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Review Paper

Impact of safety climate in manufacturing industries - A Review

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ABSTRACT

Introduction: This review explores the pivotal role of a strong safety climate in mitigating such risks, promoting proactive safety behaviors, and ultimately enhancing safety performance and productivity in the manufacturing sector.

Methods: The literature review targeted high-quality studies published between 2014 and 2024. Multiple databases, including Google Scholar, Science Direct, Research Gate, and SID, were meticulously searched using keywords such as "safety climate," "safety culture," "occupational safety," and "manufacturing industry." Strict inclusion criteria were applied to filter out duplicate and irrelevant studies, ensuring a comprehensive analysis of empirical evidence and practical interventions affecting manufacturing safety climates.

Results: The analysis reveals a consistent and significant relationship between a robust safety climate and improved workplace outcomes. Effective leadership, comprehensive safety training programs, clear and open communication, and active employee engagement emerged as key drivers in reducing workplace injuries and enhancing overall operational performance. Furthermore, the review underscores the potential of integrating targeted safety interventions and digital tools to strengthen the safety culture further and mitigate risks.

Conclusion: Strengthening the safety climate is critical for achieving sustainable improvements in manufacturing safety and productivity. Organizations are encouraged to implement continuous safety education, proactive management practices, and innovative digital safety solutions. Future research should further explore long-term safety strategies and the evolving impact of technological advancements to ensure enduring enhancements in occupational safety and overall organizational performance.

Keywords: Manufacturing industry, Occupational Safety Management, Safety Climate, Safety Culture, and Workplace Safety.

Introduction

Businesses and executives are prioritizing workplace safety and well-being in industrial environments, emphasizing the need for occupational wellness solutions and support to mitigate inherent hazards. These hazards include, but are not limited to, loud and hazardous equipment, airborne contaminants like dust, proximity to machinery, and chemical emissions.[1] A manufacturing company must ensure smooth operations and continuous employee protection by Engaging a professional workplace safety and health services provider. Meeting production targets is vital in an environment where Just-In-Time manufacturing is the standard.[2] Workplace injuries and illnesses can hinder productivity and disrupt manufacturing schedules. Ensuring employee safety is crucial in production environments. Proactive tools and on-site medical care prevent health emergencies, enhancing employee satisfaction and efficiency.[3]

Ensuring workplace safety in industrial settings involves several key measures. Protecting employees from hearing loss is essential due to the high noise levels of industrial equipment,

requiring adequate insulation and noise reduction.[4] Similarly, respiratory precautions are crucial to safeguarding workers' health and productivity from airborne contaminants. Additionally, substance abuse testing is necessary for employees operating heavy machinery to maintain focus and detect potential impairment.[5] Furthermore, large-scale immunization and testing help control the spread of infections in manufacturing environments where close worker collaboration increases health risks.

Employers are responsible for ensuring employees' safety at work. Caring for and safeguarding employees promotes productivity and protects the company's financial well-being.[6] On-site occupational safety, security, and wellness services help businesses meet complex insurance requirements, providing guidance and revealing health issues that may affect insurance rates.[7] It is undeniable that every manufacturer's daily operation must revolve around health and safety protocols.[8] However, a robust health and safety strategy protects employees beyond regulatory compliance. Companies often prioritize health and safety over productivity, quality, and cost efficiency, compromising employee well-being and company objectives.[9] Manufacturers should prioritize health and safety in the workplace to enhance productivity, ensure quality, and reduce costs. However, some companies overlook workplace wellness and security by failing to implement comprehensive health and safety programs.[10] Employers often face cases due to inadequate safety measures, such as insufficient equipment, PPE, inadequate training, and a culture that values safety.[11]

Negligent health and safety practices can result in immediate and long-term costs for manufacturing businesses, but fostering a high-value safety culture is crucial for improved safety practices[12]. Employee involvement in health and safety can be maintained by streamlining practices and processes, rewarding positive behaviors, maintaining open communication channels, and involving management.[13] Safety measures in a company encompass not only PPE but also comprehensive health and safety systems, regulations, practices, and software. Human Factors Engineering (HFE) is a field that designs tools, technologies, and systems that consider human skills, limitations, and characteristics, focusing on safety, comfort, and efficiency. HFE is rooted in biomedical sciences and is often used interchangeably with terms like user-centered design[14]. Early testing is crucial for identifying and fixing design flaws before infrastructure installation. Health and safety education is essential for those involved in patient safety initiatives, offering a proven structure to enhance a safety mindset.[15] The HFE approach is being implemented in production organizations for various employee safety tasks, such as procurement of machinery and employee security training, with significant work underway in some major manufacturing companies.[16] Given the inherent risks associated with industrial occupations, managers must ensure that employees receive adequate safety training to perform their tasks competently.[17] Additionally, a system must be in place to monitor employees' completion of training programs or modules and provide easy access to training materials.[18] An occupational safety and health education app is essential for companies to establish a comprehensive safety program. Manufacturing EHS (Environmental Health & Safety) software helps monitor job security effectively. Focusing on health and safety boosts employee morale, maintains quality, and increases productivity while reducing incident costs.[19]

A safety mindset is crucial for preventing accidents in manufacturing and construction, which mostly involve health and safety risks.[20] Proactive behavior, transparency, and prioritizing safety over efficiency can promote a successful safety environment.[21] This approach enables professionals to address issues promptly and uphold essential standards. Each employee's proactive stance toward safety demonstrates their concern for their well-being. A robust, proactive safety environment is critical to ensure employees' physical well-being on construction sites.[22] Discussing the safety culture model of the three Es—engineering, education, and enforcement, Vierendeels G, Reniers G, Nunen Kv, Ponnet K. identify key dimensions. Engineering involves designing safe machines, handling hazardous materials, and incorporating safety devices.[23] Education enhances skills, while enforcement outlines procedures and legal obligations. Ensuring safety is crucial in the design phase. It

can help increase productivity and cost savings.[24] Furthermore, a robust safety culture contributes to a happier workplace, which can enhance workers' productivity. This point will be highlighted in the subsequent discussion. This study explored how safety culture impacts employee performance within the industrial sector.[25]

Methods

Search Strategy

For this literature review paper, a rigorous search strategy has been implemented across various databases from 2015 to 2023. Well-renowned databases for research articles, such as PubMed, Scopus, ScienceDirect, Google Scholar, SID, and Magiran, were thoroughly searched and examined. The search was structured around key terms such as "manufacturing industries," "safety climate," "safety culture," "occupational safety," and "safety awareness." Over the past decade, the titles and abstracts of relevant journals were looked into. These findings were subsequently organized and evaluated based on criteria such as publication dates, industry focus, geographical regions, research locations, disciplinary domains, evaluation and analytical methodologies, and subject areas.

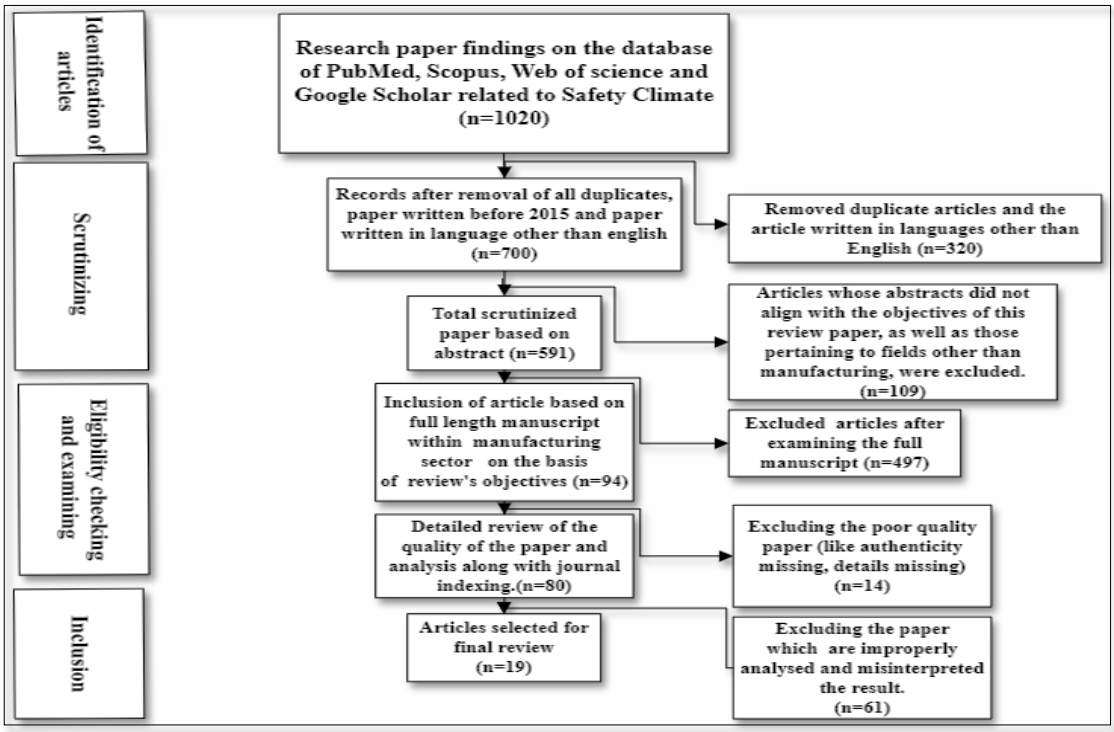

Figure: Search Strategy

Selection Criteria

By implementing inclusion and exclusion criteria, the desired quality of the study has been met. Studies considered in this research were published in English between 2015 and 2025, supported the research goals of this study, provided full texts from established academic journals, and displayed genuine findings and valid data analysis along with processing.

The research included only non-duplicate studies published after 2015, using English as the main language and containing identical abstracts and full texts that supported the study topic. Furthermore, the study conducted in an industry other than the manufacturing sector was also excluded. All research materials with deficiencies in authenticity, incompleteness, or improper analytic approaches were eliminated from the selection process. These inclusion and exclusion criteria for the research process ensured a credible and high-standard literature review.

The Article identification and selection

This research followed an organized literature review procedure that implemented specific

exclusion and inclusion standards for the article search and selection process. The first-stage database search through PubMed, Scopus, Web of Science, and Google Scholar generated 1,020 results. The remaining papers totaled 700 after applying the criteria of removing duplications, excluding works published before 2015, and restricting to non-English publications.

An evaluation of selected papers was carried out to identify relevant study abstracts, and the articles that were not conducted in the manufacturing sector were also listed, which led to the dismissal of 109 documents and proceeded with 591 full-text articles. Further, full-text detailed manuscript tests excluded another 497 studies, while the reviewed articles were reduced to 94. The quality assessment excluded 14 inadequate papers to arrive at 80 studies for examination. Additionally, another 61 papers have been removed because of improper analysis and misinterpretation of the results from the analysis. A comprehensive final review was done to check research objective alignment, resulting in the selection of 19 high-quality papers.

Results

The result of the literature review is presented in the table below, which includes all the details available regarding the safety climate in the manufacturing companies of multiple countries.

Name of the authors and year of publication	Country of study	sample size	Construct	Influential factors/Dimensions of the construct	Findings
(Abidin, et al., 2021)[26]	Malaysia	300	Safety Climate	Occupational injury	Safety climate significantly influences occupational injury. This means occupational injury can be reduced by bolstering the safety climate of the organization
(Xinxia, et al., 2015)[27]	China	3970	Safety Behavior	Safety climate, occupational injury	Safety behavior significantly impacts safety climate and occupational injury, emphasizing that improving the safety behavior of the employee can reduce workplace injuries.
(Oah, Na, & Kwangsu, 2018)[28]	Korea	376	Risk Perception	Safety climate, safety leadership	No significant association between safety climate, safety leadership, and risk perception.
			Risk Perception	Individual workload and accident experience	The individual workload and a positive influence proved by accident experience on risk perception
(Chenani, et al., 2020)[29]	Iran	252	Safety Climate	Organizational Climate	The organizational climate has a significant impact on shaping the safety climate of the organization, keeping the importance of workplace culture in safety management.
(Vithanage, Sing, Davis, & Newaz, 2022)[30]	Australia	112	Safety Climate	Safety Performance	The safety climate significantly impacts safety performance, meaning that a positive safety environment enhances employee safety performance.

(Nuruzzakiyah, Sukadarin, Hanida, & Zakaria, 2019)[31]	Malaysia	59	Safety Climate	KAP (knowledge, attitude, and practice)	KAP significantly influences the safety climate, stressing the importance of training and awareness programs.
(Znajmiecka, Roszko-W ˙ ójtowicz, & Stasiła-Sieradzka, 2022)[32]	Poland	203	Safety Climate	Demographic (position, age, area of employment, education, and service time)	Various demographics play a significant role in shaping the safety climate, indicating that safety perceptions and practices vary across different workforce segments.
(Jusoh & Panatik, 2016)[33]	Malaysia	313	Safety Climate (each factor)	Safety Performance	Each factor of safety climate significantly contributes to safety performance, reinforcing the multi-dimensional impact of safety climate on performance.
(Ghahramani, Panahi , & Hajaghazadeh, , 2021)[34]	Iran	359	Safety Climate	MSD (Musculoskeletal Disorders)	Safety climate significantly impacts MSD, suggesting that better safety practices can reduce work-related musculoskeletal disorders.
(Drăghici, Dursun, Başol, Boatcă, & Găureanu, 2022)[35]	Turkey and Romania	287	Safety Climate	Safety behavior, Transformational leadership	Transformational leadership and safety behavior have a significant impact on the safety climate, underscoring the importance of leadership in promoting safety.
(Bunner, Prem, & Korunka, 2018)[36]	Austria	122	Mediating Effect of Safety Climate	Safety Motivation, Safety Knowledge, Safety Compliance, and Safety Participation	The safety climate mediates the impact of motivation, knowledge, compliance, and participation, proving its role in strengthening workplace safety culture.
(Omidi, Karimi, Mousavi, & Moradi, 2022)[37]	Iran	205	Mediating Effect of Safety Climate	Organizational resilience and Safety performance	A positive safety climate has a significant influence on organizational resilience and safety performance, ultimately enhancing overall workplace stability.
(Kim, Park, Lim, & Cho, 2017)[38]	Korea	284	Safety Climate	Department	Department-based differences significantly impact safety climate, indicating variations in safety awareness and practices across departments.
(Ghahramani & Salminen, 2019)[39]	Iran	6	Safety Performance	Safety climate, occupational injury rate, and OHS	Safety performance is directly linked to safety climate and occupational injury rate, showing that improving safety climate reduces injuries.

(Ghahramani & Khalkhali, , 2015)[40]	Iran	269	Safety Climate Dimensions	Safety commitment & communication, safety involvement & training, positive safety practices, safety competency, safety procedures, accountability & responsibility, and a supportive environment	Multiple safety climate dimensions collectively contribute to improving workplace safety culture.
(Tesfaye, 2023)[41]	Ethiopia	220	Safety Climate	Productivity of the firm	The identified safety climate and firm productivity are significantly related, implying that better safety environments lead to improved operational performance.
(Vijalapura, Renuka, & Krishnamurthy, 2018)[42]	India	450	Safety Climate	Safety Administration, Organizational Commitment to Safety, Safety Priority over Production, Employee Commitment to Safety	Safety administration and employee commitment significantly influence the safety climate, highlighting the importance of management support.
(Hertanto, Erwandi, Widanarko, & Tejamaya, 2023)[43]	Indonesia	200	Safety Climate	Safety Behaviors	Safety climate significantly impacts safety behaviors, reinforcing that a strong safety culture leads to better workplace practices.
(Singh, Bahl, & Dhir, 2019)[44]	India	7	Safety Climate	Management commitment, safety training, safety communication, safety knowledge & compliance, work pressure, workplace layout	These factors significantly shape a safety climate, emphasizing the need for structured policies and leadership support.

The investigation by Afidah Abidin et al. (2021) in Malaysia included 300 participants to investigate the relationship between workplace safety climate and occupational injury frequency. It was found that the safety climate significantly impacts occupational injuries at a statistically significant level of p-value of less than 0.05. A well-developed safety climate system within workplaces works as an effective method to prevent occupational injuries, which proves the necessity of workplace safety standards.[26] Xinxia Liu et al. (2015) implemented research on China-based safety behavior, safety climate, and occupational injury links through a massive participant sample of 3,970 workers. Safety behavior shows a direct statistical connection to safety climate and occupational injury, according to their published findings at the significance level of 5 %. Proper safety behavior training and awareness programs serve to reduce workplace injuries since they enhance workplace safety effectiveness.[27] Shezeen Oah and colleagues (2018) studied risk perception in workplace safety among 376 Korean workers through their

research. The researchers confirmed through their research that other variables showed more impact on risk perception than safety leadership, with a p-value greater than 0.05, which shows the insignificant relationship between safety leadership and risk perception. According to trial results, individual employees who carry heavier workloads or have survived accidents showed higher workplace risk perceptions, which is also supported by the statistical analysis with a significance level of 5 % ($p < 0.05$).[28] Research by Khalil Taherzadeh Chenani et al. (2020) examined the effects of organizational climate on safety climate with a study sample of 252 participants in Iran. Their research data showed meaningful connections between safety climate and organizational climate constructs. They were also verified using the p-value at the significance level of 5 %($p < 0.05$), indicating that organizations with favorable climates create stronger safety programs through better practices and cultural values.[29] According to the article by S. C. Vithanage et al., safety climate significantly affects safety performance as per the observations collected among 112 participants in Australian manufacturing companies. This study shows that a safety climate strongly influences safety performance statistics with a significance value under 0.05, thus proving that proper safety climate implementation promotes worker safety performance while minimizing work-related accidents.[30] The research conducted by Nuruzzakiyah Mohd Ishanuddin and her team studied Malaysian participants' (n=59) perceptions to investigate the influence of knowledge, attitude, and practice (KAP) on the safety climate. Research results showed that KAP plays a significant role in shaping safety climate due to its importance in delivering safety training and education-based awareness programs, which is confirmed by the statistical parameter p-value less than 0.05 (at a 5 % significance level).[31] Marta Znajmiecka et al. (2022) evaluated the safety climate based on demographic characteristics through research that involved 203 participants from Poland. The study discovered substantial correlations between safety climate measurements and individual employee characteristics, including job rank, age level, employment sector, educational qualifications, and professional duration. Different workforce segments display varying safety climate perceptions; thus, organizations must create specific safety strategies matching employee demographics.[32] Nurul Hidayu Mat Jusoh and Siti Aisyah Panatik (2016) evaluated safety performance outcomes through their Malaysian study using a sample population of 313 participants. Research data showed that safety performance ($p < 0.01$) increases with each element of the safety climate established by workplace assessment.[45] The study conducted by Abolfazl Ghahramani and Hamid Reza Khalkhali analyzed multiple factors that influence the safety climate in Iran using a sample population size of 269. The researchers analyzed the safety climate through eight fundamental elements and found that the elements collectively contribute to enhancing workplace safety culture and climate at a significant level of 1%.[40] Abolfazl Ghahramani et al. investigated how safety climate affects musculoskeletal disorders (MSD) in a study group of 359 Iranian workers. The research results showed that safety climate is directly correlated with MSD at the 5 % significance level ($p < 0.05$) because an enhanced workplace safety climate/practices decreases the frequency of work-related musculoskeletal disorders[34]. The recent study conducted with a slaughterhouse in Nepal also suggests the importance of implementing an ergonomics strategy for improving the health of workmen and the safety climate at the workplace in the context of MSD.[46]

Draghici et al. analyzed the relationship between transformational leadership, safety behavior, and safety climate in a research study conducted in Turkey and Romania, involving 287 participants. The research showed that a safety climate adds significant value to transformational leadership and safety behavior practices ($p < 0.01$) because good leadership creates safe workplace environments. Thus, the study concluded that transformational leadership and safety behavior shape the safety climate in manufacturing industries.[35] Johanna Bunner, Roman Prem, and Christian Korunka (2018) researched the relationship between work intensification and workplace safety performance through safety climate mediation at Austrian sites involving 122 participants. According to the researchers, all variables of safety performance, including safety

motivation and knowledge, had been mediated through safety climate from work intensification ($p < 0.01$). Workplace safety performance strengthens when organizations advance their safety climate because this improvement specifically enhances employee safety motivation, along with their safety knowledge base, safety compliance levels, and safety practice engagement. The work intensification negatively affects the safety climate, affecting the organization's overall safety performance.[36]

Leila Omidi and her colleagues investigated the impact of safety climate and organizational resilience on safety performance through a research study involving 205 Iranian participants. The research showed that a safety climate is an influential element for organizational resilience and safety performance, which is confirmed by the p-value less than 0.01, which is a 1% significance level ($p < 0.01$). Thus, a solid safety climate drives stability and better workplace safety results.[37] According to Kyung Woo Kim and his colleagues, a study involving 284 participants from Korea investigated variations in safety climate across departments. The researchers found substantial differences in safety climate between various departments, which proves that workers form divergent safety climate perceptions based on their work departments. Abolfazl Ghahramani and Simo Salminen highlighted safety performance while connecting it with safety climate, occupational injury rates and occupational health and safety (OHS) in Iran. With its six-participant sample, the research demonstrated that workplace safety performance depends on safety climate and occupational injury statistics, thus demonstrating that a better safety climate leads to injury reduction.[38] In 2023, Fasil Kebede Tesfaye studied 220 participants in Ethiopia to investigate the connection between safety climate and firm productivity. Their research findings showed that a better safety climate has a positive impact on operational performance and enhanced productivity.[41]
Narayanappa et al. studied India's safety climate by evaluating 450 participants. The authors discovered that safety administration, organizational commitment to safety, safety priority over production, and employee commitment to safety serve as key drivers that influence the safety climate of the manufacturing sector. The p-value further supports this statement at a 1 % significance level ($p < 0.01$). This means a proper association exists between safety climate and other elements considered for the study. A strong safety culture requires both good management backing and dedicated workforce participation.[42]

Hertanto et al. investigated the connections between safety climate and safety behavior in Indonesia, involving 200 participants. Their research established that safety climate notably affects safety behaviors with a p-value below 0.01, validating how superior safety cultures produce better workplace safety and decrease accidents.[43]

Seven participants were included in the Singh et al. study, which examined safety climate factors in India. Research showed that management dedication, training, safety communication, safety compliance knowledge and practice, workplace design, and work pressure play substantial roles in forming a safety climate. Organizational policies and leadership support represent critical elements in establishing safe working conditions.[44]

Discussion

Research indicates that a safe climate is a crucial organizational aspect that directly impacts workplace safety, employee performance, and productivity. Three research studies demonstrate how a safety climate leads to reduced accidents at work, accompanied by improved risk detection capabilities and enhanced proactive safety culture.[47-49] According to Tappura et al., an organization benefits from a strong safety climate because it produces a positive safety culture and superior safety performance.[50]

Safety Climate and Employee Awareness

Multiple studies indicate that favorable safety climates help workers recognize potential hazards, leading to diminished workplace accidents and improved safety approaches.[48] According to Yu et al., risk perception depends heavily on safety training programs, which shows an urgent need for recurring safety training for workers operating in high-risk industrial environments.[51] Research in the Malaysian small-scale manufacturing sector discovered that

occupational injuries directly and heavily correlated with safety climate patterns for different manufacturing firms.[26] The data demonstrate that businesses must establish safety learning/training classes and strengthen their safety awareness initiatives to enhance the safety climate in manufacturing firms.

Leadership and Safety Climate

An organization's safety climate is shaped by effective leadership practices that sustain workplace safety protocols and practices. Wulandari et al. determined that the selection of leadership style creates a sustainable work safety climate.[52] Anca Draghici et al. established that transformational leadership improves employee safety behavior.[35] Research findings support the idea that high management dedication and leadership participation, while aiming for accountability, lead to safety-conscious workplaces. Organizations need to establish leadership training initiatives to ensure that management develops a comprehensive safety culture system, thereby bolstering the safety climate within any organization.

Safety Climate in Manufacturing and High-Risk Industries

The manufacturing sector operates in high-risk environments, which necessitate a proper safety climate to manage workplace risks effectively. Research conducted by Ghahramani, Khalkhali, and Srinivasaiah R. developed a manufacturing-specific safety climate scale for Iranian industries, recognizing the importance of measuring safety performance in accordance with industry-specific needs.[53,40] Srinivasaiah conducted a study that discovered crucial determinants affecting workplace safety in hazardous Karnataka industry operations to create workplace safety enhancement strategies.[54] According to Yu et al, an analysis of Chinese chemical industries demonstrated that workers aged 31-50 years with 3-10 years of experience face the highest risk of workplace incidents. Safety climate assessment tools need to be developed with consideration for specific industrial environments, based on these research findings.[51]

Safety Climate and Occupational Stress

Occupational stress influences the workplace safety climate, which develops most noticeably in labor-intensive work environments. A research investigation conducted by Kim, Park, Lim, and Cho within Korean shipbuilding showed that subcontract workers face elevated occupational stress because standard safety procedures are insufficient. Implementing better safety climate measures for occupational stress management leads to improved employee welfare outcomes and superior safety results.[38]

The Role of Organizational Safety Communication

An organization achieves a better safety climate through well-executed safety communication methods. According to Vithanage et al., safety communication represents the leading factor determining safety performance in off-site manufacturing. Safety performance depends vitally on transparent safety protocols, employee involvement, and proactive communication strategies, which work together to build a safety-conscious organizational culture.[30]

Implications and suggestions for future research

All manufacturing firms require robust assessments of safety climate improvements to strengthen the safety climate and promote a safer working culture. Organizations need to prioritize three key factors: leadership or management commitment towards safety, purposeful safety training, and clear safety communication practices and protocols to improve workplace safety performance and the overall safety climate of the manufacturing firm. Researchers should investigate how digital tools and safety management systems affect the development of a safety climate. Analyzing safety climate evolution through extended observation periods gives researchers valuable knowledge about its growth patterns, which affect organizational safety performance.

The effective improvement of a positive safety culture requires implementing all safety climate dimensions, such as leadership commitment and training programs, along with communication protocols and organizational engagement in safety awareness. Industries need to implement adequate safety climate assessment tools to address technical sector issues and allow employees to work safely and productively.[50, 55]

Conclusion

Safety climate factors directly influence workplace safety, employee performance, and organizational operational efficiency in manufacturing operations. A strong safety climate emerges from management values, effective safety communication and practices, comprehensive safety training, and adequate safety equipment. The effectiveness of the safety climate depends heavily on factors from occupational safety management, such as leadership commitment, employee engagement, OHS policies, and risk management and system audits.

Multiple elements, including workplace leadership styles, organizational commitment, employee safety knowledge, regulatory requirements, job site risk identification, and safety incentives, influence the safety climate. To maintain a safe environment, manufacturing firms must enforce strict adherence to safety protocols and establish robust systems to identify workplace hazards. Additionally, prioritizing equipment reliability and providing ongoing safety education are crucial in preventing accidents.

A professional safety climate controls occupational stress yet produces better employee performance in tasks and adaptive functions, resulting in improved workforce productivity. To enhance the safety climate, manufacturing firms must implement specific safety assessment instruments, digital management tools, and industry-specific safety intervention programs. Future research should focus more on the evolving impact of the safety climate on manufacturing safety performance and long-term operational sustainability. Additionally, future studies should explore broader areas in the industrial sector and try to include all safety climate-related dimensions in the study to get a holistic overview of the safety climate in any industry.

Limitation

This review has several limitations. Its primary target is manufacturing alongside high-risk industries, while its safety principles do not extend to other sectors, such as healthcare and construction. The lack of empirical study validation when using secondary data sources weakens the study's ability to conclude widespread application. Study assessments derived from most samples use a short-term analysis of safety climate, which may miss the progress on safety climate over a long period. The research finds limited global credibility because most studies focus on particular geographical regions. The impact of digital tools on the safety climate has not been thoroughly investigated, nor have the relationships between leadership quality and employee engagement alongside risk assessment been appropriately studied. The topic of occupational stress receives recognition, but researchers have not thoroughly studied its influence on safety climate. Future investigations need to perform empirical assessments using digital methods alongside long-term analyses to develop a comprehensive understanding of the safety climate in all industrial segments and its organizational effects.

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