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Project Management Strategies in the Construction of Photovoltaic Power Plants

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Abstract: Photovoltaic power plant project management is a complex and difficult task that requires various aspects such as project management, technical research, equipment procurement, installation and commissioning. At the same time, China's photovoltaic power station projects also face problems such as poor construction environment, unstable equipment quality, and fast technological updates. This article combines the actual situation of photovoltaic power station project management and conducts in-depth research on how to apply project management to the construction of photovoltaic power station projects. With specific examples, it elaborates on the implementation effect of efficient management strategy in engineering construction. Meanwhile, this article can also optimize and improve existing debugging techniques, provide corresponding improvement measures, and evaluate their role in improving project efficiency and quality. The cost before the design phase experiment is 1.2 million yuan, and the cost after the experiment is 1.05 million yuan, with a cost reduction ratio of 0.143 yuan; the cost before the procurement phase experiment is 2.5 million yuan, and the cost after the experiment is 2.3 million yuan. The cost reduction ratio is 0.087. The research value of this article mainly lies in the empirical analysis and optimization of the project management system for photovoltaic power station engineering.

1. Introduction

Photovoltaic power plants have become a focus of attention for countries around the world. However, with the continuous increase in engineering scale and the rapid development of technology, traditional engineering management models have encountered many new problems, such as insufficient cost control, delayed construction period, and improper resource allocation. This article explores how to more effectively manage photovoltaic power station projects based on internationally advanced engineering management theories and practices. By utilizing advanced management methods and techniques, it can improve the efficiency of project implementation, ensure project quality and progress, and provide support for the sustainable development of the photovoltaic industry.

This article takes the construction project management strategy of photovoltaic power plants as the research object, and explores and verifies the applicability and effectiveness of different types of project management methods. Firstly, this article reviews the relevant theories of photovoltaic

power station project management and analyzes some common problems that arise during the engineering construction process. On this basis, typical photovoltaic power station engineering cases are selected, and qualitative and quantitative analysis methods are used to collect and analyze relevant information, identifying key factors that affect the operational performance of photovoltaic power station projects. Then, various patterns and tools were applied, such as agile project management, and applied to selected engineering projects. In this process, it is necessary to supervise the implementation of various management measures and evaluate their effectiveness after implementation.

2. Related Work

Photovoltaic power plants are a renewable new energy source with advantages such as low pollution and low noise. They are an important way to promote China's energy structure transformation and achieve green and low-carbon development. Ma Yitao studied new technologies for multi-source reactive voltage control in photovoltaic power plants [1]. Zhu Huimin provided a virtual synchronous generator control strategy and analysis for photovoltaic power plants with energy storage links [2]. Li Tong explored the reactive power optimization method for time-varying tracking of the maximum output power of grid connected photovoltaic power plants [3]. Sun Mingwei explored the design management of pumped storage power station construction projects [4]. Ghodbane M conducted an optical numerical study on parabolic trough solar collectors for solar power plants [5]. Elazab O S explored the optimal control scheme for improving grid connected photovoltaic power plants and conducted design and experimental verification [6]. Ding W studied the research and development progress of molten salt technology for next-generation centralized solar power plants [7]. Di Lorenzo G explored solutions for photovoltaic power plant operation and maintenance faults, remote control, and monitoring tools [8]. Shakya S proposed a self-monitoring and analysis system for solar power plants using IoT and data mining algorithms [9]. Sohani A explored renewable energy recovery solutions for photovoltaic power plant systems through water flow cooling [10]. But their research lacks project management strategies.

Appropriate engineering management methods can greatly increase the probability of project success. Practice has proven that research on risk management, quality control, resource allocation, and other aspects of photovoltaic power station projects can effectively solve various problems faced by photovoltaic power station projects. However, this approach has certain limitations in practical application, such as being unable to adapt to different types of engineering. The research objective of this article is to solve the common problems in the construction of photovoltaic power station projects through a systematic project management approach, in order to achieve the optimization of overall project performance. This article intends to use methods such as field research and expert interviews to empirically analyze the problems existing in the implementation process of photovoltaic power station projects, and make targeted improvements, in order to provide theoretical basis and technical support for the sustainable development of China's photovoltaic industry. The research results show that adopting reasonable engineering management strategies can effectively improve the management quality and economic benefits of photovoltaic power station projects. The main result is increased cost savings, shortened project completion time, and increased investment returns. In addition, this study also noted that although advanced project management methods and techniques can generate significant benefits, in order to smoothly implement them, an effective support system and corporate culture adaptation mechanism must be in place.

3. Method

3.1 Organizational Structure Optimization

Photovoltaic power plants are the most important new energy source in the world, and their construction and use are increasing. In order to ensure the successful implementation of photovoltaic power station projects, it is necessary to optimize the project management strategy to ensure the quality and cost of the project. The article conducts research on photovoltaic power station construction projects from multiple perspectives.

In order to improve the effectiveness of decision-making and quick responsiveness, it is necessary to readjust the structure of the project team. On this basis, by dividing the responsibilities of each functional module in the project team, it is ensured that effective collaboration can be carried out between each functional module, optimizing business processes, and improving the efficiency of cross departmental collaboration. Adopting a flexible project management structure helps to better meet the complexity and variability of the project.

Scientific planning and adequate preparation are necessary for the successful implementation of photovoltaic power station projects. In the early stages of the project, an in-depth survey of the region's energy demand, policy environment and technology trends should be conducted. Careful consideration needs to be given to the location of the site during the planning and construction process. In addition, the objectives, tasks, timeframe and budget of the project should be refined to provide some guidance on the implementation of the project.

3.2 Cost Control Mechanism

In project cost management, the use of advanced data analysis tools can achieve real-time monitoring and prediction of project cost. The system assists project managers in effectively regulating cash flow and preventing costs from exceeding budgets. Expense control includes strict budget management provisions so that expense efficiencies can be tracked on an ongoing basis. In the construction process of photovoltaic power plant project, cost management is a very important part. From the point of view of reducing the cost of the project, the materials and equipment selected should be reasonably selected at the design stage, and products with high performance-price ratio and stable performance should be chosen. In the construction of the project, it is necessary to strictly control the cost, at the same time, optimize the construction procedures and improve the construction efficiency in order to achieve the purpose of saving investment.

Adopting agile project management is a flexible and iterative approach, particularly suitable for project environments that require rapid change. Agile project management emphasizes the cycle of short-term planning and feedback, allowing project teams to quickly adjust the environment and continuously improve productivity. In addition, to ensure the timely completion of the project, regular progress inspection and adjustment meetings need to be held.

In engineering construction, quality management is a very important link. The construction quality of photovoltaic power plants has a significant impact on the power generation efficiency and operating life of the entire system. Therefore, it is necessary to establish a rigorous quality management system to ensure effective quality control at every stage of engineering construction. At the same time, it is necessary to strengthen the supervision and management of construction sites, conduct regular inspections and evaluations of project quality, and promptly identify and correct any problems that arise.

Security management cannot be ignored. The construction of photovoltaic power plants involves a large number of high-risk operations such as high-altitude operations and electrical operations. Any slight negligence can cause significant safety accidents. To this end, it is necessary to establish

a sound safety management system, formulate a sound safety management system and operation standards. On this basis, it should also increase safety education and training for migrant workers, enhance their safety awareness and technical level. During the construction period, safety supervision can be strengthened to ensure the implementation of safety measures.

3.3 Quality Assurance Procedures

A quality control system that can implement international standards to ensure that products meet international quality standards. Through regular quality audits, not only can quality issues be identified and discovered, but it can also enhance the understanding of quality among project personnel. In addition, quality assurance also includes a complete stakeholder engagement and a feedback mechanism to ensure that all stakeholders reach consensus on quality standards. In addition, coordination and communication should also be paid attention to during the construction process of photovoltaic power station projects. It can strengthen communication and cooperation with government departments, property owners, construction and other parties to ensure that the interests of all parties can be reasonably balanced. At the same time, it is necessary to establish a sound information exchange system to ensure timely communication and feedback of project information, and provide strong support for the smooth implementation of the project.

Resource optimization formula:

$$Z = c^T x \tag{1}$$

Here, Z represents project cost, x is decision variable (such as manpower, equipment usage time, etc.), and c is cost coefficient.

3.4 Risk Assessment and Mitigation

A comprehensive risk management framework can be established that combines quality and quantity approaches. By systematically identifying potential risks in the project and designing corresponding countermeasures for different risks, the uncertainty and potential losses of the project can be reduced. In addition, the company also needs to regularly hold risk review meetings to ensure the effective implementation of risk control measures and timely adjust strategies.

On this basis, it can vigorously develop intelligent design and construction methods based on BIM (Building Information Modeling) [11]. BIM technology can not only improve the accuracy of design, but also predict and handle potential problems by simulating every step of the construction process. In addition, utilizing the latest information and software can increase the transparency and accessibility of data, thereby improving the quality and speed of decision-making [12].

4. Results and Discussion

4.1 Cost Control Effect Experiment

The research objective is to verify whether the new cost control strategy can reduce engineering costs and prevent exceeding the budget.

The research method involves comparing engineering cost data with pre - and post experimental data, and comparing engineering cost control methods.

During the design phase of this article, the pre experiment cost was 1.2 million yuan, and the post experiment cost was 1.05 million yuan, with a cost reduction ratio of 0.143%; The cost before the procurement phase experiment was 2.5 million yuan, and the cost after the experiment was 2.3 million yuan, with a cost reduction ratio of 0.087. The experimental results of cost control effect are

shown in Figure 1.

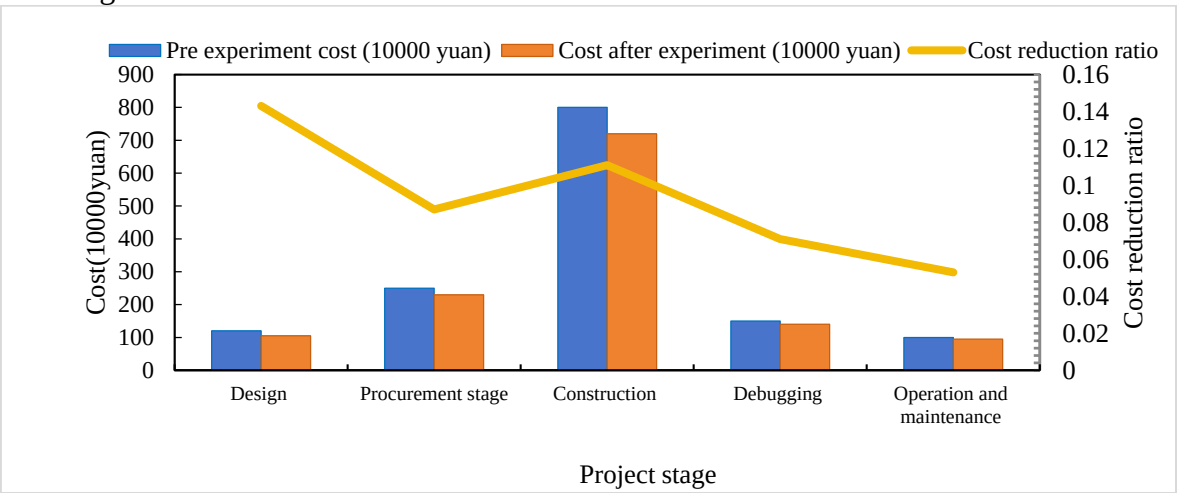

Figure 1: Experimental results of cost control effect

4.2 Progress Management Effect Experiment

The research objective is to evaluate the role of schedule management tools in completing projects on time.

The research method is to implement a new engineering schedule management strategy, conduct regular inspections of important milestones in the project, and compare them with the actual completion time. The experimental results of progress management are shown in Table 1. The percentage deviation of geological exploration progress is 2.00%, the percentage deviation of preliminary design progress is 0.00%, and the percentage deviation of electrical equipment installation progress is -0.67%.

Table 1: Progress Management Effect Experiment

Milestone node	Planned completion time	Actual completion time	Time difference (days)	Progress deviation percentage
Geologic survey	2023-03-15	2023-03-18	+3	2.00%
Preliminary design	2023-04-05	2023-04-05	0	0.00%
Construction documents design	2023-05-10	2023-05-08	-2	-1.33%
Equipment procurement/purchasing	2023-06-15	2023-06-20	+5	3.33%
Main body construction	2023-07-30	2023-07-30	0	0.00%
Electrical equipment installation	2023-08-30	2023-08-28	-2	-0.67%
Debugging operation	2023-09-20	2023-09-22	+2	1.00%
Project acceptance	2023-10-10	2023-10-10	0	0.00%

4.3 Quality Control Effect Experiment

The research objective is to verify whether quality management actions can improve the overall quality level of the project.

The research method is to compare and analyze the changes before and after quality control by referring to the control method and quality control method.

The experimental results of quality control effectiveness are shown in Figure 2. The equipment qualification rate is in the top 95% of quality control, and after quality control, it is 98%; The qualification rate of the construction process is 92% before quality control, and 97% after quality control.

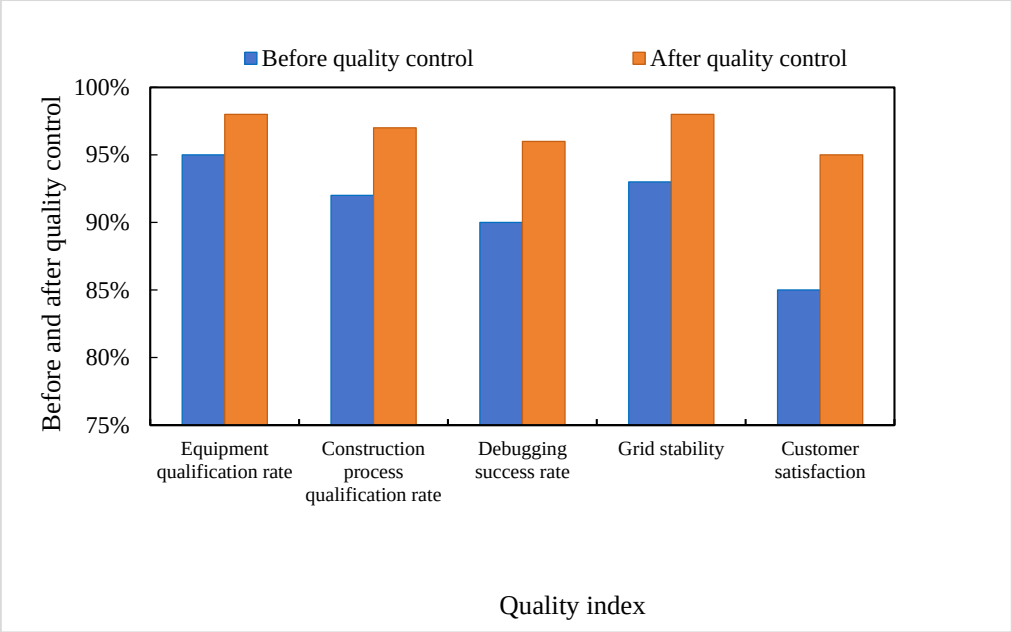

Figure 2: Experimental results of quality control effect

5. Conclusions

The focus of this article is on how to improve the management efficiency and benefits of photovoltaic power station engineering. On this basis, in-depth discussions were conducted on engineering cost, schedule, quality assurance, and risk control. This article uses various methods to empirically analyze photovoltaic power station projects. Research has found that using modern information technology tools such as engineering management software to explore the implementation process of engineering can effectively improve the transparency and effectiveness of engineering implementation. In addition, developing targeted training plans to improve the professional quality of employees is also an important guarantee for ensuring project success. This article adopts a systematic project management process to validate the structured project management process, which maximizes resource allocation and time management, thereby improving project performance and sustainability. This article can further expand to larger regions and large-scale photovoltaic power plants to test the universality of this method. In future research, it is necessary to introduce environmental factors into engineering management to promote continuous innovation and development of the photovoltaic industry.

References

[1] Ma Yitao. Research on new technology of multi-source reactive power voltage control for photovoltaic power plants. Communication power technology, 2023, 40(1):90-92.
[2] Zhu Huimin, Yuan Shun, Li Chunlai. Control strategy and analysis of virtual synchronous generator of photovoltaic power station with energy storage link. Electrical measurement and instrumentation, 2023, 60(5):45-50.
[3] Li Tong, Han Xueshan. Reactive power optimization method for time-varying tracking of the maximum output power of grid-connected photovoltaic power plants. Journal of Electrotechnical Technology, 2023, 38(11):2921-2931.
[4] Sun Mingwei. Research on the design and management of pumped storage power station construction project. Engineering technology research, 2023, 5(1):100-102.
[5] Ghodbane M, Boumeddane B, Hussein A, et al. Optical numerical investigation of a solar power plant of parabolic trough collectors. Journal of Thermal Engineering, 2021, 7(3): 550-569.
[6] Elazab O S, Debouza M, Hasanien H M, et al. Salp swarm algorithm-based optimal control scheme for LVRT capability improvement of grid-connected photovoltaic power plants: design and experimental validation. IET Renewable Power Generation, 2020, 14(4): 591-599.
[7] Ding W, Bauer T. Progress in research and development of molten chloride salt technology for next generation concentrated solar power plants. Engineering, 2021, 7(3): 334-347.
[8] Di Lorenzo G, Araneo R, Mitolo M, et al. Review of O&M practices in PV plants: Failures, solutions, remote control, and monitoring tools. IEEE Journal of Photovoltaics, 2020, 10(4): 914-926.
[9] Shakya S. A self-monitoring and analyzing system for solar power station using IoT and data mining algorithms. Journal of Soft Computing Paradigm, 2021, 3(2): 96-109.
[10] Sohani A, Shahverdian M H, Sayyaadi H, et al. Enhancing the renewable energy payback period of a photovoltaic power generation system by water flow cooling. International Journal of Solar Thermal Vacuum Engineering, 2021, 3(1): 73-85.
[11] Daikun W, Qi F, Shuaishuai C. Research of BIM Technology in Urban Rail Operation and Maintenance and Application. International Equipment Engineering and Management: English Version, 2023, 28(3):180-192.
[12] Vanrun Verman. Random Power Flow Calculation of Distribution System based on Distributed Generation. Distributed Processing System, 2020, 1(1): 17-24.