Scholar Publishing Group
Frontiers in Ocean Engineering
https://doi.org/10.38007/FOE.2022.030307
ISSN 2790-2706 Vol. 3, Issue 3: 55-64

Marine Engineering Project Planning Management Technology based on Machine Learning

Saravanan Kavita*

University of Garden City, Sudan

**corresponding author*

Keywords: Machine Learning, Ocean Engineering, Project Planning, Management Technology

Abstract: With the development of various marine exploration means, the ability to obtain marine environmental information has also been unprecedentedly improved. Marine data presents the characteristics of strong spatial-temporal correlation and diverse formats, but it brings problems such as complex relationships between data, difficult analysis of heterogeneous data, and low processing efficiency. Therefore, the marine project planning management technology has become the focus of research. This paper studies and analyzes the marine project planning management technology based on machine learning(ML) algorithm. The planning, classification, organizational structure and control principle of offshore engineering project(OEP) are discussed; This paper proposes a ML algorithm, optimizes the project schedule of marine engineering project(MEP) planning management technology through the training algorithm of smooth support vector regression model, and finally introduces each module of the system briefly in combination with the planning management of MEPs, which verifies the feasibility of the ML algorithm, improves the production efficiency of marine engineering, and has a certain reference significance for future development.

1. Introduction

Offshore engineering is a complex and diversified project, which contains a wide range of contents, complicated construction links and huge investment. From the perspective of project management, offshore engineering has all the conditions suitable for project management. With the development of offshore engineering to the deep-sea field, the scale and construction cost of offshore engineering will increase correspondingly, which puts forward higher requirements for offshore engineering enterprises. For a project with high investment such as offshore engineering, the investment in project management is the tip of the iceberg, but it brings benefits from resources, costs and reputation. Therefore, it is necessary to introduce project planning management technology into offshore engineering. Based on ML, this paper studies the technology of MEP planning management.

At present, the problem of neutralizing the global search ability to avoid falling into the local optimal solution and a better convergence speed needs to be studied in depth, and there is still a large exploration space for the project scheduling problem of offshore engineering, especially for projects with large quantities and high investment, such as offshore engineering, the schedule cost optimization problem in the production process is more practical [1]. Aiming at the problem of dynamic resource scheduling commonly existing in OEPs, this paper proposes a ML algorithm technology, which uses adaptive pheromone residue coefficient to make the algorithm have a small pheromone Volatilization Coefficient in the early stage, so as to improve the search efficiency, avoid falling into the local optimal solution, and better reduce the adverse impact of pheromone volatilization on the algorithm. Under the condition of resource constraints and schedule compressibility, the schedule and cost optimization of OEPs is finally realized [2].

This paper combines ML theory to study the planning and management technology of MEPs, and develops a digital, intelligent and operable marine data processing system based on ML technology, which meets the basic needs of Shipborne marine data processing systems, improves the processing efficiency of marine multi-source data, and improves the readability and availability of marine environment data, It provides a new solution for real-time processing and analysis of marine data for MEPs. Finally, combined with the plan management(PM) of offshore projects, each module of the system is briefly introduced, and the feasibility of the ML algorithm is verified. The results show that the planning management of OEPs can shorten the project duration, and combined with the actual enterprise management, it can achieve the purpose of reducing costs and improving production efficiency, which has certain reference significance for future development [3-4].

2. Analysis on PM of OEPs

2.1. PM of OEPs

2.1.1. Planning of OEPs

The theory and technology of project planning management explain how to carry out project planning management from the methodology, but how to apply these theories and technologies to specific MEPs is also a topic worth studying. MEPs are different from traditional shipbuilding. How should the planning management of MEPs be carried out? This paper explains how the plan of OEPs should be formulated by applying it to a practical semi submersible drilling platform project [5].

2.1.2. Classification of OEP Plans

The basic theory of the PM of OEPs comes from the project PM, but there are many differences. The biggest difference is that the data volume of OEPs is very large, and the resulting change is that for the originally simple requirements, when the data volume reaches a certain level, special processing methods need to be considered. The process of EPC project management needs a relatively long time from coarse to fine, from fuzzy to clear, There are the same problems with project PM. Corresponding to the process of continuous improvement of various types of information, PM is also a process from general to detailed. Usually, project-based PM is divided according to time and thickness. After division, a multi-level plan is formed, which is the so-called multi-level plan. Multi level PM is especially suitable for OEPs. In the initial stage, when all information may be unclear, the process of gradually clarifying from near to far is the process of classifying project plans [6-7].

2.2. Project Schedule Control Principle

Project schedule control, like cost control and quality control, is one of the key control objects of the project and an important means to ensure that the project is completed on schedule, reasonably arrange resource allocation and control input costs. The progress control of the project lasts from the start of the project to the end of the project, which is a long-lasting and dynamic process management [8-9]. After completing the preparation of the project schedule, the actual project schedule fed back from the project construction is compared with the planned schedule, so as to clarify the progress speed of the project, so as to update the schedule in time and achieve the purpose of controlling the schedule [10]. Adjust the construction schedule, as shown in Figure 1.

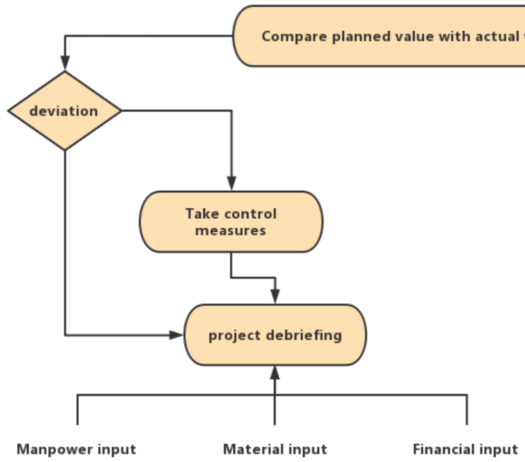

Figure 1. Application steps of dynamic control principle

The application of dynamic control principle to control the progress of offshore projects in China has not been popularized, or there is no systematic and theoretical study on the application of dynamic control principle, so it can only be said that it is still in a relatively unrestrained state [11].

2.3. PM Organization Structure

In addition to the functional organizational structure of the enterprise, another parallel management system in the management system of offshore engineering enterprises is the PM organizational structure of the project. The former can be said to be the hardware structure of the enterprise, while the latter is the software structure for the project. After the contract is signed, the offshore project enters the whole line operation process of the offshore project team. According to the time flow, it can be basically divided into four stages, namely: design stage, procurement stage, production and construction stage and equipment commissioning stage [12-13]. According to the data provided by each department, the project planning department formulates a complete project schedule management plan, which is separately managed according to the schedule management process for different stages. The schedule management process is shown in Figure 2.

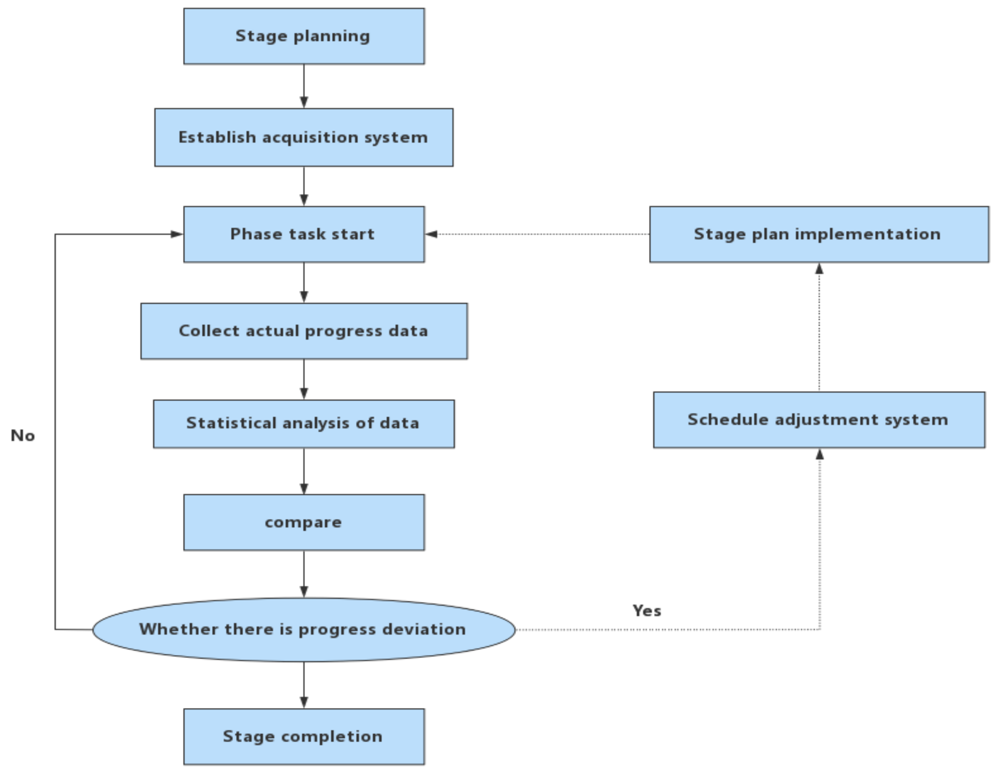

Figure 2. Schedule management flow chart

The progress PM process is implemented in each stage. In case of progress deviation, feedback shall be made and the progress plan shall be adjusted in time. If there is no deviation, the stage task shall be continued until one stage is completed, and then the next stage [14] shall be entered.

3. MEP Planning Management Technology based on ML

3.1. Smooth Support Vector Regression Model

3.1.1. Model Structure

Different from the traditional support vector regression, the originality of smooth support vector regression lies in a special built-in filter for smoothing, so as to minimize the impact of outliers and noise on marine environment data. Obviously, the proposed model can be regarded as an extension of the traditional regression model, which consists of three functional parts: data acquisition, smoothing and nonlinear approximation.

Generally, ocean data can be collected by a specific buoy system. This unmanned data acquisition device is composed of data acquisition, temporary storage and forwarding. The system can obtain appropriate multi characteristic marine data, including hydrology, meteorology, nutrients and water quality, through a variety of built-in sensors. These data are wirelessly transmitted to the remote monitoring center through Beidou satellite [15-16]. In addition, the smoothing method of the model is used to preprocess sudden fluctuation, multi noise, non static and abnormal marine environment data, and can automatically correct implicit errors and abnormal values. The smoothed data can provide a series of excellent initialization points for the next nonlinear approximation. Finally, LSSVM is trained using these smoothed data to pre process ocean data. In the training, the input space is converted into a high-dimensional feature space through a kernel function, and the method can give accurate prediction output and reduce the computational load of the algorithm [17-18].

3.1.2. Training Algorithm

Smooth LS-SVM aims to accurately predict a series of ocean data forwarded by wireless sensors. Among them, smoothing method is a data preprocessing scheme for continuous processing of marine environment data. In particular, it does not change the dimension of the data. In the scene, the following smoothing methods are considered:

The moving average method is expressed as:

$$R(a_i) = \frac{1}{2n+1}\sum_{l=-n}^{n} a_i + l \tag{1}$$

Where, a is the input data, n is the average number of moves, and R (AI) is the moving average of AI.

Gaussian smoothing method, whose expression is:

$$D(a) = \frac{1}{\sqrt{2\pi\gamma}}\exp(-\frac{a^2}{2\gamma^2}) \tag{2}$$

Where a is input data, γ Represents the standard deviation of the data, and D (a) represents the Gaussian function about a. A smooth data set can be obtained by D (a).

3.2. Mathematical model of Schedule Preparation

To meet the mathematical description of the initial schedule, define the satisfaction rate of the initial schedule δ, definition δ= , GN is the completion time of the last activity of the project. The completion time of the last activity of the project represents the construction period of the project. The shorter the construction period, the higher the satisfaction with the project schedule. Then the solution to the satisfaction rate is converted to the earliest completion time of the last activity.

In order to carry out the PM of OEPs, the following mathematical model is established:

$$T\arg\delta = \frac{1}{MinG_n} \tag{3}$$

Ensure that the number of activities scheduled at the beginning stage is 0, restrict the resource usage of each activity to not more than the total amount of resources, ensure that the arrangement of each activity is not empty, ensure that the remaining amount of resources is effective, and ensure that the completion time of the last activity meets the requirements of the longest construction period.

Suppose there are n project activities. After arranging them in order of duration, each activity has an integer number I. kn = [I1, I2,..., in] is an arrangement of the N activities to be arranged. In the arrangement kn, attribute activity time ti, resource constraint RI and immediate constraint Xi are defined for each activity, where ij is the number of the jth activity in the arrangement, TJ is the duration of the jth activity, and RJ is the resource demand of the jth activity, XJ is the immediate constraint of the jth activity.

It is assumed that when arranging activities, the time of each project activity is fixed and the resource demand is fixed, and the arrangement of project activities is only limited to the scheduling of activity sequence. According to the definition of activity scheduling priority rule, among activities with similar constraints, project activities with earlier LST have higher scheduling priority, followed by activity resource demand GRD. Therefore, it is defined as:

$$q(x) = \eta \cdot LTS + \lambda \cdot GRD \tag{4}$$

Among them, Ling η+λ= 1, η>λ> 0 is considered as the earliest completion time of project activities. Thereby defining an individual fitness evaluation function:

$$q(x) = \begin{cases} \dfrac{1}{q(x)}, & q(x) \neq 0 \\ 0, & q(x) = 0 \end{cases} \tag{5}$$

If Q (XI) > Q (XJ), it means that the priority arrangement of the active individual Xi will obtain better results.

4. MEP Planning Management Technology based on ML

4.1. Marine Project Schedule Optimization based on ML

The project schedule management of offshore engineering plays a very important role. How to deliver the project on schedule under the condition of limited resources has become the primary issue to be considered. The resource constrained project scheduling problem is a NP hard combinatorial optimization problem. If the OEP is regarded as composed of activities with fixed time and fixed resources, the scheduling problem of the OEP can be transformed into a project scheduling problem.

When the problem scale of deterministic algorithms such as linear programming method and branch definition method is too large, the calculation time will be too long due to the large solution space, and the variables and constraints set will be too many, which is unfavorable to practical applications.

4.2. Marine Project Schedule Management System

The purpose of this system is to realize the schedule management of offshore projects, including the entry of schedule, the optimization control of schedule, and the comparative analysis of schedule. Due to the great flexibility of schedule preparation, it is difficult to realize self preparation based on the system. At present, the schedule is divided manually, and then the data management is upgraded by the system to achieve schedule control. In the project window, open view p1-01 to create a project view, create a new project, and set project properties as follows.

4.2.1. Data Flow Structure

The orderly flow of data is the basis for the normal operation of the system. While designing the functional modules of the system, the data flow corresponding to the functional modules should also be designed in detail. For the progress management module, its data processing process is complex, and not a few symbols can express it clearly. Therefore, the data flow should be described hierarchically. The hierarchical relationship of data flow is reflected by numbering processing actions. At the beginning of the data flow design, the system was regarded as a black box, and only the data of the black box and external entity data submitted to the project schedule management came from different departments of the project team. The Planning Department collected and entered different data into the system to achieve unified management of data. Different data play different roles in the system. To achieve all-round management of progress control, it is necessary to sort out the source and flow direction of data.

4.2.2. Data Table Structure

The design of table structure is the cornerstone of developing project management database. For OEPs, the project is huge and complex. When data is exchanged through the system, a large number of data will flow in from various departments. In order to realize the schedule management of the project, all departments in the project team should submit all kinds of data to the project planning department in a timely manner. After the planning department processes the unified schedule, it sends it back to all departments for implementation.

In the management of offshore engineering plans, there should be unified coding rules for data tables, otherwise the project planning department cannot receive the data uniformly, that is, the rearrangement of data after receiving will be huge. If there are unified coding rules within the enterprise, the workload of data entry into the system will be greatly reduced. Aiming at this problem, this paper gives a unified name to the coding rules of the data table of the system, as shown in Figure 3.

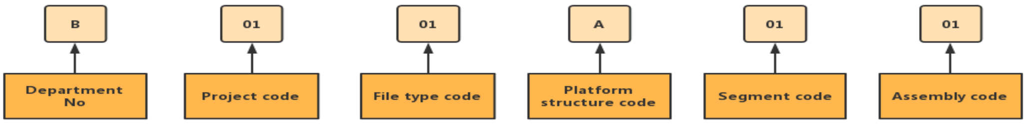

Figure 3. Data table coding rules

Among them, the department number is uniformly standardized by the enterprise. Each department in the project team has different numbers, and the project code is arranged in chronological order. At the same time, it can be used as the statistical data of the enterprise project. The document type is divided according to the data types submitted by different departments. It can be divided into superstructure, support pipe, floating structure, column, etc. the section and assembly code are named according to the division in the progress production design.

Through plan implementation and progress feedback, data analysis in the job window, view the key job views of the last two weeks, as shown in Table 1 and Figure 4 below:

Table 1. Task analysis in the job window

function	Total tasks	Plan in progress	Planned completion	Actually in progress	Actual completion	Actually not started	Proportion not started
Design	37	14	23	21	3	13	35.14%
purchase	48	37	11	35	6	7	14.58%
production	1145	667	478	94	258	793	69.26%
debugging	0	0	0	0	0	0	0.00%
well drilling	139	119	13	41	5	93	66.91%
plan	1369	837	525	191	272	906	66.18%

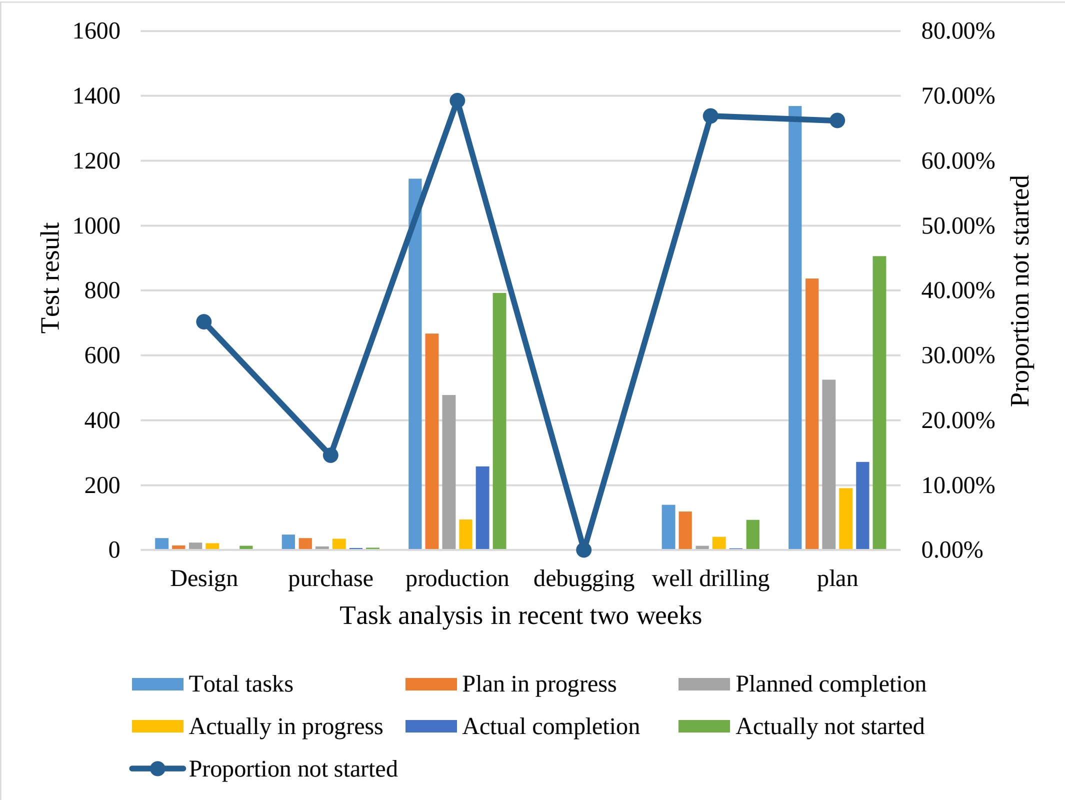

Figure 4. Task analysis in recent two weeks

It can be seen from the above chart that the project is currently in the production stage, and the rate of tasks not being completed on time in the last two weeks has reached 66%, which indicates that there is a problem in process control. It is suggested to hold a project meeting to analyze the real reason and correct this phenomenon. Otherwise, the project progress will be affected. The schedule management system of OEPs is a scientific management system for offshore engineering equipment projects, which integrates the functions of schedule planning, schedule optimization and schedule analysis. The design of the system is a network-based information integration and interaction platform. When users log in to the system, they only need to connect to the network and log in to the host domain name through the browser. After the system is started, the user cannot perform data operations because the system limits the user's authority. The user must log in to the system through user information management.

5. Conclusion

Based on the background of offshore engineering, this paper studies the schedule management technology and schedule optimization method of the whole project life cycle, and proposes a ML algorithm, which is based on the ML algorithm to generate the initial schedule of parallel projects. In this paper, the marine engineering equipment PM technology and schedule optimization technology are studied, the MEP schedule management system is developed, and verified with examples. However, because the MEP involves a wide range of contents, the project system is huge, and the production management modes of different enterprises are different, some problems need to be studied in depth: the development of marine engineering in China can be said to be still in its infancy, The upgrading of project schedule management of offshore engineering has a long way to go. The preparation of multi-level project schedule is basically completed manually. To realize the automatic preparation of schedule is a qualitative leap for the schedule management of OEPs. With the continuous development of schedule management technology, to achieve more accurate management of the project, it is necessary to formulate a more detailed schedule; In order to improve the international competitiveness of domestic offshore engineering, the high PM technology of offshore engineering needs further in-depth research.

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.

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