

The impact of occupational health and safety system implementation on work-related illnesses among drilling rig workers: A review article

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ABSTRACT

The oil and gas drilling industry is widely recognized as a high-risk sector in terms of occupational safety and health (OSH). Workers in this field are frequently exposed to a range of physical, chemical, biological, and ergonomic hazards, which significantly increase their vulnerability to various occupational diseases (ODs). These include, but are not limited to, respiratory disorders, musculoskeletal injuries, and dermatological conditions. Given the complex and hazardous nature of drilling operations, implementation a comprehensive and systematic OSH management system has become essential. This review article aims to synthesize recent literature examining the relationship between the application of Occupational Safety and Health (OSH) systems and the prevention of occupational diseases among drilling rig workers. A thorough evaluation of both national and international studies published in the last five years reveals that effective implementation plays a critical role in reducing the incidence of ODs. The findings consistently highlight that the most significant improvements are achieved through proactive risk control measures, ongoing worker training programs, and continuous environmental monitoring. These strategies, when integrated into daily operations, contribute to creating a safer work environment, thereby enhancing both worker well-being and overall operational efficiency in high-risk industries such as oil and gas drilling.

Keywords: Occupational safety; occupational health; occupational diseases; rig workers, K3 systems

1. INTRODUCTION

The oil and gas drilling industry is a sector with high risks to occupational safety and health [1]. Drilling rig workers are exposed to a variety of hazards, such as toxic gases, hazardous chemicals, extreme noise, high temperatures, and heavy physical workloads [2]. These risks can cause various occupational diseases (PAK), including respiratory disorders, musculoskeletal disorders, and skin disorders [3], [4]. Data shows that work accidents are often caused by unsafe acts and unsafe working conditions [5]. In addition, unsafe working environments, such as lack of environmental protection and adequate lighting, also contribute to the high number of work accidents [6]. Therefore, the implementation of an effective occupational safety and health (K3) system is very important to protect workers from these risks [7].

Over the past decade, attention to the importance of implementing occupational safety and health (OHS) systems in the drilling industry has continued to increase, especially due to the high risks faced by workers in the field. Various studies have shown that a systematic approach to hazard identification, risk assessment, and risk control—such as through the Job Safety Analysis (JSA) method—is very effective in reducing the potential for occupational diseases (OSDs) [8]. The implementation of an



integrated K3 management system is not only aimed at fulfilling legal and regulatory requirements, but also at building a sustainable work safety culture as part of organizational management [9]. This culture reflects a collective commitment to workforce protection and the sustainability of the Company's operations [10]. However, the implementation of the K3 system in the drilling sector still faces various challenges, including limitations in routine training, lack of technical knowledge of workers regarding work hazards, and weak supervision of the use of personal protective equipment (PPE) [11]. This shows that the success of the K3 system is highly dependent on the involvement of all parties and a consistent and adaptive approach [12]. Therefore, a continuous improvement strategy is needed which includes education, training, periodic evaluation, and updating of work safety technology so that the K3 system can be implemented optimally in the field.

Although various studies have examined the implementation of occupational safety and health (OHS) systems in the drilling industry, challenges to the effectiveness of their implementation continue to emerge, especially in the context of occupational disease prevention (OCD). This indicates an urgent need to explore new approaches that are more innovative and adaptive to modern working conditions. One approach that has great potential is the integration of digital technology into the OHS system [13]. Technologies such as wireless sensors to monitor air quality, temperature, noise levels and the presence of hazardous gases can provide real-time data that can greatly assist in rapid decision-making to prevent hazardous exposures [14]. Additionally, mobile applications that allow for direct reporting of hazards by workers can speed up response to potential risks [15]. On the other hand, participatory approaches, where workers are involved in the process of hazard identification, risk analysis, and OHS decision-making, have been shown to increase a sense of responsibility and compliance with safety procedures. Simulation-based or virtual reality (VR) training is also increasingly relevant to improving workers' understanding of complex hazard scenarios [16]. By combining technology and active participation, the OHS system can be significantly improved to address the occupational health challenges in the modern drilling sector [17].

The main objective of this review article is to evaluate the extent to which the implementation of occupational safety and health (OHS) systems can reduce the incidence of occupational diseases (PAK) in the drilling rig work environment. Drilling rigs are known as high-risk work areas, where workers are exposed to various potential hazards every day such as toxic chemicals, high pressure, extreme temperatures, noise, and heavy physical activity that occurs continuously [18]. In this context, a structured and sustainable K3 system is believed to play an important role in efforts to prevent long-term health risks that can lead to PAK [19]. Therefore, this article is prepared with a literature synthesis approach that collects, compares, and analyzes various related study results from the last five years, both those conducted in Indonesia and in an international context. This study not only describes the existing conditions of the implementation of the OHS system in various drilling companies, but also identifies best practices, implementation barriers, and recommendations that can be applied to strengthen the effectiveness of the OHS system in reducing PAK incidents. Thus, this article is expected to provide a useful scientific contribution to the development of OHS policies and practices in the energy industry sector.

2. METHOD

This study uses a narrative literature review approach as the main method to collect, examine, and synthesize information from various relevant scientific sources. This approach was chosen because it is able to provide a comprehensive picture of the relationship between the implementation of occupational health and safety (OHS) systems and occupational diseases (PAK) in drilling rig workers. Literature searches were carried out systematically using several main databases, namely Scopus, PubMed, Google Scholar, and Garuda, in order to reach both reputable international publications and national scientific articles indexed by Sinta. The search process used keywords such as "occupational health and safety", "oil and gas drilling rig", "occupational diseases", and "workplace safety system", both in Indonesian and English. All publications found were then evaluated based on the suitability of the topic and its scientific contribution to the focus of this study.

The inclusion criteria were strictly set to ensure the relevance and quality of the information reviewed. The selected articles had to meet several requirements, namely (1) published between 2018

and 2024, to reflect the current context and challenges in the field of OHS in the oil and gas drilling industry; (2) have a primary focus on the topic of occupational safety and health systems in the oil and gas sector, especially on drilling rigs; and (3) present empirical findings or conceptual analysis that link the implementation of the OHS system with aspects of worker health, especially related to incidents of occupational diseases. Articles that only discuss safety aspects without a health dimension were not included, as were articles with weak methodological quality. The selection was carried out by reading the abstract and main content to ensure that each selected article was relevant and of high quality according to the needs of the study.

In the initial search results that produced more than 80 articles, a multi-layered screening process was carried out to ensure that only articles with high relevance were used. After going through a selection process based on inclusion criteria, 25 scientific articles were selected that met the requirements for further analysis. The articles were then classified based on geographical area (national or international), type of research approach (quantitative, qualitative, or mixed), and focus of the study (prevention, risk management, training, or monitoring aspects of the work environment). The synthesis process was carried out narratively, namely by grouping the main findings of each article and identifying consistent thematic patterns related to the effectiveness of the implementation of the K3 system in reducing the prevalence of occupational diseases in the drilling rig environment. Thus, this method not only provides a systematic literature mapping but also supports the development of a conceptual framework that can be used for further research.

3. RESULTS AND DISCUSSION

Types and risks of occupational diseases in drilling rig workers

Drilling rig workers face a variety of complex and interrelated potential risks, which in the long term can cause occupational diseases (OCD). Based on the results of a review of 25 selected articles, it was found that the most dominant types of OCD in rig workers include respiratory system disorders due to exposure to toxic gases such as hydrogen sulfide (H₂S), silica, and bioaerosols originating from drilling waste management. A study by Eriksen et al. showed that offshore drilling waste workers experienced a significant increase in symptoms of respiratory disorders and skin irritation due to exposure to microorganisms and immunogenic agents in the air [20]. Other common types of PAK are musculoskeletal disorders that arise from repetitive physical activity, heavy lifting, and non-ergonomic working positions. In addition, hearing loss due to prolonged noise exposure, as well as neurological disorders and muscle fatigue due to mechanical vibration, are also commonly found in rig workers. A study by Mahalkar et al. noted a high prevalence of hearing loss, peripheral neuropathy, and motor system disorders in oil and gas workers who were exposed to continuous noise and vibration [21]. On the other hand, psychosocial stress such as chronic work stress is also a serious issue, especially on offshore rigs that implement strict shift work systems and operate in isolated environments. Mehta et al. in their qualitative study showed that offshore workers experience severe fatigue due to high physical and mental work demands, poor sleep quality, and social and emotional stress, all of which can lead to mental health disorders and work accidents [22].

All of these types of PAK are rooted in risk factors that are often undetected or under-appreciated in operational management systems, such as poor ventilation, inadequate lighting, unsustainable OHS training, and inconsistent use of personal protective equipment (PPE). Therefore, early identification of risk factors is a strategic step in preventing the emergence of PAK cases more widely. The literature reviewed shows that regular risk mapping through direct observation and quantitative measurements of the work environment—such as measuring hazardous gas levels, noise levels, and microbiological exposures—is an important practice that drilling companies must implement to protect workers' long-term health.

The impact of implementing the K3 system on reducing PAK incidents

The implementation of a comprehensive occupational safety and health (OHS) system has been proven to have a significant correlation with the reduction in the incidence of occupational diseases (PAK) in the oil and gas drilling sector. Various studies have shown that companies that implement an OHS management system based on international standards such as ISO 45001:2018 or national SMK3

experience a reduction in the number of OHS by 30-50% within three years of implementation. For example, research in the Waha Oil Company oil and gas field in Libya revealed that all components of ISO 45001:2018 contributed negatively to the number of work accidents, meaning that the more complete the system implementation, the lower the level of incidents that occur [23]. Similar findings were also seen in a study of OHS system monitoring in the mining and drilling sector in Indonesia, which noted improved safety performance through the socialization of work procedures and regular training based on ISO standards [24].

Some of the most effective system elements include ongoing occupational safety training, regular health checks, periodic monitoring of the work environment, and risk control through engineering and safe work procedures. Organizations that adopt the ISO 45001 system are better able to develop measurable risk action plans and controls in their operational activities [25].

In addition, the active participation of workers in OHS activities such as Safety Toolbox Meetings, Near Miss reporting, and internal audits also strengthen the work safety culture. This culture is important in forming organizational resilience to high work pressure and emergency conditions in the field. The ISO 45001 structure that follows the Deming cycle (Plan-Do-Check-Act) encourages organizations to continuously improve their OHS performance through effective participation and communication [26].

However, the effectiveness of the OHS system is highly dependent on top management commitment and resource availability. A study at the Iraqi Ministry of Oil identified that weak internal audits and lack of training resulted in high levels of non-conformity to the ISO 45001 standard, which directly increased potential work risks [27]. Periodic evaluation of the effectiveness of the system is crucial as part of continuous improvement efforts, so that the K3 system is not only administrative in nature, but is truly integrated into the daily work culture.

4. CONCLUSION

The implementation of a comprehensive and sustainable occupational safety and health (OHS) system plays an important role in reducing the incidence of occupational diseases (OCD) in drilling rig workers. The main objective of this article is to evaluate the effectiveness of the OHS system on the prevalence of OCD, considering the high risk of exposure to physical, chemical, biological, and ergonomic hazards in the work environment. The study method used is a narrative literature review of 25 selected articles from leading databases, both national and international, with strict criteria to ensure relevance and quality. The results of the review indicate that the types of OCD that commonly occur include respiratory, musculoskeletal, hearing, and psychosocial disorders, which are mostly triggered by continuous exposure to toxic gases, noise, vibration, and heavy physical and mental workloads. The implementation of an OHS system based on ISO 45001:2018 or a national OHSMS has been proven to be able to reduce the OCD rate by up to 50% within three years, especially if it includes ongoing training, routine health checks, work environment monitoring, and technical risk control. Active worker participation in OHS activities and top management support are important factors in forming a strong safety culture. However, the success of the K3 system still faces challenges in terms of limited resources and technology implementation. Therefore, a collaborative approach and the use of digital innovation are recommended to strengthen the K3 system that is adaptive to modern work dynamics..

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