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Application of Project Management Processes for Construction of Gas Pipeline Projects

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ABSTRACT: Project management processes offer a methodology to assist in accomplishing goals for the firm. The major criteria for a proper project management process is selection of a software which can help the personnel in planning, organizing and managing tasks and resources. Project management tools offer many features that are adjustable and can be personalized to meet the needs of users. But as we know that every project is unique and for each project the firms have different requirements. Also, the managers perspective behind selecting any software depends upon the exposure he has received from his experience in different organizations. With the best selection of a project management tool the firm can deliver more projects successfully and gain larger projects.

KEYWORDS: Project management, schedule management, AHP, Saaty scale, Primavera.

I. INTRODUCTION

Project management is the process and activity of planning, organizing, motivating, and controlling resources, procedures, and protocols to achieve specific goals in scientific or daily problems (HalilCicibas et al., 2012). With the develop of both information technology and construction industries, we find several project management software in the market. Therefore, the selection has become quite complex with keeping different constraints in mind. Project management software is a term covering many types of software, including scheduling, cost control, budget management, resource allocation, collaboration, communication, quality management and documentation (Shahi Rozenes, 2006). The main scope of this research is selection of a project management software that meets the managers expectations which ultimately leads to a profitable project.

In this study, we analyzed a set of project management software. Then, we compared these software's using a set of criteria. In addition to the criteria we developed, we used the criteria listed in [HalilCicibas et al., 2012]. At the end, we present our findings. Our goal in this study is to help project managers in choosing project management software efficiently with the aid of Analytical Hierarchy Process (AHP) method.

II. RELATED WORK

A "project" is defined by A Guide to the Project Management Body of Knowledge (PMBOK® Guide) (PMI, 2004) as "a temporary endeavour undertaken, to create a unique product or service." "Temporary" means that every project has a definite beginning and a definite end. "Unique" means that the product or service is different in some distinguishing way from all similar products or services. As time passes, there is a need to update the methods, tools, and techniques used in the management of projects [6].

Even though the technology is advancing at a rapid speed, we cannot find standardized processes to carry out many functions like Cost management, Risk management, etc. IT projects exist in a volatile environment thus they don't fall under the umbrella of conventional methods. They are nowadays managed by Agile or Scrum methods. But the complexities in the construction projects are also on a rise, specially Gas Pipeline projects. They are constructed in a harsh environment and require multiple permits from multiple agencies. Without a standard process to track the progress of the project it is bound to be budget overrun, which happens in most cases today.

Gas Pipeline projects are influential tools for creating economic value. The need for managing such projects in a more efficient way is rising due to the strong faith that the alignment of project management processes will lead to more profits. "Project management is fundamental for attaining the results of a project, manage its contributors and outcomes, as well as drive and assess the alternatives in order to fulfill the different stakeholders' needs" [4]. As per Söderlund, project management is an approach that helps organizations to solve complex problems.

The very first methodology for project management – PERT (Program Evaluation Review Technique) was developed by the US Navy in 1962 for schedule management. This was then used for earned value analysis. Because of uncertainties in project environment and disorganized cost/schedule tracking practices, it is difficult to determine the real-time performance of project. An earned value management system allows the project managers to track schedule progress and overall physical change with respect to cost, thus giving a more accurate view of project performance [5]. There isn't a standard earned value methodology for available for gas pipeline projects so this thesis will help in identifying the most effective method for the collection and monitoring of both cost and schedule data.

Project management software is a process which involves estimation, sequencing the activities, resources allocation and timing [3]. Planning and scheduling of construction projects requires a huge amount of paperwork and human effort, which can be reduced with the help of project management software. But today a few such software are available in the market which leads to confusion in its selection. HPPPM, MS-Project and Primavera are the widely used software. Different project managers tend to use different software which depends upon the exposure they have received. There is no standard methodology developed which helps in the heuristic selection of a project management software [2]. So, this research also aims to develop a model which helps in multi-criteria decision making, depending upon the selection criteria given by different project managers.

Cost forecasting is the practice of developing a time phased projection of cost to complete for a project, in order to provide an accurate reflection of expected cost outcome at project completion. Cost forecasting allows variances between a baseline and a plan to be identified, explained, and monitored over time as trends. Both onetime variances and trends can be used to direct management attention to project issues and provide an opportunity for mitigation. The project cost forecast plan versus actual will be shown both on a graph and a table showing the forecast, actual, and variances. Variances will be explained by indicating the lower level detail that attributed to the deviation from the forecast. This process involves incorporating all possible variables each month to formulate an educated forecast on how much will be spent and on which individual scopes of work [7].

III. METHODOLOGY

The Analytic Hierarchy Process (AHP) developed by Saaty provides an elastic and easy way of analyzing risk factors. It is a multicriteria decision-making procedure that allows subjective along with objective factors to be considered. It allows the participation of decision makers (managers) in reaching agreement. A methodology and steps for developing the model is discussed here. HP (HP-PPM), MS-Project and Oracle (Primavera, 2014) will be analyzed by this process.

There are seven steps for applying AHP (Saaty, 1980):

1. Problem definition and determination of goals.
2. Structuring of the hierarchy of all the criteria of selection.
3. Constructing a set of pair-wise comparison matrices.
4. There are $n*(n-1)$ judgments required to develop the set of matrices in step 3. Reciprocals will be assigned in each pair-wise comparison.
5. Weights for each criterion are calculated and eigen values are determined.
6. After completing all the pair wise comparisons we then find the consistency and it should be below 10 percent as per research.
7. Steps 3-6 are achieved for all levels in the hierarchy structure. To meet the research objectives four research tasks will be carried out mainly through literature review, questionnaire and then analysing the data.

IV. EXPERIMENTAL RESULTS

In this method, predilections between options are determined by making pair wise comparisons matrices. The person choosing between options prioritizes one over the other using a predetermined scale of number. Saaty provided a scale range of 1-9 to prioritize, meaning 9 is the best option and 1 indicates not suitable. Table 1 indicates the pair-wise scale used here.



Table 1: Pair-Wise Comparison Scale for AHP Preferences

Rating	Prioritization
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

In order to apply this method, we now need the basis of our selection or the priority vectors that would govern the selection of tool. Based upon the interviews of six Industry Experts and Project Managers, the following selection vectors are determined as in Table 2.

Defining the selection vectors is the most critical step of constructing this model as the verdict of users are base of these. To define the most apposite selection vector, first the literature is studies comprehensively and then experts that use project management software from different sectors are interviewed.

- HP-PPM: 2 experts from IT sector
- MS-Project: 1 expert from global facilities and 1 expert from information/communication services sector
- Primavera: 2 experts from Oil & Gas Sector

Table 2: Selection Vectors

Selection Vector	Description
Task Scheduling	This feature allows to put start and end dates for a task to get an idea of project completion time.
Resource Management	This feature allows to allocate resources at the right place and right time to complete the project
Time Tracking	This feature allows to track the activities and expense of each employee to estimates the overhead costs
Risk Assessment	This feature allows to identify and plan for the potential uncertainties
Change Management	This feature allows to manage the impacts on objectives of the project

Based upon the Selection vectors, the experts provided a ranking on a scale of 1-9 as mentioned earlier. The next step is to prepare a Pair Wise Comparison Matrix (A) as below:

$$A = \begin{matrix} & C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & \dots & C_n \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ \dots \\ C_n \end{matrix} & \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} & \dots & a_{1n} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} & a_{26} & \dots & a_{2n} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & \dots & a_{3n} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & a_{46} & \dots & a_{4n} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & a_{56} & \dots & a_{5n} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & \dots & a_{6n} \\ \dots & \dots & \dots & \dots & \dots & \dots & 1 & \dots \\ a_{n1} & a_{n2} & a_{n3} & a_{n4} & a_{n5} & a_{n6} & \dots & 1 \end{bmatrix} \end{matrix}$$

Figure 1 - Generic Pair Wise Comparison Matrix



In Figure 1:

n = selection vector number to be weighed

C_i = ith selection vector,

a_{ij} = weight of ith criteria according to jth criteria

The next step is to calculate (λ_{max}) so as to lead to the Consistency Index and the Consistency Ratio [10].

The formula of Consistency Index (CI) as follows:

$$CI = (\lambda_{max} - n) / (n - 1) \dots\dots\dots(1)$$

Consider [Ax = λ_{max} * x] where x is the Eigenvector.

Then the Consistency Ratio (CR) is assessed in order to measure the rate of consistence of the judgments, comparative to substantial samples of indiscriminate judgments. If CR is greater than 0.1 then the judgments are unreliable.

Table 3 - Pair Wise Comparison Matrix

	Task Scheduling	Resource Management	Time Tracking	Risk Assessment	Change Management
Task Scheduling	1	7	7	8	8
Resource Management	0.1428	1	7	8	8
Time Tracking	0.1428	0.1428	1	8	5
Risk Assessment	0.125	0.125	0.125	1	9
Change Management	0.125	0.125	0.2	0.1111	1
COL. TOTAL	1.5357	8.3928	15.325	25.1111	31

To find the standing of matrices, namely the Eigen vector, the column entries are normalized by dividing each entry by the sum of the column. After that the overall row averages are taken. Eigen vector represents the ranking of criteria.

To check the consistency of the decisions, model checks the Consistency Ratio. AHP assumes that the users are rational decision makers which mean if A is preferred to B and B is preferred to C, then A is preferred to C. For this purpose, Consistency Ratio is checked and if it is greater than 0.1, then the judgments are unreliable and must be repeated (Saaty, 1980).

The last step in AHP is to attain the ranking of the 3 software’s by combining the two matrices from. Let us denote the matrix in Table 3 as A and the matrix in Table 4 as B. The ranking is attained by multiplying the two matrices, A*B. Table 5 confirms the ranking of the tools.



Table 4 - Normalized Matrix

	NORMALIZED SCORE	NORMALIZED PERCENTAGE
Task Scheduling	2.518623915	50.37247829
Resource Management	1.245590763	24.91181525
Time Tracking	0.655171781	13.10343561
Risk Assessment	0.434591162	8.691823244
Change Management	0.14602238	2.920447602

Table 5 – Weight Distribution

HP-PPM	0.22
MS Project	0.35
Oracle Primavera	0.43

V. CONCLUSION

After interviews with 6 experts from different sectors namely IT, telecommunication, global facilities, construction, and oil & gas, calculations were completed using AHP template prepared with Excel and the results are presented in Table. As it can be seen from Table 5, scores are not far away from each other. The major steps completed in current work are: Literature about project management processes is studied systematically and important selection vectors are obtained. Interviews were held with industry experts and criteria for the AHP method were determined based upon these. Additionally, three mostly used project management software are selected for this study. AHP method is applied with five different expert’s opinion on the selection vectors are used to reach a subjective conclusion. Furthermore, Oracle Primavera came out to be the best alternative for software tool to use for schedule management.

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