

# Designing a Safety Culture Maturity Model

Sari Tappura<sup>1</sup>, Aki Jääskeläinen<sup>2</sup>, Julius Pirhonen<sup>3</sup>

**Abstract** Safety culture has received increasing attention during the last decades. A recent critical review compiled previous models established for the evaluation of safety culture. A need still exists for a maturity model that covers the most important factors of the existing validated models and proposes an approach to maturity evaluation. The objective of this study is to design a new maturity model for measuring and analyzing safety culture. Fourteen safety culture maturity models that had been assessed for reliability or validity were selected, analyzed, and compared. The most common themes and evaluation criteria for safety culture were used as a basis for the new model. The five main themes of the model were communication, training, organizational learning, management commitment, and employee commitment and involvement. The model evaluates maturity by combining written descriptions of best practices and the overall satisfaction of employees in the evaluated aspects. The perspective of employee satisfaction with safety culture acknowledges the need to fit the practices into contextual needs. The model is unique because of its balance between rigor (validated content from the literature) and relevance (written evaluation levels). The model can be used as an assessment, audit, benchmarking, and improvement tool.

**Keywords** Safety and health, Safety performance, Maturity analysis, Performance measurement, Design science

## 1. Introduction

Safety culture has received increasing attention during the last decades. Studies

---

<sup>1</sup> Tampere University, sari.tappura@tuni.fi, 0000-0002-1442-2883

<sup>2</sup> Tampere University, aki.jaaskelainen@tuni.fi, 0000-0002-6427-8437

<sup>3</sup> Tampere University, julius.pirhonen@gmail.com

show that there is a clear link between safety culture and performance in the chemical (Carder & Ragan, 2003; Vinodkumar & Bhasi, 2009), construction (Molenaar et al., 2009), nuclear (Lee, 1998), and mining (Stemn et al., 2019) industries, among others. Safety performance refers to the promotion of health and safety (hereafter, safety) at work (International Organization for Standardization, 2018). Safety performance can be measured by, for example, safety culture or climate (Hale et al., 2010; Singh & Verma, 2020). Safety culture is often regarded as difficult to measure since it concerns individual and group attitudes, values, beliefs, and behaviors (Hale, 2000). Safety culture or climate are generally measured, for example, by questionnaires, audits, and maturity models (Goncalves Filho & Waterson, 2018; Grote & Künzler, 2000; Hoffmeister et al., 2014; Vinodkumar & Bhasi, 2009).

Maturity models have been introduced in many managerial fields, such as information and strategy management, performance management, and safety performance measurement (Van Aken et al., 2005; Jääskeläinen et al., 2020b; Jääskeläinen & Roitto, 2015; Wettstein & Kueng, 2002). A maturity model defines maturity levels that evaluate the perfection of the analyzed subjects via different sets of multidimensional criteria and describes vital attributes that could characterize an organization's operation at a particular level (Goncalves Filho & Waterson, 2018). A maturity model can be used as a tool for both assessment and improvement (Goncalves Filho & Waterson, 2018; Maier et al., 2012) since it can provide information on the desirable characteristics for operation (Bititci et al., 2015).

Maturity analysis is one way to measure safety culture levels in organizations (Goncalves Filho & Waterson, 2018). It can provide information on the present state of safety culture and possible ways to improve it. Evaluating safety culture maturity level can also be used for setting targets and benchmarking, predicting the outcomes of safety interventions, and following up improvements. Various maturity models have been established for the evaluation of safety culture. A critical review by Goncalves Filho and Waterson (2018) compiled the previous models constructed for the safety culture evaluation. However, many models have not been assessed for reliability or validity. The review did not present detailed measures to evaluate the level of safety culture maturity. Current models have somewhat limited scope and do not always give adequate insight into the level of safety culture and the factors affecting it or how they are related to each other.

The objective of the current study is to design a new maturity model for analyzing safety culture. There is a call for a maturity model that covers the most frequently recurring factors of the existing validated models and proposes an approach to maturity evaluation. Once this model exists, safety culture measurement could be better utilized in safety promotion. An objective, transparent, and validated maturity model could also diminish the need for third parties to evaluate the state of safety culture.

## 2. Materials and Methods

We utilized a design science approach in the current study since the intention is to both develop scientific knowledge and solve practical problems (van Aken, 2007). Here, the objective is to design a new maturity model for analyzing safety culture and to propose recommendations for its implementation. The study utilizes the first three phases of the design science process (De Bruin et al., 2005), namely, defining the scope, design, and content of the model. Testing, deploying, and maintaining phases are not in the scope of this study. The testing phase of the model and developed survey tool was reported in Pirhonen et al. (2022) study.

In the defining phase, the scope and target population are defined. The scope of the model is limited to safety culture, and the model is applicable to different organizations without limitations. In the second phase, the design of the model is defined. The idea is that the model could be used as a self-assessment tool by any organization. The model should be suitable for safety culture evaluation at any level of the organization. The evaluation variables are identified by combining existing literature. The model contains four written maturity levels, and higher levels build on the requirements of lower levels. The maturity stages are identified by a down-up approach, in which the measures are identified first, and the maturity levels are then defined to reflect the measures. The selected approach is appropriate for a developed field where existing evidence representing maturity is available (De Bruin et al., 2005).

In the third phase, the main content of the model is defined. A recent critical review examining safety culture maturity models (Goncalves Filho & Waterson, 2018) was utilized as a starting point. Fourteen safety culture maturity models that had been assessed for reliability or validity were selected, analyzed, and compared (see Table 1). The most frequently recurring themes and evaluation criteria were identified from these models.

**Table 1.** Selected maturity models for analysis

No	Reference	Industry	Included maturity levels for the items measured
1	Ashcroft et al., 2005	Healthcare	No
2	Fleming & Wentzell, 2008	Healthcare	No
3	Fleming, 2007	Oil and gas	Yes
4	Goncalves Filho et al., 2010	Oil and gas	Yes
5	Gordon et al., 2007	Air traffic	Partial
6	Jabonete & Concepcion, 2016	Healthcare	No
7	Jespersen et al., 2016	Food	Yes
8	Kirk et al., 2007	Healthcare	Partial
9	Law et al., 2010	Healthcare	No
10	Parker et al., 2006	Oil and gas	Yes

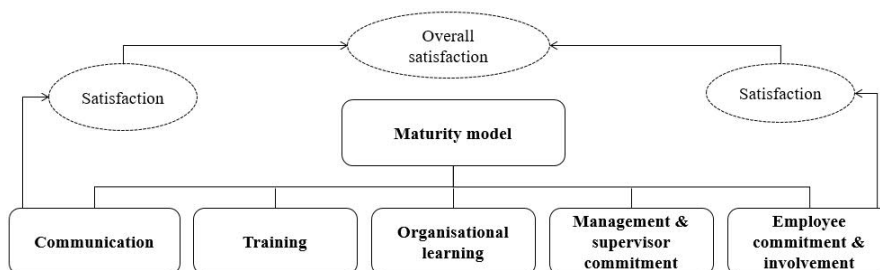
11	Reiman & Pietikäinen, 2010	Nuclear	Partial
12	Saunders et al., 2017	Construction	Partial
13	Tappin et al., 2015	Nonspecific	No
14	Vongvitayapirom et al., 2013	Oil and gas	No

Four maturity levels reflecting the development level in respective evaluation criterion were established by applying and adjusting the presentation from existing models. The evaluation approach in the model with its four maturity levels resembles the recent maturity model for measuring safety performance developed and tested in five case companies (Jääskeläinen et al., 2020a, 2020b; Lilić et al., 2020). The third phase included preliminary testing of the developed model as well. Four company representatives from the intended population and two fellow scholars evaluated the model and questionnaire. Finally, a revised survey instrument was tested with two company representatives.

### 3. Results

#### 3.1. Maturity model framework

The five main themes of the new model are communication, training, organizational learning, management and supervisor commitment, and employee commitment and involvement (see Fig. 1). These themes were selected for this model based on the number of models that covered these themes. The 5 themes presented were identified in at least 8 of the 14 maturity models. The main framework for the developed maturity model is presented in Fig. 1. The analysis of the previous maturity models identified many other themes of minor importance regarding safety culture, such as reporting, investigation of incidents, and rules and procedures. However, these were not included as separate themes in this model as they can be seen as subcategories for the five selected themes.



**Fig. 1.** The main themes of the maturity model for safety culture

This study reports a list of areas for evaluation that can be utilized as a checklist in the analysis of safety culture. The study presents an approach for evaluating maturity that combines written descriptions of best practices and the overall satisfaction of employees in the evaluated categories. By capturing satisfaction, the new model highlights the purposeful objectives of developing a safety culture. It acknowledges that more elementary practices may also suffice if employees are satisfied. In this way, the model takes different contextual criteria for safety management practices into account.

The most relevant evaluation criteria were selected for each of the 5 themes. Table 2 describes the selected criteria and related references under the 5 themes of the model. Each of the themes had 3 to 7 evaluation criteria, and an additional Likert scale question regarding the respondent's overall satisfaction with each theme. Some existing safety culture models have over 100 questions, which may complicate their use in practice. In the design of the new model, an intentional decision regarding the length of the survey was made to balance between comprehensiveness and practicality. The moderate length of the survey enables organizations to focus on the key aspects of safety culture. Also, it keeps under control the time needed to answer it. In any case, the thorough literature review ensures that the selected evaluation criteria cover the most important aspects of each theme.

**Table 2.** Evaluation structure of the model

Theme	Evaluation criterion	Reference
Communication	1. Supervisors' interest in communicating safety issues with the work force	Parker et al., 2006
	2. Organization's way of sharing safety-related information	Fleming, 2007
	3. Attitudes toward safety communication in the organization	Goncalves Filho et al., 2010
Training	1. Training of supervisors	Fleming, 2007
	2. Training of employees	Fleming, 2007
	3. Employees' attitudes towards training	Parker et al., 2006
	4. Supervisors' attitudes towards training	Parker et al., 2006, Gordon et al., 2007
	5. Systematism of the training	Reiman & Pietikäinen, 2010
Organizational learning	1. Existing system for reporting incidents and safety suggestions	Goncalves Filho et al., 2010
	2. How employees feel about reporting incidents and safety suggestions	Goncalves Filho et al., 2010
	3. Organizational learning from reported events	Parker et al., 2006
	4. Support for changes that might affect safety performance	Hale et al., 2010

Management & supervisor commitment	1. What causes the accidents in the eyes of management?	Parker et al., 2006
	2. Who is responsible for the accidents in the eyes of management?	Parker et al., 2006
	3. Management's attitudes toward safety	Gordon et al., 2007
	4. Balance between safety and profitability	Parker et al., 2006
	5. Supervisors' active role in safety	Fleming, 2007
	6. Supervisors' commitment to corrective and proactive actions	Reiman & Pietikäinen, 2010; Saunders et al. 2007
	7. Supervisors' views on auditing	Parker et al., 2006
Employee commitment & involvement	1. Employees' commitment and level of care for colleagues	Parker et al., 2006
	2. Employees' attitudes towards safety	Goncalves Filho et al., 2010
	3. Employees' actions to promote safety	Gordon et al., 2007
	4. Work done under pressure	Saunders et al., 2017
	5. Rewards for safe performance	Parker et al., 2006

### 3.2. Evaluation instrument

The actual evaluation of the criteria included in the model is carried out with four maturity levels with written descriptions representing the sophistication level for each criterion. The descriptions were based on previous maturity models that included such descriptions and were modified for this study. Most of the previous models had five maturity levels, and therefore each question needed slight revision to fit the four-level scale. An example of the descriptions in maturity levels is presented in Table 3.

**Table 3.** Example of descriptions in four-step maturity levels

Example item	Management's attitudes toward safety
Level 1	Managers consider safety an employee responsibility. Lip service is paid by management to the importance of safety.
Level 2	Managers are interested in participating in safety-related issues only when accidents occur.
Level 3	The majority of managers are interested in participating in safety-related issues.
Level 4	Managers clearly think safety is an important part of general management.

Written evaluation criteria were chosen to differentiate the model from earlier maturity surveys using Likert scales and to gain certain benefits. First, written maturity levels provide clearer and more objective alternatives for the respondents than

do Likert scales (Cocca & Alberti, 2010). Second, presentation of written maturity levels raises awareness of best practices, generates discussion, and facilitates the identification of areas needing development during the completion of the survey (Maier et al., 2006). Third, written maturity levels decrease the need for respondents to use external consultants and knowledge on practices outside their own organizations in the evaluation (Garengo et al., 2005).

Likert scales have their advantages as well, and they were used to evaluate the respondents' satisfaction with each theme. Satisfaction is highly subjective and thus difficult to measure, and it cannot be put into words as can other cultural measures. Table 4 provides an example of measuring satisfaction with training, which was one of the themes measured.

**Table 4.** Example of measuring satisfaction

Sample item	Overall, how satisfied are you with the attitudes toward safety-related learning in your organization?
Level 1	Very dissatisfied
Level 2	Dissatisfied
Level 3	Neither satisfied nor dissatisfied
Level 4	Satisfied
Level 5	Very satisfied

An evaluation of both the actual safety culture and the satisfaction toward it enables a more comprehensive understanding of the state of safety culture to be achieved.

#### 4. Discussion

The importance of safety culture has been recognized for decades, but companies still struggle to measure and develop their safety cultures. Regarding measuring safety culture, it may not matter what technique is used to make safety culture discussable (Hale, 2000). The literature provides many models of the maturity measurement of safety culture but inadequate evidence of their validity and reliability (Goncalves Filho & Waterson, 2018). The model developed in this study responds to this challenge by synthesizing the previous models that have been tested for validity and reliability (see Table 1).

The main contribution of this study is the presentation of a new kind of maturity model that can be used as a tool for the analysis of safety culture. The model evaluates maturity by combining written descriptions of best practices and the overall satisfaction of employees in the evaluated aspects. The perspective of employee satisfaction with safety culture acknowledges the need to fit the practices into contextual needs. Sometimes more elementary practices may suffice if the

employees are satisfied. This model is unique because of its balance between rigor (validated content from the literature) and relevance (written evaluation levels); this uniqueness reflects the key ideas of design science.

The model can be used as an assessment and improvement tool (Bititci et al., 2015; Goncalves Filho & Waterson, 2018; Maier et al., 2012). The maturity analysis of safety culture provides information on the current level of safety culture and how it could be improved. The analysis specifies best practices and enables benchmarking between organizations with comparable criteria. Based on the analysis, recommendations for improvement measures that will enable higher maturity levels to be reached can be derived and prioritized (Goncalves Filho & Waterson, 2018). The resulting model will benefit both research into and the practice of safety management. It may be used in large-scale surveys and in auditing safety culture, for example, through group interviews or workshops. It may be answered by all the employee groups in a company.

The presented model and related survey tool were tested in two Finnish companies (Pirhonen et al., 2022). The maturity analysis showed that the level of safety culture and employees' satisfaction with it were relatively high in studied companies. Both companies could still further develop their safety culture based on the analysis. The study identified differences between organizational levels which should be perceived when the model is applied. Further research should test the presented model in different regions and with more case companies to enhance the reliability of the results. Moreover, the results should be statistically analyzed to better understand the differences between respondent groups and the relationships between different dimensions of safety culture.

## Acknowledgments

The authors acknowledge the Finnish Work Environment Fund, participating companies, and Tampere University for providing funding for this study.

## References

- Ashcroft, D. M., Morecroft, C., Parker, D., & Noyce, P. R. (2005). Safety culture assessment in community pharmacy: Development, face validity, and feasibility of the Manchester Patient Safety Assessment Framework. *Quality & Safety in Health Care, 14*(6), 417–421. <https://doi.org/10.1136/qshc.2005.014332>
- Bititci, U. S., Garengo, P., Ates, A., & Nudurupati, S. S. (2015). Value of maturity models in performance measurement. *International Journal of Production Research, 53*(10), 3062–3085. <https://doi.org/10.1080/00207543.2014.970709>
- Carder, B., & Ragan, P. W. (2003). A survey-based system for safety measurement and improvement. *Journal of Safety Research, 34*(2), 157–165. [https://doi.org/10.1016/S0022-4375\(03\)00007-0](https://doi.org/10.1016/S0022-4375(03)00007-0)



- Cocca, P., & Alberti, M. (2010). A framework to assess performance measurement systems in SMEs. *International Journal of Productivity and Performance Management*, 59(2), 186–200. <https://doi.org/10.1108/17410401011014258>
- De Bruin, T., Rosemann, M., Freeze, R., & Kaulkarni, U. (2005). Understanding the Main Phases of Developing a Maturity Assessment Model. In D. Bunker, B. Campbell, & J. Underwood (Eds.), *Australasian Conference on Information Systems (ACIS)* (pp. 8–19). Australasian Chapter of the Association for Information Systems. <https://eprints.qut.edu.au/25152/>
- Fleming, M. (2007). *Developing safety culture measurement tools and techniques based on site audits rather than questionnaires* (pp. 1–63) [Final Project Report]. Saint Marys University.
- Fleming, M., & Wentzell, N. (2008). Patient safety culture improvement tool: Development and guidelines for use. *Healthcare Quarterly*, 11(3), 10–15.
- Garengo, P., Biazzo, S., & Bititci, U. S. (2005). Performance measurement systems in SMEs: A review for a research agenda. *International Journal of Management Reviews*, 7(1), 25–47. <https://doi.org/10.1111/j.1468-2370.2005.00105.x>
- Goncalves Filho, A. P., Andrade, J. C. S., & Marinho, M. M. de O. (2010). A safety culture maturity model for petrochemical companies in Brazil. *Safety Science*, 48(5), 615–624. <https://doi.org/10.1016/j.ssci.2010.01.012>
- Goncalves Filho, A. P., & Waterson, P. (2018). Maturity models and safety culture: A critical review. *Safety Science*, 105, 192–211. <https://doi.org/10.1016/j.ssci.2018.02.017>
- Gordon, R., Kirwan, B., & Perrin, E. (2007). Measuring safety culture in a research and development centre: A comparison of two methods in the Air Traffic Management domain. *Safety Science*, 45(6), 669–695. <https://doi.org/10.1016/j.ssci.2007.04.004>
- Grote, G., & Künzler, C. (2000). Diagnosis of safety culture in safety management audits. *Safety Science*, 34(1), 131–150. [https://doi.org/10.1016/S0925-7535\(00\)00010-2](https://doi.org/10.1016/S0925-7535(00)00010-2)
- Hale, A. R. (2000). Culture's confusions. *Safety Science*, 34(1), 1–14. [https://doi.org/10.1016/S0925-7535\(00\)00003-5](https://doi.org/10.1016/S0925-7535(00)00003-5)
- Hale, A. R., Guldenmund, F. W., van Loenhout, P. L. C. H., & Oh, J. I. H. (2010). Evaluating safety management and culture interventions to improve safety: Effective intervention strategies. *Safety Science*, 48(8), 1026–1035. <https://doi.org/10.1016/j.ssci.2009.05.006>
- Hoffmeister, K., Gibbons, A. M., Johnson, S. K., Cigularov, K. P., Chen, P. Y., & Rosecrance, J. C. (2014). The differential effects of transformational leadership facets on employee safety. *Safety Science*, 62, 68–78. <https://doi.org/10.1016/j.ssci.2013.07.004>
- International Organization for Standardization. (2018). *Occupational health and safety management systems—Requirements with guidance for use (ISO 45001:2018)*. <https://www.iso.org/cms/render/live/en/sites/isoorg/contents/data/standard/06/37/63787.html>
- Jääskeläinen, A., & Roitto, J.-M. (2015). Designing a model for profiling organizational performance management. *International Journal of Productivity and Performance Management*, 64(1), 5–27. <https://doi.org/10.1108/IJPPM-01-2014-0001>
- Jääskeläinen, A., Tappura, S., & Pirhonen, J. (2020a). Maturity Analysis of Safety Performance Measurement. In T. Ahram, W. Karwowski, S. Pickl, & R. Taiar (Eds.), *Human Systems Engineering and Design II* (pp. 529–535). Springer International Publishing. [https://doi.org/10.1007/978-3-030-27928-8\\_80](https://doi.org/10.1007/978-3-030-27928-8_80)
- Jääskeläinen, A., Tappura, S., & Pirhonen, J. (2020b). Safety Performance Measurement Maturity in Finnish Industrial Companies. In P. M. Arezes, J. S. Baptista, M. P. Barroso, P. Carneiro, P. Cordeiro, N. Costa, R. B. Melo, A. S. Miguel, & G. Perestrelo (Eds.), *Occupational and Environmental Safety and Health II* (pp. 41–49). Springer International Publishing. [https://doi.org/10.1007/978-3-030-41486-3\\_5](https://doi.org/10.1007/978-3-030-41486-3_5)
- Jabonete, F. G. V., & Concepcion, L. R. (2016). Perceived safety culture of healthcare providers in hospitals in the Philippines. *J Sci Technol Arts Res*, 2, 1–14.
- Jespersen, L., Griffiths, M., Maclaurin, T., Chapman, B., & Wallace, C. A. (2016). Measurement of food safety culture using survey and maturity profiling tools. *Food Control*, 66, 174–182. <https://doi.org/10.1016/j.foodcont.2016.01.030>

- Kirk, S., Parker, D., Claridge, T., Esmail, A., & Marshall, M. (2007). Patient safety culture in primary care: Developing a theoretical framework for practical use. *BMJ Quality & Safety*, *16*(4), 313–320. <https://doi.org/10.1136/qshc.2006.018366>
- Law, M. P., Zimmerman, R., Baker, G. R., & Smith, T. (2010). Assessment of safety culture maturity in a hospital setting. *Healthcare Quarterly*, *13*(11), 110–115.
- Lee, T. (1998). Assessment of safety culture at a nuclear reprocessing plant. *Work & Stress*, *12*(3), 217–237. <https://doi.org/10.1080/02678379808256863>
- Lilić, N., Jääskeläinen, A., Cvjetić, A., & Tappura, S. (2020). Analiza merjenja performansi sistema bezbednosti i zdravlja na radu u rudarsko energetsom kompleksu (Analysis of occupational health and safety system performance measurement in mining and energy complex). *Tehnika*, *75*(6), 573–579. <https://doi.org/10.5937/tehnika2005573L>
- Maier, A. M., Eckert, C. M., & John Clarkson, P. (2006). Identifying requirements for communication support: A maturity grid-inspired approach. *Expert Systems with Applications*, *31*(4), 663–672. <https://doi.org/10.1016/j.eswa.2006.01.003>
- Maier, A. M., Moultrie, J., & Clarkson, P. J. (2012). Assessing Organizational Capabilities: Reviewing and Guiding the Development of Maturity Grids. *IEEE Transactions on Engineering Management*, *59*(1), 138–159. <https://doi.org/10.1109/TEM.2010.2077289>
- Molenaar, K. R., Park, J.-I., & Washington, S. (2009). Framework for Measuring Corporate Safety Culture and Its Impact on Construction Safety Performance. *Journal of Construction Engineering and Management*, *135*(6), 488–496. [https://doi.org/10.1061/\(ASCE\)0733-9364\(2009\)135:6\(488\)](https://doi.org/10.1061/(ASCE)0733-9364(2009)135:6(488))
- Parker, D., Lawrie, M., & Hudson, P. (2006). A framework for understanding the development of organisational safety culture. *Safety Science*, *44*(6), 551–562. <https://doi.org/10.1016/j.ssci.2005.10.004>
- Pirhonen, J., Tappura, S., & Jääskeläinen, A. (2022). Analysis of Safety Culture Maturity in Two Finnish Companies. In P. M. Arezes, J. S. Baptista, P. Carneiro, J. Castelo Branco, N. Costa, J. Duarte, J. C. Guedes, R. B. Melo, A. S. Miguel, & G. Perestrelo (Eds.), *Occupational and Environmental Safety and Health III* (pp. 53–61). Springer International Publishing. [https://doi.org/10.1007/978-3-030-89617-1\\_5](https://doi.org/10.1007/978-3-030-89617-1_5)
- Reiman, T., & Pietikäinen, E. (2010). *Indicators of safety culture—Selection and utilization of leading safety performance indicators* (No. SSM--2010-07). Swedish Radiation Safety Authority. <https://www.osti.gov/etdeweb/servlets/purl/979791>
- Saunders, L. W., Kleiner, B. M., McCoy, A. P., Ellis, K. P., Smith-Jackson, T., & Wernz, C. (2017). Developing an inter-organizational safety climate instrument for the construction industry. *Safety Science*, *98*, 17–24. <https://doi.org/10.1016/j.ssci.2017.04.003>
- Singh, V., & Verma, A. (2020). A review, simple meta-analysis and future directions of safety climate research in manufacturing organizations. *International Journal of Occupational Safety and Ergonomics*, *26*(4), 678–704. <https://doi.org/10.1080/10803548.2018.1476203>
- Stemm, E., Bofinger, C., Cliff, D., & Hassall, M. E. (2019). Examining the relationship between safety culture maturity and safety performance of the mining industry. *Safety Science*, *113*, 345–355. <https://doi.org/10.1016/j.ssci.2018.12.008>
- Tappin, D. C., Bentley, T. A., & Ashby, L. E. (2015). An implementation evaluation of a qualitative culture assessment tool. *Applied Ergonomics*, *47*, 84–92. <https://doi.org/10.1016/j.apergo.2014.08.012>
- van Aken, E. M., Letens, G., Coleman, G. D., Farris, J., & Van Goubergen, D. (2005). Assessing maturity and effectiveness of enterprise performance measurement systems. *International Journal of Productivity and Performance Management*, *54*(5/6), 400–418. <https://doi.org/10.1108/17410400510604557>
- van Aken, J. E. (2007). Design Science and Organization Development Interventions: Aligning Business and Humanistic Values. *The Journal of Applied Behavioral Science*, *43*(1), 67–88. <https://doi.org/10.1177/0021886306297761>

- Vinodkumar, M. N., & Bhasi, M. (2009). Safety climate factors and its relationship with accidents and personal attributes in the chemical industry. *Safety Science*, 47(5), 659–667. <https://doi.org/10.1016/j.ssci.2008.09.004>
- Vongvitayapirom, B., Sachakamol, P., Kropsu-Vehkapera, H., & Kess, P. (2013). Lessons Learned from Applying Safety Culture Maturity Model in Thailand. *International Journal of Synergy and Research*, 2(1–2). <https://doi.org/10.17951/ijrsr.2013.2.1-2.5>
- Wettstein, T., & Kueng, P. A. (2002). A maturity model for performance measure system. In C. Brebbia & P. Pascola (Eds.), *Management Information Systems: GIS and Remote Sensing* (pp. 113–122). WIT Press.