Scholar Publishing Group
Frontiers in Ocean Engineering
https://doi.org/10.38007/FOE.2021.020405
ISSN 2790-2706 Vol. 2, Issue 4: 35-43

Quality Management Improvement of Ocean Engineering Projects Based on Genetic Algorithm

Rasa Lillien*

Binghamton University State University of New York, The United States of America

corresponding author

Keywords: Genetic Algorithm, Ocean Engineering, Project Quality, Management Improvement

Abstract: Quality management in offshore engineering is one of the key processes to strengthen the overall management of offshore engineering projects, and its quality can directly affect the state and final effect of offshore platforms in the actual construction process. The purpose of this paper is to study the improvement of engineering project quality management based on genetic algorithm. The characteristics of the quality management of marine engineering projects are studied, and the quality management mode of marine engineering projects is formed based on the idea of improving the quality management of marine engineering projects. Construction project quality management system composition. At the same time, through the comparative analysis of example simulation and calculation results, it is concluded that after optimization, the total construction period of offshore engineering project one is reduced by 21, and the total construction period of project two is reduced by 26, which verifies the feasibility, effectiveness and superiority of the composite genetic-simulated annealing algorithm.

1. Introduction

The characteristics of marine engineering projects determine that they must implement project management methods. Ocean engineering projects must be managed with the modern project quality management model [1]. In practice, the quality of marine engineering projects is affected by many internal and external factors. If scientific and reasonable planning and effective control are not used, the project will be out of control. Project managers are very busy every day with little success. Therefore, it has certain practical significance to effectively apply the relevant theories of schedule quality control to the construction of offshore engineering projects [2].

In order to improve the work efficiency of offshore petroleum engineering, oil companies are gradually integrating the project management information system into the management of offshore petroleum engineering projects [3]. Some scholars have analyzed the informatization requirements of marine engineering project management, and then analyzed the relevant system information, and finally put forward the marine engineering project management strategy based on the project management information system, which can provide reference for researchers related to offshore oil management [4]. There are also scholars who analyze the construction of various projects of land construction in marine engineering. On the basis of understanding the actual situation of the marine project, the construction unit strengthens the analysis of the problems in the construction of various specialties of land engineering, and formulates corresponding construction technical plans, and ensures the use and update of the management system through process control, thereby improving the construction quality of the project, to lay a solid foundation for the construction of subsequent marine engineering projects [5]. Therefore, the project quality management technology for marine engineering projects in the whole industry is not mature, and there are certain defects. Project quality management is one of the three goals of project management [6].

My country's offshore engineering industry has not formed a complete and unified project quality management process, control method and management standard. Based on the status quo of the schedule management of typical offshore engineering enterprises, and guided by intelligent management, it reshapes the schedule management process and method of offshore engineering projects, and proposes marine engineering projects. The improvement principle of project quality management provides theoretical support for realizing the goal of project quality management. Through the compound genetic-simulated annealing algorithm, the multi-project scheduling schedule optimization model of offshore engineering is solved, and the intelligent decision-making of schedule management of offshore engineering projects is realized.

2. Research on the Improvement of Quality Management of Offshore Engineering Projects

2.1. Quality Management of Marine Engineering Projects

Extending from the characteristics of project quality management, it can be concluded that the quality management characteristics of ship and offshore engineering construction projects are as follows, including but not limited to the following:

(1) The project is large and complex, and the construction period is long. The execution of marine and marine engineering services requires coordination among multiple departments and disciplines, and communication is more complex. There are many quality problems in the process, and some problems have a long process [7].

(2) There are many processes in shipbuilding and marine engineering activities, and each process is a time. In the same project, except for maintenance, there is no process repetition, which is difficult to calculate and control using traditional quality control methods. Since the process is not repeated, it is difficult to measure the quality control method from project initiation to completion, and it is also difficult to unify the evaluation method [8].

(3) The construction level of various external structures is inconsistent, the stability of construction personnel is not enough, and factory workers with special types of work are often replaced [9].

(4) The importance and difficulty of quality control of each project are different. There is less information that can be shared between different projects, except for the design issues of the project and the difficulty of purchasing the same equipment from the same supplier, all of which must be individually identified and resolved [10].

(5) Offshore engineering includes the joint construction of various facilities such as buildings, pipelines, equipment, ventilation, and electrical equipment, and various facilities are different jobs.

In the production process, the production plan is organized by region and assigned to different production activities according to the region. In the final project acceptance stage, according to the project acceptance process, acceptance is a multi-channel, cross-regional complex system. Therefore, there is a phenomenon of asynchronous and incompatible construction and acquisition [11-12].

2.2. Improvement Principles

The main body of offshore engineering quality management process improvement includes the company's internal functional agencies and project management agencies in each project team. Among them, the project management agency is mainly responsible for the design management of each stage of the processing design, which also includes the supervision and management of the quality of the processing design [13-14]. At the same time, it is necessary to regularly optimize the project scheduling period, and deal with and prevent the unqualified situation in the processing design stage. The company's offshore engineering construction project management system needs to prevent and revise the possible unqualified project schedule on a macro level. Continuously carry out continuous and comprehensive optimization to improve the effectiveness of measures such as improvement and prevention [15-16]. The company's quality improvement work for offshore engineering needs to be carried out around the following principles:

(1) Process improvement; improve each process of the project according to the principle of the whole process.

(2) Circular improvement; continuous optimization based on the principle of improvement, consolidation, improvement, consolidation [17].

(3) Initiative improvement: fully mobilize the enthusiasm of the staff and stimulate their subjective initiative to actively participate in the work.

(4) Preventive improvement: strengthen preventive improvement, improve predictability, and propose predictable suggestions for design optimization [18].

3. Investigation and Research on Quality Management Improvement of Ocean Engineering Projects Based on Genetic Algorithms

3.1. Composition of Quality Management System for Offshore Engineering Construction Projects

As an important part of the company's comprehensive management system, the management system is mainly divided into the following components:

(1) The organizational framework and personnel composition are shown in Figure 1. After each offshore engineering project is approved, the management will select personnel with the same type of project experience to form the project quality management department according to the scale and type of the project. Risk managers and managers with rich management experience will be selected according to the difficulty of project quality management, and related professional quality engineers will also be selected according to the scope of work included in the project.

(2) Operation and execution of project quality management as an important part of the project execution plan, the company's marine engineering project quality management is mainly composed of the following parts: quality analysis and quality control.

(3) Quality monitoring and assurance of project scheduling optimization management the scheduling optimization module is the main function module in this system, where the core scheduling function is located. The plan prepared in the construction plan module will be submitted after review. According to the current project operation, it will be divided into scheduling

optimization of a single project and scheduling optimization of multiple projects in parallel. Multi-project scheduling optimization takes the optimization of construction period as an optimization goal, while single-project scheduling optimization is to try to optimize the three objectives of resources, quality and cost at the same time under the premise of not violating the construction period to find the scheduling scheme with the best comprehensive optimization effect.

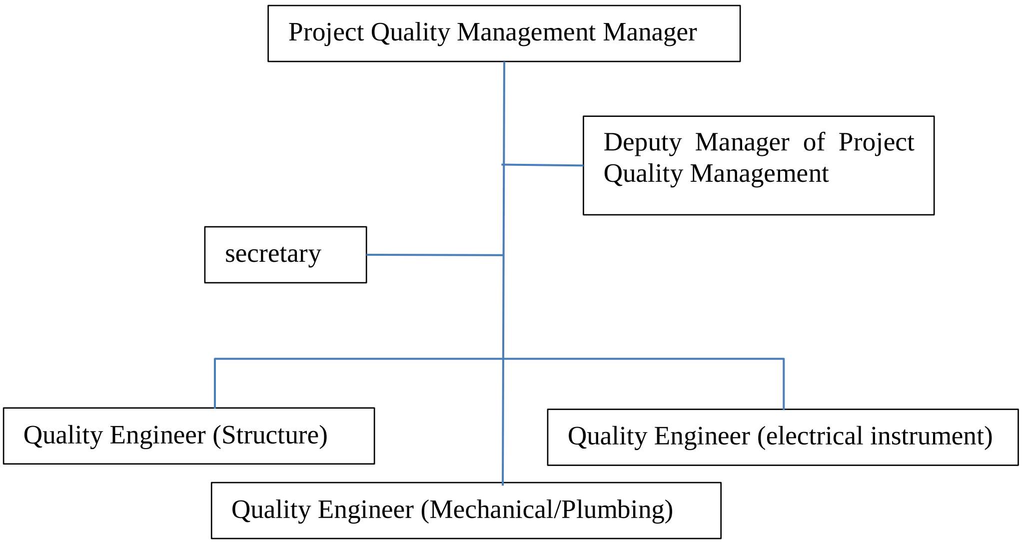

Figure 1. Project quality management organization chart

3.2. Complex Genetic-simulated Annealing Algorithm to Solve the Multi-project Scheduling Optimization Model of Marine Engineering

When using genetic algorithm to solve practical problems, in order to facilitate the calculation, the parameters in the parameter set of the actual problem need to be converted into operators in the algorithm, that is, coding operations. This article chooses integer encoding. Different integers represent different plans, so each chromosome is a string of numbers, and the order of the numbers in the chromosome indicates the execution order of the plan.

In view of the particularity of this encoding, the method of combining topological sorting initialization and random initialization is selected for the population initialization in this paper: (1) First, determine multiple plans with context constraints, treat multiple plans as one plan to schedule, and then Randomization is used to determine gene values on the entire chromosome. (2) Each gene value (number corresponding to the plan) occurs only once in each chromosome (3) The plan without context can be freely scheduled.

The mutation method adopts reverse mutation, that is, randomly selects two genes in the chromosome, such as 1 and 10, and then reverses the sequence of the gene segments cut from the two genes to obtain a new chromosome details as follows:

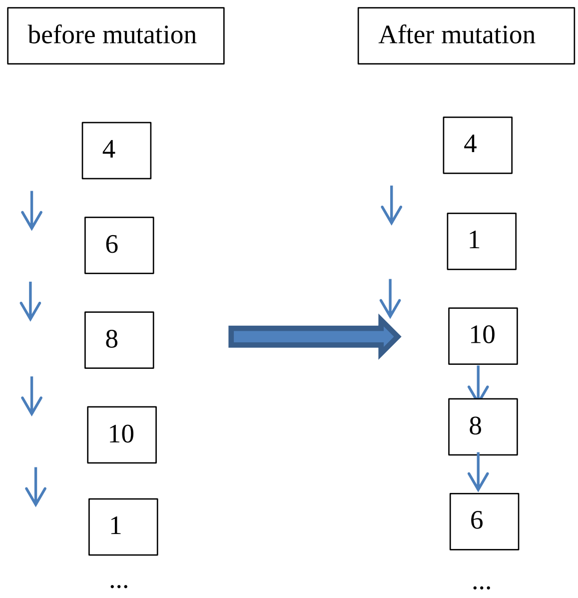

Figure 2. Diagram of chromosomal variation

This paper chooses an adaptive mechanism to determine the probability of hybridization and mutation. The probability of the algorithm in the early stage is large to ensure its global search ability; the probability in the later stage is small to ensure that the good individuals in the population are inherited and avoid divergence. The hybridization probability Pc and mutation probability Pm of the algorithm are determined as follows:

$$P_c = \begin{cases} P_{c\max} \sin(\frac{\pi}{2} + \frac{g}{G} \times \frac{\pi}{2}) & P_c \geq P_{c\min} \\ P_{c\min} & P_c \geq P_{c\min} \end{cases} \quad (1)$$

$$P_m = \begin{cases} P_{m\max} \sin(\frac{\pi}{2} + \frac{g}{G} \times \frac{\pi}{2}) & P_m \geq P_{m\min} \\ P_{m\min} & P_m \geq P_{m\min} \end{cases} \quad (2)$$

Where: G is the maximum number of iterations at which the algorithm terminates;

g is the current iteration number;

Pcmax is the maximum value of the set crossover probability.

Because the genetic algorithm in the first stage only requires a part of individuals with good enough performance to reconstitute the population, and then transfer to simulated annealing algorithm calculation after decoding.

Given the initial temperature T0 and the end temperature TE, give X a small perturbation (generally a partial element replacement of the solution) to generate a new solution X*, accept the current solution as the optimal solution with a certain probability Pro, and set the annealing method as :

$$\Delta_T = \lambda_t * T_0, T_k = T_0 - k * \Delta_T \quad (3)$$

If $T_k \leq T_E$, terminate the calculation.

4. An Example Verification of the Improvement of Quality Management of Marine Engineering Projects Based on Genetic Algorithm

This paper uses the actual construction data of marine engineering to verify the feasibility of the above scheduling optimization results. The selected data are part of the plan data of two offshore platforms under construction in an enterprise, and virtual plans are added at the beginning and end of each platform project to make it meet the conditions of model scheduling. A total of 6 third-level plans are taken for project one, and six third-level plans are taken for project two, as shown in Table 1 and Table 2. After scheduling the fourth-level and fifth-level plans of the project, the third-level plan time is shown in Table 3.

Table 1. Project 1 planned timeline

Process number	Process name	resource balance
1	Sectional electrical outfitting installation	-5
2	Segmented electric outfitting welding	-1
3	Sectional duct and bracket installation	0
4	Sectional piping installation	1
5	Sectional group erection	-6
6	segmented pre-densification	-2

Table 2. Project 1 planned timeline

Process number	Process name	resource balance
1	Segmented CNC cutting	-10
2	Segmented slat cut	-8
3	Segmented door cut	-5
4	Staged thermal processing	3
5	Segmented steel cutting	-4
6	Sectional loading and assembly	-1

Table 3. Three-level planning schedule before project scheduling optimization

plan number	item one	Project two
1	19	31
2	21	25
3	16	11
4	22	18
5	17	20
6	13	21
Total duration	108	126

In the hybrid genetic-simulated annealing algorithm, the values of various parameters are as follows: the initial population size in the first stage is 300, the evolutionary generation of the population is 400, the maximum crossover probability Pcmax0.7, the minimum crossover probability Pcmin0.2, the maximum variation Probability Pmmax0.05, minimum mutation probability Pmmin0.01, determine the probability of hybridization and mutation. The initial temperature of the second stage algorithm is taken as 100. The temperature drop rate was 0.01, and the termination temperature was taken as 25 degrees. After two stages of scheduling optimization, the construction period of the new scheduling scheme is obtained as shown in Figure 3:

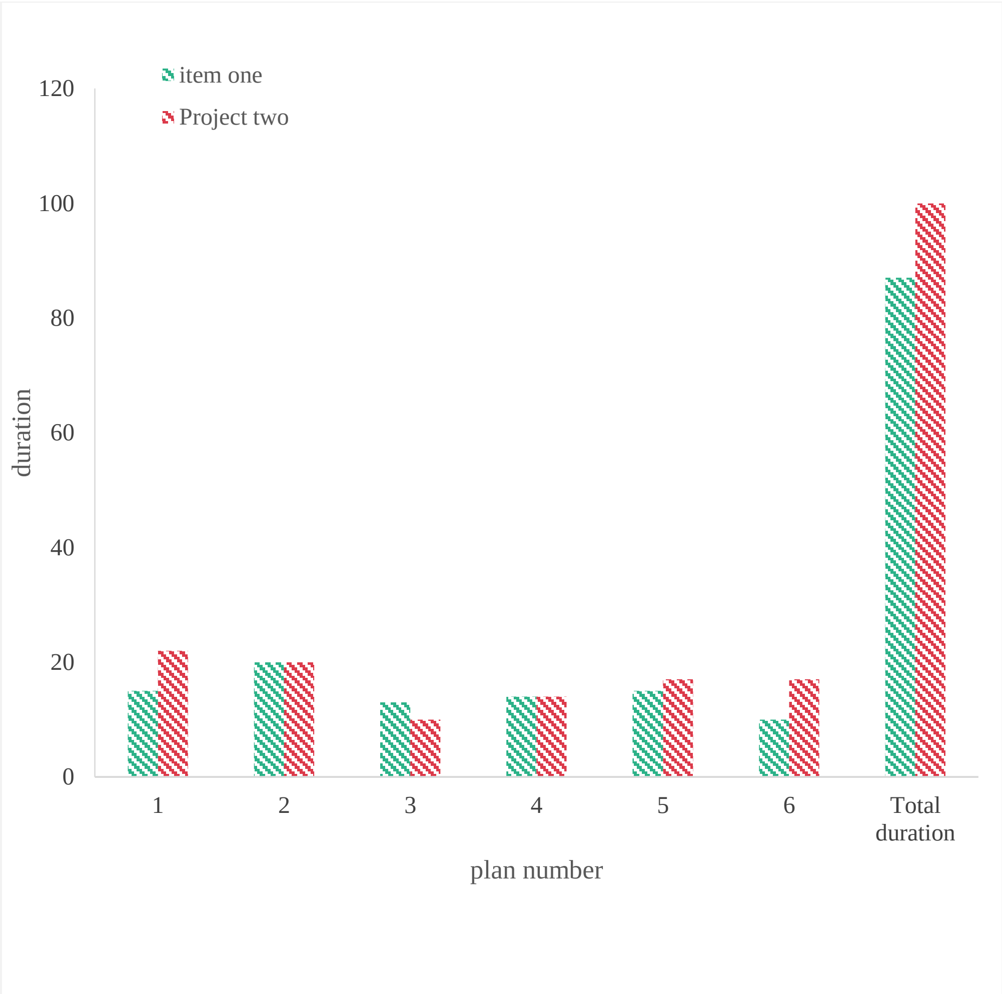

Figure 3. Three-level planning time after project scheduling optimization

According to the solution results, it can be seen that the total construction period of project one before optimization is 108, the total construction period of project two is 126, the total construction period of project one after optimization is 87, and the total construction period of project two is 100. It can be seen that the scheduling optimization method can be used to a greater extent optimization period.

5. Conclusion

The quality of marine engineering projects is affected by many internal and external factors. If scientific and reasonable planning and effective control are not used, the project will be out of control. Project managers are very busy every day with little success. Therefore, it has certain practical significance to effectively apply the relevant theories of schedule control to the construction of marine engineering projects. Based on the research experience and project data of actual marine engineering enterprises, this paper applies the composite genetic-simulated annealing algorithm to the modeling of marine project scheduling, and realizes the function of the marine engineering project quality management system. Certain reference significance and application value. However, due to the limited time and lack of ability, the modeling of some problems has not been perfected, and the development of each function of the system needs to be further improved, which also puts forward more requirements for the follow-up work and study.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Labianca C , Gisi S D , Notarnicola M . Assessing the correlation between contamination sources and environmental quality of marine sediments using multivariate analysis. Environmental engineering and management journal, 2018, 17(10):2391-2399. https://doi.org/10.30638/eemj.2018.237

[2] Anisimov A N , Furgasa D M , Menshikov V I . Methodological problems in algorithm planning procedures of program and target management of vessel safety. Vestnik Of Astrakhan State Technical University Series Marine Engineering And Technologies, 2020, 2020(4):7-15. https://doi.org/10.24143/2073-1574-2020-4-7-15

[3] Cooper N , Cooke S . Considerations for dealing with unexploded ordnance on maritime engineering projects. Proceedings of the Institution of Civil Engineers, 2018, 171(MA3):121-131. https://doi.org/10.1680/jmaen.2017.30

[4] Paglialonga L , Springer P , Mehrtens H , et al. Research Data Management.. J Med Libr Assoc, 2018, 103(3):154-156. https://doi.org/10.3163/1536-5050.103.3.011

[5] Kim H I , Shin Y J . A Study on the Impact on Management Performance of Hidden Champions Using Blue Ocean Strategy to Develop a New Product. Journal of Society of Korea Industrial and Systems Engineering, 2020, 43(1):42-49. https://doi.org/10.11627/jkise.2020.43.1.042

[6] Kwon K Y , Lee J . Fabrication Assessment Method for Dimensional Quality Management of Curved Plates in Shipbuilding and Offshore Structures. Journal of Ocean Engineering and Technology, 2018, 32(2):106-115. https://doi.org/10.26748/KSOE.2018.4.32.2.106

[7] Sahoo B , Bhaskaran P K . Multi-hazard risk assessment of coastal vulnerability from tropical cyclones – A GIS based approach for the Odisha coast. Journal of Environmental Management, 2018, 206(JAN.15):1166-1178. https://doi.org/10.1016/j.jenvman.2017.10.075

[8] Raja A , Gopal S , Manoharan K , et al. Coastal Pollution Management Plan in Odisha Coast. International Journal of Recent Technology and Engineering, 2019, 8(2S11):2994-3004. https://doi.org/10.35940/ijrte.B1383.0982S1119

[9] Onaka S , Ichikawa S , Izumi M , et al. Implementaion Of Adaptive Management On Gravel Beach Nourishment In Tuvalu. Journal of Japan Society of Civil Engineers Ser B3 (Ocean Engineering), 2018, 74(2):I_797-I_801. https://doi.org/10.2208/jscejoe.74.I_797

[10] Utne I B , Schjolberg I , Roe E . High reliability management and control operator risks in autonomous marine systems and operations. Ocean Engineering, 2019, 171(JAN.1):399-416. https://doi.org/10.1016/j.oceaneng.2018.11.034

[11] Yasseri S F , Bahai H . Availability assessment of subsea distribution systems at the architectural level. Ocean Engineering, 2018, 153(APR.1):399-411. https://doi.org/10.1016/j.oceaneng.2018.01.099

[12] Dawid H , Kopel M . on economic applications of the genetic algorithm: a model of the cobweb type. Journal of Evolutionary Economics, 2019, 8(3):297-315. https://doi.org/10.1007/s001910050066*

[13] Hossain D , Capi G , Jindai M . Optimizing Deep Learning Parameters Using Genetic Algorithm for Object Recognition and Robot Grasping. Journal of Electronic ence & Technology, 2018, v.16(01):13-17.

[14] Mustafa A , Heppenstall A , Omrani H , et al. Modelling built-up expansion and densification with multinomial logistic regression, cellular automata and genetic algorithm. Computers, Environment and Urban Systems, 2018, 67(jan.):147-156. https://doi.org/10.1016/j.compenvurbsys.2017.09.009

[15] Krol A , Sierpinski G . Application of a Genetic Algorithm With a Fuzzy Objective Function for Optimized Siting of Electric Vehicle Charging Devices in Urban Road Networks. IEEE Transactions on Intelligent Transportation Systems, 2021, PP(99):1-12.

[16] Martowibowo S Y , Damanik B K . Optimization of Material Removal Rate and Surface Roughness of AISI 316L under Dry Turning Process using Genetic Algorithm. Manufacturing Technology, 2021, 21(3):373-380. https://doi.org/10.21062/mft.2021.038

[17] Alshheri M , Sharma P , Sharma R , et al. Motion-Based Activities Monitoring through Biometric Sensors Using Genetic Algorithm. Computers, Materials and Continua, 2021, 66(3):2525-2538. https://doi.org/10.32604/cmc.2021.012469

[18] Gamal M , Elsawy A , Atta A . Hybrid Algorithm Based on Chicken Swarm Optimization and Genetic Algorithm for Text Summarization. International Journal of Intelligent Engineering and Systems, 2021, 14(3):319-131. https://doi.org/10.22266/ijies2021.0630.27