



# AMERICAN JOURNAL OF AGRICULTURAL SCIENCE, ENGINEERING AND TECHNOLOGY (AJASET)

ISSN: 2158-8104 (ONLINE), 2164-0920 (PRINT)

VOL: 5 ISSUE: 2 (2021)



PUBLISHED BY: E-PALLI, FLORIDA, USA

The American Journal of Agricultural Science, Engineering and Technology (AJASET) is blind peer reviewed international journal publishing articles that emphasize research development and application within the fields of agricultural science, engineering and technology. The AJASET covers all areas of Agricultural Science, Engineering and Technology, publishing original research articles. The AJASET reviews article within approximately two weeks of submission and publishes accepted articles online immediately upon receiving the final versions.

**Published Media:** ISSN: 2158-8104 (Online), 2164-0920 (Print).

**Frequency:** 2 issues per year (January, July)

**Area of publication:** Agricultural Science, Any Engineering and Technology related original and innovative works.

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**AN INTEGRATED SAFETY IMPLEMENTATION ANALYSIS BASED ON RISK  
ASSESSMENT TO ENHANCE THE SAFETY ENGINEERING PRACTICE IN THE  
GAS FIELDS OF SYLHET REGION, BANGLADESH**

**Md. Enamul Haque<sup>1</sup>, M. Farhad Howladar<sup>2</sup>, Md. Numan Hossain<sup>3</sup>**

**DOI: <https://doi.org/10.5281/zenodo.5590416>**

**ABSTRACT**

The industrial sectors of Bangladesh mostly depend on the petroleum industry. Historically, risk and hazards are the common scenario in the petroleum industry occurring due to lack of efficient risk assessment, resulting in financial loss, injury, or harm for people, and the environment. To prevent these losses, it is essential to implement the best risk assessment plan. The objective of this research is to enhance the implementation of safety engineering systems in the petroleum industry through risk assessment. For this, purpose at first, the questionnaire survey for the perception of risk identification and safety system is performed to determine the current defects in the safety engineering system. Then, using SPSS software the risk analysis as well as ANOVA and reliability analysis of the collected data is accomplished to examine top risk factors. Concerning both interview and questionnaire analysis, an integrated risk assessment-based safety analysis has been performed to optimize the performance of the safety engineering system. The outcomes of this research expose the technical, procedural, and behavioral gap in the current risk assessment for the safe implementation of the safety engineering system of the petroleum industry of Bangladesh.

**Keywords:** Safety Implementation, Risk Assessment, Petroleum Fields, Safety Engineering

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<sup>1</sup> Department of Petroleum & Mining Engineering, Shahjalal University of Science & Technology, Sylhet, Bangladesh. Email: [enamul7277@gmail.com](mailto:enamul7277@gmail.com)

<sup>2</sup> Department of Petroleum & Mining Engineering, Shahjalal University of Science & Technology, Sylhet, Bangladesh. Email: [farhadpme@gmail.com](mailto:farhadpme@gmail.com)

<sup>3</sup> Department of Petroleum & Mining Engineering, Shahjalal University of Science & Technology, Sylhet, Bangladesh. Email: [numan.hossain10@gmail.com](mailto:numan.hossain10@gmail.com)



## INTRODUCTION

We live in a world comprised of systems and risk. When viewed from an engineering perspective, most aspects of life involve systems. Systems and technology also come exposed to accidents because systems can fail or work improperly resulting in damage, injury, and deaths (Ericson, 2005). The possibility of a system fails and results in death, injury, damage, and loss is referred to as risk. System safety is the formal process of identifying and controlling risk. As systems become more complex and more hazardous, more effort is required to understand and manage system mishap risk. The ideal objective of system safety is to develop a system free of hazards. Nonetheless, absolute safety is not possible because complete freedom from all hazardous conditions is not always possible, especially when dealing with complex, inherently hazardous systems, such as the oil and gas production industry. Thus, safety matters must be the top priority during conducting production. Because without guaranteeing safe working conditions, we cannot permit anyone to perform any task whatsoever. Bangladesh is ascetically supplemented with natural gas (Khan & Nasir, 2014). Natural gas was first discovered in Bangladesh in 1955 (by PPL) from which production started in 1962 (Imam, 2013). There is 29 gas field in Bangladesh till now which are in production state (Hassan Shetol et al., 2019). From the beginning of journey, petroleum sectors of Bangladesh faced some accidents (Khan & Nasir, 2014). Petroleum sector is a more dangerous industry as it deals with hazardous materials. But it is possible to minimize the chance of such types of accidents by taking proper inherent safety measures and implementation. This research aims to enhance the implementation of safety engineering systems in the petroleum industry through risk assessment application in Bangladesh. In this study, top risk factors in gas production industries from the point of view of employees will be evaluated. Risk assessment implementation poses a multi-pronged issue, such as technical, procedural, and behavioral. In this study, complications such as technical, procedural, and behavioral issues have been conducted for the petroleum industries to enhance the effectiveness of the risk assessment by adapting data analysis model using both the quantitative and qualitative procedure. This research will encourage the development of a great HSE culture among the risk associated petroleum industries in Bangladesh, such as 'Bangladesh Oil, Gas and Mineral Corporation (Petrobangla)' and in 'Bangladesh Petroleum Exploration & production (Bapex)'.

## **RESEARCH METHODOLOGY**

### **Area of the study**

Among 29 gas fields in Bangladesh 22 are in the underproduction stage (Hassan Shetol et al., 2019). The country's native 3 companies including BGFCL, SGFL, and BAPEX are associated with petroleum production which operates 18 gas fields, other 4 fields are operated by the international oil company (Chevron & Tullow). For this survey-based research work, it required the actual answer of the questionnaires from the employees of the petroleum industry for conducting this research. In this study, data were collected from 4 gas fields under the operation of the country's well-known company Sylhet Gas Fields Limited (SGFL). These are 'Haripur Gas Field', 'Beanibazar Gas Field', 'Kailashtila Gas Field', and 'Kailashtila MSTE Plant'.

### **Study design**

The goal of this research is to identify the risk associated with risk sources, work tasks, and job stress and evaluating the proper implementation of the safety engineering system in the petroleum industry through risk assessment in SGFL. In this study, a similar approach performed by Ghanim Kashwani (Kashwani et al., 2018), Andersen & Mostue (Andersen & Mostue, 2012) and T. Rundmo (T. Rundmo et al., 1998) is followed, and a survey is utilized to determine the risk analysis and identification methods of the SGFL, along with their weaknesses that alter the implementation of risk assessment. In this research, we will have a combination of exploratory and descriptive methodology approaches.

It is a survey-based study and the sets of questionnaires contain information about the individual perception of risk sources, work tasks /activities, job stress, procedural safety, technical safety, and behavioral safety which were distributed among the different employees from five departments of the gas fields. Based on their answer to the questionnaire the crucial information about the four gas fields of Bangladesh under Sylhet Gas Fields Limited was obtained which were the hearts of this research. The questionnaire evaluation procedure was rating based. The evaluations included ratings on a five-point rating scale for each test item. The scale for risk perception ranged from 'very safe' to 'very unsafe'. The job stress scale ranged from 'strongly agreed' to 'strongly disagreed'. The technical, procedural, and behavioral safety-based queries scale ranged from 'strongly agreed' to 'strongly disagreed'.

### **Data collection & analysis procedures**

Two types of response from employees were collected: response from questionnaire and response from interview. The questionnaire sheets were distributed directly among the employees of four gas production fields of SGFL and collected from them. Approximately 82

questionnaires were distributed, and 60 employees returned that. The response rate was 73.17%. The interview section has been split up into few sections which cover up the following areas: interviewee 's background in the petroleum industry and their roles, factors that affect risk assessment, updated safety procedures and regulations, existing safety culture in the gas fields, and technical safety. The interview will also examine the interviewee 's opinion about the government 's part in confirming the efficiency of the organization's procedural schemes. Torner and Pousette employed the interview approach to determine the influential factors that increase the gap between workers and managers (Törner & Pousette, 2009).

After accumulating the data, these have been analyzed by using SPSS Software (version25). For this frequency analysis, ANOVA analysis and reliability analysis were performed to obtain the outcomes. The flowchart (Figure-1) represents the methodology.

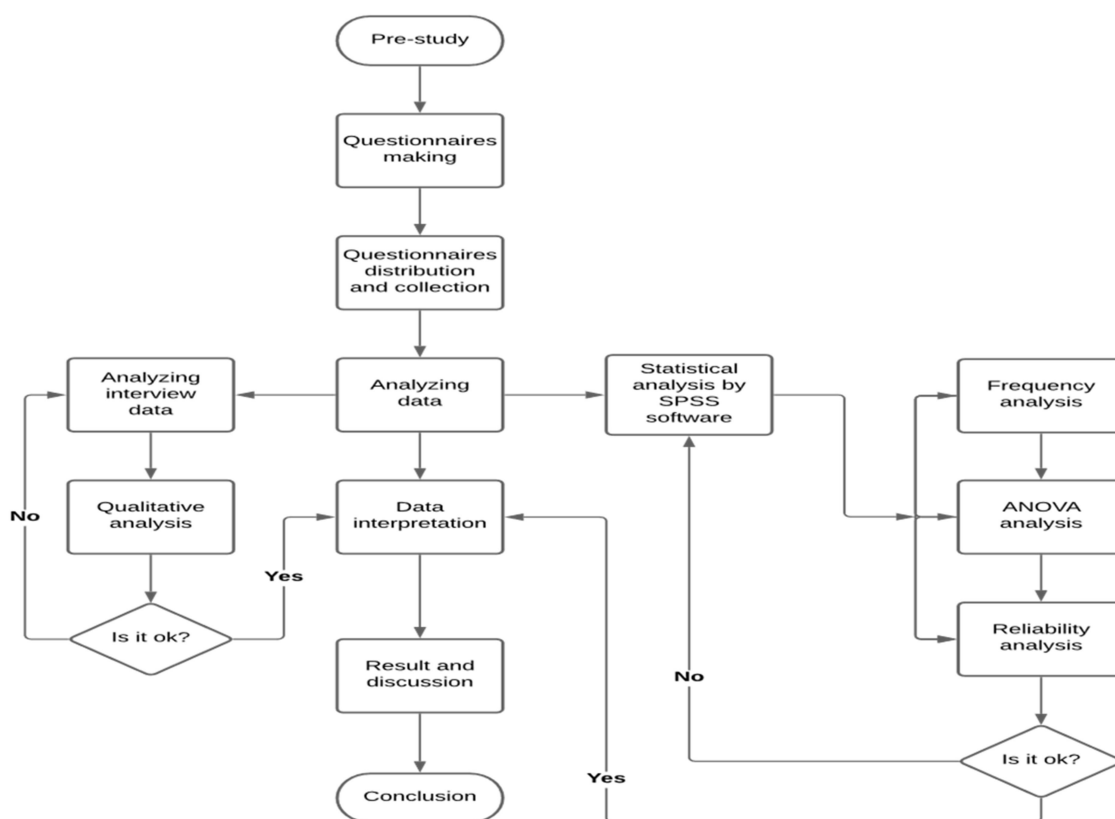


Figure 1: The flowchart of the methodology.

## **RESULTS AND DISCUSSION**

### **Analysis of risk perception and safety implementation issues**

In this section the terms Safe\* stands for both 'Safe' & 'Very safe', Unsafe\* stands for both 'Unsafe' & 'Very unsafe', Agreed\* stands for both 'Strongly agreed' & 'Agreed', and Disagreed\* stands for both 'Strongly disagreed' & 'Disagreed' to analyze the frequency easily.

### **Employee's risk perception analysis from risk sources and work tasks/activities**

The risk sources to the installation and risk sources to the individual are included here. The percentages of employees feeling safe with risk sources to the installations and individuals ranges from 81.5% to 95%, where feeling unsafe 0% to 11.7% and feeling neither safe nor unsafe ranges from 3.3% to 10%. The Employees feeling was safe for overall 89.72% which is greater than others comparison. On the contrary the percentages of feeling safe according to Flin et al (1996) in the Uk. Offshore Oil Industry ranges from 61% to 79% and overall, 70.12% (Flin et al., 1996). According to Rundmo on the offshore petroleum of the Norwegian Continental Shelf, this ranges from 43% to 79% and overall, 63.17 Rundmo (1992). The percentages of employees feeling safe during work tasks/activities ranges from 80% to 96.6%. The overall value of feeling safe during working in the gas field is 92.14% which is pretty much higher than (Flin et al., 1996) 75.2% and (Torbjørn Rundmo, 1992a), (Torbjørn Rundmo, 1992b) 80.5%. From the result of the analysis showed in Figure-2, it is clear that the employees of the SGFL feel safer relatively than other cases while performing work tasks/activities and tasks associated with risk sources.

### **Risk associated with job stress**

For justification of job stress and satisfaction, personnel of petroleum fields were questioned about their work tasks, work environment, and their interactions with their colleagues. Here, the percentage of agreeing is 66.22% for all of these job-related statements where 23.85% of employees disagreed and 9.93% employees neither agreed nor disagreed which is represented in Figure-3. So, it can be said that the working environment and the interactions of the employees in various departments of the gas field are satisfactory.

### **Technical questions analysis**

In this section safety issues with technical factor are analyzed which is very important for ensuring the safety implementation of the respected gas fields. The percentages of employees agreeing that the organization has HSE management system, employees familiar with risk assessment system, safety policy is up to date etc. are quite satisfactory. Overall 82.3% employees agreed that the industry implements the proper safety regarding technical factors;

on the other hands 23.85% employees disagreed. Figure-3 depicts the analysis of the technical issues for the safe implementation of the safety engineering system.

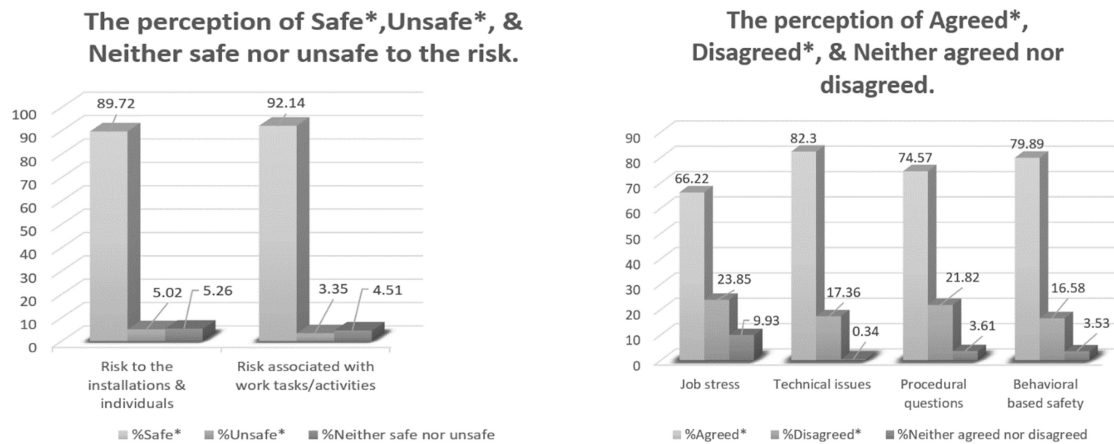
### **Procedural question analysis**

Most of the employees believe that their company provides enough training to ensure the safety competencies level between its employees (86.6%). The agreed\* percentages if 'there are efficient communication channels between the management and the laborer's', 'top management conducts regular safety tours to construction fields', 'you always attended the safety meeting in your department' ranges from 86% to 98%. But they also denied that the company does not spend sufficient resources to ensure safety to a significant percentage (Disagreed\*35.3%). The percentage of the company takes disciplinary actions against people violating policies and safety procedures are 55% which is a triggering number for encouraging the employees to violate safety rules. Approximately 74.57% respondent found satisfied with the procedural safety implementation issues where 21.82% respondent disagreed and 3.61% neither agreed nor disagreed which is portrayed in Figure-3.

### **Behavioral-based question analysis (BBS)**

Though all the employees have claimed that they understand their role and responsibilities towards safety in the job and have agreed that safety implementation is a direct output of the company's strategic plan, but in a personal interview, the given information was encountered as a little bit contradictory especially in the case of auxiliary staff. About 28.3% of the employees (mostly production department employees) believe that their colleagues do not have a good understanding of the safety policies and procedures. The percentage of agree\* on providing a safe workplace (76.5%), full implementation of risk assessment (78.3%), providing an efficient and effective safety monitoring system towards safety issues at the construction fields (76.5%), strong safety culture between employees at the construction site (82.4%) are impressive number for the implementation of safety in the field. The percentage of agreed\* (88.4%) of human factors are always considered in the hazard identification stage is an excellent indicator of enhanced safety implementation.





**Figure-2: Frequency analysis of %Safe\*, & Unsafe\*, and %Neither safe nor unsafe.**

**Figure-3: Frequency analysis of %Agreed\*, %Disagreed, and Neither agreed nor disagreed.**

### ANOVA Analysis

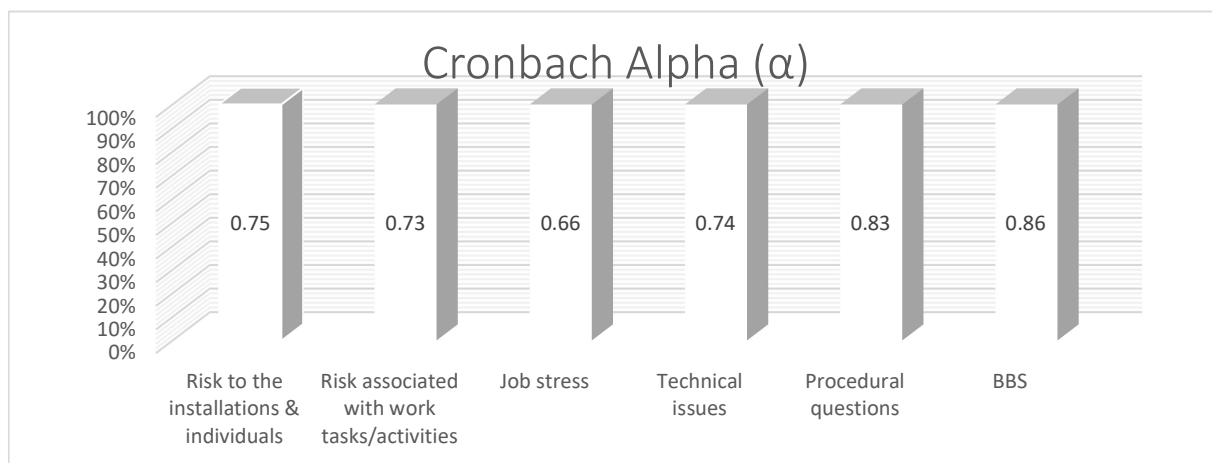
From ANOVA analysis of risk sources, risk associated with work tasks/activities, risk associated with job stress, technical issues, procedural issues, and BBS implementation with the perspective of 5 different departments, the statistical significance is identified. Almost for all of the case analysis of every section's questionnaires the P-value is less than 0.05 which proves the statistical significance of the data analysis procedure. P values determine whether the hypothesis test results are statistically significant. The P-value that is less than 0.05 would suggest that the result is statistically significant. The P-value that is larger than 0.05 would suggest that the result is not statistically significant (that is within normal sampling error). Table-1 depicts the overall ANOVA analysis result of the total questionnaires items.

**Table-1: ANOVA Analysis results.**

ANOVA Analysis					
		Sum of square	df	Mean square	F
Between people		113.749	16	7.109	
Between items		326.646	67	4.875	
Within people	Residual	869.427	1072	0.811	6.011
Within people	Total	1196.074	1139	1.05	0.005
Total		1309.823	1155	1.134	
Grand Mean = 3.91					

### Reliability analysis

Among the types of reliability, Cronbach's alpha measures the internal consistency of results across items within a test (Cronbach's Alpha: Simple Definition). Cronbach's alpha tests to see if multiple-question Likert scale surveys are reliable. The value of Cronbach Alpha ( $\alpha$ ) for risk sources (0.75), work tasks/ activities (0.73), technical factors (0.74), procedural factors (0.83), and behavioral factors (0.86) have relatively high internal consistency which indicates an acceptable or good existing correlation between the factors. The factors associated with job stress have relatively low internal consistency. The value of Cronbach Alpha ( $\alpha$ ) is 0.66 which indicates a questionable existing correlation between the factors associated with job satisfaction (Figure-4).



**Figure-4: Comprehensive reliability analysis.**

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

The objectives of this study are to include all the key areas which can lead to any type of accident in the petroleum industry. An integrated assessment must be conducted to achieve a qualitative and effective safety implementation method. For this, at the first of the study, an organized approach has been followed to identify the perceived risk and safety issues in the field. After questionnaires data analysis, it was discovered that the percentages of feeling safe with risk sources (89.7%) or work tasks (92.14%) overall on the four petroleum fields of Bangladesh are high enough where these percentages are less than 70% in the previous study in Norway and UK Offshore Petroleum Fields Limited. So, it can be proclaimed that the personnel feel safer here comparing with others. The risk associated with work tasks/activities were not found significant. But there were some issues with the technical

operation which need to be improved such as manual lifting and handling of materials. When analyzing job stress data, the conditions related to job satisfaction, freedom, interaction with their colleagues were at moderate level. The communication gap between the managers and laborers was quite visible. The knowledge associated with safety issues among workers was questionable. One more thing was noticeable which was conducting two or more departmental duties at the same time by an individual. For example, the employee appointed for technical engineering activities was found to be performed safety tasks, and technical tasks at the same time. This extended job stress can lead to severe fatalities/accidents proving the weakness of the efficient manpower in the organization. The present gaps in the organization exposed the technical skills gap due to the lack of safety training and communication procedures between management and laborers. The absence of workers in the safety committee indicated poor management and leadership visibility in the industry. The promising mentality to motivate the workers towards following safety regulations with available current safety tools and safety budget provided by the authority is undoubtedly praiseworthy.

### **Recommendations**

This survey presents the following testimonials: A monthly safety-based questionnaire program may be organized to retain enthusiasm for safety maintenance; Special concern should be paid to improving evacuation facilities and escape routes in case of any severe accidents; Workers should be included in the safety committee to influence safety implementation among workers; Prize giving ceremony can be arranged to encourage employees for maintaining proper safety; The manager must follow safety rules as a visionary leader to spread the spirit of safety regulations among workers and senior staff too; Increasing manpower and allowing employees sufficient facilities to improve functioning in their respective fields. Employees should regularly attend seminars or training in this regard; BBS programs can be arranged for developing the safety culture; A simplified safety manual can be developed to help workers understand; An organizational well-being plan must be implemented.

### **Acronyms**

ANOVA: Analysis of variances  
BAPEX: Bangladesh Petroleum Exploration & production  
BBS: Behavioral based safety  
BGFCL: Bangladesh Gas Fields Company Limited  
HSE: Health Safety and Environment  
PPL: Pakistan Petroleum Limited  
SGFL: Sylhet Gas Field Limited

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