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A review on disaster risk mitigation in the oil and gas project

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Abstract. In addition to the very complex risks, hazards potentially lead to disasters in the oil and gas projects. These risks can certainly be anticipated with the application of risk management, but an unsystematic and ineffective implementation of risk management will still bring adverse impacts. According to the eleven risk management principles in ISO 31000:2009, the application of risk management must pay attention to all aspects, both internal and external factors. Thus, this paper aims to identify variables that could affect the disaster mitigation efforts of oil and gas projects. This research began with literature study to determine the problems of risk management in oil and gas projects, so the affecting variables as the study objectives can be specified subsequently based on the literature review as well. The variables that must be considered in the efforts of disaster risk mitigation of oil and gas project are the risk factors and sustainability aspect.
Keywords: oil and gas project, risk management, sustainable development

1. Introduction

Oil and gas projects are at risk due to the massive capital investment, the involvement of many parties, the use of complex technology, as well as the high environmental and social impacts [1]. The risk is the possibility of the occurrence of some uncertain, unexpected, and even unwanted events, which will change the probability prospect of a given investment [2]. There have been social conflicts and casualties due to the gas leakage that always occurs in the area of oil and gas industry [3]. In general, risk factors and hazards could be induced in the oil and gas sector by the parameters contained in the industrial system [4]. Disasters can happen at any time and certainly cannot be prevented, but their impacts can be minimized by the adoption of a strategy for dealing with disasters. Risks should be mitigated since the beginning to prevent disasters. Therefore, any risk analysis must be integrated with the disaster risk assessment.

All kinds of inherent risks in the project life cycle must be identified so a framework for measuring risks can be prepared to achieve the success of the project. It should also be noted that related to the abatement of social, environmental, and economic challenges in the construction industry; the constructors should give priority to the concept of sustainable development in their activities [5].Based on the description above, this paper aims to discuss variables that could affect the disaster mitigation efforts of oil and gas projects.

2. Research Method

2.1. Project risk in oil and gas industry

A risk is an internal or external condition or situation that can influence and change the initial state of a project, as well as affect its time and cost [6]. A risk is an uncertain event that could have an impact on project objectives including the scope, schedule, cost, and quality parameters [7]. The risk can be defined from various viewpoints. Based on the process point of view, the risks are factors that may affect the achievement of objectives, leading to unintended consequences. On the other hand,from the result standpoint, the risk is an unpredictable, uncertain, and undesirable outcome because it is considered counterproductive. Therefore, the risk plays an important role in the decision-making and can affect the performance of the project [8].

There are two (2) types of project risks, i.e., the risk of a single project and multi-project risk combination [9]. There are two (2) sources of risk factors, namely the internal and external aspects [10]. Oil and gas projects are in jeopardy due to the large capital investment, the involvement of many parties, the use of complex technology, as well as the high environmental and social impacts [1]. Every activity in the oil and gas industry poses risks that not only could obstruct the project but also threaten the environment, society, and economy [11], [12].

2.2. Disaster in oil and gas industry

Oil and gas projects also have the potential of becoming dangerous to life, property, and the environment if the activity is not controlled and regulated appropriately [13]. Moreover, the gas leakage that frequently occurs in this industry leads to social conflicts and casualties [3]. In addition to risks, hazards entail the potency of turning into disasters [4]. Disasters are certainly not possible to be avoided and can occur at any time, but their circumstances can be anticipated by considering the risks and the level of toughness [14].

Hazards are classified into three (3) categories:

1. Natural hazard is the harm caused by factors related to the climatic and geographical aspects.
2. The technological hazard is the harm caused by technological or industrial accidents, also the presence of dangerous procedures, infrastructure failures, or other events that may cause loss of life or injuries, property damage, social and economic disruptions, as well as environmental degradation.
3. Environmental degradation is a deterioration process of natural resources or an adverse alteration of natural ecosystems caused by human activities and behaviors, sometimes even combined with natural disasters.

The application of a strategy for dealing with disasters can help to minimize their impacts since one the disaster causes is the absence or the lack of risk mitigation efforts. Hence, disaster risk assessments must be performed along with risk analysis.

3. Results and Discussion

3.1. Identification of risk factors

Identification results obtained by previous research mentioned that both internal and external risk factors affect oil and gas projects. The risk factors are summarized in Table 1.

Table 1. Risk factors of oil and gas projects.

Risk factors	References
Internal factors	
Design	16, 1, 17, 18
Construction	16, 1, 12
Procurement	16, 17, 12
Finance	16, 1, 17, 18
Operational factor	16, 1, 17, 19
Contract	1, 17, 20, 18
Stakeholders	1, 17
Logistics	1, 17
Technology	20, 4, 15, 21, 18
Accidents	19, 18
Employee distribution and lost	1, 17, 20, 18
Management	17, 12, 14, 18
External factors	
Social factor	11, 16, 1, 22, 12, 13, 14
Political factor	16, 12
Law	1, 17
Production competition	23, 24
Economy	16, 24, 25, 12, 13, 14
Environment	11, 22, 16, 1, 12, 13, 25, 26, 14, 18
Property	13

Disaster factors of oil and gas projects are listed in Table 2.

Table 2. Disaster factors of oil and gas projects.

Disaster Factors	References
Third party	
Water pollution	27, 28, 29, 30, 31, 32
Noise pollution	27, 28, 29, 30, 31, 32
Soil pollution	27, 28, 29, 30, 31, 32
Operations with a removal of vegetation	27, 28, 29, 30, 31, 32
Operations with a high potential of erosion	27, 28, 29, 30, 31, 32
Chemical pollution	27, 28, 29, 30, 31, 32
Public health effects	27, 28, 29, 30, 31, 32
Social disruption	27, 28, 29, 30, 31, 32
Theft/embezzlement	27, 28, 29, 30, 31, 32
Technological failures	27, 28, 29, 30, 31, 32
Explosion	27, 28, 29, 30, 31, 32
Fire	27, 28, 29, 30, 31, 32
Economic vulnerability	27, 28, 29, 30, 31, 32
Physical vulnerability	27, 28, 29, 30, 31, 32
Vulnerability of life support infrastructure	27, 28, 29, 30, 31, 32
Chemical exposure	27, 28, 29, 30, 31, 32
Social exposure	27, 28, 29, 30, 31, 32
Economic exposure	27, 28, 29, 30, 31, 32
Physical exposure	27, 28, 29, 30, 31, 32
Exposure to life support infrastructure	27, 28, 29, 30, 31, 32
Ecotoxicity	27, 28, 29, 30, 31, 32
Earthquake	27, 28, 29, 30, 31, 32

3.2. Risk mitigation

Currently, the leading oil and gas companies must have applied the risk management and complied with ISO 31000:2009 as a framework that can integrate various management processes—including the management of HSE (Health, Safety, and Environment) risks—to achieve sustainable development. It cannot be denied nonetheless that the activities that continue to this day still cause negative impacts, particularly for the surrounding environment. In addition, international oil and gas companies nowadays place more emphasis on preventive measures than coping methods [33], indicating that the concept of sustainable development has not been fully considered in risk management applications.

The risk management of construction projects must be carried out with respect to the objectives of Sustainable Development Goals which strive to achieve sustainability and eradicate poverty. The efforts to alleviate poverty must be accompanied by a progressive economic growth so that all sorts of risk that could adversely affect the economy can be well managed, including those related to disaster risks and vulnerabilities in the development plan. It is indeed on account that disaster can be a significant threat to achieving and sustaining development plans and objectives [34].

The importance of risk management in the pursuit of sustainable development objectives encourages researchers to examine them with different methods. Researchers [27] developed the concept of risk management by the AHP (Analytic Hierarchy Process) approach that can support the decision-making system on the maintenance aspects of oil and gas pipelines so that the pipeline project can survive by taking the quality of pipes and environmental conditions into account.

Reseacher [28] presented the concept of risk management in pipeline projects, referring not only to political and economic benefits but also the needs of society and environmental conditions to achieve sustainable projects. The results of research conducted using theoretical statistical techniques show that risk management can be used comprehensively and effectively in project management to reduce the impact of emerging risks. The concept presented in the outcome of the study only analyzes the risks in general and does not present how to manage the risks in the context of attaining sustainable projects.

The oil and gas pipeline project entails the potential of a dangerous failure so that methods to predict failures are highly required. Reseachers [30] proposed a Neurofuzzy approach that has been proven to be able to predict leak-related failures and explosions that impact financial and environmental conditions. The method can be applied in the planning and maintenance phase. Failures in the pipeline project can also be caused by the theft of oil and gas through pipelines. Therefore, Reseacher [31] performed a risk analysis using AHP (Analytic Hierarchy Process) which can support the decision-making system on the improvement of pipeline network security and optimization of security cost.

4. Conclusion

The results of this study state that the risk factors of projects in the oil and gas industry are truly complex that the risk analysis must be carried out to address various aspects of the project itself, the environment, as well as disaster occurrence. Also, it should be integrated with sustainable development aspects.

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