A road map to generative safety culture: An integrated conceptual model

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A road map to generative safety culture: An integrated conceptual model

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Abstract. Evidence has shown that maturity models are a popular means of assessing safety culture in organizations. Maturity models involve defining maturity stages or levels from less to more advanced safety cultures. A maturity model is a descriptive model in the sense that it describes essential, or key, attributes that would be expected to characterize an organization at a particular level. Existing culture maturity models still lacks a concise roadmap of strategies that can guide an organization to progress through the maturity stages from less to advanced. This work proposes a concept to integrate the present general and workplace models and techniques that provides a roadmap to generative safety culture. In doing so, a summary of the current general and workplace literature will be provided, method to integrate them to develop an integrated conceptual model for a generative safety culture, as well as the final integrated model is discussed. This conceptual model can be the basis for further research in order to provide a comprehensive picture of the safety culture improvement and maturity process. Lastly, implications for specific interventions to develop targeted safety culture improvement practices and work towards achieving generative safety culture will be discussed.

1. Introduction

The cultural aspects of safety have been one of the main focus in process industries to improve safety in the organizational settings. This is due in part to the findings of investigations into some major disasters in process industries (e.g. Texas City), other industries such as nuclear power (e.g. Chernobyl) and space travel (Challenger & Columbia), reported safety culture as one of the major causes. The term 'Safety Culture' officially emerged from the initial analysis report of the 1986 Chernobyl nuclear power plant accident [1]. This analysis first time introduced safety culture as a concept, to manage safety in a more advanced way and to look beyond the direct engineering and technical failures by dwelling more deeply into the underlying causes of accidents. Most explicitly defined by HSE (2005) as: "Organisations with positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety, and by the confidence in the efficacy of preventive measures" [2].

A lot of research is available what safety culture consists of and on application of performance measurement frameworks, [3-7], their influence on safety outcomes i.e., frequency of accidents or lost time injuries and as well as on the use of safety culture maturity models for assessment and multi-level characterization [8-9]. Mostly, these measurement methods and maturity models of safety culture lack motivation for continuous improvement and theoretical framework [8, 10-11]. These signs clearly direct us to move from the contemporary approaches and explore new strategies for continuously improving safety culture.

In order to understand the nature of a continuously improving safety culture it is inevitable to know what are the most representative factors that make up a safety culture and how the factors can be identified, what steps should be done before embarking into a safety culture assessment, what strategies should be adopted to have an always monitoring and improving safety culture?
The questions stated above calls for a simplified integrated process for development of a conceptual integrated framework that can help to identify steps towards a generative safety culture. Therefore, this paper focuses on the integration of general and workplace models relevant to selection process of most representative factors, methods of assessment and improvement strategies that can pave a way towards a continuously improvement safety culture.

1.1. Selection of Factors for Safety Culture

Identifying and selecting the most representative factors for safety culture is challenge, particularly those factors that help in proactively improving the safety culture. Since, these factors are the one that will be assessed, evaluated and applied across the organization settings, it requires organizations to develop deep knowledge and understanding of how and what methods can be used for the identification and selection process.

There has been a voluminous work done on identifying and selecting factors of safety culture. Selection process of factors depends on various types of statistical and analytical tools, methods such as linear or arithmetic mean, aggregate mean. Furthermore, the selection process also depends on type of industry and country. Depending on organizational setup some factors might be of importance in one while others factors in a different organization [12].

A meta-analytic study done by Flin et al. [13] , analysed 18 studies and came out with the five most common themes, that are, work pressure, management/supervision, risk, competence and safety system. Similarly, Seo et al. [14], suggested that there are five main factors of safety culture, co-worker safety support, management commitment to safety, supervisor's safety support, competence level of employees with regard to safety and finally employee participation in safety-related decision making and activities. While in meta-analytic study by Clarke [15], analysed 16 studies and performed factor analysis and extracted the dominant themes common across the studies and he ended up with five main categories, i.e. Work task/work environment, Management attitude, Management actions, individual responsibility and involvement, and lastly safety management system. A literature review of 10 studies conducted by Wiegmann et al. [16], identified five indicators of safety culture namely, reporting system, management involvement, rewarded system, employee empowerment, and organizational commitment. Farrington et al. [17] after reviewing 15 studies, identified reporting system, management commitment, immediate supervisors and supervisor sub-ordinate relationships, involvement, competency, training, attitude, behaviour rules, procedures and communication were the common factors. A report prepared for the Health and Safety Executive, 2005 (HSE) identified two-way communication, leadership, involvement of staff, existence of learning culture and existence of just culture as five core dimensions [15]. The summary shows that no strict consistency in the factorial structure and no definitive set of factors has been reported.

1.2. Methods of Safety Culture Assessment

Safety culture can be assessed using different Safety Culture assessment tools. The assessment tool gives response on how well some organizational factors related to safety are working and what factors need to be improved and the effect of attitudes and behaviours on frequency of accidents or other safety outcomes. The most common assessment method being used are listed as:

a) Universal Assessment Instrument (UAI)
b) Safety Element Method (SEM)
c) Self-Diagnostic OHS Tool
d) Tripod Delta

The essential features of these methods are tabulated as follow in table.1.

Table 1. Safety performance related methods

Method	Author	Objective	No. of Elements	Safety Outcome
SEM	B.Alteren, 1998 [11]	Evaluation and improvement of OSH management performance	Six key elements: management, feedback systems and learning, safety culture, documentation, results, goals and ambitions	lost time injuries frequency, and a severity rate of injuries
UAI	Redinger and Levine, 1998 [18]	Evaluate the performance of OSH Management System	Consists of 27 sections, 118 OSH MS principles, and 486 measurement criteria	Nor reported
Self-Diagnostic OHS Tool	Cadieux et al., 2006, [19]	Subjective self-evaluation of OSH MS performance	Nine subject areas namely: organizational systems, prevention-oriented activities, management commitment, organizational structures, employee responsibility, norms and behaviours, communication, continuous improvement, and workplace compliance	The need for alteration to attain a satisfactory validation level
Tripod Delta	Cambon et al. 2006 [20]	Accident are prevented by identifying weak areas in working environment	Questionnaire-based tool, with 1500 validated questions	Corrective actions, the improvement of communication between the management staff and employees

All these methods are being validated, provide basic theoretical framework and provide relation between technical, organizational and human. Furthermore, these assessment methods can be used in different work settings and have the ability of motivation for safety improvements. [10].

1.3. Safety Culture Maturity Model

Maturity Models consists of maturity stages which assess the completeness of a process in an organization by using a different sets of criteria [8-21]. Westrum [22-23], proposed a concept that there exist a different level of cultures within an organization. He proposed three different organisational cultures, which he called pathological, bureaucratic and generative. The most immature stage of organisation has a pathological culture, which is one in which information is hidden, failure is covered up, new ideas are actively crushed and discouraged, sharing and learning from each other is actively discouraged. In such a culture, organization do not spend time risk management and safety issues.

A next higher-level in organisational culture is the bureaucratic one that handles the flow of information in a systematic way but may probably then be ignored, new ideas to improve the safety are seen to create problems, and learning and sharing might be listened but not encouraged. The generative organisation characterizes the most progressive stage of cultural maturity. Here information is actively pursued, and there are trained safety staff members collect it. New ideas are being appreciated and welcomed, and failures are promptly investigated rather than cover-up or blame. Westrum's tripartite typology was later modified to a five-level model and adapted by Parker and Hudson [24] specifically by adding up a reactive, and proactive level, and replacing the label bureaucratic with calculative with respect to safety culture (figure 1).

Reports from many accidents investigations reveals that the approach to safety within the industries in general is mostly 'reactive'. Organizations with reactive approach to safety adjust their safety policies

after an event has occurred. At calculative level, organizations have systems in place to manage all possible risks, and learn to use the information they possess to manage safety professionally [24]. Proactive organizations look actively for safety gaps in the system and places safety as a priority before injury or incidents occur. At this level, organizations comply with safety performance standards, have clear safety objectives and there is active safety participation at all levels of management [25].

Figure 1. HSE Safety Culture Maturity Model [24].

1.4. PDSA Cycle for Safety Improvement

The PDSA method focuses on the translation of ideas and intentions into learned and informed actions. The PDSA (Plan-Do-Study-Act) is a tool that has been used widely by healthcare for quality improvement projects and bring positive changes in the processes effecting favourable outcomes [26-30].

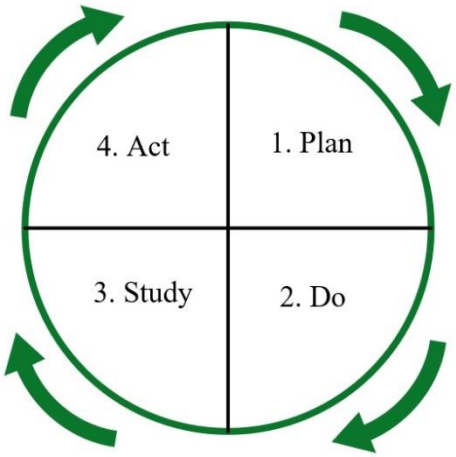

Figure 2. Demings' PDSA Cycle [31].

The PDSA cycle, shown in figure 2, is a model for learning and improvement of a product or a process. The brief description of the key components of the model are:

a) The very first step is 'Plan' a change, clear objectives, or test, aimed at improvement.
b) The second step is 'Do' that is, carry out the change or test.

c) The third step is 'Study' the results of the second step. The core objective of this step is to study or analyse the data and the process itself. Some critical questions in this step are:
   - Did it work out as planned?
   - What were the lessons learned?

d) The last step is 'Act'. Act is a vital element that ensures what measures and procedures are available to adopt the change or abandon it. Also enquiring on the state of readiness to make another change, which leads on to generating a plan for the next PDSA cycle.

The PDSA model is flexible, holistic in nature and easy to learn and use. The model supports continuous improvement efforts in a full range from the very informal to the most complex. It can be used to improve a new product line and for services improvements in a major organization setting.

2. Methodology

Based on the gaps and similarities of both the general and workplace models discussed above will help to build a new conceptual framework. The data collection for developing framework was done in five stages.

i. **First Stage:** It is the primary stage which describes the process and phenomenon of identifying and selecting different models from the existing literature.
ii. **Second Stage:** The data is structured together in new ways. Identifying a fit model from general or workplace models by looking deeply into identifying relationships between selected models. The goal is to make distinct connections between different dimensions, known as the "paradigm model". This stage helps in understanding and explaining the relationships between different categories of the models and helps to understand the phenomenon or dimensions to which they relate.
iii. **Third Stage:** This stage involves the integration of all the processes related to each model based on the similarities and overlapping features.
iv. **Fourth Stage:** This stage is systematically finalizing the overall integrated framework and the processes for the new model.
v. **Fifth Stage:** The final stage is validation and justification of the framework based on literature-based evidence provided.

The criterion to develop the integrated conceptual model is general or work place models shall be from different disciplines, including Occupational Health and safety management system, Safety culture assessment methods, Safety Culture Maturity Models and process improvement studies. The criterion not only offers new perspectives but increases the validity of the conceptual integrative framework by bringing together evidence from different disciplines. The search was to find simple methods or models and found a total of three general and workplace models which met the above criteria. Different stages of the process are described as below in table 2.

Table 2. General and Workplace Models

No.	Andersen [32]	OGP [25]	Brett & Jeffrey [33]
1.	Plan	Establish implementation team	Safety Culture Assessment
2.	Do	Assess performance	Analysis of Assessment & Survey Results
3.	Study	Confirm critical process and barriers	Recommended Practice Selection
4.	Act	Monitor weaknesses	Implementation Plan
5.		Set improvement actions	Safety Culture Assessment
6.		Regular monitoring	Analysis of Assessment & Survey Results

3. Discussion

3.1. Conceptualizing the integrated framework for generative safety culture

Based on findings from literature, a conceptual framework for generative improvement of safety culture is developed by utilizing various stages discussed in section 2. This conceptual Model is not proposed to be a final rigid structure for application purposes but is rather a flexible mean to provide guidance for discussion and further research. Further, the different stages in framework model are being discussed as follow.

- *Plan for Safety Culture Objectives.* The goal towards a generative safety culture is the continuous monitoring and improvements on every aspect of safety culture. Some main steps are discussed as below:

- Before embarking on an intervention for safety culture, the very first critical step is to ensure what being measured is specific, representative and relevant to the system. A better solution is to select vast set of factors based on validated studies. A Delphi method can be used to get experts opinion in the field for building up consensus on given set of factors. Analytical Hierarchy process (AHP) can be used to prioritize, or choose the most relevant and representative set of factors based on their importance by a definitive criterion while ANP (Analytical Network Process) can be used to find the structural influence.

- Identification of causal and influential effect in between the factors serves as a basis to track path for accidents before it happens by detecting deficiencies, errors and gaps in the safety and at the same time serves to design strategies to fill up the safety gaps and proactively improve the safety. Methods such Fuzzy Decision Making Trial and Evaluation Laboratory (F-DEMATEL) [34] and Analytical Network Process (ANP) [35], can be used to identify the influential and improvement paths. The benefit of using such methods that it can convert the relations between cause and effect of factors into a visual structural model, but also can be used as a way to handle the inner dependences within a set of factors.

- Review in detail the factors that are to be selected and compared across an organization. Systematically understand how these factors can be used to conduct a safety culture assessment in the company.

- Find partners in the same field, acknowledge them and obtain their acceptance for embarking in the progressive journey or identify inter-organizational departments for improvements and learning process.

3.1.2. Do the safety Culture assessment process. Establish a team to carry out the safety culture assessment process throughout the whole organization from top management to bottom personnel. Conduct the inter-organizational or intra-organizational safety culture assessment for benchmarking purposes, which serves as improvement strategies. The process of benchmarking is more than just a means of gathering data on how well a company performs against others. Benchmarking is the process by which companies look at the “best” in the industry and try to imitate their styles and processes. This helps companies to determine what they could be doing better. Since, organizations progress sequentially through the maturity stages, by building on the strengths and re- moving the weaknesses of the previous levels the assessment process shall be designed in a way to carry out the safety culture maturity status.

3.1.3. Study the Results. The effectiveness of safety culture data as a tool for safety improvement requires processes for developing a shared organizational understanding of the underlying meanings and causes, and it also requires processes for identifying the range of potential actions relevant to those interpretations. Rather than viewing the assessment results as an end point, the information should be

considered the starting point from which action and organizational safety changes emerge. Analyze the results from the assessment process helps identify strategies, set safety targets and key success areas for safety improvement. The safety areas identified as problematic can provide material for further analysis of underlying ‘‘root causes’’ and for generating improvement ideas from staff directly involved in the issues. Benchmark the process for inter-organizational and intra-organizational improvements. Data from safety culture assessments can be used to compare units within one organization or to examine differences across different organizations or systems.

3.1.4. Act on the improvement plan. Improvements strategies developed and acted upon based on the findings from the observation and analysis of the safety culture assessment and benchmarking partners. Regularly monitor the action plan, as it can be a basis for learning and speeding up positive developments and can be considered a promising step in improving safety culture. The outcomes at this stage can be used for the next assessment study with the purpose of continuous improvements and to learn from others as a basis for developing measures and programs which are aimed at increasing their own performance.

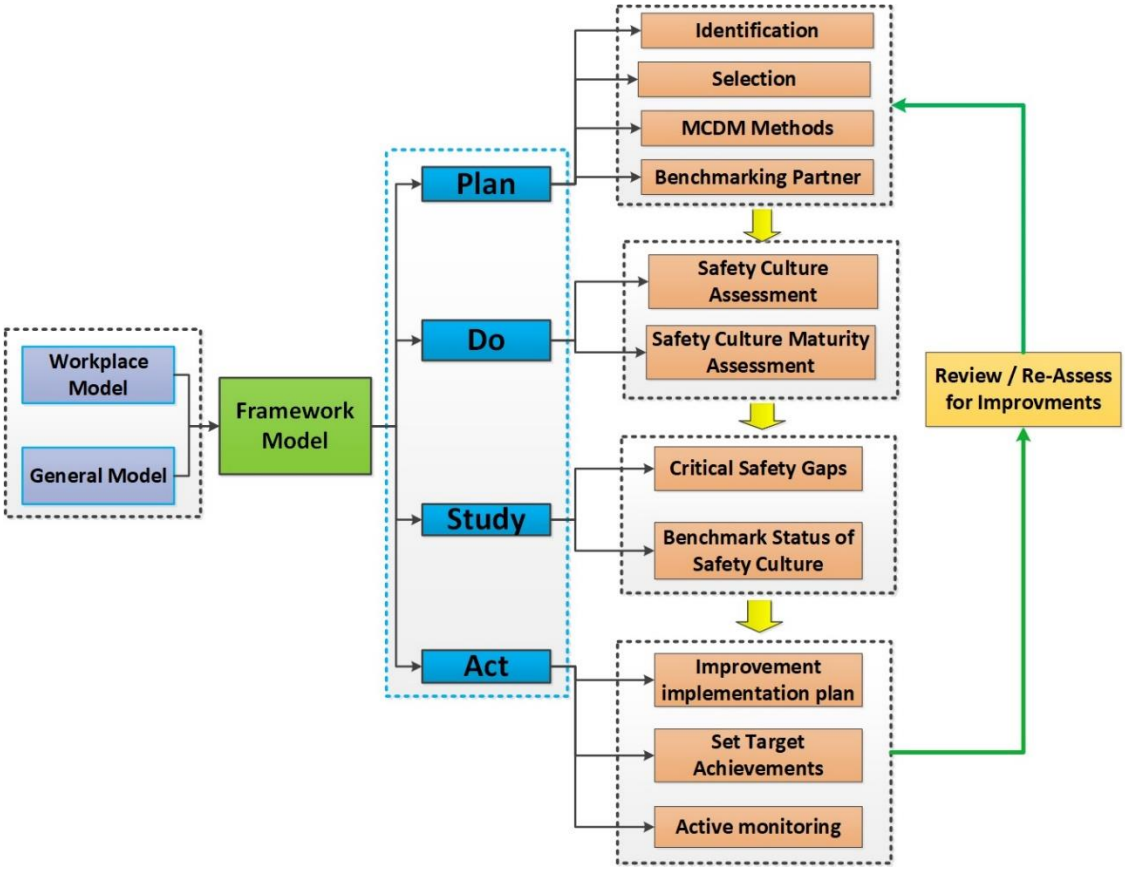

Figure 3. Conceptualizing the Integrated Framework for Generative Safety Culture

4. Conclusion

Our review of general and workplace models offers a new perspective into developing an integrated conceptual framework model for generative safety culture. PSDA model, OGP’s KPI selection model, Safety culture improvement map fulfilled the criteria to be included in the study. As shown in figure 3, we propose an integrated conceptual model for generative safety culture. The integration process utilizes and explains the relationships and the overlapping features of PSDA model, OGP’s KPI model and Safety Culture improvement map. By integrating work from different sources, we have systematically structured different concepts and related them to each other. The paper therefore has a theoretical contribution by combing different areas of research into a more comprehensive model.

The paper also discusses the critical importance of various steps and strategies that can guide an organization to progress through maturity stages from less to advanced.
The principal contribution of this paper is to provide a comprehensive integrated conceptual model for a generative safety culture. This is a flexible framework model and the various steps involved can be modified and accordingly validated using expert's opinion for further research or practical study.

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