

## The Influence of Duration Optimization on Cost

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**Abstract.** The methods and steps of seeking the lowest cost in the process of duration optimization were introduced under the condition of certain constraints in this paper through the compression of network plan effectively to find the optimal solutions. Besides, it combined with engineering examples to illustrate the principle of optimizing project duration cost optimization in the practical application, so as to achieve the purpose of controlling cost within reasonable project duration.

### Introduction

The optimization of duration and cost is to express the work with network planning. The network planning has relationship with the time and expense. We can find a key line from the network planning, then, compression the key line. On the one hand, the duration is shortened. On the other hand, the cost is reduced.

### The Relationship between the Duration and Cost

The project cost means the total fixed asset investment cost, which the project is in accordance with the construction content, standard, scale, requirement and function when it is completed [1]. The project cost is made up of construction and installation costs, equipment and instrument purchase expense, reserve cost, other construction expense, interest on loans during construction period and adjustment tax on orientation of fixed assets investment. And the construction and installation cost consists of direct cost, indirect charges. The direct engineering cost means labor cost, material cost and mechanical cost when the project is under construction. The indirect charges include the management fees, venue rental fees.

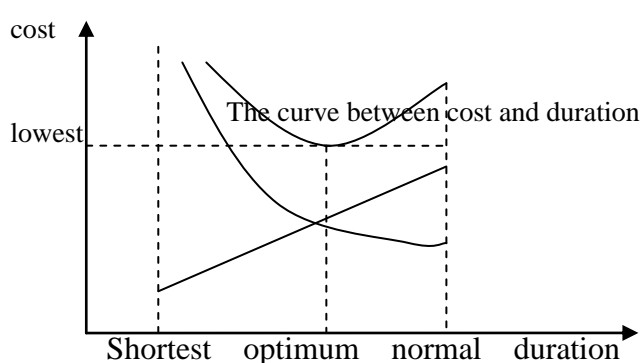


Figure 1. The relationship between the duration and cost.

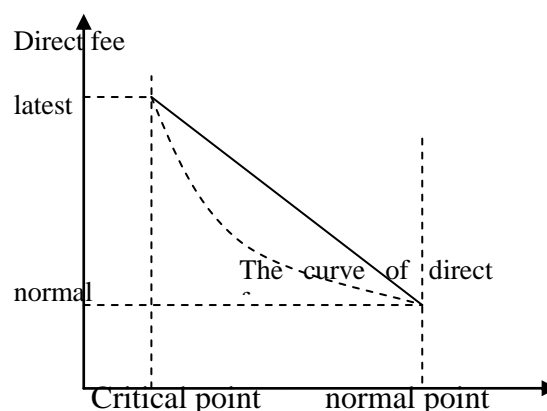


Figure 2. The relationship between the duration and direct fees

As shown in Fig. 1, between the shortest duration and longest duration, the construction cost is gradually reduced with the extension of time. Between the optimum duration and normal duration, the construction cost is gradually increased with the extension of time. The difference between the two periods is that the rate of direct fee is different from the indirect one. Therefore, the figure of duration and cost is shown above when the two curves are grouped.

As shown in Fig. 2, we can see the relationship between the two factors is a curve. In order to simplify the calculation, we can treat the curve as a straight line within the prescribed time. In this period, the direct fee is reduced with the extension of time [2]. When the duration reach the normal point the direct fee will increase. What's more, when the duration is shortened in a critical point, the direct fee will increase rapidly. The normal point in this figure means the duration when work is completed under the normal construction term, reasonable labor organization. The critical point means that the duration can not be shortened no matter how much material, labor were put in this project. Besides, the direct fee will continuously increase. So, we have to control the duration between the critical point and the normal point. In this period, the direct fee and duration can be described as formula [3].

$$K_{i-j} = (C_1 - C_2) / (t_2 - t_1) \quad (1)$$

$K_{i-j}$ —— The rate of direct fee about work i-j

$C_1$ —— The need of the direct fee when the work i-j is shortened to the least

$C_2$ —— The need of the direct fee in normal duration when the work i-j is completed

$t_2$ —— Normal duration of work i-j

$t_1$ —— The least duration of work i-j

## The Principle and Method of Time-Cost Optimization

**The Principle of Time-Cost Optimization.** The optimization of the cost is an important step during the construction. Under the established time limit, we should optimize the duration when the time is over the established time [4]. But in the network planning, there is a situation that the non-critical key maybe changes into the critical key. So, when we shorten the time, we should be sure the critical key doesn't change. On the critical way, it doesn't have another time left. So the duration on the critical key decides the construction time. Therefore the optimization of time-cost is constantly shortening the duration meanwhile, keep the right critical key. So that the cost can be keep in a low point [5].

**The Method of Time-Cost Optimization.** Usually, we shorten the critical way to optimize the project and keep the work in the same term. The step of time-cost optimization is as follows [6].

Make a chart to ensure the cost of each work and the duration.

Map network optimization according to the normal duration, mark the time parameter and calculate the key way.

Find the rate of direct fee under the normal duration of each work.

Find the work which has the least rate of direct fee in the critical way.

Repeat the step until the time can not be shortened.

Compare the construction fee after each compression, and find the least cost and time.

## Instance analysis

There is a job which is composed of six jobs. It is an office. The rate of indirect fee is 160 Yuan one day. The indirect fee is 4000 Yuan under the normal duration. Each of the parameter is shown as follows.

Table 1 The working parameters

Job number	The normal time		The limit time		The rate of the direct fee
	duration	Direct fee	duration	Direct fee	
1 to 2	4	700	3	850	150
1 to 3	6	1200	4	1510	155
2 to 4	6	900	5	1060	160
3 to 4	7	1050	5	1300	125
3 to 5	8	800	5	1280	160
4 to 5	3	1100	2	1260	160
total		5750			

According to the data, we can map the primary network planning, as shown in Fig. 3.

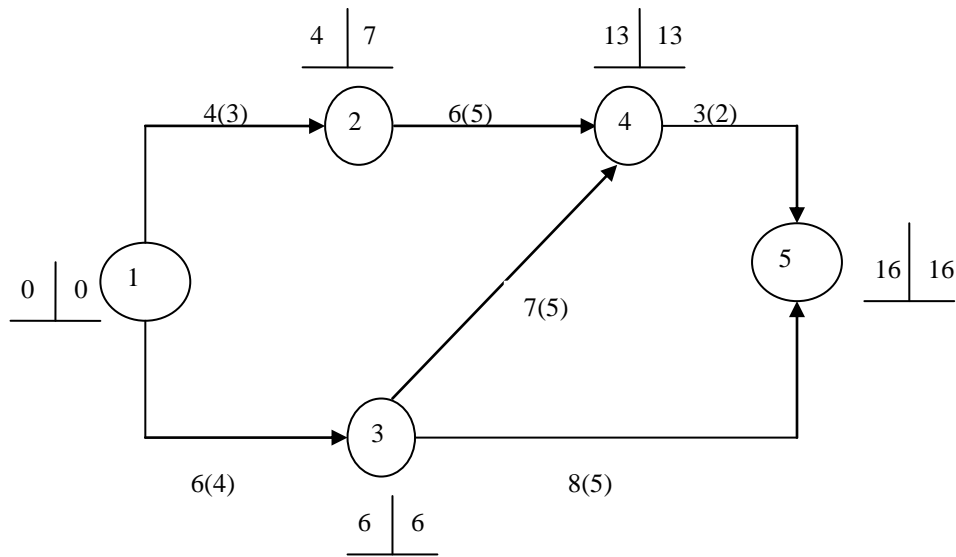


Figure 3. The primary project of network planning

As is shown in network planning, the normal duration is 16 Yuan one day, the indirect fee is 4000 Yuan and the direct fee is 5750 Yuan. In total, the whole cost is 9750 Yuan.

Before the optimization, we should conform the critical way. The critical works on the way are 1 to 3, 3 to 4 and 4 to 5. Among these works, the work 3 to 4 has the least rate of direct fee. So, we can shorten the working time by 2 days. After the compression, the direct fee will increase 250 Yuan. And the indirect fee will reduce 320 Yuan. The cost of the project is 9680 Yuan. The network planning is shown as Fig. 4

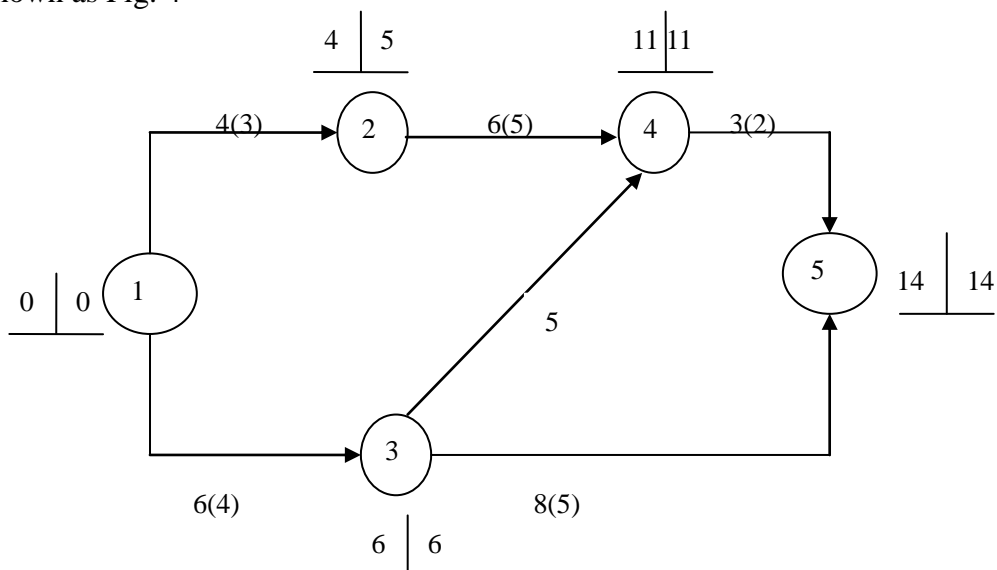


Figure 4. The first optimization of network planning

As is shown in Fig. 4, when we shorten the work 3 to 4, there are two critical ways. One is made up of the work 1 to 3, 3 to 4 and 4 to 5 another is made up of the work 1 to 3 and 3 to 5. The duration is 14 days. On this occasion, in order to keep the critical way remain unchanged, we can shorten the time of work 1 to 3 by 1 day. According to the chart, the direct fee will increase 155 Yuan, and the indirect fee will reduce 160 Yuan, the whole cost is 9675 Yuan. The second network planning is shown as Fig. 5

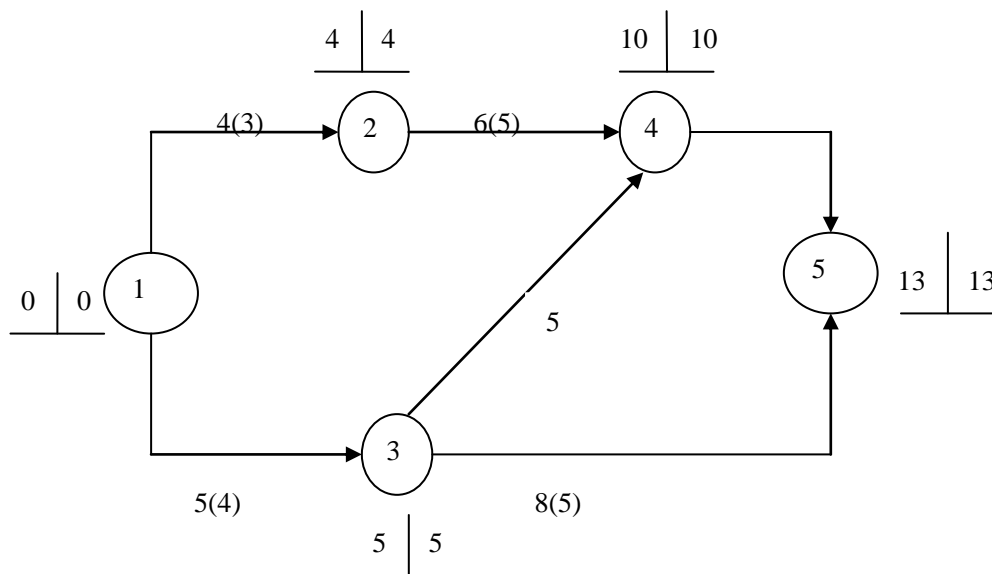


Figure 5. The second optimization of network planning

As is shown in Fig. 5, after the second optimization, the critical way is changed into 3 lines. The first way is composed of the work 1 to 3, 3 to 5 and 4 to 5. The second way is composed of the work 1 to 2, 2 to 4 and the third way is composed of 1 to 3, 3 to 5. On this basis, we can shorten the time of work 1 to 2 and 1 to 3 by 1 day on the same time. As a result, the direct fee will increase 305 Yuan. The indirect fee will reduce 320 Yuan. The whole cost of the project is 9660 Yuan. The third network planning is shown as Fig. 5

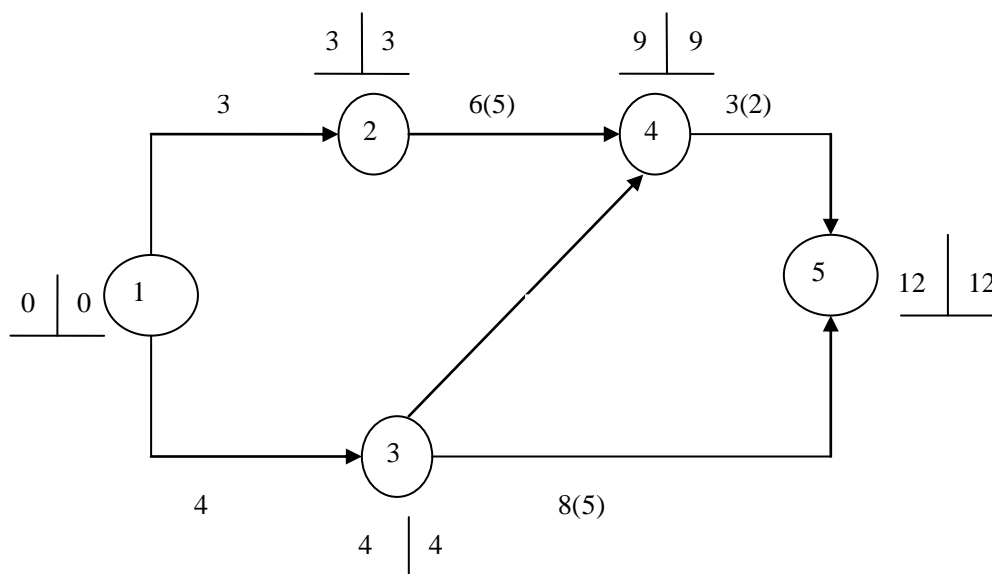


Figure 6. The third optimization of network planning

As is shown in Fig. 6, after the third optimization, there are also three critical ways. The first way is composed of the work 1 to 3, 3 to 4 and 4 to 5. The second way is composed of the work 1 to

2, 2 to 4 and 4 to 5. The third way is composed of the work 1 to 3, 3 to 5. So, we can shorten the time of work 3 to 5 and 4 to 5 by 1 day on the same time. The direct fee will increase 320 Yuan. The indirect fee will reduce 320 Yuan. The whole cost is 9660 Yuan. The forth network planning is shown as Fig. 5.

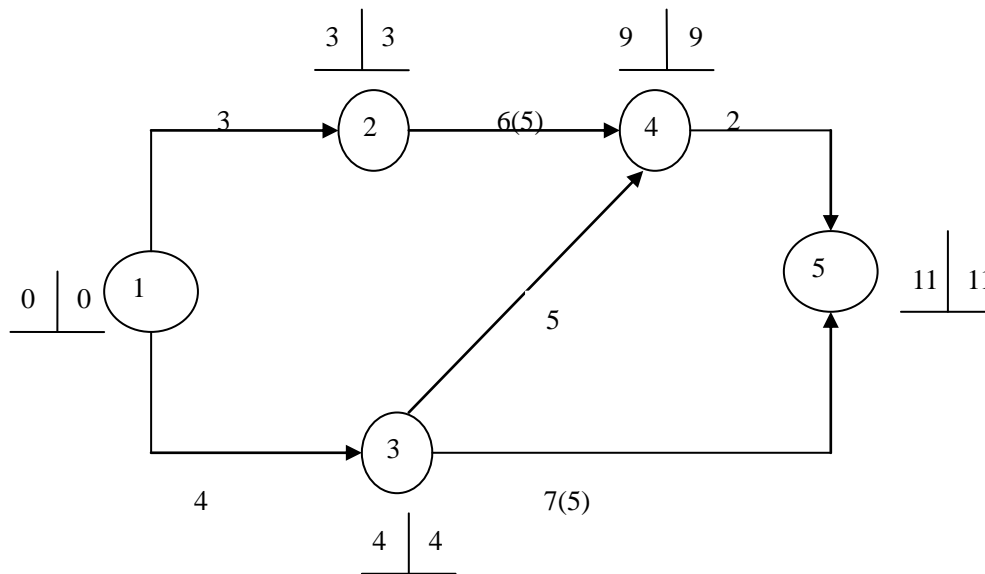


Figure 6. The forth optimization of network planning

According to the whole optimization, the fundamental is changing the time on the critical way. We can adjust the direct fee and indirect fee through shorten the time. Once and once again, until we find the combination between the direct fee and indirect fee.

## Conclusion

According to the optimization, the progress of optimization is trying to shorten the time on the critical way. The rate of direct fee is the mainly reference. During the optimization, we can find the best case. However, although this method has the feasibility, the technology has not been widely used in engineering practice. The reason is that small people are pay attention to this theory, and there are not enough tools to study it. In order to change the situation, we should improve the technology of network planning. Vigorously promoting it's in use in actual.

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