Critical Path Backward Pass Method Based on Project Management and Its Application

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Abstract—A large project implementation arrangement needs to be rational. To achieve better efficiency, its managers must pay attention to the problem. Critical path method provides an effective method by which you can find the key routes and key point of management to improve management efficiency. If your project involves multistage decision problems, it is more characteristic. Combining the critical paths in project management method with dynamic programming in reverse, this paper puts forward solutions to complex multi-stage decision making problems, namely "Critical Path Backward Pass Method", which is applied in the training of talents in colleges and universities in programme development.

Keywords-Critical Path; Project Management; Dynamic Planning; Multistage Decision; Talent raining Development Program

I.   INTRODUCTION

Many human activities can be operated by project, resulting in the project management. The so-called project is established under the constraint of resources and requirements, contact with each other in order to achieve certain one-time tasks. In simple terms, developing a new product, building a block of flats or arranging a show can be called a project. It consists of three meanings

(1) Project is a task that remains to be done, with specific environments and requirements. (2) In certain organizations within the limited resources of human, material and financial resources, to complete the task in a specified time. (3) The tasks meet the requirement of the performance, quality, quantity, specification, and so on.

Modern project management was developed in the implementation of the defense industrial plans such as Manhattan during the late World War II. Due to project management methodology to fundamentally improve the operational efficiency of the management personnel, especially accompanied with the critical path method (CPM) and Program Evaluation and Review Technology (PERT) produced and promoted in the 1950s, from the 1970's to now, the theories and methods of project management has been beyond industry boundaries, extending it applied range to all fields rapidly from aerospace, defense, construction, chemical industry and other sectors, continuously intersected with other disciplines, and then the project management knowledge system was summed up to be the basic knowledge on which all project management staff in the industry could rely.

II.   CRITICAL PATH BACKWARD METHOD FOR PROJECT MANAGEMENT

A.   Critical Path Method，CPM

CPM (Critical Path Method, CPM) is more commonly used as a method in project management methodology. It is a network analysis technique to predict the duration of the project by analyzing which sequence of events (line) of schedule flexibility (total float) is the minimum value. Critical path method is the key to determine the critical path of the project network diagram, this work relies on the active list, network diagrams and activity duration estimates, the steps are as follows:

1) Each activity, duration of each activity and subsequent activities are reflected in a work table to establish a project network diagram.

2) Forward line, using the project network diagram and activity time to estimate and calculate the earliest start time of each activity ES and the earliest end time EF.

Formula: EF=ES + activity duration estimates.

ES Principles: The earliest start time for each activity (ES) equals to the maximum value of the earliest finish time for all of its previous activities (EF). The earliest finish time for the last activity in the project is the total time required to complete this project.

3) We choose the earliest finish time obtained from the above step as the latest finish time for the last activity, backward through the route, and determine the latest finish time (LF) and the latest ltart time (LF).

Formula: LS = LF - activity duration estimates.

LF principles: LF latest finish time for each activity is equal to the LS activities all succeeding the late start time of minimum value.

4) Calculate the total slack TF of each activity, calculated as

$$TF = LS - ES = LF - EF.$$

5) Find out the total time a minimum of activities these activities constituted key routes.

Note: during step 2 through 5, we could use the labels to operate.

B. Reversed Order Method for Dynamic Programming

In real administrative work, because of its specificity, we should divide the process into several interconnected stages. Decisions need to be made at each stage, so as to make the entire process achieve the best results. Decisions at all stages of selection cannot be therefore determined; it depends on the current state and influence future development. This type of problems is called multi-stage decision problems.

Dynamic programming is a branch of operation research, which is a mathematical method for optimization of multi-stage decision. The so-called "dynamic" refers to that, in the multi-state decision making of problems, in a certain order, according to the different selected decision from each step, will immediately cause the transfer of state, and then finally produces a decision sequence in the state of change. Dynamic programming is the sequence in order to make optimal decisions under certain conditions. The basic idea is: according to the spatial and temporal characteristics and following the direction of the selected system, the solution of complex problems can be divided into several stages of contact reversing the direction, calculating from the end point to the starting point one by one, looking for some sort of decision on each stage, making the entire process to achieve optimal, which is the so called reverse decision.

C. Method for Critical Path Backward Pass

For many of the more complex multi-stage decision making problems, merely using the reverse method of dynamic programming could not solve them. If converted into multiple single-stage optimization models, it is not only difficult to describe the actual problems objectively, but also relatively hard to solve them. This paper attempts to combine project management critical path method with dynamic programming in reverse to put forward "to reverse the critical path method". Implemented as follows:

1) Determine the project's critical path in accordance with the critical path method.

2) In accordance with the key activities on the critical path, vertically and reversely from the final event of the line, it can be divided into several stages, according to the actual issues determine the number of stages; each stage must include at least one of the key activities.

3) Horizontally determine activities in this phase according to the specific constraints of each stage, the sequence in the project network diagram would be the main basis for determining a phased sequence of activities, combined with resource constraints at all stages to complete the decision-making arrangements for all phases of specific activities

III. APPLICATION EXAMPLES

The formulation of a professional training program in colleges and universities is a multi-stage decision making problem, which can be seen as a huge system project plan and schedule. The plan for each semester is project task decomposition, which exist between each course sequencing and restriction of total credit hours per semester. Therefore, whether the course schedule is rational or not directly affects whether the students could finish school faster and better for a limited time. We can use the critical path method, based on course duration and sequencing relationship to draw network diagrams, on the basis of which to determine the critical path, and with this we can use backward pass method to adjust and optimize it, then eventually develop training programs. Steps in details are as follows:

1) Make clear of the learning curriculum, number of hours corresponding to this major, each course prerequisites, also called foundation course (must be completed prior to this course). If this course has to be finished in several semesters, then it could be regarded as several ones, at the end achieve the final course list.

2) To draw course network diagram is the key developing training programs. According to the final course list we could construct course network diagrams: courses corresponding to the nodes on the network (represented by a rectangle), arc (indicated by a line with an arrowhead) representing the order of priority between the various courses. In addition, the network also adds some nodes in the diagram to represent the beginning and end of learning in that major. Course network diagrams could represent the relationships between various courses.

3) By marking method along forwarding route, we could find the earliest start time (ES) and the earliest finish time (EF) of all courses in the network.

4) Take EF of the last activity as LF of this activity, by marking method along backward route to calculate the latest start time (LS) and the latest finish time (LF) of all courses in the network.

5) Confirm the relaxation of each course: $TF = LS - ES = LF - EF$

Relaxation number TF express that, under the condition of which without extending the overall learning hours, the starting time of this course can be delayed.

6) Find those courses with the minimum of TF (usually 0), and they called critical courses would constitute the critical path. These critical courses should be delayed as much as possible, otherwise it would affect the whole academic finish time.

7) Divide all courses on the critical path to each semester; make sure that there is at least one critical course within each semester.

8) Starting from the last courses on the critical path, according to the overall teaching arrangements for each semester, combined with the total teaching time constraints, reverse to set each semester's course, which is, making the reverse recursion from the last teaching semester one by one, focusing on those courses on the critical path, meanwhile, make reasonable arrangements for other courses should be combined with the objective factors such as, sequencing of courses on the network diagrams, teaching resources limited and etc.

Training program development is system engineering, which has to meet the demand of teaching requirements and be constrained by the semester and whole teaching time. Based on the principle of front-loading, we could make some minor adjustments on the programs if needed.

Once found the finish time unacceptable after analyzing course network diagrams, must rethink its original course network diagrams, figure out whether we could adjust the course prerequisites or not, otherwise, consider appropriate changes over the courses on the critical path, finally come to a scientific and effective training program through the proper adjustment and optimization.

IV. CONCLUSION

Critical path method is mainly used in large-scale production arrangements for the project. Applying this method in multi-stage decision problems is relatively effective. We should pay attention to some of the key in the application process: such as the accuracy of project network diagram, critical path searching, multiple stages of refinement, and critical path backward. Horizontal, vertical and comprehensive consideration should be made in the decision-making process. In addition, computing software could be used to obtain the project critical path.

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