NONREGULATED SAFETY CASES
Effectiveness in the Drilling Industry

By Karim A. Ali

THE SAFETY CASE REGIME as a control measure to major incident hazards was introduced to the oil and gas industry 3 decades ago following the *Piper Alpha* disaster. This study investigated the effectiveness of nonregulated safety cases within one oil and gas drilling company by determining its level of utilization and examining its impact on the risks of major incidents and other rig incidents.

The study design was cross sectional, retrospective and experimental. A questionnaire was administered, and the incident logs of 10 rigs were analyzed.

The majority of respondents indicated that they did not perceive a rig safety case as the most effective tool in reducing major incident risks. Also, although the majority had not read the complete safety case document, they perceived that safety cases were still needed in the drilling industry.

The level of utilization of nonregulated safety cases was evaluated to be below average. Furthermore, the evidence showed that safety cases did not reduce the risk of major incidents or other rig incidents. The information and the outcome of the research challenge the concept of having a nonregulated safety case as a best practice; this includes the onshore and offshore rigs that operate in the U.S.

KEY TAKEAWAYS
- **The safety case regime as a control measure to major incident hazards was introduced to the oil and gas industry in the U.K. following the *Piper Alpha* tragedy in 1988.**
- **It appears that nonregulated safety cases had not passed cost-benefit analyses, their effectiveness has not been ascertained, and they might not add value to a well-developed management system.**
- **Nonregulated safety cases were proven to be ineffective and may not be considered a best practice.**

Introduction
Overview

A safety case is a control measure that aims to reduce major incident risks. Hydrocarbons in a formation that can result in a blowout, toxic gas that can be released, flammable material that can cause a fire or explosion, and helicopter operations that can lead to a crash are examples of major hazards and major incidents (IADC, 2015). An inclusive definition of the term *major accidents* is given in Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015, which also classifies "any other event arising from a work activity involving death or serious personal injury to *five or more persons* [emphasis added] on the installation or engaged in an activity on or in connection with it" as a major accident (U.K. HSE, 2015).

The safety case regime was introduced to the oil and gas offshore industry in the U.K. following the *Piper Alpha* tragedy in 1988 (OGUK, 2008). The *Piper Alpha* disaster was one of several offshore major incidents that resulted in hundreds of fatalities and damages of billions of dollars (Verdict Media, 2019). The *Piper Alpha* investigation report, commonly known as the Cullen Report, contained 106 recommendations. A key recommendation was for U.K. Health and Safety Executive (HSE) to introduce legislation requiring those managing offshore installations to develop and present a safety case to the regulator for approval (Cullen, 1990). In turn, the safety case regulation took effect in 1992 and by the end of 1995, all safety cases of the U.K. offshore operators had been accepted (OGUK, 2008).

A safety case is "a structured argument, supported by a body of evidence that provides a compelling, comprehensible and valid case that a system is safe for a given application in a given operating environment" (U.K. Ministry of Defense, 2007). In other words, a safety case is a document that outlines all major hazards, potential consequences and controls, and aims to demonstrate that the operator is capable of managing all major incident risks that arise from the operator's activities (U.K. HSE, 2006).

Over the years, safety cases spread locally and globally. The regime continued to be adopted by different industries, such as the chemical and rail industries through the introduction of the Control of Industrial Major Accident Hazards (CIMAH) Regulations 1984 and to the Railways (Safety Case) Regulations 1994 (Inge, 2007). In addition, safety cases became a legislative requirement in other countries such as Norway and Australia. Figure 1 provides an overview of where safety cases are legally required and where they are considered a best practice (IADC, 2015). Although the U.S. took a closer look at adopting the safety case regime following the *Deepwater Horizon* disaster in the Gulf of Mexico in 2010, the initiative was believed to be costly and not in line with ongoing endeavors to enhance the American offshore regulations

FIGURE 1

ADOPTION OF SAFETY CASES ACROSS THE WORLD

(Eaton, Power & Gold, 2010) and, hence, some believed that safety cases should not come to the U.S. (Steinzor, 2011).

Nonregulated Safety Cases

Safety cases may fail in the absence of a regulator. One pillar of a successful safety case regime is the presence of a potent regulator who can challenge, scrutinize, judge and even reject the content of a safety case (Wilkinson, 2002). When a safety case is not regulated, the burden falls on the drilling contractors to self-regulate the safety cases that they developed. In the author's experience, it is not uncommon for a nonregulated safety case to be developed in a manner that is least expensive, disruptive and hectic since the primary goal is to check the box that a safety case is in place. There seems to be agreement on the importance of the regulator's role in the safety case regime; this was highlighted by Hopkins (2012), who envisaged that "without scrutiny by an independent regulator, a safety case may not be worth the paper it is written on."

The evidence indicates that without a regulator, a nonregulated safety case may be pointless.

Safety Cases as Best Practice

Where safety cases are not legally required, they become an optional control measure. Accordingly, several factors may influence the choice of having a safety case, such as the effectiveness of existing standards, and the applicability, practicability, benefits, cost and effectiveness of safety cases. Some of those aspects are discussed next.

Drilling rigs' safety cases tend to follow the International Association of Drilling Contractors (IADC) guidelines. IADC has issued guidelines for mobile offshore drilling units (MODU) and land drilling units (LDU) to aid with harmonizing international health, safety and environmental standards into a single methodology that is custom-made to the drilling industry. As the guidelines conform to all the existing safety case regimes, the IADC health, safety and environmental case guidelines can be adopted by any rig that is working anywhere (IADC, 2015). Nonetheless, IADC acknowledged that pursuing an international standardization of a drilling health, safety and environmental case has not yet been encouraged due to the different roles and responsibilities of stakeholders in different countries (Hoffmark, 2016).

The IADC safety case consists of six parts: Part 1 is purely an introduction to the health, safety and environmental case and its requirements. Part 2 describes the elements of the operator's management systems: policies and objectives; organization, responsibilities and resources; standards and procedures; performance monitoring; and management review and improvement. Part-3 describes the rig equipment and systems, including safety equipment and lifesaving appliances. Part 4, the central part, contains the hazard register and safety-critical activities, and demonstration of the ALARP (as low as reasonably practicable) level. Part 5 describes the rig contingency procedures. Part 6 describes the performance monitoring arrangements (IADC, 2009; 2015).

It could be argued that a safety case does not introduce anything new to a company with a well-developed management system. Part 2 summarizes the company's health, safety and environmental manuals. Part 3 lists the rig equipment that is part of the rig asset register. Part 4 is a smaller version of the company risk register. Moreover, the demonstration of the ALARP level might not even be required by law. Part 5 is a reflection of the rig emergency response plan. Part 6 is, again, copied from the company health, safety and environmental manuals to communicate the monitoring procedures (ISO, 2015; BSI, 2018). It seems that a health, safety and environmental case does not add much value, if any, to a company with a comprehensive management system that major drilling contractors would be expected to have.

The Effectiveness of Safety Cases

It appears that the effectiveness of safety cases in reducing major incident risks may not have yet been proven. Although safety cases were designed to prevent major incidents, there seems to be agreement that due to the rare occurrence of major incidents, it is difficult to establish a sound connection that safety cases have achieved what they were intended to do (Fenning & Boath, 2006; Hopkins, 2014). In addition, as noted, the process of putting together a safety case document entails copying elements from the drilling contractor's safety management system; hence, it might be possible to argue that neither the document nor the process adds much value to the rig workforce or the overall risk reduction.

Cost of Safety Cases

The cost of a safety case may be unjustifiable. There seems to be agreement that completing a cost-benefit analysis for a safety case is difficult, if not impossible. Hopkins (2014) argues that it is "impossible to quantify the benefits of preventing rare but catastrophic events." Although Hopkins bases his theory on data obtained from the U.K. and Norway only and did not consider other major incidents worldwide, major incidents remain rare events (Vinnem, 2010; Wilkinson, 2002). Hopkins's argument was backed by the impact assessment carried out by the European Commission following the *Deepwater Horizon* incident in 2010 to evaluate the proposal of introducing a safety case regulation for the offshore industry. The European Commission concluded that it was "very difficult to generalize about the economic costs of offshore accidents" (European Commission, 2011). The conclusion was attributed to the numerous intangible costs of major incidents that cannot have monetary values associated, such as the effects on oil prices, future of the oil industry, impact on the energy supply, loss of corporate reputation and security of offshore occupations. On the other hand, the process of developing a safety case for one rig, in the author's experience, may cost more than $100,000, taking into account consultancy fees, costs related to holding the hazard identification workshop and staff working hours. Therefore, it may not be possible to quantify the gains of rare events that may not even take place; accordingly, it

FIGURE 2
RESEARCH VARIABLES

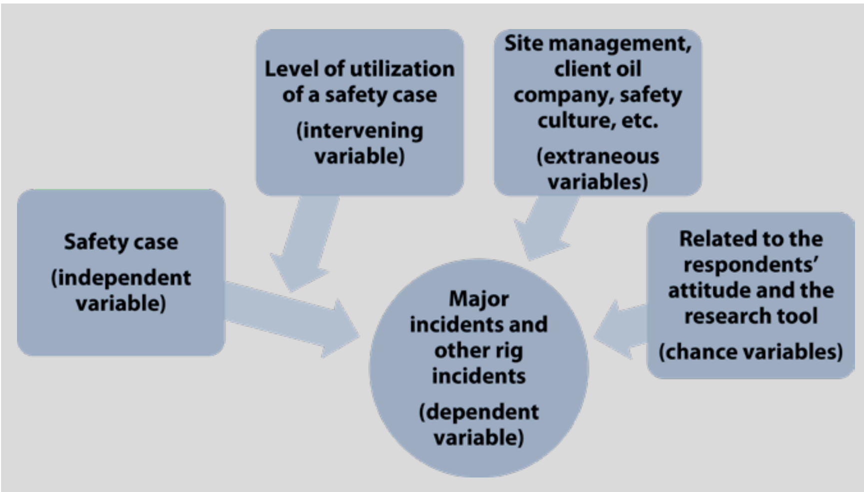


FIGURE 3
SURVEY EXCERPT

Following is an excerpt from the survey instrument.

9) Have you read the complete HSE case of your rig? (Y/N)

10) Please rank the tools below according to their effectiveness in reducing risks of major accidents. (1 being the most effective and 4 being the least effective):
- **Rig HSE Case**
- **Rig specific job safety analysis (JSA)**
- **Rig specific emergency response procedure (ERP)**
- **Company risk register**

11) How easy is it to implement the HSE case (very easy; easy; neither easy nor difficult; difficult; very difficult)?

12) Do you feel that there are gaps between the HSE case requirements and what is being implemented at the rig? (Y/N)

13) Please explain your answers to the previous question.

may be challenging to explain the rationale behind the sacrifices that go into developing a safety case.

The Motivation

It appears that safety cases have not passed cost-benefit analyses; their effectiveness have not been ascertained and they add limited, if any, value to a well-developed safety management system. This study aimed at investigating the contemporary effectiveness of nonregulated safety cases within one oil and gas drilling company. The outcome of this study may provide sufficient evidence that nonregulated safety cases may not be the best investment for drilling contractors; this could enhance the decision-making process of companies that are considering developing/maintaining safety cases where not legally required, including those working in the U.S.

The Setting

The research was conducted at one drilling company that has been operating in a country where safety cases are recommended as a best practice but not regulated or enforced. The drilling contractor had a fleet of 20 assets out of which 10 rigs had safety cases. The rigs had been drilling for national and international oil and gas companies.

Methods

Description of the Study Design

The study design was cross sectional, retrospective and experimental. The independent variable was the availability of a safety case. The dependent variables were the number of major incidents and other incidents. The intervening variable was the level of utilization of a rig safety case; the chance variables were ignored, and an attempt was made to quantify some of the extraneous variables by introducing a control group that consisted of rigs without safety cases. Figure 2 elucidates the research variables.

Data Collection Methods

A questionnaire was used to obtain insights from rig personnel on the level of utilization, importance, ease of implementation, degree of enforcement and extent of the operationalization of rig safety cases. The sample population consisted of five rig supervisors of 10 rigs that owned safety cases. The questionnaire consisted of a mix of 15 open- and close-ended questions. Figure 3 shows an excerpt from the survey. The questionnaire was electronically developed and administered after it had been tested to ensure its validity and reliability. In addition, several techniques were adopted to overcome the typical challenges of using a questionnaire.

The company incident logs were used as secondary data sources. The definition of the term *major accidents* as described in Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015, was used to identify and count the number of major incidents. Additionally, due to the rare occurrence of major incidents, other rig incidents were also taken into account to examine the influence of safety cases in reducing the overall risk of undesirable events. Furthermore, a risk severity matrix was developed to quantify the actual and potential risks of each incident.

Data Analyses

For six onshore rigs, the risk of major incidents and other rig incidents for 4 years were compared before and after the introduction of safety cases, and a paired t-test was carried out to investigate whether the difference is statistically significant. In addition, for two rigs that had safety cases since start-up, the incident trends were analyzed over time. Furthermore, for two offshore rigs that had safety cases for several years, the risk was compared against a control group, which consisted of four rigs that did not have safety cases, and an independent t-test was conducted. Also, to attempt to investigate the potential relationship between the level of utilization of a rig safety case and the number of major incidents and other rig incidents, a one-way ANOVA (analysis of variance) technique was utilized. Figure 4 summarizes the statistical procedures used in this study.

Limitations

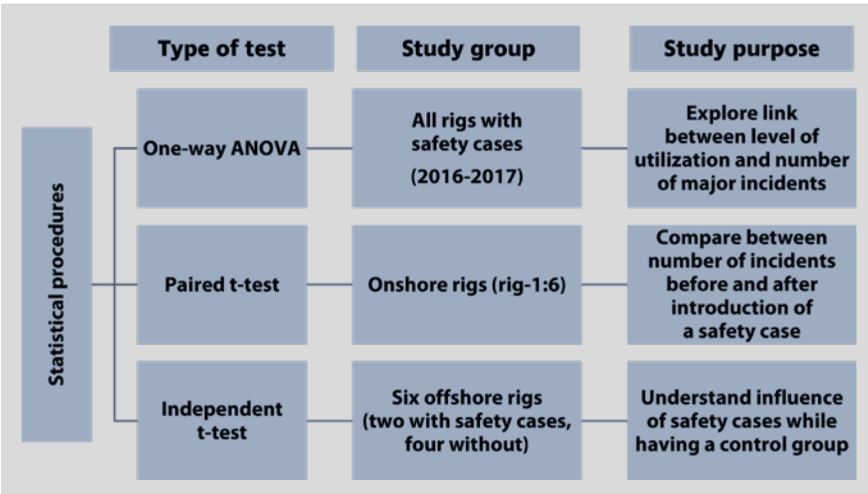
The research had several limitations. First, due to the limited resources of the study, only lagging indicators were used to determine the effectiveness of safety cases rather than incorporating leading indicators such as the status of preventive maintenance of safety-critical equipment. Another limitation was the relatively small number of participants. Also, despite the researcher's efforts to overcome the challenges associated with the use of questionnaires, not everyone within the sample population responded. Furthermore, the study was based on data that had been obtained from only one company.

Result

Feedback on Questionnaire

The questionnaire was administered to 50 rig supervisors; 48 accessed the survey and 42 completed it. Hence, the completion percentage was 84%, which was relatively high (Matthews & Ross,

FIGURE 4
STATISTICAL PROCEDURES



2010). The questionnaire responses showed that a rig safety case was not perceived as the most effective tool in reducing the risks of major incidents. Moreover, two-thirds of the respondents, who were rig supervisors, had not read the complete safety case document and, accordingly, they might not have been fully aware of its requirements. Also, the majority (52%) of the respondents stated that they would not initiate a request to have a rig safety case developed if they moved to another rig that does not have a safety case. Furthermore, three-quarters of the respondents identified that gaps existed between the safety case requirements and the rig practices. Despite that, the majority (83%) of the respondents perceived that safety cases were still needed in the drilling industry, which is attributed, in the author's experience, to the company and clients' emphases on the importance of safety cases.

The Level of Utilization of Safety Cases

The level of the utilization of nonregulated safety cases within the company was evaluated to be below average. The feedback from five rigs indicated low use, three rigs showed medium use and the two offshore rigs demonstrated high use.

The investigation of a potential relationship between the level of the utilization of a rig safety case and the number of major incidents, using a one-way ANOVA technique, showed that there was not a significant effect at the $p < 0.05$ level for the three conditions [$F(2, 7) = 0.547$, $p = 0.601$]. Moreover, there was not a significant effect of level of utilization of the rig safety case on the number of other rig incidents at the $p < 0.05$ level for the three conditions [$F(2, 7) = 0.469$, $p = 0.644$].

The Impact of Safety Cases

To attempt to have an overview of the potential impact of the introduction of safety cases on the six onshore rigs, the incident data for 2 years before and after the safety case was developed were compared. The figures showed that while the number of major incidents plateaued over the years, the number of other rig incidents and the risk of major incidents and other rig incidents experienced an uptrend.

To attempt to determine whether statistical evidence existed that the number of major incidents and other rig incidents before and after introducing rig safety cases was significantly different from zero, a paired *t*-test was conducted. Since the number of major incidents was the same before and after the introduction of the safety case, a significant difference did not exist in the scores for major incidents before the safety case ($M = 0.67$, $SD = 0.816$) and major incidents after the safety case ($M = 0.67$, $SD = 0.516$) conditions; $t(5) = 0.0$, $p = 1.0$. Similarly, a significant difference did not exist in the scores for other rig incidents before the safety cases ($M = 4.67$, $SD = 2.066$) and other rig incidents after the safety cases ($M = 5.83$, $SD = 3.251$) conditions; $t(5) = -0.759$, $p = 0.489$. Hence, the null hypothesis (that safety cases do not reduce the number of major incidents and other rig incidents) was retained. In short, the outcome showed that the introduction of safety cases did not result in a difference in the number of major incidents and other rig incidents, which was statistically significant.

The other two onshore rigs, which had safety cases since start-up, showed contradicting trends: while one exhibited a downtrend in the risk of major incidents and other rig incidents, the other was the opposite.

The incident statistics of the two offshore rigs were compared with the average incidents of the control group. The result showed that the number of major incidents of the rigs with safety cases was not less than the rigs without safety cases. Additionally, one offshore rig that had a safety case had four times the number of the averaged major incidents of the control group. In addition, to establish whether statistical evidence existed that the rig incident data and the average incident data of the control group were significantly different, an independent *t*-test was carried out and the findings were that a significant difference did not exist in the scores for major incidents of the rigs with safety cases and the rigs without. Furthermore, the risk of other rig incidents showed an opposition when the statistics of the two offshore rigs were compared with the control group.

Discussion & Conclusion

Summary

The aim of this study has been to investigate the effectiveness of nonregulated safety cases. The research took place within one oil and gas drilling company. While taking into consideration the ethical issues related to the different research stakeholders, the study attempted to answer the research problem by examining the effectiveness of nonregulated safety cases in reducing the risk of major incidents and other rig incidents.

The methodology section provided an overview of the techniques that were used to conduct the research. The section discussed the study design, type, data collection methods, population, validity and reliability, and data analysis.

Nonregulated Safety Cases Are Not Being Adequately Utilized

The first objective was to determine the level of utilization of nonregulated safety cases at the drilling contractor's rigs. This was achieved by developing and sending a questionnaire to the rigs that owned safety cases. The questionnaire provided a mix of qualitative and quantitative data that measured and explained participants' perceptions. Before analyzing the data obtained from the questionnaire, the data had been cleaned and coded. The level of utilization of nonregulated safety cases was evaluated to be below average. It was inferred that while safety cases are still needed, they had not been adequately utilized during the day-to-day operation of the rigs.

Nonregulated Safety Cases Do Not Reduce the Risk of Major Incidents

The second objective was to ascertain the ability of nonregulated safety cases in reducing the risk of major incidents. This was achieved by examining the company incident records and filtering out those that fell under the definition of a major incident. Additionally, a risk severity matrix was developed to quantify the actual and potential severities of each incident. To investigate the influence of safety cases, major incident risks before and after the introduction of a rig safety case was compared for some of the rigs. Also, major incident trends were analyzed for other rigs that had safety cases since start-up. In addition, for two rigs that had safety cases for several years, the risk of major incidents was compared with a control group to quantify some of the extraneous variables that influenced the risk of major incidents. Furthermore, several statistical analyses were carried out to investigate the strength of association. It appears that safety cases did not result in a reduction of the number of major incidents. The evidence showed that not only was the number of major incidents the same before and after the introduction of safety cases and between the rigs with safety cases and rigs without (in the control group), but also one of the rigs with a safety case had more major incidents compared with its control group. As noted, although a safety case is one of many barriers that control major incident hazards, it is safe to conclude that nonregulated safety cases have not succeeded in fulfilling their primary purpose.

Nonregulated Safety Cases Do Not Reduce the Risk of Other Incidents

The third objective was to examine the ability of nonregulated safety cases in reducing the risk of other rig incidents. The same technique was used to count the number of other rig incidents, and the severity matrix was employed to quantify the actual and potential severity of each incident. The evidence showed that the number of incidents, actual incident severity and potential incident severity after the introduction of a safety case increased. In addition, the rigs that had safety cases since start-up showed contradictory trends: one rig exhibited a reduction in the number and severity of incidents while the other rig demonstrated otherwise. The same contradiction was revealed when the rigs in the control groups were compared with the rigs that had safety cases for several years. The evidence shows that although it was not possible to discern the ability of safety cases in reducing the risk of other rig incidents over the years, the introduction of safety cases to six rigs did not decrease the risk of other rig incidents.

Aim, Objectives & Recommendations

It is safe to conclude that the aim and objectives of this study have been fulfilled. The contemporary effectiveness of nonregulated safety cases has been investigated by verifying its level of use, which was determined to be below average. The ability of nonregulated safety cases to reduce the risk of major incidents and other rig incidents was examined and evidently proven ineffective. Finally, recommendations were made to company management and future researchers (Ali, 2019). **PSJ**

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