



Review of Recordable Injuries in an Oil and Gas Company by Using Human Factors Analysis and Classification System for the Oil and Gas Industry (HFACS-OGI)

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KEYWORDS

The Human Factor,
Oil And Gas Industry,
Recordable Injury

ABSTRACT

Recordable injuries, defined as occupational incidents resulting in injuries beyond first aid, serve as critical indicators of safety performance within the oil and gas industry. Understanding the root causes of these injuries is essential for preventing their recurrence and enhancing safety outcomes. Employing the Human Factors Analysis and Classification System for the Oil and Gas Industry (HFACS-OGI) promises valuable insights into these incidents, with a focus on human factors. By reclassifying existing investigation findings into the HFACS-OGI framework, this study examines the distribution of causal categories across its five classification levels. It reveals that recordable injury causes span across four of these levels: Level 1 – Unsafe Acts, Level 2 – Preconditions of Unsafe Acts, Level 3 – Unsafe Supervision, and Level 4 – Organizational Influences. Moreover, the analysis underscores the interconnected nature of these levels, emphasizing comprehensive understanding and integrated management of safety risks.

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INTRODUCTION

Human factors have been an avid discussion topic within the oil and gas industry, especially relating to incidents/accidents. Based on an analysis of accidents from 1970 to 2016, human errors have been proven consistent as the main source of accidents as well as the catalyst for their amplification (Mignan, Spada, Burgherr, Wang, & Sornette, 2022). Catastrophic accidents in the oil and gas industry often result in multiple fatalities, such as the Piper Alpha disaster (1988), BP Texas City Refinery Explosion (2005), and Deepwater Horizon (2010). Research has been made to analyze the contribution of human factors in incidents within and outside the oil and gas industry, where it is indeed proven that human factors, whether directly or not, play a big role in incident occurrence (Filho, Souza, Siqueira, Souza, & Vasconcelos, 2019; França & Hollnagel, 2023; Fu, Xie, Jia, Tong, & Ge, 2020; Uğurlu, Yıldırım, & Başar, 2015).

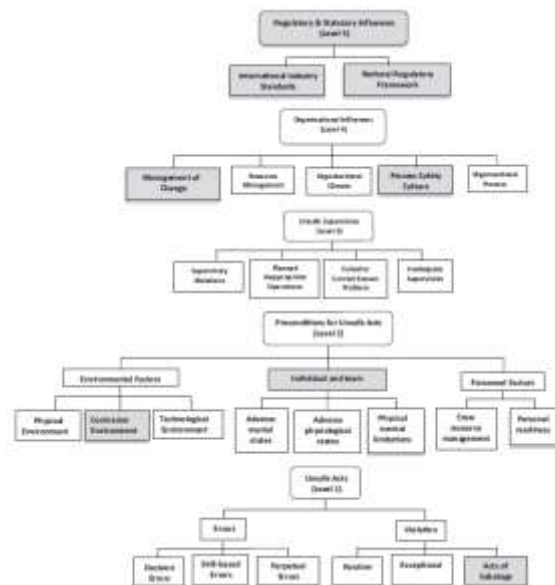


Figure 1. Human Factors Analysis and Classification System for the Oil & Gas Industry

Decades by decades, experts have formulated models and approaches to learn about the causation of accidents/incidents, including those focusing on human errors. The Human Factors Analysis and Classification System (HFACS) is one method originally developed for the aviation industry, which became popular and is widely used in safety domains in all industries. Shappell & Wiegmann (2017) based this method on James Reason's Swiss Cheese Model of active and latent failures (George, Moideen, Varghese, Warriar, & Khan, 2022; Hulme, Stanton, Walker, Waterson, & Salmon, 2019; Nwankwo, Arewa, Theophilus, & Esenowo, 2022a; Theophilus et al., 2017; Wiegmann & Shappell, 2017) then divided the failures into 4 (four) different levels: (1) Unsafe Acts; (2) Preconditions for Unsafe Acts; (3) Unsafe Supervision; and (4) Organizational Influence (Wiegmann & Shappell, 2017). In an attempt to adjust the HFACS method to the unique needs of specific industries, HFACS has been modified from its original framework to analyze accidents including in marine, railway, construction, and healthcare (Hulme et al., 2019).

The various framework in different industries has each been used and succeeded in providing valuable information for safety management and policy development (Wang, Zhang, Zhao, Wang, & Tong, 2020), creating accident development paths and corresponding possibilities (George et al., 2022), and finding the most contributing causal factors (Nwankwo, Arewa, Theophilus, & Esenowo, 2022b; Zhang, Chen, Xi, Hu, & Tang, 2020). In flexibility, review using HFACS can also be combined with another model such as the Bayesian network to calculate the failure probability of incidents (Li, Liu, & Liu, 2020; Qiao, Liu, Ma, & Liu, 2020).

Theophilus et al., (2017) finally developed a modified HFACS for the oil and gas industry by adding a category(ies) in level 1 – Unsafe Acts, level 2 – Preconditions of Unsafe Acts, level 4 – Organizational Influence, as well as including level 5: Regulatory and Statutory Influences. This modified method, consequently referred to as The Human Factors Analysis and Classification System for the Oil and Gas Industry (HFACS-OGI) was evaluated by comparing the analysis of 11 notable refinery accidents that occurred between 1998 and 2012.

Objectives

In a company context, the number of accidents/incidents has long been an indicator to measure a company's safety performance. The lower the incident rate is, the better the safety performance. However, to make improvements, counting numbers is not enough, therefore a learning-from-events system is established to better review the significance of accidents/incidents to improve the company's overall performance.

The International Association of Oil & Gas Producers (IOGP) has published an annual report on Safety Performance since 1985, which is summarized from the data obtained from its company

members, including the number and causal factors of incidents. In the last 5 years, the recordable injury rate has been fluctuating, with started by a decrease during the pandemic in 2020, and then slightly increasing along with the shifting of the pandemic situation (Joseph, Astesani, & Maliekkal, 2022). This trend is also seen if we look into the annual reports of major oil and gas companies operating in Indonesia (Elsayed, 2022; Kaufmann et al., 2023; Sari, 2022; Wahua et al., 2023)

The company being in the review object has diligently applied the learning from events process by conducting comprehensive investigation and analysis to recordable injuries (injuries beyond the first aid) and high potential incidents. Such analysis is made by using the cause tree analysis (CTA) model, which classified the incident's root causes into three groups: human factors, job factors, and management system dysfunctions. Other than that, immediate causes (unsafe acts and unsafe situations) of incidents are also considered. Within the last 10 years, the analysis still indicates that unsafe acts and human factors take the biggest if not the second biggest portion of the recordable injuries causes.

Reviewing these causes with the framework of HFACS-OGI is expected to provide a new perspective on the learning from events results. In this light, applying the HFACS-OGI framework promises to provide novel perspectives on these learning-from-events initiatives, fostering continuous improvement in safety performance.

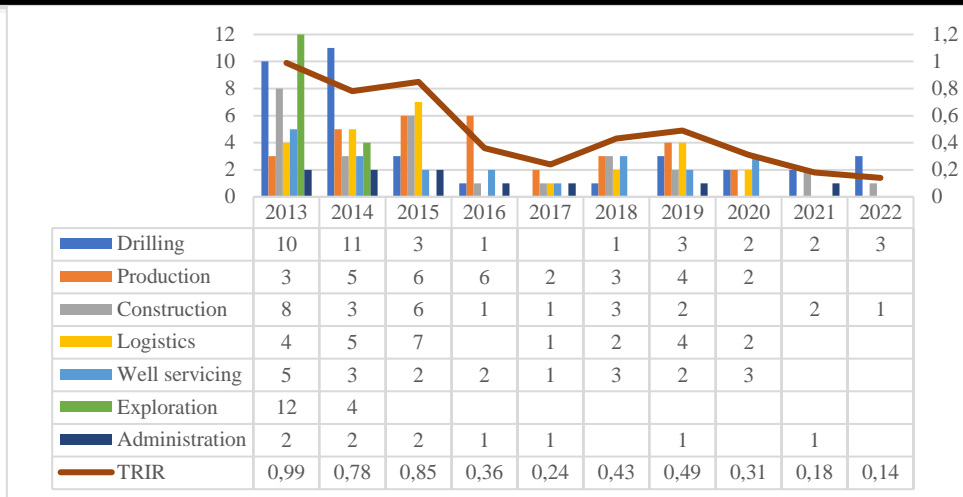
METHODS

The review focused on recording reportable injuries that occurred from 2013 to 2022 within the company. The decision to use this timeframe was based on the availability of comprehensive investigation data starting in 2013 and the consistent application of the investigation analysis technique until 2022. Data on investigation outcomes was extracted from the company's database tools, specifically Synergy, which includes details such as descriptions, timing, locations, immediate causes, and root causes of the injuries. These original causes were subsequently reclassified into the five-level HFACS-OGI categories, aligning with the general HFACS classification guidelines (Wiegmann & Shappell, 2017) and the modified HFACS-OGI (Theophilus et al., 2017). The review process involved examining the distribution of causal categories within each level of HFACS-OGI, drawing insights from the investigation findings. Furthermore, relationships between levels were explored by analyzing incidents that had causes spanning different HFACS-OGI levels.

RESULTS and DISCUSSION

Recordable Injuries Statistics

Within the years 2013 to 2022, there were 166 incidents resulting in 178 recordable injuries in the company as one incident may lead to multiple injuries. The most severe incident led to 7 injuries. The number of incidents is consistently decreasing by years from tens to units. Drilling and Production disciplines take the lead in contributing the greatest number of incidents, while others took place in Construction, Logistics, Well Servicing, Exploration (Seismic), and Administration. While administration discipline seems to have a lesser risk of injuries, this proves that all kinds of activities in oil and gas industries are still exposed to incident risks. Examples of incidents in the administration area: a launderer at the field got a burn injury while ironing clothes, a kitchen personnel got scratched on the palm by an uneven plate edge during dishwashing activity, and personnel got ill upon consuming food provided by the company at Sites. Graph 1 below shows the trend of recordable injuries per year and discipline.



Graph 1. Recordable Injuries Trend in 2013 – 2022

Regarding the frequency of incidents, the start of the decrease in injuries was in 2017 when activities were significantly dropping due to the transfer of ownership. When operational activities returned to normal in 2018, injuries were also slightly increasing, and once again decreasing in 2020 during the COVID-19 pandemic. This trend can also be shown by the evolution of the Total Recordable Injuries Rate (TRIR), which is the number of injuries compared to the million manhours worked in the same year.

HFACS – OGI Analysis

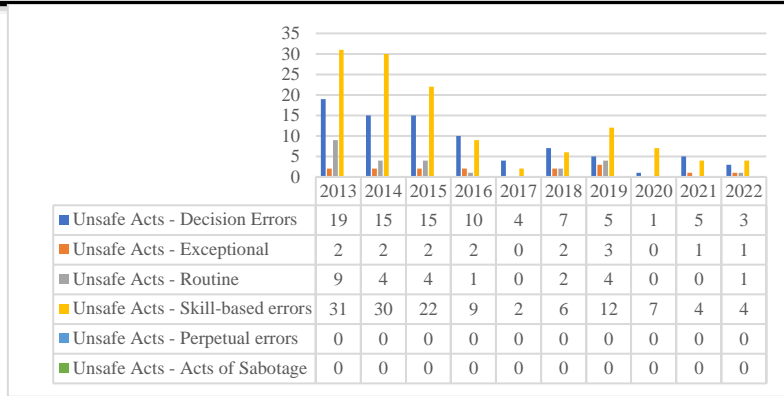
Level 1 – Unsafe Acts

In this level of the HFACS-OGI Framework, Skill-based errors and Decision errors respectively contribute to 51% and 33% of all incident causes. The two categories that have no contribution to incidents are Perpetual errors and Acts of Sabotage.

Skill-based errors refer to errors resulting from failure of attention and/or memory (Wiegmann & Shappell, 2017). These errors often take place without conscious control as smooth, automated, and highly integrated patterns of behavior (Moencks, Roth, Bohné, & Kristensson, 2022). Within the company system, these errors relate a lot to adopting unsafe work positions, posture, placement, and improper manual handling. These activities are routines that do not require thinking and can be done just instinctively. Examples of incidents in this array are ankle sprain due to wrong footing, being caught between bulwark and mooring rope during mooring activities, hit by a valve when standing up.

Decision errors involve intentional behavior that is wrongly executed or having inadequate or inappropriate plans for certain situations (HFACS). Mapping from the company system to HFACS-OGI includes failure to check equipment before use; failure to comply with procedure/instruction; or using inadequate/defective tool / PPE. These are common practices within the company’s day-to-day operations; however, complacency may lead to the occurrence of incidents.

Skill-based and decision errors cannot often be solved by training or discipline. What can be done is to create a condition where there would be so little potential to err. If the problem is with the design of equipment or layout of the environment, then the company would need to study possible modifications of such designs or conduct housekeeping. If procedures are the problem, then the company would need to ensure that such procedures are applicable to the working environment and easy to understand.



Graph 2. Distribution of Unsafe Acts

Level 2 – Preconditions of Unsafe Acts

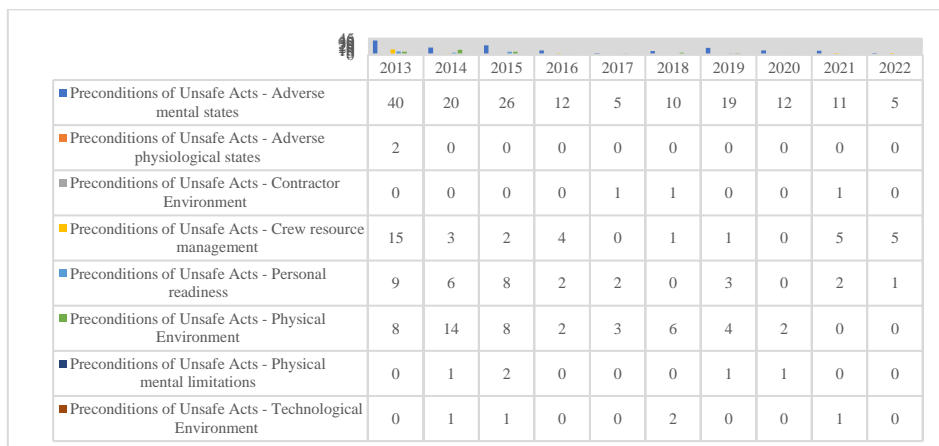
While it is important to solve the problems with unsafe acts, it is not wise to only focus on that matter without understanding the underlying causes (Wiegmann & Shappell, 2017). Therefore, the next level of classification is identified as the preconditions of unsafe acts. Within the HFACS-OGI framework, this level comprises environmental factors, personnel factors, and individual & team factors.

Adverse mental states contribute to more than half of incident causes within Preconditions of Unsafe Acts level with 55%. Other than that, Physical Environment and Crew Resource Management take the next spots. Individual shortcomings included in adverse mental states are lack of safety awareness or attention or discipline, as well as complacency and hasty work execution. While physical environment includes human interaction with the environment such as poorly-managed working environment, extreme climate, and hazardous substances exposure; and crew resource management covers personnel’s qualifications and training.

Reviewing the data year by year, adverse mental states and crew resource management consistently appear as the causes of incidents, while the physical environment decreases. This might show the company’s success in creating a better working environment, which can be achieved with routine inspection and/or mitigation to deal with physical or biological hazards. There are also interesting facts relating to the adverse mental state occurrences:

- a) They often result in injuries due to slipping, tripping, hitting, or pinched between materials.
- b) Almost 60% of the incidents caused by adverse mental states are also caused by skill-based errors.

These facts might prove that the preconditions of unsafe acts really affect the occurrences of skill-based errors. Therefore, mitigations done to prevent the situations classified as level 2 will also tackle the problems of level 1. Some of these mitigations include sufficient induction/basic training to the personnel, encouraging report of anomalies (unsafe acts/unsafe situations), proper inspection and housekeeping, balanced crew scheduling and task allocations.



Graph 3. Distribution of Preconditions of Unsafe Acts

Level 3 – Unsafe Supervisions

The causal chain of events may be traced back up to the supervisory chain of commands (Wiegmann & Shappell, 2017). Therefore, this level deals a lot with the processes of planning, supervising, and improving past mistakes/problems. The unsafe supervision is the only level in HFACS that is fully adopted into the HFACS-OGI frameworks without modification.

Most causes that occurred at this level relate to planned inappropriate operations (50%) and failure to correct known problems (35%). Planned inappropriate operations in the company’s context refer to supervisory failures in risk assessment, planning, and inspection/control, while failure to correct known problems include, among others, the non-acknowledgment of missing safety guards, uncertified equipment, and failure to warn an apparent unsafe act.

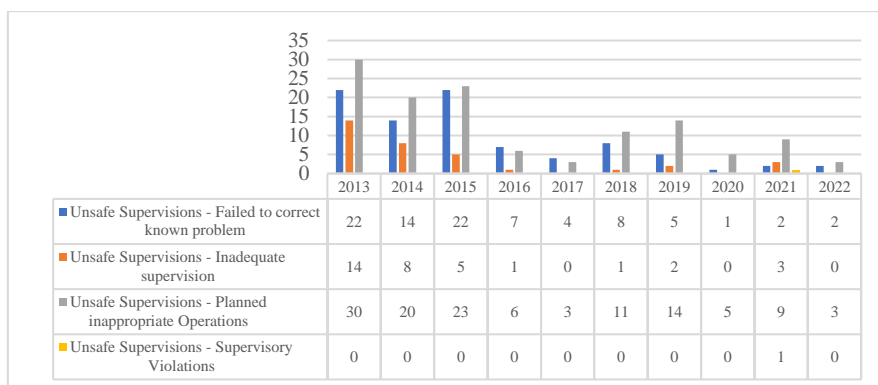
Common problems relating to these failures are:

- a) Using a general risk assessment for specific jobs. While general risk assessment is important and valid to be used, the mitigations are subject to be adjusted according to the needs of specific jobs as tools and locations might be different.
- b) Missing an inspection or quality control when it is due.
- c) Failure to follow up recommendations/follow-up from past incidents or anomaly findings
- d) Unsafe acts being ignored by supervisors.

Shappell & Wiegmann, (2017) discussed that failures in planning inappropriate operations and correcting known problems significantly affect the physical environment in level 2. While this is not apparent in this review, corrections to this problem are indeed related to the environment which is interacting with humans. Reason (2014) said that human supervisory control was not conceived with humans in mind, instead, errors of control are actually delayed effects of system design failures.

A study by Hadi et al., (2023) highlights the important competencies that must be possessed by supervisors in the oil and gas industry, which top 5 are:

- a) Judgment and decision making: supervisors must be able to assess, and compare data from past experience or occurrences before making a decision and solving problems.
- b) Team working: not only asking to work but supervisors must also be involved with the team to achieve goals or complete work.
- c) Communication: supervisors should be able to convey messages clearly, and open to any information or ideas from the team.
- d) Empowering and delegating: supervisors at times should assign tasks and responsibilities as well as give chances to the team.
- e) Leadership: supervisors must be able to influence people.



Graph 4. Distribution of Unsafe Supervision

Level 4 – Organizational Influence

Fallible decisions of top management often influence supervisory practices (Wiegmann & Shappell, 2017). Improper supervisory patterns may be caused by how the organization sets its goals. Top management directs the organization on a strategic level, with concern for the limited resources

such as funding, equipment, and talent (Diller et al., 2014). Aside from safety, there is also productivity to be considered.

Organizational process (42%) and organizational climate (30%) dominate the causes of incidents in level 4. Organizational process includes the absence or lack of procedure, conflicting objectives, and inadequate HSSE programs, while organizational climate talks about management’s commitment and communication. Not so far behind, resource management contributes to 26% of incidents. 37% of incidents having problems with the organizational influence are also caused by planning inappropriate operations of level 4, while 64% are also caused by failure to correct known problems of level 4. This might indicate that organizational policy affects how supervisors lead or influence the team.



Graph 5. Distribution of Organizational Influence

Level 5 – Regulatory & Statutory Influence

While the company classified compliance with laws and regulations as one of its incident causes, however, none of the recordable injury investigations conclude this aspect as one of the causes. Therefore, the review of this level cannot be done.

Internal Improvement Programs

Following the result of the incident investigation, the company has made continuous improvements to safety programs, one of them being “TEMAN” (Tegur jika saya tidak aman/Remind me to be safe), launched in 2020. TEMAN aims to encourage personnel to report unsafe acts observed in their surroundings, and this was preceded by the fact that there was so little report of unsafe acts compared to unsafe situations. With this program, the company would like to assert to the personnel that reporting unsafe acts is not for “telling” out a friend, but to ensure that everyone is safer.

Other than TEMAN, the company is also starting to apply a “Just and Fair Culture,” which is established and coordinated by the parent company. A just and fair culture is mainly integrated into incident investigations. After an investigation concludes that there is a root cause with a tendency to human violation, a committee will be formed to further assess the human errors. This committee will decide whether such human errors are intentional and subject to punishment. With this system, it is expected that the medicine to the errors is effective.

CONCLUSION

Recordable injuries is one of the closely-monitored indicators to define a company’s safety performance. Recordable injuries usually contribute to the lagging indicator called Total Recordable Injury Rate (TRIR), and this rate is expected to decrease each year, along with better safety performance and safety culture. The company being reviewed has an established system of reporting and investigating incidents. Incident records can be found as far back as 2006, however, complete investigation results are only diligently stored years after. The results of the investigation are reclassified into HFACS-OGI to find a new perspective on the incident analysis.

It is found that for each level of HFACS-OGI, one category is mostly dominating over the others. For Level 1 – Unsafe Acts, the biggest contributor is skill-based errors, for Level 2 – Preconditions of Unsafe Acts is adverse mental states, for Level 3 – Unsafe supervisions is planned inappropriate operations. For Level 4 – Organizational influence, 3 categories contributing almost the same amount are organizational process, organizational climate, and resource management. Despite no statistical test applied for this review, the relationship between levels of HFACS-OGI can be seen. It is expected that

this result would assist the company in setting strategies to improve human performance in a safety context.

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