Planning and optimization of oilfield surface construction engineering scheme based on cyclic neural network

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Abstract. In order to solve the problems of high oil and gas gathering energy consumption and construction cost and poor efficiency after the application of oilfield surface construction engineering scheme planning, this paper studies an optimization method of oilfield surface construction engineering scheme planning based on cyclic neural network. Firstly, determine the objective function of the optimization of the oilfield surface construction scheme, set the constraint conditions of the optimization model, thus complete the design of the optimization method of the scheme based on the circular neural network. The experimental results show that the design method in this paper can effectively reduce the construction cost of oil field surface engineering and oil and gas gathering and transmission consumption, improve the construction efficiency of oil field surface engineering, the optimized total cost is 104.663 million yuan, the minimum oil and gas gathering and transmission consumption is 6.9 MWh, and the construction time is only 67.2 days, which has certain application value.

Keywords: Recurrent neural network; intelligent algorithm; oil field ground construction; construction engineering scheme and optimization

1 Introduction

Oilfield surface engineering is a subsystem in the large system of oil and gas field development and production, and a necessary link in oil and gas development and production. It is an important aspect to realize efficient development, reflect the development effect and economic and technical level, and is an important means to reduce the cost of investment control and improve the development efficiency[1]. In order to maximize the benefits of oilfield projects, it is urgent to study the planning scheme of oilfield surface construction engineering scheme, so as to better meet the social demand for oil and gas and improve the feasibility of oilfield surface construction engineering scheme planning.

Reference [2] puts forward the rational planning and arrangement of construction project optimization scheme, and further realizes the project objectives by standardizing the budget scope, planning and scheduling time and cost. Reference [3] puts forward a risk management planning scheme in construction projects, which implements, records and monitors risk management activities based on the whole life

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cycle of the project, and provides risk managers with templates and practices for recording and determining risk priorities. Reference [4] puts forward a plan for planning, progress and delay analysis of construction projects, specifies the availability of resources, external factors, performance of all parties and structural types, and provides control measures for overdue in the project. Reference [5] puts forward the planning scheme of construction and urban project management, connecting the project objectives, scope, time and other resources, promoting knowledge decision-making, reducing project losses and improving project quality.

The recurrent neural network (RNN) is a kind of recurrent neural network which takes sequence data as input, recurs in the evolution direction of the sequence, and all nodes (circulating units) are connected in chain. It has the characteristics of memory, parameter sharing and Turing completeness, so it has certain advantages in data learning optimization. Oil field surface construction projects usually include multiple links and stages, involving time-related data and decision-making, such as geological exploration, drilling, production operation, etc. RNN is a neural network model suitable for processing sequence data, which can naturally capture the time dependence. In the oilfield surface construction project, different projects may have different lengths and time spans. RNN can flexibly handle the input with different lengths and keep the sequence information. Therefore, this paper introduces RNN into the oil field, and designs an optimization method of oil field surface construction project plan based on cyclic neural network.

2 Optimization method design of oilfield surface construction engineering scheme

2.1 Objective function of optimization of oilfield surface construction engineering scheme

An optimization objective function is established with energy consumption, construction cost, and construction efficiency as the optimization objectives[6] for oil and gas gathering and transportation. Firstly, assuming variable $k_{ij}(i=1,2,3...,n; j=1,2,3...,m)$, the optimization objective function can be obtained in formulas (1) - (3):

$$\int_1 = \min G = \sum_{i=1}^{n}\sum_{j=1}^{m} G_{ij}k_{ij} \tag{1}$$

$$\int_2 = \min E = \sum_{i=1}^{n}\sum_{j=1}^{m} E_{ij}k_{ij} \tag{2}$$

$$\int_3 = \max Q = \sum_{i=1}^{n}\sum_{j=1}^{m} Q_{ij}k_{ij} \tag{3}$$

In formulas (1) - (3), i represents the construction process of oilfield surface construction engineering; j is the amount of machinery used in oilfield surface construction projects[7]; G_{ij} represents the energy consumption of oil and gas gathering and transportation in oilfield surface construction projects; E_{ij} represents the construction cost of oilfield surface construction projects; Q_{ij} represents the efficiency of oilfield surface construction engineering construction.

2.2 Constraints for optimization of oilfield surface construction engineering scheme

$$P_{\min} \le P \le P_{\max} \tag{4}$$

$$E_{\min} \le E \le E_{\max} \tag{5}$$

$$Q_{\min} \le Q \le Q_{\max} \tag{6}$$

In formulas (4) - (6), $P_{\min}$ and $P_{\max}$ represent the minimum and maximum allowable energy consumption for oil and gas gathering and transportation in oilfield surface construction projects, respectively; $E_{\min}$ and $E_{\max}$ are the minimum and maximum allowable construction costs for oilfield surface construction projects, respectively, to measure the economic benefits of oilfield surface construction projects; $Q_{\min}$ and $Q_{\max}$ are the minimum and maximum allowable construction periods for oilfield surface construction projects, respectively.

2.3 Planning and optimization of oilfield surface construction project scheme

This paper uses the circular neural network to solve the optimization model of oilfield surface construction engineering scheme[8-9]. The construct structure of the recurrent neural network is shown in Figure 1.

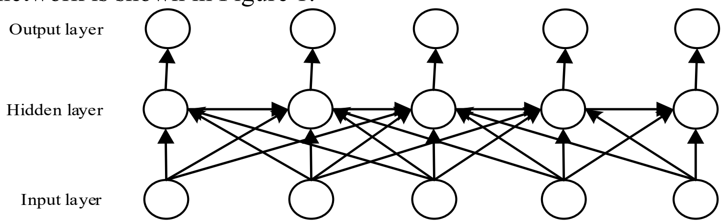

Fig. 1. Structure diagram of the recurrent neural network

As can be seen from Figure 1, the recurrent neural network constructed in this paper mainly consists of three parts, namely, the input layer, the hidden layer, and the output layer. The operation rule is to feedback the calculation results of the initial input to the recurrent neural networkIn theLearning training [10]. The input layer is responsible for receiving original data, including geological exploration results, engineering budget, equipment performance parameters, environmental factors, etc. The input layer converts these data into a digital format that can be processed by the neural network and inputs them into the network as initial information. The hidden layer is the core part of the recurrent neural network, which contains a series of neurons, which process and integrate the input information through weights and offsets. In the hidden layer, information will be transmitted between different time steps, forming a circular structure.The output layer is responsible for transforming the output of the hidden layer into the final planning scheme, including a series of parameters, such as project layout, equipment configuration, construction sequence, etc. During the whole cycle, RNN optimizes its performance by constantly adjusting the weights and offset values. Through continuous learning and adjustment, RNN can gradually improve the accuracy and efficiency of its plan for oilfield ground construction projects.

3 Comparative analysis of the experiments

Taking an oil field surface construction project as the research object of this test, the effectiveness of this method is verified. Literature [4] method and literature [5] method are selected as the comparison methods of this experiment. The oilfield ground construction project selected for this experiment needs to be designed including substation, power station, oil and gas treatment area, tank area, LPG production and storage area, central control room, produced water treatment and water injection area and other ground system supporting works. The construction site is shown in Figure 2:

Fig. 2. Site drawing of oilfield surface construction project

3.1 Comparison results of construction efficiency of oilfield surface engineering

The comparison results of the construction efficiency of oilfield surface engineering are shown in Table 1.

Table 1. Comparison results of construction efficiency after optimization of oilfield surface engineering construction scheme planning

Domain	Design method / days	Document [4] method / days	Document [5] method / days
Converting station	10.4	12.5	11.8
Power station	8.2	9.6	9.0
Oil and gas treatment area	7.9	9.3	8.8
Storage area	6.4	9.5	8.1
The LPG production, storage and transportation area	8.6	10.3	9.5
Central control room	5.2	8.5	6.8
Production water treatment and water injection area	7.7	10.2	9.4
Other ground system supporting works	12.8	14.5	14.1

According to the data presented in Table 1, In the different functional areas, Different construction efficiency of different methods, However, no matter in the construction process of substation, power station, oil and gas treatment area, tank area, LPG production and storage area, central control room, produced water treatment and water injection area and other supporting projects of the ground system, this is because the method in this paper considers the factors such as resource utilization rate, production efficiency and investment cost, and determines the objective function of oil field surface construction project planning optimization. By reasonably designing the objective function and matching it with appropriate weights, the optimal construction scheme can be found more accurately and the overall construction time can be shortened.

3.2 Economic Comparison Results of Oilfield Surface Engineering Construction

In order to further verify the effectiveness of the design method, the cost of materials, machinery, measure items, labor, subcontracted, management and total costs, and the calculation results are shown in Table 2.

Table 2. Cost comparison results of optimized oilfield surface engineering construction plan planning

Table 2 Cost comparison results of optimized oilfield surface engineering construction plan planningproject name	Design method / ten thousand yuan	Literature [4] method / ten thousand yuan	Literature [5] method / ten thousand yuan

material cost	5325.0	6319.8	6941.3
Mechanical costs	706.8	791.4	816.9
Measures for project costs	1136.7	1216.6	1239.7
expenses of labour	1089.7	1120.7	1189.6
Subcontract fee	2018.4	2217.3	2287.6
general expenses	189.7	219.7	289.2

From Table 2, compared with the [4] and [5] methods, the design method has the lowest material costs, mechanical costs, labor costs. This is because when the method in this paper sets the constraint conditions for the optimization of the oil field surface construction project plan, it fully considers the restrictions and control requirements of various expenses. By reasonably setting the constraints of parameters such as material cost, machinery cost and labor cost, these costs are kept within a reasonable range in the optimization process, avoiding unnecessary waste and excessive investment, thus reducing the total cost. Therefore, this method can ensure that the cost can be saved to the greatest extent under the premise of meeting the requirements of quality and time limit, and the various expenses can be weighed and adjusted, so that the overall cost can be reduced as much as possible and the economy can be optimized while ensuring the smooth progress of the project.

3.3 Comparison results of oil and gas gathering and transmission energy consumption

Finally, the results of oil and gas gathering and energy consumption after the construction of different methods are compared again. The comparative analysis results of oil and gas gathering and transmission energy consumption are shown in Figure 3.

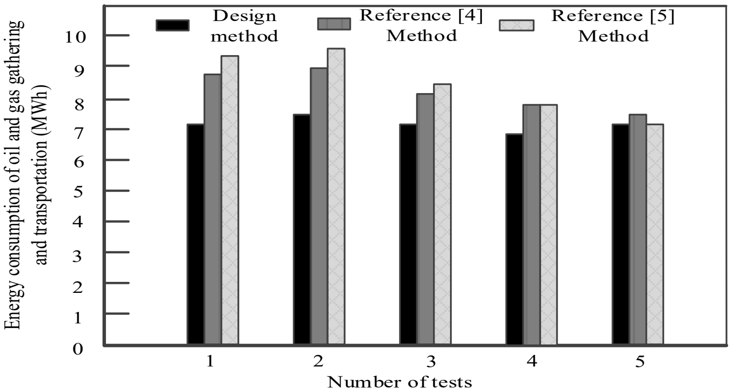

Fig. 3. Comparison results of oil and gas transportation energy consumption

According to Figure 3, the oil and gas gathering energy consumption of the literature [4] and [5] method is relatively high and more unstable. In contrast, the oil and gas gathering energy consumption of this method is relatively stable, and the oil and gas gathering energy consumption is always lower than that of the literature [4] and [5] method, and the lowest is only 6.9 MWh. This is because the method in this paper uses RNN as a neural network model to deal with sequence data and time dependence, and can capture the complex relationships and laws between data in the process of learning and training historical data. By modeling and forecasting historical energy consumption data, energy consumption of oil and gas gathering and transportation can be effectively reduced and energy utilization efficiency can be improved. Through a large number of historical data and real-time monitoring data, combined with the prediction ability of circular neural network, the energy consumption of oil and gas gathering and transportation is dynamically adjusted and optimized. Adjust the energy utilization scheme in time according to the actual situation, avoid energy waste, improve energy utilization efficiency, and ensure the sustainable development of oilfield ground construction projects.

4 Conclusion

In this study, the scheme planning of oilfield surface construction engineering is deeply studied by the optimization method of oilfield surface construction engineering scheme planning based on cyclic neural network. Firstly, the objective function of project planning optimization is defined to ensure the minimization of construction time, cost and energy consumption on the premise of meeting the project quality and safety. Setting reasonable constraints and integrating various limiting factors in practical engineering into the optimization model enhance the feasibility and practicability of the scheme. The results of this study show that the optimization method of oilfield surface construction project planning based on cyclic neural network has obvious advantages and application value. This method can not only improve the economy of oilfield ground construction engineering, but also improve the efficiency and sustainability of engineering construction.

References

1. Wang Chunsheng, Chen Guolong, Shi Yun, et al. Research on the development scheme of Liuhua deepwater Oilfield Group in the South China Sea [J]. China Offshore Oil and Gas, 2020,32 (3): 143-151.
2. Patil P S. Proper Planning and Scheduling of a Construction Project to Optimize Time and Cost[J]. International Journal for Research in Applied Science and Engineering Technology, 2023, 11(5): 6218-6225.
3. Manta A M, Dima C. Risk Management Planning in a Construction Project[J]. Scientific Bulletin of the Politehnica University of Timişoara Transactions on Engineering and Management, 2023, 4(2): 20-28.
4. Sasane P Y. A Project Report on Planning, Scheduling, and Delay Analysis of a Construction Project during Covid-19 Pandemic: A Case Study[J]. International Journal for Research in Applied Science and Engineering Technology, 2022, 10(12): 539-553.
5. Tapia bueno J, Leal P R M. Enhancing Construction and Urban Planning Outcomes: An Examination of Project Management Institute Methodology[J]. Journal of Urban Development and Management, 2023, 2(2): 95-103.

6. Feng Qiling, Li Yufeng, Li Zhaoxi, et al. Study on the optimization of pipeline low volume transmission scheme in the old area of Zhongyuan Oilfield [J]. Journal of Beijing Institute of Petrochemical Technology, 2021,29 (3): 32-35.
7. Xin Yanping. Study on analysis, evaluation and optimization of gathering and transmission network in TH Oilfield [J]. Energy Conservation Technology, 2019,37 (4): 371-375.
8. Zhang Jinliang, Ma Xinzhong, Jing Laihong, Yang Libin. Optimization of the western route of the South-to-North Water Diversion Project [J]. South-to-North Water Transfers and Water Science & Technology (Chinese and English), 2020,18 (5): 109-114.
9. Naumova O S .Basic factors of modeling and optimization of technological processes of construction production[J].IOP Conference Series: Materials Science and Engineering, 2019, 656(1):012038 (7pp).
10. Zhao Yadong. Optimization and implementation of the transition engineering scheme in the throat area of the loading yard [J]. Shanxi Architecture, 2021,47 (8): 133-137.