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Applying Safety Lessons Learned from Commercial Aviation to Oil and Gas Industry

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Abstract

Commercial aviation safety-related protocols and initiatives have received considerable interest from several industries due to the widely recognition of their effectiveness as an ultra-safe industry. And yet, it's not clear how to adopt these protocols in oil and gas sector. Thus, this article provides a typology of these protocols to apply to the oil and gas sector. This paper examines seven examples of error counter measures used in commercial aviation safety. Examples are Crew Resource Management (CRM) and Line Operations Safety Audit (LOSA) methodology. This would help in developing a conceptual typology that might potentially apply to the oil and gas industry. The initiatives examined in this article fall into twofold themes: concepts that seek to increase collective awareness of safety values; and concepts that promote safety by design. The results of this research revealed that all task checklists, joint safety briefings, and the confidential safety reporting system are protocols that help users routinely enhance workplace safety. However, initiatives such as the sterile cockpit system and LOSA approach in frontline operations fall under the responsibility of middle and upper management to ensure safety performance. Examining and discussing the proposed typology with the sector's safety experts and front-line professionals before the implementation process would highlight any unanticipated challenges, and therefore proactively reduce them to promote an organizational safety culture in the oil and gas sector which enables operational cost reduction

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and mitigates loss-time injury. Finally, this study outlines that it is possible to benefit from aviation safety standards in the oil and gas sectors and achieve higher safety performance.

Keywords: Oil & Gas Safety; Occupational Safety; Safety Management; Safety Culture; Aviation Safety; Threat and Error Management.

تطبيق دروس السلامة المستفادة من قطاع الطيران المدني التجاري على صناعة النفط والغاز

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الملخص:

حظيت البروتوكولات والمبادرات المتعلقة بسلامة الطيران التجاري باهتمام كبير من العديد من الصناعات بسبب الاعتراف الواسع النطاق بفعاليتها كصناعة فائقة الأمان. ومع ذلك، ليس من الواضح كيفية اعتماد هذه البروتوكولات في قطاع النفط والغاز. وبالتالي، توفر هذه المقالة تصنيفًا لهذه البروتوكولات لتطبيقها على قطاع النفط والغاز. تتناول هذه الورقة سبعة أمثله لتدابير مكافحة الأخطاء المستخدمة في سلامة الطيران التجاري حيث لا يتم استخدام الكثير منها بشكل روتيني في قطاع النفط والغاز. ومن الأمثلة على ذلك قاعدة إدارة موارد قمرة القيادة ومنهجية لوزا. وهذا من شأنه أن يساعد في تطوير تصنيف نظري يستخدمه خبراء السلامة المتخصصين في مجال النفط والغاز لمناقشة لماذا يمكن تطبيق مثل هذه المبادرات المماثلة على صناعة النفط والغاز. تنقسم المبادرات التي تم تناولها في المقالة إلى موضوعين: المفاهيم التي تسعى إلى زيادة معرفة المجموعة بقيم السلامة؛ والمفاهيم التي تعزز السلامة حسب التصميم. وقد كشفت النتائج في هذا البحث أن قائمة

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مراجعة المهام و إحاطات السلامة المشتركة ونظام تقارير السلامة السرية بروتوكولات تساعد المستخدمين في تعزيز سلامة العمل بشكل روتيني، إلا أن مبادرات مثل نظام الهدوء في قمرة القيادة والتدقيق على السلامة في خطوط العمليات الأمامية تقع علي عاتق الإدارة الوسطي والعليا لضمان أشمل للسلامة.إن فهم المبادرات المقترحة لتعزيز ثقافة السلامة التنظيمية في قطاع النفط والغاز ومناقشتها مع خبراء السلامة وخبراء عمليات الخطوط الأمامية من شأنه أن يعزز الوعي باحتمالية حدوث تحديات فنية فالتطبيق وبالتالي معالجتها بشكل استباقي مما يتيح خفض التكاليف التشغيلية وتخفيف الخسائر الناجمة عن الإصابات. و أخيرا، أثبتت هذه الدراسة أنه من الممكن الاستفادة من معايير السلامة الجوية في قطاعي النفط والغاز وتحقيق معدل سلامة أعلي.

الكلمات المفتاحية: سلامة الطيران; إدارة التهديدات والأخطاء; ثقافة السلامة; أدارة السلامة; السلامة المهنية; سلامة النفط والغاز.

1. Introduction

It is accurate to say that commercial aviation safety standards are widely recognized as the safest standards in use in transport systems, and proposals to apply these standards to other industries abound. Nevertheless, when aviation accidents do occur, the consequences are calamitous. In commercial aviation, the percentage of fatality rates is less than one percent per ten million flights [1]. Fatal accident rates on non-jet airlines declined from 19 in 2014 to six in 2023 [2]. In comparison, and based on OSHA reports, 490 oil and gas (O&G) workers lost their lives in the US only between 2014 and 2019, of which 14.5% were fatal explosive events, 21% were contact injuries, and 26.8% were workplace vehicle incidents [3]. Despite fatal explosive events, representing the lowest percentage of fatality rates, oil rig fires, which are part of the explosive events are particularly devastating because they often begin with an explosion and then turn into chemically fueled fires that are tough to extinguish .

To mitigate fatality rates and their associated costs, several industries, such as the healthcare industry, have successfully adopted systematic safety lessons from the aviation industry and

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substantially improved patient safety culture by reducing fatalities among cardiac patients, for instance, by more than 33 percent [1]. Likewise, oil and gas extraction (OGE), for example, was not an exception. Non-technical skills such as Threat and Error Management (TEM), which evolved from Crew Resource Management (CRM) in aviation, were adopted to promote process safety in drilling operations [4]. Accordingly, evaluating the implementation process of aviation safety initiatives was found to be inexpensive and appropriate in other settings, such as OGE .[3]

The research on adopting aviation safety initiatives and protocols, given its remarkable success, has proven the success of implementing several initiatives, from work task checklists to CRM and TEM [3, 5]. Nevertheless, several measures used to reduce errors and their related risks in aviation are underrepresented in the oil and gas field, and highlighting their importance is expected to contribute to the growing recognition of commercial aviation safety influences on high-risk industries such as the OGE sector. High-risk industries have a similar set of underlying safety and quality concepts [5]. Therefore, this article argues that despite the fact that OGE has certainly unique operational characteristics, professionals and researchers in this field should meticulously and cautiously proceed with learning from other fields, such as aviation, because O&G workers and engineers would be best able to identify which safety initiatives work best in OGE and they can make any adjustments they feel are necessary .

In this article, the authors describe seven safety initiatives used in the aviation industry on a daily basis. Each of these seven initiatives has its own application to OGE; however, some of these initiatives are used in practice in this setting. Out of these seven examples, we identify two main themes to produce a conceptual typology for categorizing error countermeasures and risk mitigation. Therefore, the aim of this study was to draw on the lessons learned from aviation industry experiences through the last half century in developing safety standards to examine safety initiatives and protocol transfers using a screening and literature search, analysis, and classification of the initiatives that operate at different levels

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that might influence multi-level organizational safety practices. Accordingly, this article aims to address the following question .

(i) What aviation non-technical skills operating at different organizational levels affect the safety practices, and therefore the likely adoption of such skills in oil and gas organizations؟

This question is answered based on an examination of the available safety literature on commercial aviation and oil and gas. This article elaborates on the advantages of applying such initiatives to an effective safety system, benefiting both oil and gas corporations and outsourced service providers. This paper is structured based on four main sections. Following the introduction, the authors first describe the methodology used in this review. In this section, seven examples of safety initiatives in aviation and their potential application to the oil and gas fields are presented in a table format. In the following section, we address the main findings of the study and discuss them in relation to the available literature. The paper then concludes with some suggestions for future work in Section 4 .

2. Results

As illustrated in Table.1, the findings are categorized into twofold themes: concepts that seek to improve group knowledge of safety values; and concepts that promote safety by design. These themes are a reflection of the analysis of seven examples stated in table 1.

2.1.Concepts that seek to improve group knowledge of safety values.

This element aims to enhance collective awareness of safety values and refers to the safety information and values that need to be shared and communicated to all employees in oil and gas domain. In aviation domain for example, before pilots and cabin crews commence their work, they meet in groups, share the flight plan, and reach an agreement about what safety protocol should be followed in emergency and non-emergency situations and what responsibilities should be assigned to each member. to create a

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common knowledge of safety values and protocols .

Applying group knowledge of safety values is expected to promote OGE professionals' safety awareness and safety practices applied in the aviation field on a daily basis in order to enhance occupational and organizational safety on different levels. In a nutshell, initiatives like task checklist, CRM and, joint safety briefings might play a role in enhancing safety practices on an individual level and a group level as a whole. These initiatives work in procedures format and are designed to enhance safety culture and therefore, it could reduce workload and inappropriate reliance on self-memorization of professionals in onshore and offshore oil and gas operations. Following these procedures promotes safety behavioral practices of oil and gas workers and ultimately leads to error reduction. Thus applying safety experiences adopted in aviation to onshore and offshore oil and gas front-line operations would enhance operational safety and cost reduction.

2.2. Concepts that endorse safety by design

Promoting safety by design refers to enhancing safety practices and behaviors through the human factors approach. Engineering human factors to design safety systems and protocols such as forcing functions, sterile cockpit initiatives, and LOSA methodology (see table 1) endorse the concept of safety culture and practices. Engineering safety systems based on human factors are already applied in OGE. A noteworthy example is the SCADA system, which is designed to mitigate risks and unintended errors. However, in this article, the authors believe that promoting safety by design through the science of human factors can be more widely applied in the OGE field to improve safe practices and behaviors. This could be achieved through adopting systems such as forcing functions in pipeline operations and computational pipeline monitoring, sterile cockpit rule in control rooms, and LOSA in helioffshore, control rooms, and drilling operations. Adopting these concepts to be applied in OGE could be achieved through creating a clear organizational guidelines and safety manuals. These manuals should be consistent with OSHA safety standards and guidelines. In

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addition, these concepts can be applied through a constant training for front-line workers, and training content might include training videos and storytelling practice. Adopting these concepts can play a significant role in improving occupational safety levels, and reducing costs when they are implemented and managed collectively .

3. Discussion

The field of OGE may often encounter some individuals' odd practices and behaviors. This might include when workers and engineers would respond to deficiencies and technical issues by taking short-cut procedures or finding ways around the deficiencies they face in sharp-line operations. For example, when pieces of equipment or tools are missed, mechanics or engineers use inappropriate tools or adjust equipment designed for a different purpose in order to maintain workflow. Mechanics might indicate these activities as "finding a way" to get the task done on time, regardless of the procedures set in organizations' operational and safety protocols. Accordingly, the potential for adverse events on the front line degrades the level of safety culture. However, the ability of OGE organizations to respond to these adverse events heavily relies on the resilience of these organizations and the characteristics of their safety system. Therefore, this article argues that the way in which front-line professionals' negative response to an error.

Table 1. Aviation safety initiatives and their suggested application to oil and gas

Safety protocol	Practice in commercial aviation	Potential application to oil and gas
1-Task checklist	Engineers and pilots use several sorts of paper or electronic checklists to maintain safe and proper operations: The I'm SAFE checklist is a personal health assessment used to ensure a pilot's health	Before any mechanic/professional commences work procedures in oil and gas extraction, they should perform a health self-assessment. Practicing this approach helps oil and gas workers keep themselves and

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	before flight. The I is for illness; do I have any symptoms? M for medication (which might impact Pilot's performance), S for stress (financial, health, and social issues), A for alcohol, F for fatigue, and E for emotions [6]. A pilot must review the I am safe checklist before each flight to assess their mental and physical health. READ-DO checklist: an engineer or mechanic completes the checklist step-by-step in order while reading directly from the checklist. In other words, workers carry out the task as they check them off. For example, pre-flight, daily, weekly; and transit checks are done through a pre-defined checklist as stated in the aircraft maintenance manual. Aide memoire checklist: This kind of checklist is used for reminding the technicians and pilots of what they should do before a flight. It is like an agenda to remind them of the items they should cover before commencing the flight.	their colleagues safe before they start work tasks. Sharp-line employees should review I'M SAFE factors and ask themselves certain questions in order to perform their duties in a safe manner. The fire safety checklist is an example of a "read and do checklist''; the drilling rig daily inspection checklist is an example of a Read-DO checklist. This might include a pipe rack checklist and an offshore crane maintenance checklist. This includes daily, weekly, and monthly checks to maintain safety and performance. The OSHA gas and oilfield safety inspection checklist is composed of several parts to maintain a standardized inspection protocol to aid training and recognize the inspection process. OSHA advises that inspection should be focused, actionable, brief, and specific with safety operations and procedures. OSHA has encouraged adaptation of this checklist. This checklist helps oil and gas workers work based on pre-defined age ranges to make best use of it in order to maintain the highest safety standards.
2- Crew resource management (CRM)	CRM is a set of training protocols designed to be used in environments in which human errors can lead to major risks to operations.	CRM training was first suggested in high risk industries such as offshore oil and gas [4,5]. It is taken for granted that the oil and gas

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	CRM is basically used to enhance aviation safety and focuses on inter-personal communications, leadership, and decision making in the cockpit. Most aircraft accidents happen due to a lack of communication, poor leadership, and ineffective individual collaboration rather than mechanical failures [6]. As a result, CRM was developed. The CRM concept encourages the significance of utilizing all the available resources, equipment, and human elements to make sure the aircraft is operated in a safe manner. Studies found that threats and errors to safety are inevitable [3], and therefore training on non-technical skills is important for mitigating the threat of errors. CRM training is mandated in many industries, such as commercial aviation, healthcare, and firefighting. This is to include training on, situational awareness, problem-solving, decision making, teamwork, and communication skills. And accordingly, reduce the hierarchy and the level of power distance in order to encourage juniors to speak-up and ultimately to promote safety [7].	industry is characterized by extensive teamwork and communication in a hazardous environment, and therefore CRM training is pertinent to this industry. There are evidence-based findings that CRM training has increased communication, assertiveness, and decision-making quality [5]. Hence, CRM is expected to improve controller skills in the pipeline control room and therefore improve safe operation. The CRM training helps controllers put safety at the forefront of every decision they make. As with aviation, the oil and gas industry will never eliminate unanticipated events; thus, the most recent version of CRM in aviation, named Threat and Error Management (TEM), might be specifically fit for the oil and gas field. TEM depends on the probability of errors and hazards and trains pilots on slips and lapses and hazards mitigation methods before they turn into serious undesired states [4,5]. This applies to oil and gas by training controllers, for example, by reacting to abnormal conditions that pose a threat to landowners, emergency responders, or their members of the public who report that they noticed something unusual near a pipeline. Threats might include operational threats (i.e., time

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		pressure, irregular operations, or unexpected leaks), environmental threats, technological threats (such as power outages, cyber-attacks, or equipment malfunctions), organizational threats (such as poor management, policies, and procedures), and other threats such as disruptive people or cultural barriers.
3- Joint Safety briefings	Before each flight, flight crews and cabin crews meet together for a joint safety briefing. This protocol is also adopted by ground engineers and mechanics. Despite the content of these meetings varies from airline to airline, the crews in such meetings discuss their work plan, which includes up-to-date safety-related issues. At the end of these meetings, crew members may be required to read and sign safety related plans pertaining to flight safety. The purpose of joint safety briefings is to enhance safety and promote proactive risk management. In addition, at the end of these meetings, the crew members should have a shared mental model of the intended operation and its threats and mitigations.	Analogous joint safety briefings may be applicable for oil and gas before the start of drilling, welding operations, handoff, hazard awareness briefings such as the hazard of hydrocarbon gases, and at the beginning of every operative shift. Front-line workers and duty managers may be asked to gather for a focused safety awareness meeting on a related safety issue and required to sign that they understand the safety notices pertinent to their work task procedures.
4- Forcing functions	Forcing functions refer to functions of a design that warn the human of the errors that occur in the system by deliberately bringing the	Similar to aviation technology, oil and gas utilize up-to-date technology to maintain safe and efficient operations. A modern control room

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	user's attention to that error. These include the flight warning system and engine and airframe systems that malfunction. When the flight warning system alerts, it grabs the pilots' attention to both internal and external dangers. These alerts can be visual, aural, or sensory, and this depends on the aircraft type. The basic purpose of an integrated flight warning system is to prioritize all alerts to improve crew situational awareness, thereby ensuring that the crew tackles the warning posing the most immediate threat to safety. Some of these alerts include, for example, but are not limited to, the Traffic Collision Avoidance System (TCAS). TCAS detects several aircraft in the vicinity but only gives warning alerts when the traffic is a potential collision threat. When two or more aircraft continue on the same flight path, the TCAS issues a traffic advisory. Other alerts include bells, which accompany fire warnings, whereas accompanies autopilot disconnect, synthetic voices are used for traffic alerts and ground proximity warning systems. Finally, the stall warning system can be considered an example of a sensory warning system.	continuously streams real-time information to the controllers, covering every aspect of pipeline operations. From here, tanks, valves, pumps, and even the pipes themselves can all be monitored and operated through a Supervisory Control and Data Acquisition (SCADA) system. The SCADA system allows controllers to monitor the pressure, temperatures, flow rates, and specific attributes of all the liquids in the pipelines and transmit commands to remote equipment such as pumps and valves. In abnormal conditions, the SCADA system triggers automatic alarms to bring controllers to attention. In addition, many control rooms use computational pipeline monitoring (CPM) systems to help detect leaks. CPM continuously analyzes the volume and physical properties of the liquids that are pumped into and out of the pipelines.
5- Confidentia	Regulatory bodies such as ICAO mandate the	Many leading organizations in the O&G sector already

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l reporting system	contracting states to implement the safety culture concept [8]. The aviation safety reporting system is a core element of safety culture that offers confidentiality and anonymity to organizational personnel who report unsafe acts and attitudes that might breach safety within a timeframe of ten days. A reference number is then issued to the submitted report, and all the identifying details remain confidential before starting the investigation process and sharing lessons. However, the employee can still submit a report anonymously without referring to their identity by sending the report to a box designed for such cases, and this might include self-reporting.	encourage operators to practice error reporting systems, such as OMAR in the UK and BSEE (the Bureau of Safety and Environmental Enforcement) in the US [9]. It is believed that implementing a confidential and anonymous reporting system based on a transparent mechanism would enhance shared safety awareness and mitigate the risk of occurrence. The remaining challenge ahead of the anonymous and confidential reporting system is the climate of fear and culture in which filing an incident report is perceived as disloyal or whistle blowing to colleagues [10].
6- Sterile cockpit initiative	Airlines and aircraft manufacturers have come up with a procedure called a sterile cockpit below 10,000 feet. This concept means that pilots should fully reduce unnecessary conversations and activities to an absolute minimum and only use standard operating phraseology to ensure a safe cockpit operation in the critical flight phases (landing; take-off, and taxiing in and out) where a high demand for concentration is required [11]. The sterile cockpit rule is designed to avoid distraction, so pilots and cabin crews can	Workers and engineers are constantly exposed to remarkable distractions at the workplace. Therefore, an analogous sterile cockpit practice of reducing non-essential activities during work-related activities is expected to promote safety practices and thus reduce work errors. For example, during monitoring input and output instrumentations in the gas control room, where high vigilance and focus are required for monitoring or measuring temperature, pressure, flow, and flammable and combustible gases,

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	perform their work safely. Therefore, to avoid distraction, communications with the cabin crew can only be established in case of an emergency. Even after landing, the sterile cockpit procedure applies until the completion of the parking checklist.	especially in hazardous situations. This rule might apply better when a crew room management plan is set up by qualified operators and approved by the Pipeline and Hazardous Material Safety Administration (PHMSA). Other industries, such as healthcare, have implemented this rule, and it has been found that the rate of errors has decreased (Pape2003). Therefore, the idea of applying this rule to O&G would contribute to operational efficiency and cost reduction. Like in aviation, where the crews are trained on practicing this rule, O&G workers and engineers should undergo such training, and a clear signal within and outside the control room is needed to indicate that the rule is in operation. Therefore, the workers and engineers should become aware that the rule is in force and thus reduce non-necessary activities and become more careful of their behaviors.
7- LOSA method	Line Operations Safety Audit (LOSA) is a practical-based method to develop a structured approach to reduce operational errors [12]. The LOSA method is designed around the concept of TEM to identify operational safety threats and risks. LOSA assesses aviation safety in a proactive manner. Trained observers collect detailed data about crew behavior on the	This article would suggest exploring how LOSA methodology might be extended to O&G to cover TEM aspects evolved based on CRM to produce an acceptable level of safety. LOSA can introduce an operational risk management tool in helioffshore operations for frontline transportation to and from offshore oil rig platforms. Likewise, Thorogood and

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	flight deck to capture data on how cabin crews manage errors and undesirable threats. This includes accidents and associated behaviors. The LOSA method in aviation was extended to ground maintenance and ramp operations to ensure that ground operators follow procedures in the correct way. In a nutshell, LOSA is when a senior pilot sits behind the flight crews with a notebook called the LOSA observation form and writes down how that flight crew behaves in real life, recording performance and whether they effectively manage the risks and threats and what the outcome was, and then being able to comment on it and then send feedback to the pilots and the organization to improve quality.	Crichton have succeeded in conducting an analogous link between drilling operations in process safety and the aviation TEM. An appropriate use of the LOSA methodologies in everyday operations promotes organizational safety performance and safety culture, thereby minimizing the probability of minor incidents that lead to major ones.

Or threat is relevant to the culture of “finding a way”. In aviation, however, the core of a strong safety culture is the team and the system. Thus, promoting similar cultures and protocols in OGE therefore requires individual’s approaches to the culture of “find a way” to be restrained, which might be performed through restricted measures and promoting the role of the safety system in ensuring occupational and organizational safety culture. These restraints are expected to be perceived as challenging to the culture of “find a way,” and worker opposition is inevitably expected.

In aviation, the culture of following safety rules, procedures, and protocols is in professional’s approaches to adverse events, and professionals’ responses to such events are not to “find a way” but rather to follow the steps stated in the task checklist procedures, and then report these events into an open reporting system. In aircraft

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maintenance engineering, each checklist procedure clearly defines the safety steps in the form of cautions and warnings. These cautions and warnings are marked in red to grab mechanics and engineers' attention to safety protocols. The authors, however, assert that excessive restraints on worker's approaches to "finding a way" to missing appropriate tools or unexpected events not stated in the protocols might foster a culture of climate of fear on a long-term basis. Thus, adopting an open reporting system would mitigate such a climate of fear.

4. Conclusion

Despite sector wide normative expectations of a strong safety culture within oil and gas industry, this study demonstrates that safety culture in this sector can be improved by adopting aviation safety standards. This research aimed to review the literature and suggest the possibility of transferring safety initiatives applied in aviation industry into oil and gas field. The following conclusions can be drawn from the study to substantiate the main findings as follow:

- Safety initiatives drawn from aviation safety standards can be categorized into two hitherto elements, shared knowledge of safety values, and concepts endorse safety by design.
- Shared knowledge of safety values revealed from this study represent joint safety briefings, CRM, and confidential reporting system whereas,
- Concepts endorse safety by design were task checklist, forcing functions, sterile cockpit initiative and LOSA approach to support organizational and occupational safety culture.
- The findings revealed from this research could provide operators with the required tools and initiatives that contribute to cost reduction and loss-time injuries.

This research results highlighted the important elements in organizational safety that underpin effective safety culture and safety practices in aviation sector and they may be readily transferrable from aviation to OGE field.

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