The Development of the Repository Safety Model Canvas as a Database to Improve Safety Culture Maturity (A Case Study of PT. Prima Alam Gemilang)

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Abstract

Creating a safe work environment is essential and a top priority. One indicator of the work environment assessment is to assess the safety culture applied by the company's management. A good safety culture will successfully prevent potential hazards in the workplace and vice versa. Therefore, this study aimed to develop the Repository Safety Model Canvas (Repository SMC) as a tool to improve safety culture maturity based on best practices in scientific articles about Occupational Health and Safety (OHS). Additionally, it aimed to measure safety culture based on seven dimensions of the safety model canvas (commitment, leadership, responsibility, competence, engagement & involvement, information & communication, and organizational learning). Furthermore, it validated the SMC repository using a case study of PT. Prima Alam Gemilang provided recommendations for improvements to companies implementing the SMC repository. Data was collected by distributing questionnaires based on random cluster sampling to 112 workers. The results of the assessment of the maturity level of safety culture in the observed company obtained a value of 3,428 in the calculative category. This study showed the sequence of safety culture improvement that needed to be addressed by company management, starting from the dimensions of competence (1), commitment (2), engagement & involvement (3), organizational learning (4), information & communication (5), responsibility (6), and leadership (7). The smaller the number in the priority flow, which indicated the level of the tendency, required to be addressed first. Meanwhile, the strategic recommendations for each stage in the SMC Repository were determined based on the needs and suitability of the company's circumstances.

Keywords
Safety Culture, Safety Culture Maturity, Safety Model Canvas (SMC), SMC Repository.

1. Introduction
The health and safety of the work environment often become determinant factors in assessing a company's success. No wonder various companies worldwide have high occupational health and safety regulations standards. It is directly proportional to the increasingly complex machine tools used at work, so special attention needs to be paid to prevent near-miss incidents. One indicator of the work environment assessment is to assess the safety culture applied by the company's management. A good safety culture will successfully prevent potential hazards in the workplace and vice versa. If the workplace safety culture is bad, there is a high possibility of potential accidents at work.

Based on the International Labor Organization (ILO) data, 2.78 million people worldwide die every year due to work-related accidents. Meanwhile, in Indonesia, the Central Bureau of Statistics (BPS) recorded 109,215 work-related accidents and material losses, amounting to 213,866 million rupiahs in 2018. The increase in the number of work accidents was due to the lack of application of a safety culture in the work environment and the company's inconsistency in managing the occupational safety and health management system. Therefore, with a company that accommodates workers, it is necessary to pay attention to safety aspects to protect human resources. Workers are an important asset for companies that act as a driving force to achieve goals.

According to Foster & Hoult (2013), the safety culture maturity level parameter consists of five stages: basic, reactive, planned, proactive, and resilient. A method or tool that can assist in mapping the condition of safety culture

maturity flexibly to changes in the impact of safety problems is required to reach the highest level, namely the generative stage.

The Safety Model Canvas (SMC) is a new model developed to arrange recommendations for safety improvements in the practice of an organization (Sudiarno et al., 2021). Measurements on the SMC consist of Seven Building Blocks, namely the dimensions of organizational learning, the dimensions of commitment, the dimensions of leadership, the dimensions of responsibility, the dimensions of engagement & involvement, the dimensions of information & communication, and the dimensions of competence. SMC works begin with measuring the maturity level of an organization's safety culture. Then, the assessment results are developed to build the SMC line of thinking. In the safety model canvas, the seven measurement dimensions are divided into three stages: input, process, and output. At the initial stage, the perception of risk is an input. The next stage of the process explains how to enforce, improve, and accelerate the implementation of occupational health and safety. Furthermore, the last is the output stage, where risk can be controlled as the final result of the canvassing process. Previously, research related to the safety model canvas had been carried out by several previous researchers, such as those conducted by Imanuddin (2019) and Astika (2020). Broadly speaking, both research used the SMC modeling framework to assess a company's safety culture. However, there has been no implementation of a repository-based SMC model in previous research. Therefore, this research background was to develop a repository integrated with the SMC mapping framework. It became more practical and easier for management to obtain suggestions for safety improvements.

In general, the development of the SMC Repository has a basic concept similar to the Triz Repository, namely solving problems based on data and logic. The SMC Repository Scheme began with collecting best practice data contained in previous research related to the company's key to success in managing workplace safety culture. Then, the data was packaged into a solution in the form of an SMC mapping framework based on seven priority sequences of safety culture dimensions. The results of the development of the SMC Repository would then be tested on one of the companies, i.e., PT. Prima Alam Gemilang. This kind of research was significant because it could provide education for industry players regarding the condition of the company's safety culture and how to overcome these problems.

2. Literature Review

The safety culture maturity level parameter can be reviewed based on five stages: pathological, reactive, calculative, proactive, and generative (Foster & Hoult, 2013). The pathological stage explains the company's indifference to managing workplace safety culture. The reactive stage explains the concern that arises every time an accident occurs. The calculative stage describes the formation of a system to treat each hazard in the workplace. The proactive stage explains the role of leadership, and the value of safety encourages continuous improvement. Furthermore, the generative stage explains the safety culture that has been embedded in the company's organization as a whole.

Safety culture maturity is an assessment pattern used to assess the level of understanding of safety culture at every organizational level in the company. The safety culture maturity assessment refers to five stages that have been previously designed by Foster & Hoult (2013). The assessment can develop a safety culture, especially in companies with a high level of work risk. According to Hudson (2007), safety culture maturity has long been applied in various industries, including construction, oil & gas, aviation, and health. It is possible because safety culture maturity is a practical tool for identifying strengths and weaknesses in the company's safety management system.

3. Method

3.1 Research Design

The research design consisted of four stages. The first stage was a scoping review by collecting key success stories from various best practices in Occupational Health and Safety scientific articles, which will later be used to develop the SMC Repository. The second stage was distributing questionnaires to employees of PT. Prima Alam Gemilang, with the cluster random sampling technique. This research took samples from several sampling units that were groups of elements (Singh & Masuku, 2014). The third stage was processing questionnaire data with SPSS and Triangular Fuzzy Number (TFN) applications to assess the maturity of the company's safety culture. The fourth stage determined the flow of safety culture improvement and strategy for each stage using the SMC repository.

3.2 Questionnaire Design

The questionnaire design consisted of 70 question items resulting from the development of the seven dimensions of SMC. In addition, the questionnaire items were based on a likert scale which had an ordinal form of data. The score from the statement of each indicator contained the maturity of the safety culture, which was mapped into a score at each level of safety culture maturity.

3.3 Determination of the Respondents

The research respondents consisted of PT. Prima Alam Gemilang employees worked in the division or department directly related to the raw material processing system and machine maintenance area. The selection of the five work units was based on the high potential for hazards in the work area. The five work units in question were the Process House, Mill House, Power Plant, Warehouse, and Machine Shop & Maintenance departments. Meanwhile, the number of samples determined used the Slovin equation with an error of 9% to obtain 115 respondent sample data.

3.4 The Determination of the *Safety Culture Maturity* Value

This research applied a safety culture maturity assessment using a Triangular Fuzzy Number (TFN). The steps used were as follows.

a. Calculating the average TFN

$$\text{TFN}\,(\text{TFN}_l, \text{TFN}_m, \text{TFN}_r) = \frac{\begin{array}{c}((1,1,2) \times \text{Frequency } 1)) + ((1,2,3) \times \text{Frequency } 2)) \\ + ((2,3,4) \times \text{Frequency } 3)) + ((3,4,5) \times \text{Frequency } 4)) \\ + ((4,5,5) \times \text{Frequency } 5))\end{array}}{\text{Number of Frequency}} \quad (1)$$

b. Determining the fuzzy weight on each TFN boundary

$$\tilde{w} = \text{TFN}\,(l, m, r) \times 10 \quad (2)$$

c. Calculating the value of Middle of Maxima (MOM) and normalization

$$y^* = \frac{mi + Mi}{2} \quad (3)$$

$$Ni = \frac{\text{MOMi}}{\sum_{i-1}^{n} \text{MOMi}} \quad (4)$$

d. Determining the maturity level scale

4. Results and Discussion

4.1 Scoping Review of Occupational Health and Safety Scientific Articles

The basic component of forming an SMC Repository was to do a scoping review. Scoping review is a series of processes to identify detailed literature obtained from various reliable sources (Levac et al., 2010). The literature consisted of a collection of best practice Occupational Health and Safety scientific articles covering experiences and success stories of various industries in improving safety culture in the workplace. The data summary was then compiled and used as an alternative solution for companies that want to increase the safety culture maturity level.

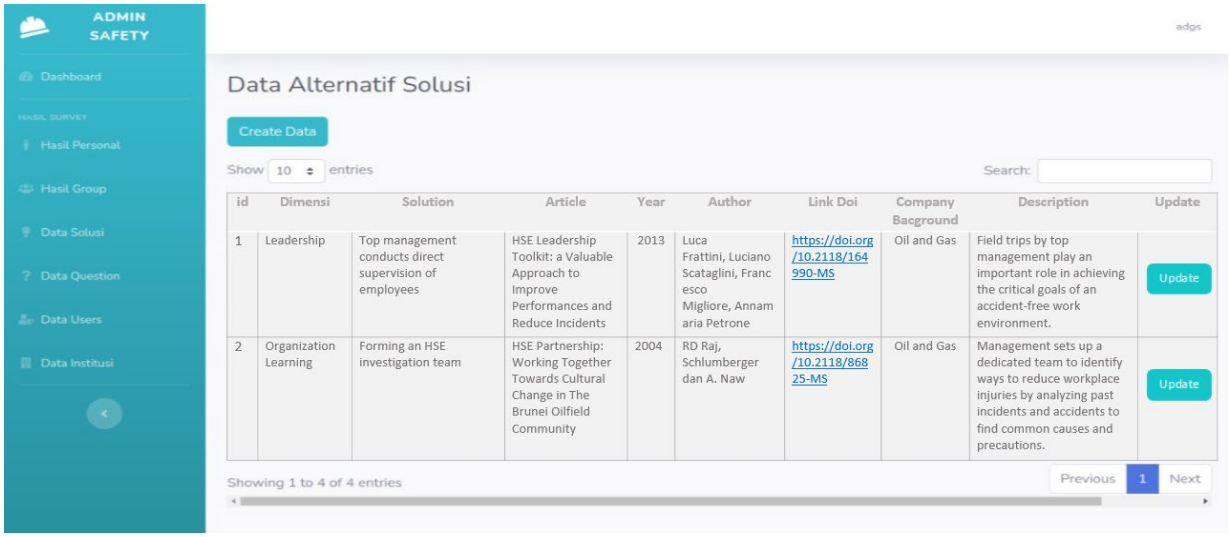

Figure 1. Scoping Review of Occupational Health and Safety Scientific Articles

4.2 Respondents' Characteristics

Based on the results of the distributed questionnaires, data on the respondents' characteristics have been obtained. The following was data on the respondents' characteristics according to age, work experience, and education level.

Table 1. Respondents' Characteristics

No	Category	Total	Percentage
1.	Age (>30 years)	16 respondents	16%
	Age (<30 years)	96 respondents	86%
2.	Work Experience (<4 years)	79 respondents	71%
	Work Experience (>4 years)	33 respondents	29%
3.	Education (Bachelor)	46 respondents	41%
	Education (Diploma)	31 respondents	28%
	Education (Senior High School)	28 respondents	25%
	Education (Junior High School)	7 respondents	6%

Table 1 for the first category showed that 16 respondents or 14% were more than 30 years old. Meanwhile, 96 respondents, or 86%, were less than 30 years old. Furthermore, in the second category, namely, work experience, it can be seen that 79 respondents, or 71%, have worked for less than four years. Meanwhile, 33 other respondents, or 29%, have worked more than four years at PT. PAG. Moreover, in the last category, namely education, the undergraduate education level was the highest percentage, with respondents as many as 46 or 41%. Furthermore, there were 31 respondents, or 28% at the diploma level, followed by high school education with a total of 28 respondents or 25%. Meanwhile, the smallest level of education was the junior high school level, with seven respondents or 6%. Based on the results of research observations, it could be concluded that PT. Prima Alam Gemilang recruited more workers with undergraduate education because of the need for positions in operational work.

4.3 *Safety Culture Maturity* Assessment

A safety culture maturity assessment was needed to determine the level of safety culture at PT. PAG uses five basic, reactive, calculative, proactive, and resilient parameters. It could facilitate research in determining the current situation and the steps to be taken. The data recapitulation of the maturity level of safety culture in five work departments or divisions is as follows.

Table 2. Recapitulation of Safety Culture Maturity Levels Using TFN

No	Dimensi SMC	TFNl	TFNm	TFNr	MOM	*Maturity Level*
1	*Commitment*	2,416	3,412	4,307	3,378333333	3,378333333
2	*Leadership*	2,573	3,569	4,429	3,523666667	3,523666667
3	*Responsibility*	2,495	3,494	4,397	3,462	3,462
4	*Engagement and Involvement*	2,428	3,425	4,35	3,401	3,401
5	*Competence*	2,376	3,367	4,31	3,351	3,351
6	*Information and Communication*	2,492	3,479	4,373	3,448	3,448
7	*Organizational Learning*	2,459	3,459	4,372	3,43	3,43
Safety Culture Maturity		**2,462714**	**3,457857**	**4,362571**		**3,4277143**

Based on Table 2, the assessment of safety culture maturity at PT. Prima Alam Gemilang obtained the value of the maturity level of safety culture with the middle of maxima approach from the calculation of the fuzzy value was 3,428. The value was included in the calculative category. This condition stated that the company's management had demonstrated an operational OHS management system. Every dimension involved was aware of the implemented OHS management system and participated in its implementation. However, there were significant differences in perceptions, behavior patterns, and commitments related to OHS at each dimension level. Therefore, increasing the safety culture's maturity level was necessary to have a flow of improvement and a strategy for each stage obtained from the SMC Repository.

4.4 The Flow of Improvement Safety Culture

After the maturity level values for each SMC dimension are known, the next step is to interpret the data into the SMC Repository system. The repository safety model canvas was a new model developed to develop recommendations for safety improvements in the practice of an organization that could offset the changing impact of safety culture issues. In the SMC Repository system, there were main menu options that the user could use. One of them was the SMC roadmap needed to determine the safety culture improvement flow.

The SMC roadmap would display a template of seven building blocks: organization learning, commitment, leadership, competence, responsibility, engagement & involvement, and information & communication. Furthermore, the seven building blocks had some similar basic properties. These properties were divided into three main parts: primary key, enhancer, and catalyst. The primary key block described the dimensions as the main key in enforcing OHS discipline. The dimensions included in the primary key were the dimensions of organization learning, commitment, and leadership. Meanwhile, the enhancer block described indicators that could improve the implementation of Occupational Health and Safety. The dimensions that were classified as enhancers were the dimensions of competence, responsibility, and engagement & involvement. Lastly, the catalyst block described indicators that could accelerate the improvement of OHS implementation. The dimensions included in the catalyst were information & communication. The flow of safety culture improvement in the SMC Repository can be seen in Figure 2 below.

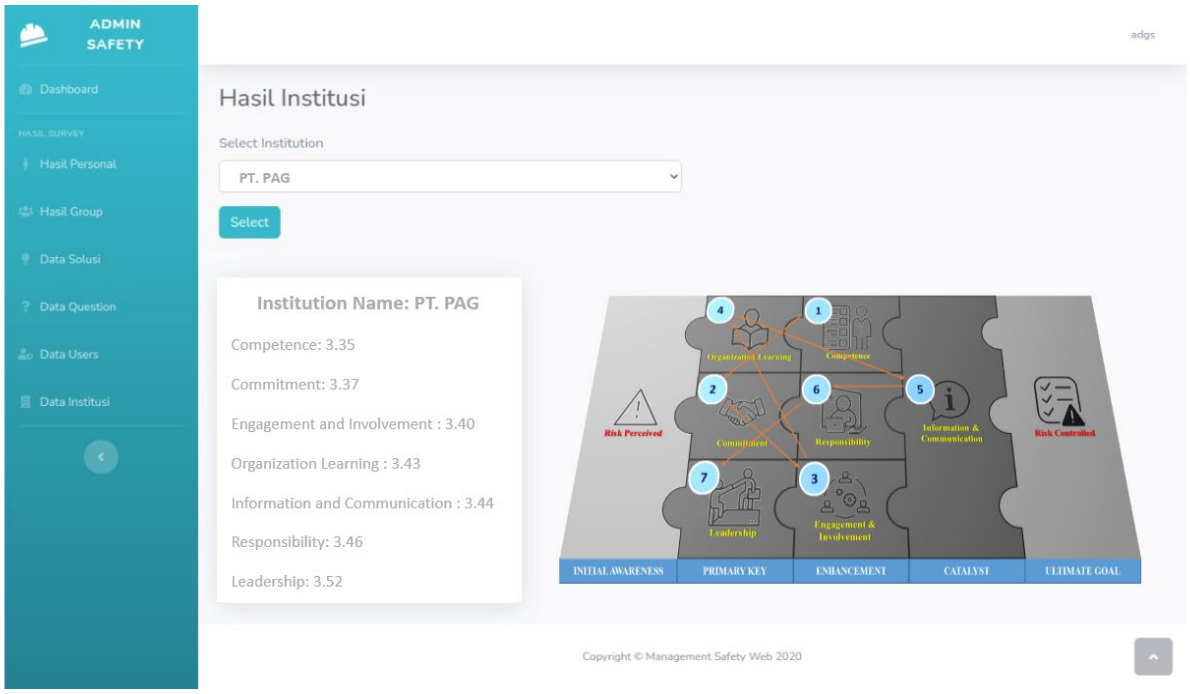

Figure 2. The flow of Improvement Safety Culture

In Figure 2, red arrows show the priority flow required to be addressed by the company's management. The smaller the number on the SMC roadmap indicated the tendency level to be addressed first. Thus, the flow of improvement of the SMC dimension could be started from the competence dimension because it obtained the lowest maturity level value, which was 3.35. It was followed by the commitment dimension with a maturity level of 3.37. Furthermore, the engagement & involvement dimension with a maturity level value was 3.40, the organization learning dimension with the maturity level value was 3.43, and the information & communication dimension with a maturity level value was 3.44. Besides, the responsibility dimension with a maturity level value was 3.46, and the leadership dimension with the highest maturity level value was 3.52.

4.5 Health and Safety Recommendations

Every company has a variety of problems and different ways of handling them. Therefore, with the development of the SMC Repository, every company can obtain recommended solutions according to the company's needs to improve the atmosphere of a safety culture.

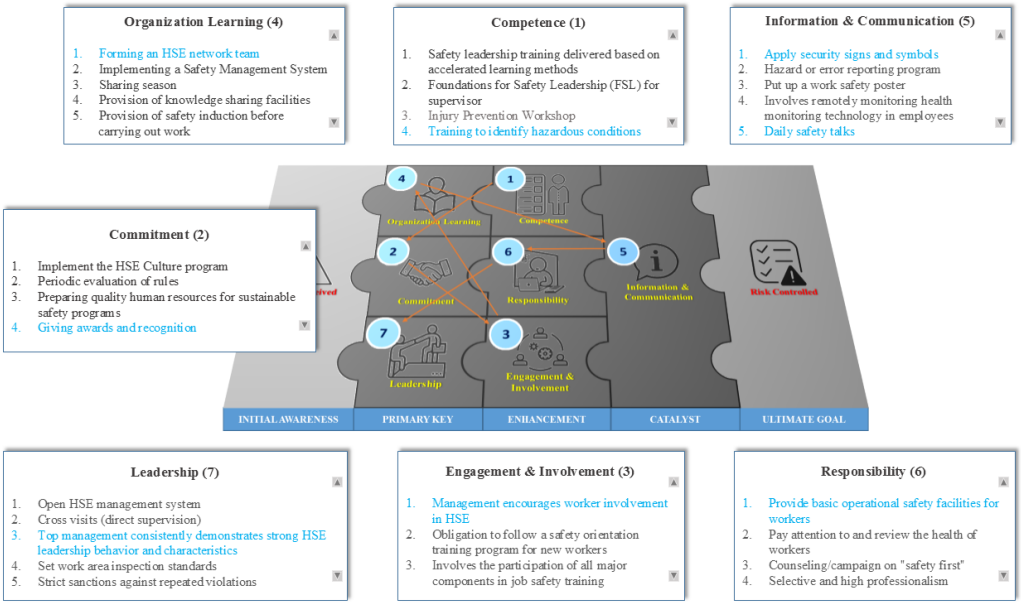

Figure 3. Data Solution Repository SMC

Figure 3 shows the seven-dimensional blocks of SMC and a list of solutions that can be chosen to be implemented by enterprise management. The various solution options were derived from a collection of scoping review results in Occupational Health and Safety scientific articles. The next step was to select a data solution by marking the blue text as a recommendation for the chosen solution to be implemented by PT. PAG management was based on the company's needs and input from HSE assistant managers during the survey.

The first aspect that needs to be strengthened is competence. It can be enhanced through training in identifying hazards in the workplace. According to Wang et al. (2012), hazard identification training is not only carried out when new employees enter the factory but must be continuous throughout their careers regardless of age and position. The second aspect that needs to be improved based on the results of the SMC Repository is commitment. According to Lyon (2004), this aspect can be strengthened by giving awards and recognition. With the rewarding system, members who get rewards are shown their achievements in all divisional units so that they can motivate themselves and trigger other members to compete in creating a safe work environment. The third aspect is engagement & involvement. According to Mataqi & Adivi (2010), this aspect can be improved by involving workers in HSE. Regularly scheduled meetings at all levels of the organization allow for increased two-way dialogue on HSE issues.

The fourth priority based on the results of the SMC Repository is organizational learning. According to Raj & Nawi (2004), this dimension can be strengthened by forming an HSE network team. This special team is tasked with digging up information and analyzing past accident incidents to obtain information on the causes and preventive actions that should be implemented. The fifth aspect that needs to be strengthened is information & communication. According to Nkwocha & Ekeke (2018), this aspect can be improved by providing safety signs and symbols in the work area. These safety symbols and signs are placed in several work areas to inform certain places that are considered unsafe.

In addition, according to Kosmoski (2014), information & communication needs to be improved by conducting daily discussions with Occupational Health and Safety before the work shift begins. Furthermore, the sixth priority aspect was responsibility. According to Krujalo & Hasanguluyev (2019), this aspect can be strengthened by providing safe facilities for workers. The safety facilities in question include safety shoes, welding goggles, masks, helmets, and other safety equipment tailored to each type of work. The last priority aspect of the SMC Repository results is leadership. According to Breitsprecher et al. (2012), this aspect can be improved by utilizing the role of top

management by demonstrating strong and consistent HSE leadership behaviors and characteristics. Provide real examples of positive habits related to work safety aspects that should be applied in daily life.

4.6 Limitations

Filling out questionnaires to employees was still done manually. It was because the SMC Repository was still in the refinement stage. Hopefully, in the future, regulations for filling out questionnaires could be done online through a questionnaire link that was integrated directly into the repository system so that the final results obtained were more accurate and used time more efficiently.

5.0 Conclusion

Combining two different components, namely the Repository and the Safety Model Canvas (SMC) method, was the latest combination in occupational safety and health. With the existence of the SMC Repository, hopefully, it can become a tool to increase the safety culture maturity in every company in Indonesia. The test results of the safety culture maturity assessment at PT. Priama Alam Gemilang obtained a maturity level value of 3,428. Furthermore, it was included in the calculative category. The order of priority aspects that need to be improved could be started from the dimensions of competence (1), commitment (2), engagement & involvement (3), organizational learning (4), information & communication (5), responsibility (6), and leadership (7). Meanwhile, the recommended solution in Figure 3 was a strategy that the company could apply to increase the safety culture's maturity level.

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