Construction cost control and duration analysis of rehabilitation project

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Abstract. In the process of rapid urbanization, the green ecological project is not only an important part of the function of urban space, but also an important way to promote the implementation of ecological civilization in the industrial economy and society. In China, green ecological project is mainly embodied in the form of urban landscape engineering. Due to the expansion of the size of the city and the increase of the urban population, many of the original urban landscape projects cannot be matched with the current situation. Such as the original vegetation is destroyed, the equipment becomes old, functional single and so on. Today if the re-construction of the project under the original engineering conditions is carried out, this kind of re-construction project is called the green ecological project. And the construction of the rehabilitation project is called an effective means to realize the value of green ecological projects. This paper takes the landscape and greening re-construction project of Kaifeng West Division scenic spot as the research object, through the system of construction cost control and the construction period analysis research, the case on behalf of the re-construction of the construction.

Keywords: Reconstruction project; construction cost; duration analysis; optimization strategy.

1. Introduction
The restoration project refers to the reconstruction on the basis of the original construction project [1]. Compared with the relocation, new construction, renovation and other projects, construction and renovation projects consider the factors more complex and diverse [2, 3]. The basic cost of construction costs are: labor costs, material costs and mechanical costs [4]. In the landscaping project, the material cost price and the mechanical cost are clear, considering the quality of the project, we will not compress the material cost and the mechanical cost. Therefore, the construction cost of basic engineering fees in labor costs, construction costs can be considered to control the duration. Therefore, we can regard duration as an important factor [5, 6]. Compared to the quality, safety and other indicators, the practical transformation of the project is more important. Therefore, we usually require the transformation of the project, under the premise of meeting the original other elements of the index, shorten the construction period, to reduce costs and restore the purpose of the social function of the project [7].

This paper takes the afforestation and rehabilitation project of Kaifeng West Division scenic spot as an example, and combines the experience of the construction period analysis of two similar projects in 2015 and 2016 [8, 9]. To interpret the typical landscape restoration project and analyze its cost control and construction period, we put forward the effective strategy to provide construction cost and construction period control suggestions for the same type of project.
2. Method of research

2.1. Construction cost control for complex projects

In the macro perspective, looking at the problem of landscaping construction costs, construction costs can be simply understood as the sum of the costs generated by the construction site \([10, 11]\). And the ultimate goal of our implementation of cost control is to minimize the sum of costs.

Further, construction cost control can be considered from two dimensions, one is the cost form, based on the construction time has to judge, including the budget cost, plan cost and actual cost. The second is the cost relationship, including landscaping project fixed costs and change costs. In this article, from the perspective of convenience of presentation, the cost of the above two dimensions under the integration, unified as direct costs and indirect costs categories. Among them, the direct cost of landscaping project includes rehabilitation process based on engineering entities direct consumption and the formation of various costs, such as labor costs, material costs, equipment costs, transportation costs, maintenance costs and etc. Such costs are the focus of the construction cost control. The indirect cost mainly includes the invisible cost of project construction preparation, organization, contact and management.

Landscaping works as a branch of construction engineering, construction cost control steps and the same building works:

1. Prior control, based on the specific project plan of preparation foundation, the implementation of the target management and responsibility to implement, to avoid the phenomenon or factors that may cause the cost of over budget.
2. Things in control, based on the side of the implementation, statistics, the adjustment method, through the stage audit implementation.
3. Post-event control: after the completion of the project, through the formation of the full cost of a comprehensive accounting, if there is a large amount of actual costs over budget costs (savings or overruns), we need to analyze the reasons, sum up the experience, to further pursue personal or related departments responsibility, put forward remedial measures, the accumulation of cost control experience.

2.2. Construction period analysis of rehabilitation works

The special point of the rehabilitation project is that, under the premise of the existence of the original project, we need to effectively deal with the inherent part of the construction object, in order to expand the actual construction of the rehabilitation, which means that a considerable part of the duration is invalid. For example, the original landscaping project to clean up useless parts, repair damaged parts, the need to retain part of the circumvention. Which showed the characteristics of landscape restoration works: comprehensive and strong. It is not only different from the general construction projects, construction and installation can be carried out directly; also different from the new landscaping projects, can be directly soil, vegetation, landscape and other projects. In other words, the impact of the construction period includes the following three aspects \([12, 13]\).

First, the climate factor. Although the landscape restoration project includes a lot of artificial landscape, but the restoration of the main body is green vegetation, flowers, turf, trees and other life as a body, its survival, and growth are directly affected by the climate. Restoration project is not only to protect the proper placement of green vegetation in the construction process, the smooth survival, but also to protect the ecological regulation, improve the role of the environment throughout the project life cycle, so green vegetation not only related to the entire project cycle, but also related to the project cost sum, such as the rainy season, dry season. It is not suitable for the construction of the out-of-season vegetation.

Second, engineering changes. Compared to conventional construction projects, landscaping project is artificial + natural complex, which contains a large number of artistic considerations standards, and from the perspective of human cognitive differences, resulting in the probability of engineering changes
are relatively high. Especially in the reconstruction project, we also consider the new landscaping design part, and the original landscaping project theme is consistent with the surrounding environment is fusion, and the development of the times is commensurate with, in addition to the design side, the owner's side of the outside, the municipal party will also seek the views of the masses. This diversity of the subject of the phenomenon of repeated debate will also affect the duration.

Third, cross construction. Rehabilitation is the main connotation of restoration construction, for some cultural sites, historical remains, we emphasize according to the original restoration, but for urban landscape engineering, rehabilitation can be understood as a shallow repetitive construction, it retains the original landscape engineering themes and concepts on the basis of further adding new functional elements, design ideas. In order to play a better urban space ecological value. As a result, repair and new two construction is bound to produce cross, for example, some of the inherent landscape restoration of construction, and some basic facilities (such as roads, electrical systems, etc.) need to be dismantled and rebuilt, inevitably interfere with each other.

2.3. Construction cost control and duration

Based on the above two parts, the construction period of the rehabilitation project has an important impact on the construction cost, and this effect is the dynamic mechanism of action. Research on its causes, we found that the direct costs of rehabilitation projects are constant, such as material costs, labor costs, equipment costs, etc. However, duration is a changing factor, when it is longer the cost of consumption is higher, otherwise - lower. Based on this, the construction cost control of Landscape Restoration Project for the duration is to seek the shortest period of time to achieve completion [14].

Based on the total cost of the rehabilitation project, the relationship between the duration can be expressed by equation (1):

\[ C = C_1 + C_2 \]  \hspace{1cm} (1)

where \( C \) – the complex project total cost; \( C_1 \) – the complex project direct cost; \( C_2 \) – the indirect cost of the complex project [1]. \( C_1 \) under the principle of constancy, once shorten the duration of the project means that the unit time direct costs will rise rapidly, but indirect costs can be significantly reduced, refers to extend the duration of the explore the problem, as shown in Fig. 1.

![Figure 1](image-url)

**Figure 1.** Schematic diagram of the relationship between construction cost control and construction period.

Direct cost input constant, in the figure showed a straight line trend, \( T_L \) point represents the starting point of the duration, \( T_0 \) represents the optimization period. Greater input at the \( T_L \) point (the starting point of the project), in line with the construction project one-time investment of the law, and indirect
costs in $T_2$ point of investment is small, with the duration of the extension of the cost of rising. Direct and indirect costs during the optimization period ($T_0$-$T_2$) can be controlled to a balanced state. They are presented as necessity cost expenditure.

3. Results and discussion

Kaifeng West Division scenic landscape rehabilitation project belongs to the scope of municipal afforestation, according to the municipal planning materials show that the project is located in the center of Kaifeng City, Henan province, originally belong to the ancillary part of the Baogong temple Scenic Area, in 2007 the north side of the Baogong temple Scenic Area "West Division Bridge" after the opening. In 2009 the West Division Scenic Area expansion, construction of a total area of about 80,000 square meters, the construction period is expected to 90 days, on the basis of the original project expansion of 25,000 square meters, the requirements to enhance the whole project garden art theme features, increase the necessary cultural landscape and modern facilities, including antique buildings, sculpture. Construction site is located in urban space, a large population density, short duration, heavy workload under the premise, must ensure traffic safety, effectively prevent construction pollution (dust, noise, etc.).

![Figure 2. West Division scenic plan.](image-url)
3.1. Preparation for construction of complex projects
First, the preparation of technical for 25,000 square meters of expansion part and the original 55,000 square meters of old parts, respectively, to provide technical support, construction units need to go through the drawings will be examined, organize professional construction personnel involved in the technical requirements, resources, such as co-ordination. Related to the plan, structural diagram, the old and new parts of the two parts of the construction layout, the construction of the various parts of the detailed drawings; preparation of construction drawings budget and construction budget, requesting signatures from all parties, requiring the signature of the parties to confirm the budget as the main basis for completion [15].

Second, the preparation of the material. Construction side to develop material specifications and standards, before entering through strict acceptance, the main materials include civil engineering materials, construction equipment and green vegetation, and so on.

Third, the preparation of personnel. According to the different construction content, labor personnel were organized into the field, as a whole requires a corresponding landscape engineering qualifications of personnel, the team overall control, subcontracting part is mainly the construction of infrastructure.

Fourth, the preparation of the site. Based on the total area of construction design and construction of the total plane, to ensure the smooth flow of roads, hydropower system is complete, so that no interference between the re-construction and the new part, the site to achieve three-way condition.

3.2. Duration guarantee mechanism
The project is expected to total duration of 90 days, the construction process of soil engineering, hydropower engineering, electrical engineering and other smooth progress. According to the schedule, vegetation planting and renovation of the presence of a large delay (7±1.5). Through the field to understand and ask the construction staff, we learned that in order to avoid excessive extension of the construction period, the construction side (project Department) to adopt the security mechanism mainly:

1. To strengthen the project design side, the construction side, the owner and the local government departments of communication, for the sudden impact of vegetation intervention factors;
2. The extension of the new approach to the road, to avoid cross-site construction and repair;
3. Unified project supervision, strict supervision of the construction team quality and quantity, during the cancellation of two construction units’ qualifications;
4. To avoid the establishment of bad weather, the natural environment of the adverse impact of emergency plans, such as the construction site drainage ditch, buried pipeline cleaning.

3.3. Optimization of construction cost control based on duration control
Take the network planning technology for the West Division scenic landscape complex construction cost control optimization, and duration as a dynamic factor, as shown in Fig. 3, outside the brackets for the normal duration and the cost of consumption, in parentheses for the shortest duration and cost of consumption (arrow unit: yuan, under the arrow position: days) [16, 17].

Figure 3 represents the planning data can be calculated separately normal duration and shortest duration under the construction cost difference, combined with Fig. 1, the goal of cost control is to protect the key line feasibility, as shown in fig. 4 and fig. 5, respectively, the normal duration and the shortest duration.

In conjunction with Fig. 4 is not difficult to see, under normal construction period need to consume 91 days, more than the expected 90 day requirements. However, according to the minimum period of the standard, the entire construction in 60 days will continue to maintain the highest intensity, is not scientific. Because in the actual construction process, we cannot maintain the construction workers, construction equipment, construction materials and other sustainable operation.

Further analysis, the cost of key routes (direct costs) is the least, in accordance with the order of ①→③→⑤→⑥→⑦, a total cost of 14,160 yuan (2047 dollars). And in the shortest period of time, in
accordance with the key line ①→②→④→⑤→⑥→⑦ of the implementation, the cost will be maximized to 21420 yuan (3096 dollars). According to the projections, the gap between the normal construction period and the minimum working period reached 31 days, the cost difference of 7260 yuan (1050 dollars). Cost control to optimize the direction, it is necessary to normal duration to minimum duration direction of transformation, to the site construction may reach the limit state.

In the specific duration of the compression process, you need to follow three basic principles:
1. The cost of minimizing the amount of increase caused by the compression duration;
2. The principle of minimizing the compression time in each compression process;
3. Under the premise of the existence of a number of key routes, compression and comparison should be launched at the same time the best mode.

![Network Plan](image1)

**Figure 3.** West Division Scenic Area Landscape rehabilitation project network plan.

![Normal Duration](image2)

**Figure 4.** Normal duration.

![Shortest Duration](image3)

**Figure 5.** Shortest duration.

In the reconstruction project, the key part of the compression should be repair works. The key work can be expressed as ①→③→⑤→⑥→⑦, where the lowest cost rate ⑥→⑦ (completion acceptance),
the cost is $\Delta C_{6-7}=60$ yuan/day, the duration compression can be expressed as $\Delta t_{6-7}=12-8=4$ days. After the four-day duration is compressed, the normal 91-day duration is compressed to (91-4)=87 days. On this basis, statistics direct costs can be expressed as $C = 14160 + 60 \times 4 = 14400$ (yuan), and the above key path has not changed.

4. Conclusion

The construction cost control of the rehabilitation project and its duration have close relationship, specific to the landscaping project level. The key to compressing the duration is to grab the important time node.

Such as the case of the West Division scenic landscape restoration project, the key path related to the early do not change easily. The reason is that the green vegetation key element in the permeability of each link is strong and in the completion acceptance part of the $\overline{6} \rightarrow \overline{7}$ can be high-strength compression, during which attention to observe the duration of the compression caused by the magnitude of changes in construction costs.

In this paper, network planning techniques are used for cost control. In addition, the life cycle theory, PDCA model and other equally applicable, according to the specific content of the rehabilitation project are used to expand the research. In the application of life cycle theory, we should consider a concrete rehabilitation project as a living body. We call each process of the project "life process", the project business contact, planning and design, construction implementation, warranty period, demolition and reconstruction of the "life process" analysis, the purpose is to minimize the cost, the entire duration of the reduction to the shortest.

So obviously, we need to use the life cycle theory to consider the factors will be more, the cycle will be longer. As in the construction phase should not only consider the economic cost of the corresponding part of the rehabilitation demolition, but also consider the cost of time and so on. And PDCA is (Plan-Do-Check-Action) loop test mode. In its application process, you can target the cost and duration of stage construction combine, after the completion of a cycle, to observe whether Beyond or below expectations, according to exceed or below expectations, make the appropriate improvements, and to avoid the corresponding error in the next round of the cycle.

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