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Design of Project Networks and Solving by Critical Path Analyzes

K. Bharathi

Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya, Kanchipuram, Tamilnadu,India

A B S T R A C T

Designing the project work as a network model by applying rules of construction framed using directed network model and to find the complexity in design is termed as critical path analyzes. The main aim of the design is to find the critical path and investigate the duration of the real time project. The modeled project network is inputted in the open software in the detailed manner and applying the processes of the software to find the critical path. The general mathematical design of project network is given as a crisp detail with the basic application of critical path analyzes. An example of project network is simulated and the critical path is calculated as the result.

Keywords: Project, Network, Critical Path, Open Software, Complexity and Construction

1. Introduction

Project Network is a procedure required for planning and scheduling of major and minor projects in many fields such as construction, maintenance, fabrication, purchasing, computer system instantiation, research and development planning. The mathematical model of this type of project design can be solved using design present in optimization methodologies. In the real world application, most of the designed mathematical programming models are represented as the Network models. In general the Network analysis is termed as Programmer Evaluation and Review Technique, Critical Path Method, PEP Programmer Evaluation Procedure, Least Cost Estimating and Scheduling, Scheduling and Control by Automated Network System.

The construction of network of the project is a graphical representation as a directed graph. Normally this graphical design is named as arrow diagram in which each vertex represents the activities and weighted edges represents the time duration or cost required to complete the process of the corresponding activity. Programmer Evolution Review Technique and Critical Path Method are the two most widely applied techniques.

2. General Consideration and Application of Project Network

A project is a one-shot, time-limited, goal-directed, major undertaking, requiring the commitment of varied skills and resources. A project is defined as a combination of interrelated activities which must be executed in a certain order in for its completion. Network analysis is the general name given to certain specific techniques which can be used for the planning, management and control of projects. Any individual operation, which utilizes resources and has an end and a beginning, is called activity. The process flow of Project management processes is given below. The various elements of project management life cycle are as Need identification, Initiation, Planning, Executing and Controlling.

In[4], Donghyeon Yu defined Network representations have been used to describe interactions between entities of interest in various areas. In particular, network representations are useful to analyze and visualize complex biological activities. Global patterns in a large-scale complex system can be shown by representing the entities and their interactions with nodes and edges, respectively. Project management is concerned with the overall planning and co-

* *Corresponding author.*
E-mail address: kbharathi@kanchiuniv.ac.in

ordination of a project from conception to completion aimed at meeting the stated requirements and ensuring completion on time, within cost and to required quality standards. Project management is normally reserved for focused, non-repetitive, time-limited activities with some degree of risk and that are beyond the usual scope of operational activities for which the organization is responsible.

Industrial, financial, commercial or any kinds of project have at least one common feature: the better organized they are, the higher the profit or the lower the cost. Project management is the principle of planning different projects and keeping them on track within time, cost and resource constraints. The need for effective project management is ever-increasing. The complexity of the environment we live in requires more sophisticated methods than it did just a couple of decades ago. Project managers might face insurmountable obstacles in their work if they do not adapt themselves to the changing circumstances. On the other hand, better knowledge of project management can result in better plans, schedules and, last but not least, more contracts and more profit. This knowledge can help individuals and firms to stay alive in this competitive market and, in the global sense, utilize the finite resources of our planet in a more efficient way [2].

N. Ravi Shankar [3], explained that the Critical Path Method (CPM) is useful for planning, analyzing, controlling the progress and the completion of large and complex projects. The ant colony optimization (ACO) algorithms are applied to solve many complex combinatorial optimization problems, such as the traveling salesman problem, the vehicle routing problem, the problem of graph coloring, the quadratic assignment problem, the problem of network traffic optimization, the job-shop scheduling problem, etc. In this paper, we present a study of enhanced ant colony optimization algorithm for tackling project management problem using critical path method.

In particular, we propose an empirical estimation approach to evaluate the time duration of the network constructed by the ants. The proposed method is investigated for a selected project network. The results demonstrate that compared to conventional methods, the method proposed in this paper is more effective in determining the critical path and subcritical paths. Studying biological networks, such as protein-protein interactions, is key to understanding complex biological activities. Various types of large-scale biological datasets have been collected and analyzed with high-throughput technologies, including DNA microarray, next-generation sequencing, and the two-hybrid screening system, for this purpose. In this review, we focus on network-based approaches that help in understanding biological systems and identifying biological functions [4].

2.1. Basic Definitions:

The network scheduling by CPM/PERT for any project consists of the following four stages:

- Planning is started by splitting the total project into small projects. The smaller projects are further divided into different activities and are analyzed by a department or section. The relationship of each activity with respect to other activities are defined and established.
- Scheduling is the objective of scheduling is to give the earliest and the latest allowable start and finish time of each activity as well as its relationship with other activities in the project. The schedule must pinpoint the critical path i.e. time activities which require special attention if the project is to be completed in time.
- Allocation of resources is performed to achieve the desired objective. Resource is a physical variable such as labor, finance, space, equipment etc. which will impose a limitation for completion of a project.
- Controlling is the final phase in the project management is controlling. After making the network plan and identification of the Critical path, the project is controlled by checking progress against the schedule, assigning and scheduling manpower and equipment and analyzing the effects of delays. This is done by progress report from time to time and updating the network continuously. Arrow diagram and time charts are used for making periodic progress reports.

Activity - Any individual operation, which utilizes resources and has a beginning and an end, is called an activity. An arrow is used to depict an activity with its head indicating the direction of progress in the project. It is of four types:

- **Predecessor activity**: Activity that must be completed immediately prior to the start of another activity.
- **Successor activity**: Activities which cannot be started until one or more of other activities are completed but immediately succeed them are called successor activity.
- **Concurrent**: Activity which can be accomplished concurrently is known as concurrent activity. An activity can be predecessor or successor to an event or it may be concurrent with the one or more of the other activities.
- **Dummy activity**: An activity which does not consume any kind of resources but merely depicts the technological dependence is called a dummy activity.

  Dummy activity is inserted in a network to classify the activity pattern in the following situations:

  i) To make activities with common starting and finishing points distinguishable.

  ii) To identify and maintain the proper precedence relationship between activities those are not connected by events.

3. Design Methodology to find Critical Path in Network Analyzes

The design of the project is normally constructed as model of Network design and represented as a weighted directed graph and applied with the following proposed method to get an Critical path.

- The project is normally constructed as model of Network design and represented as a weighted directed graph, here the weight represent the time to complete the activity or cost required for the activity.
- The weighted directed graph is given as an input in the software as compiled in source with its specified weight as a arrow diagram.
- Simulations are done to get the Critical path from the start vertices to the end vertices of the weighted directed graph.
- The critical path with its earliest start and finish and latest start and finish are tabulated as the result.

3.1. Example for Network Analysis:

Let us consider a project which contains 12 jobs to be completed with the following duration of time and the possible order of the activity are represented as job activities. The data is represented in the table 3.1.1.

Table 3.1.1 Duration of Jobs

Job	Duration
1-2	10
1-3	8
1-4	9
2-5	8
3-7	16
4-6	7
5-7	7
5-8	7
6-7	8
6-9	5
7-10	12
8-10	10
9-10	15
10-11	8
11-12	5

The project is normally constructed as model of Network design and represented as a weighted directed graph, here the weight represent the time to complete the activity or cost required for the activity. The arrow diagram is as Fig. 3.1.1.

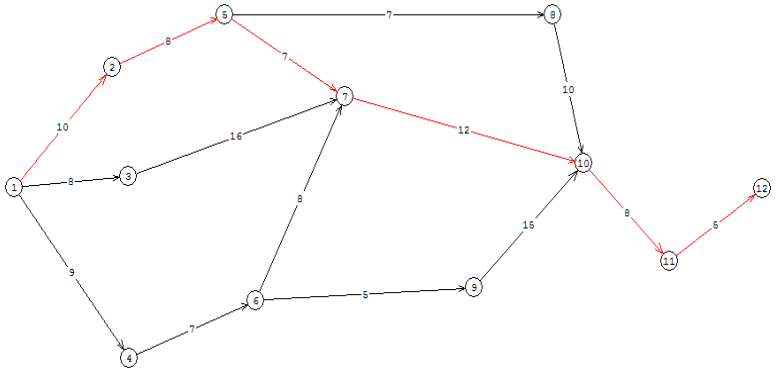

Fig. 3.1.1: Weighted directed Graph - Arrow Diagram

The weighted directed graph is given as an input in the software as compiled in source with its specified weight as a arrow diagram. Simulations are done to get the Critical path from the start vertices to the end vertices of the weighted directed graph. The critical path as in table 3.1.2 with its earliest start and finish and latest start and finish are tabulated in the table 3.1.3 as the result.

Table 3.1.2: Critical Path

1	Start Point	1
2	End point	12
3	Critical Path Length	50
4	Critical Path	1- 2-5- 7-10-11-12

Table 3.1.3: Earliest and Finish Units

Job	Duration	ES	EF	LS	LF
1-2	10	0	10	0	10
1-3	8	0	8	1	9
1-4	9	0	9	1	10
2-5	8	10	18	10	18
3-7	16	8	24	9	25
4-6	7	9	16	10	17
5-7	7	18	25	20	27
5-8	7	18	25	18	25
6-7	8	16	24	17	25
6-9	5	16	21	17	22
7-10	12	25	37	25	37
8-10	10	25	35	27	27
9-10	15	21	36	22	37
10-11	8	37	45	37	45
11-12	5	45	50	45	50

The results shown in the table 3.1.2 and 3.1.3 by simulation and the critical path is given with red colour in the figure.

4. Conclusion

The design of the project work as a network model by applying rules of construction framed using directed network model and to find the complexity in design is termed as critical path analyzes. The main aim of the design is to find the critical path and investigate the duration of the real time project. The modeled project network is inputted in the open software in the detailed manner and applying the processes of the software to find the critical path. The general mathematical design of project network is given as a crisp detail with the basic application of critical path analyzes. An example of project network is simulated and the critical path is calculated as the result.

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