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Analysis on the Application of Green Ecological Discharge Project Management in SK Hydropower Plant

Hongbin Chang[1], Wenting Tan[2,*]

[1]School of Artificial Intelligence, Hezhou University, Hezhou, China
[2]Water Resources Bureau of Babu District, Hezhou, China
[*]Corresponding author

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Abstract: The construction of hydropower engineering projects is a multidisciplinary and complex process. Scientific management of hydropower construction projects is an inevitable requirement for the sustainable and efficient development of enterprises. In view of the construction project of the new green ecological unit of SK Hydropower Plant, this study planned and researched management methods from the perspective of project implementation assurance. Through a field investigation and considering the actual situation of the power plant, this study preliminarily explored the project management of this project from six aspects, including project scheduling applications, building maintenance management, and safety production standardization construction. Management systems were formulated for the three, while the construction organization management, planning and control, mechanical equipment assurance, and construction quality assurance measures were discussed. Finally, the construction safety measures management was elaborated in detail from two aspects of construction safety measures and safety assurance measures. The application research of the project management described above not only ensured the quality of the entire project but also effectively improved the production schedule, laying a solid foundation for this project to become a high-quality endeavor. This research has certain theoretical and practical significance and can provide useful references for the management of other hydropower engineering projects.

1. Introduction

The SK Power Plant Reservoir Project, located in W City, is a large-scale type II water conservancy hub primarily dedicated to flood control and irrigation, with secondary objectives of water supply, power generation, fishery, and tourism. A green ecological unit was recently constructed downstream in the auxiliary plant building beneath the SK hydropower station's spiral case. This unit utilizes an 800 mm diameter steel pipe to produce hydropower from diverted water. During the dry season when the river water level is low and hydropower generation at the original station is not feasible, the newly built ecological unit will operate 24 hours a day from September of one year to April of the next, naturally generating a downstream ecological flow. This ensures that there is adequate water supply for the ecological conservation mandate of the hydropower plant in a stable and sustainable manner. Such a mechanism of maximal ecological outflow eases the water deprivation in the downstream

river segment and supports preservation of the vast wetland resources, including diverse flora and fauna, on both sides of the river over tens of thousands of square kilometers. This project holds monumental significance, as it increases the utilization efficiency of clean energy and pushes forward the comprehensive advancement of ecological civilization. Original hydroelectricity plant authorities oversee and organize the project's ecological water release plans, as depicted in Figure 1, depicting the project's engineering management architecture [1].

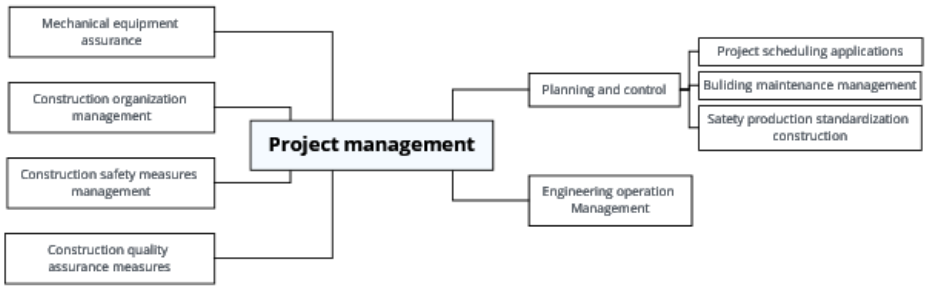

Figure 1: Project management framework.

2. Project Operation Management

2.1. Project Scheduling Applications

After the primary flood season in the reservoir, from September of the preceding year to April of the succeeding year, the No. 1 and No. 2 principal generator units of the hydropower station are idle, and the green ecological unit operates during the shutdown period of these primary units. The ecological unit generates power between September of the preceding year and April of the succeeding year, for at least six months each year. The interruption of the principal generators means that the water from the reservoir can no longer flow downstream [2]. As a result, ecological flow needs to be discharged, otherwise it would be wasted. Fortunately, the ecological unit established by Shankou hydropower plant operates 24 hours a day, naturally producing ecological flow and releasing it into the river. It ensures that ecological water use of the downstream satisfies the hydropower plant's ecological protection functions while facilitating the discharge of ecological flow to the maximum extent possible. This measure helps safeguard humid resources and wildlife, covering nearly 100,000 square kilometers of wetlands and the river banks of the dehydrated segment.

In the event of consecutive or heavy floodwaters, while ensuring the safety of the dam and minimizing flood damage downstream, a rational discharge plan must be devised based on precise water conditions forecasted. In light of the stored water volume and meteorological projections, a scheduling plan must be formulated and adjusted as necessary to satisfy irrigation and urban water supply requirements while maximizing benefits. The scheduling plan for each year's flood period must be determined in accordance with requirements from superior flood prevention departments and flood predictions [3]. Post-flooding, the timely accumulation of water ensures both the safety of the project and the full use of the reservoir's intended function.

2.2. Building Maintenance Management

(1) In addition to inspecting the power plant, the ecological unit should be regularly checked, observed, and maintained. Any issues should be dealt with promptly. Scientific management should be carried out for monitoring and protection equipment, and data should be collected and stored to be analyzed and summarized in combination with changes in the ecological environment to make

appropriate adjustments.

(2) Water diversion system management should ensure that the trash racks at the intake are cleaned in a timely manner, and the intake gates and their opening and closing devices are inspected regularly. The power generation water diversion tunnel should be regularly purged and cleaned of debris and undergo maintenance.

(3) Power plant management should conduct regular equipment maintenance and repair, and unit overhauls can be assigned to relevant professional units. Management personnel should be familiar with the relevant information regarding the design, construction, and operation of the engineering project. Dynamic tracking of project buildings, equipment, and other related matters should be carried out regularly, and hydrological forecasting should be done to establish and perfect various files. This maximizes the economic benefits of the project.

2.3 Safety Production Standardization Construction

Based on the notification documents from relevant national departments, the SK hydropower plant strictly adheres to safety production regulations and technical standards. The hydropower plant guarantees safety investment, regulates operation management, strengthens education and training, and gradually promotes the safety production standardization construction of the hydropower plant to ensure its safety management meets the standard. In order to ensure that the hydropower plant completes its safety production standardization construction as soon as possible and meets safety management standards, the hydropower plant should develop and implement plans in the following areas: safety production targets, organizational structure and responsibilities, safety production investment, laws and regulations and safety management systems, education and training, production equipment and facilities, work safety, hidden danger investigation and remediation, major hazard monitoring, occupational health, emergency rescue, accident investigation and handling, performance assessment, and continuous improvement. The implementation of safety production standardization construction is divided into two stages: planning stage and implementation stage.

3. Construction Organization Management

To begin with, the SK hydropower plant green ecological discharge project department will be established at the construction site, where experienced professional construction teams will be organized to form the operational layer for the entire project implementation. The project management structure will be established and perfected, with the clear definition of the responsibilities of each department and position. Thought-political work and logistical support will be intensified at the construction site.

Subsequently, target management will be implemented during the construction process, and good economic contracting will be achieved through task, duration, safety, quality, and environmental protection. Policies will be enforced, and incentives and penalties will be implemented to increase the enthusiasm, initiative, and creativity of all employees.

Finally, extensive “labor competitions” and “mobile red-flag equipment competitions” will be carried out to inspire the labor passion of employees and improve labor efficiency. A substantial reward will be bestowed on those who complete the task ahead of time, while a heavy penalty will be imposed on those who are unable to complete the task on time. Those who continually fail to complete tasks adequately will be removed from their position. Figure 2 illustrates the construction technology assurance flowchart [4].

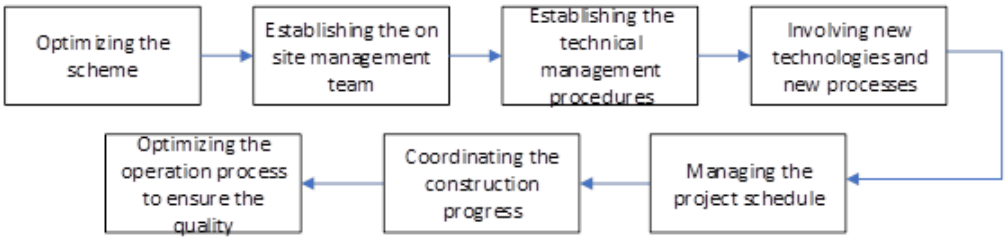

Figure 2: Flowchart of construction technology assurance

4. Planning and Control

To ensure project success, the "demanding timetable on critical routes and efficiency on non-critical routes" approach will be adopted. For each sub-project and process on critical routes, dynamic management will be implemented. Strong organizational, technical, administrative, and economic measures will be taken to ensure that deadlines are met, and delays are not allowed.

Under the control of the overall schedule plan and special project plan, monthly work plans will be established, and weekly and daily implementation plans will be developed by teams and groups. All work will be under strict plan control [5]. A monthly, weekly, and daily progress meeting system will be established to check project progress and plan execution, analyze potential issues that may impact the project's progress, and make sufficient preparation in all aspects such as drawings submission, material equipment access, weather conditions, design changes, and personnel changes to avoid any foreseen unnecessary shutdowns and delays.

In the event of construction progress delays due to foreseeable difficulties or factors, an acceleration plan will be immediately put in place. Through control of the daily plan to ensure the weekly plan, control of the weekly plan to ensure the monthly plan, project milestone and total project duration can be fully achieved.

5. Mechanical Equipment Assurance

To ensure timely availability of the required construction equipment and maximize its utility, proactive measures will be taken across the organization for machinery maintenance and repair. Once equipment is available according to plan, an adequate quantity of high-performance and properly matched construction equipment will be arranged based on the construction schedule, with suitable allowances made for unexpected circumstances.

An optimal system for machinery maintenance and repair will be established at construction sites to ensure maximum effectiveness of equipment [6]. Mandatory equipment maintenance will be conducted during construction to maintain equipment functionality and ensure operational efficiency.

6. Construction Quality Assurance Measures

To achieve the quality commitment, mandatory clauses and quality management system documents will be formulated. Technical management and quality management will be strengthened, and practical and effective measures will be taken to continuously improve the construction management level [7]. Adequate manpower, materials, and financial resources will be allocated to ensure project progress and project quality. A Quality Management and Continuous Improvement Leadership Group will be established. A quality veto system and verification and acceptance system will be implemented, along with regular quality tracking inspections. Relevant technical standards and requirements will be strictly enforced during the construction process. A comprehensive set of

quality responsibility systems will be established, emphasizing individual responsibility at all levels, from materials sourcing to every stage of the construction process. Various measures and policies, including organizational measures, technical measures, quality measures, and data measures, will be developed to further strengthen quality management and ensure the achievement of quality goals.

7. Construction Safety Measures Management

The safety construction objective of the project is to strictly follow the safety guidelines of "safety first and prevention as a priority", establish a safety guarantee system, formulate safety management methods, establish safety production responsibility systems, implement a zero safety accident management objective, and ensure that all accident rates are below industry standards, thereby striving to become a leading safety project management unit [8].

A safety management system, led directly by the project manager, will be established to ensure comprehensive management of construction safety, traffic safety, fire prevention, theft prevention, and poison prevention within the project scope. The project manager will serve as the primary person in charge of safety production and implement national laws and regulations related to safety production.

7.1 Main Construction Safety Measures

1) General safety requirements:

(1) Personnel entering construction sites must wear appropriate safety gear and use necessary safety equipment, in accordance with safety management regulations. All individuals must understand relevant safety operation rules and strictly adhere to their work responsibilities while sober.

(2) All facilities and pipelines within the construction site must comply with anti-flooding, fire prevention, anti-smashing, anti-wind, industrial hygiene, and environmental protection requirements. Material storage should be safe, reliable, orderly and unobstructed.

(3) Traffic must be kept clear and traffic personnel should be designated to control heavily trafficked crossroads and hazardous areas. Traffic signals and warning signs should be installed when necessary.

2) Excavation safety measures:

(1) Prior to commencing excavation work, all floating rocks and debris within a radius of at least 5 meters outside the design borderline should be cleared away. If necessary, a water collection trench and safety protective fence should be installed [9].

(2) Excavation should be carried out from top to bottom for all sloped surfaces, embankments, and ditch excavations beyond the opening line. For deeper excavation heights of the slope (wall), slope clearing, measurements, and inspection should be performed every 5 meters. For adverse geological structures such as faults, cracks, and fragmentation zones, timely reinforcement or protection should be carried out according to the design requirements to prevent the formation of high slopes before excavation.

(3) All machinery within the construction site must be managed and coordinated by one designated person to ensure safe production during mechanical joint operations.

7.2 Safety Assurance Measures

(1) We should strictly adhere to relevant national and local safety production laws, regulations, and directives while establishing a safety post responsibility system. We should develop safety production regulations for each work surface and process in accordance with the *Technical Work Manual for Water Conservancy Engineering Construction and Installation* [10].

(2) We should safely conduct annual quality and safety month activities, monthly safety production inspections, weekly safety days, and pre-shift safety talks while assigning production tasks.

(3) We should strengthen the management system for the production, transportation, storage, and use of flammable and explosive dangerous goods. We should strengthen measures to prevent fires, provide first aid, send alerts, use electricity safely, guard against lightning strikes, and implement inspection and management work. Adequate safety firefighting equipment and tools should be provided.

(4) All electrical equipment and buildings that are susceptible to electric shock or lightning strikes should be equipped with grounding or lightning protection devices. Practical flood control and emergency measures should be implemented during the rainy season. Sufficient lighting conditions as per regulations should be provided in construction work areas.

8. Conclusion

In conclusion, project management plays a crucial role in hydroelectric power plant construction. It is not only related to production progress but also tied to the overall project quality. By analyzing management tasks, setting objectives, and establishing management teams, effective supervision and assessment can be carried out to ensure that hydroelectric projects are completed on time and of high quality. In the future, it is necessary to apply information technology to safety management to achieve the informationization of project management in the hydroelectric industry.

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