Execution Phase's Integrity Model of the Offshore Facility Project

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Abstract. With using existing methods of change management for large projects, it is often not possible to track the full list of the results of making changes to a project, for example, an increase in the total weight and overall dimensions of separate units. In the case of offshore oil and gas facilities (OF), this makes it impossible to locate the equipment in the available area and necessitates a new calculation, changing the piping, and complicating access to the equipment. As a result, the deadlines for completion of the facility are postponed and the total cost is increased, there is a need for a special order for equipment with higher prices. This research presents a project execution model (PEM), which considers the detailed composition and sequence of project stages and works in the OF life cycle, which are formed based on analogues - previously executed projects and developed completion criteria of works and project stages. It is proposed to integrate PEM with the methodology of digital engineering data management (DEDM), which contains an information model (IM) of the facility with created interconnections of the technical parameters of equipment units or total process unit. The DEDM allows generating information on the number and scale of deviations in a technical project after making changes to it in an automated mode, which significantly increases the rationality and accuracy of decision making. The result is a tool for the operator departments and contracting companies involved in the design and construction of the OF, which makes it possible to more accurately plan project costs, timelines for its execution and minimizes costs at various stages of the facility’s life cycle.

1. Research rationale

Offshore oil and gas platforms are complex and unique facilities, which include significant material and human resources involved in design and construction. Operator companies are not able to fully control and coordinate the technical and operation parts of the project, and as a result, some conflicts cause capital and time costs that cause capital and time costs. Collisions and mistakes are found in the design calculations at the FEED stage, procurement and construction of the offshore platform. This creates the need to systematize project adjustments. The methodology for tracking the consequences of making adjustments to one or another part of the project is absent with the existing methods of change management [1,2], which can lead to an increase in dimensions and weight of the equipment, inability to place it in an available space, in some cases it becomes necessary to hang unit on consoles over the sea, change the piping. The opportunity to use serial equipment disappears and there is a need to order special equipment at high prices. For example, an increase in the required capacity of the drilling
complex leads to the adoption of forced technical solutions, such as the introduction of additional temporary offshore facilities at the drilling stage. Therefore, the procedure under consideration is very relevant and needs to be deeply developed.

The system (Project Execution Model), which allows structuring project processes, was described by Kvaerner [3]. It is assumed that during the execution of the pilot project, a knowledge base is formed containing details of the stages of the project (Work Breakdown Structure). In carrying out the following projects, this approach allows us to more accurately formulate the project budget and estimate the timing of its execution. Experts record each stage of the work performed in parallel with the execution of the project. Also, the criteria for completing the stage of the project should be formed, which should allow the future to track the progress of project execution. A similar concept is described by the author of [4].

External connections based on the Building Information Modeling technology [5,6] should be fixed in the project information model to prevent errors when making changes to the parameters or replacing units of equipment in the chain. The technical analysis protocol should be attached to the equipment data sheet for internal use when checking the technical parts of the suppliers’ offers [7].

2. Research objective
This research attempts to solve the main operational and technological problems during the execution of a large-scale project: creating and structuring an information model based on a large amount of data, coordinating the contractors involved in the project and the entire production chain [8], arranging technological equipment in a limited space of the offshore platform, providing accuracy of preliminary calculations.

Serious problems arise between areas of responsibility, which can be formed both between technical systems running sequentially in the technological chain and between areas of related departments and customer services [9]. The technical analysis of the facility should be applied when creating information models for each technological unit of the facility — interconnections of subsystems are outlined, interconnections between individual technical parameters of equipment units in the technological chain are highlighted.

3. Theoretical background
We propose using the structural matrix of the project routes to integrate the change management system into the project execution model — a logically formalized visualization of the main parts, processes, subjects, objects and their relationships in the project management system (Figure 1). When constructing the ‘matrix’, the main stages of the project are initially planned, for the designation of which control levels are formed [10]. It is necessary to build relationships between the project entities (operator company departments), the project object (offshore oil and gas facilities and the constituent technological units), the phases of the project (types of activities that arise during the creation and execution of the project) and time complexes (distribution of the main stages of the project according to the order of their execution) An example of integration of project management and company structure is described in [11]. The next step is planning the routes for the execution of project processes regarding the main parts of the project. The process should be carried out in parallel with work on the technical part of the project. The main advantage of the matrix is the ability to control the routes of changes made to the project and determine the mutual influence of platform elements on adjacent elements of the facility. The proposed algorithm allows in the future to automate the tracking of the routes of changes made to the project and the construction of algorithms for the mutual influence of project components. The engineering data of the facility are operated based on information modeling technology [12,13,14].
Table 1. Scheme of routing matrix.

| Part | Description                                      |
|------|--------------------------------------------------|
| 1    | Departments of the Operator Company (Subjects)   |
| 2    | Object lifecycle                                |
| 3    | Gas-lift treatment and pressure reduction unit   |
| 4    | Project phases                                  |
| 5    | Time segments                                   |

The total number of processes is determined by the product of the number of components of the five vectors (according quantity of parts) [15].

Figure 1. Change management algorithm.
4. Practical implication

Christmas trees for gas-lift gas were purchased as part of the first stage of oilfield development, along with Christmas trees for production and water injection wells. The maximum working temperature of the valves was agreed with the deviation from project data - equal to 120°C according to API 6A standards. During the execution of the project in terms of re-equipment, it was found that while maintaining the equipment parameters, according to the project, the temperature of gas-lift gas when passing through the Christmas trees will exceed the maximum operating value. As a result of the technical meeting, it was decided to make changes to the parameters of the heat exchanger, to lower the outlet gas temperature. Due to the decrease in the outlet temperature, the parameters of the heat exchanger changed (the weight increased from 3.5 to 15 tons). Besides, the cost of final manufacturing increased, and there was also a risk that the equipment could not be placed in the allotted space.

The described problem could be predicted and avoided if the company operator could track in advance the consequences of the deviation of the maximum operating temperature of the fountain valves from the design parameters. Figure 2 shows an algorithm for managing changes using a matrix. The object level of the matrix is divided into 3 sublevels: Level 1 - collisions with other parameters of the unit; Level 2 - collisions with the parameters of dependent units; Level 3 - collisions with systems and structural elements of the offshore platform. After changing an individual parameter of the fountain valves, the system shows collisions with dependent units of equipment and suggests finding alternative solutions. For example, the use of specialized sealing elements of the Christmas tree, which would increase the maximum operating temperature to design values and eliminate the need for a more powerful heat exchanger. Thus, the human factor is minimized when making technical decisions.

5. Conclusion

The proposed integrated project execution model allows to minimize the time spent on communication and information search for decision making, reduce the workload of project team members, and significantly increase the efficiency of engineering and construction management. It is necessary to integrate the proposed “matrix” into the design process for managing engineering data, that is, creating a project management system for complex technological objects. The relationships and dependencies between the models of the technological blocks of the object are built-in common information space of the project using the digitalization of the design process [16, 17] and the use of the "matrix".

A result is a tool for coordination and technical decision-making between the operator’s services and the contractors involved in the design and construction of OF. The tool will allow you to most accurately predict the costs of the project, its completion time and minimize costs at various stages of its life cycle from the design stage to liquidation.

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