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The Overview of Safety Culture in Manufacturing Industry: A Systematic Literature Review

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Abstract

Safety Culture refers to the attitudes, norms, and beliefs in the progress of an Industry. Manufacturing is no exception, as the third largest sector in employment and has consistently been the largest contributor to Indonesia's economic growth. So far, there have been no studies discussing the description of safety culture in the manufacturing sector. This study aims to look at the variables and critical points of safety culture in manufacturing. The method used in this research is Preferred Reporting Items for Systematic Reviews & Meta-Analysis (PRISMA). The search was based on two data-driven journals: Scopus and Web of Science. From the search results, 10 literatures could be systematically analyzed. There were 7 articles that were cross sectional studies and 3 articles that were experimental studies by providing interventions to participants. Most of the safety culture indicators identified in this literature review were management commitment, safety leadership, safety representative commitment, employee participation or involvement, individual responsibility, and safety communications.

Key words: Safety Culture, Manufacture, Safety Culture in Manufacture

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Introduction

The manufacturing industry plays an important role in the progress of a country. This is because the manufacturing industry is still the main driver of the national economy. Based on data obtained from the Ministry of Industry (2023), the manufacturing sector is the third largest sector in terms of labor absorption and has consistently been the largest contributor to Indonesia's economic growth, namely 5.17%.

Even though the manufacturing industry has been the largest contributor to economic growth, this industry has the highest number of work accidents compared to other industries (DOSH, 2020). This is supported by data on cases of work accidents and occupational diseases obtained from the Ministry of Manpower, that in Indonesia itself the manufacturing business sector (various industries) is the largest percentage contributor, namely 22.3% compared to other business sectors in the period 2019 to 2021. Therefore, occupational health and safety is an important aspect to be implemented in every industry which aims to ensure worker welfare.

Cultivating a positive safety culture is important in preventing workplace accidents (Zakaria et al., 2019). In recent times, attention to safety culture issues has increased. This is due to researchers' findings which show that safety culture is related to the frequency of accidents. Apart from that, it was also found that many accidents were caused by poor safety culture (Lin et al., 2017). Organizational accidents have been linked to poor safety culture (CAIB, 2003; IAEA, 1992; Vaughan, 1996 in Nordlöf et al, 2014). Therefore, by understanding the safety culture in an organization, the relationship between accident-related factors and worker perceptions can be better understood (Akyuz et al., 2018).

One of the most significant findings that caused this disaster was due to errors and violations of operating procedures and the fact that the organization had a poor safety culture (Zakaria et al., 2019). Safety culture generally refers to organizational schemes developed for handling errors and risk management (Choundry et al., 2007). Meanwhile, according to Hale (2000), safety culture refers to the attitudes, beliefs and perceptions held by a group that define norms and values, which in turn will determine the way people act and react to risks and risk management (Petitta et al., 2016).

Based on research by Nordlöf et al, (2014) workers revealed that they face ongoing challenges and debates in achieving a balance between productivity and safety in the workplace. These results are also in line with the view that safety culture including knowledge, involvement and training has a significant impact on production and operational management in production and operational management (Longoni et al., 2014; Mellat-Parast, 2013 in Hald, 2019). Safety culture is an important aspect in the manufacturing sector.

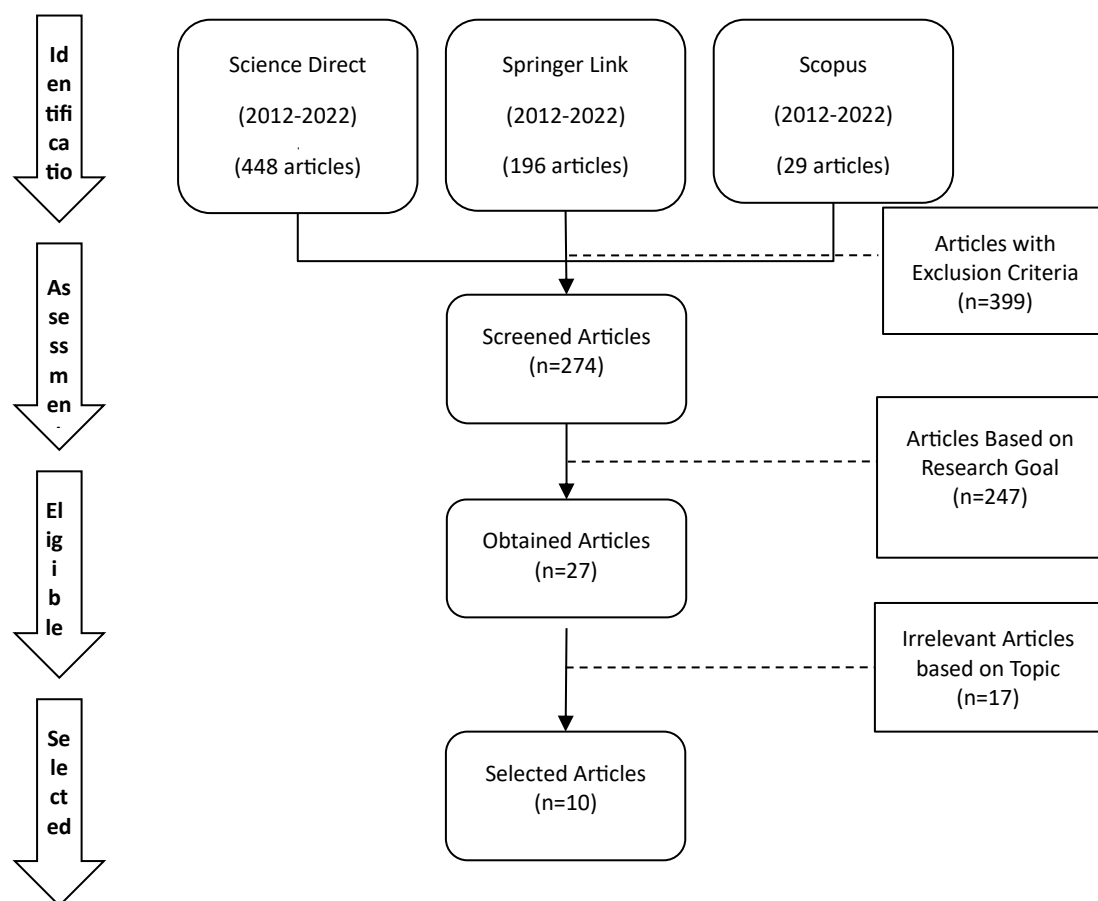
Several safety culture literature studies conducted in other industries explain that management commitment and communication at work are the most important factors in building an industry's safety culture (Duarte et al., 2019; Ismail et al., 2021)

So far, there has been no research that has identified the factors of safety culture in manufacturing as well as the main factors that shape safety culture in the manufacturing industry. As the sector with the third largest absorption with challenges in the manufacturing industry in establishing a safety culture. Researchers want to conduct a literature review to look at the factors that shape safety culture in the manufacturing industry.

Materials and Methods

This study is a Systematic Literature Review which focuses on exploring safety culture in the manufacturing industrial sector. The method used in this study is Preferred Reporting Items for Systematic Reviews & Meta-Analysis (PRISMA). The selected articles used by researchers in this study had inclusion criteria, namely research articles, publication year range 2012-2022, journal impact quartile Q1-Q3, and in English.

Data collection techniques were carried out by reviewing studies that were included in the inclusion criteria. The study search was carried out using the keywords "Safety Culture" AND "Safety Climate" AND "Manufacturing" via Science Direct, Scopus, and Springer Link. Using the PRISMA method, researchers have found a total of 673 related articles.



Results and Discussion

From the results of the study, there were 10 selected pieces of literature obtained from several literatures regarding safety culture in the manufacturing sector in various countries such as Italy, Sweden, New Zealand, Denmark, Iran, Canada and Taiwan. There are 7 articles which are cross sectional studies, and 3 articles are experimental studies providing interventions to participants.

The types of research from the articles reviewed include quantitative (n=5), qualitative (n=3), and mixed-method (n=2) research. In quantitative research, data collection is carried out through questionnaires with a Likert scale to find the safety culture score of an organization. For qualitative research, safety observations and interviews were conducted to explore each participant's perception of the safety culture of an organization. Most instruments used are self-construct instruments which were created based on literature reviews from various literature and previous research. Therefore, it was found that the safety culture indicators for each article varied greatly.

Table 1. Relevant Research Summary

No.	Researcher Name and Research Year	Title of Research	Research Variables	Summary
1	Laura Petitta, Tahira M. Probst, Claudio Barbaranelli, Valerio Ghezzi, 2016.	Disentangling the roles of safety climate and safety culture: Multi-level effects on the relationship between supervisor enforcement and safety compliance.	The five cultural dimensions in the safety context are leadership styles including autocratic, bureaucratic, clan-patronage, technocratic, and cooperative.	The research results show a complex relationship between organizational safety culture and safety climate, indicating that organizations with a safety culture are more likely to develop a more positive safety climate. In addition, worker compliance with safety is also a function of the safety supervisor's leadership.
2	Hasse Nordlöf, Birgitta	A cross-sectional study of factors	Company size, safety rules, risk	Safety culture has a significant influence on OHSM practices in a

	Witavaara, Hans Högberg, Ragnar Westerling, 2017.	influencing occupational health and safety management practices in companies.	acceptance, management commitment, productivity pressure, worker involvement, individual responsibility, incident reporting, no fatalism, no blame, feedback from colleagues, safety training, communication, and continuous improvement.	company. This research provides support for the idea that safety culture is indeed a construct that can be measured and influences occupational health and safety management in organizations.
3	Hasse Nordlöf, Birgitta Witavaara, Ulrika Winblad, Katarina Wijk, Ragnar Westerling, 2014.	Safety culture and reasons for risk-taking at a large steel-manufacturing company: Investigating the worker perspective.	Acceptance of risk (tolerance for danger, fatalistic beliefs), individual responsibility for safety (reliance on the individual, low company commitment), trade-off between productivity and safety (management expectations, worker expectations, practical barriers), importance of communication (thinking about safety, collaboration between co-workers, incident reporting), today's conditions and external conditions (new people at work, fatigue, indifference, routine, small number of staff, high speed).	Risk acceptance: workers feel that risks in their work environment must be accepted by making the best of the existing situation. Individual responsibility for safety: workers recognize that safety performance in the workplace is an individual responsibility. Trade-off between productivity and safety: workers report that there is always a trade-off between productivity and safety, they say that these two things conflict with each other. The importance of communication: workers feel that communication is very important for work safety. Today's conditions and external conditions: workers say that the interaction between these factors influences risk taking.
4	Pete Kines, Dorte Andersen, Lars Peter Andersen, Kent Nielsen, Louise Pedersen, 2012	Improving safety in small enterprises through an integrated safety management intervention.	Safety participation, organizational affective commitment, trust, safety leadership, safety knowledge, safety involvement, attitude towards safety regulations, safety representative	Implementation of the proposed integrated safety management system is a challenge for small companies and needs to be adapted to their more informal and often resource-limited safety culture. This study helps fill the gap in the need for systematic implementation and evaluation of injury prevention and safety management systems targeted at small businesses. Considering that more than 95% of companies in most countries have less than 20 workers, there is

			commitment	great potential in implementing the proposed approach in certain industries.
5	K.J. Nielsen, P. Kines, L.M. Pedersen, L.P. Andersen, D.R. Andersen, 2013.	A multi-case study of the implementation of an integrated approach to safety in small enterprises.	Safety leadership, safety knowledge, safety involvement, safety behavior, commitment of safety representatives, effectiveness of commitment, trust, safety participation.	There have been significant improvements in all aspects of safety culture in metals companies. Apart from that, there has been an increase in the aspect of "safety representative commitment" in wood control companies. However, there is a decline in the aspects of "safety leadership" and "safety knowledge" in metal handling companies. Based on the results of interviews, this is due to differences in management's commitment to processes in the company, as well as a lack of trust and mutual perception between workers and superiors.
6	Morteza Haghighi, Mohammad Hossein Taghdisi, Haidar Nadrian, Hamed Rezakhani Moghaddam, Hassan Mahmoodi, Iraj Alimohammadi, 2016.	Safety Culture Promotion Intervention Program (SCPIP) in an oil refinery factory: An integrated application of Geller and Health Belief Models.	Perceived vulnerability, perceived severity, perceived benefits, perceived barriers.	Health Belief Models (HBM) scores increased significantly in the experimental group after participating in the safety culture education program intervention compared to the control group. Before the intervention, there were no significant differences between the two groups based on the total scores of cognitive factors and HBM constructs. In the control group, the only significant difference in HBM constructs before and after the intervention was found in respondents' perceived vulnerability. This finding may be due to the sensitivity created among respondents in the control group by asking pre-test questions regarding their vulnerability to unsafe behavior in the work environment. The control group after a certain period of time was given the opportunity to think about these issues and found themselves more susceptible to unsafe behavior in the work environment.
7	Małgorzata Peçiłło, 2015.	Results of Implementing Programmes for Modifying Unsafe Behaviour in Polish Companies.	Physical well-being, psychosocial well-being, need for change in the workplace, commitment and participation, K3 training and accident analysis, core values, relationships between workers and a sense of community company	Implementation of the Safety Culture Promotion Intervention Program (SCPIP) has an impact on improving safety culture and worker welfare, as well as reducing cases of unsafe behavior throughout the company. There was a slight decrease or stabilization in the number of identified causes of unsafe behavior. Workers involved in programs to change unsafe behavior gave the highest scores to awareness of their own risks as an element of safety culture, as well as a sense of responsibility for their own safety and that of other workers. However, their

			ownership (sense of belonging), responsibility and awareness, safe behavior.	knowledge in this regard has not been verified in practice. There is no correlation between training and the sense of responsibility and awareness of workers in any company.
8	Hassan Iqbal, Bushra Waheed, Husnain Haider, Solomon Tesfamariam, Rehan Sadiq, 2019.	Mapping safety culture attributes with integrity management program to achieve assessment goals: A framework for oil and gas pipelines industry.	Management commitment, employee development, communication, organizational environment, safety leadership commitment, vigilance, empowerment and accountability, resilience.	A safety culture maturity assessment was conducted at 17 O&G pipeline companies operating in British Columbia (Canada) by establishing a logical relationship between Integrity Management Program (IMP) components and their contribution to the level of safety culture maturity. This framework is expanded so that managers can plan corrective actions based on severity, which can effectively improve underperformance of IMP components and improve safety culture attributes. The severity depends on several influencing factors, such as asset type, condition, demographic location, product type, etc. The results of the sensitivity analysis showed that the IMP components classified in the 'high significance' group had a greater impact on the safety culture attributes, namely 'leadership role and commitment', 'vigilance', 'empowerment and accountability', and 'resilience'.
9	Niresh Behari, 2019	Assessing process safety culture maturity for specialty gas operations: A case study.	Competency and training, human factors and risk assessment, incident reporting and investigation, procedures, alarm handling, maintenance, safe behavior, safety communication, control room design & interfaces, workload, change management, process safety management, supervision, and leadership.	There are four process safety culture frameworks presented along with process safety performance indicators in this study, which relate to the results of Human Factors Checklist interviews and surveys, severity of hydrocarbon leak incidents, leadership behavior with organizational entropy, and process safety audits. Performance indices are assessed against each framework to identify current and future states of maturity. Some critical success factors that can accelerate process safety maturity are organizational learning and continuous improvement supported by interdependent team leadership behavior. The maturity scale descends with several factors measured as a function of management commitment, leadership behavior, and human factors assessment.
10	Shu-Chiang Lin , Ilma Mufidah, Satria Fadil Persada, 2017	Safety-Culture Exploration in Taiwan's Metal Industries: Identifying the Workers' Background Influence on Safety Climate.	Workers' perceptions of safety, safety communication, and safety management systems.	This research reveals that job position influences safety culture significantly on three factors: safety perception, safety communication and safety management system. It was found in this research that safety culture decreases as the position increases. In this study, executives and frontline workers had similar years of employment in the industry, indicating

				that different levels of safety culture were related to job responsibilities, with top positions bearing the greatest safety culture responsibilities.
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Table 2. Factor Summary Regarding Safety Culture

No.	Factor	Articles										Total Number of Article	
		1	2	3	4	5	6	7	8	9	10		
1.	Safety Leadership	✓			✓	✓					✓		4
2.	Safety Rules	✓			✓								2
3.	Safety Procedures		✓								✓		2
4.	Management Commitment		✓	✓	✓	✓		✓	✓	✓	✓		8
5.	Safety Representative Commitment				✓	✓		✓	✓				4
6.	Employee Participation or Involvement		✓		✓	✓		✓					4
7.	Promotion and Intervention						✓	✓					2
8.	Worker Obedience	✓											1
9.	Individual Responsibility		✓				✓	✓		✓			4
10.	Incident Reporting		✓							✓			2
11.	Safety Competency and Training		✓					✓		✓			3
12.	Safety Communications		✓						✓		✓		4
13.	Trust				✓	✓							2
14.	Safety Knowledge				✓	✓							2
15.	Job Position										✓		1

This study aims to look at various aspects of safety culture that influence the manufacturing industry. Based on the results of research conducted by several researchers around the world, it was found that there are various aspects that influence safety culture in the manufacturing sector.

Based on research conducted by Petitta et al (2016), it was found that a good safety culture indicates that the organization is developing a more positive safety climate. This research also suggests that safety culture has implications for leadership which will influence worker compliance with safety regulations (Petitta et al., 2016).

Furthermore, a study conducted by Nordlöf et al (2017) in one of the manufacturing company supports that safety culture influences the implementation of occupational safety and health management in an organization, which includes aspects of safety rules and procedures, management commitment, worker participation, individual responsibility, incident reporting, safety training, safety communication, and implementing continuous improvement.

Research conducted in one of the steel manufacturing industries also shows that management commitment plays an important role in encouraging worker behavior and attitudes towards safety in forming a positive organizational safety culture (Nordlöf et al., 2014). Worker

participation in safety, affective organizational commitment, trust, safety leadership, safety knowledge, safety involvement, attitudes towards safety regulations and safety representative commitment also contribute to improving safety culture in a company (Kines et al., 2012).

Nielsen et al (2013) conducted research comparing safety culture in metal companies and wood producing companies. This research provided intervention in the two companies by providing safety coaching and safety workshops and obtained the results that there was a significant increase in all aspects of safety culture in metal companies., as well as increasing the safety culture aspects of safety representative commitment in wood producing companies. However, there is a decline in safety culture in the aspects of leadership and knowledge about safety in metal companies. Based on the results of interviews conducted, this is due to differences in management commitment, as well as a lack of trust and mutual understanding between workers and superiors in supporting a positive safety culture.

There was also research conducted by Haghghi et al (2016) in one of the oil refinery factories to see the impact of a safety culture promotion and intervention program on the status of safety culture among oil refinery factory workers in Tehran, by implementing integration Geller model and Health Belief Models (HBM). The results obtained in this study showed that the Health Belief Models (HBM) score increased significantly in the experimental group after participating in the safety culture education program intervention compared to the control group. In addition, it was found that the only significant difference before and after the intervention was found in the respondents' perceived vulnerability. So, what can be concluded from this research is that workers who are not exposed to safety culture program interventions find themselves more vulnerable to unsafe behavior in the work environment. This is also supported by previous research conducted by Peçiĥo (2015), which also saw the impact of safety culture promotion and intervention programs on improving safety culture and worker welfare, as well as reducing cases of unsafe behavior throughout the company.

Iqbal et al (2019) conducted research and found that without good safety culture aspects such as management commitment, worker development, communication, organizational environment, safety leadership commitment, vigilance, empowerment and accountability, the resilience of the safety management system will not be efficient.

Research conducted by Behari (2019) measured the maturity level of safety culture in the gas processing sector. It was found that the critical factors for this success are organizational learning and continuous improvement supported by interdependent leadership behavior, management commitment, leadership behavior, and human factors assessment. Other aspects of safety culture were also found in research conducted by Lin et al (2017), where job position also influenced safety culture. The results of this research are in line with other research where top management commitment plays an important role in implementing a positive safety culture in an organization.

Aspects of safety culture in the manufacturing industrial sector are a trade-off between productivity and safety or an exchange between productivity and safety (Nordlöf et al., 2014), which means that safety culture plays an important role in achieving a balance between productivity or operational efficiency while maintaining high safety standards in the process.

Conclusion

From the results of the literature analysis, it can be concluded that the management commitment variable is the main thing that is mostly found in shaping a sustainable safety culture in the manufacturing industry. However, it is equally crucial that safety leadership, safety representative commitment, employee participation, individual responsibility, and safety communications also play a role in safety culture. This is the fact that it will be difficult for workers to be in the right side of safety if there is no direct example from management with good safety leadership and communication in enforcing safety regulations in the manufacturing industry.

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