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Application of Scheduling using Critical Path Method to Hydraulic Performance of Impeller for a Multistage Submersible Pump

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Abstract: ***The present study is an application of scheduling using critical path method without any restriction in resource.The study describes a full evaluation on hydraulic performance of impeller for a multistage submersible pump. Based on the planning project duration for completion wasfifty two weeks. However, the application of critical path to the study resulted tothirty nine weeks, a difference of 13 weeks reduction.***

Keywords: ***Critical path analysis, scheduling, hydraulic performance of impeller for a multistage submersible pump.***

I. INTRODUCTION

Since 1950's the critical path method is existing and used effectively. This method is a method of scheduling the study of individual activities in a sequence which has to be completed on scheduled time. Each activity has to be processed only after completing the activity that is scheduled previously. To reduce the costs of plant shutdown, DuPont Company in 1957 developed critical path method by a pair of mathematicians. In this sense, to reduce the money in making designs, the production engineers identified the sequence of activities to be followed, as proved by the ''life cycle Lay out'' theory. But, the life cycle theory lists, although the great majority of product design depends on basic design. Many of these types of lay out are implicitly determined in the early period of development. At those time their research explained that fundwould not be wasted by focusing efforts on working on the right tasks at the right times, rather than outpouring theproblem with workers to stay on schedule. Just- in-time strategy ensures that customer-specific needs are satisfied. Success of any business is customer's satisfaction. In most of the industrialized countries competition from low-cost regions has become an increasing concern for manufacturer. Scientists agree that companies must find a best fit with their customers needwhich will only result in best performance of their operations.The dimension of the cost is related to the standardized style. Kelly JE and Walkerin MR developed critical path method to help the construction and maintenance of chemical plant in Dupont. Critical Path Method assumes that the durations of the activities are definitely determined.The strategy behind critical path method is that each project has a path which comprises of the task that may delay the entire work in case of a delay in the start, finish or completion. At the same time, the era of competing with quality and cost is replaced with the era of competing through speed,service and innovation [1].

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Critical path method provides a graphical representation of the project and predicts itscompletion time [2]. Whiledeveloping new product,analysis in completion and performance of the product and the requirement this analysis on scheduling is required because of people with high competence.

II. METHODOLOGY

A. Description of case study

The present study employed an application on scheduling hydraulic performance of impeller for a multistage pump. The duration wasfifty two weeks for the scheduled project. Planned activities, in the study, their durations are represented in the form of a table.

Table 1: Planned activities

ID	Task	Preceding activity	Duration (weeks)
A	CAD drawing impeller fabrication	-	3
B	Mathematical modeling of flow simulation in impeller passage	A	4
C	Identification of test facility within the organization	A	8
D	Fabrication of impeller and pump assembly	B	6
E	Identification and testing of suitable motor with calibration performance	B	5
F	Identification of test facility outside the organization	C, D, E	4
G	Performance study within the organization	F	5
H	Comparison and evaluation of the test result with literature	G	5
I	Iteration of the impeller design for the expected performance	H	6
J	Report	I	6

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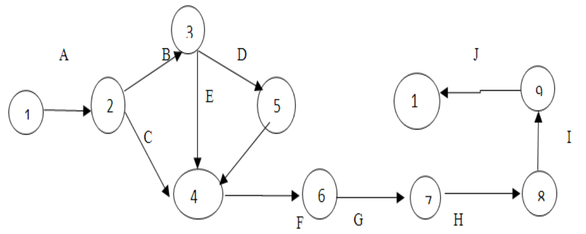


Figure 1

B. Construction of activity – on – node method

In the current study the flow of the network is based on, activity-on-node and activity-on-arrow [3]. Activity- on-node uses a square or circle to denote a task, while in activity-on-arrow an arrow is used to denote a task. This network is adopted due to its simplicity. With the help and guidance of eight procedural rules [4] the current study is constructed using activity-on-node involves forward passing and backward passing. The steps followed in constructing the activity-on-node and to evaluate the critical path via the critical path method is as followed by Larson and Gary [3].

The early time, the late time, and the slack for forward pass and backwardpass were obtained by applying Equation (1) - Equation (4):

Forward pass

Earliest completion time = Earliest beginning time + Duration of the task(1)

Slack = Latest beginning time + Earliest beginning time (2)

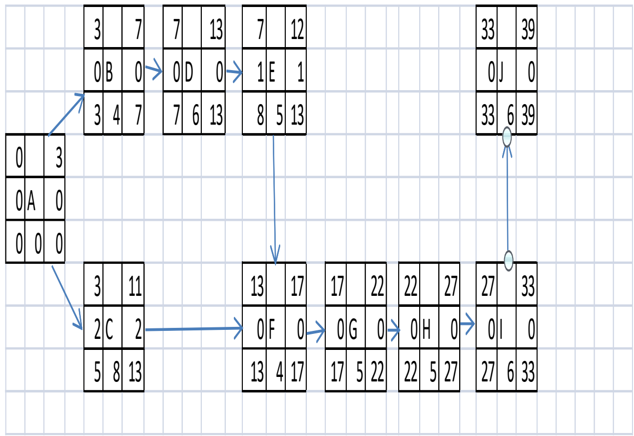
Backward pass

Latest beginning time = Latest completion time – Durationof the task(3)

Slack = Latest completiontime – Earliest completion time (4)

III. RESULTS AND DISCUSSION

The activity-on-node network with backward and forward pass for the present study on the performance of the submersible pump is depicted in Figure 2. Task in an activity-on-node of a project are elements of the project that require time and are connected sequentially by a path [3]. Three major types of task, the predecessor task, the successor task and the concurrent/parallel task are associated with activity-on-node [5]. For example, in Figure 2, activity Band C are the successor task to taskA while taskBis a predecessor task to D and E. This indicates that task B should be completed before D and E can start. Furthermore, tasks C, D and E are parallel tasks to B. This indicates that these activities could run independent of each other. In addition, the critical path, which indicates the critical activities to be completed to ensure no delay in the completion date of the research, connects the tasks with zero (or smallest slack) in the path.



EST		EFT		EST- Earlist start Time
S	ID	S		LST- Latest Start Time
LST	D	LFT		EFT-Earlist Finish Time
				LFT-Latest Finish Time
				D-Duration

Figure 2

With the help of the construction that is computed and displayed in Figure 2, the critical path and the completion time for the design and study on the hydraulic performance of impeller for a multistage submersible pump is the network A-B-D-F-G-H-I-J. Earliest finish time for report writing in the network indicates the finishing time of the project because earliest finish time for the report writing in critical path is the longest in the activity-on-node. From this study, earliest finish time for report writing, the last task on the critical path is 39 weeks. The difference between the planned project duration fifty two weeks and the earliest finishing time computation using critical path method was 13 weeks. The 13 weeks decrease on the planned duration in designing and study time on the performance of the pump means a substantial decrease.And also, completing the current study indesigning the performance of a pumpsearlier than the planned duration saves time and energy without compromising the quality of the pumps performance. Suppose, if the hydraulic performance of the multistage submersible pump is designed and planned with resource-restrictions, then we would not able to complete the current studyof the project as scheduled. Since the study is planned with no restrictions on resources, no delay is expected in the designing on the hydraulic performance of the multistage submersible pump project. Suppose there is a delay due to unavoidable situation of any task it will surely affect forthcoming task planned and will reduce the slack of the forthcoming task. If slack of any of the tasks in the critical path is greater than zero, the expected time thirty nine weeks in designing the hydraulic performance of the multistage submersible pump could be more than the expected time.

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IV. CONCLUSIONS

After computing the critical path finally we arrive to the conclusion that thework could be finished in thirty nine weeks instead of fifty two weeks which was scheduled in the beginning, we derived with a reduction of 13 weeks to complete the design and performance of impeller ofthe multistage submersible pump. The final reduction of 13 weeks from the planned duration will result in the reduction in man and recourse power and this would reduce unnecessary stress on budget.Finally, from the study on scheduling with approximate duration using critical path method is recommended and applied in the management of hydraulic performance of impeller for a multistage submersible pump. In this application of critical path method on hydraulic performance of impeller for a multistage submersible pump a non-resource constrained planning is only considered, where the durations planned to complete the proposal is not limited. In case if the study is resource-constrained then the critical path method planned for completing the researchwould not be the same as mentioned above.

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