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# Prioritizing Critical Success Factors for Implementing Safety Programs in Upstream Oil and Gas Projects

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**ABSTRACT:**Planning for success in implementation and execution of the policies in organization, especially in safety, is always an inevitable process, and one of the daily challenges in this industry is developing strong plans and not realizing them during the life cycle of the project.Therefore, identifying and analyzing the critical success factors in implementation of safety plans at all stages in projects, especially upstream, can lead to a better understanding of the role of each factor in optimal implementation of project safety plans.Also, with sufficient understanding of the critical success factors, costs should be reduced in proportion and by focusing on the most important critical success factors, faster implementation and establishment of safety programs in the project to create sustainability will happen.In this research, by prioritizing critical success factors for implementation of safety programs in oil and gas projects, it is possible to improve the project's productivity with a sustainable development approach while fully implementing the project's safety plan.

**Keywords:**Critical Success Factors (CSF), Sustainability, Safety Programs, Step-wise Weight Assessment Ratio Analysis (SWARA)

## I. INTRODUCTION

Along with the growth of industry, technical and engineering sciences also grew and underwent extensive changes, because the demand for energy carriers increased every day and required companies to develop oil and gas fields to produce more energy resources.Naturally, with the development and growth of industry and technology, risks and industrial accidents, especially in the oil and gas industries, which include risks due to the use of all kinds of toxic, flammable and explosive substances and as a result of heavy and irreparable losses of life, financial and credit, increases that if the appropriate strategy and plan are not considered to deal with them, the occurrence of various damages and delays in the implementation and even the failure of the projects will be possible.[1][2]

Today, the use of fossil fuels, firstly coal and then oil and gas, which has always been of special attention as a valuable resource[3], and in this regard, various projects related to exploration and production in the oil industry are being defined at the country level. It is implemented that in these projects, the search for finding potential underground or submarine fields and the exploration and drilling of wells with the aim of extracting oil and gas are being carried out. Therefore, safety in these national and strategic projects is very important in order to maintain production.

Sustainable development is a process that envisages a favorable future for human societies in which living conditions and resource use meet human needs without harming the integrity, beauty and stability of vital systems.[4] Sustainable development offers solutions to the structural, social and economic patterns of development in order to avoid issues such as the destruction of natural resources, the destruction of biological systems, pollution, climate change, excessive population growth, injustice and the lowering of the quality of life of people today. and prevent the future. Sustainable development is a process of using resources, directing investments, directing technological development and institutional changes, to be compatible with current and future needs. Sustainable development, which has been emphasized since the 1990s, is an aspect of human development related to safety, health, environment and future generations.

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The importance of developing oil and gas fields on the one hand and paying attention to sustainable production in the country's oil and gas industry, especially in relation to safety, health and environmental issues, dealing with sustainable development that links environmental, social and economic issues together. It seems more necessary than ever. Therefore, in the projects, it is necessary to plan and have a prepared plan to implement the safety, health and environment plan of the project and then review the safety, health and environment plan of the project before starting the project. Now, the main challenge for the development and review of plans is that by focusing on the critical success factors(CSFs) in the implementation of safety plans, one can be more optimistic about the implementation of plans and the realization of the goals set in the safety plan of the project. In this research, we prioritize these critical success factors.

In order to achieve their goals, organizations must be aware of each critical success factor and the changes between them. The term was first used in the world of data analytics and business analytics.[5]

**Overview:**

In 2022, Singh et al. by identifying the critical successfactors of safety performance,presented a practical framework for measuring the safety performance of workers in the construction industry. [6]

The ability to influence managers in organizations is recognized as a critical capability for safety professionals. Although safety decisions are made at all levels within an organization, those critical safety decisions related to strategies, priorities, operating procedures, and resource allocation are primarily made by management.

Research in 2021 by Ms. Madigan et al. examines the specific influencing behaviors/tactics employed by safety professionals for upward influence and the sequence of tactics used for initial and subsequent influence efforts with the same manager. Safety professionals understand that enablesor hinders their ability to influence strategically. Qualitative analysis revealed that logical persuasion was the dominant influencing strategy for initial efforts, while the integration tactic was more commonly used in later efforts. They also identified three new influencing tactics used by safety professionals that were similar to those described in traditional influence models. They were different. This study, with existing theory and empirical research, shows the direct impact of safety professionals in organizations.[7]

Workplace stuff remain an important concern for workers in the oil and gas industry, where workers are constantly exposed to various types of occupational hazards. A study by Mr. Benson et al. was conducted in 2021 with the aim of identifying various health hazards and their sources in the oil and gas industry to determine the risks associated with health hazards. A qualitative approach was used to identify various risks associated with the operational environment. A total of 1000 questionnaires were randomly distributed in different sectors of oil and gas industry and 327 questionnaires were returned to the research team. Data analysis was done using SPSS software. The results show that among the risks evaluated in the industry, ergonomic risks are more dominant. Ergonomic risks are 30%, physical risks are 26%, chemical risks are 23%, psychosocial risks are 18% and biological risks are 3%. Considering the objectives of this study and the risks that expose workers to unpleasant diseases, adequate monitoring of workers in the workplace should be applied, appropriate risk assessment should be carried out in the industry, and mandatory medical tests should be carried out on workers at all times in order to determine the health status of workers. Let them know. The construction industry is known for both its importance in economic growth and its dangerous nature. Statistically, poor safety performance is the leading cause of accidents on sites. To improve safety performance, it is inevitable to investigate the potential factors involved in safety management.[8]

Research in 2021 by Mr. Khalid et al examines the relative importance of critical success factors affecting health and safety in performance and the rationale for developing a robust safety management system that brings all factors into a single framework. This paper adopts an empirical research method based on literature review and secondary data collected systematically from peer-reviewed journals. There are about sixty critical success factors affecting health, and these are generally assigned to factors that form six groups: "organizational," "managerial," "legal," "social," "environmental" factors, and "Personal". In the development of the safety management system framework logic, it has been revealed that effective safety performance can only be achieved through (1) effective implementation of safety regulations, (2) leadership, (3) safety planning. (4) safety compliance, (5) performance measurement, (6) risk assessment, (7) safety inspection, and (8) safety culture. These factors are related to each other and

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cannot be separated, but in order to significantly improve the goal of safety performance in construction projects, there is a need to readjust and balance the priorities set for factors affecting safety performance.[9]

Sabrina Letícia Couto da Silva et al. mentioned occupational accidents and disease are events that can and should be controlled preventively by planning, organization and assessment of the performance of the means of control implemented. Excellence in Occupational Health and Safety (OHS) depends on models that allow the adoption of preventive measures to reduce work-related risks by proactive action to improve the workers' health, safety and satisfaction. The objective of this article was to verify success factors, barriers and indicators present in the process of implementing an Occupational Health and Safety Management System. A systematic review of literature was performed by two independent researchers, based on the protocol of Preferred Reporting Items for Systematic Reviews and MetaAnalyses (PRISMA). After a search in the databases Scopus, Science Direct and Web of Science, applying inclusion and exclusion criteria, 21 articles in English language, published between the years 2007 and 2018, remained in the final analysis. The results allowed evidencing the methodologies, tools and indicators used in OHS management. The analyses pointed out weaknesses in the existing models, particularly about the use of epidemiological indicators that allow helping the organizations to manage the occurrences with their workers proactively. A predominance of analysis was observed focusing on matters related to occupational safety to the detriment of analysis referring to occupational health which are given less emphasis.[10]

In order to investigate the factors affecting mine safety and the relevant interactive mechanisms, a study was conducted by Mr. Weng et al. in 2018. The statistics of 58 death accidents in coal mines, during the period from 2010 to 2014 were calculated and the causes of the accident. summarized the mine safety index system including 22 factors at 6 levels: organizational management, group leaders, frontline workers, safety culture, underground environment and machinery and equipment. Through the questionnaire, logical relationships between different influencing factors were quantified. After that, by combining decision test and evaluation test and conceptual structural model, the degree of influence, centrality and causality of different influencing factors are calculated. According to the research results, safety monitoring and safety philosophy are essential for mine safety. Laws and regulations, safety climate, safety investment, communication, safety training, operational plan, safety awareness, knowledge and skills and safety attitude are important factors, while leadership and coordination, personal characteristics, job satisfaction, safety awareness, knowledge And skill, compatibility of equipment and facilities, operating tools, safety equipment, operating conditions, physical environment and geological conditions are direct factors that lead to accidents in coal mines.[11]

Safety programs implemented by contractors have always been known as one of the most effective ways to reduce accidents and injuries in construction sites. Numerous studies have been conducted to determine and evaluate the relative effectiveness of critical safety program factors. However, the interaction between these factors has rarely been investigated. In 2018, research was conducted by Mr. Bavafa et al., the purpose of which is to evaluate the causal relationships of safety program factors in construction projects. First, fuzzy Delphi method was used to identify safety program factors. Then, the decision test and evaluation test, which is a multiple criteria analysis tool, was used to investigate the interdependence between safety program factors. Then, the causal relationships between all factors of the safety program were observed through the cause-and-effect relationship diagram. In this article, 11 safety program factors were identified through the fuzzy Delphi method. Finally, the results obtained from the decision-making experiment and evaluation laboratory show that "Safety commitments and responsibilities", "Selection of subcontractors and personnel", "Supervisor and safety experts", "Safety plan" and "Employee participation and safety evaluation" from Safety programs are critical. Agents. It was concluded that focusing on these five influencing factors leads to improvement of all safety program factors [12].

In 2018, Korkusuz et al. identified fifteen critical performance indicators that are needed to measure occupational health and safety performance as a result of literature review and interviews with experts and prioritized them using the hierarchical analysis process. [13]

In 2016, Yarahamdi et al prioritized health and safety indicators in the small and large construction industry in research. First, 28 indicators by experts from a list of The precise performance indicators were selected and then

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weighted and prioritized according to the key performance indicators of safety and health in the construction industry.[14]

## II. METHODOLOGY:

This research is practical in terms of research purpose. In terms of the research method, this research is a descriptive, survey research, and in terms of the nature of the data, it is quantitative and qualitative. This study is important during the stages of projects for the implementation of project safety plans and plans.In this research, using authentic scientific articles and questionnaires completed by expertshave done, thecritical success factors have been identified and quantitatively analyzed.

In this research, the data of the upstream oil and gas projects and especially the drilling of oil and gas wells are used. The sources are electronic and then questionnaires. On the other hand, the resources available in the organization, databases and other relevant information have been used. In this research, the gradual weighting evaluation analysis method is used. The tools used to collect information include questionnaires using existing databases and electronic resources. Identifying the characteristics and indicators affecting the research activities have been determined according to a complete review of the research literature and on the other hand, the opinion of experts in the industry and university.

The focus of this study is to identify and analyze the critical success factors in the project safety plan for the implementation of a successful plan in the oil and gas project using the Step-wise Weight Assessment Ratio Analysis (SWARA), which shows which critical success factors are more important. In the SWARA first, the score of the indicators is obtained using the opinion of experts, and also the relative importance of each indicator is calculated according to the average of the total points calculated for each criterion, then the importance of each criterion is determined compared to the previous criteria. And the coefficient Kj is calculated and then the initial weight of each criterion is calculated in this step. In the last step, the final weight of the indices is calculated by normalizing the indices and the final ranking is done. [15]

### 2.1 Step-wise Weight Assessment Ratio Analysis:

Step-wise Weight Assessment Ratio Analysis method was introduced for the first time by Keršuliene along with Zavadskas and Turskis in 2010. SWARA method is one of the new methods in estimating and evaluating weights in which experts play an important role in evaluating and calculating weights, so this method can be useful in cases where the priority of the criteria is clear. To be the use of SWARA method is recommended as one of the group decision-making methods in high-level and very important decisions based on collective agreement among experts. This method is easy to understand and has fewer pairwise comparisons compared to methods such as Analytical Hierarchy Process (AHP) and Analytical Network Process (ANP).

### 2.2 The implementation steps of this method are as follows:

- **First step:** determining the rank of each index

First, the rank of each index is determined according to the opinion of each expert, and each expert determines the most important criterion with his own priority. Scoring is done in the range of zero to one. In this way, the most important criterion is assigned the 1st rank and the least important criterion is assigned the last rank.

- **Second step:** calculating the average of the total ranks of each criterion

The average of the total points assigned to each criterion is calculated by the experts in this step. In this way, the total points assigned to each criterion are calculated and divided by the number of experts.

- **The third step:** determining the relative importance of each criterion ($\mathbf{S_j}$)

First, according to the average value of the group ranks obtained from the experts, the criteria are arranged in descending order. Then, by comparing two by two the average scores of the criteria, the relative importance of each index is calculated. In fact, the index $\mathbf{S_j}$shows how much more important criterion j is than criterion j+1.

Note: The index $\mathbf{S_j}$can be determined by calculating the average value difference between two criteria.

- **Fourth step:** Calculate the coefficient$\mathbf{K_j}$

In this step, according to the calculation $\mathbf{S_j}$in the third step, the coefficient of each index is calculated. The first criterion assigns a coefficient of one, and the coefficient of other options is determined based on the following relationship.

$$K_j = S_j + 1$$

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- **Fifth step:** Calculate the initial weight of each criterion

In this step, the initial weight of each criterion is calculated by the following equation. It should be noted that the weight of the first criterion is equal to one

$$Q_j = \frac{Q_{j-1}}{K_j}$$

- **Sixth step:** Calculate the final normal weight

In the last step of the SWARA method, the final weight of the indices is calculated by normalizing the indices in a linear way according to the following equation.[16]

$$q_j = \frac{Q_j}{\sum Q_j}$$

## III. CONCLUSION:

To prioritize thecritical success factors,a number of experts in the upstream oil and gas industry were used to use the SWARA method, and the results are shown in the table 3.1.

According to the opinions of experts, the priority of the results obtained in order:

1. Management support 2. Clear and realistic goal 3. Allocation of sufficient resources 4.Employee motivationwhich are most important.

| Grade | Qj | Subject |
|---|---|---|
| 1 | 0.164 | **Management support** |
| 2 | 0.121 | **Clear and realistic goal** |
| 3 | 0.105 | **Allocation of sufficient resources** |
| 4 | 0.085 | **Employee motivation** |
| 5 | 0.084 | **Qualification of employees** |
| 6 | 0.083 | **Teamwork** |
| 7 | 0.082 | **Authority,responsibilities and accountability** |
| 8 | 0.071 | **Correct supervision** |
| 9 | 0.061 | **Evaluation of programs** |
| 10 | 0.05 | **Safety meetings** |
| 11 | 0.041 | **Safety training** |
| 12 | 0.031 | **effective implementation of regulations** |
| 13 | 0.022 | **Safetyequipmentand their maintenance** |

**Table 3.1** Calculating the final weight of options and ranking by SWARA

In Table 3.2, the cumulative frequency of each factor is specified and it is shown in order according to their priority from the highest percentage to the lowest percentage.

| N | Qj | f % | F% |
|---|---|---|---|
| 1 | 0.164 | 16.42% | 16.42% |
| 2 | 0.121 | 12.11% | 28.53% |
| 3 | 0.105 | 10.51% | 39.04% |
| 4 | 0.085 | 8.51% | 47.55% |
| 5 | 0.084 | 8.41% | 55.96% |
| 6 | 0.083 | 8.31% | 64.26% |
| 7 | 0.082 | 8.21% | 72.47% |
| 8 | 0.071 | 7.11% | 79.58% |
| 9 | 0.061 | 6.11% | 85.69% |
| 10 | 0.05 | 5.01% | 90.69% |

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| | | | |
|---|---|---|---|
| 11 | 0.041 | 4.10% | 94.79% |
| 12 | 0.031 | 3.10% | 97.90% |
| 13 | 0.021 | 2.10% | 100.00% |

**Table 3.2**Cumulative frequency of critical success factors

Dr. Joseph Juran implemented Pareto's discovery in economics on the issue of labor productivity and promoted Pareto's law; For example, he realized that 80% of production problems are the result of 20% of employee errors.

It was from this discovery that today the implementers of small and large projects know that 20% of the work takes up 80% of their time and energy, and this 20% consists of the two 10% that are dedicated to the beginning and end of the project. In general, Pareto's principle is a powerful and useful law that significantly helps to optimize and focus the project on more critical issues by using the right solution.[17]

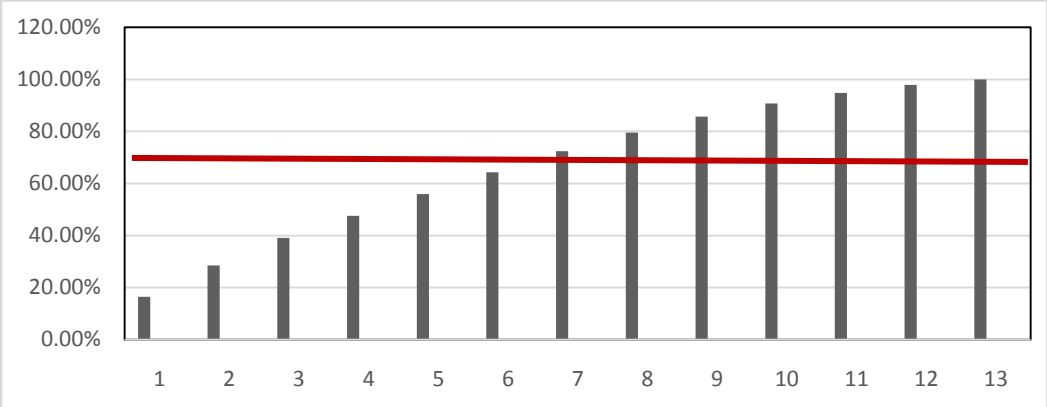


**Fig.3.1**Pareto of critical success factors

According to the drawn Pareto chartFig. 3.1, in this research we find that approximately 80% of the successes for the successful implementation of HSE-PLAN in the project are due to these 8 items, namely:

1. Management support
2. Clear and realistic goal
3. Allocation of sufficient resources
4. Employee motivation
5. Qualification of employees
6. Working group
7. Authority, Responsibilities and Accountability
8. Proper supervision

If we focus on the first 8 factorswe can prevent or reduce many incidents in the upstream oil and gas industry at a lower cost.

Contractor relationship management, leadership involvement, role clarity, and empowerment are also important factors for failure-based learning, both directly and through increased knowledge exchange.[18]

One of the most important CSFs in implementing the HSE plan and reducing accidents radically is management support.

In general, in various books related to safety issues, we often see the review of the role of management in planning, implementing and improving safety performance.

Management support is an effective indicator that is important in the long run, and in most cases its effect is seen with a delay in the safety process.[19]

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