REVISTA PERCURSO

ENVIRONMENTAL CRISIS MANAGEMENT ON OFFSHORE OIL WELL DRILLING RIGS: EMERGENCY EFFLUENT DISPOSAL AND ANALYSIS OF ENVIRONMENTAL AND HEALTH IMPACTS

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ABSTRACT: This study examines environmental crisis management and emergency effluent disposal on offshore drilling platforms, focusing on an incident that occurred a decade ago. The analysis covers the technical and legal responses to the event, highlighting health and environmental risks, and suggests improvements in managing such situations. Offshore platforms generate waste and effluents that require effective management. The study investigates a critical failure in the effluent treatment system that led to the decision to discharge untreated effluent into the sea, triggering an environmental crisis. The research conducts a case analysis of the incident, exploring the interaction between Brazilian regulations and international

guidelines. It includes a description of the event, an assessment of legal and scientific issues, and a review of the corrective measures implemented. The incident revealed the challenges of balancing environmental compliance with health protection. The controlled release of untreated effluent minimized immediate damage but raised long-term concerns, highlighting tensions between national regulations and stricter international standards. The study contributes to the understanding of crisis management on offshore platforms, emphasizing the risks of inadequate effluent management and proposing recommendations to improve environmental management and emergency response.
Keywords: Environmental Crisis Management; Environmental Compliance; Brazilian Environmental Regulations; International Guidelines; Offshore Drilling Rigs

GESTÃO DE CRISES AMBIENTAIS EM PLATAFORMAS DE PERFURAÇÃO DE POÇO DE PETRÓLEO OFFSHORE: DISPOSIÇÃO EMERGENCIAL DE EFLUENTES E ANÁLISE DOS IMPACTOS AMBIENTAIS E DE SAÚDE

RESUMO: Este estudo examina a gestão de crises ambientais e o descarte emergencial de efluentes em plataformas de perfuração offshore, com foco em um incidente ocorrido há uma década. A análise abrange as respostas técnicas e legais ao evento, destacando os riscos para a saúde e o meio ambiente, e sugere melhorias na gestão dessas situações. As plataformas offshore geram resíduos e efluentes que exigem uma gestão eficaz. O estudo investiga uma falha crítica no sistema de tratamento de efluentes que levou à decisão de liberar efluente não tratado no mar, desencadeando uma crise ambiental. A pesquisa realiza uma análise de caso do incidente, explorando a interação entre as regulamentações brasileiras e as diretrizes internacionais. Inclui uma descrição do evento, uma avaliação das questões legais e científicas, e uma revisão das medidas corretivas implementadas. O incidente revelou os desafios de equilibrar a conformidade ambiental com a proteção da saúde. A liberação controlada de efluente não tratado minimizou os danos imediatos, mas gerou preocupações a longo prazo, destacando tensões entre as regulamentações nacionais e as normas internacionais mais rigorosas. O estudo contribui para a compreensão da gestão de crises em plataformas offshore, evidenciando os riscos de uma gestão inadequada de efluentes e propondo recomendações para aprimorar a gestão ambiental e a resposta a emergências.
Palavras-chave: Gestão de Crises Ambientais; Conformidade Ambiental; Regulamentações Ambientais Brasileiras; Diretrizes Internacionais; Plataformas de Perfuração Offshore

1. INTRODUCTION

Offshore oil drilling rigs play a pivotal role in the exploration and extraction of energy resources essential to global supply. These operations, however, are fraught with complex environmental challenges, particularly regarding effluent management and adherence to stringent environmental regulations. The operational environment of offshore drilling, characterized by its isolation and the need for rapid response capabilities, demands exceptional attention to detail in managing waste and effluent byproducts. Any lapse in these areas can lead

to significant crises with far-reaching consequences for both human health and the marine ecosystem.

The marine environment in which these rigs operate is not only challenging but also highly sensitive. The high stakes of energy extraction in such environments necessitate a robust framework for environmental protection, ensuring that the activities do not irreparably damage the surrounding ecosystem. In particular, the management of effluents—ranging from sewage and synthetic drilling fluids to various chemical byproducts—requires advanced treatment systems and vigilant operational protocols. The failure to effectively manage these effluents can result in severe pollution, with cascading effects on water quality, marine life, and the broader ecological balance. Moreover, the health and safety of the workforce aboard these rigs are directly linked to the adequacy of sanitary conditions, underscoring the dual imperative of protecting both environmental and human health.

In this context, compliance with environmental regulations becomes not just a legal obligation but a fundamental aspect of responsible offshore operations. The complexity of managing effluents in such a challenging environment is further compounded by the need to adhere to both local and international standards, which often impose rigorous restrictions on waste discharge practices. Any deviation from these standards, whether due to technical failures or emergency situations, can trigger legal and ethical dilemmas, as well as significant reputational risks for the operating companies.

This introduction sets the stage for a detailed exploration of the environmental challenges associated with offshore drilling, particularly in the realm of effluent management. The subsequent sections will delve into the context of offshore operations, the importance of regulatory compliance, and the inherent challenges of managing environmental crises in this demanding and highly regulated industry. Through a focused case study, this work aims to shed light on the intricacies of crisis management in offshore drilling and to propose strategies for improving both environmental stewardship and operational resilience.

1.1. CONTEXT OF OFFSHORE OPERATIONS

Offshore operations, particularly in the oil and gas industry, are characterized by their complexity and the challenging environments in which they are conducted. These operations involve the exploration, extraction, and processing of hydrocarbons beneath the ocean floor, often in deep and ultra-deep waters. The remote locations of these platforms, coupled with harsh

weather conditions, make offshore operations inherently risky and demanding in terms of logistics, safety, and environmental management.

The offshore industry has grown significantly over the past decades, driven by the global demand for energy. As reserves onshore become increasingly depleted, companies have pushed further into offshore areas, seeking new reserves in deeper waters. This expansion has necessitated the development of advanced technologies and sophisticated infrastructure to support exploration and production activities. However, with this expansion comes an increased potential for environmental impacts, particularly related to the discharge of effluents and the management of waste generated during operations.

One of the primary environmental concerns associated with offshore operations is the production and disposal of effluents, including drilling fluids, produced water, and other waste by-products. These effluents, if not properly managed, can have significant adverse effects on marine ecosystems. The discharge of untreated or inadequately treated effluents can lead to pollution, affecting marine life and potentially disrupting the ecological balance of the surrounding areas.

Moreover, offshore platforms operate in a regulatory landscape that is both complex and evolving. Regulations governing offshore operations vary by region and are influenced by both national laws and international guidelines. Operators must navigate this intricate regulatory framework to ensure compliance while maintaining efficient and safe operations. The challenges of regulatory compliance are compounded by the need to balance economic interests with environmental protection, a task that becomes even more critical in the face of an environmental crisis.

In addition to the environmental challenges, offshore operations must also address issues related to health and safety. The remote and isolated nature of these platforms means that any incident, whether it be a spill, leak, or equipment failure, can quickly escalate into a major crisis with far-reaching consequences. Effective crisis management plans, therefore, are essential to mitigate risks and ensure the safety of personnel and the environment.

Given the critical role of offshore operations in meeting global energy needs, the importance of sustainable and responsible management practices cannot be overstated. This includes not only adhering to regulatory requirements but also implementing best practices for environmental stewardship. In this context, the ability to respond swiftly and effectively to environmental incidents is paramount, as is the ongoing evaluation and improvement of effluent management systems.

In summary, the context of offshore operations is defined by a confluence of technical, environmental, and regulatory challenges. The industry's ability to address these challenges through robust management strategies will determine its capacity to operate sustainably in the long term. This study's focus on an environmental crisis within this context underscores the need for continuous improvement in the management of effluents and the overall environmental impact of offshore operations.

1.2. IMPORTANCE OF COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

Compliance with environmental regulations is key to mitigating the risks associated with offshore operations. Several jurisdictions, including Brazil and the foreign countries of origin of the operating companies, have strict legislation designed to protect the marine environment and ensure safe operating practices. These regulations often include severe restrictions on the discharge of effluents and pollutants into the marine environment, requiring proper treatment and minimization of impacts.

In Brazil, for example, Law No. 9.605/1998 establishes penalties for environmental infractions and prohibits the discharge of pollutants without treatment, reflecting concern for environmental preservation. CONAMA Resolution 357/2005 defines the standards and conditions for discharging effluents, while Decree 6.514/2008 regulates inspection and the imposition of sanctions. Internationally, company guidelines and multilateral agreements also guide responsible operating practices and the protection of the marine environment.

1.3. CHALLENGES IN ENVIRONMENTAL CRISIS MANAGEMENT

Managing environmental crises on offshore rigs is a significant challenge due to the combination of technical, operational and legal factors. Failures in effluent treatment systems, such as the failure of an Effluent Treatment Plant - ETE shown in figure 1, can lead to emergency situations where the disposal of effluent becomes unavoidable. In this context, the decision to release effluent into the sea can be influenced by several factors, including the urgency of the situation, the available treatment capacity, and legal and corporate guidelines.

Figure 1: WWTP used on oil rigs. Credits: Veolia Water Technologies & Solutions

The response to such crises must balance the immediate need to ensure adequate sanitary conditions for workers with compliance with environmental regulations. Even if controlled, the decision to release effluent into the marine environment raises ethical and legal questions and can have long-term implications for the company's environmental health and reputation.

1.4. STUDY OBJECTIVES

This case study aims to analyze the management of environmental crises and the emergency disposal of effluents on offshore drilling rigs, exploring a specific incident that occurred more than a decade ago. The aim is to evaluate the technical and legal response to the incident, identify the risks to workers' health and the environment, and propose recommendations for improving environmental and operational management in similar situations. The analysis integrates Brazilian and international legislation, highlighting the challenges faced and the best practices recommended for dealing with and mitigating environmental crises in offshore operations.

By offering a detailed overview of the incident and the practices involved, this article contributes to the understanding of the challenges associated with effluent management on offshore rigs and provides guidelines for strengthening environmental compliance and improving emergency response in the oil and gas sector.

2. METHODOLOGY

This study employs a case study approach, focusing on the detailed analysis of an environmental crisis on an offshore oil drilling rig. The methodology follows a qualitative and quantitative mixed-method approach, ensuring a comprehensive evaluation of the incident and its implications. The methodological framework is structured into the following key stages:

2.1 DATA COLLECTION - THE STUDY INTEGRATES MULTIPLE DATA SOURCES TO BUILD A ROBUST ANALYSIS, INCLUDING:

• Official Reports and Documents: Governmental and corporate records related to environmental incidents and compliance reports (Soares et al., 2020).
• Regulatory Frameworks: Brazilian and international environmental laws, industry best practices, and offshore drilling safety guidelines (Medes et al., 2014).
• Interviews and Expert Opinions: Consultations with professionals from the oil and gas sector, environmental specialists, and regulatory authorities.

2.2 CASE STUDY SELECTION CRITERIA

The selected incident was chosen based on:
• Severity of Environmental Impact: The case involved the emergency discharge of untreated effluent, presenting significant risks to marine ecosystems (Pazniak, 2022).
• Regulatory and Corporate Conflict: The event showcased legal and operational challenges, including discrepancies between national regulations and corporate environmental policies (Kojola;Lequieu,2020).
• Data Availability: The case was well-documented, enabling a thorough examination of crisis management measures and their outcomes.

2.3 DATA ANALYSIS TECHNIQUES

To ensure a rigorous assessment, the study applied the following analysis methods:

• Content Analysis: Examine reports, legal documents, and policy guidelines to identify key themes and regulatory gaps (Horobeț et al., 2024).

• Comparative Legal Analysis: Evaluation of Brazilian environmental laws against international standards to assess compliance and enforcement challenges (Oliveira; Junior, 2024).

• Environmental Impact Assessment (EIA): Review of pollution levels, marine biodiversity impact reports, and potential long-term consequences of the effluent discharge (Zhang, 2025).

• Risk Assessment Frameworks: Apply established environmental risk models to quantify the severity of the incident and identify preventive measures (Vora et al, 2021).

2.4 ETHICAL CONSIDERATIONS

The study adheres to ethical research guidelines by:

• Ensuring confidentiality of sensitive corporate and regulatory information.

• Maintaining neutrality and objectivity in the interpretation of findings.

• Prioritizing environmental and public health interests over corporate or political influences (Ajemba; Arene, 2022).

2.5 LIMITATIONS OF THE STUDY

While the research provides an in-depth analysis, some limitations must be acknowledged:

• Data Access Restrictions: Some proprietary corporate data on environmental compliance were unavailable for detailed review (Shea et al., 2023).

• Evolving Regulations: The study is based on legal frameworks at the time of the incident, which may have since undergone modifications (Stoughton, 2013).

• Long-term Environmental Effects: Due to time constraints, the study does not include longitudinal environmental impact assessments beyond immediate post-incident reports (Hardcopf et al., 2021).

By structuring the methodology with these elements, the study ensures a rigorous, well-documented, and multi-perspective analysis of environmental crisis management on offshore drilling rigs.

3. INCIDENT DESCRIPTION

The incident analyzed took place on an offshore drilling rig, a complex and autonomous facility responsible for the exploration and extraction of oil offshore. The rig in question was equipped with a sewage treatment system (STS), designed to manage and treat the waste generated by the crew on board, including wastewater from toilets and other sanitary areas. This system is crucial for maintaining adequate living conditions and ensuring compliance with environmental regulations, prohibiting untreated effluent discharge into the marine environment.

However, the rig's ETE suffered a significant technical failure, which compromised its operation. After an initial repair period, the plant was reinstalled and began operating again. However, the WWTP suffered another breakdown within a matter of hours of being restored. This failure was critical since the plant was already filled with effluent accumulated during the period it was inoperative. With the WWTP out of operation again and the treatment system unable to process the effluent, the situation on board became untenable.

Faced with this scenario, the rig team implemented an emergency solution: transferring the accumulated effluent to one of the mud tanks. This tank, used to store synthetic mud used in drilling oil wells, was not designed to manage sewage effluent, as illustrated in Figure 2.

Figure 2: Synthetic mud tank used on oil rigs. Credits: fonelovear

The aim was to gain additional time to repair the WWTP, but this measure presented its own set of challenges. As the mud tank filled up with effluent from the WWTP, the available capacity for synthetic mud began to decrease, raising new concerns about storage capacity and the continuity of drilling operations.

With the mud tank reaching its maximum capacity and no immediate plans to resolve the problems with the wastewater treatment plant, the platform faced a health crisis. The resources available for using the toilets were drastically reduced, affecting both the bathing facilities and the toilet areas for workers' basic physiological needs. The compromised sanitary conditions on board created a potentially unhealthy environment, increasing the risk of health problems for workers.

Faced with deteriorating living conditions and the urgency of the situation, the rig's captain, a professional of foreign origin, suggested releasing the effluent directly into the sea. This decision was intended to relieve pressure on the storage system and restore minimum sanitary conditions on board. However, this proposal conflicted with the company's environmental guidelines, which prohibit the release of untreated effluent into the sea. According to the company's rules, which were stricter than local requirements, any discharge into the marine environment had to be avoided at all costs.

The rig’s manager, lined up with company guidelines, initially denied the captain's request. However, the situation on board continued to worsen, and the Brazilian fiscal engineer

responsible for supervising operations intervened. Under pressure and considering the imminent health risks, the engineer authorized the release of the effluent into the sea. This decision was documented and reported immediately to the company's headquarters in Brazil.

The incident generated a prompt response from local authorities, including the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) and the Brazilian Navy. An investigation was set up to ascertain the circumstances and possible violations of environmental regulations. The company, upon identifying the captain as responsible for going against corporate guidelines, arranged for him to be disembarked for further clarification and assessed the possibility of disciplinary action.

The environmental impact of the incident was minimized by the controlled release of effluents, with no immediate evidence of significant damage to the marine environment. However, the event highlighted the critical need for efficient crisis management, the importance of compliance with regulations, and the implementation of effective corrective measures to prevent similar occurrences in the future. (Bussmeyer; Henkes, 2015)

4. LEGAL AND SCIENTIFIC ANALYSIS

Analyzing the incident involving the failure of the sewage treatment plant and the subsequent release of effluent into the sea requires a detailed understanding of both Brazilian environmental regulations and the company's international guidelines. This examination highlights the legal and scientific aspects that shaped the response to the incident and the compliance implications.

4.1. BRAZILIAN LEGISLATION

Brazilian environmental legislation establishes a strict framework for the management of effluents and the protection of water resources. The main regulations that apply to the incident are:

- Law No. 9.605/1998 defines penalties for environmental infractions and prohibits the release of pollutants into the environment without proper treatment. According to Law No.

9.605/1998, any activity that results in the release of pollutants without proper treatment is considered an environmental crime, subjecting those responsible to fines and other sanctions (Brasil, 1998). In the context of the incident, the release of untreated effluent into the sea violated this law, establishing the need for penalties following Decree 6.514/2008 (Brasil, 2008).

- CONAMA Resolution 357/2005 establishes the standards and conditions for discharging effluents into bodies of water, including the sea. CONAMA Resolution 357/2005 requires effluents to be treated in such a way as to meet the established standards before being released into the environment (Brasil, 2005). In the case of the rig, the failure of the ETE and the subsequent release of effluents into the sea represented a direct violation of these standards, since the effluents were not properly treated.
- Decree No. 6.514/2008 regulates the supervision and application of sanctions for environmental crimes, including fines and other penalties for violations of environmental standards (Brasil, 2008). The application of this decree is essential to ensure that companies that commit environmental infractions are held accountable and that corrective practices are implemented. In the incident analyzed, although the legislation allows for exceptions in emergencies to protect public health, the company would have faced significant risks of sanctions and fines if the release had not been controlled.

4.2. INTERNATIONAL COMPANY GUIDELINES

The company responsible for the platform is of foreign origin and follows strict environmental guidelines, which prohibit the disposal of untreated effluent at sea, regardless of the emergency circumstances. These guidelines are aligned with the environmental standards of the company's country of origin, which are often stricter than local regulations. Compliance with these international guidelines is essential to maintain the company's reputation and avoid penalties in its home jurisdiction (Benson et al., 2021).

However, the rigidity of these guidelines came into conflict with the emergency need to ensure adequate sanitary conditions for the crew on board. The foreign-owned company establishes policies that aim to minimize any environmental impact, even in crises, which can be seen as a preventative approach to protecting the environment (Benson et al., 2021). However,

this approach can also generate practical challenges in emergencies, where strict compliance may not be feasible without compromising the health and well-being of workers.

4.3. INTERSECTION BETWEEN LEGISLATION AND GUIDELINES

The incident highlights a critical intersection between Brazilian environmental legislation and the company's international guidelines. Although Brazilian legislation allows for some exceptions in emergencies to protect public health, the decision to release the effluent into the sea without treatment was a measure of last resort. The application of international standards and the attempt to comply with corporate guidelines, combined with the urgent need to guarantee health conditions on board, created an ethical and practical dilemma (Lindgren et al, 2016; Li et al, 2013).

The analysis of regulations and guidelines reveals the complexity of managing environmental crises in an international context. The interaction between local regulations and corporate policies requires a balanced approach that considers both environmental protection and the health and safety of workers. The response to the incident and the decision to release the effluent into the sea, despite the legal and environmental implications, were shaped by this delicate balance (Lindgren et al, 2016; Li et al, 2013).

5. RISKS AND IMPLICATIONS

5.1. ENVIRONMENTAL RISKS

The emergency release of untreated effluents into the marine environment can have several negative consequences for the environment:

- Marine Pollution: The inadequate disposal of effluents can lead to the contamination of ocean waters, resulting in the degradation of marine ecosystems. Untreated pollutants and nutrients can cause eutrophication and the proliferation of harmful algae, compromising water quality and affecting marine biodiversity (Jorgensen, 2009).
- Impact on Fauna and Flora: The presence of toxic substances or a high organic load can alter marine habitats and cause damage to the local biota. Species of fish, invertebrates,

and aquatic plants can be affected by pollution, which can lead to a reduction in species populations and a loss of biodiversity (Gordon, 1998).

5.2. RISKS TO WORKERS' HEALTH

In addition to the environmental impacts, the release of untreated effluents posed significant risks to the health of workers on board the platform:

- Diseases Associated with Contaminated Water: Exposure to contaminated water can increase the risk of outbreaks of gastrointestinal and infectious diseases. Untreated wastewater often contains pathogens that can cause infections and health problems among workers, who depend on the water for consumption and hygiene (Benson et al., 2021).
- Poor Sanitary Conditions: The lack of adequate facilities and reduced use of toilets resulted in unhealthy sanitary conditions. Prolonged exposure to poor conditions can lead to additional health problems, such as infections and diseases related to poor hygiene (Parkes, 2014).

6. RESOLUTION AND CORRECTIVE MEASURES

6.1. IMMEDIATE ACTION AND INVESTIGATION

After identifying the failure in the sewage treatment plant and the emergency need to release the effluent into the sea, the company took measures to control and minimize the environmental impacts. The effluent was released in a controlled manner, which helped to reduce the potential for damage to the environment. This approach aimed to mitigate marine pollution and limit the impact on local fauna and flora (Jorgensen, 2006; Abuqamar, 2024).

The captain of the platform was immediately disembarked and sent to clarify the decision taken, to assess his compliance with the company's environmental guidelines. At the same time, the company reviewed its environmental compliance policies to ensure that such incidents did not happen again. Local authorities, including IBAMA and the Brazilian Navy, conducted a detailed investigation to assess the legal and environmental implications of the

incident. The investigation focused on assessing compliance with Brazilian regulations and analyzing the environmental impacts resulting from the controlled release (Benson et al., 2021).

6.2. RECOMMENDATIONS

To prevent similar incidents from recurring and to strengthen the company's environmental management, the following actions are recommended:

- Environmental Experts: It is essential to incorporate specialized environmental professionals into the platform team. The presence of environmental specialists can guarantee ongoing compliance with environmental regulations and guidelines, as well as provide proactive risk management and the implementation of best practices for environmental protection (Gordon, 2013). Hiring specialists will help ensure that effluent treatment and disposal measures are lined up with the required standards.
- Employee training: Developing and implementing specific training programs on environmental regulations and emergency procedures is crucial. Continuous employee education on environmental regulations and waste management best practices will help prepare staff to deal effectively with crises and minimize the risk of future operational errors (Lindgren et al., 2016). Training should include emergency simulations to improve staff response to environmental incidents.
- Contingency Plans: The implementation of robust contingency plans is essential for dealing with environmental and operational emergencies. These plans should include clear procedures for managing failures in critical systems, such as sewage treatment plants, and rapid response strategies to reduce environmental impacts. Regularly reviewing and updating contingency plans ensures that the company is prepared to deal with unforeseen situations effectively (Li et al., 2013). Regular testing and maintenance of equipment is also an integral part of these plans.

7. RESULTS

The results of this case study comprehensively reflect the challenges associated with managing environmental crises on offshore oil drilling platforms. This specific incident exposed vulnerabilities in critical systems, such as the Effluent Treatment Plant (ETP), and underscored the urgent need for an agile response that balances operational, regulatory, and occupational health demands. The detailed analysis not only identified triggering factors but also provided insights into the environmental impacts and health risks faced by workers.

Managing environmental crises on offshore platforms is particularly challenging due to the operational complexities and isolation of these facilities. When essential systems such as the ETP fail, the consequences extend beyond immediate operational disruptions, revealing weaknesses in emergency response protocols. This case highlighted the complexity of decision-making under pressure, where ethical, legal, and environmental considerations play crucial roles.

The findings provide a precise technical diagnosis of the risks faced, both environmentally and in terms of human health, while also highlighting gaps in local and international regulations that influenced operational decisions. These gaps not only complicated the immediate management of the incident but also created challenges for future compliance and corporate reputation.

It is evident that failures in crisis management can lead to far-reaching consequences, affecting both marine biodiversity and the health of workers exposed to unsanitary conditions. This study offers a robust foundation for developing practical recommendations, such as implementing preventive maintenance plans and revising corporate guidelines, ensuring that offshore operations can mitigate risks and respond effectively to emergencies.

Detailed results are presented below, aiming to provide an exhaustive and technical analysis of the incident, elucidating the contributing factors and the measures undertaken for mitigation and future prevention.

7.1. IDENTIFICATION OF CRITICAL FAILURES

- Maintenance Failures:

A lack of robust preventive maintenance protocols for the ETP resulted in recurring operational breakdowns. The inability to diagnose issues in advance contributed significantly to the disruption.

- Improvisation in Waste Management:

Emergency solutions, such as transferring effluent to synthetic mud tanks, highlighted infrastructure inadequacies, creating cascading logistical and environmental challenges.

- Operational and Regulatory Conflicts:

Tensions between corporate environmental guidelines and Brazilian emergency response regulations underscored critical dilemmas in compliance and health prioritization.

7.2. OBSERVED ENVIRONMENTAL IMPACTS

- Marine Pollution:

The discharge of untreated effluent introduced harmful substances into the ecosystem, with risks including eutrophication and biodiversity disruption.

- Flora and Fauna Threats:

Species-level impacts from toxic substances highlighted the ecological sensitivity of the surrounding marine environment.

7.3. HEALTH RISKS TO WORKERS

- Contaminated Exposure:

Prolonged contact with untreated wastewater posed significant risks of infectious diseases among workers onboard.

- Sanitation Challenges:

The compromised hygienic conditions created severe threats to personnel well-being, exacerbating health vulnerabilities.

7.4. DEFICIENCIES IN CRISIS RESPONSE MECHANISMS

- Lack of Rapid Protocols:

The absence of predefined procedures resulted in reactive, rather than preventive, management during critical moments.

- Limited Expertise:

A shortage of environmental and technical specialists onboard hindered effective mitigation strategies.

7.5. CORRECTIVE MEASURES IMPLEMENTED

- Controlled Discharge:

The effluent was released with strategic moderation to minimize ecological damage.

- Policy Revisions:

Corporate compliance frameworks were adapted to incorporate emergency scenarios without compromising environmental integrity.

- Enhanced Training:

Programs were initiated to empower staff with knowledge and practices for handling potential environmental crises.

- Technological Overhauls:

Preventive maintenance schedules and diagnostics systems were integrated into operational workflows.

8. DISCUSSION

The incident analysis reveals several complexities and challenges associated with environmental crisis management on offshore drilling platforms. The failure of the sewage treatment plant (STP) and the subsequent decision to release untreated effluent into the sea exposed crucial issues for both legal compliance and operational practice in emergencies.

8.1. INTERSECTION BETWEEN LEGISLATION AND INTERNATIONAL GUIDELINES

The conflict between Brazilian environmental legislation and the company's international guidelines highlights the tension between regulatory compliance and emergency crisis management. Brazilian legislation, represented by Law No. 9.605/1998 and CONAMA Resolution No. 357/2005, establishes strict standards for the treatment of effluents and prohibits the release of pollutants without adequate treatment (Brasil, 1998; Brasil, 2005). These standards aim to protect the marine environment and ensure the sustainability of water resources.

However, the company's international guidelines, which align with even stricter regulations, create a more restrictive and conservative framework (Benson et al., 2021). The decision to release effluent into the sea, even though it was an emergency measure, represented a violation of corporate and local policies. This situation illustrates the difficulty of balancing compliance with environmental regulations and the need for rapid response in crises, where protecting workers' health becomes an immediate priority.

8.2. ENVIRONMENTAL AND HEALTH IMPACTS

The discussion about the environmental impacts of releasing untreated effluent into the sea reinforces the seriousness of the potential consequences. The resulting marine pollution can have long-lasting effects on biodiversity and the health of marine ecosystems. Previous studies have highlighted that untreated effluents can cause eutrophication and harmful algal blooms, which affect water quality and marine life (Jorgensen, 2009; Abuqamar, 2024). The controlled release of effluents has minimized, but not eliminated these risks.

In addition to the environmental impacts, the situation has revealed significant risks to workers' health. Exposure to contaminated water can lead to outbreaks of infectious and gastrointestinal diseases, a risk widely documented in situations where sanitation is inadequate (Benson et al., 2021). The poor sanitary conditions on board increased workers' vulnerability to health problems related to poor hygiene, as indicated by Parkes (2014). These factors highlight the importance of maintaining operational wastewater treatment systems and ensuring the health and safety of workers even in crises.

8.3. RELEVANCE OF CORRECTIVE MEASURES

Analysis of the corrective measures adopted after the incident demonstrates the importance of a rapid and effective response to mitigate future impacts. The review of environmental compliance policies and the investigation conducted by local authorities were essential steps to address the failures identified and prevent recurrences (Lindgren et al, 2016; Li et al, 2013). The incorporation of environmental experts, the development of training programs for employees and the implementation of robust contingency plans are crucial recommendations to strengthen environmental management and emergency response on offshore platforms.

In conclusion, the case study highlights the need for a balance between compliance with environmental regulations and the ability to respond to emergencies. The integration of effective crisis management practices, aligned with legal and corporate guidelines, is key to ensuring the protection of the environment and the health of workers in offshore operations.

CONCLUSION

This case study on environmental crisis management on offshore drilling rigs provides a detailed and critical overview of the challenges faced during the sewage treatment plant (STP) failure incident and the subsequent emergency disposal of effluent at sea. The incident highlighted the complexity and necessity of effective crisis management, especially when it comes to balancing regulatory compliance with the urgent need to protect workers' health and well-being.

The analysis revealed that the interaction between Brazilian environmental regulations and the company's international guidelines introduced significant tension. Brazilian legislation, with its strict standards for effluent treatment, contrasted with the company's even more restrictive guidelines, creating a scenario where compliance with environmental regulations and rapid response in emergencies clashed. This dilemma underlines the difficulty of managing crises in an environment where both environmental protection and human health are critical priorities.

The environmental and health impacts resulting from the controlled release of untreated effluent were evident. Although the release was minimized to reduce damage, the risks associated with marine pollution and workers' health reinforce the importance of robust effluent

treatment systems and effective crisis management practices. Exposure to contaminated water and deteriorating sanitary conditions on board highlight the need for preventive action and rapid responses to protect both the environment and workers' health.

The corrective measures adopted after the incident were crucial to mitigating future impacts and improving crisis management. Reviewing environmental compliance policies, incorporating environmental experts, developing training programs and implementing robust contingency plans are essential steps to strengthen emergency response and ensure the continued protection of the environment and workers' health.

In short, this case study highlights the need for a delicate balance between compliance with environmental regulations and the ability to respond quickly in crises. The integration of effective crisis management practices, aligned with legal and corporate guidelines, is key to ensuring a sustainable and safe approach to effluent management in offshore operations. The experience gained from this incident should serve as a guide for improving environmental and operational management in future similar situations, promoting a more integrated and efficient approach to dealing with environmental crises on offshore drilling rigs.

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