Logistic Analysis of Classifications of Mobile Drilling and Workover Equipment for Oil and Gas Wells on Land

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Abstract—The utilization of pattern recognition is on the rise within comprehensive information systems. The convergence of advancements in image processing theory and the accessibility of open-source libraries enables the application of inventive solutions to diverse practical challenges. One such issue pertains to the automated processing of responses in extensive examinations. This paper introduces an engineered system explicitly crafted to manage the outcomes of such examinations, showcasing its capacity to deliver a dependable, efficient, and impartial assessment.

Keywords—classification, winches, hoisting units, mobile drilling complexes, logistics

I. INTRODUCTION

The primary activities carried out at onshore oil and gas wells involve drilling and executing underground operations, including both capital and ongoing repair work at production wells. In traditional onshore operations utilizing stationary drilling equipment and rigs for drilling, as well as stationary drilling rigs and mobile winches for lowering and lifting operations, such practices do not align with contemporary production logistics in the oil industry. This work organization necessitates higher expenditures in terms of labor, finances, technology, and other resources, with the utilization rate of stationary oil and gas equipment and drilling rigs for well repair and drilling ranging only between 5-8%. This article predominantly focuses on a logistic analysis of classifications pertaining to mobile equipment designed for the drilling and overhaul of onshore oil and gas wells.

II. DESCRIPTION OF THE CLASSIFICATION METHODS

In the context of logistical analysis and the classification of drilling rigs for mobile drilling and continuous maintenance within the oil and gas industry, the presented method not only achieves the systematic organization and categorization of rig data but also establishes a framework for defining criteria for categorization. This approach facilitates a more accurate and efficient utilization of the equipment. The study places specific emphasis on pinpointing essential parameters and characteristics of drilling rigs that significantly influence their effectiveness and productivity.

By scrutinizing technical specifications, technological attributes, and the operational track record of the rigs, the following key aspects have been discerned:

A. The 7Rs of Logistics

B. Classification of mobile drilling and underground workover rigs for oil and gas wells according to European manufacturers.

C. Classification of mobile drilling and underground workover rigs for oil and gas wells according to manufacturers of special equipment in the Republic of Azerbaijan and in the CIS countries.

These key aspects form the basis for a more precise and adapted categorization of drilling aggregates, thereby contributing to the optimization of the selection and utilization of equipment in the diverse conditions of oil and gas operations.

A. The 7Rs of Logistics

Over the past decades, with the development of mechanical engineering and materials science, mobile units have been capable of performing the functions of stationary units and plants (which have a low utilization rate) for drilling and repair work on land. Mobile installations for drilling and workover of oil and gas wells are mainly based on caterpillar tracks or pneumatic wheels with high permeability. Mobile installations designed for drilling and workover activities in oil and gas wells primarily utilize caterpillar tracks or pneumatic wheels with high permeability. Notable examples, such as Satvia TB1800V, Salzgitter ZA420, ZJ40/2250CZ, -200, demonstrate the capability to achieve high performance

and effectively drill wells with conditional depths of up to 4500 meters. These mobile installations offer exceptional mobility and are specifically tailored for autonomous operations, making them suitable for challenging environments like deserts with limited communication infrastructure [1].

When performing an analysis based on the 7 Rs of logistics (table 1) for the performance of mobile drilling rigs and underground repair work, the study revealed the following advantages and disadvantages:

TABLE I. ANALYSIS OF THE 7 RS OF LOGISTICS IN MOBILE INSTALLATIONS

The 7 Rs of Logistics		
Num.	Name	Pros and cons
R1	Product	There is uncertainty in the classification and identification of mobile installations.
R2	Customer	These installations are easier to maintain and repair, do not require highly skilled workers, and are cost-effective.
R3	Time	The drilling rig, being mounted on the chassis of a car or trailer, can move at car speed.
R4	Place	These installations exhibit high autonomy and the ability to operate in remote conditions.
R5	Condition	They have high performance and positive technical characteristics.
R6	Quantity	High mobility and a quicker cycle of installation and dismantling make it possible to serve many wells.
R7	Cost	These installations have lower costs compared to stationary installations.

As we can see in the logistic analysis carried out by 7R, R1 revealed problems associated with the classification of mobile installations. Undoubtedly, one of the most important parts of the logistics of mobile drilling and workover equipment for oil and gas wells is the classification of mobile installations, or the Right Product (R1). As a result, it leads to difficulties in the classification of mobile drilling and equipment (table 2).

As observed in the logistics analysis conducted using the 7R framework, R1 exposes challenges related to the classification of mobile installations. Undoubtedly, the classification of mobile installations, or the Right Product (R1), stands out as a crucial aspect of the logistics for mobile drilling and workover equipment in the oil and gas well domain. Consequently, this issue contributes to complications in the classification of mobile drilling and equipment (table 2).

TABLE II. CHALLENGES IN MOBILE DRILLING AND WORKOVER EQUIPMENT CLASSIFICATION: AN ANALYSIS BASED ON THE 7RS OF LOGISTICS

Issue	Description
Lack of Standardization	Various producers may classify their products according to different criteria, causing confusion
Inconsistent Terminology	Different locations or industries using different names for the same type of equipment can be confusing
Technological Changes	Constant technological advancements can create new devices that may not neatly fit into established classifications
Specificity of Equipment	Categorizing highly specialized equipment into a broad system can be challenging
Regulation Variations	Equipment classification may be impacted by regulations that vary between nations or areas

B. Classification of mobile drilling and underground workover rigs for oil and gas wells according to European manufacturers.

The standardization of terminology in logistics is a crucial area of research, particularly within the framework of the "7Rs of logistics." With numerous stakeholders involved, variations in terminology can result in misunderstandings that significantly impact logistics operations.

For instance, different names for identical types of vehicles, warehouses, or equipment used for moving goods in different locations or industries can lead to confusion within the supply chain. This confusion, in turn, may result in delays in deliveries, errors in order processing, and a decline in service quality.

The economic consequences of linguistic uncertainty are substantial, as it compromises the effectiveness of logistical procedures, reducing the overall dependability of the supply chain. Therefore, standardizing terminology and procedures emerges as a critical initial step in managing logistics operations. The objectives include reducing order execution times, optimizing resource utilization, and enhancing the quality of equipment service.

In the examination of classifications related to mobile oil and gas equipment for repair and drilling, insights from leading manufacturers of special equipment for the oil industry indicate that, according to European classifications, mobile drilling and underground workover rigs for oil and gas wells, specifically truck-mounted drilling and workover rigs, are categorized into classes, as depicted in Figure 1.

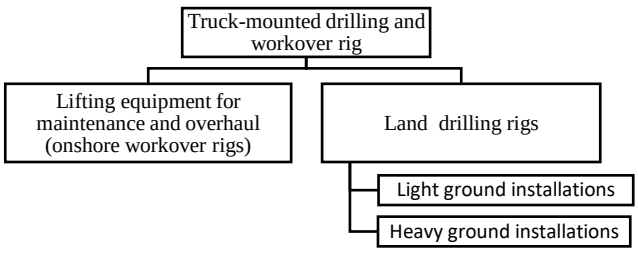

Fig. 1. Classification of mobile drilling and underground workover rigs for oil and gas wells from European manufacturers

C. Classification of mobile drilling and underground workover rigs for oil and gas wells according to manufacturers of special equipment in the Republic of Azerbaijan and in the CIS countries.

In recent times, major manufacturers have not extensively produced mobile winches without towers, commonly referred to as "host rigs" or "lifting winches" [2,3]. Consequently, many European classifications of mobile installations do not explicitly incorporate terms like 'host rig' or 'lifting winch.' However, in the classifications of mobile installations for underground repair in the Republic of Azerbaijan and CIS countries, manufacturers of specialized equipment introduce a subclass known as mobile winches (e.g., LTP-8 (ЛПТ-8), LTP-10 (ЛПТ-10), etc.). Notably, it is interesting to observe that mobile drilling complexes lack subcategories in these classifications.

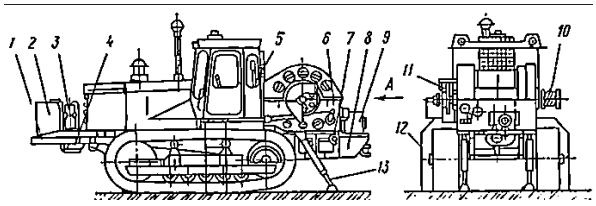

Fig. 2. Hoisting winch LPT-8: 1 — frame; 2 — fuel tank; 3 — air balloons; 4 — compressor; 5 — control panel; 6 — winch; 7 — universal joint shaft; 8 — console frame; 9 — gearbox; 10 — safety coil; 11 — rotor drive mechanism; 12 — detachable extension ladder; 13 — folding screw support.

As per Professor O.F. Danilov's classification at Tyumen State Oil and Gas University (TSOGU), mobile lifting equipment is divided into three subclasses: lifting winches, lifting units or installations, and a lifting unit complex. In this context, equipment that integrates the mast, winch, and all necessary components for lowering and lifting operations is categorized as lifting units or lifting installations [4]. Furthermore, if a lifting unit incorporates additional features to facilitate drilling operations, it can be classified as a drilling complex.

To illustrate further, let's consider specific examples. Kuyurgazinsk Oilfield Equipment Plant LLC manufactures APRS-50 (АПРС-50) and APRS-40 (АПРС-40) lifting units designed for well workover. Importantly, APRS-50 (АПРС-50) possesses the added capability of conducting drilling work. Another instance is AzINMASH 60/80 (АзИНМАШ 60/80), which, according to the manufacturer's classification, is labeled as a lifting unit. This equipment is designed for maintenance, overhaul, and drilling of oil and gas wells up to 1600 meters deep [5]. Simultaneously, AzINMASH-37 (АзИНМАШ-37), UP-50 (УП-50), UPT-32 (УПТ-32), and similar models are also considered lifting units but are exclusively intended for lowering and lifting operations during the underground repair of oil and gas wells [6].

It is noteworthy that manufacturers in the CIS and Azerbaijan typically do not subdivide drilling machines into subclasses. As a result, both 50- and 200-ton drilling machines are encompassed within the same class—the category of "mobile drilling complexes".

The conducted studies reveal a lack of clear definition in the demarcation between lifting winches, units for overhaul and underground repairs, and mobile drilling equipment. Equipment with distinct purposes and fundamental components (such as rotor, elevator, hydraulic pump, etc.) is uniformly classified and not further subdivided into subclasses.

The examples provided lead to the conclusion that distinctions between units designed for maintenance and workover of wells and low-power drilling rigs are conditional. In some cases, a unit may be exclusively utilized for maintenance, while in others, it may serve for workover or drilling. This conditional nature of classifications poses both organizational and technical challenges.

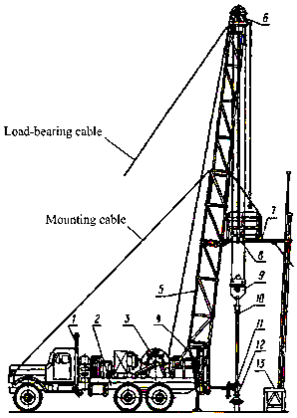

Fig. 3. AzINMASH-37A: 1 — front stabilizer; 2 — chassis of the KrAZ-260; 3 — winch; 4 — rear stabilizer; 5 — MAS (presumably an abbreviation or a specific component); 6 — upper work platform; 7 — centering device; 8 — hoist block; 9 — pipe elevator; 10 — manipulator MT-3; 11 — spider SG-32; 12 — substructure.

In 2014, Azerbaijan and other CIS countries adopted GOST (ГОСТ) ISO/TR 12603–2014 standards for the classification of construction machinery and equipment [7]. However, these standards lack a dedicated section for oil and gas drilling machines and lifts for underground well workovers. Notably, mobile lifting and drilling equipment used in oil and gas wells exhibit structural differences from construction lifting and drilling equipment. Despite initial visual similarities with comparable construction equipment, oil and gas equipment have a specific set of units essential for drilling, including a rotor, elevator, drilling piston pumps, a swivel, and other specialized components.

III. CATEGORIZATION OF DRILLING RIGS

In the established standard, construction machinery and equipment are systematically categorized according to the technological approach to work and the volume of work

accomplished [8]. For example, trucks are classified by carrying capacity, and aerial platforms are sorted based on the height of the basket. When it comes to mobile rotary and turbo drilling equipment, considering parameters like drilling depth as the primary technical characteristic or volume of work performed is logical. However, it's crucial to recognize that drilling depth is influenced not only by the technical specifications of the drilling equipment but also by various factors such as the geological structure of the earth, bit quality, drilling fluid pressure, well diameter, and more.

Given these complexities, a more refined approach to classification could involve categorizing mobile rotary drilling machines based on the rated torque of the rotor, whether transmitted to the drill rod or from the hydraulic pump to the turbo drill. At this research stage, the primary technical characteristic for drilling machines could be their conditional drilling depth. Conversely, for lifting units and winches, a pertinent criterion defining the work performed could be the carrying capacity. This nuanced classification system takes into account the distinctive functionalities and performance parameters of these equipment types, contributing to a more accurate representation in the standards.

To address the aforementioned issue, I propose classifying mobile rigs for drilling and repair work in the following manner, with a precise delineation of work boundaries based on purpose and scope (figure 4) [9].

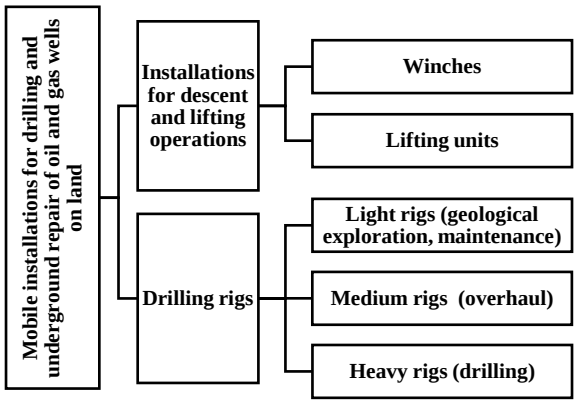

Fig. 4. Classification of mobile rigs for drilling and repair work

Mobile equipment designed for underground repair and drilling in oil and gas wells can be effectively categorized based on their technical capabilities into at least two primary classes: Installations for descent and lifting operations and Drilling rigs. Within the Installations for descent and lifting operations class, two distinct subclasses emerge: Winches and Lifting units. Meanwhile, the Drilling rigs class is proposed to be further divided into three subclasses to provide a more detailed classification:

1. Light rigs: Intended for drilling geophysical and structural wells with depths up to 300 meters (approximately 980 feet).

2. Medium rigs: Designed for drilling wells up to 2000 meters (about 1.24 miles) in depth, catering to both drilling and overhaul purposes.

3. Heavy rigs: Tailored specifically for drilling wells that exceed 2000 meters (more than 1.24 miles) in depth.

This classification system is devised to offer a clear and comprehensive framework for distinguishing mobile equipment based on their specific functions and capabilities within the context of oil and gas well operations.

IV. Conclusion

Through our research, it has become evident that the current classification for mobile drilling rigs and underground workover units for onshore oil and gas wells is conditional, outdated, and lacks precision in identification. This ambiguity has resulted in organizational and technical challenges during operations. In response, we propose a simplified classification for mobile units involved in drilling and repair work on oil and gas wells. This streamlined classification aims to address the shortcomings of the current system and enhance the clarity and efficiency of categorizing these essential units in the field.

References

[1] H. Fang and M. Duan, “Offshore Oil and Gas Drilling Engineering and Equipment. Offshore Operation Facilities”, Gulf Professional Publishing, China, No. 1196, pp. 141-340, September 2014.

[2] R. Baker, “A Primer of Oil Well Drilling”, Petroleum Extension Service, Houston, Texas, 1979.

[3] N. Vaddadi, “Introduction to Oil Well Drilling”, New Delhi, India, 2015.

[4] O. F. Danilov, “The Device of Special Automotive Equipment for the Oil and Gas Industries”, Nedra Publishing House, Moscow, 1997.

[5] P. V. Kutsyn, “Mechanization of Work in the Construction of Oil and Gas Wells”, Nedra Publishing House, Moscow, 1989.

[6] A. D. Amirov, “A reference book on current and major repairs of oil and gas wells”, Nedra Publishing House, Moscow, pp. 7-59, 1979.

[7] “Interstate Standard GOST ISO/TR 12603-2014 Construction Machinery and Equipment Classification”, Moscow, 2016.

[8] N. Solovyov, “Handbook of the Engineer of the Enterprise of Technological Transport and Special Equipment”, Infra-Engineering, Moscow, 2015.

[9] J. Sh. Talibov, “Defining the Potential and Technical Zones. Actual Problems of Economics", Scientific Economic Journal, Kyiv, No. 9(159), pp. 534-539, 2014.