derived distribution. A simulation is only good to the extent the individual task boundaries are set. For a project like Great Eastern Hotel Restoration varieties of experts are required to estimate the probable time. Stakeholders who were geographically dispersed collaborated interactively in the web site for assigning time constraints. Guha [10] then traced the relationship between time and probabilities of completion during the design development phase which is presented in Figure 4.

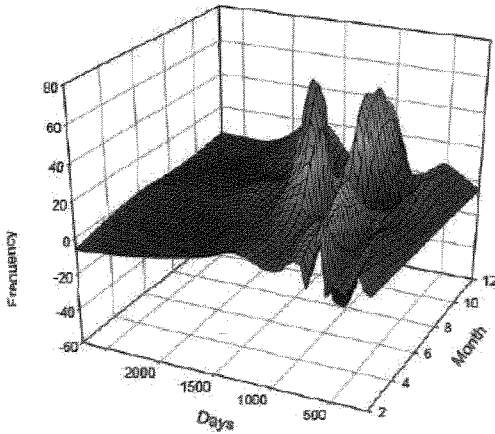


Figure 4: Probabilities of completion during Design Development Phase

In a similar study, Guha [11] extended the estimate to probable distribution of cost which is presented in Figure 5.

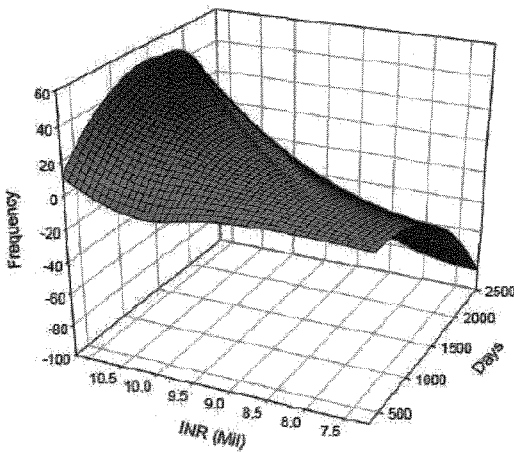


Figure 5: Costing probabilities during Design Development Phase

Such studies could not be practically done without the collaborative system implemented on the said website.

8. Time Cost Optimizing Example

In project management, time-cost optimization of a PERT chart is usually done by linear programming. A network can be represented by a set of linear equations. Once the objective function is known a linear programming model can be formulated as shown in the following example:

Objective function:
Minimize $\sum Y_i C_i$
Subject to:

$$CT_j \geq NT_j - Y_i + ST_j$$

i from 1 \rightarrow n th activity
 $CT_{jn} \geq NT_{jn} - Y_{in} + ST_{jn}$

Where,

Y_i : No of days of reduction possible by crashing the activity i .

C_i : Cost increase per day of reduction of activity i

CT_{j1} : Completion time of event J_1

CT_{jn} : Completion time of event J_n

NT_{j1} : Normal time for activity j_1

NT_{jn} : Normal time for activity j_n

Y_{i1} : Days of reduction of activity i_1

Y_{in} : Days of reduction of activity i_n

ST_{j1} : Starting time of the event j_1

ST_{jn} : Starting time of the event j_n

In this case, estimating the cost per day of crashing (Y_i) is to be made from calculation and detailed knowledge about the tasks. A web based spreadsheet was made where stakeholders provided their respective set of estimates for the tasks. A commercial Microsoft Excel add-on product called 'What is best' was used and further tuning up were made to arrive at a time-cost relationship for the network as shown in Figure 6.

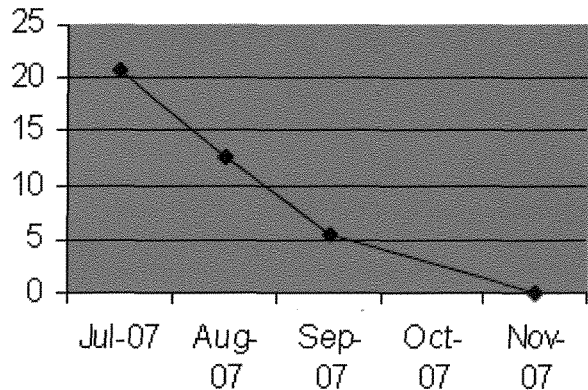


Figure 6: Linear Programming Results

One may note that about 20% cost increase in minimum shall take place by crashing the project for 4 months. Such studies require interactive input from stakeholders and are not practically feasible without the collaborative facility of the web site.

9. Collaboration Benefits

The web based collaboration allowed several consultants to update the data conveniently. As the consultants were filling up the cost estimate for crashing of individual task the C_i values were changing continuously because the contributing factors are

changing with time. As a result the plan arrived by linear programming was also varying. In such situation the planning for the tasks that should be crashed to reduce the time most economically would change every month.

10. Training Module

Training is of paramount importance for software application. In this case, a number of stakeholders with different background and computer exposures are required to be involved.

The training and learning processes has been greatly modified with the advent of the web technology. First attempts in personalized, also called adaptive, learning environments appeared in the early 1990s. 1996 is considered as a turning point in the area of adaptive systems [12]. Recent approaches to Web based education try to take into account various dimensions of individual differences, such as level of knowledge, cognitive styles, and learning styles [13]. In line with these approaches, a training module for use of the system and collaborative project management has been integrated in the website.

Usual components of training that are normally used for any academic course or training has been developed as presented in the following:

1. Notes to appraise the reader about the topic.
2. References to provide web links for further study.
3. Query Form for feedback and references.
4. Practice data to practice collaboration concepts.
5. Quiz to take computer graded online tests.
6. Wiki to record experience and improvements.

11. Conclusions

Web enabled technology for construction informatics is relatively a new field in the Indian context. Web enabled project management systems is an efficient system of management as experienced in industrialized countries. The web based collaboration proposed in this study is coined as Enterprise 2.0 by McAfee [14] and many feel that this trend would increase rapidly in near future. The Enterprise 2.0 concept has been further extended to project management learning in this paper.

However, localization is necessary for effective results. The present website is only a starting venture in this direction.

Acknowledgments

The author thanks Professor Shibnath Chakrabarty, Department of Civil Engineering, Jadavpur University, India for his help and support.

References

1. Ma Zhiliang and Qin Liang, (2004) "A Framework of Information Management System for Construction Projects", Department of Civil Engineering, Tsinghua University, Beijing.
2. Tang Jia, (2003) "Corporate Culture and Integrated Management Systems: - A case study of the UK construction Industry" Masters of Science Thesis, University of East Anglia.
3. Broomfield J.R. et al (2003) "ISO 9001-2000 Interpretive Guide for the Design and Construction Project Team", ASQ Quality Press, Mil, USA.
4. Amor R, Betts M et al. (2002) "Information Technology for Construction: Recent Work and Future Directions" in *ITcon 7*, 245-258.
5. Wetherill M, Rezgui Y et. al.(2002), "Knowledge Management for the Construction Industry: The ECognos Project" in *ITcon 7* (2002) 183-196.
6. Mervi L, Veli H et al. (2002), "Multidisciplinary Information Management in Construction Industry, Example of Facilities Management" *ITcon 7*, 213-244.
7. Guha S (2007) "Construction Management Through Web Service in Calcutta, India", International Business Informatics Conference 2007, Dublin City University, Dublin, Ireland.
8. Guha S (2007) "Development of a Web Based Construction Management System", National Conference of Information Technology, New Delhi 2007.
9. REAnalysis (2007) – A MS Project add-on application.
<http://www.sssolutionsonline.com/reanalysis/>
10. Guha S (2007) "Time Estimate of a Heritage Building Restoration Project By Monte Carlo Simulation" International Conference on Modeling and Simulation, CIT, India.
11. Guha S (2007) "Planning with Uncertainties for a Heritage Building Restoration Project in Calcutta, India", IEEE International Conference on Industrial Engineering and Engineering Management, Singapore 2007.
12. Brusilovsky P. "Course Sequencing for Static Courses? Applying ITS techniques in large scale web based education" *Conference on Intelligent Tutoring Systems (ITS 2000)*, Montreal Canada (pp. 625-634), Berling: Springer Verlag.
13. Magoulas G & Chen S (2006) "Web based Education" Information Science publishing.
14. Wikipedia (2007) "Enterprise Social Software", Nov.2007.
http://en.wikipedia.org/wiki/Enterprise_social_software