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CONCEPTUAL APPROACHES TO IOT-BASED PERSONNEL HEALTH MANAGEMENT IN OFFSHORE OIL AND GAS INDUSTRY

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1. Introduction

The offshore oil and gas industry is one of the leading segments of industry and plays a key role in global oil and gas supplies. Currently, about 40% of oil and 30% of gas is produced in offshore fields. According to the experts' estimates, in the next 20-30 years, the deposits located at a considerable distance from the coast, i.e. "deepwater" (from 400 m to 1.5 km) and "ultra-deepwater" (from 1.5 km or more) are estimated to become the main source of expansion of hydrocarbon production [4]. A stable tendency to develop hydrocarbon resources in more "difficult" conditions requires the use of high-tech equipment, new innovative methods for collecting, transmitting and processing a large amount of data received from geographically distributed offshore facilities [2,8]. These factors stimulate the growing interest of oil companies in digitalizing the industry and introducing new technologies, in particular, the Internet of Things (IoT), in numerous business processes [3, 11].

However, achieving production efficiency based solely on the digitalization of various operational processes does not seem realistic. Today, a large number of skilled workers and specialists are involved in many oil and gas operation processes, whose functional duties and labor activities are associated with potential health hazards, especially in the offshore segment. This has a significant impact on the physiological state of the latter and their behavior, increases the probability of errors and involvement in emergency situations [1, 7]. According to experts, IoT technologies can eliminate a number of potential dangers for humans [9]. Moreover, the concept and tools of Industry 4.0 provide the opportunity to develop IoT-based cyberphysical systems, which in the future will partially or fully depersonalize the operational processes implemented in the offshore oil and gas segment [5, 6, 10]. At the same time, we share the opinion of the authors who believe that a human will be involved in the oil and gas industry management circuit (human in the loop) at all stages of the life cycle of the latter for a long time. Therefore, the digital transformation, first of all, should be aimed at creating an ambient intelligence for residence and working activity of a human. In this regard, the present work focuses on the study of the capabilities of IoT to support the safety and health of oil and gas industry personnel with an emphasis on the offshore segment.

2. Conceptual statement of the problem

In this article, an object of the study is offshore oil facilities, equipped for residence and working activity of personnel in accordance with their purpose (hereinafter a term "offshore oil platforms" (OOP) will be used), and a subject of the study is the issues of intelligent health management of the personnel engaged in offshore oil and gas industry.

The goal of this study is to develop a conceptual approach to the development of an intelligent health management system for OOP personnel based on IoT technology, which we call the Digital Health complex. The main idea of the proposed conceptual approach is to include continuous remote monitoring of health indicators, geolocation parameters, behavioral patterns of personnel during the work shift on OOP, and the environmental parameters using IoT technology as the main component of the personnel health management.

In essence, IoT technologies in the personnel safety and health management system, which are a tool for continuous monitoring of physiological, geolocation and other parameters of employees, provide a "snapshot" of the health status, location and actions of the personnel, provide real-time feedback from the employees to coastal medical Smart center for personnel health management.

Conceptually, the process of managing the health of OOP personnel can be grouped into three main stages (Fig.1):

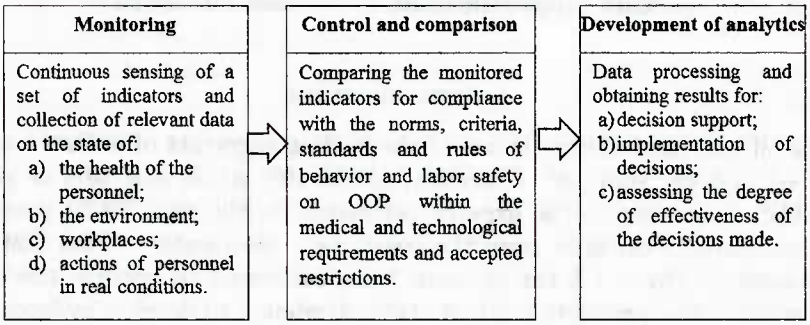

Figure 1. Functional model of personnel health management of OOP .

3. Solution to the problem

Within the framework of the concept, we propose to develop a three-level intellectual health management system Digital Health for the personnel working on OOP. Each level of the Digital Health complex (distributed system) is an address information system that has its purpose and functions, and at the same time, is integrated into a single decision support process for managing the health of the personnel.

The first level of the distributed system (DS) Digital Health system includes the place of residence of the personnel, i.e. OOP. The personnel undergoing the shift on OOP, in this case, acts as a biological object equipped with wearable medical sensors, and is a source of information. Intelligent sensors measuring various physiological and tracking (positioning) parameters of the employee, as well as the environmental parameters, transmit this information (with a certain frequency or in case of deviation from the norm) to the Local Situation Center for Emergency Response (LSCER) located on OOP (Dew Computing level). The need for such centers on OOP in oilfield areas is due to the fact that, first of all, operational decisions related to ensuring the safety of personnel must be made at the scene of the incident that and, in particular, immediate first aid must be provided by an authorized person (health worker).

The second level of the Digital health includes a remote intelligent personnel health monitoring system (RIPHMS), which is located in a stationary (coastal) medical center for personnel health monitoring. RIPHMS is intended for the collection, storage, information-analytical processing and evaluation of various types of data on the health of oil workers. The system is designed as the central link of an integrated hierarchically distributed system for personnel health management. At this level, the basic processes for providing remote medical care are performed and an integrated information database is formed, which includes retrospective medical data and conclusions of systematic examinations, as well as pre-shift medical examinations, continuously

received current data on the health status of workers during the shift on OOP (Fog Computing level). Making decisions on the provision of prompt medical care on OOP in each specific situation depends on the criticality of the values of the monitored medical indicators, considering the retrospective information on the health status of the victim.

The third level of the DS Digital Health system (Cloud Computing level) includes:

(1) analytical tools for data mining and decision support (DSS, BI, BigData analytics, etc.);
(2) private clouds, containing Electronic Health Records of each employee, consolidating the personal medical records of the employee, accumulated in medical organizations, which the latter has been visiting throughout his life;
(3) an intelligent drug selection system that takes into account the individual characteristics of the body and the negative reaction of each employee to certain medicines.

The electronic system Digital Health implies the support for retrospective data. The systematic replenishment of the information base with sensed data on the health status of oil workers over a long period of time (several years) will allow for the formation of a fairly representative medical database of each employee, which is one of the main components of the Digital Health system. This, in turn, will provide an opportunity to develop a personalized model (trajectory) of employees' "health" behavior and provide responsible persons with the information to support decisions on the professional eligibility of an employee in his position. The information collected will also allow for making informed decisions to improve the activities regarding the safety of the personnel, preventing the risks of accidents and injuries.

Keywords: Offshore Oil Platform, Internet of Things (IoT), Safety of Personnel on OOP, Personnel Health Management, Conceptual Model of Digital Health.

AMS Subject Classification: 68M14, 68T30, 93C41, 93C62.

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