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SAFETY CULTURE: A SYSTEMATIC REVIEW FOR THE OIL AND GAS INDUSTRY

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ABSTRACT

This article presents a systematic review of the literature on safety culture. The focus is on methodological approaches to safety culture assessment implemented in the oil and gas industry. The objective was (i) to show differences and convergences between the different methods and (ii) to discuss the main results. Despite the recent and growing development of studies and research, the differences in methodological approaches make clear the lack of clarity of the theoretical bases of reference. The transformations in industrial security practices and concrete implementations are still relatively few among the studies analyzed, focusing especially on communication between different hierarchical levels and on training on the subject.

KEYWORDS: Safety Culture, Diagnosis, Oil and Gas Industry.

1. INTRODUCTION

This study is an integral part of research for Marina P. Prado's master's thesis in Management and Innovation at PEP/COPPE/UFRJ.

The oil and gas sector has been developing various industrial safety programs over the past few years. Although there has been a focus on reducing accident frequency rates, the most commonly used methods are not considered efficient in preventing the most serious accidents (HUDSON, 2007).

The persistence of such accidents has led this sector to rethink its focus on safety and to have a greater interest in Safety Culture (SC) and Human and Organizational Factors in Industrial Safety. The term SC emerged from the analysis of the Chernobyl nuclear accident in 1986 (COX & FLIN, 1998) and refers to the sharing of attitudes, beliefs, perceptions, and values of employees about safety (Cox & Cox, 1991).

Initial discussions and learning about SC in the oil and gas sector were derived from studies of the Piper Alpha accident in 1988 (COX & CHEYNE, 2000). As a consequence, new safety regulations were implemented (COX & CHEYNE, 2000; MEARNS et al., 1998). However, despite the increasing effort to improve safety in the industry, many investments focus mainly on managerial aspects with low integration and understanding of the contribution of human and organizational factors to industrial safety (Cross Industry Safety Leadership Forum, 1997, as cited in COX & CHEYNE, 2000).

To be improved, culture needs to be understood first (ANTONSEN, 2009a). For the assessment of SC, the type of method used can be quantitative, qualitative, or both (ANTONSEN, 2009b). In this sense, this article analyzes and discusses the methodological approaches to SC assessment implemented in the oil and gas industry in order to present differences and convergences between different methods and discuss the main results.

2. METHODOLOGY

According to Jahan (2016), a systematic review analyzes different databases to compile articles and conduct a critical analysis, providing insights into a specific topic (JAHAN, 2016). For this article, the search was conducted in the Web of Science database, using the terms "safety culture", "oil and gas", "petroleum", and "offshore", which were combined with the boolean operators "AND" and "OR". The "OR" operator was used between the terms "oil and gas", "petroleum", and "offshore", and the result of this combination was crossed with the term "safety culture" using the "AND" operator. This initial search yielded ninety-two (92) articles.

The studies were exported to the Rayyan application and underwent content refinement selections. The selection was carried out in two stages: (i) reading of title and abstract, and (ii) reading of the full text. Forty-eight (48) articles were excluded based on title and abstract readings, and twenty-five (25) studies during the full-text reading. The inclusion criteria used were as follows: (i) SC studies specifically conducted in the oil and gas industry, (ii) published in scientific journals, and (iii) in English. The exclusion criteria were: (i) duplicate articles, (ii) studies that did not apply or discuss SC evaluation methods, (iii) studies that were only discussing a specific factor, (iv) studies related to other types of organizations besides the oil and gas industry, such as food safety or healthcare sector, (v) studies published in conferences, and (vi) literature review studies.

After reading the full texts, recursive searches were also conducted, resulting in nineteen (19) studies, which were classified according to the main characteristics of safety culture diagnostic methods and discussed based on their main results.

3. RESULTS

In this research, different approaches were identified, as well as common characteristics. A summary with the corresponding data on types of methods, tools, and research topics is presented in Table 1.

Table 1. Characteristics of Studies

Author(s) / Year	Method Type	Tools	Research Subjects
Antonsen (2009a)	Mixed	Questionnaire, Interview, Field Observation.	Leadership and Workforce
Cox and Cheyne (2000)	Mixed	Questionnaire, Interview, Field Observation, Document Analysis.	Leadership and Workforce
Cox et al. (2006)	Qualitative	Interview, Field Observation, Document Analysis, Participation in Regular Meetings..	Leadership and Workforce
Didla et al. (2009)	Mixed	Questionnair e, Interview.	Leadership
Gonçalves Filho et al. (2010)	Qualitative	Questionnair e, Interview.	Leadership
Høivik et al. (2009)	Qualitative	Interview.	Leadership and Workforce
Kongsvik et al. (2016)	Qualitative	Interview, Document Analysis.	Workforce
Lawrie et al. (2006)	Qualitative	Questionnaire	Leadership and Workforce
Mearns et al. (1998)	Qualitative	Questionnaire	Leadership and Workforce
Mearns et al. (2004)	Qualitative	Questionnaire	Leadership and Workforce

Mearns et al. (2001a)	Qualitative	Questionnaire	Leadership and Workforce
Mearns et al. (2001b)	Qualitative	Questionnaire	Leadership and Workforce
Nævestad (2010)	Qualitative	Interview, Field Observation.	Leadership and Workforce
O'deaandFlin (2001)	Qualitative	Questionnaire.	Leadership
Olsen (2010)	Qualitative	Questionnaire	Workforce
Olsen et al. (2009)	Mixed	Questionnaire, Interview, Field Observation, Document Analysis, Participation in Regular Meetings, Focus Groups.	Leadership and Workforce
Parker et al. (2006).	Qualitative	Interview.	Leadership
Şimsekogluand Nordfjærn (2017)	Qualitative	Questionnaire	Workforce
Tharaldsen et al. (2008)	Qualitative	Questionnaire	Workforce

A macro perspective allows us to classify methodological approaches into three types of methods: quantitative, qualitative, and mixed. The proportion of each method type is indicated in Figure 1.

Figure 1. Method Type
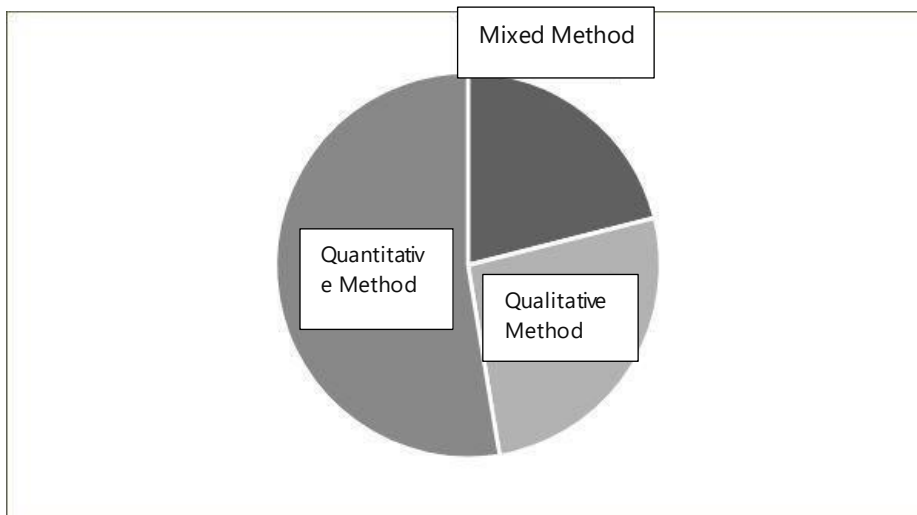
Most of the studies included in this review used only quantitative method (53%), employing only questionnaires (MEARNS et al., 1998; MEARNS et al., 2001a; MEARNS et al., 2001b; MEARNS et al., 2004; THARALDSEN et al., 2008; GONÇALVES FILHO et al., 2010; OLSEN, 2010; ŞIMSEKOGLU E NORDFJÆRN, 2017; O'DEA E FLIN, 2001; LAWRIE et al., 2006). Although most studies use quantitative designs, some authors acknowledge that qualitative studies are important for provoking group interactions (MEARNS et al., 1998; OLSEN, 2010; THARALDSEN et al., 2008).

Studies that used qualitative designs compose 26% of the studies found (COX et al., 2006; PARKER et al., 2006; HØIVIK et al., 2009; NÆVESTAD, 2010; KONGSVIK et al., 2016). These qualitative studies were based on interviews, and some of them on group discussions, field observations, document analysis, and/or participation in regular meetings.

It was identified that 21% of the analyzed articles used a combination of quantitative and qualitative methods (mixed method) (COX E CHEYNE, 2000; ANTONSEN, 2009a; DIDLA et al., 2009; OLSEN et al., 2009). The most common tool is the application of questionnaires (74% of the studies). Interviews are present in nine (9) out of nineteen (19) studies (47%), and they can be either group or individual. Other tools used are: field observations, team meeting monitoring, and organizational document analysis (ANTONSEN, 2009a; COX E CHEYNE, 2000; COX et al., 2006; NÆVESTAD, 2010; OLSEN et al., 2009). According to OLSEN et al. (2009) and ANTONSEN (2009a), the design of mixed methods is more effective when it comes to understanding the dynamics and practical effects of a program on industrial safety (OLSEN et al., 2009; ANTONSEN, 2009a).

3.1. Research Subjects

The choice of actors to be studied leads to the discussion of results, as a fair and informed culture is built through interaction between various hierarchical levels (REASON, 1998).

Considering the research subjects, eleven (11) out of the nineteen (19) studies evaluated the safety culture among all employees, including both leadership and the workforce (ANTONSEN, 2009a; COX E CHEYNE, 2000; COX et al., 2006; HØIVIK et al., 2009; MEARNS et al., 1998; NÆVESTAD, 2010; LAWRIE et al., 2006; MEARNS et al., 2001a; MEARNS et al., 2001b; MEARNS et al., 2004; OLSEN, 2009). Four (4) studies analyzed only the leadership perspective (DIDLA et al., 2009; GONÇALVES FILHO et al., 2010; O'DEA E FLIN, 2001; PARKER et al., 2006), and four (4) specifically studied the viewpoint of the workforce (KONGSVIK et al., 2016; OLSEN, 2010; ŞIMSEKOGLU E NORDFJÆRN, 2017; THARALDSEN et al., 2008).

Six (6) out of the eleven (11) articles that evaluated the safety culture of both the workforce and leadership concluded the benefit of improving interaction and sharing of safety issues among different hierarchical groups (ANTONSEN, 2009a; COX E CHEYNE, 2000; Cox et al. 2006; HØIVIK et al., 2009; MEARNS et al., 1998; NÆVESTAD, 2010). Other works from this group showed congruent elements. For example, for Olsen et al. (2009), a good safety management system must take into account the specificities of organizational subgroups.

The main emphasis of studies with a homogeneous type of interviewed subjects is on the utility of a better safety management system (DIDLA et al., 2009; MEARNS et al., 2001a; MEARNS et al., 2001b; OLSEN, 2010; PARKER et al., 2006; ŞIMSEKOGLU E NORDFJÆRN, 2017; THARALDSEN et al., 2008). However, among these articles, we also find studies that support more safety communication, involving factors such as good interpersonal relationships, trust, and openness among different hierarchical groups. For O'dea and Flin (2001), close management influences safety. These authors report the manager's posture as influential for an open and participative relationship with the subordinate, thus for improving safety culture.

3.2. Practical Proposals

In the construction of the evaluation process, there is a diversity of elements considered. Among them, communication is the most recurring. All studies discuss or at least

mention communication, however, they use this term with different perspectives. One perspective is top-down communication (GONÇALVES FILHO et al., 2010; LAWRIE et al., 2006; PARKER et al., 2006; SIMSEKOGLU AND NORDFJÆRN, 2017; THARALDSEN et al., 2008). In this case, the point is to find "how, when, and what" to communicate to employees and build an effective open communication channel that allows understanding of what is communicated. For example, in Tharaldsen et al.'s study (2008), the worsening of communication, or employee understanding, is related to the implementation of a new work permit system. For them, the organization should focus on effectively communicating its safety procedures.

Another perspective is related to communication as the act of reporting accidents, incidents, or near misses (DIDLA et al., 2009; KONGSVIK et al., 2016; MEARNS et al., 2001b).

A third perspective addresses the two-way exchange between leadership and employees (COX AND CHEYNE, 2000; MEARNS et al., 1998; MEARNS et al., 2001a; MEARNS et al., 2004; COX et al., 2006; HØIVIK et al., 2009; ANTONSEN, 2009a; OLSEN, 2009; O'DEA AND FLIN, 2001; OLSEN; 2010). This perspective seeks to verify: (i) if safety information, issues, and policies are effectively communicated to employees, (ii) how employees perceive this communication, (iii) if they are involved in decision-making, and (iv) if there is open dialogue to report experiences. These studies establish relationships between communication and other aspects, such as information flow (COX AND CHEYNE, 2000; MEARNS et al., 1998), participation (MEARNS et al., 2004), worker involvement (COX AND CHEYNE, 2000; MEARNS et al., 2004; O'DEA AND FLIN, 2001), trust (COX et al., 2006), and cooperation or collaboration (COX et al., 2006; ANTONSEN, 2009a; HØIVIK et al., 2009).

In the research conducted by Mearns et al. (1998), although the respondents feel well informed and have clear guidelines, more than two-thirds of them say they are not consulted during decision-making, and over half feel they cannot influence decisions. Mearns et al. (2004) compared English and Norwegian workers, contrasting the terms 'participation' and 'involvement'. Workers surveyed in Norway are encouraged to express their perceptions and participate in decision-making on a range of issues, including safety. In contrast, UK workers are involved only when management deems it appropriate. O'dea and Flin (2001) concluded that the Offshore Installation Manager (OIM) of a British organization believes that communication (open and trusting relationships, listening to workers, and accepting their suggestions) needs more attention, as opposed to technical issues that are already more frequently discussed. Promoting training and discussing Safety Culture (CS) in team meetings is one way to engage employees in safety (COX AND CHEYNE, 2000).

Cox et al. (2006) attribute communication and cooperation deficiencies between employees and managers to low levels of trust. This is related to the blame attribution system and penalization of individuals in accidents, incidents, or near misses. Fearing that reports will have negative impacts on their evaluation and potential promotions, individuals do not feel comfortable reporting safety-related information. This lack of trust is even greater when it comes to subcontracted employees.

Antonsen (2009a) discusses social and communication conventions among offshore teams. Due to the proximity promoted by confinement, the sense of solidarity and community is a cultural trait that can foster an atmosphere of care and open communication. However, the quest to minimize conflicts in the community may conceal information and ideas that would be positive for safety. In Høivik et al (2009), communication between managers and employees, and among colleagues, was often mentioned based on attitudes that should lead to practices. For example, employees describe good communication as the practice of discussing work situations before starting work, as well as sharing different ways of viewing a problem.

According to Olsen (2010), communication about errors is a component of organizational learning, along with feedback and the pursuit of continuous improvement. These factors together contribute to teamwork and safety behavior (OLSEN, 2010). The author concluded that the strategy should define and implement a safety program or develop safety interventions, and raise awareness among workers of their contribution to safety.

4. CONCLUSION

This work conducted a literature review on Safety Culture (CS) diagnoses in the oil and gas industry, presenting the differences and convergences between different methods and discussing the main results.

Despite the progress made in CS in the oil and gas industry since the Piper Alpha accident, more than half of the assessments did not result in practical actions to improve CS. Some studies provide only isolated suggestions, and a small number of studies focus on effectively improving CS. This may be justified because CS research requires some time to verify concrete results, due to the naturally slow process of cultural transformation (GULDENMUND, 2000).

However, it was possible to outline a general framework for CS diagnostic methods in the oil and gas sector. The low number of practical solutions presented among the studies highlights the need for research on CS development, including challenges in workers' everyday situations.

5. ACKNOWLEDGEMENTS

REFERENCES

ANTONSEN, S. The relationship between culture and safety on offshore supply vessels. *Safety Science*, v. 47, n. 8, p. 1118-1128, 2009a.

ANTONSEN, S. Safety Culture: Theory, Method and Improvement. Ashgate Publishing, Ltd., 2009b.

Cross Industry Safety Leadership Forum. Step Change in Safety. Safety Leadership Forum, 1997.

COX, S. J., CHEYNE, A. J. T. Assessing safety culture in offshore environments. *Safety Science*, v. 34, n. 1, p. 111-129, 2000.

COX, S., COX, T. The structure of employee attitudes to safety: a European example. *Work & Stress* 5, 93-106, 1991.

COX, S., FLIN, R. Safety culture: philosopher's stone or man of straw?. *Work & stress*, v. 12, n. 3, p. 189-201, 1998.

COX, S., JONES, B., COLLINSON, D. Trust relations in high‐reliability organizations. *Risk analysis*, v. 26, n. 5, p. 1123-1138, 2006.

GONCALVES FILHO, A. P., ANDRADE, J. C. S., DE OLIVEIRA MARINHO, M. M. A safety culture maturity model for petrochemical companies in Brazil. *Safety Science*, v. 48, n. 5, p. 615-624, 2010.

GULDENMUND, F. W. The nature of safety culture: a review of theory and research. *Safety Science*, v. 34, n. 1-3, p. 215-257, 2000.

JAHAN, N. et al. How to conduct a systematic review: a narrative literature review. *Cureus*, v. 8, n. 11, 2016.

HØIVIK, D. et al. An explorative study of health, safety and environment culture in a Norwegian petroleum company. *Safety Science*, v. 47, n. 7, p. 992-1001, 2009.

HUDSON, P. Implementing a safety culture in a major multi-national. *Safety Science*, v. 45, n. 6, p. 697-722, 2007

KONGSVIK, T., GJØSUND, G., VIKLAND, K. M. HSE culture in the petroleum industry: Lost in translation?.*Safety Science*, v. 81, p. 81-89, 2016.

LAWRIE, M., PARKER, D., HUDSON, P. Investigating employee perceptions of a framework of safety culture maturity. *Safety Science*, v. 44, n. 3, p. 259-276, 2006.

MEARNS, K. et al. Measuring safety climate on offshore installations. *Work & Stress*, v. 12, n. 3, p. 238-254, 1998.

MEARNS, K. et al. Evaluation of psychosocial and organizational factors in offshore safety: a comparative study. *Journal of Risk Research*, v. 7, n. 5, p. 545-561, 2004.

MEARNS, K. et al. Human and organizational factors in offshore safety. *Work & Stress*, v. 15, n. 2, p. 144-160, 2001a.

MEARNS, K., WHITAKER, S. M., FLIN, R. Benchmarking safety climate in hazardous environments: a longitudinal, interorganizational approach. *Risk analysis*, v. 21, n. 4, p. 771-786, 2001b.

NÆVESTAD, T. Evaluating a safety culture campaign: Some lessons from a Norwegian case. *Safety Science*, v. 48, n. 5, p. 651-659, 2010.

O'DEA, A., FLIN, R. Site managers and safety leadership in the offshore oil and gas industry. *Safety Science*, v. 37, n. 1, p. 39-57, 2001.

OLSEN, E., BJERKAN, A. M., NÆVESTAD, T. Modelling the effects of a large-scale safety culture programme: a combined qualitative and quantitative approach. *Journal of Risk Research*, v. 12, n. 3-4, p. 389-409, 2009.

OLSEN, E. Exploring the possibility of a common structural model measuring associations between safety climate factors and safety behaviour in health care and the petroleum sectors. *Accident Analysis & Prevention*, v. 42, n. 5, p. 1507-1516, 2010.

PARKER, D., LAWRIE, M., HUDSON, P. A framework for understanding the development of organizational safety culture. *Safety Science*, v. 44, n. 6, p. 551-562, 2006.

REASON, J. Managing the risks of organizational accidents. Aldershot, UK: Ashgate, 1997.

REASON, J. Achieving a safe culture: theory and practice. Work & Stress, v. 12, n. 3, p. 293-306, 1998.

ŞIMŞEKOĞLU, Ö., NORDFJÆRN, T. The role of safety culture/climate and social cognitive factors for driving behaviors of Turkish professional drivers transporting petroleum products. *Journal of risk research*, v. 20, n. 5, p. 650-663, 2017.

THARALDSEN, J. E., OLSEN, E., RUNDMO, T. A longitudinal study of safety climate on the Norwegian continental shelf. *Safety Science*, v. 46, n. 3, p. 427-439, 2008.