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BEHAVIOR BASED SAFETY IN ACTION. A CASE STUDY AND FIELD TEST RESULTS IN SIX OIL AND GAS DRILLING RIGS IN KUWAIT

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Abstract: *The research aims to perform a systematic scientific investigation of the factors affecting the implementation of the behavior-based safety approach in the oil and gas industry. Six drilling and work-over rigs from the state of Kuwait which belongs to four different drilling contractor companies were chosen for the case study and behavioral observations were conducted. Baseline observations were conducted in June and July 2023. Based on 4,041 observations from all rigs, the data collected and analyzed were processed and interpreted, indicating a safe working environment and/or where is still room for improvement in safe working behaviors. Adequate site-specific intervention methods are proposed to exert a positive impact on workers so that in the very near future the number of at-risk behaviors gradually decreases from one observation session to the next.*

Key words: *Behavior Based Safety (BBS), oil and gas industry, safety performance, Critical Behaviors Checklist (CBC), intervention method.*

1. INTRODUCTION

In the last 30 years, the emphasis put on increasingly safer operations became the standard for numerous companies that have the potential to cause major human and environmental disasters. In the public's eye, these are not that different. The oil and gas industry, especially the drilling industry, has joined this kind of approach increasingly energetic and systematic in recent years. This requirement for increased safety and health standards was significantly strengthened due to several major accidental events that have occurred in this industrial field of activity and due to the awareness of the need to identify more economical operating methods, considering the pressures exerted on the profit rate by globalization, competitive developments and major changes in the science of risk management [1]. Essentially, workplace safety has become like a double-edged weapon in the case of drilling industry. It has become a way of letting employees be aware that even in the volatile, uncertain and complex world of re-engineering, restructuring, cost-cutting and other difficult life-saving processes which should necessarily

be undertaken by any organization, this takes accountability about for employees, in a dedicated and committed manner [2].

Behavioral Based Safety (BBS) is acknowledged as a main technology for applying psychological principles to maintain occupational health and safety of workers [3]. Part of the current format of the behavior-based safety approaches seems to differ from available structures and practices, which would have included various other things [4]. Certain industrial organizations have already implemented an adapted version of BBS processes. However, these programs were developed and conducted mainly by key performance indicators (KPIs); this makes them struggle with the numbers instead of prioritizing the quality of program execution and its effectiveness [5]. Several consultants have tried to implement BBS programs copyrighted and have had varying success [6]. The effectiveness of BBS programs depends on their effective practical materialization. The component to be included in the implementation stages of the BBS approach differs from one researcher to another. Although implementations have been reported in previous studies, the current

behavior-based safety approaches are facing critical difficulty in achieving long-lasting and highly effective consequences [7], [8].

The components of behavior-based technology go beyond behavioral observation methods and statistical techniques to chart the improvement of workplace safety performance. They include, according to Geller, ways to improve interpersonal communication, individual accountability, teamwork, morale, involvement, peer support, follow-up interventions, and other factors needed to continuously improve workplace safety [9], [10], [11].

The behavior-based approach is the “*most efficient and effective way to achieve a Total Safety Culture in the workplace*” [12]. It is a continuous process of improvement which needs continuous and extended involvement of workers and staff members (human factors) which should be kept safe. Indeed, basically, in any kind of activity/industry, these are the operators/workers, but the more general denomination could be the human factor. Sustainable employee involvement and participation imposes the development of a better understanding and wholly trust in continuously applying and reinforcing principles underpinning the process [13].

When effective managers/leaders or safety officers/consultants are guiding the customization of such a process, they are often stating their requirements/expectations but they are not giving out always specific instructions. They show both confidence and uncertainty [14], [15]. Otherwise said, they trust the fact that an ensemble of clear procedures is designed, but they do not accurately realize what is the right way to materialize them in the current organizational practice. This fact allows the workers to generate and maintain a state of attention, creativity and personal and collective motivation with the natural result of increasing the feeling of belonging to the company's values, of the level of trust and satisfaction, of the perception of the personal role in achieving the production/safety objectives; this effect will next generate a greater and deeper level of employee engagement [16]. In order for a BBS process to be successful in a company, the procedural details will need to be worked out

with the full and unconditional participation of workers whose commitment is required. The processes need to be customized in such a way that they will smoothly fit the organizational company culture.

The critical behaviors checklist (CBC) is specific tool developed as a way of looking for the materialization of critical behaviors during the activity of performing a working task/job and then giving individual workers feedback regarding what observations were made as being a safe behavior and what was considered a risky behavior. This process is called behavioral coaching and will be explained in more detail. The checkmarks in the safe and risky columns of a CBC can easily be synthesized in a value of “percentage of safe behaviors.” A global score can be then computed using the division between the total number of performed behavioral observations (i.e., all the checks done in all the applied CBCs) and the whole number of safe behaviors observed. This gives a total/global estimate of the workforce's safety score with respect to the critical behaviors targeted in the observation phase of the DO IT process [17].

The overall “*percentage of safe behaviors*” score does not provide an indication of behaviors that need to be improved, but it can motivate the workforce to want to improve. It is a goal - oriented value that puts accountability at worker's level for all the details regarding safety which are in their control, with special emphasis on the prevention vector. It obviously admits that all the workers involved do clearly have enough knowledge related to the safe operating procedures for each job/working activity they are performing.

In all cases when certain involved workers are unsure about the non-risk technique to carry out a particular working task, detailed behavioral guidance should be provided. An “overall safety percentage scoring system” is obviously not good enough. It is highly recommended to ensure extra behavioral guidance, by providing it during individual training/coaching sessions, generally in the stage when the CBC is reviewed. On this occasion, the operator can really “see” which critical behaviors have been highlighted as “safe” and - respectively “at risk”. Based on open

discussions, workers can understand see which considered behaviors are not risky and which critical behaviors need improvement. The results can be displayed in a visible place and discussed during team meetings.

Often, behaviors that are not concerned within CBC's are becoming significant and therefore, within a cyclical process of continuous improvement, certain aspects identified during the implementation will be considered later by including them in the revised versions of the CBCs. In what follows, the main results of an exploratory study carried out regarding the influencing factors that determine the effectiveness of the implementation of a BBS type approach in several multinational companies operating in the drilling industry are presented. Six drilling rigs from four different companies were chosen for the case study.

2. MATERIAL AND METHOD

This research paper has developed and delivered a BBS training program for drilling operations and tested the implementation of basic BBS procedures on several drilling rigs from different drilling contractors. Behavioral observations were conducted at six drilling and workover rigs from the state of Kuwait which belongs to four different drilling contractor companies. Two of the companies participating in the research were the local drilling contractors' company and the other two were international drilling contractors' company. Rig A (n=23) and Rig B (n=25) are in the south-east of Kuwait. Rigs C (n=30), D (n=22), E (n=27) and F (n=23) are all located in the northern part of Kuwait. Participants were 100% male, 73% Asian and 27% North African. Although the locations were slightly different in terms of the number of employees, each was similar in terms of equipment used, rig capacity and level of activity. Other notable differences were the managerial approach to occupational health and safety from each individual company, the length of time that workers on each rig worked together, and the competence and involvement of site leaders in safety related concerns.

Baseline observations were conducted at locations A and B in April 2023 for two weeks

prior to the start of the actual program. Employees were unaware of the targeted behaviors, although they knew they were being observed. The Rig Manager and RSO (Rig Safety Officer) at each site were given brief but descriptive instructions on how to correctly complete the Behavior Checklists for the baseline measurements. Three different types of critical behavior checklists were used for this phase of the research. The critical behavior checklists covered three different operations such as working at height, crane lifting operations and other very common operations such as tripping in and out of the well. Each checklist has been divided into different sections that would be aimed at observing a few different behaviors.

Observations from this phase of the research were conducted twice a week for each facility for two months (June 2023 and July 2023). Each observation session lasted between 30 and 90 minutes. The data collected from four of the drilling rigs indicated a safe working environment, although this may not be entirely true. The research concludes that BBS (behavior-based safety) is effective in increasing safe working practices. Training as the only intervention method was not sufficient, but like the previous behavioral research on BBS field, behavioral feedback led to a significant improvement in safety performance. Based on 10569 observations from April to July 2023, in the baseline phase and in the observation phase, with the caveat that in the first period the observations occurred without employees being aware of the Behavioral Safety Process elements and structure. The overall safety performance scores at these four locations increased following the introduction of the BBS feedback process.

Procedure - For all six drilling rig locations, behavioral observations were conducted by walking around the rig with the Rig Safety Officer (RSO) or the Rig Manager. Behavioral observations consisted of either myself or, in my absence, the RSO (Rig Safety Officer) or Rig Manager completing a Critical Behavior Checklist (CBC) observing all employees engaged in the targeted critical behaviors above-

mentioned mentioned operations that the CBC's were developed to be evaluated.

Workplace safety assessment and development of the implementation team - At the beginning of the assessment phase, a "Program Overview Session" was held, which consisted of six meetings, one session for each rig, lasting three hours with all supervisors in each facility, i.e. Rig HSE Officers and Rig Managers. The agenda for the Program Overview Session included the rationale for the process, an outline of the milestones, the planned time frame of the project, and time for questions from the audience. Prior to implementation in the experimental areas, a thorough workplace safety assessment was conducted. The objectives of the assessment were to identify existing safety efforts, integrate employee feedback, identify high-risk areas and activities, identify training needs, and obtain management support for implementation of the BBS process. The workplace safety assessment was conducted by interviewing staff (approximately 20 Safety Officers and site supervisors) and facilitating a workplace accident analysis by a team of employees.

Behavioral observation and feedback training - Participants learned about the principles and practical applications of BBS, with a focus on behavioral observation and feedback. Employees were informed and educated about the process through lectures, discussions and group activities. The training included an educational component that taught employees the basic principles of BBS, as well as a training component that gave participants the opportunity to: exercising the behavioral observation of a coworker; completing the critical behavioral checklist; providing feedback on safe and at-risk behaviors of coworkers.

3. RESULTS AND INTERPRETATION

3.1 The Baseline phase: Critical Behavioral Checklists used

Baseline observations were carried out at sites A and B in April 2023 for two weeks prior to the start of the actual program. Employees were not aware of the targeted behaviors, although they knew they were being observed. The Rig Manager and RSO (Rig Safety Officer)

at each site were given brief but descriptive instructions on how to correctly complete the Critical Behavior Checklists (CBCs) for the baseline measurements. As mentioned above, three different types of CBCs were used for this phase of the research. The critical behavior checklists covered three different operations such as working at height, crane lifting operations and tripping operations. As can be seen in the example below, each checklist has been divided into different sections that will target the observation of a few different types of critical behaviors.

The checklist (Figure 1) consists of three sections as follows: the first section is the section on wearing personal protective equipment, which focuses on the use of personal protective equipment (PPE) such as harnesses and lanyards, protective gloves, protective footwear, protective eyewear and a hard hat with a chin strap (which is mandatory to reduce the risk of dropping the hard hat from height).

Task-Specific Checklist: Working at Height

Location:	Date:	Observer:
Behaviors		
Safe	At-Risk	Comments
Wearing PPE		
- Harness, lanyards		
- Gloves		
- Foot protection		
- Eye protection		
- Hard Hat with chinstrap		
Body position and body mechanics		
- Hand placement, avoiding pinch points areas		
- Manual lifting, bending knees, not waist(back)		
- Twisting, overreaching, awkward body position		
Job planning		
- Use of proper tethered tools		
- Use of SRL 's, LAD-SAF for safe ascending and descending on ladders		
- Use of manlift for access where no ladders or platforms in place		
- Rigid barriers installed on the mud tanks and rig floor created open edges		
- Approaching open edges only when secured with WAH equipment		
- Horizontal lifelines installed where necessary		
Totals		

Fig. 1. Representations of manual handling activities type 1, 2 and 3 – selective (template document).

The second section focuses on body position and body mechanics, which focuses on behaviors such as hand placement (avoiding pinch point areas), manual lifting (bending the knees, not the waist (back) and twisting,

reaching or any other awkward body position. The third and final section of this working at height checklist is the Job planning section, which includes the following observable behaviors: Use of appropriate tools for working at height, Use of self-retracting safety devices like Use of SRL's, use of LAD-SAF devices for safe ascending and descending on ladders, Use of manlift for access where no ladders or platforms in place, Installation of rigid barriers on mud tanks and rig floor where open edge areas are created, approaching open edges only when secured with working at height equipment, and Installation of horizontal safety lines where required.

At Site A, 6 different observational sessions were conducted for the baseline phase and during all the sessions 782 behavioral observations were recorded using three different checklists for three different site-specific operations. The percent safe performance for all behavioral observations at Site A averaged 81.11%, as seen in Figure 2.

At Site B, 6 different observational sessions also took place and during all the sessions, 723 behavioral observations were conducted using the same three different checklists for the same three site specific operations.

The percentage safe for all behavioral observations conducted at Site B averaged at 67.51% (Figure 3). The difference between the two sites in the safety performance (behavioral observations percent safe) that was statistically significant, but the average of the percentages between the two sites, which is 74.31%, was taken as the baseline value.

The data collected from the behavioral observations at the first two rigs which were used for benchmarking and to determine the baseline values indicated a safe working environment for Site A, with an average score of 81.11% Safe Behavior, although this may be an overly optimistic conclusion.

For Site B, with an average of 67.51% Safe Behaviors, it indicated a high need for improvement in safety performance for most of the behaviors observed during this phase of research.

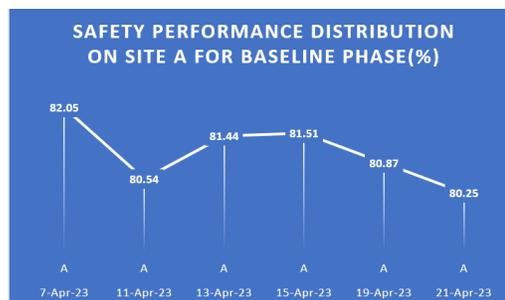


Fig. 2. Safety performance distribution on site A for baseline phase of the research.

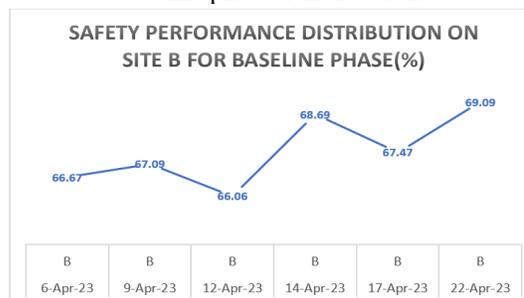


Fig. 3. Safety performance distribution on site B-baseline values.

Based on 1505 observations conducted over two-weeks period at both sites, the overall Safe Behaviors percentage scores increased slightly at both sites, with scores ranging from 66.06% to 69.09% at Site B and from 80.25% to 82.05% for Site A. The current results advocate the need for preliminary training in the fundamentals of the BBS process to increase awareness and safe work practices for both sites, especially for Site B.

3.2 Behavioral observations phase

At each of the six locations, a BBS education/training program was conducted with all on-site employees to familiarize them with the program and its concepts. Employee training sessions lasted for two hours at each site and were held at 10 AM before the first shift with the first crew and at 12 PM after the first shift with the second crew. Employees at each site received the same training, all were explained the purpose of the program and were introduced to the definitions and concepts of behavior-based safety program.

The Rig Safety Officers at each site designed a convenient place to display the results of the completed behavioral checklists on a whiteboard that was made available in nearby dining rooms or locker rooms for employees to view the

weekly results of the completed CBCs'. It is important to note that the checklists were completely anonymous; actions and behaviors recorded could not be attributed to any of the employees. Completed CBCs were collected for research purposes and analyzed. Performance data on critical behaviors were provided periodically (weekly and monthly) at each site, updating rig management and rig crews on their safety performance progress.

CBC development - The same three different types of critical behavior checklists were used for this phase of the research. As previously mentioned, these critical behavior checklists covered three different operations, such as working at height, handling loads using the cranes, and another common operation such as tripping operations. The behaviors were observed and marked appropriately on the checklists as Safe Observations or At-Risk Observations on different columns. At the end of each observation session, all safe observations and risky observations were counted and the safe percentage was determined based on the formula given below.

$$\begin{aligned} & \% \text{ Safe Observations} = \\ & = \frac{\text{Total Safe Observations}}{\text{Total Safe Observations} + \text{At - Risk Observations}} \\ & \times 100 = \underline{\quad}\% \end{aligned} \quad (1)$$

Behavioral observations were conducted at all six drilling rigs' locations in June 2023 throughout the whole month. Beginning at this stage, employees were aware of the targeted behaviors as they had been educated in training sessions on the fundamentals of the BBS process and the purpose of the research, therefore they knew they were being observed and were aware of the safe and at-risk behaviors being targeted for each activity. The observation sessions were conducted partly by the researcher and partly by the managers of each site, (Rig Manager and Rig Safety Officer). The supervisors of each site were given descriptive instructions during the training sessions on how to correctly complete the critical behavior checklists and how to correctly calculate the safe percentage results at the end of the observation session.

Behavioral observations were conducted at all locations throughout July 2023. Employees were aware of the targeted behaviors as they had experienced the same in the previous observation phase that was conducted in June, therefore, workers began to feel more comfortable being observed and receiving feedback on their safe and at-risk behaviors that were targeted for each operation. Observation sessions were conducted again partly by the researcher, and partly by the Rig Manager and the Rig's Safety Officer at each site. During each behavioral observation session, if any risky behavior or potentially dangerous conditions were observed, observers stopped the work and discussed the circumstances with the individuals involved. Unsafe behaviors were stopped immediately, unless stopping the worker could have created a greater hazard. If the action was not instantly dangerous to human life and health, observers were asked to use their judgement to decide whether it was better to wait a few moments before stopping work.

After each observation session carried out at each location, a feedback session was held with all the workers involved in the observed activity being carried out, and the results were discussed and shared with all of them. All workers involved in the activity were asked to explain what they were trying to achieve, what the hazards and risks were for the undergoing activity and what were the operational and safety protocols for the activity. They were asked what are some things that could go wrong and how they could be injured while working and who would be negatively affected if they were to be injured. The next step in any feedback session was to ask the workers involved how they could carry out the work more safely (e.g., change in procedures or practices, use of different tools, use of other personal protective equipment). The observers were instructed to allow the workers to explain how they think the work can be done more safely; during the feedback session, the task of the observers is to listen; a worker who would be allowed to figure out his own response to a situation is more likely to do the job properly in the future. Observers were asked to act as a guiding coach to help modify some at-risk behavior and offer praise when a particular task is performed properly.

Based on 4,041 observations from all rigs, the data collected and analyzed indicated a safe working environment for Site A, Site C, Site D and Site F, with an average score of 81.11% safe behavior for Site C up to an average of 85.38% that was registered for Site F, which was the highest score of all sites during the June observation sessions. All data indicate a safe working environment for all four sites mentioned above, but there is still room for improvement in safe working behaviors.

For Site B, the safety performance for June averaged 74.55%, slightly higher than the baseline of 74.31%, but with some signs of improvement compared to the 67.51% average safe behavior recorded in April when this site was part of two weeks baseline observation phase. All the data for Site B still indicate a great need for improvement in Safe Working Behaviors for most of the behaviors observed during this phase of the survey. For Site D, the Safe Working Behavior percentage for June averaged 71.99%, slightly lower than the baseline of 74.31%, and the lowest Safe Working Behavior percentage score out of all six sites. Like Site B, all the data for Site D indicate a great need for improvement in safe working behaviors (Figure 4).



Fig. 4. Safety performance distribution on the sites investigated (compared to baseline value).

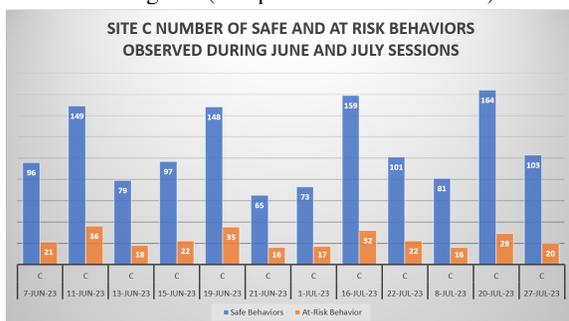


Fig. 5. Statistics of safe and at-risk behaviors observed in June and July 2023 sessions on site C.

The total number of total observed behaviors increased from 4041 in June to 5023 observations for all facilities visited in July; the increase is due also to an increase in the number of observation sessions for sites A and B from three to six visits in July. On average, the number of observations per session increased from 134.7 observations on average per session in June to 139.52 observations on average per session in July. This increase indicates a more positive attitude among workers toward observers and a better understanding of the BBS process and its impact on employees' occupational health and safety.

Based on the data that was collected and analyzed for all observation sessions in July, a safe working environment was concluded for sites A, E and F, with an average score of 87.88% safe behaviors for site E, 88.55% for site A and 88.67% for site F, which was the highest score of all sites during the July observation sessions. The highest score of all visits was recorded at 89.74% for site A during the observation session conducted on July 13 and for site F during the observation session conducted on July 31st. All data indicate a safe working environment for all three sites mentioned above, but there is still room for improvement in safe working behaviors for some of the behaviors observed during this phase of the survey. Also, these three sites showed the greatest indication of an upward trend compared to the June observation session, with an increase from 2.48% for Site A, 3.29% for Site E to an increase of 3.55% for Site E.

The increasing trend in safety performance indicates that feedback sessions at these sites held at the end of each observation session and positive reinforcement methods applied during the observation sessions when safe behavior has been observed had a positive impact on the workers, as the number of unsafe behaviors gradually decreases with each observation session. To maintain the positive trend of increasing safe behaviors at these sites, it is recommended that all three sites continue with feedback sessions at the end of each observation session.

For Site C, the average safety rating for July was 83.12%, higher than the baseline of 74.31%

and slightly up from June's levels of 81.11%. The data that was collected and analyzed indicated a safe working environment with some signs of improvement compared to the average recorded in June. The upward trend of only 2.01% for Site C indicates a need for improvement in safe work behaviors for some of the behaviors observed during this phase of research. The proposed intervention methods for this site consist of two parts: the first part is to raise awareness for all workers on site by organizing several training sessions on topics such as hazard identification and hazard control techniques. The second part is continued feedback sessions at the end of each observation session, coupled with positive reinforcement methods applied during observation sessions when safe behavior is observed. For the month of July, Site B and Site D recorded the lowest scores for the number of safe behaviors observed.

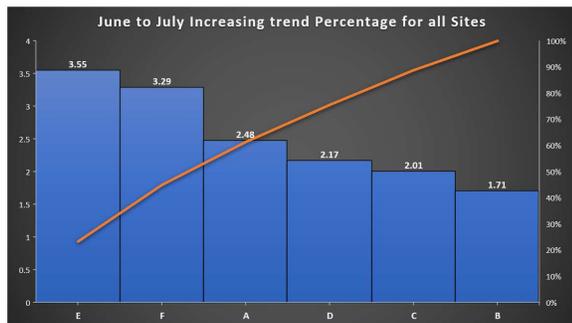


Fig. 6. Increasing trend in safety performance (June to July 2023).



Fig. 7. Average distribution scores for observed safe behaviors (compared to baseline value).

For Site B, the Percentage Score for Safe Behaviors for July averaged 76.26%, slightly higher than the baseline of 74.31% and with some signs of improvement compared to the

74.55% average for the same site recorded in June. Although it appears that Site B has shown a consistent improvement, with an 8.75% increase from the April benchmark, when the average score was recorded at 67.51%, the difference between June and July is not so consistent at only 1.71%. All the data for Site B still indicate a great need for improvement in safe working behaviors for most of the behavior observed during this research phase.

For Site D, the average score for safe behaviors recorded in July was 74.16%, up 2.17% from the June average, but still slightly lower than the baseline of 74.31% and again the lowest average score for safe behaviors recorded in July across all six locations used for this research. As with Site B, all of the data for Site D indicate a great need for improvement in safe work behaviors for most of the behaviors observed during this research phase.

The proposed intervention methods for this site consist of two parts: the first part is the administration of several training sessions on topics such as hazard identification and hazard control methodologies to raise awareness among all employees at these two sites.

The second part is continued feedback sessions at the end of each observation session, coupled with positive reinforcement methods applied during observation sessions when observing safe behavior.

4. CONCLUSIONS

The application of BBS approach in the oil and gas drilling industry faces a serious obstacle, namely that safety performance may decline when BBS intervention is eliminated for other reasons.

The BBS strategy is effective in raising the standards of worker behavior and occupational safety as a solution to mitigate workplace accidents and injuries. In the industrial branch, it can be more difficult to achieve a persistent quality of compliance with behavior-based safety results, as work is both dynamic and transient. While quite a lot of factors can affect the outcomes of the BBS approach, this issue is often explained through the flaws of the overall implementation strategy and characteristics of the very implementation process.

Behavioral observations were conducted at six drilling and work-over rigs from the state of Kuwait which belongs to four different drilling contractor companies.

A contributing factor behind the observed ceiling effect was the inability to observe all possible work behaviors, as previously stated the observation sessions lasted between 30-90 minutes per observation session. Behavioral observations were only allowed when one of the worksite supervisors was physically present. As such, the data collected reflects information when facilities were operating under favorable circumstances. An additional limitation of this study was the lack of larger employee participation. Also, some of the managers and supervisors did not believe in the BBS process and usually emphasized the importance of production and operations over the workplace health and safety.

Some of the main challenges of implementing the BBS approach in the drilling industry are related to data governance, executive management commitment, workers acceptance of the program, involvement and participation, safety culture maturity level in the organization and all of the previous ones being potentiated by eventual financial barriers. The main factors influencing the implementation of the BBS are organizational commitment, available competencies of top management, employee training and their understanding towards the BBS process.

Future research will take into consideration the creation of a safety climate in relation with safety leadership behavior, as presented in [18] and [19].

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Securitatea bazată pe comportamente în acțiune. Studiu de caz pe șase platforme de foraj petrol-gaze din Kuwait

Această cercetare investighează factorii care afectează implementarea abordării de securitate bazată pe comportament în industria petrolului și gazelor. Pentru studiul de caz au fost alese șase instalații de foraj din statul Kuwait, care aparțin de patru companii diferite de antreprenori de foraj și au fost efectuate observații comportamentale. Două dintre companiile care au participat la cercetare au fost companii locale, iar celelalte au fost companii internaționale. Observațiile de referință au fost efectuate în iunie și iulie 2023. Pe baza a 4.041 de observații de la toate platformele, datele colectate și analizate au fost procesate și interpretate, indicând un mediu de lucru sigur și/sau unde mai este loc de îmbunătățire a comportamentelor de lucru sigure. Sunt propuse metode adecvate de intervenție specifice șantierelor pentru a exercita un impact pozitiv asupra lucrătorilor, astfel încât în viitorul foarte apropiat numărul de comportamente riscante să scadă treptat de la o sesiune de observare la alta.

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