Factors influencing the adoption and implementation of Occupational Health and Safety Standards

TU Delft Delft University of Technology

Factors influencing the adoption and implementation of Occupational Health and Safety Standards

Master thesis submitted by

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to Delft University of Technology
in partial fulfillment of the requirements for the degree of

Master of Science

Management of Technology

Student Number: 5946646

To be defended in public on 23 June 2025

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Acknowledgements

The past two years have been a remarkable and transformative phase of my life as I embarked on my master's journey at TU Delft. I am deeply grateful for the opportunities, challenges, and growth that this journey has offered me.

I would like to express my sincere gratitude to the Justus & Louise van Effen Excellence Scholarship and JN Tata Endowment Scholarship for their generous financial support during my studies. These prestigious scholarships gave me financial independence, allowing me to concentrate fully on both my academic and personal development.

I extend my heartfelt gratitude to my thesis supervisors, Professor Karolien van Nunen and Professor Geerten van de Kaa, for their expert guidance, insightful feedback, and continuous encouragement throughout the research and writing process. Their academic expertise and support were invaluable in shaping this thesis and enhancing the quality of my work. I'd also like to thank Prof. Jafar Rezaei for guiding me through the Best Worst Method-related doubts.

A very big thank you to all the experts who agreed to be part of my thesis research and supported me with my work. Without their responses, precious time, and guidance, the results wouldn't have been possible. I'm grateful to have such an approachable and willing network.

I am also profoundly thankful to my parents, family, and my fiancé Varad Abhyankar for their unwavering love, sacrifices, and moral support across all stages of this journey. Baba and Aai have laid the foundation of values for my career. Varad's belief in me has been my greatest source of strength and motivation. A special thanks to my siblings, Bokya and Shubu, for helping me check grammar and spelling in my report.

My Teaching Assistant Job at TPM always gave me happiness throughout my thesis period. I'd like to thank Joost, Patricia and Nitesh for their cheer and enthusiasm, which kept me motivated with my thesis. Special thanks to Aashish Sadaphal, Chinmayi, Ramya, Rohan Rege, Nikhil Shitole, Vamsi, Anh Tran, my MDR 8 roommates and all my friends for their constant encouragement, understanding, and for making this experience memorable and enjoyable. Your friendship has been a vital pillar of support.

Finally, I would like to acknowledge the Faculty of Technology, Policy and Management at TU Delft for providing excellent facilities, software, and resources that were crucial for conducting my research. The collaborative and innovative environment at TPM has been truly enriching and inspiring.

Thank you all for being part of this incredible journey.

Sharada Atul Gavade
Delft, The Netherlands
June 2025

Executive Summary

Ensuring workplace safety and providing guidelines to the organization, safety standards play a crucial role. These standards enhance employee well-being and improve operational performance. But even though these standards exist the question lies with the inconsistent adoption and implementation success. And this raises a question about what factors drive these processes and how we can influence these factors to better support improving workplace safety.

Substantial research has been done on quality and compatibility standards adoption, but the research on safety standards remains limited, fragmented and unclear about the difference between adoption and implementation. This research addresses this gap by aiming to identify factors that influence these two distinct stages of adoption and implementation. While the current literature struggles to distinguish these stages, this research defines them clearly setting a guideline. Adoption is defined as internal decision by a company to encompass, whether to use or not use a safety standard, choosing between different available safety standards. Implementation is defined as the process of integrating the chosen safety standard into organizational operations. i.e. integration in the (safety) management systems such that the company complies with the chosen standard. Further, this research also evaluates the relative significance of these factors and explores how the most important factors can be influenced by different stakeholders. Thus, it provides organizations and policymakers with actionable insights to promote safer and more resilient workplaces.

A 3-step methodology was used for this research. First, to identify the factors influencing the adoption and implementation of safety standards, a systematic literature review and exploratory investigation were conducted. The factors were organized into two frameworks: one for adoption (13 factors grouped under four categories) and one for implementation (6 factors). The adoption factors divided into 4 categories, included External Influence (Regulatory Pressure, Value Chain Pressure, Broader Societal Pressure), Firm Characteristics (Management Commitment, Resources), Company Goals (Image, Operational Efficiency, Safe Working Environment, Cost Savings, Global expansion) and Standard Characteristics (Quality, Compatibility, Cost).

Table 1: Framework of Adoption Factors

Factors Influencing the Adoption of Occupational Safety Standards			
External Influence	**Firm Characteristics**	**Company Goals**	**Standard Characteristics**
Regulatory Pressure	Management Commitment	Company Image	Compatibility
Value Chain Pressure	Resources	Cost Savings	Cost of Standard
Broader Societal Pressure		Safe Working Environment	Quality of Standard
		Operational Efficiency	
		Global Expansion	

For implementation, the factors relate to Commitment (from all the levels of the company), Communication & Training, Continuous Improvement Mechanisms, Resources, Compatibility with the Company, and Government Support.

Table 2: Framework for Implementation Factors

Factors Influencing Implementation of Occupational Safety Standards					
Communication & Trainings	Compatibility with the Company	Commitment	Resources	Government Support	Continuous Improvement Mechanisms

The second step of the research used the Best Worst Method (BWM) to quantify the relative importance of each factor with the help of experts. The results show that the Management Commitment and Regulatory Pressure are the most significant factors in adoption, while Commitment and Communication & Training are key for implementation.

In the third step, a literature review was conducted, and the experts were interviewed to identify the stakeholders influencing the top 2 ranked factors from both adoption and implementation frameworks. This step also focused on providing insights on how these highly important factors can be influenced. The findings show that these factors are influenced by various stakeholders: governments provide external pressure, top leadership drives internal prioritization, and middle management shapes implementation through engagement and awareness. These findings align with institutional theory, emphasizing coercive, mimetic, and normative pressures in shaping organizational behavior.

The practical implications of this research are twofold. Policy makers can use the findings to develop more targeted regulatory policies, provide incentives, and offer support mechanisms tailored to organizational needs, particularly for SMEs. The key recommendations for policymakers include:

- Use financial incentives such as tax benefits or grants to encourage adoption.
- Offer subsidized training programs and access to safety equipment or consultancy services, helping overcome internal capability gaps in SMEs.
- Promote recognition programs (e.g., safety awards) that link compliance to public image and reputation.
- Support benchmarking and performance transparency by publishing industry-wide safety metrics.

Managers, on the other hand, can better structure their internal strategies by aligning safety goals with business objectives, improving training programs, and enabling open communication across levels. The recommendations for managers include:

- Frame safety as a strategic priority, not just a compliance requirement. Integrate safety-related KPIs into performance evaluation and business continuity planning.
- Develop a formal commitment strategy that links goals, resource allocation, and contingency planning. This ensures alignment and accountability.

- Empower middle management and safety officers to act as translators of safety vision into daily operations. Provide them with authority, tools, and training to lead implementation.
- Appoint individuals with strong safety values and past industry experience. These champions can help shape safety culture and mentor others.
- Foster involvement by enabling employee participation through safety committees, open communication channels, and continuous feedback loops.
- Benchmark safety performance against industry peers and learn from leaders.
- Ensure continuity by embedding safety into onboarding and leadership development programs, sustaining commitment even during organizational transitions.

In conclusion, this research offers a structured and actionable understanding of what drives safety standard adoption and implementation. By separating the two phases, identifying key influencing factors, and highlighting stakeholder roles, the study contributes to academic theory and provides practical value for creating safer organizational environments.

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Nomenclature

AHP	Analytic Hierarchy Process
B2B	Business-to-Business
B2C	Business-to-Consumer
BWM	Best Worst Method
CEO	Chief Executive Officer
CSO	Chief Safety Officer
HSC	Health and Safety Committee
HSE	Health, Safety, and Environment
ISM	Interpretive Structural Modelling
KPI	Key Performance Indicator
MADM	Multiple Attribute Decision Model
MCDA	Multi-criteria decision analysis
MCDM	Multi-criteria decision making
MoT	Management of Technology
OHS	Occupational Health and Safety
OHSMS	Occupational Health and Safety Management Systems
PDCA	Plan Do Check Act
SEM	Structural Equation Modelling
SLR	Systematic Literature Review
SMEs	Small and Medium-sized Enterprises
SMS	Safety Management Systems
TPM	Technology, Policy and Management
WoS	Web of Science

1 Introduction

1.1 Background and Context

Occupational Health and Safety (OHS) is vital for the health and well-being of workers and defined as a science of anticipation, recognition, evaluation, and control of hazards arising in or from the workplace (Alli, 2008). In the year 2021, together WHO and ILO reported that almost 2 million deaths occur due to work-related injuries and diseases (WHO/ILO, 2021). These accidents, causing human loss, also carry huge social and economic costs. However, this situation can be changed by ensuring the health and safety of workers. The application of OHS standards can ensure workplace health and safety by providing clear guidelines and regulations (Lemen et al., 1989). These standards are aligned with national regulations such as OSHA regulations in the United States or the EU Occupational Safety and Health Directives, ensuring adherence to the legal framework.

Beyond regulatory compliance, OHS standards offer significant business advantages that contribute to long-term success. They can cultivate a proactive safety culture and are important in enhancing operational performance (Lo et al., 2014a). OHS systems minimize disruptions and associated costs by reducing operational workplace accidents and illnesses, fostering a more stable operational environment (Marhavilas et al., 2022a). These standards also facilitate risk management, especially in high-risk sectors such as the nuclear and chemical industries (Hofmann et al., 1995). With all these benefits, the strong focus on safety enhances the productivity and morale of the employees (Malek et al., 2010). But all the above benefits are subject to the effective adoption and implementation of these standards.

In 2018, ISO 45001 was introduced as the International Standard for health and safety at work, offering a clear and single framework for Occupational health and safety management systems (ISO, 2018). Earlier, OHSAS 18001 was a popular standard that focused on managing OHS risks.

Various standards help industries choose the most appropriate methods and provide clear guidelines and benchmarks for development. For instance, quality standards contribute to ensuring consistency in the products and services, and compatibility standards facilitate interoperability. Researchers have studied compatibility and quality standards, and a vast amount of literature is available on factors influencing the adoption of these standards. However, the existing literature has not extensively studied and highlighted the factors affecting the adoption and implementation of Occupational Health and Safety standards. Despite the high importance of safety standards and their increasing awareness, standardization literature mostly focuses on compatibility and quality standards. Only a limited amount of literature on safety standards is available, and this available literature is also bounded by a limited scope and is discrete. Understanding the relevant factors driving the adoption and implementation of the safety standards could contribute to promoting these standards. Further, it could also lead to exploring the barriers in the adoption and implementation process, and resolving these identified barriers could result in the effective utilization of these standards.

Identifying these factors will lead to the effective adoption and implementation of safety standards. When the identified factors are ranked according to their importance, it can clarify

which factors are critical and which need to be addressed first. Categorizing these factors will help understand which domains are essential, such as financial or human resource-related factors.

Management could benefit from the identified factors in this research. When deciding to adopt safety standards, they can consider these factors to make better choices regarding which standards to choose. Additionally, the implementation factors can guide discussions on applying various management systems. This process will help organizations recognize their strengths and weaknesses which could prove to be beneficial in the adoption and implementation phases. Thus, the identified factors could give a holistic approach to the considerations, helping them make strategic decisions. Further, this could encourage widespread adoption and implementation of OHS standards.

1.2 Problem Statement

The research on safety standards, particularly their adoption and implementation, remains limited compared to compatibility and quality standards. The underexplored nature of this topic creates a significant knowledge gap in identifying these factors.

These influencing factors could create a cyclic impact, i.e., identifying factors affecting the adoption of standards could lead to more effective implementation, and further understanding the factors influencing the implementation of the standards could drive effective maintenance of complying with these standards. This exploration could also help us deep dive into exploring why companies choose to adopt and not adopt standards. Further, it could also help us point out the significant actors influencing the adoption and implementation of safety standards. By addressing these factors and understanding the actors influencing them, this research can aid organizations in achieving a broader goal of improving workplace safety and promoting a culture of safety within organizations.

This research will contribute to the literature on standardization, by exploring influencing factors for safety standards adoption and implementation. Researchers can utilize these factors to explain and potentially predict the adoption of safety standards. Management and decision-makers within various industries can use these factors as a checklist to evaluate whether to adopt a specific standard and identify factors that may influence its implementation. Additionally, governments and standards organizations can use this checklist to formulate strategies to encourage companies to adopt and implement their standards effectively.

1.3 Research Question & Sub-Question

This research seeks to identify and factors influencing the adoption and implementation of safety standards by reviewing the existing literature and consulting domain experts.

Main research question

Which factors affect safety standards adoption and implementation, and how can the most important factors be influenced?

Sub-questions

1. What are the relevant factors for the adoption and implementation of safety standards according to the literature and the experts?

   To identify and categorize the factors influencing the adoption and implementation of safety standards by reviewing the existing literature and consulting domain experts.

2. What is the importance of factors for the adoption and implementation of safety standards according to experts?

   To evaluate the relative importance of these factors based on insights from experts with relevant experience.

3. How can the most important factors be influenced, and by whom?

   To identify the roles of various stakeholders (e.g., regulators, organizations, employees) influencing the most important factors (top 2 ranked factors) to facilitate effective safety standard adoption and implementation.

1.4 Report Structure

Each section in this report follows a coherent structure. Chapter 1 discusses the background of the research problem, further elaborating on the research problem and stating the research question and sub-questions. Chapter 2 introduces the theories of standard adoption and explores the significance of safety standards. It also discusses some perspectives towards the adoption and implementation of safety standards in the current literature. The methodology used for this research unfolds in a sequence of sub-research questions in Chapter 3. The results obtained for each sub-question are presented sequentially in Chapter 4. This chapter also discusses the changes in approaches that occurred during the research process. Chapter 5 presents the discussions by elaborating on the theoretical and practical implications of the research. It also discusses the limitations of this research, along with future recommendations. Chapter 6 includes the summarized answers to the research questions. Chapter 7 consists of Self-Reflection and the Relevance of the Thesis within the Management of Technology (MoT) Curriculum. It is followed by the References sections and Appendices A to E, which include additional information and supporting data for this research.

2 Theoretical Background

This chapter of the proposal delves into the theoretical foundation of the research topic by integrating findings from existing literature, defining key concepts, and synthesizing relevant theories to guide the study.

2.1 Safety Standards

Occupational safety and health standard means a standard which requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment (U.S. Department of Labor, 1970). The safety standards aim to promote effective occupational health and safety practices based on a structured management system within organizations. To support the adoption of Occupational Health and Safety Management Systems (OHSMS), various international organizations and institutions have published several standards, such as ISO 45001:2018, OHSAS 18001:2007, BS 8800, and ILO-OHS-2001 (Abad et al., 2013).

The components of safety standards are as follows

Table 3: Components of Safety Standards

Components	Explanations
Hazard Identification and Risk Assessment	Standards require systematic assessment of risks from physical, chemical, biological, ergonomic and psychosocial hazards in the workplace (Erickson, 1996).
Preventive and Control Measures	Implementation of engineering controls, administrative procedures, and personal protective equipment (PPE) to eliminate or minimize occupational risks.
Legal and Organizational Responsibility	Employers are mandated to comply with national and international occupational safety laws (e.g., OSHA, ISO 45001), while employees are entitled to training and participation in safety decisions (Howard, 2023).
Standards-Based Management Systems	Internationally recognized frameworks like ISO 45001 establish structured systems for continual monitoring, evaluation, and improvement of workplace safety programs (Yang & Maresova, 2020). It also involves the indications to use of PPEs and Emergency preparedness as per the type of industry.

ISO 45001 in particular requires organizations to address OHS risks and opportunities that may impact the effectiveness of an OHSMS. It places greater emphasis on top management's role in effectively implementing an OHSMS. The safety standards define minimum acceptable practices for identifying workplace hazards, controlling risks, and fostering organizational accountability in protecting workers' health.

2.2 Terminology

To initiate the understanding of factors influencing the adoption and implementation of safety standards, it is important to understand that the process of standardization takes place in different stages. At the outset, the design and development of the standard form the first stage, followed by acceptance of the standard (Lyytinen & King, 2006; van de Kaa, 2023).

After the development stage, standards *adoption* and *implementation* follow. Hence, for this topic's theoretical background, it is crucial to define the terms of adoption and implementation. Adopting a standard means deciding to use or apply a particular standard. The next step after the adoption is the implementation of standards, which involves putting them into practice by integrating them into processes, systems, products, or services. To summarize, adoption is a commitment to applying a standard, and implementation is applying that standard.

Another crucial term to discuss is *Safety Management Systems (SMS)*, which is highlighted by most of the research articles available in the literature. Hence, it is important to understand how it relates to safety standards. Safety Standards are specific guidelines and requirements that organizations must adhere to, ensuring compliance with legal and safety regulations. They focus on creating safe & healthy workplaces and preventing work-related injuries (Marhavilas et al., 2022b). SMS are comprehensive frameworks that help organizations systematically manage safety and health risks. They involve setting policies, planning, implementing, monitoring, and reviewing safety practices to continuously improve safety performance (Gardner et al., n.d.; Redinger et al., 2011; Uhrenholdt Madsen et al., 2020). They require active participation from all organizational levels and are often aligned with other management systems like quality and environmental management (Ramos et al., 2020).

Safety standards at times act as legal and regulatory requirements and often serve as comprehensive documents and foundation for developing SMS and accomplishing Occupational Safety goals in an organization (Marhavilas et al., 2022b; Shekari, 2020). From the definitions of adoption and implementation, we can infer that compliance with safety standards and adoption convey similar meanings and are closely related. On the other hand, Safety Management Systems primarily focus on implementing these safety standards. Understanding the correlation between these important terms is helpful in deciding the keywords to search for relevant literature.

The term *certification* is yet another important term and is distinct from adoption and implementation. It is when a company decides to have a formal verification of the safety standard that they have implemented by means of an external audit.

The following table explains the differentiations between these 3 important phases of the process of standardization

Table 4: Difference between adoption, implementation, and certification

Aspect	Adoption	Implementation	Certification
Definition	The internal decision by a company to encompass 1. Whether to use or not use a safety standard 2. Choosing between different available safety standards.	The process of integrating the chosen safety standard into organizational operations. i.e. integration in the (safety) management systems such that the company complies with the chosen standard.	The formal verification by means of an audit by an external body that the organization complies with the safety standard. Hence, the company receives the official recognition of the standard (or not based on the outcome the audit).
Focus	Following the chosen safety standards.	Integration of safety standards and systems within the company	Official certificate proving compliance with the standard.
Example	A company decides to adopt ISO 45001 (Occupational Health and Safety).	The company trains employees, updates safety procedures, and conducts internal audits.	An external auditor verifies compliance, and the company receives ISO 45001 certification.

2.3 Significance of Safety Standards

Ensuring workplace safety through structured standards is not only a regulatory necessity but also a strategic approach to enhancing organizational performance and employee well-being. Safety standards are significant to reduce the cost resulting from accidents in the workplace, originating from an inadequate workplace environment and insufficient information. Safety standards bring in safety practices that create a safer working environment, fulfilling workers' safety needs and allowing them to focus on operational targets. Hence, Yang & Maresova (2020), mentioned that an OHSMS may also act as an "iron cage" for firms.

Granerud & Rocha (2011) stated that safety standards are important to compel firms to formulate targets, adhere to legal requirements, ensure a safe and appropriate work environment, and implement proper management systems. According to the study by Wang et al. (2016) firms with OHSMS have a higher triple bottom line efficiency score. Lo et al. (2014) also noticed that firms that adopt safety standards report higher operating performance with regards to sales growth, productivity, safety and profitability.

Among the many safety frameworks, OHSAS 18001 emerged as a dominant system for continuous safety improvement (Fernández-Muñiz et al., 2012; Lo et al., 2014b). The effect of OHSAS 18001 on safety performance has been studied through various studies of the effectiveness of OHSMSs (Robson et al., 2007; Vinodkumar & Bhasi, 2011). Lafuente & Abad (2018) highlighted that manufacturing organizations show more compatibility with the systematic and codified nature of the OHSAS 18001 as compared to organizations in other industries. They also noted that the implementation benefits of the safety standards are likely to be lower in organizations with a low level of systematic operating conditions, for example, construction businesses. This indicates that adoption of safety standards may also instill the importance of structured operating conditions within the organization, beneficial to adopt integrated standards systems. Furthermore, when compared with companies with ISO 9001 and

noncertified companies, Vinodkumar & Bhasi, 2011) found that OHSAS 18001-certified companies had a commendable level of commitment to management, proper safety training, involvement of workers in safety communication and feedback, as well as procedures and rules of safety and safety promotion policies.

Beyond improving safety conditions, the implementation of safety standards positively influences a company's image among both internal and external stakeholders. Some studies have shown a reduction in fines imposed by authorities on companies after safety inspections (Madsen et al., 2022). Lo et al. (2014) showed in a study of 211 Manufacturers from the USA that those who adopt COHSMS have a better position than nonadopters in terms of the relative number of safety-related violations.

In an organisation, the safety policy acts as a prime mover as it creates a clear direction for the performance of safety and boosts safety awareness among employees (Hinze & Wilson, 2000). Studies have also noted that the implementation of OHSAS1800 improves the morale of the employees, the safety of the workplace, and the reputation of the organization. It is also noted that safety culture improves safety performance, which ultimately results in enhanced productivity (Rajaprasad & Chalapathi, 2015).

In conclusion, adopting and implementing safety standards such as OHSAS 18001 goes far beyond ticking regulatory checkboxes. It enhances operational efficiency, boosts employee morale, improves stakeholder perception, and can lead to measurable reductions in compliance failures, leading to safer and effective operations in industries.

2.4 Standards Adoption

Many researchers with a diverse range of views have looked at the process of establishing standards. Sudden events that shake up the industry once in a while are characterized by technological advancements (Anderson & Tushman, 1990). The radical technological innovation is fueled by these technological discontinuities. A single de facto standard is formed by the convergence of various path-dependent choices (Abernathy & Utterback, 1978; Utterback & Abernathy, 1975).

It is argued by the industrial economist that from economic mechanism standards become adopted. The value of technology perceived by the users increases in a market characterized by increasing returns to adoption. Technology with an early market lead is mostly dominating in the market (Arthur, 1989). Network effects are included in the underlined sources. Users often follow other users in the choice of adoption because of these economic effects. The expected return from the standard is increased, which results in a bandwagon effect (Farrell & Saloner, 1985). Network effects have another side in terms of switching costs, which also influence the adoption process of standards (Techatassanasoontorn & Suo, 2011). Higher switching costs may lock the user into one standard restricting adoption of a new standard (Lambertini & Shy, 2002).

The reasons companies adopt a particular standard stem from internal and external pressures on the firm. Scholars studying standard adoption identify normative, mimetic, and coercive influences that lead a firm to select a specific standard. (Dimaggio & Powell, 2021; Henderson et al., 2011).

The application of innovation adoption and diffusion literature often explains the reason for companies' adoption of standards. The scholars note that the adoption of a standard is influenced by its characteristics. The compatibility of the standard with the firm also influences the firm's decision to adopt the individual standard.

Scholars with innovation management and standardization backgrounds have completed investigations to explain the establishment of dominant designs and standards. It is the characteristics of the standard and the strategies that help the achievement of the dominance of the particular standard.

Over the last decade, studies have examined the emergence of single dominant designs, focusing on the level of design openness and strategic entry timing. Few scholars also focused on the factors affecting the probability of a firm adopting a standard. These scholars studied the steps taken by standard organizations in order to achieve success with their technological standards. These scholars describe specific factors for standard adoption through qualitative empirical research. To study standard adoptions few scholars have conducted case studies.

2.5 Perspectives in Literature

Safety standard adoption and implementation, particularly OHSAS 18001 and ISO 45001, have been studied from multiple perspectives. Some of the literature emphasizes internal organizational drivers, while others explore external pressures. The literature also uses the terms adoption and implementation interchangeably despite their distinct organizational implications. Hence, while noting the findings from the literature, the definitions mentioned in section 2.4 are considered for framing the subsequent analysis. Motivation behind adoption, barriers, and enablers of implementation discussed in the literature indicate the influential factors. These perspectives in the literature offer a fragmented yet rich understanding of how companies engage with safety standards.

The adoption and implementation of occupational safety standards are influenced by both internal, i.e., organizational priorities, as well as external pressure. While İnan et al. (2017) emphasize internal operational excellence and performance measurement, Yang & Maresova (2020) point to external legitimacy and strategic positioning as primary motivators. İnan et al. (2017) propose a Multiple Attribute Decision Model (MADM) leveraging the OHSAS 18001:2007 framework, using Simo's procedure and the VIKOR method to comparatively assess a firm's implementation of OHS standards within Turkey's packaging industry. The findings emphasize that top management's commitment to resource allocation and the continuous improvement process played a pivotal role in the effective implementation of Occupational Health and Safety Management Systems (OHSMS). Yang & Maresova (2020) focus on the financial ramifications of Safety Standards adoption, analyzing 125 Chinese pharmaceutical firms from 2010 to 2018 using panel regression models. They found that certification with OHSAS 18001 or ISO 45001 positively correlates with short-term financial performance indicators. Their analysis stresses the role of institutional pressures, such as regulatory demands and stakeholder expectations, in motivating adoption, aligned with institutional theory. Beyond the regulatory pressure, the adoption of OHS standards is also greatly influenced by internationalization and value chain pressure. (Singh, 2024) explores this factor in a case study of Indian auto-component producers with multiple certifications (ISO 9001, ISO 14001, OHSAS 18001). The findings of this article show

that companies with international operations or those exporting to high-tier firms were more likely to adopt OHSAS 18001 as part of a broader strategy to align with global standards

The article by Ghahramani (2016) considered both internal and external factors affecting the adoption and implementation of OHSAS 18001. The findings drawn from the qualitative interviews emphasize the importance of management commitment in the adoption success. This article also discusses internal factors of employee involvement, communication & training, and the external factors of regulation enforcement and external audits. Similar to Ghahramani (2016), through a comprehensive review of empirical studies, Uhrenholdt Madsen et al. (2020) identify three key program theories—operational, institutional, and compliance. These theories emphasize the integration of safety practices, organizational learning, and adherence to external regulations as necessary for success. While Ghahramani (2016) and Uhrenholdt Madsen et al. (2020) study OHSAS 18001, Darabont et al. (2017) explore the implementation of ISO 45001. Using the case study approach of an electrical board manufacturing company, they echo the findings of Ghahramani (2016). Also, the study underscores the need for a strong safety culture, effective risk management, and achieving continuous improvement.

Along with focusing on internal and external factors and the different types of safety standards, it is important to note the impact of integrated management systems on adoption and implementation. Abad et al. (2016)contribute to understanding safety standard adoption by exploring the perceived difficulties in integrating multiple management systems, including OHSAS 18001, ISO 9001, and ISO 14001. Using survey data from 102 Spanish firms, the study identifies employee resistance to change as the most significant barrier to integration. This finding reveals that human and cultural factors significantly impact the effective safety standards implementation beyond technical or procedural aspects. This study also highlights that the integration method, whether simultaneous or progressive, affects the intensity of perceived challenges. The research also indicates that companies using a simultaneous integration approach experienced higher levels of resistance, likely due to the abrupt changes implemented across the organization. In contrast, a gradual integration method facilitated smoother assimilation of new practices and routines. Similarly, Vlachos (2018) focuses on OHSAS 18001 alongside ISO 14001 and ISO 22301 to understand how these management systems can help tackle operational risks. This study employs a theoretical approach combined with case studies from large mining corporations. The research indicates the importance of the compatibility of standards within the organization and integration of certifiable management system.

Beyond process integration, studies also assess the performance outcomes associated with OHSMS adoption. Lafuente & Abad (2018) find the impact of adopting OHSAS 18001 on business performance, focusing on manufacturing, construction, and professional services sectors. This research utilizes a quantitative approach, employing a dataset of 149 Spanish firms between 2006 and 2009. The results identify the importance of prior safety knowledge and experience for effective OHSAS 18001 implementation. This suggests that organizational context is critical in realizing the standard’s benefits.

Gökçek & Güyagüler (2011) represent a case study of the application of OHSAS 18001 at Bigadiç Boron Mine. The methodology involves qualitative risk assessment techniques, including hazard identification and job-specific safety analysis forms. The case discusses challenges leading to ineffective implementation of safety standards. Thus, it highlights the factors influencing the implementation process, such as the critical role of top management commitment and

employee engagement. The findings of Castiblanco et al. (2020) align with Gökçek & Güyagüler (2011) as they focus on the Plan-Do-Check-Act (PDCA) cycle and risk assessment. Castiblanco et al. (2020) outline a systematic approach to design and implement the OHSMS of the ISO 45001 standard; a case study in a low-voltage electrical panels manufacturing company. This article also shows the importance of communication and training in the implementation of safety standards.

The hindrances in the adoption of safety standards are the focus area of research by Pedrosa et al. (2024). This study points out that the 85 companies (under consideration) in the Portuguese footwear industry struggled with low employee involvement in adopting OHSAS 18001. The methodology involves a structured questionnaire, which includes multiple-choice and dichotomous questions to assess the companies' OHS services, certification, training, consultation practices, and near-miss management. The research highlights key internal factors such as management commitment, employee engagement, and the integration of safety into the company culture.

The article by da Silva & Amaral (2019) presents a systematic literature review on identifying success factors and barriers for the implementation of OHSMS. This research focuses on the effectiveness of the implemented OHS Management system. It discusses organizational structures, leadership commitment, and employee engagement as major factors for effective implementation. These findings highlight the importance of leadership commitment in implementation, as this factor appears consistently across articles of İnan et al. (2017), Abad et al. (2016), Pedrosa et al. (2024) and many others.

A more nuanced understanding of implementation effectiveness is offered by studies that distinguish between formal compliance and actual safety performance. Madsen et al. (2022) present a comparative analysis between adopters and non-adopters of safety standards. This article displays a broader understanding of safety standards implementation by distinguishing between process compliance and actual on-the-ground safety improvements. It highlights the importance of cultural and operational integration of safety practices within companies.

Region-specific empirical studies further enrich this understanding by identifying context-specific influences on implementation. Through a survey of 230 enterprises, Vu Gia et al. (2024) investigate factors influencing the implementation of safety standards in high-risk industries of Vietnam. This study found that management's ability and responsibility were the most significant factors, followed by employee involvement in safety practices. These findings are consistent with da Silva & Amaral (2019) and many others. Similarly, Rajaprasad & Chalapathi (2015) analyze implementation factors for OHSAS 18001 in the Indian construction industry by using the Interpretive Structural Modelling (ISM) approach. This study classifies factors into three categories: driver variables (management commitment, safety policy), linkage variables (safety culture, performance), and dependent variables (employee morale, safety training).

Bevilacqua et al. (2016) identifies critical factors for the successful adoption of OHSAS 18001 using case studies of Italian Companies. The findings from this research suggest that the decisional factors of external pressure and the desire to improve safety culture are strong motivators for adoption. Along with the characteristics of the company’s safety culture, the size of the company also plays an important role in the adoption. Campanelli et al. (2021) explore this size factor with the adoption of ISO 45001 in Brazilian companies. The findings reveal that

the large companies tend to have more advanced OHSMS while the Small and Medium-sized Enterprises (SMEs) struggle with the resources. This leads to a negative impact on the adoption decision and the effectiveness of the implementation of the safety standard. While Bevilacqua et al. (2016) studies adoption factors in Europe and Campanelli et al. (2021) in the South America, Ling et al. (2015) explore the same in Southeast Asia. Based on the survey study with 128 participants from Malaysia, Ling et al. (2015) find that top management's support and the company's work environment are decisive for the adoption of OHSAS 18001.

The findings of Ling et al. (2015) also suggest that work involvement and incentives were not significant determinants for the adoption of OHSAS 18001. And on the contrary, the article by Fernández-Muñiz et al. (2012) showcases the rewarding aspects of OHSAS 18001 adoption, such as reduced workplace injuries and robust risk management. These factors indicate the contribution of employee involvement to the adoption decision in companies.

The summary of all the above-mentioned articles is provided in Table 19 in Appendix B.

Along with the valuable insights provided by the literature, there are several limitations that become a potential research gap to be addressed. The use of terms such as adoption, implementation, and certification is often inconsistent, with studies frequently using them interchangeably. This lack of conceptual clarity obscures the distinctions defined in Section 2.4 and creates ambiguity in interpreting findings. Furthermore, while internal and external factors influencing safety standards have been widely discussed, they appear scattered across studies and lack a cohesive framework that shows their interrelations, importance, and the relevant actors involved. These observations indicate having an integrated approach to distinguish between adoption, implementation, and certification, and systematically identify and organize the influencing factors. Addressing this need, the present research seeks to develop a broader framework and engage with expert perspectives to build a more structured and practically useful understanding of safety standard engagement.

3 Methodology

3.1 Research Design

The research design for this study was divided into three main stages to answer each sub-research question and, hence, achieve the research objectives. The first step aimed to arrive at relevant factors influencing both the adoption and implementation of safety standards. This step had two parts: a literature analysis and exploratory expert interviews. The second step involved Multi-criteria Decision Analysis using the Best Worst Method with experts to evaluate weights per factor. The third step involved exploratory interviews with experts and supporting literature analysis to understand stakeholders and their influence on the top-ranked factors. The research aimed to have practical significance by providing insights and generalizations based on the expertise and experiences of these experts.

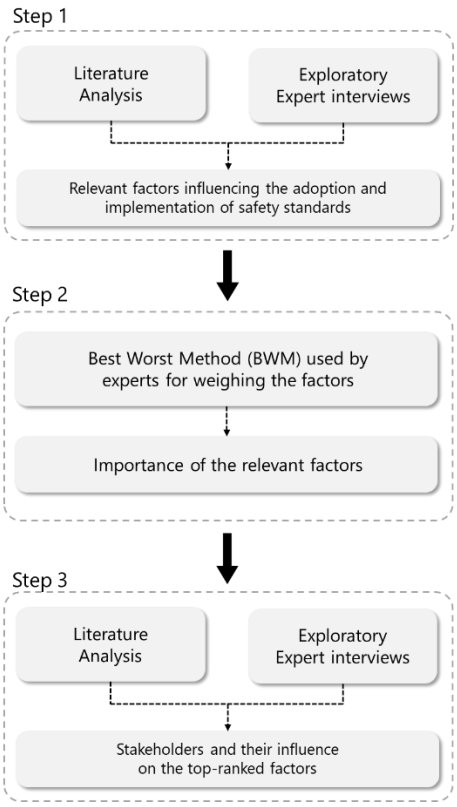

Figure 1: Flowchart depicting the outline of the research framework

3.2 Literature Analysis

A systematic literature review (SLR) has been used widely in factor identification. van de Kaa, (2023) used the systematic analysis to study factors determining the adoption of quality and compatibility standards. Similarly, Hoogerbrugge et al. (2023) used this method to identify factors for quality standards adoption. The literature has also used this method to identify success factors and barriers to the implementation of OHSMS (da Silva & Amaral, 2019) SLR allows an extensive and transparent study of the literature, which leads to the finding, reviewing, and combining of key findings.

To answer the first research question of identifying relevant factors influencing the adoption and implementation of safety standards, a systematic literature review was chosen as one of the methods. For the literature analysis, relevant research articles containing reviews and case studies of various Occupational Health & Safety Standards adoption and implementation were collected through databases like Scopus and Web of Science (WoS). WoS was chosen as one of the databases as it has more older papers than Scopus. And choosing Scopus had the advantage of including sources like books published by academic publishers (Wee et al., 2023).

The term safety standard is quite broad; hence, to specify this term while filtering research articles, the keyword "Occupational Safety Standards" or "OHS" is used. This helps eliminate the occurrence of search results irrelevant to occupational safety. To keep it relevant to the age, literature published from 2010 to 2025 (final publication year) was considered. Also, it was noted that there were no significant publications before 2010. Hence, the search was limited to 15 years. This helped cover both popular safety standards, OHSAS 18001 (until 2018) and ISO 45001 (2018 onwards).

3.2.1 Searching for relevant articles in the database

A systematic methodology was followed to refine the literature selection process. Research articles were retrieved from two major academic databases: Web of Science and Scopus. The search string employed included key terms related to Occupational Health & Safety Standards (e.g., "OHSAS 18001," "ISO 45001," "occupational safety standard," "workplace safety standard," "health and safety standard") combined with terms associated with adoption and implementation (e.g., "adoption," "certification," "compliance," "effectiveness," "case study"). To ensure relevance to workplace safety and exclude unrelated topics, terms such as "food safety" and "food industry" were explicitly omitted from the search. The following table presents the search strings used for the literature search.

Table 5: Search Query for factors literature

Sr. No.	Database	Search String	No. of results generated
1	Web of Science	TS=("OHSAS 18001" OR "ISO 45001" OR "occupational safety standard" OR "workplace safety standard" OR "health and safety standard" OR "Occupational Health and Safety Standards") AND TS=("adoption" OR "implementation" OR "certification" OR "compliance" OR "apply" OR "use" OR "follow" OR "choose") NOT TS=("food safety" OR "food industry")	228 (from 2010 to 2025 and limited to the English language)
2	Scopus	(TITLE-ABS-KEY ("OHSAS 18001" OR "ISO 45001" OR "occupational safety standard" OR "workplace safety standard" OR "health and safety standard" OR "Occupational Health and Safety Standards") AND TITLE-ABS-KEY ("adoption" OR "implementation" OR "certification" OR "compliance" OR "apply" OR "use" OR "follow" OR "choose") AND NOT TITLE-ABS-KEY ("food safety" OR "food industry")) AND PUBYEAR > 2010 AND PUBYEAR < 2025 AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final"))	391 (from 2010 to 2025 and limited to the English language)

3.2.2 Articles Screening

After collecting articles from the database, relevant studies were screened based on their titles and abstracts. The articles collected from the databases were added to the reference Management software Mendeley. The Mendeley folder was then exported as .ris file. This .ris file was then imported into the Covidence software. Covidence provides a feature to detect and delete duplicate articles; 136 duplicates were removed. It also offers a screening view for articles, displaying the title and abstract, along with options to respond: "Yes," "No," or "Maybe." Selecting "Yes" will move the article to the full-text review list, while selecting "No" will remove it from consideration.

Based on the relevance of the article's title and abstract with the adoption and implementation of safety standards, 482 articles were screened. The article focusing on occupational safety standards and discussing adoption and implementation were considered for further Full -Text Review. Thus, 341 articles were found irrelevant as they were not focused on occupational safety standard adoption decisions or the implementation process.

3.2.3 Full-text review

After screening the articles,141 articles were considered for full-text review. Based on the content of each article, they were tagged. During the full-text review, relevant articles were tagged, and notes regarding important discussions within those articles were added. The following tags were used. These tags were further helpful in deciding the eligibility criteria for the articles. An eligibility criterion was devised to select the final papers for the literature review. The articles with limited generalizability, focusing only on certification rather than adoption and implementation, less relevant to the research question were excluded.

Table 6: Tags for research articles

Tag	Description
Adoption	Articles discussing the adoption phase of occupational health and safety standards.
Implementation	Articles discussing the implementation phase of occupational health and safety standards.
Certification	Articles discussing the certification phase of occupational health and safety standards.
Direct Factors	Articles explicitly mentioning factors influencing adoption or implementation of safety standards.
Indirect Factors	Articles implicitly mentioning factors influencing adoption or implementation of safety standards.
ISO 45001	Articles specifically focusing on the ISO 45001 standard.
OHSAS 18001	Articles specifically focusing on the OHSAS 18001 standard.
Integrated Management System	Articles discussing Integrated Management Systems – Quality, Safety, and Environment Standards combined.
Case Study	Articles presenting case studies related to these standards.
Government Stakeholder	Articles highlighting the role or involvement of government stakeholders.
Management Stakeholder	Literature emphasizing the role or perspectives of management stakeholders.
Scholar Stakeholder	Articles discussing academic or research-oriented perspectives related to these standards.

Finally, 19 papers were selected, and 1 paper was considered by backward snowballing. Hence, 20 papers were then used to explore the factors.

The following PRISMA flow chart summarizes the paper selection process.

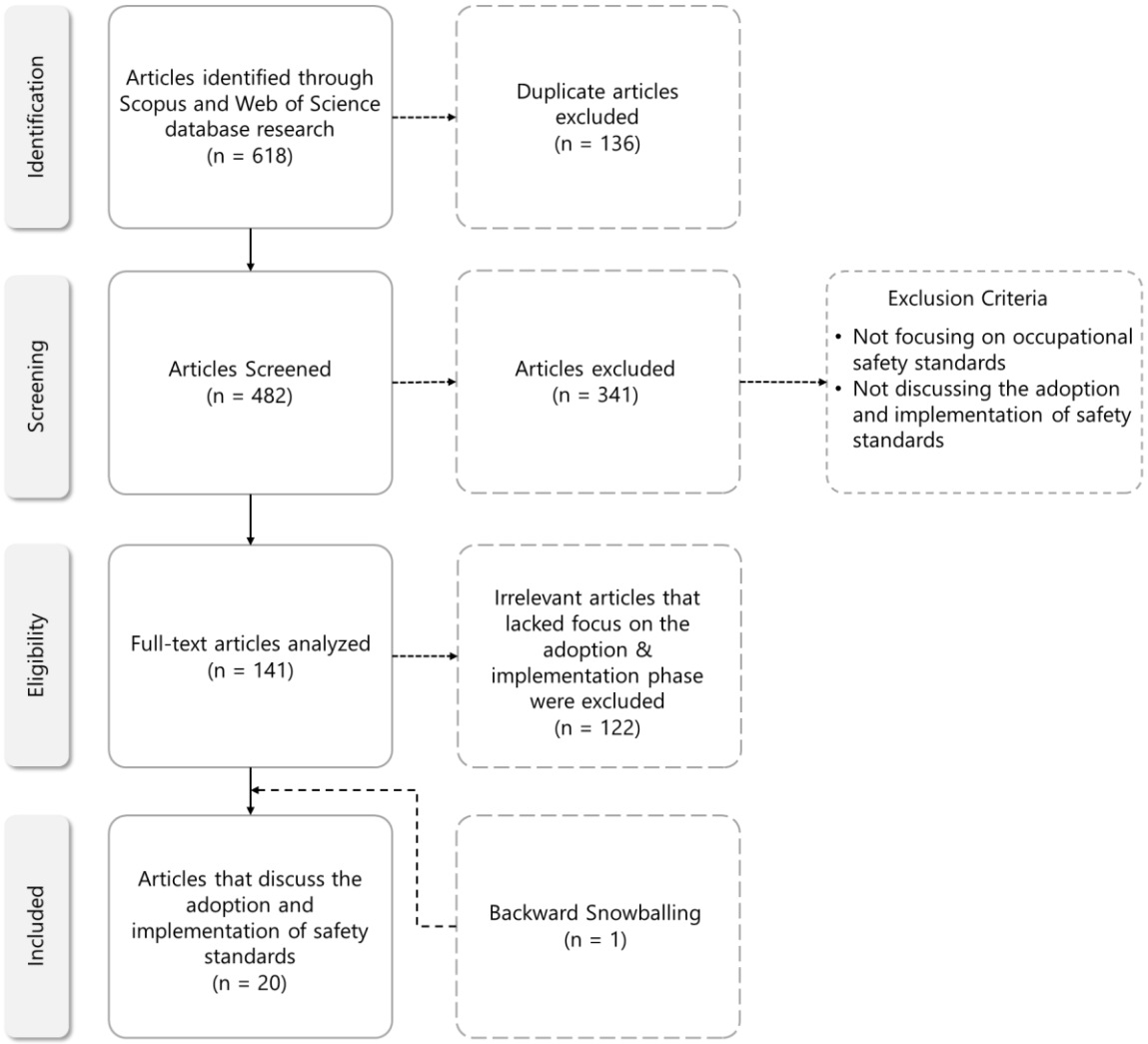

Figure 2: PRISMA Flowchart for systematic literature review (Moher et al., 2009)

3.2.4 Data Analysis - Coding for full-text review

According to Sekaran & Bougie (2016), qualitative data analysis consists of three main steps: Data reduction, Data display, and Drawing conclusions. Among these, the most crucial step is data reduction. This process involves coding and categorizing the collected data. Coding is an analytical method that entails reducing, reorganizing, and integrating qualitative data to develop theories. The main purpose of coding is to help derive meaningful conclusions from the data. Codes function as labels assigned to units of text, which are then grouped and classified (Sekaran & Bougie, 2016). Categorization involves organizing, arranging, and classifying these coded units (Sekaran & Bougie, 2016). The software ATLAS.ti is utilized for analyzing qualitative data in research. This tool facilitates thematic analysis by generating codes and categorizing the qualitative data collected. Codes and categories can be developed through both inductive and deductive approaches. All the selected articles were coded in ATLAS.ti 25 (Version 25.01.32924). All themes related to adopting and implementing occupational safety standards were coded

through inductive coding. The relevant excerpts were given a code, and the code comment explained the code. It is important to note that the transcripts of the exploratory interviews were also coded along with the research articles. The detailed codebook is provided in Appendix E.

Overall, 105 codes were created for adoption and 63 for implementation. These codes were preliminarily grouped together based on their affinity. The final categorization was done through a brainstorming session with thesis supervisors (experts in the fields of Safety culture and Standardization). Each code was taken into consideration, and codes with similar meanings and fields of responsibility were placed together to form a single factor. E.g., the codes of "Government Regulations", "Policy Compliance", "Policy Makers", and "Regulatory Pressure" were coined as the Factor – "Regulatory Pressure". Further, the factors that referred to a similar aspect were grouped under a single category. E.g., the factors of "Regulatory Pressure", "Value Chain Pressure", and "Broader Societal Pressure" were grouped under the category of "External Influence." These factors under the category of "External Influence" affect the decision of adoption of safety standards from outside the organization, hence, grouped together. This exercise resulted in 13 factors for adoption grouped under 4 categories. Similarly, this exercise was carried out for implementation and resulted in the formation of 6 factors (Note: The implementation framework follows a single-layer structure, consisting solely of factors. In contrast, the adoption framework is two-layered, with categories at the top layer that further branch into factors.)

3.2.5 Stakeholder Influence – Literature Analysis

To understand the influence of stakeholders on the top-ranked factors, specifically "Management Commitment," a literature review was conducted. The terms "Management Commitment; Leadership Commitment; influence; affect; safety," and their synonyms were used to frame search queries in the WoS database. The articles related to standard adoption, which explained the influences on the factor of Management Commitment, were chosen. The curated 5 articles were used as supporting literature for the expert interviews to answer the third research question.

3.3 Interviews

Interviews serve as a source of data collection at all stages of this research design. Semi-structured expert interviews were chosen for their flexibility in capturing in-depth insights while allowing comparability across responses. This method was preferred over surveys and focus groups due to the complexity and context-specific nature of the topic. A total of 18 interviews were conducted (2 exploratory for factor identification, 8 for MCDA and 8 for stakeholder analysis). Of the 18 interviews, 3 were conducted in person at the respondent's workplace and 15 were conducted via Microsoft Teams. All interviews were recorded with consent and transcribed using Microsoft Teams' automatic AI transcription. The interview transcripts were cleaned to remove any repeated filler words, correct grammar and formatting, and were anonymized by replacing the names of the experts with Participant Tags, such as "Expert 1" or "Participant 1". Field notes were also taken during the interviews to aid in data interpretation.

3.3.1 Exploratory interview for factor identification

In the first step, conducting a literature analysis and combining it with exploratory expert interviews qualifies as triangulation. Using triangulation as a qualitative research strategy, validity can be tested through information convergence from different sources, such as literature analysis and expert interviews (Carter et al., 2014). A test interview was conducted with the first supervisor (Prof. Karolien van Nunen), which led to refinement in the phrasing and sequence of interview questions to improve questioning style, flow, clarity and timely execution of the interviews. The interview questions are provided in Appendix C.1.

The first step involved interviews with 2 experts, one from a research background and the other from an industrial background. The detailed list of experts is presented in Table 20. These interviews were semi-structured exploratory interviews that started with open questions to identify factors experts think would be more salient for adopting and implementing safety standards. Later in the discussion of the ideas, the research framework and the literature analysis were presented to the experts. The interviews were held during the third week of March 2025, with each lasting one hour. With ethical considerations and norms, these interviews were recorded and transcribed.

As mentioned earlier, the transcripts were also coded in ATLAS.ti 25 (Version 25.01.32924), along with the research articles, to identify influential factors for Safety Standards adoption and implementation.

3.3.2 MCDA Interviews for Significance of Factors

In the second step of the interviews, a different set of experts was involved in weighing each factor in deciding the importance of the factors arrived after consulting the first step. The interviews took place during the first two weeks of April 2025 and lasted one hour.

Experts were selected from various industries that have already adopted and implemented the safety standards. These experts targeted were from industrial backgrounds like Safety officers, Consultants, etc., with more than 5 years of experience in the field of safety standards. These experts were contacted via LinkedIn networking, cold emailing, and connections via supervisors. A detailed list of experts is provided in Table 20. The interviews of these experts were included a survey. This survey was in the form of an Excel sheet with questions to get the scores for the pairwise comparison for the Best Worst Method (BWM) of Multi-criteria decision analysis (MCDA) for ranking the factors. At the beginning of the interview, a short presentation was made for the experts to understand the Factors framework and the BWM method. Further, during the survey, the definitions of each factor were discussed before moving on to the ranking. In this interview, a separate section was included to explore the influence of different stakeholders on the identified factors.

The reasons for collecting the necessary data through interviews were threefold:

1. The interview allowed for a discussion of the expert's explanations for their answers and ratings, providing a qualitative foundation for the accompanying quantitative data.
2. Although the survey was designed to be as intuitive as possible, it may take some time for users to become accustomed to the questioning method. Being present while

respondents completed the survey proved helpful in ensuring that they understood both the questions and the implications of the ratings they provided.

3. Certain factors were formulated in a way that allowed for multiple interpretations. Therefore, it was helpful to clarify the meaning of each factor during the completion of the surveys.

3.3.3 Stakeholder Interviews

The results of the MCDA analysis were presented to the experts, and the top 2 ranked factors were chosen for stakeholder interviews. The document with detailed information was shared earlier. The interview questions were open-ended, aimed at helping the experts think and explore the stakeholders behind the top two ranked factors. Experts were asked to answer how these two top-ranked factors can be influenced and how they can influence these factors. This was done for both adoption and implementation. The detailed questionnaire is in Appendix C.4. The ethical clearance was included in the MCDA consent form itself. A total of 8 experts were interviewed. The list of experts interviewed is available in Table 20. These interviews were conducted in the last week of April and the first week of May 2025 and lasted for around 30 to 45 minutes. The interview transcripts were coded in ATLAS.ti 25 (Version 25.01.32924) to identify the stakeholders influencing the top 2 ranked factors for adoption and implementation. 48 codes were generated, 25 for adoption and 23 for implementation factors.

As there were 4 factors discussed in the interviews – Under adoption – Management Commitment and Regulatory Pressure; for implementation – Commitment and Communication & Trainings. Each code indicated to which factor it belonged, which stakeholder influenced that factor, and was followed by how the stakeholder was influencing the factor (each of these separated by an underscore sign "_"). To indicate the factor, numbers were used in the code i.e. 1 was used to indicate the factor Management Commitment, 2 for Regulatory Pressure, 3 for Commitment and 4 for Communication & Trainings.

Each code was assigned a comment summarizing its meaning based on the explanations provided by the experts. As coding progressed, the nuances discussed by different experts were incorporated into the comments to capture all insights. These comments were developed throughout the coding process and were later used to define each code.

E.g.: the code *1_Government_ExternalPressure* indicates that the code is for the factor *Management Commitment* and is influenced by the Stakeholder – *Government* and the influence that it has on the Management Commitment is to have an *External Pressure*. And the corresponding comment says "Give external drive to the company's management commitment - external incentive," which further transcends into the definition of this code: "Provides external incentives that drive management's commitment to safety through regulations and policies."

3.4 Best Worst Method

Answering the first research question involved coding the curated literature and expert interviews. This resulted in a list of factors influencing adoption and implementation. The MCDA interviews were further carried out to identify the significance of these factors by weighing them using the Best Worst Method (BWM). The BWM by Rezaei (2015), was used because it is one of the reliable and consistent Multi-Criteria Decision Making (MCDM) methods. This method uses

the most and least important factors as the reference to provide a structured methodology for the experts to conduct the pairwise comparison. Also, the number of pairwise comparisons required to be made with this process is less than any other MCDM method.

Best Worst Method has been applied in the literature very widely, e.g. Hoogerbrugge et al. (2023) used this method to weigh the factors determining the quality standard for corporate greenhouse gas inventories. Similarly, Jurg et al. (2025) applied BWM to determine the significance of factors affecting the adoption of quality standards in the semiconductor industry.

The linear Best-Worst Method (BWM) offers significant benefits in managing cognitive biases and enhancing data efficiency in multi-criteria decision-making (MCDM). By asking decision-makers to identify only the most and least important criteria, BWM reduces the cognitive load associated with extensive pairwise comparisons. This structured approach helps mitigate common biases, such as anchoring, where initial information unduly influences judgments, and equalizing bias, which occurs when similar importance is assigned to all criteria. As a result, BWM increases the reliability and consistency of the preferences that are expressed (Rezaei, 2022).

BWM is more data-efficient than traditional methods, such as the Analytic Hierarchy Process (AHP). While AHP requires a full set of pairwise comparisons, BWM greatly reduces the number of comparisons needed. This streamlining of the decision-making process does not compromise accuracy. This efficiency is especially advantageous in complex decision scenarios with a large number of criteria (Wu et al., 2024).

These attributes make the linear BWM a robust and practical tool for deriving reliable criteria (henceforth denoted as factors) weights in various MCDM applications.

3.4.1 BWM Process

The BWM for weighing the factors includes the following steps Rezaei, 2015, 2016):

Step 1: Identify a set of decision-making factors, i.e., the framework for adoption and implementation. In this step, a set of factors $(c_1, c_2, \dots, c_n)$, are chosen based on the literature review and exploratory interviews.

Step 2: The expert chooses the best (i.e., the most influential) and the worst (i.e., the least influential) factor in each category. We only need to compare factors within the same category at this stage. For example, we first compare the factors within the "External Influence" category. Hence, factors from the "Firm Characteristics" category are not considered for comparison with those from the "External Influence" category. Next, we compare factors within the "Firm Characteristics" category, followed by the "Company Goals" category, and then "Standard Characteristics".

Similarly, for the categories, the expert determines the best (i.e., the most influential) and the worst (i.e., the least influential) category.

Since, in our case, we have 13 factors for adoption, and they are clustered in 4 categories, now the experts also perform pairwise comparison among these 4 categories. At the end, we multiply the weight obtained for each factor belonging to each category by the weight of the whole category to get the "global" weight of the factor.

Step 3: The expert determines the preference of the best factor to the rest of the factors within the same category. And the same to determine the preference of the best category to the rest of the categories. This is done using scores between 1 and 9, where 1 implies equally influential and 9 means extremely influential. The Best-to-Other vector would be something like: $A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$ where, a_{Bj} refers to the preference of the best factor B over the factor j.

Step 4: The expert determines the preference of all the factors over the worst factor by using a number between 1 and 9. Similarly, the preference of all the categories over the worst category is determined. This delivers the Others-to-Worst vector: $A_W = (a_{1W}, a_{2W}, \dots, a_{nW})^T$, where a_{jW} is the preference of the factor j over the worst factor W.

Step 5: According to Rezaei (2016) the optimal weights $(w_1^*, w_2^*, \dots, w_n^*)$ are calculated, where we have to find a solution by which the maximum absolute differences of $|w_B - a_{Bj}w_j|$ and $|w_j - a_{jW}w_W|$ should be minimized. This is translated to the following mathematical model:

$$\min max_j \{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\}$$

such that

$$\begin{gathered} \textstyle\sum_j w_j = 1, \\ w_j \geq 0, \text{ for all } j \end{gathered} \tag{1}$$

Model (1) is equivalent to the following model:

$$\min \xi,$$

such that

$$\begin{gathered} |w_B - a_{Bj}w_j| \leq \xi, \text{ for all } j \\ |w_j - a_{jW}w_W| \leq \xi, \text{ for all } j \\ \textstyle\sum_j w_j = 1 \\ w_j \geq 0, \text{ for all } j \end{gathered} \tag{2}$$

Solving model (2) results in the optimal weights $(w_1^*, w_2^*, \dots, w_n^*)$ and ξ^*. The consistency ratio is determined by using specific formulas for input-based BWM (Liang et al., 2020):

$$CR = \max_j CR_j$$

Where,

$$CR_j = \begin{cases} \frac{|a_{Bj} \times a_{jW} - a_{BW}|}{a_{BW} \times a_{BW} - a_{BW}}, & a_{BW} > 1, \\ 0, & a_{BW} = 1. \end{cases} \tag{3}$$

The consistency ratio calculated is compared to the threshold values in the table below.

Table 7: Thresholds for various combinations using input-based consistency measurement (Liang et al., 2020)

Scales	Factors						
	3	**4**	**5**	**6**	**7**	**8**	**9**
3	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667
4	0.1121	0.1529	0.1898	0.2206	0.2527	0.2577	0.2683
5	0.1354	0.1994	0.2306	0.2546	0.2716	0.2844	0.2960
6	0.1330	0.1990	0.2643	0.3044	0.3144	0.3221	0.3262
7	0.1294	0.2457	0.2819	0.3029	0.3144	0.3251	0.3403
8	0.1309	0.2521	0.2958	0.3154	0.3408	0.3620	0.3657
9	0.1359	0.2681	0.3062	0.3337	0.3517	0.3620	0.3662

In case of the category "Firm Characteristics," it includes only two factors, viz. "Management Commitment" and "Resources". Here, there is no need to check consistency; the comparison is fully consistent because there are no additional factors to introduce inconsistency. Here, the expert decides the weights of the factors by stating the level of significance, e.g., "Management Commitment" (a) is 3 times more important than "Resources" (b). Then the weights of the factors will be $W_a = 0.75$ and $W_b = 0.25$ by simple normalization.

Once we find all the weights, the local average weights of all the factors and the categories from the experts' responses are calculated. Note that the local average weight calculated is the geometric mean. Now, to form the global weights of the 13 factors, we multiply the local average weight of each factor by the local average weight of its respective category.

E.g., the "Regulatory Pressure" belongs to the "External Influence" category. To calculate the global weight of the "Regulatory Pressure" factor, we multiply its local average weight of 0.66 by the local average weight of the "External Influence" category, i.e., 0.23. Thus, we obtain the global weight of the "Regulatory Pressure" factor as 0.15. Similarly, we carry out this for all the other factors.

We perform all the above steps for the implementation factors as well; however, since categories do not exist in the implementation framework, we follow the process only for the factors, assuming they fall under one category.

4 Results

4.1 Framework for Adoption and Implementation Factors

4.1.1 Literature Research

The factor identification for adoption and implementation was divided into 2 parts: Literature Review and Exploratory Expert interviews. This section presents the findings, along with mentioning the changes in approach for the literature review. After a systematic review, 20 research articles were finalized for the factor identification. Section 2.5 This text provides a concise overview of the methodology and findings from the articles. The final list of papers considered for factor identification is provided in Appendix B, Table 16. The following figure shows a visual representation of key themes in the selected articles.

The initial idea to search for the articles was to perform a separate search of papers for adoption and implementation. After defining the search queries for these separate searches, it was observed that several articles were repeatedly occurring in both searches. On skimming a couple of articles and reading the abstracts of these articles, it was also observed that the notion of adoption and implementation of safety standards was mixed. The terms adoption, implementation, and certification were often used interchangeably. Hence, it was decided to first define these 3 terms and set a clear frame to look through each research article. This led to a combined search for articles to identify factors for adoption and implementation. These definitions proved to be useful for distinguishing the adoption and implementation factors mentioned in the research articles.

The selected 20 papers were coded in ATLAS.ti. The codes generated are provided in Appendix E. The codes were maintained separately for Adoption and implementation in order to be able to make 2 different frameworks.

The following paragraphs present the findings from the literature that led to the formation of the factors in the framework.

Adoption

Many of the articles focused on the aspect of external pressure on companies to adopt a safety standard. The frequently occurring concept was regulatory or governmental pressure. The literature mentioned that the companies adjust their strategic approach and adopt safety standards for securing their legitimacy and meeting the government's requirements. It was also noted that the policymakers promote the use of safety standards by making it a regulatory requirement to facilitate a safe working environment and control occupational risks within the industries (da Silva & Amaral, 2019; Ghahramani, 2016; İnan et al., 2017; Yang & Maresova, 2020).

Along with the Regulatory pressure, a lot of articles mentioned the influence of the stakeholders external to the company. Literature stressed the influence of the dominant industry in the sector, driving its suppliers to adopt safety standards (Madsen et al., 2022; Rajaprasad & Chalapathi, 2015; Singh, 2024). Such pressure could be considered as pressure from the industry leader or

an extrinsic-driven effort to follow the industry trend or the basic B2B customer demand (Fernández-Muñiz et al., 2012; Pedrosa et al., 2024; Vlachos, 2018). Furthermore, a few articles highlighted the pressure of market competition on companies to stay relevant in the market by adopting safety and other integrated management systems (Castiblanco et al., 2020; Fernández-Muñiz et al., 2012). Literature also mentioned the pressure from the labor union demanding that the company adopt a safety standard for the welfare of the workers (Fernández-Muñiz et al., 2012). All the concepts indicated the effect of value chain pressure on the adoption of safety standards.

One of the most widely discussed concepts in the literature was the Management Commitment. Scholars indicated proactive and dedicated leadership as one of the factors for driving the adoption (da Silva & Amaral, 2019). The literature addressed various aspects of this factor, including the systematic management approach to prioritizing safety and enhancing awareness of safety standards. The aspect dealt with internal motivation and internal polices of the companies (da Silva & Amaral, 2019; Ghahramani, 2016). Along with studies, the role of resource availability within the company for the adoption decision was also emphasized. Availability of resources indicated the company's size, available workforce, financial resources, and other competencies. Campanelli et al. (2021) noted that small and medium-sized companies often lack the specialized staff to be involved in the adoption decision and the standards implementation.

Along with the characteristics of the companies and external factors, various intrinsic motivations were also observed as drivers of adoption. One of the factors closely linked to the external factors was the image of the company. It is necessary that the company maintains a reputation in the market, i.e., within the industry, as well as among the general public. It also needs to have a good relationship with the government. Nowadays, industries focus on showcasing how the products are made, and hence, along with quality standards, sustainability, and safety standards, have also seen demand from consumers. Also, adopting safety standards helps build a clean image for the company in the government's eyes. Thus company image becomes a driver for standards adoption (Ling et al., 2015; Rajaprasad & Chalapathi, 2015; Vu Gia et al., 2024).

The literature also emphasized that the safety standards suggest effective risk management strategies and help improve the working conditions in the industries. With this benefit, companies aiming toward safe working environments adopt safety standards. The goal of the firm is to focus on employees' well-being, improve safety performance, and even hazard identification, which would lead to the decision on adoption (Campanelli et al., 2021; Castiblanco et al., 2020; Fernández-Muñiz et al., 2012; Rajaprasad & Chalapathi, 2015). This aim could also extend towards providing a better infrastructure and guidelines for employee safety training (Ling et al., 2015).

The intrinsic motivation to adopt a safety standard could also be driven by the benefits of adoption. Studies provide evidence of cost savings and increased operational efficiency due to safety standard adoption (Lafuente & Abad, 2018b; Vlachos, 2018). In their study, Ling presented the fact that adoption of safety standards leads to 80.9% of accidental cost reduction (Ling et al., 2015). Beyond this, complying with the international safety standards opens doors to global expansion of the companies by selling the products and services across the continent, thus increasing the business opportunity (Singh, 2024).

The literature also gave importance to the relevance of standards to the company's operation while discussing the choice of standard adoption. This gave rise to the factor of compatibility, as the studies stressed the importance of compatibility of the standard to address the operational risks within the company (Uhrenholdt Madsen et al., 2020). Furthermore, the cost of standard, availability of the resources, and consultants to guide the adoption process were found to be the decision-shaping factors (Abad et al., 2016; Bevilacqua et al., 2016; Madsen et al., 2022). The quality of standards was also one of the valued factors in the literature. Madsen et al. (2022) gauged the quality by the process of certification. They stated that the process of audit helps to uncover incompetent OHSMS and highlights the scope of improvement by systematic risk assessment.

Overall, the literature underscored the importance of external and internal factors influencing adoption, along with discussing intrinsic motivations and the company and standard characteristics.

Implementation

Similar to the adoption of safety standards, Commitment was one of the most frequently occurring factors for implementation. But here it was not just the managerial commitment. The literature emphasized the involvement and dedication of all employees at the company, from top to bottom levels. There were 2 key aspects to this factor: first, Management Involvement, and second, overcoming employee resistance. Management Involvement is in terms of dedication toward providing necessary support (Bevilacqua et al., 2016) and motivating the middle-level and lower-level employees for the upcoming change in the implementation (Ghahramani, 2016). Along with this, the upper management leads the changes to the safety policy (Campanelli et al., 2021) of the company, thus influencing both the safety culture and implementation. Rajaprasad & Chalapathi (2015) recognized Employee resistance as a critical barrier to safety standards implementation. They also discussed parallel concepts of the morale of Employees, employee encouragement as a part of employee commitment. This intensified the importance of the role of lower-level commitment in the implementation process.

Another frequently occurring theme was the necessity of communication and training for the implementation of safety standards. Though this factor had various aspects, from employee demographics to technology integration, the major focus lay on the training programs. Pedrosa et al. (2024) quoted from Cox et al. (1998) that "*the quality of safety training is considered a key factor for a strong safety culture.*" Rajaprasad & Chalapathi (2015) mentioned that "*Safety trainings - Continuous process as it will influence on behavior of employees*". This indicated that to overcome employee resistance and to take control measures for behavioral change, continuous training as part of a continuous improvement mechanism is crucial. Many of the authors mentioned the benefits of the awareness created by the proper and clear communication to the employees (Campanelli et al., 2021; Darabont et al., 2017).

As the compatibility of the standard was discussed when studying adoption, this term showcased similar importance in the implementation phase as well. Compatibility of the standard discussed various key points, ranging from company size to company culture. The match of the standard with the characteristics of the company defines the effectiveness of the implementation. Darabont et al. (2017) mentioned that the relevance of an OHSMS is very essential as it could fit the structure of the organization and provide a proper assessment of risk

elements. This analysis is crucial for a better operational integration of the standard and, hence, an effective implementation (Lafuente & Abad, 2018b).

The literature also stressed the availability of resources for implementation. Here, resources refer to the company's available financial assets, skilled personnel, and infrastructure necessary for implementing safety standards (Abad et al., 2016; Ghahramani, 2016; Rajaprasad & Chalapathi, 2015). Few studies also highlighted the support of external resources, such as government support with trainings and audits, as an influential factor for implementation (Campanelli et al., 2021; Ghahramani, 2016; Pedrosa et al., 2024).

Thus the above findings from the literature discuss various requirements, barriers, and success factors that influence the implementation of safety standards.

4.1.2 Exploratory Expert Interviews

This section presents the findings from two exploratory expert interviews conducted to identify the factors influencing the adoption and implementation of occupational safety standards. The insights have been thematically organized into five main categories: external factors, internal factors, barriers to implementation, implementation strategies, and the role of technology. The detailed questionnaire used for these interviews is in Appendix C.1.

External Factors Influencing Adoption

The experts highlighted various external forces, from regulatory to various value chain pressures, shaping the decision of safety standards adoption.

- Industry Norms and Peer Influence: P1 observed that the influence of dominant companies in the industry significantly affects the adoption decisions made by smaller companies within the same sector. This pressure could be from the perspective of adopting a standard to the establishment of a particular standard throughout the industry. Thus, this leads the smaller companies to tend to follow the industry leaders to stay competitive and maintain legitimacy in the market.

- Customer-Supplier Demands: Both experts stressed the importance of Business-to-Business (B2B) customer expectations. Especially in sectors like pharmaceuticals and manufacturing, clients often require suppliers to comply with established safety frameworks. This results in an external value chain pressure from the customers to comply and hence adopt safety standards. P2 also mentioned that with increased awareness in society, there is also pressure in the Business-to-Consumer (B2C) sector, where the end-consumers demand compliance with safety standards by the company, leading to the adoption decision.

- Regulatory and Insurance Pressures: Government regulations and policies were described as extremely influential. P1 also highlighted that companies with poor safety records face higher insurance premiums, which incentivizes the adoption of formal safety management systems to mitigate risk and reduce costs.

- Cultural and Social Expectations: P2 noted that local social and cultural norms impact how safety is perceived and prioritized. In regions where safety and sustainability are

emphasized, companies are more likely to adopt formal standards to align with public expectations.

Internal Factors Influencing Adoption

The experts gave a brief overview of factors, internal organizational aspects that influence the decision of adoption.

- Management Commitment: The factor concerning the support and dedication from the top management was heavily emphasized by both experts. P1 stated that "Without top management support, safety standards will remain just a formal procedure." It was also mentioned that it is management's commitment to allocate the resources for standards adoption and implementation. This showcases that the factor of "Management Commitment" is one of the primary factors as it affects and influences other related factors.

- Organizational Culture: As discussed in the external influences about the broader cultural aspect, workplace culture and company values are equally important as an internal factor. This factor impacts the prioritizations of safety within the organization. P2 linked safety culture directly with employee motivation, explaining that if safety is embedded in daily routines and values, implementation becomes smoother. P1 mentioned the Influence of the Mother Company on the standards adoption, based on the values and geographic location of the Mother Branch of the company, the adoption decision of other locations is impacted.

- Company Size and Resources: The experts also noted that larger organizations typically have more financial and human resources to allocate toward safety initiatives. Smaller firms may struggle due to limited budgets or a lack of specialized personnel.

- Employee Engagement and Trust: P2 heavily emphasized the development of trust. Trust in leadership and perceived fairness in implementation influence employee participation. Both experts agreed that involving employees early increases ownership and compliance.

Barriers to Adoption and Implementation

Discussing the barriers reveals the underlying factors impacting the decision and process of adoption and implementation

- Resistance to Change: Resistance to any kind of change is inevitable from both employees and managers. Experts noted that it is a major consideration, especially if the organization has not experienced major safety incidents. P1 noted that in such cases, the perceived need for formal standards may be low.

- Resource Constraints: As discussed in the internal factors as well, financial, technological, and human resource limitations are frequently mentioned as barriers, particularly for small and medium enterprises or organizations operating in financially constrained environments. These hinder the adoption and effective implementation.

- Complexity and Documentation Requirements: P1 pointed out that the bureaucratic nature of many safety standards requires heavy documentation and audits. This adds considerable extra activities to the worker in order to implement a safety norm. Such implementation fatigue may lead to ineffectiveness. This factor is an indication of the quality and compatibility of the safety standard**.**

Strategies for Successful Implementation

Successful implementation strategies depict the factors that can be controlled or changed for an effective process of implementation. The following factors were discussed by the experts

- Employee Involvement: To avoid the implementation fatigue issues as mentioned in the earlier section, both experts emphasized early and active involvement of employees as critical. They highlighted that including staff in planning, training, and feedback processes improves buy-in and practicality.

- Leadership Support: The importance of visible and sustained leadership support was repeatedly highlighted. Allocation of resources, communication of importance, and integration of safety into overall strategic goals by the leadership; were the key strategies.

- Integration with Existing Systems: Aligning safety standards with current operational and management systems was suggested as a best practice to avoid redundancy and ensure smoother adoption.

- Continuous Monitoring and Improvement: P1 stressed that implementation should not be seen as a one-time project but as an ongoing process involving regular evaluation and updates.

Role of Technology

Both experts acknowledged the growing influence of technology in safety management. P2 discussed the role of Artificial Intelligence (AI) in improving risk assessments and supporting "design for safety" approaches. But it was also noted that technological solutions must be introduced carefully, especially in organizations with a senior workforce that may not be familiar with advanced systems.

4.1.3 Final Framework

In a brainstorming session with supervisors, a thematic analysis of 20 peer-reviewed articles and two expert interviews resulted in the formation of 4 main categories, with a total of 13 factors that influence adoption, and 6 factors that influence the implementation of Occupational safety standards. The final framework for adoption and implementation is as follows

Adoption Factors

Combining the codes with similar aspects and grouping them according to their affinity, the factors were formed. These factors were further grouped to form 4 categories, viz. External Influence, Firm Characteristics, Company Goals, Standard Characteristics.

The entities external to the company showed influence on the company's decision to adopt safety standards. These outside pressures were from the Governments, the consumers, labor unions, insurance companies, or even from society, further mainly denoted as Regulatory Pressure, Value Chain Pressure, and Broader Societal Pressure. All these factors were grouped under the External Influence category.

The factors that indicated the sole attributes of a company, e.g., the commitment of management toward adoption of a standard and the resources available to that company, were put under the category of Firm/ Company Characteristics.

Factors that showcased the motive behind the adoption of safety standards formed the Company Goals categories. Companies would have multiple reasons that drive the decision of adoption, e.g., having a safe working environment for its employees could be a decisive factor, as well as being able to sell its product across the continents and expanding to global markets, be the reason.; both will require safety standard adoption and compliance.

Along with the consideration of external and internal factors, some factors are also related to the attributes of standards that could determine the choice of standard for adoption. It consisted of Compatibility, Cost, and Quality of a standard, and these factors were grouped under the category of Standard characteristics.

The following table contains the definitions of these factors, which include the essence of the codes that formed the factors. These definitions were useful in providing a guideline for all the experts involved in the MCDA interview.

Table 8: Definition of Adoption Factors

Category/ Factors	Definitions
External Pressure	This category includes factors influencing adoption that are outside or external to the company deciding to adopt safety standards. It includes 3 factors broadly covering all the external forces.
Regulatory Pressure	This refers to the external influence of the laws, policies, or regulatory bodies that compel organizations to decide whether to adopt safety standards. It points to the pressure from government mandates formed to encourage the adoption of safety standards for workplace safety.
Value Chain Pressure	This refers to the pressure from external stakeholders in the value chain and beyond. This includes pressure from the organizations to which the company is supplying to or even the direct consumers. This pressure also includes peer pressure and industry leaders' pressure to follow the trends in the industry to remain competitive. This pressure also highlights the influence of insurance companies to push companies toward adopting safety standards to gain insurance benefits.
Broader Societal Pressure	Broader societal pressures refer to the collective influence exerted by society at large—individuals, communities, and cultural norms—on a company or industry to adopt certain behaviors, practices, or standards. These pressures are often rooted in ethical and social considerations that aim to create benefits for society as a whole. This idea also connects deeply to how companies address Corporate Social Responsibility (CSR)

Firm/ Company Characteristics	This category includes 2 factors defining firm/ company characteristics i.e. the all round commitment of the company's management and the resources available with the company influencing the adoption of safety standards.
Management Commitment	This refers to the dedication of the top management and the leadership to adopt the safety standards. It also deeply roots the policy and culture within the company to promote and consider safety standards adoption as a priority task. It involves all the decision-making moments that management commitment takes toward standards adoption. It also highlights the influence of the parent company on its branches in other locations.
Resources	This refers to the availability of resources within the company. Assets like employee skills and numbers, finance, materials, time, size and infrastructure that a company has to or can manage to adopt the safety standards.
Company Goals	This category refers to the company goals that drive the adoption of safety standards. There are 5 factors under this category.
Company Image	This refers to the reputation and perception a company wants to build among its stakeholders, including the public, industry peers, customers, and the government. By adopting safety standards, companies aim to project a responsible and ethical image, enhancing trust, credibility, and market appeal.
Cost Savings	This refers to the reduction of expenses or financial outlays achieved through minimizing government fines (for non-adoption), lowering accident-related costs, reducing insurance premiums by adopting standards and systems
Safe Working Environment	This refers to the commitment to ensuring the physical and psychological well-being of employees and workers. Prioritizing safety, companies align with their values by adopting safety standards.
Operational Efficiency	This refers to maximizing outputs while minimizing inputs, such as costs, time, and resources. Adopting safety standards can significantly improve operational efficiency by minimizing accidents and ensuring smoother workflows.
Global Expansion	This refers to the strategic goal of extending its operations, products, or services beyond domestic borders into international markets. Hence, it involves adapting to global safety standards to ensure compliance and competitiveness in diverse regions. By expanding globally, companies aim to access new customer bases, diversify revenue streams, enhance brand recognition, and achieve sustainable growth in a competitive global landscape.
Standard Characteristics	This category defines attributes of a standard, including its scope, applicability, and effectiveness in achieving specific goals, such as safety, quality, or efficiency.
Compatibility	This refers to how well a standard aligns with a company's existing systems, processes, and culture. For example, integrating ISO 45001 for safety with ISO 9001 for quality ensures seamless adoption.
Cost of Standard	This includes all expenses related to adopting a standard, such as certification fees, training costs, and implementation expenses.
Quality of Standard	This measures the standard's ability to effectively address its intended purpose, such as protecting employees from workplace hazards or ensuring product reliability. High-quality standards provide tangible benefits and align with organizational goals.

Implementation Factors

Table 9: Definitions of Implementation Factors

Factors	Definitions
Communication & Trainings	This involves the exchange of information and the education of employees to ensure they understand and effectively implement standards. It includes clear communication from leadership and structured training programs to align everyone with the processes and goals.
Compatibility with the company	This refers to how well a standard integrates with a company's existing systems, culture, and values. Smooth compatibility ensures faster adoption and minimizes disruptions during implementation.
Commitment	This represents the dedication of management, leadership, and employees to allocate resources and prioritize the implementation of safety standards. It reflects the organization's willingness to embrace change and uphold safety standards and systems.
Resources	It encompasses the human, financial, and material assets required for implementing standards. Adequate resources ensure the successful integration and ongoing compliance with the chosen standards.
Government Support	This refers to the assistance provided by governmental bodies to facilitate the implementation of standards. It can include subsidies, consultations, internal audits, or awareness programs that reduce barriers and accelerate implementation.
Continuous Improvement Mechanisms	This is an ongoing effort to enhance processes, systems, and practices within an organization. It involves monitoring, feedback loops, compliance checks, and audits to identify areas for improvement. The PDCA (Plan-Do-Check-Act) cycle is often used as a framework to drive these iterative enhancements. Continuous improvement influences the process of implementation of safety standards.

4.2 Significance of Factors

4.2.1 BWM Results for Adoption Factors

The Best-Worst Method (BWM) facilitated the calculation of importance weights for all the factors within each category, as well as the overall importance weights for each category, for each expert. By multiplying the weight assigned by the expert to a factor within a category with the weight attributed to that category, we can compute a resulting global weight of importance. These global weights can then be compared to understand the significance of each factor. The following table presents these weights and rankings for adoption factors.

Table 10: Weights of importance attributed by the experts for all evaluated adoption factors

No.	Categories and Factors	E1	E2	E3	E4	E5	E6	E7	E8	Local Average Weight	Global Average Weight	Global Ranking
A	**External Influence**	**0.21**	**0.14**	**0.07**	**0.18**	**0.47**	**0.29**	**0.59**	**0.26**	**0.23**		
A1	Regulatory Pressure	0.68	0.67	0.58	0.67	0.67	0.60	0.76	0.66	0.66	0.15	2
A2	Value Chain Pressure	0.26	0.26	0.31	0.26	0.25	0.33	0.11	0.24	0.24	0.06	3
A3	Broader Societal Pressure	0.06	0.07	0.11	0.07	0.08	0.08	0.13	0.10	0.09	0.02	10
B	**Firm Characteristics**	**0.53**	**0.58**	**0.22**	**0.27**	**0.27**	**0.51**	**0.12**	**0.49**	**0.33**		
B1	Management Commitment	0.83	0.60	0.83	0.67	0.91	0.75	0.60	1.00	0.76	0.25	1
B2	Resources	0.17	0.40	0.17	0.33	0.09	0.25	0.40	0.00	0.12	0.04	6
C	**Company Goals**	**0.21**	**0.23**	**0.13**	**0.48**	**0.13**	**0.15**	**0.06**	**0.18**	**0.17**		
C1	Image	0.11	0.10	0.10	0.09	0.06	0.13	0.10	0.23	0.11	0.02	11
C2	Cost Savings	0.18	0.17	0.17	0.05	0.10	0.06	0.44	0.42	0.15	0.03	9
C3	Safe Working Environment	0.48	0.25	0.44	0.52	0.25	0.47	0.17	0.16	0.31	0.05	4
C4	Operational Efficiency	0.18	0.44	0.25	0.15	0.13	0.26	0.25	0.09	0.20	0.03	7
C5	Global Expansion	0.05	0.05	0.05	0.20	0.46	0.09	0.05	0.09	0.09	0.01	12
D	**Standard Characteristics**	**0.05**	**0.05**	**0.58**	**0.06**	**0.13**	**0.05**	**0.24**	**0.07**	**0.10**		
D1	Compatibility	0.08	0.70	0.20	0.67	0.63	0.75	0.57	0.60	0.43	0.04	5
D2	Cost of Standard	0.12	0.19	0.09	0.07	0.17	0.08	0.14	0.08	0.11	0.01	13
D3	Quality of Standard	0.80	0.11	0.71	0.26	0.20	0.17	0.29	0.33	0.29	0.03	8

External Influence

The following figure represents the Global Average Weights of the factors in the External Influence Category. Regulatory Pressure scored the highest in the External Influence category with a global average weight of 0.15. In BWM, all the experts placed this factor as the Best factor. Expert 1 noted, "If *something is in law, it will always take precedence."* The factor Boarder Societal Pressure scored the lowest in this category. Though Expert 7 ranked this factor higher than Value Chain pressure, all other experts ranked it the lowest in the category. Expert 3 mentioned a caveat regarding broader societal pressure. The expert noted that this pressure ranks lower unless the pressure from society on a company is very high, particularly in the case of a publicized accident. Such incidents can lead to immense damage to a company's image, prompting society to demand improvements in the company's safety measures.

The Value Chain Pressure was evaluated as the second most influential factor in this category. The experts noted that the external entities to the value chain, i.e., the suppliers and the insurance companies, pressurize the adopters. This pressure is in terms of the reduced insurance premium benefits or the placement of new orders with the company after the safety standards adoption. This indicated that the business choices of a company are driven by the value chain and they also affect the standards adoption.

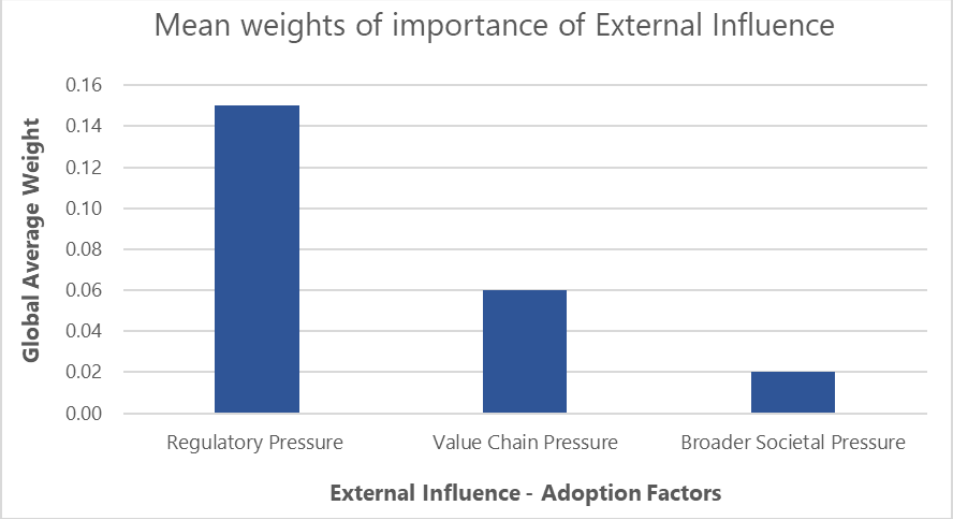

Figure 3: Mean weights of importance of External Influence – Adoption Factors

Firm Characteristics

Among the 2 factors in this category, the Management Commitment factor was observed to be most influential, with a global mean weight of 0.25. Expert 5 mentioned that "*Management commitment, because it starts there. Otherwise, it doesn't make sense. So, doesn't matter whether they have resources or not, because there are never infinite resources in any company. And if the management commitment is there, they will find a way to do it. So, they will do the resource allocation."* This indicates that management commitment is primary to resource allocation, as management decides on the allocation of resources and brings in the necessary resources if they are not available. Expert 6 also noted that, "*If they are not committed, then there is no*

approval for the resources, like it could be material or the number of employees, workers, etc., and everything." All other experts also considered Resources to be less influential than Management Commitment.

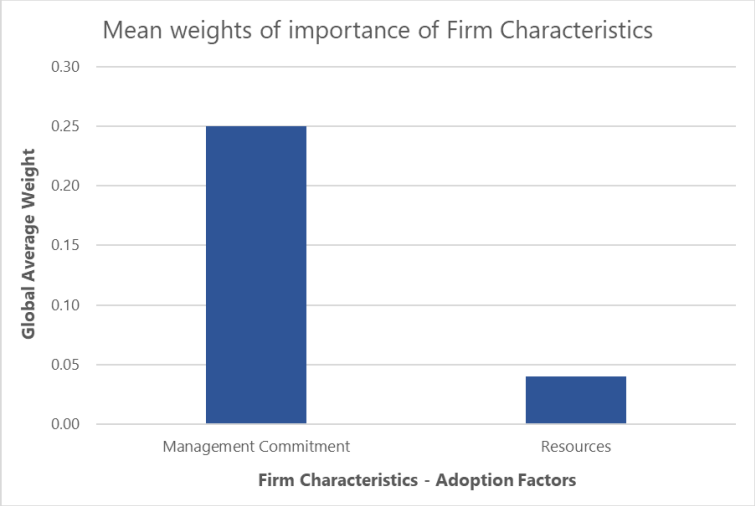

Figure 4: Mean weights of importance of Firm Characteristics - Adoption Factors

Company Goals

This category represents the motivation and the goals of the company driving the decision to adopt safety standards. Providing a Safe Working environment to the workers and the employees in the company proved to be the most influential factor in this category, with a global mean weight of 0.05. The factors of Operational Efficiency and Cost Savings hold equal importance in this category, with Company Image following closely.

When considering individual experts' responses, Expert 2 weighed the Factor Operational Efficiency based on the experience in various production industries. Experts 7 and 8 ranked Cost Savings as the most influential factor in this category. Expert 7 noted, "*If you don't make a profit or a good profit. Then it will be hard to work on image, or a safe working environment, or even global expansion*." Similarly, Expert 8 emphasized that Cost Savings is the primary goal, which could be achieved by having good operational efficiency, but it starts with Cost Savings. Expert 5 mentioned a caveat stating, "A *small to medium-scale company would definitely say that cost savings is the most influential. They would definitely look into the cost-saving factor, whereas a large-scale industry would definitely have Operational Efficiency and Global Expansion in their mind.*"

Global expansion ranked the lowest in this category. Expert 1 noted, "*The trouble with global expansion is that most companies on Earth are not thinking about global expansion if you're strict because they're very unlikely to ever go abroad with their product or service.*" Parallel to this comment, Expert 3 also said, "*Because my perception and my experience is that global expansion is a more obscure goal of organizations, and many organizations do not have global requirements. For example, construction companies may be very strongly based on their home country. That's*

why it comes very low on my criteria." These comments indicated that Global Expansion is the least influential factor.

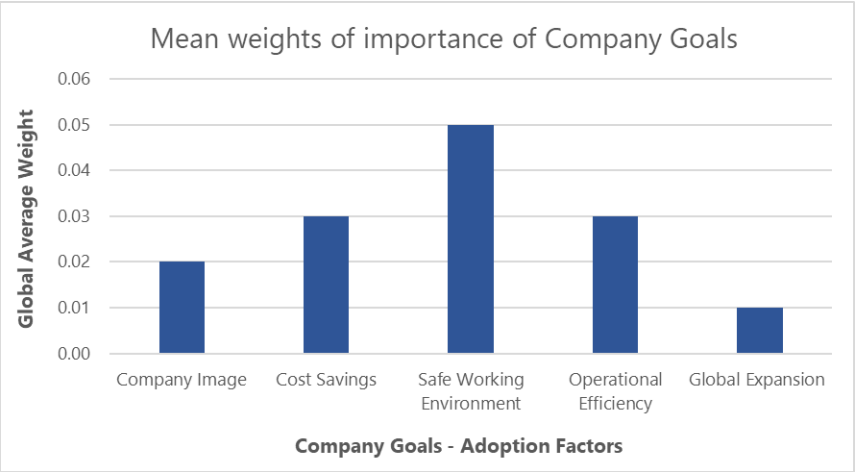

Figure 5: Mean weights of importance of Company Goals - Adoption Factors

Standard Characteristics

The factor indicating Compatibility of the Standard with the Company is found to be the most influential in this category, with a corresponding global weight of 0.04. Further down the ladder of importance stands the Quality of the standards and then the Cost of the standards. To support the choice of cost standards as the least important factor and compatibility as the most important one, Expert 5 explains that if a standard is expensive, it becomes a serious business resource when it is compatible. Thus, Compatibility is something to carefully consider before adopting a standard. And hence, cost becomes secondary to compatibility. Expert 1 also supported this by mentioning, "*Cost of the standard is a secondary consideration because when you want to standard, you want it understand that comes with requirements*." On the contrary, Experts 1 and 3 considered the quality of the standards to be the most influential, as they mentioned that quality ensures the effective implementation of the standards.

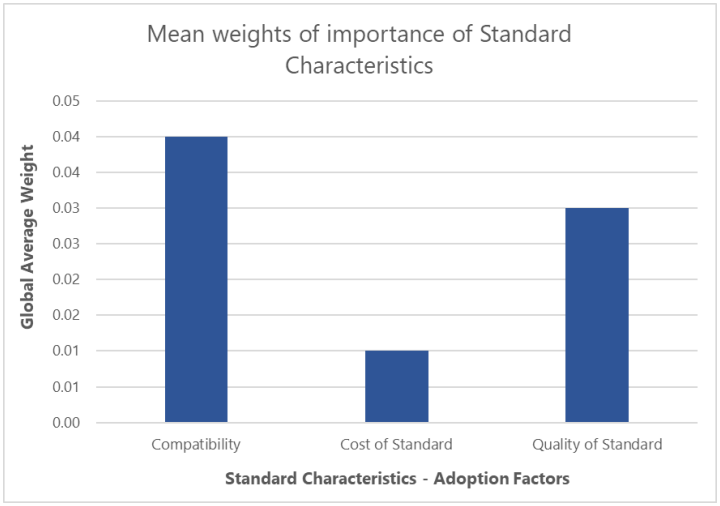

Figure 6: Mean weights of importance of Standard Characteristics - Adoption Factors

Adoption Categories

Amongst the categories of Adoption factors, Firm Characteristics weighed the most, followed by External Influence, Company Goals, and then Standard Characteristics. While ranking Firm Characteristics as the Best factor, Expert 1 notes, "*parties outside of the company might set priorities that do not necessarily flow from its management commitment*." This showed the comparison between the external force and the management commitment represents the firm characteristics. Further, the experts also explored the interdependence between the company goals and expert influence, Value chain pressure. They mentioned that the Company's goals of Global Expansion and operational efficiency are linked to the pressure from their supplier as consumers. Hence, External influence was weighed more than the Company Goals by most of the experts. Experts mention that the characteristics of standards are less influential compared to other categories, which have factors of greater E.g. the decision-making process regarding the adoption of standards is likely to be driven more by legal requirements than by the cost of the standards. Irrespective of the cost, the company needs to adopt the standard to meet the regulatory compliance.

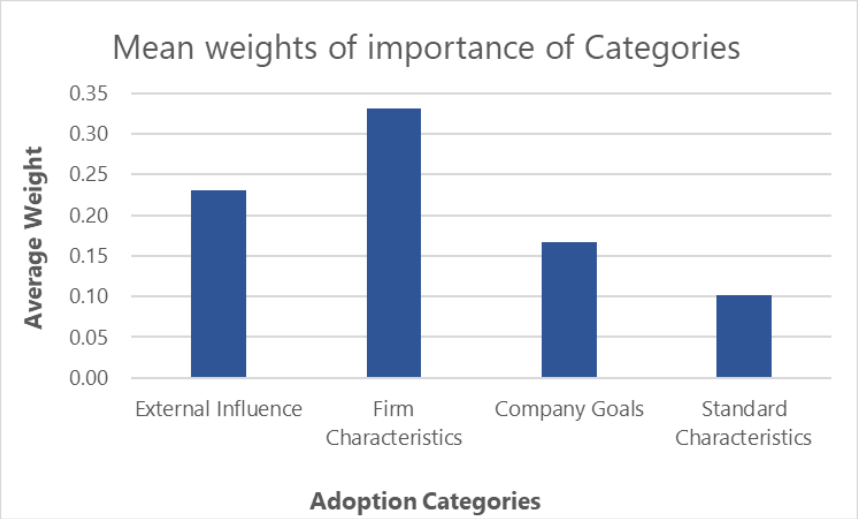

Figure 7: Mean weights of importance of Adoption Categories

4.2.2 BWM Results for Implementation Factors

The following table presents the weights and rankings for implementation factors. Parallel to the BWM results of the adoption factors, Commitment ranked topmost among all the implementation factors. This factor weighed 0.35 and proved to be the most influential one. Experts emphasized this factor as it involved the commitment of everyone in the organization, from top management to lower-level employees.

Followed by Commitment, the factor of Communication and Training weighed 0.17. Experts highlighted the importance of this factor by mentioning that without training and communication, the information and guidelines regarding effective implementation cannot be understood by the employees. It is important that the information reaches the concerned person

who is supposed to follow the guideline, and that person is trained to do so. This factor is the bridge between standard implementation being on paper and it being put into practice.

The factors of Continuous Improvement Mechanisms, Resources, and Compatibility were weighed close to each other. On stressing the importance of the Continuous Improvement mechanism, Expert 6 said, "*There is no value for just having the training done and keeping it as a record. I need to update myself every now and then and do my renewal trainings like a refresher training.*" The factor of Resources, when weighed lower than the commitment, Expert 4 emphasized, "Where *there's will, there is a way.*" This indicated that required resources can be made available to the company if it is committed to doing so. The Resource availability will not act as a hindrance to the path of effective implementation if there exists a strong commitment. On the Compatibility of the standards, experts mentioned that not implementing a relevant standard could lead to inefficiency in work and disengagement among employees.

Government Support weighed to be the least influential factor for implementation. Expert 3 noted, "*Government support is enormously varies from country to country. …My answer is from the United Kingdom standpoint, over Great Britain standpoint, excluding Northern Ireland and I will be scoring it lower than in many the other countries….However, in other countries, it could be a decisive issue.*" Most of the experts mentioned that, compared to other factors in the framework, they see Government Support as the least influential. Their explanations indicated that in their previous experiences, support from the government was negligible. This developed into an understanding that companies can achieve effective implementation without government support. But though a caveat was mentioned that Government Support might play an important role in developing and underdeveloped countries.

Table 11: Weights of importance attributed by the experts for all evaluated implementation factors

Factors	E1	E2	E3	E4	E5	E6	E7	E8	Average Weight	Ranking
Communication & Trainings	0.15	0.09	0.24	0.21	0.18	0.10	0.15	0.37	0.17	2
Compatibility with the Company	0.23	0.14	0.04	0.14	0.08	0.12	0.11	0.05	0.10	5
Commitment	0.39	0.47	0.39	0.37	0.46	0.24	0.39	0.21	0.35	1
Resources	0.11	0.18	0.16	0.09	0.13	0.08	0.23	0.06	0.12	4
Government Support	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.10	0.05	6
Continuous Improvement Mechanisms	0.09	0.08	0.12	0.14	0.11	0.42	0.08	0.21	0.13	3

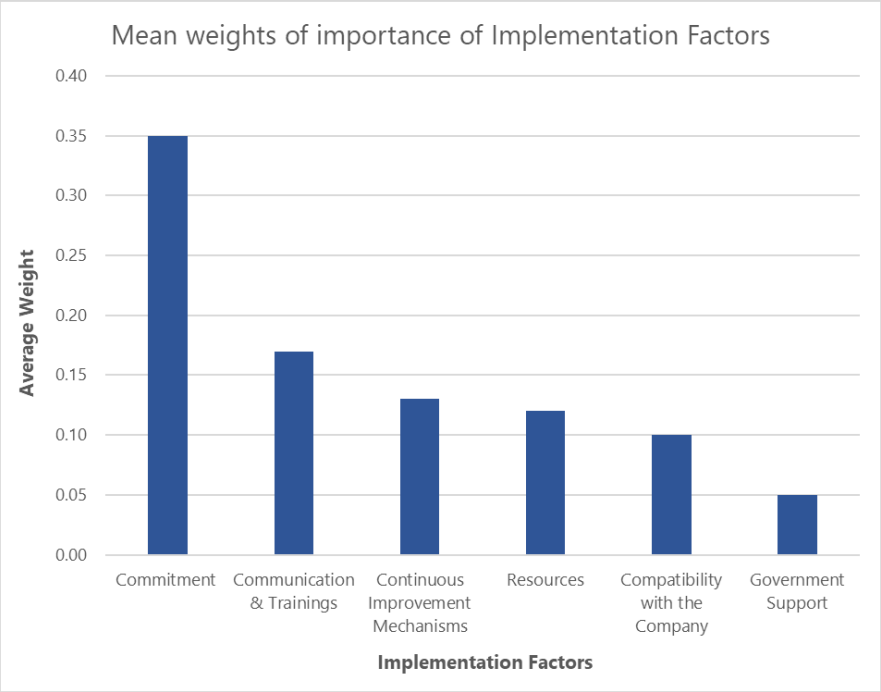

Figure 8: Mean weights of importance of Implementation Factors

4.3 Stakeholders' Influence on Factors

This section presents the influencing aspects and stakeholders for the top 2 ranked factors for adoption and implementation in the MCDA Analysis. The results in this section are intended to answer the third research question.

A separate round of interviews was planned to answer the third research question. The results of the MCDA Analysis were shared with all the experts, and a request for a new interview was made. This process had the advantage of involving experts from the exploratory interview as well. On the contrary, the disadvantage was that not all the experts from MDCA who were interviewed were part of this round due to their limited availability. The list of experts interviewed for this round is available in Appendix C, Table 16.

A detailed document was made to be shared with experts, which included the MCDA results for both adoption and implementation, questions to be answered in the interview, and definitions of the top 2 ranked factors. The top 2 factors weighed extremely higher than others, thus indicating a greater influence on decision-making outcomes. Owing to the negligible weights of the other factors, only the first 2 were selected for Stakeholder identification. The list and definition of the codes are provided in Appendix C.5.

The following subsections present the detailed results for each of the top two ranked factors—Management Commitment and Regulatory Pressure for adoption, and Commitment and Communication & Trainings for implementation. For each factor, a list of stakeholders identified

through expert interviews is provided, along with an analysis of their influence on the adoption and implementation of safety standards. The stakeholders have been grouped based on the nature of their influence, and thematic patterns were used to structure the findings.

4.3.1 Management Commitment

The list of stakeholders influencing the factor of Management Commitment identified from the expert interviews is as follows

Table 12: Stakeholders influencing Management Commitment

Sr. No.	Stakeholders	Influence
1	Government	External Pressure
2	Insurance Companies	External Pressure
3	Labor Unions	Safety Demand
4	Middle Management/ Supervisors/ Safety Officers	Awareness Creation
5	Mother/Parent Company	Safety Culture
6	Shareholders	External Pressure
7	Society	External Pressure
8	Industry Leaders	External Pressure

The management includes individuals such as the Board of Directors, CEOs, Chief Safety Officers (CSOs), and Health, Safety, and Environment (HSE) Directors. They are responsible for establishing the company's vision and mission, defining safety priorities, and building a strong safety culture. The level of management commitment to safety is influenced by the availability of resources since risk management and safety improvements often require financial investment. Thus, Top Management controlling the resource allocation plays a decisive role in safety prioritization. Management's dedication to safety is shaped by the desire to maintain a positive public image and to fulfill corporate social responsibility (CSR) goals.

Management commitment also involves how management prioritizes safety (AlKalbani et al., 2016; Seixas et al., 2013; Siddique et al., 2024). The actions that influence the prioritization of safety by management can be considered to influence commitment itself. The factor of Management Commitment could be influenced in 3 ways by addressing – Affective, Normative and Calculative Commitment of the management, a typology suggested by Fruhen et al. (2019). Each of these has an interplay of intrinsic and extrinsic motivations. E.g. the Calculative Commitment is influenced by the extrinsic motivations of Regulations and intrinsic motivations of Business Key Performance Indicators (KPIs). The Neo-institutional theory suggests 3 types of pressure (Coercive, Mimetic and Normative) to influence the above-mentioned 3 types of commitments. Newton et al. (2024) also mentioned that the institutional pressure encourages management and instills a sense of legitimacy in their efforts. This encouragement leads to a change in priorities and hence strengthens the commitment.

Coercive pressure refers to formal influences exerted by powerful stakeholders such as the government or regulators that may include legal mandates, policy requirements, and financial incentives (van de Kaa, 2023). Coercive (Regulatory) pressure can act on the Calculative Commitment. Calculative commitment refers to the rational or transactional requirement

influenced by external drivers such as regulations, business metrics (KPIs), where safety is portrayed as an obligation to the business (Fruhen et al., 2019). E.g. a construction company follows strict safety protocols due to regulatory requirements from governing bodies, making safety a business necessity rather than just a value-driven choice.

Mimetic pressure refers to when organizations imitate the actions of peer firms, particularly industry leaders or competitors, to gain legitimacy or reduce uncertainty. By aligning with prevailing industry norms or widely adopted standards, companies hope to maintain their reputation and credibility (van de Kaa, 2023). The affective commitment of industry leaders — a personal and emotional attachment to safety values (Fruhen et al., 2019) — may inspire mimetic pressure. By observing and emulating the practices of these emotionally committed leaders, other firms may adopt safety values out of a sense of social responsibility, thereby demonstrating normative commitment. E.g. if a high-profile company in petrochemicals improves its safety culture through emotional obligation, other firms may follow suit to improve their reputation and reduce incidents.

Normative pressure arises from values or norms and professional expectations that are internalized by employees or management. These can originate from formal education, industry training or ethical commitments (van de Kaa, 2023). Normative (Societal) pressure can act on Affective Commitment, as employees who are taught about the importance of safety may come to value it emotionally. Affective Commitment refers to a personal and emotional attachment to safety values (E.g. ISO safety standards, industry certifications, and corporate social responsibility (CSR) initiatives, which influence firms to embed safety into their organizational values, aligning with management's moral sense of obligation.

Table 13: Mapping Institutional Pressure to Types of Management Commitments

Institutional Pressure	Types of Management Commitments	Explanation
Mimetic Pressure	Normative Commitment	Industry leaders demonstrate emotional commitment to safety (Affective). Other firms imitate them, but the resulting motivation is often moral/social (Normative).
Normative Pressure	Affective Commitment	Societal norms, education, and professional expectations influence employees to emotionally value safety.
Coercive Pressure	Calculative Commitment	Regulatory or stakeholder demands lead firms to adopt safety measures for compliance or business continuity.

External pressure has been identified as a significant force in prompting or accelerating management commitment. Participant 1 mentioned, "*If there is a need for a change in management commitments, it will take a very long time if there is no external pressure*". This suggests that the external pressure can help the management commitment overcome the inertia of adoption and implement quick actions in promoting safety requirements. The Calculative Commitment focuses on enabling priority of safety. If the government is providing tax benefits for safety standard adoption, then there is a transactional requirement to adopt them. This action by the government affects the calculative commitment of the management. Also, Insurance companies could provide incentives in terms of lower premiums if the company

adopts safety standards. To avail these benefits provided by the government and insurance companies, management is influenced to prioritize safety and adopt safety standards.

When the government imposes regulatory compliance, it becomes an obligation for businesses to adopt these standards. Management's primary interest is in the business, which in turn leads to increased priority associated with the adoption of safety standards. Thus, government agencies and insurance companies play crucial roles through their policies, inspections, and incentives (such as lower premiums), encouraging management to commit to safety standards.

Some governments also issue awards to companies that successfully adopt and implement safety standards. This can also improve the public image of the company. When companies display these awards, they often obtain contracts from customers and clients, which in turn boosts their business. As a result, to stay competitive, gain recognition, and attract potential customers for better business, management's commitment to adopt safety standards can be influenced through such circumstances.

Siddique et al. (2024) showed that government regulations positively influence management commitment among small and medium-sized enterprises (SMEs). The study found that many SMEs lack the necessary resources, which results in reduced commitment to adopting new practices. Therefore, if the government implements policies to provide training for adopters and assists in acquiring necessary equipment, this could strengthen management commitment to adoption.

This phenomenon was proven in the study by AlKalbani et al. (2016) who presented that the coercive pressure, i.e. the regulatory polices, makes the management change their priorities and hence influence the commitment. They analyzed survey responses of public organizations in Oman, using Structural Equation Modelling (SEM) and discovered that both coercive pressures (regulations) and mimetic pressures significantly affect management's commitment.

Shareholders also act as influential stakeholders, pressuring management to adhere to safety guidelines, especially when company image, regulatory compliance, or profitability are at stake. Societal response, particularly following safety incidents, serves as another pressure point that shifts management commitment towards adopting safety standards to maintain legitimacy and avoid reputational risks.

The calculative commitment also involves the internal motivation from the Business KPIs. As discussed in Chapter 2, safety standards enhance the operational efficiency of a company by improving not only accident rates but also overall productivity and minimizing employee absenteeism.. These metrics can be established as KPIs to evaluate management performance. Poor performance on these KPIs in companies lacking safety standards may indicate a need for improvement. Implementing such standards can lead to progress in these indicators, thus acting as an incentive.

Affective commitment arises from individuals responsible for safety-related decisions who have a strong passion for promoting safety within the organization and ensuring the well-being of all employees. Their past experiences significantly influence management's commitment to safety by demonstrating the importance of adopting safety standards, ultimately altering how safety

is prioritized. This was backed by the experts, 1 and 8, who mentioned that new incoming employees often bring the safety values from their previous companies. Due to the type of industry (e.g. more hazard-prone industries like petrochemical) and the culture at their former workplaces, these individuals tend to place a higher importance on safety and demonstrate a strong commitment to it. Consequently, they carry that attitude into their new organization. This illustrates how workplace culture influences individuals and how a single influential person can enhance management's commitment to safety. By appointing highly motivated individuals responsible for safety-related strategies, management commitment can be influenced.

Parallel to this, Expert 4 expressed about the mimetic pressure, "*Firms can also benchmark against competitors and use audits to highlight compliance gaps.*" This explains that the competitor firm's safety performance can push the management commitment to get better and stay on par with the safety requirements. The motivation can also be driven by the cost savings achieved by the competitor firm. The management can thus prioritize safety standards adoption and increase their commitment.

The value of moral and safety culture within a company significantly influences the normative commitment of its management. The influence of the parent/ mother company also plays a critical role in cascading values and safety culture down to its subsidiaries, promoting alignment and consistency across the corporate structure. This approach helps instill a safety culture throughout the subsidiaries by encouraging the adoption of safety values and practices from the corporate level down to operational levels. As Expert 2 mentioned, "*The headquarters will have an influence on the management's decision and their commitment*". To enhance management commitment, it's essential to instill human values and encourage striving for what is right and to create a culture of safety within the organization. This can be achieved through training programs that emphasize ethical leadership and the importance of integrity in decision-making (Tappura et al., 2017). Such initiatives can be introduced by external regulatory bodies, corporate governance boards, or even safety-conscious departments within the organization that recognize the long-term benefits of a strong safety culture. Even if initial management commitment is lacking, pressure from industry leaders, labour unions, or liability concerns may act as motivators for management to initiate or accept such programs. Providing a safe working environment is crucial for upholding these values related to safety. The adoption of safety standards facilitates this moral obligation, thereby strengthening the management's commitment to ensuring safety in the workplace.

The active and visible support of the management needs a commitment strategy (Zwetsloot et al., 2017). Expert 2 highlighted the point of the commitment strategy as a tool to ensure commitment. The expert mentioned that if the company has clear strategic definitions of what it wants to achieve, how the necessary resources need to be pulled and if the contingencies are planned, the management can stay committed. Management Commitment of the top management is motivated by the respect and concern towards the employees. The culture of the company fosters shared values, ensuring that safety is prioritized alongside business goals. It empowers managers to take ownership of safety initiatives, reinforcing their dedication to maintaining a safe work environment. And open communication within a strong safety culture strengthens management's commitment to continuous improvement (Zwetsloot et al., 2017).

An additional stakeholder influencing Management Commitment comes from the operational levels of the organization, particularly where awareness and demand for safety begin. Workers often advocate for safer conditions, especially in high-risk or poorly regulated environments. Middle management and supervisors act as conduits for reporting safety issues, while safety officers are essential in communicating risks and aligning operations with strategic commitments. Thus, experts suggested that the bottom-up dialogue from the employees to the management, creating awareness and demand, showcasing the need and urgency of safety, impacts their commitment.

Seixas et al. (2013) investigated whether a Health and Safety Committee (HSC) intervention can influence management commitment in a small, high-hazard workplace with a largely immigrant workforce. The study used mixed methods, including worker questionnaires, safety observations, and industrial hygiene measurements, to assess effectiveness. Researchers implemented an intervention including an eight-hour HSC training to improve committee structure, communication, and worker engagement. But they observed that the pressures from the bottom (employees) and from the HSE committee interventions do not substantially influence management's commitment.

Labour unions amplify the voices of workers and, in some cases, lobby externally to advocate for stronger safety enforcement. Together, these stakeholders play a crucial role in creating bottom-up pressure and raising awareness. The possibility of worker strikes and subsequent production losses may influence management's attitudes and commitment to adopting safety standards.

Table 14: Summary of Stakeholder Strategies and their Influence on Management Commitment for adoption

Sr. No.	Strategy for influencing	Stakeholders	Mechanism of Influence
1	Offering tax incentives for companies	Government	Financial incentives serve as extrinsic motivation to prioritize safety.
2	Lower insurance premiums for companies	Insurance Companies	Reduces operational costs and encourages investment in safety.
3	Instituting safety performance awards and public recognition	Government, Society, Shareholders	Improves public image and generates pride and emotional buy-in.
4	Industry benchmarking and safety audits	Industry Leaders, Labor Unions	Motivates emotional commitment by peer comparison.
5	Having committed individuals on board	Middle Management/ Supervisors/ Safety Officers	Transfer of safety values, influence through role modelling and cultural reinforcement.
6	Safety leadership training programs	Parent Company, Government	Builds moral awareness and safety-related values internally.

To influence management commitment, specific actions must target the affective, normative, and calculative dimensions. Calculative commitment can be influenced by enforcing regulatory compliance, providing tax benefits, and offering lower insurance premiums, which create transactional motivations to adopt safety standards. Governments can further support this by

offering training and equipment support (to SMEs), while awarding safety achievements enhances public image and competitiveness. Affective Commitment can be enhanced by appointing individuals with strong past safety values, especially for hazard-prone industries who carry forward a culture of safety. Encouraging benchmarking against competitor firms through audits can create mimetic pressure to align with industry standards. Normative commitment is strengthened by instilling safety values through influence from the parent company, training programs, and fostering ethical leadership. Commitment can also be promoted through a clear commitment strategy, linking resources, plans and objectives. Bottom-up awareness and demand from workers, supported by supervisors, safety officers, and labour unions, create internal pressure. These combined actions address motivations and overcome inertia, thereby strengthening management commitment.

4.3.2 Regulatory Pressure

The list of stakeholders influencing the factor of Regulatory Pressure identified from the expert interviews is as follows

Table 15: Stakeholders Influencing Regulatory Pressure

Sr. No.	Stakeholders	Influence
1	Industry Associations	Lobbying
2	Inspection Bodies	Reporting/Data
3	Insurance Companies	Advising
4	Labor Unions	Lobbying
5	Media	Spreading Awareness
6	Policy Makers	Strategy formation
7	Society	Pressure
8	Standards Organizations	Policy Development

Participant 2 mentioned that "*compliance with legal requirements must be 100%*." This showcases the importance and stringency of the Regulatory Pressure. Policy Makers and Inspection Bodies are at the core of this factor of Regulatory Pressure. Policy makers are responsible for formulating legislative strategies and frameworks that establish mandatory safety norms across industries. As a stakeholder, they influence the factor of Regulatory Pressure by determining the scope and strictness of safety regulations that companies must comply with. Inspection bodies, such as governmental labor or safety agencies, conduct audits, collect data, and report safety violations. These reports often highlight gaps in workplace safety and serve as triggers for regulatory updates, thereby increasing the pressure on organizations to adopt safety standards proactively.

Insurance Companies influence the Regulatory Pressure by advising both governments and individual organizations on risk mitigation strategies, often linking safety compliance to financial incentives such as reduced premiums. Standards organizations, such as the international bodies like ISO, OSHA, and ILO, provide frameworks that shape national policy development. They support governments in customizing safety standards to fit local industrial needs. Expert 2 and Participant 1 stressed the importance of the Media. It plays a powerful role in shaping public opinion and drawing attention to safety lapses. Through widespread coverage of accidents or

unsafe practices, the media raises societal awareness and indirectly pressures governments to respond with stricter policies.

Industry associations, labor unions, and society as a whole play a crucial role in lobbying and applying social pressure for better safety standards. Participant 1 mentioned, "*In the chemical industry, you have some overarching agencies that really lobby for or even against sometimes stricter regulation, of course, depending on the interests of their members.*" Industry associations often lobby policymakers to influence regulations that reflect their interests, whether by promoting specific safety standards or fighting against excessive regulation. Labor unions advocate for stronger protections for workers and their rights, particularly in high-risk sectors, ensuring that worker welfare remains a priority in political discussions. After major safety incidents, society often responds by demanding accountability and calling for reforms in regulations. This societal pressure creates a feedback loop that encourages both companies and governments to enhance safety governance.

4.3.3 Commitment

The list of stakeholders influencing the factor of (Implementation) Commitment identified from the expert interviews is as follows

Table 16: Stakeholders Influencing (Implementation) Commitment

Sr. No.	Stakeholders	Influence
1	Employees	Involvement in All Stages
2	Management	Commitment Strategy, Past Experience, HSE Policy, Resource Availability, Value Chain Commitment
3	Middle Management/ Supervisors	Encouragement, Implementation practices
4	Top Management	Encouragement, Stressing Safety Importance

Employees and Top Management represent two ends of the organizational hierarchy but share a vital role in strengthening commitment. Experts consistently emphasized the importance of involving employees in all stages of safety standard implementation, including during the initial adoption phase. Their engagement ensures that safety practices are realistic, well-received, and tailored to ground-level realities. Participant 2 underscored this by mentioning, "*The leadership needs to have an active listening to what employees say to understand the normal work and the risk traps, and work together with employees, communicating it clearly.*" Participant 1 also highlighted that, "Number 1 thing is involving employees in all stages of your implementation… even already in the adoption phase". Involving the employees brings them awareness and a smooth transition in the implementation, thus influencing their commitment towards the standard implementation. Top Management plays a crucial role in driving implementation from the top down through motivation and strategic reinforcement. Their commitment to safety is demonstrated through visible encouragement, building trust, prioritizing safety in organizational agendas, and emphasizing the importance of safety in all communications and decisions. When leaders consistently highlight safety, it creates a strong example for others to follow. Expert 6 highlighted this by mentioning, "*Leadership demonstrating safety by the leadership itself. Leading by example.*"

Management (including top-to-bottom level management) influences commitment through several interlinked factors: formulating commitment strategies, drawing from past experiences, enacting robust HSE policies, and ensuring resource availability. Expert 8 elaborated that Managers may draw on previous experiences from educational, personal, or professional—that influence their dedication to safety, such as past incidents or safety culture in former workplaces. Expert 6 mentioned that the management as stakeholders extends the commitment by paying attention to value chain actors, including suppliers, contractors, interns, and visitors, reinforcing a culture of safety beyond the core workforce. Middle management and supervisors translate strategic commitment into everyday practices. Their role involves actively encouraging safety compliance among workers and ensuring that implementation measures are carried out effectively. Supervisors, being closer to the workforce, monitor adherence to safety guidelines, provide feedback to upper management, and play a hands-on role in reinforcing a culture of safety at the ground level. Therefore, these stakeholders are responsible for instilling a deep commitment within the organizational structure to influence the implementation of safety standards.

4.3.4 Communication & Trainings

The list of stakeholders influencing the factor of Communication & Trainings identified from the expert interviews is as follows

Table 17: Stakeholders Influencing Communication & Trainings

Sr. No.	Stakeholders	Influence
1	Consultancy Agencies	Training Support
2	Employees	Demographics, Feedback, Training
3	Government	Providing Guidelines
4	Management	Clear Communication, Communication Channels, Continuous Training, Frequent Communication
5	Safety Officers/ Supervisors	Spreading Awareness, Training
7	Top Management	Resources, Stressing Safety Importance

The influence on this factor comes from both internal and external stakeholders. Internally, Top Management, Management (including top-to-bottom level management), Safety Officers/ Supervisors, and Employees are counted. As a stakeholder, Top Management influences this factor by ensuring the availability of resources, including training budgets, personnel, and infrastructure. Management at various levels contributes by ensuring clear and transparent communication, establishing effective communication channels, and organizing continuous and frequent training programs. These efforts aim to keep safety awareness alive and adaptive to operational changes. Safety officers and Supervisors act as the front-line communicators and trainers. They facilitate training sessions and also raise awareness about the importance of safety standards, ensuring consistent messaging and practices across teams. Participant 2 stressed the importance of the type of training (interactive/ e-learning), which also influences this factor. Further, Expert 2 elaborated that the Employees' demographics, including education level, language, and cultural background, determine how training should be tailored for maximum impact. The experts also emphasized that employees influence by contributing to a two-way communication process, enabling management to adjust communication strategies and

improve training effectiveness. Participant 1 and other experts also highlighted that involving employees early on and maintaining continuous training is critical to embedding safety into the organizational culture.

External stakeholders, consultancy agencies and government bodies play a supportive and regulatory role. Consultancy agencies provide specialized training support, offering expertise in structuring, delivering, and evaluating safety training programs. Their involvement influences the level of communication and trainings carried out for implementation. Government bodies influence training and communication through the provision of guidelines and policy frameworks. These guidelines help standardize safety communication across industries and ensure that companies meet regulatory requirements.

5 Discussions

This paper presents a framework that identifies the factors influencing the adoption and implementation of safety standards. The factors in the framework has been ranked by the experts using the Best Worst Method. It includes 13 influencing factors for adoption and 6 for the implementation of safety standards. Among these, Management Commitment and Regulatory Pressure were the top 2 ranked factors for adoption. And for implementation, Commitment (from all levels) and Communication & Training were the 2 most influential factors. Further, the experts were interviewed to explore the stakeholders influencing these top factors.

5.1 Interpretation of the Results

In the adoption framework, the most influential factor of Management Commitment had a weight of 0.25. It was also observed to be one of the most frequently occurring themes in literature. While rating this factor, experts noted that without the willingness and the dedication of the management, nothing can move. The experts also linked it with the resource's allocation for safety standard adoption; Expert 5 stated, "*If the management commitment is there, they will find a way to do it.*" This indicates the high decisive power of the management. And as the definition of adoption relates to the decision of choice and compliance of the standard, the extreme importance of management cannot be neglected. In their study Ling et al. (2015) also found Management Commitment as the most crucial factor for adoption. This factor is non-tangible in nature. In the study by Hoogerbrugge et al. (2023) The most important factor for quality standard adoption for GHG accounting was Government Support, which is also intangible in nature. Thus, we can observe that these non-tangible factors also hold an upper hand beyond tangible factors like resources.

Similarly, the factor of commitment was also ranked as the most influential for implementation. Here, these factors indicated the commitment from all levels of the organization, from top to bottom. Noting the importance of bottom-level commitment, Abad et al. (2016) mentioned employee resistance and lack of staff involvement as the most important barriers to implementation. The factor of Commitment was also presented by van de Kaa (2023) under the Firm Characteristic category in his quality and compatibility standard adoption framework. While defining this article van de Kaa (2023) highlighted how the lack of top managerial commitment can lead to ineffective implementation by ignoring standard recommendations and neglecting training offerings (W. Wang et al., 2016). Further, he also mentioned that this limited commitment also negatively impacts standards adoption (Yen & Yen, 2012).

A key insight that emerges—and warrants further exploration—is the cascading effect of management commitment from adoption into implementation. The early commitment of management at the point of adoption may serve as a catalyst for fostering deeper, organization-wide commitment necessary for effective implementation. When top leaders make this decision of safety standards adoption, it may also set the stage for its implementation. This may initiate a cultural momentum where other levels of the organization—middle management, supervisors, and frontline workers—begin to align their behaviours and attitudes accordingly. In this way,

commitment at the adoption stage may act as a seed, setting expectations and signaling priorities before implementation formally begins. Future research could investigate these cascading effects on commitment in the implementation stage.

The second key implementation factor, Communication & Trainings, confirmed that implementation is not just a managerial task but an organizational learning process. Without clear communication, training, and role clarity, safety practices fail to take root across operational levels. As found in studies like Castiblanco et al. (2020) and (Pedrosa et al., 2024), the absence of adequate training programs and feedback mechanisms can significantly hinder effective safety integration, especially in sectors with high workforce turnover or language diversity.

The influence of external factors on adoption was observed to be heavily important. The factor of Regulatory Pressure ranked second with a global average weight of 0.15. Expert 1 noted, "If *something is in law, it will always take precedence.*" This point confirms the Neo-institutional theory of coercive pressures, i.e. the pressures from governmental bodies (Dimaggio & Powell, 2021). This theory also appears in the cases of quality standards adoption, but in the form of support from the government. It is interesting to observe that the factor of government support ranked first in the quality standards adoption framework for greenhouse gas accounting by Hoogerbrugge et al. (2023). On the contrary, the factor of government support in the implementation framework presented in this research ranked the lowest. This could be an effect of the nature of the standard itself. As Hoogerbrugge et al. (2023) study the GHG accounting standard, which is relatively new to safety standards. Consequently, industries require support from the government, which is why this issue is ranked high.

But while discussing the influence of the regulatory pressure for implementation and adoption, experts emphasized the crucial role of the government in raising awareness and providing support for SMEs. This factor reflects coercive institutional pressures, where regulatory mandates or government expectations act as external drivers. This resonated with Newton et al. (2024) and AlKalbani et al. (2016), who found that regulatory environments can either accelerate or hinder adoption depending on clarity, enforcement, and support mechanisms. Especially for SMEs, this factor becomes more decisive in compensating for limited internal capabilities. Thus, organizations adopt safety standards not only for internal improvement but also to gain legitimacy and reduce liability.

To influence the regulatory pressure, the experts mentioned the theme of lobbying, i.e. the industry association and even the labour unions intervening in governmental policies. Industry Associations consider their needs in the account and interpret the government's decisions on safety standard policy, either bringing in the standard of their choice or even enforcement of the standard as a policy. This also appears in the literature for multimode standardization by van den Eijnden et al. (2019) mentioning various forms of lobbying to influence government decisions on standards.

In sum, the results illustrate that safety standard adoption and implementation are complex processes shaped by a combination of management commitment, institutional context, and multi-level stakeholder interactions.

5.2 Theoretical Contributions

This research contributes to the literature on Standards Adoption. Earlier, the literature focused mainly on technology innovations, compatibility standards and quality standards. Hovav et al. (2011) developed an adoption framework for internet standards, van de Kaa (2023) presented the framework for both compatibility and quality standards. Hoogerbrugge et al. 2023) and Jurg et al. (2025) both created frameworks for quality standards for Greenhouse gas accounting and the semiconductor industry, respectively. However, there was a lack of a comprehensive and widely applicable framework for safety standards. This study presents this concrete framework from the perspective of companies choosing to adopt and implement the safety standards.

Earlier in the safety standards literature, the terms "adoption," "implementation," and "certification" were used interchangeably, which should not have been the case. This led to overlapping frameworks and mixed factors regarding adoption and implementation. This study contributes to clearer definitions and distinctions between these stages, thereby providing a foundation for a transparent framework. Another limitation with the safety literature is that the papers often present Integrated Management systems. Hence, the frameworks are based on a combination of standards and not individual safety standards. But this paper purely contributes to the framework on safety standards.

The primary focus of the existing literature is centred on barriers, success factors, or specific standards like OHSAS 18001. This study adopts a broader perspective by integrating these various factors that have been scattered throughout the literature. It not only provides insights into these factors but also highlights the key stakeholders and their potential roles in altering strategies for adoption and implementation. This contribution also provides an advantage of validation from the experts.

It is also important to note that the current literature has a very limited scope when it comes to the implementation of standards. Rajaprasad & Chalapathi (2015) presented a list of influencing factors for OHSAS 18001 implementation in the Indian Construction Industry. But the overlapping of adoption and implementation factors exists, and frameworks remain niche. This research provides a complete framework for the implementation of safety standards, along with discussing the significance of each factor.

Limited papers in the literature have researched the significance of the influencing factor. The ranking methodologies were mostly conducted on risk assessment framework parameters rather than the factors influencing safety standards. For instance, İnan et al. (2017) used the visual ranking method of Simos' procedure for weighing the OHSMS adoption criteria presented in their study. This technique is prone to subjective interpretation, leading to low consistency in the responses. But this research involves an expert for ranking the factors and uses the MCDA BWM method for the same. By utilizing BWM, the study ensures highly consistent pairwise comparisons and manages cognitive biases.

This study enhances the understanding of safety standards adoption by creating a comprehensive framework and identifying the key stages in the process. By integrating various success factors and applying consistent weighting through Best Worst Method (BWM), it reinforces the foundation for future research and industry applications.

5.3 Practical Implications

The insights from this study have direct relevance for both policymakers and organizational managers aiming to improve workplace safety through standard adoption and implementation. By understanding how key factors can be influenced, stakeholders can take targeted actions to drive meaningful and sustainable change in occupational health and safety practices.

Advice to Policymakers

The findings of this research offer valuable insights for policymakers seeking to improve the adoption and implementation of Occupational Health and Safety (OHS) standards across industries. Regulations can influence management commitment through coercive institutional pressure. Specifically, in the case of small and medium-sized enterprises (SMEs), governments can take initiatives to spread awareness regarding the standards. Governments can leverage this role by developing clear, enforceable safety regulations and ensuring rigorous inspection and enforcement mechanisms. Introducing recognitions such as awards and financial incentives for compliant organizations can motivate organizations to adopt safety standards. This study also highlights the value of using incentives such as tax breaks and lower insurance premiums, which appeal to management's calculative commitment and help justify the investment in safety.

To address resource limitations, policymakers can consider capacity-building initiatives such as subsidized training programs, technical guidance documents, and access to standardization consultants. These interventions can reduce the perceived burden of compliance and improve organizational readiness. Moreover, public campaigns and awareness drives can create normative pressure, shifting societal expectations and encouraging firms to prioritize workplace safety not only to meet legal obligations but to enhance their social legitimacy and brand image.

Publishing sector-wide safety performance data can support benchmarking practices and encourage mimetic pressure, prompting organizations to emulate industry leaders and align with prevailing norms. Regulatory bodies can also foster benchmarking practices by publishing performance comparisons and promoting transparency in safety performance data across sectors.

Advice to Managers

Managers, especially those at senior and middle levels, play a vital role in incorporating safety into the organization's culture and daily operations. This study indicates that Management Commitment is the most critical factor for both adopting and implementing safety measures. To achieve positive outcomes, top managers need to clearly communicate the strategic importance of safety and consistently allocate the necessary resources—financial, human, and technical—for safety initiatives. By treating safety as a core business value rather than merely a compliance obligation, managers can align organizational goals with long-term sustainability. This commitment should also be supported by a clear strategic framework that links safety goals, resource planning, and accountability mechanisms. It is also important to note that employee involvement right from the beginning of the adoption decision is necessary. This ensures that the decisions are truly beneficial to the employee and hence the company.

After adoption comes implementation. Middle managers and safety officers are key in translating strategy into practice. Hence, top management needs to empower these individuals by providing them with decision-making authority, training, and effective communication tools. Establishing open dialogue platforms and participatory mechanisms, such as safety committees and employee feedback systems, can significantly enhance the implementation of safety standards.

Appointing safety-conscious individuals, particularly those with prior experience in high-risk industries, can strengthen affective commitment and foster a culture of safety across the organization. Managers should also prepare for workforce transitions by integrating safety principles into onboarding and leadership development programs, ensuring continuity of commitment even during organizational changes. Along with this, sustaining the implemented system and evaluating it through regular audits is crucial to make it effective.

Benchmarking performance against competitor firms and conducting internal audits also triggers mimetic commitment and continuous improvement. Besides this, benchmarking against industry leaders and monitoring safety performance metrics can guide ongoing improvement efforts and reinforce a culture of accountability.

5.4 Strengths of Research

This research possesses methodological and conceptual strengths that enhance its overall validity and reliability. Firstly, the interview protocols were carefully developed based on insights from an extensive literature review and were aligned with the conceptual framework constructed during the early phases of the research. This alignment ensured a strong theoretical grounding and improved the construct validity of the data collected. Secondly, the use of a systematic and transparent methodology—including a structured literature review, multi-criteria decision analysis (BWM), and clearly staged expert interviews—ensured internal consistency and replicability of the study. The stepwise design of the research process, along with detailed documentation of procedures and coding strategies, supports the reliability of the results. Furthermore, triangulating data from academic literature and exploratory expert inputs, enhanced the credibility of the findings. The separation of adoption and implementation phases, and the development of distinct yet connected factor frameworks for each, provides a unique contribution to the literature and offers nuanced insights for both theory and practice.

5.5 Limitations of Research

It is crucial to recognize the study's limitations, as they affect the interpretation of the findings and suggest potential directions for future research.

The results and discussion sections highlight the limitations related to factors that vary according to a country's policies and development status, which affect the generalizability of the framework. Additionally, while a few experts have experience across different continents, the majority focus primarily on Europe. This concentration could introduce bias when evaluating the factors involved.

Some factors are more important for certain industries while others are not. This industry-wise factor differentiation is not captured in this study. One reason for this is that the selected experts come from various types of industries and have experience in different fields, including processes, energy, chemicals, product manufacturing, FMCG, pharmaceuticals, and more. Furthermore, the experts come from larger industries; hence, it is important to note that there could be bias regarding the size of industries in their responses. Another bias that can be observed is related to the hierarchical levels of the experts. The selected experts come from both middle and top management levels within the organizations. Although these experts have interacted with lower-level employees during their assessments and have observed ground-level work in various industries, it is still important to recognize the potential bias that may exist. The hierarchical levels of the experts vary significantly, ranging from junior safety officers to vice presidents, but still this hierarchical level of bias is a potential limitation. As a result, the research might have obtained a biased weight of the factors based on the experts' experiences. However, certain caveats are mentioned in the results and discussion sections that partially address this limitation of the study.

5.6 Future Recommendations

This research provides a solid foundation for future studies that can build upon it. The framework provided in the research can be validated by applying it to relevant cases. Earlier, frameworks for various quality standards adoption are presented in the literature. For instance, the quality standards adoption framework is presented by van de Kaa (2023), while Jurg et al. (2025) presented a framework specifically for the Semiconductor industry, and Hoogerbrugge et al. (2023) developed a framework specific to greenhouse gas accounting standards. Similarly, the framework presented in this research could be further developed for safety standards concerned with a specific type of industry, e.g., the process industry or construction. This approach can be further expanded by exploring the frameworks for a specific type of safety standard, e.g., for fire protection, or electrical environment, etc.

It is observed that certain factors in the framework, e.g., Government support, vary from country to country based on their policies and depend on whether the country is developed, developing, or underdeveloped. It would be interesting to further elaborate on such factors and see how the framework and weight of factors vary depending on the development status of the country.

İnan et al. (2017) used Simos' procedure for weighing for OHSMS adoption criteria presented in their study. In this research, the linear Best-Worst Method from MCDA was used in the factor weight calculation. This method is popularly used for alternative selection. For future research, other MCDA techniques like AHP (Analytic Hierarchy Process) or Bayesian Best-Worst Method can be used, and the comparison between the weights obtained for the factors can be studied. Provided the results need to be obtained using two different methods with the same set of experts for consistent comparison. It is also important to note that the experts interviewed for this research come from middle and top management levels. It would be interesting to study how the people from different levels in the organization would weigh the factors in this framework.

Future research could explore the influence of management commitment in the implementation stage on the adoption stage, specifically, the depth and speed of implementation. This study confirms that commitment is crucial in both adoption and implementation stages. But, in both stages, the mechanism through which initial managerial commitment cascades into broader organizational commitment remains underexplored. Investigating this link could offer valuable insights into how organizations can strategically front-load commitment during adoption to accelerate and strengthen implementation outcomes. Case-based analyses could help understand how management commitment during adoption can facilitate faster implementation.

There is an opportunity to explore the interrelation between the factors identified in the frameworks. Although management commitment is ranked as the most important factor, regulatory pressure significantly influences it, particularly in terms of coercive pressure. Thus, future research can investigate how these factors affect one another.

This research can be taken one step further by not limiting it to just safety standards. A brief comparison between the framework in this research and the quality standard adoption framework is provided in the discussion section. But it would be interesting to dive deep into the comparison and similarities of these 2 standards and contribute to the literature on integrated management systems. The weights of the common factors present in these different frameworks can be compared, and the key stakeholder and their influence behind this can be determined.

In this study, the third sub-research question was answered by using the methodology of expert interviews and literature review. There is also a scope to understand the conflicts between the presented stakeholders and how these conflicts might affect the adoption and implementation. This study could be further translated into a Power-Interest Grid of the stakeholders and could also be validated for other types of standards. The strategies for influencing key factors may vary depending on the size of the company. For example, government financial support for industries might affect the management commitments of small enterprises differently than those of large corporations. This variation in strategies based on industry size could be explored further as an extension of this study.

6 Conclusion

6.1 Answers to the research questions

This research aimed to explore the factors that influence the adoption and implementation of Occupational Health and Safety (OHS) standards, a topic that is often overlooked in standardization literature. By integrating insights from academic studies and industry experts, the study provides a structured and prioritized framework of these influencing factors. This enhances both theoretical understanding and practical application.

6.1.1 Sub-research Question 1

What are the relevant factors for the adoption and implementation of safety standards according to the literature and the experts?

The research identified 13 key factors influencing adoption and 6 factors influencing implementation. For adoption, the factors were divided into 4 categories, including External Influence (Regulatory Pressure, Value Chain Pressure, Broader Societal Pressure), Firm Characteristics (Management Commitment, Resources), Company Goals (Image, Operational Efficiency, Safe Working Environment, Cost Savings, Global expansion) and Standard Characteristics (Quality, Compatibility, Cost). For implementation, the factors relate to Commitment (from all the levels of the company), Communication & Training, Continuous Improvement Mechanisms, Resources, Compatibility with the Company, and Government Support.

6.1.2 Sub-research Question 2

What is the importance of factors for the adoption and implementation of safety standards, according to experts?

Using the Best Worst Method (BWM), 8 experts ranked the identified factors in terms of relative importance. The results show that for adoption, Management Commitment and Regulatory Pressure are the top 2 most significant. For implementation, Commitment and Communication & Training are prioritized.

6.1.3 Sub-research Question 3

How can the most important factors be influenced, and by whom?

The stakeholder interviews revealed that different actors influence different factors. Government agencies, industry associations, and insurance companies play a key role in exerting external pressure through regulation, incentives, and enforcement. Top management is pivotal in driving internal commitment, resource allocation, and strategic alignment. Middle management, safety officers, workers, and labor unions contribute through communication, feedback loops, and bottom-up awareness. Institutional theory (coercive, mimetic, and normative pressures)

effectively explains these multi-level influences. The detailed list of stakeholders and their influence is provided in Chapter 4.3.

6.1.4 Main Research Question

Which factors affect safety standards adoption and implementation, and how can the most important factors be influenced?

This research concludes that the adoption and implementation of Occupational Health and Safety (OHS) standards are influenced by a combination of internal organizational factors and external institutional pressures.

For adoption, the most critical factors include:

- Management Commitment, reflecting leadership's strategic prioritization of safety,
- Regulatory Pressure, driven by government rules and enforcement,

For implementation, the most influential factors are:

- Commitment from all levels of the company ensures ongoing support and alignment with operations,
- Communication & Training, which enables knowledge transfer and behavioural change.

These factors are shaped by various stakeholders, such as government regulators, top management, safety officers, industry associations, and labour unions, each playing a role in the adoption and implementation of safety standards. The findings demonstrate that successful safety engagement requires strategic leadership, operational integration, and multi-level stakeholder collaboration.

7 Reflection

7.1 Self-Reflection

I was searching for professors who could provide thesis topics when I had the opportunity to meet Prof. Geerten van de Kaa one fine evening. He offered a brief overview of a potential thesis topic and explained what the research process would entail. Without hesitation, I decided to pursue this topic, as it provided a clear path and a well-defined question to guide my research.

Later, I met Prof. Karolien van Nunen, who helped clarify the topic further. Each time I met with her afterwards, she alleviated my doubts and confusion regarding my thesis. I feel fortunate to have received immense encouragement from both of these supervisors.

Initially, I had very little knowledge about safety standards, particularly regarding their adoption and implementation. Prof. Geerten brought expertise in standards, while Prof. Karolien possessed knowledge about safety. My first challenge was my struggle to find relevant literature for my thesis topic. From that point on, my supervisors guided me through the process. Their structured questions led me to the answers I needed, and their confidence in me helped me stay on track as I continued my journey.

My exploration began with learning how to create effective search queries for databases. I found notes from the Preparation of Master Thesis course and various YouTube videos quite helpful. There were times when I felt lost in my research questions and doubted my research direction. The quick fix for these confusions was emailing my supervisors, whose short and swift replies consistently got me back on track.

The next challenge involved reading a vast number of research papers and filtering them based on specific criteria, which took up most of my time. During this stage, I realized that the terms "adoption," "implementation," and "certification" are often used interchangeably. Therefore, with the assistance of my professors, I defined these terms more clearly and refined my methodology. This experience ultimately helped me speed up the filtering process for research articles in subsequent rounds. I recall going through many YouTube videos to understand coding in ATLAS.ti, which helped me learn about the software interface and the different levels of coding I could create.

For the expert interviews, I appreciate my own foresight. In January, when I had a rough idea of my research topic, I reached out to experts on LinkedIn. I made connections and informed them that I would be contacting them around the end of March for the interviews. I also kept them updated on my progress with short messages, maintaining communication with the experts I had contacted. This technique proved helpful, and I did not struggle at the last moment to find the experts. Prof. Karolien also helped with the process with her contacts and chose appropriate experts for my thesis.

Through the whole process, I have learned time management, honed my communication skills. Interviewing is a skill, and I'll always remember the tips from Prof. Karolien. At the beginning,

the topic just seemed to be a topic, but it developed into a passion when I spoke to the experts. Their passion for their profession motivated me to do better in my research work. Towards the end of the research, I was also able to relate my work to my own past experiences of growing up in a village surrounded by a lot of small mechanical industries.

What I absorb from this process is, "Thesis is a process of answering the questions you have using the methods that are scientific."

7.2 Relevance to Management of Technology (MoT) Study Program

This research aligns closely with the objectives of the Management of Technology (MOT) program, which aims to equip engineers with the strategic, analytical, and managerial tools necessary for making informed and responsible decisions in technology-driven environments. This research investigates the factors influencing the adoption and implementation of safety standards. It also presents clear definitions of terms such as adoption, implementation, and certification to establish a clear distinction in these phases of standardization. The theories taught in the course Technology Strategy and Entrepreneurship (MOT132A) form the basis of this thesis. Theories like Neo-institutional pressure develop discussions on the significance of and the correlation of the factors in the framework. To identify the factors from the literature and the experts' interviews, this research followed qualitative research methods. The concepts of coding taught in the course on research methods were proven to be handy in this process. Similarly, the course Preparation for Master Thesis played a crucial role in framing the systematic review for literature selections and even in the very initial stages of research proposal creation. Right from framing the research question and then setting up a clear methodology for the research, these 2 courses have proved to be a strong foundation for this thesis.

To explore the significance of the identified factors, the study incorporates the methodologies taught in the Multi-Criteria Decision Analysis (MCDA) (TPM032A). It uses the Best-Worst method to rank the factors according to their influence. By conducting a stakeholder-driven analytical study on the safety standards, the research provides insights into how companies can successfully address barriers to adoption and harness the strength of facilitators in safety standard adoption.

This study contributes to academic understanding and also suggests frameworks for effective adoption and implementation of safety standards for policymakers and companies. It highlights how MOT graduates offer value by integrating organizational strategy, regulatory insight, and management practices to support the implementation of safety standards.

In this way, the thesis demonstrates an understanding of safety standards as a strategic and organizational resource influenced by regulation, corporate behaviour, and inter-organizational dynamics. The research process also reflects the MOT program's emphasis on responsible decision-making and integration. This program is well-structured and intellectually challenging, offering a good balance between theoretical frameworks and practical application.

References

Abad, J., Cabrera, H. R., & Medina, A. (2016). An analysis of the perceived difficulties arising during the process of integrating management systems. *Journal of Industrial Engineering and Management*, *9*(3), 860–878. https://doi.org/10.3926/jiem.1989

Abad, J., Lafuente, E., & Vilajosana, J. (2013). An assessment of the OHSAS 18001 certification process: Objective drivers and consequences on safety performance and labour productivity. *Safety Science*, *60*, 47–56. https://doi.org/10.1016/J.SSCI.2013.06.011

Abernathy, W. J., & Utterback, J. M. (1978). Patterns of Industrial Innovation. *Technology Review*, *80*(7).

A.F. van den Eijnden; G. van de Kaa; N Doom. (2019). *Factors involved in successful multi-mode standardization in case of phosphorus recovery in form of struvite from municipal wastewater | TU Delft Repository* [Delft University of Technology]. https://repository.tudelft.nl/record/uuid:6a737952-4719-42aa-8c5e-53fab61ec404

AlKalbani, A., Deng, H., Kam, B., & Zhang, X. (2016). *Investigating the impact of institutional pressures on information security compliance in organizations*. https://aisel.aisnet.org/acis2016/26/

Alli, B. O. (2008). Fundamental principles of occupational health and safety Second edition. *Ilo.Int*.

Anderson, P., & Tushman, M. L. (1990). Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. *Administrative Science Quarterly*, *35*(4). https://doi.org/10.2307/2393511

Arthur, W. B. (1989). Competing Technologies, Increasing Returns, and Lock-In by Historical Events. *The Economic Journal*, *99*(394). https://doi.org/10.2307/2234208

Bevilacqua, M., Ciarapica, F. E., & De Sanctis, I. (2016). How to successfully implement OHSAS 18001: The Italian case. *Journal of Loss Prevention in the Process Industries*, *44*, 31–43. https://doi.org/10.1016/j.jlp.2016.08.004

Campanelli, L. C., Ribeiro, L. D., & Campanelli, L. C. (2021). Involvement of Brazilian companies with occupational health and safety aspects and the new ISO 45001:2018. *Production*, *31*, 1–13. https://doi.org/10.1590/0103-6513.20210005

Carter, N., Bryant-Lukosius, D., Dicenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Onf.Ons.OrgN CarterNumber 5/September 2014, 2014•onf.Ons.Org*, *41*(5), 545–547. https://doi.org/10.1188/14.ONF.545-547

Castiblanco, Y., Perilla, A., Velasquez, P., & Santis, A. (2020). Design of Occupational Health and Safety Management System Based on ISO 45001, for a Company that Manufactures and Commercializes Low Voltage Electrical Boards. *CET Journal-Chemical Engineering Transactions*, *82*.

Cox, S., Tomás, J. M., Cheyne, A., & Oliver, A. (1998). Safety culture: The prediction of commitment to safety in the manufacturing industry. *British Journal of Management*, *9*(SPEC. ISS.). https://doi.org/10.1111/1467-8551.9.s1.2

da Silva, S. L. C., & Amaral, F. G. (2019). Critical factors of success and barriers to the implementation of occupational health and safety management systems: A systematic review of literature. *Safety Science*, *117*, 123–132. https://doi.org/10.1016/J.SSCI.2019.03.026

Darabont, D. C., Antonov, A. E., & Bejinariu, C. (2017). Key elements on implementing an occupational health and safety management system using ISO 45001 standard. *MATEC Web of Conferences*, *121*, 11007. https://doi.org/10.1051/MATECCONF/201712111007

Dimaggio, P. J., & Powell, W. W. (2021). THE IRON CAGE REVISITED: INSTITUTIONAL ISOMORPHISM AND COLLECTIVE RATIONALITY IN ORGANIZATIONAL FIELDS. In *The New Economic Sociology: A Reader*. https://doi.org/10.2307/2095101

Farrell, J., & Saloner, G. (1985). Standardization, Compatibility, and Innovation. *The RAND Journal of Economics*, *16*(1). https://doi.org/10.2307/2555589

Fernández-Muñiz, B., Montes-Peón, J. M., & Vázquez-Ordás, C. J. (2012). Occupational risk management under the OHSAS 18001 standard: Analysis of perceptions and attitudes of certified firms. *Journal of Cleaner Production*, *24*, 36–47. https://doi.org/10.1016/j.jclepro.2011.11.008

Fruhen, L. S., Griffin, M. A., & Andrei, D. M. (2019). What does safety commitment mean to leaders? A multi-method investigation. *Journal of Safety Research*, *68*, 203–214. https://doi.org/10.1016/J.JSR.2018.12.011

Gardner, D., Diego, C. W.-Q. assurance (San, Calif.), undefined, & 1997, undefined. (n.d.). Occupational health and safety management systems. *Europepmc.OrgD Gardner, C WinderQuality Assurance (San Diego, Calif.), 1997•europepmc.Org*. Retrieved February 11, 2025, from https://europepmc.org/article/med/9509550

Ghahramani, A. (2016). Factors that influence the maintenance and improvement of OHSAS 18001 in adopting companies: A qualitative study. *Journal of Cleaner Production*, *137*, 283–290. https://doi.org/10.1016/J.JCLEPRO.2016.07.087

Gökçek, S., & Güyagüler, T. (2011). Application of OHSAS 18000 to Bigadiç boron work to improve existent working condition. *IMCET 2011 - Proceedings of the 22nd International Mining Congress of Turkey*, 397–406.

Granerud, R. L., & Rocha, R. S. (2011). Organisational learning and continuous improvement of health and safety in certified manufacturers. *Safety Science*, *49*(7), 1030–1039. https://doi.org/10.1016/j.ssci.2011.01.009

Henderson, D., Sheetz, S. D., & Trinkle, B. S. (2011). Understanding the intention to adopt XBRL: An environmental perspective. *Journal of Emerging Technologies in Accounting*, *8*(1). https://doi.org/10.2308/jeta-10251

Hinze, J., & Wilson, G. (2000). Moving toward a Zero Injury Objective. *Journal of Construction Engineering and Management*, *126*(5). https://doi.org/10.1061/(asce)0733-9364(2000)126:5(399)

Hofmann, D. A., Jacobs, R., & Landy, F. (1995). High reliability process industries: Individual, micro, and macro organizational influences on safety performance. *Journal of Safety Research*, *26*(3). https://doi.org/10.1016/0022-4375(95)00011-E

Hoogerbrugge, C., van de Kaa, G., & Chappin, E. (2023). Adoption of quality standards for corporate greenhouse gas inventories: The importance of other stakeholders. *International Journal of Production Economics*, *260*, 108857. https://doi.org/10.1016/J.IJPE.2023.108857

Hovav, A., Hemmert, M., & Kim, Y. J. (2011). Determinants of Internet standards adoption: The case of South Korea. *Research Policy*, *40*(2), 253–262. https://doi.org/10.1016/J.RESPOL.2010.09.016

Howard, J. (2023). Occupational Safety and Health Act. *Patty's Toxicology*, 1–47. https://doi.org/10.1002/0471125474.TOX154

İnan, U. H., Gül, S., & Yılmaz, H. (2017). A multiple attribute decision model to compare the firms' occupational health and safety management perspectives. *Safety Science*, *91*, 221–231. https://doi.org/10.1016/j.ssci.2016.08.018

ISO. (2018). *ISO - ISO 45001 – All you need to know*. https://www.iso.org/news/ref2271.html

Jurg, M. F. M., Kamp, L. M., & van de Kaa, G. (2025). Factors affecting the adoption of quality standards in the semiconductor industry: The importance of stakeholder pressures. *Journal of Innovation & Knowledge*, *10*(3), 100690. https://doi.org/10.1016/J.JIK.2025.100690

Lafuente, E., & Abad, J. (2018a). Analysis of the relationship between the adoption of the OHSAS 18001 and business performance in different organizational contexts. *Safety Science*, *103*, 12–22. https://doi.org/10.1016/j.ssci.2017.11.002

Lafuente, E., & Abad, J. (2018b). Analysis of the relationship between the adoption of the OHSAS 18001 and business performance in different organizational contexts. *Safety Science*, *103*, 12–22. https://doi.org/10.1016/j.ssci.2017.11.002

Lambertini, L., & Shy, O. (2002). The Economics of Network Industries. *Southern Economic Journal*, *69*(1). https://doi.org/10.2307/1061567

Lemen, R. A., Mazzuckelli, L. F., Niemeier, R. W., & Ahlers, H. W. (1989). Occupational safety and health standards. *Annals of the New York Academy of Sciences*, *572*, 100–106.

Liang, F., Brunelli, M., & Rezaei, J. (2020). Consistency issues in the best worst method: Measurements and thresholds. *Omega (United Kingdom)*, *96*. https://doi.org/10.1016/j.omega.2019.102175

Ling, T. C., Hashim, F., & Liang, C. W. (2015). Occupational health and safety advisory services (OHSAS) 18001 management system adoption: Assessing the determinants. *Jurnal Pengurusan*, *43*, 61–72. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84952892821&partnerID=40&md5=2b10410d4d1a2b815bf6904e997e675e

Lo, C. K. Y., Pagell, M., Fan, D., Wiengarten, F., & Yeung, A. C. L. (2014a). OHSAS 18001 certification and operating performance: The role of complexity and coupling. *Journal of Operations Management*, *32*(5), 268–280. https://doi.org/10.1016/J.JOM.2014.04.004

Lo, C. K. Y., Pagell, M., Fan, D., Wiengarten, F., & Yeung, A. C. L. (2014b). OHSAS 18001 certification and operating performance: The role of complexity and coupling. *Journal of Operations Management*, *32*(5), 268–280. https://doi.org/10.1016/j.jom.2014.04.004

Lyytinen, K., & King, J. L. (2006). Standard making: a critical research frontier for information systems research. *Mis Quarterly*, *30*, 405–411.

Madsen, C. U., Thorsen, S. V., Hasle Peter and Laursen, L. L., & Dyreborg, J. (2022). Differences in occupational health and safety efforts between adopters and non-adopters of certified occupational health and safety management systems. *SAFETY SCIENCE*, *152*. https://doi.org/10.1016/j.ssci.2022.105794

Malek, M., El-Safty, A., El-Safety, A., Sorce, J., Professor, M. D., & El, A. (2010). The Correlation between Safety Practices in Construction and Occupational Health. *James Sorce/Management Science and Engineering*, *4*(3).

Marhavilas, P. K., Pliaki, F., & Koulouriotis, D. (2022a). International management system standards related to occupational safety and health: An updated literature survey. *Sustainability*, *14*(20), 13282.

Marhavilas, P. K., Pliaki, F., & Koulouriotis, D. (2022b). International Management System Standards Related to Occupational Safety and Health: An Updated Literature Survey. *Sustainability 2022, Vol. 14, Page 13282*, *14*(20), 13282. https://doi.org/10.3390/SU142013282

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Antes, G., Atkins, D., Barbour, V., Barrowman, N., Berlin, J. A., Clark, J., Clarke, M., Cook, D., D'Amico, R., Deeks, J. J., Devereaux, P. J., Dickersin, K., Egger, M., Ernst, E., Gøtzsche, P. C., … Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. In *PLoS Medicine* (Vol. 6, Issue 7). https://doi.org/10.1371/journal.pmed.1000097

Newton, S., Susainathan, S., George, H. J., Quttainah, M., & Parayitam, S. (2024). Top management commitment as a moderator in the relationship between green banking adoption practices and performance: evidence from India. *Journals.Sagepub.ComS Newton, S Susainathan, HJ George, M Quttainah, S ParayitamIndian Journal of Corporate Governance, 2024•journals.Sagepub.Com*, *17*(1), 33–62. https://doi.org/10.1177/09746862241236553

Pedrosa, M. H., Salazar, A. K., & Guedes, J. C. (2024). Characterisation of the Portuguese Footwear Industry Relative to Occupational Health and Saefety. In *Studies in Systems, Decision and Control* (Vol. 492). https://doi.org/10.1007/978-3-031-38277-2_19

Rajaprasad, S. V. S., & Chalapathi, P. V. (2015). Factors Influencing Implementation of OHSAS 18001 in Indian Construction Organizations: Interpretive Structural Modeling Approach. *Safety and Health at Work*, *6*(3), 200–205. https://doi.org/10.1016/J.SHAW.2015.04.001

Ramos, D., Afonso, P., & Rodrigues, M. A. (2020). Integrated management systems as a key facilitator of occupational health and safety risk management: A case study in a medium sized waste management firm. *Journal of Cleaner Production*, *262*, 121346. https://doi.org/10.1016/J.JCLEPRO.2020.121346

Redinger, C., Dotson, K., & Leibowitz, A. (2011). Occupational Health and Safety Management Systems. *Patty's Industrial Hygiene*, 2109–2162. https://doi.org/10.1002/0471435139.HYG049.PUB2

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega*, *53*, 49–57. https://doi.org/10.1016/J.OMEGA.2014.11.009

Rezaei, J. (2016). Best-worst multi-criteria decision-making method: Some properties and a linear model. *Omega (United Kingdom)*, *64*. https://doi.org/10.1016/j.omega.2015.12.001

Rezaei, J. (2022). *The Balancing Role of Best and Worst in Best-Worst Method*. 1–15. https://doi.org/10.1007/978-3-030-89795-6_1

Robson, L. S., Clarke, J. A., Cullen, K., Bielecky, A., Severin, C., Bigelow, P. L., Irvin, E., Culyer, A., & Mahood, Q. (2007). The effectiveness of occupational health and safety management system interventions: A systematic review. In *Safety Science* (Vol. 45, Issue 3). https://doi.org/10.1016/j.ssci.2006.07.003

Seixas, N. S., Crollard, A., Neitzel, R., Stover, B., & Dominguez, C. (2013). Intervening at the bottom: Can a health and safety committee intervention influence management commitment? *Policy and Practice in Health and Safety*, *11*(1). https://doi.org/10.1080/14774003.2013.11667785

Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. john wiley & sons.

Shekari, A. M. (2020). Safety management systems standards & guidelines: A comparative analysis. *Professional Safety*, *65*(09), 32–37.

Siddique, H., Dominic, D. D., & Bhushan, S. (2024). The Role of Government Regulations on Manufacturing SME's Readiness for Industry4. 0 in Malaysia. *SpringerH Siddique, DD Dominic, S BhushanInternational Conference on Machine Learning, Advances in Computing, Renewable, 2024•Springer*, *1232*, 391–401. https://doi.org/10.1007/978-981-97-5231-7_33

Singh, N. (2024). Occupational safety and multiple management systems certifications: The influence of internationalisation of the firm. *Safety Science*, *169*. https://doi.org/10.1016/j.ssci.2023.106324

Tappura, S., Nenonen, N., & Kivistö-Rahnasto, J. (2017). Managers' viewpoint on factors influencing their commitment to safety: An empirical investigation in five Finnish industrial organisations. *Safety Science*, *96*, 52–61. https://doi.org/10.1016/J.SSCI.2017.03.007

Techatassanasoontorn, A. A., & Suo, S. (2011). Influences on standards adoption in de facto standardization. *Information Technology and Management*, *12*(4). https://doi.org/10.1007/s10799-011-0089-2

Uhrenholdt Madsen, C., Kirkegaard, M. L., Dyreborg, J., & Hasle, P. (2020). Making occupational health and safety management systems 'work': A realist review of the OHSAS 18001 standard. *Safety Science*, *129*, 104843. https://doi.org/10.1016/J.SSCI.2020.104843

U.S. Department of Labor. (1970). *Occupational Safety and Health Act of 1970 – Section 3*. OSH Act of 1970. Occupational Safety and Health Administration

Utterback, J. M., & Abernathy, W. J. (1975). A dynamic model of process and product innovation. *Omega*, *3*(6). https://doi.org/10.1016/0305-0483(75)90068-7

van de Kaa, G. (2023). Standards adoption: A comprehensive multidisciplinary review. *Heliyon*, *9*(8). https://doi.org/10.1016/J.HELIYON.2023.E19203/ASSET/F23B4CE0-115E-4F9C-A3AF-43B1129692C3/MAIN.ASSETS/GR3.JPG

Vinodkumar, M. N., & Bhasi, M. (2011). A study on the impact of management system certification on safety management. *Safety Science*, *49*(3), 498–507. https://doi.org/10.1016/J.SSCI.2010.11.009

Vlachos, T. (2018). Certifiable Risk Management & Business Continuity Approach in Mining Industry. *Proceedings of the World Congress on Mechanical, Chemical, and Material Engineering*. https://doi.org/10.11159/mmme18.108

Vu Gia, K., Huyen, T. N. T., Le Anh, T., Nguyen Trung, H., Nguyen Lam Kim, T., & Cao Phuoc, K. (2024). Factors affecting the implementation of labor safety and hygiene in specific enterprises: a case in Vietnam. *Cogent Social Sciences*, *10*(1). https://doi.org/10.1080/23311886.2024.2365402

Wang, W., Zhang, S., & King, A. P. (2016). Research on the adoption barriers of the engineering construction standards in China. *Structural Survey*, *34*(4), 367–378. https://doi.org/10.1108/SS-02-2015-0010

Wang, X., Lin, H., & Weber, O. (2016). Does adoption of management standards deliver efficiency dain in firms' pursuit of sustainability performance? An empirical investigation of chinese manufacturing firms. *Sustainability (Switzerland)*, *8*(7). https://doi.org/10.3390/su8070694

Wee, B. van, Systems, D. B.-J. of D., & 2024, undefined. (2023). Literature review papers: the search and selection process. *Taylor & FrancisB van Wee, D BanisterJournal of Decision Systems, 2024•Taylor & Francis*. https://doi.org/10.1080/12460125.2023.2197703

WHO/ILO. (2021). *WHO/ILO: Almost 2 million people die from work-related causes each year*. https://www.who.int/news/item/17-09-2021-who-ilo-almost-2-million-people-die-from-work-related-causes-each-year

Wu, Q., Liu, X., Zhou, L., Qin, J., & Rezaei, J. (2024). An analytical framework for the best–worst method. *Omega (United Kingdom)*, *123*. https://doi.org/10.1016/j.omega.2023.102974

Yang, M., & Maresova, P. (2020). Adopting occupational health and safety management standards: The impact on financial performance in pharmaceutical firms in china. *Risk Management and Healthcare Policy*, *13*, 1477–1487. https://doi.org/10.2147/RMHP.S261136

Yen, Y. X., & Yen, S. Y. (2012). Top-management's role in adopting green purchasing standards in high-tech industrial firms. *Journal of Business Research*, *65*(7), 951–959. https://doi.org/10.1016/J.JBUSRES.2011.05.002

Zwetsloot, G. I. J. M., Kines, P., Ruotsala, R., Drupsteen, L., Merivirta, M.-L., & Bezemer, R. A. (2017). The importance of commitment, communication, culture and learning for the implementation of the Zero Accident Vision in 27 companies in Europe. *Safety Science*, *96*, 22–32.

A Safety Standards

The following section gives an overview of the classification of Safety Standards available

Table 18: Classification of Safety Standards

Category	Key Elements	Examples
Occupational Health & Safety (OHS)	Risk assessment and hazard control Worker training and safety culture Workplace ergonomics and exposure limits	ISO 45001 – Occupational health and safety management systems OSHA 29 CFR 1910 – US occupational safety regulations ILO Occupational Safety and Health Convention (C155, C187) – International labor safety guidelines EN 12100 – European machinery safety standard
Machine & Equipment Safety	Machine guarding and interlocks- Lockout/Tagout (LOTO) procedures Automated safety systems and emergency stops	ISO 13849 – Safety of machinery and control systems IEC 60204 – Electrical safety for industrial machinery ANSI B11 – Safety requirements for different industrial machines
Fire & Explosion Safety	Fire detection and suppression systems Flammable material handling and storage Explosion-proof equipment for hazardous areas	NFPA 70E – Electrical safety and fire hazards ATEX 2014/34/EU – European directive for explosive atmospheres IEC 60079 – Standards for explosive gas and dust environments
Electrical Safety	Safe electrical design and grounding Protection against electric shocks Arc flash hazard prevention	IEC 61508 – Functional safety of electrical systems NFPA 70 (NEC) – National Electrical Code for safe electrical installations IEEE 1584 – Arc flash hazard analysis
Process Safety Management (PSM)	Hazard identification and risk assessment Safety instrumented systems (SIS) Emergency response planning	OSHA PSM (29 CFR 1910.119) – Process safety regulations for hazardous chemicals API RP 750 – Risk-based process safety for petroleum industries IEC 61511 – Safety instrumented systems for process industries
Environmental Health & Safety (EHS)	Waste management and pollution control Safe disposal of hazardous materials Noise and air quality regulations	ISO 14001 – Environmental management systems EPA Regulations (USA) – Industrial pollution control EU REACH – Registration, evaluation, and authorization of chemicals
Personal Protective Equipment (PPE)	Protection against chemical, physical, and biological hazards Comfort, durability, and performance of PPE Certification and testing of safety gear	ANSI Z87.1 – Eye and face protection standards EN 388 – Protective gloves against mechanical risks ISO 20345 – Safety footwear requirements
Construction & Structural Safety	Fall protection and scaffolding safety Structural integrity and load-bearing calculations Safe material handling and excavation practices	OSHA 1926 – Construction industry safety standards BS 5975 – Temporary works and scaffolding safety ISO 2631 – Vibration exposure limits in construction
Transportation & Logistics Safety	Safe loading and unloading procedures Transportation of flammable, toxic, and explosive materials Fleet management and driver safety	ADR Agreement – European regulations for road transport of hazardous goods DOT Regulations (49 CFR) – US Department of Transportation safety standard IMO IMDG Code – International maritime dangerous goods regulations
Radiation & Nuclear Safety	Radiation shielding and exposure limits Waste disposal for radioactive materials Monitoring and emergency response	ICRP Recommendations – International radiation protection guidelines IAEA Safety Standards – Nuclear safety and emergency preparedness 10 CFR Part 20 (US NRC) – Radiation protection regulations

B Literature review process

B.1 Choice of Database

The databases used for searching the research articles were Scopus and Web of Science, which were made available by TU Delft. Google Scholar was not used for two primary reasons.

Firstly, nesting of Boolean Operators like AND, OR to narrow down the search results seemed to be difficult in Google Scholar. i.e. Google Scholar does not allow including a search query like: *("workplace safety standard" OR "health and safety standard") AND ("adoption" OR "certification")* where the Boolean operation OR is nesting inside AND. Hence this resulted in extensive search results initially around 17000. Even after refining the keywords, the number of results remained high at around 3960, making it difficult to capture relevant articles by filtering.

The second challenge was exporting the obtained search results, the whole list into any form of file like .BIB or .RIS. While Mendeley Chrome extension was tested for capturing results from Google Scholar, it was inconsistent – sometimes functioning correctly and other times failing to capture all entries on the single search page. The manual process of saving individual references was time consuming and inefficient. Attempts to find alternative solutions online did not yield any practical results.

List of the final 20 research articles considered for the literature review is as follows

Table 19: List of final papers selected for factor identification

Paper No.	Paper Title	Reference
1	A multiple attribute decision model to compare the firms' occupational health and safety management perspectives	İnan et al., 2017
2	Adopting Occupational Health and Safety Management Standards: The Impact on Financial Performance in Pharmaceutical Firms in China	Yang & Maresova, 2020
3	An Analysis of the Perceived Difficulties Arising During the Process of Integrating Management Systems	Abad et al., 2016
4	Analysis of the relationship between the adoption of the OHSAS 18001 and business performance in different organizational contexts	Lafuente & Abad, 2018
5	Application of OHSAS 18000 to Bigadiç Boron work in order to improve the working conditions	Gökçek & Güyagüler, 2011
6	Certifiable Risk Management & Business Continuity Approach in Mining Industry	Vlachos, 2018
7	Characterisation of the Portuguese Footwear Industry Relative to Occupational Health and Safety	Pedrosa et al., 2024
8	Critical factors of success and barriers to the implementation of occupational health and safety management systems: A systematic review of literature	da Silva & Amaral, 2019
9	Design of Occupational Health and Safety Management System Based on ISO 45001, for a Company that Manufactures and Commercializes Low Voltage Electrical Boards	Castiblanco et al., 2020
10	Differences in occupational health and safety efforts between adopters and non-adopters of certified occupational health and safety management systems	Madsen et al., 2022
11	Factors affecting the implementation of labor safety and hygiene in specific enterprises: a case in Vietnam	Vu Gia et al., 2024
12	Factors Influencing Implementation of OHSAS 18001 in Indian Construction Organizations: Interpretive Structural Modeling Approach	Rajaprasad & Chalapathi, 2015
13	Factors that influence the maintenance and improvement of OHSAS 18001 in adopting companies: A qualitative study	Ghahramani, 2016
14	How to successfully implement OHSAS 18001: The Italian case	Bevilacqua et al., 2016
15	Involvement of Brazilian companies with occupational health and safety aspects and the new ISO 45001:2018	Campanelli et al., 2021
16	Key elements on implementing an occupational health and safety management system using ISO 45001 standard	Darabont et al., 2017
17	Making occupational health and safety management systems 'work': A realist review of the OHSAS 18001 standard	Uhrenholdt Madsen et al., 2020
18	Occupational Health and Safety Advisory Services (OHSAS) 18001 Management System Adoption: Assessing the Determinants	Ling et al., 2015
19	Occupational risk management under the OHSAS 18001 standard: analysis of perceptions and attitudes of certified firms	Fernández-Muñiz et al., 2012
20	Occupational safety and multiple management systems certifications: The influence of internationalisation of the firm	Singh, 2024

Table 20: Sources of Adoption Factors

Source	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Category / Factor	İnan et al. (2017)	Yang & Maresova (2020)	Abad et al. (2016)	Lafuente & Abad (2018)	Gökçek & Güyagüler (2011)	Vlachos (2018)	Pedrosa et al. (2024)	da Silva & Amaral (2019)	Castiblanco et al. (2020)	Madsen et al. (2022)	Vu Gia et al. (2024)	Rajaprasad & Chalapathi (2015)	Ghahramani (2016)	Bevilacqua et al. (2016)	Campanelli et al. (2021)	Darabont et al. (2017)	Uhrenholdt Madsen et al. (2020)	Ling et al. (2015)	Fernández-Muñiz et al. (2012)	Singh (2024)	P1 Interview Transcript	P2 Interview Transcript
External Influence																						
Regulatory Pressure	X	X			X			X		X	X	X	X	X	X				X		X	X
Value Chain Pressure	X	X	X	X	X	X	X	X	X	X		X		X	X			X	X	X	X	X
Broader Societal Pressure								X				X						X			X	X
Firm Characteristics																						
Management Commitment		X		X	X	X	X	X				X	X		X			X	X	X	X	X
Resources					X		X	X		X	X		X		X	X			X		X	X
Company Goals																						
Company Image						X		X	X	X	X	X		X	X			X	X	X	X	X
Cost Savings		X		X		X	X	X			X			X	X			X	X			X
Safe Working Environment		X		X	X	X	X	X	X	X	X	X		X	X			X	X		X	X
Operational Efficiency		X		X		X		X	X	X				X	X	X		X			X	
Global Expansion	X					X		X	X						X			X	X	X		
Standard Characteristics																						
Compatibility		X				X	X	X	X		X	X			X	X		X				X
Cost of Standard			X							X	X	X		X	X				X			
Quality of Standard			X	X		X			X	X		X			X	X		X			X	

Table 21: Sources of the Implementation Factors

Source	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
	İnan et al. (2017)	Yang & Maresova (2020)	Abad et al. (2016)	Lafuente & Abad (2018)	Gökçek & Güyagüler (2011)	Vlachos (2018)	Pedrosa et al. (2024)	da Silva & Amaral (2019)	Castiblanco et al. (2020)	Madsen et al. (2022)	Vu Gia et al. (2024)	Rajaprasad & Chalapathi (2015)	Ghahramani (2016)	Bevilacqua et al. (2016)	Campanelli et al. (2021)	Darabont et al. (2017)	Uhrenholdt Madsen et al. (2020)	Ling et al. (2015)	Fernández-Muñiz et al. (2012)	Singh (2024)	P1 Interview Transcript	P2 Interview Transcript
Factor																						
Commitment	X	X	X		X		X	X			X	X	X	X	X			X	X		X	X
Communication and Training	X			X	X	X	X	X	X		X	X	X	X	X	X		X	X		X	X
Compatibility with the Company	X		X	X			X	X		X		X	X	X	X	X	X	X	X	X	X	X
Continuous Improvement	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	
Government Support							X						X		X							
Resources	X		X	X	X		X	X			X	X	X	X	X	X		X	X	X	X	X

Table 22: Summary of Research Articles

No.	Reference	Methodology	Findings	Conclusions	Relevance to RQ 1
1	İnan et al. (2017)	Multiple Attribute Decision Model (MADM) using VIKOR method. Focus on packaging firms in Turkey.	Firm-level commitment and top management support were key factors. The OHSMS adoption varied across firms, depending on resources and organizational structure.	Top management commitment is critical for successful OHSMS adoption. Structured decision-making models help in evaluating different perspectives for OHSMS implementation.	Highlights the role of leadership commitment and organizational context in OHSMS adoption, aligning with your RQ about internal factors.
2	Yang & Maresova (2020)	Panel regression models analyzing data from 125 pharmaceutical firms in China.	OHSMS adoption led to improved financial performance, particularly in terms of return on assets (ROA) and profitability.	OHSMS adoption improves financial outcomes in pharmaceutical firms, especially in larger companies.	Provides evidence of financial benefits from OHSMS adoption, which can be a strong motivator for firms, responding to external pressures for adoption.
3	Abad et al. (2016)	Survey-based study on 102 firms in Spain using Kruskal-Wallis test.	Resistance to change was the biggest challenge in integrating OHSMS with other systems. Smaller firms faced more integration difficulties.	A progressive integration approach is recommended to minimize resistance and improve OHSMS implementation.	Relates to organizational barriers (resistance to change, integration difficulties), addressing internal organizational challenges in OHSMS adoption.
4	Lafuente & Abad (2018)	Quantitative analysis of firms across different sectors in various countries.	OHSAS 18001 adoption improved organizational performance, especially in manufacturing and construction.	OHSAS 18001 leads to better organizational outcomes, particularly in high-risk industries.	Focuses on performance improvements after OHSMS adoption, supporting the argument that OHSMS adoption improves safety and performance.
5	Gökçek & Güyagüler (2011)	Case study of Bigadiç Boron Mine in Turkey with qualitative methods.	Significant safety improvements were noted, but challenges remained in full employee engagement and data management.	Effective leadership and employee involvement are critical for OHSMS success, especially in high-risk industries.	Discusses internal barriers (employee engagement, leadership) in the mining sector, adding depth to the challenges faced in OHSMS adoption.
6	Vlachos (2018)	Qualitative analysis with case studies from mining companies.	Certifiable risk management approaches, including OHSAS 18001, helped reduce operational and safety risks.	Integrating OHSMS with business continuity planning can significantly improve safety and operational stability.	Provides insights into integrating OHSMS with broader risk management practices, relevant to organizational approaches to safety.
7	Pedrosa et al. (2024)	Survey-based methodology with 85	Most companies lacked formal OHS certifications. Companies rely on external providers for safety, with	Leadership commitment and proactive safety measures are critical for effective OHSMS implementation.	Provides a sector-specific look at challenges in OHSMS adoption, highlighting internal factors (management

		Portuguese footwear companies.	minimal focus on proactive safety measures like ergonomics.		commitment, employee engagement) and gaps in industry practice.
8	da Silva & Amaral (2019)	Systematic review of literature from various industries.	Management commitment, employee engagement, and systematic processes are critical for OHSMS success. Financial constraints and resistance are major barriers.	OHSMS adoption is more successful when leadership is committed, and a structured approach is implemented.	Summarizes key factors for successful OHSMS adoption, providing a comprehensive framework for analyzing barriers and success factors in your RQ.
9	Castiblanco et al. (2020)	Design-focused study using ISO 45001 implementation framework.	A structured OHSMS, incorporating ISO 45001 standards, improved safety measures and reduced risks.	A systematic design process based on ISO 45001 can lead to long-term safety improvements.	Provides practical insights into designing OHSMS, relevant to your RQ as it discusses the adoption of ISO 45001 and its organizational benefits.
10	Madsen et al. (2022)	Comparative analysis of adopters and non-adopters of certified OHSMS using survey data.	Adopters of certified OHSMS had better safety records, fewer injuries, and greater organizational commitment to safety.	Certification leads to improved safety outcomes, but the process can be challenging for organizations that lack internal resources.	Directly answers the RQ by comparing efforts between adopters and non-adopters, highlighting the importance of certification in improving safety outcomes.
11	Vu Gia et al. (2024)	Survey study of 230 enterprises in Vietnam's construction and manufacturing sectors.	Factors like management ability, employee responsibility, training, and regulatory environment were key to safety implementation.	A comprehensive approach to training, regulatory adherence, and management involvement is essential for improving safety practices.	Highlights factors like management and regulatory compliance, directly contributing to understanding barriers to OHSMS adoption in developing countries.
12	Rajaprasad & Chalapathi (2015)	Interpretive Structural Modeling (ISM) approach applied to the construction sector in India.	Management commitment, safety policy, safety culture, and performance were found to be key drivers of OHSAS 18001 adoption.	Strong organizational commitment and a safety-focused culture are critical for the successful implementation of OHSAS 18001 in construction.	Highlights internal factors like management and safety culture, providing insights into organizational behavior and barriers to OHSMS adoption.
13	Ghahramani (2016)	Qualitative study with interviews from firms adopting OHSAS 18001.	Continuous commitment from management and employee involvement were key to maintaining and improving OHSAS 18001.	Ongoing management commitment and employee engagement are essential for sustaining OHSMS.	Relates to your RQ by emphasizing the importance of management and employee engagement in maintaining OHSMS and the role of continuous improvement.

14	Bevilacqua et al. (2016)	Case study of Italian companies implementing OHSAS 18001.	A structured, step-by-step implementation process with strong leadership involvement led to successful OHSMS implementation.	Clear planning, strong leadership, and employee involvement are necessary for successful OHSAS 18001 implementation.	Offers practical insights into OHSMS implementation, focusing on planning and leadership commitment, which are directly relevant to your RQ.
15	Campanelli et al. (2021)	Survey of Brazilian companies on OHS practices and adoption of ISO 45001.	Brazilian companies are increasingly adopting ISO 45001, driven by regulatory pressures and market demands.	ISO 45001 adoption is increasing in Brazil, but challenges remain in fully integrating it into organizational processes.	Relates to your RQ by discussing ISO 45001 adoption, its challenges, and external pressures, contributing to the understanding of the global adoption of safety standards.
16	Darabont et al. (2017)	Design-based analysis of implementing ISO 45001 in an electrical board manufacturing company.	ISO 45001 implementation led to a comprehensive approach to hazard identification, risk assessment, and continuous improvement.	A systematic approach based on ISO 45001 ensures long-term safety improvements and organizational alignment.	Focuses on the practical aspects of ISO 45001 implementation, aligning with your RQ as it addresses design and implementation factors.
17	Uhrenholdt Madsen et al. (2020)	Realist review of the OHSAS 18001 standard, analyzing mechanisms and outcomes across industries.	OHSAS 18001's success depends on the organizational context, including leadership and employee involvement.	OHSAS 18001 works when embedded into an organization's culture with active participation from both management and employees.	Directly addresses the factors influencing OHSMS adoption, supporting the idea that organizational culture and leadership are central to success.
18	Ling et al. (2015)	Survey-based study on the determinants of OHSAS 18001 adoption in Malaysia.	Management support, a supportive environment, and financial resources are key determinants of adoption.	Management commitment and a supportive environment are crucial for OHSAS 18001 adoption, particularly in SMEs.	Relevant to your RQ by addressing the factors influencing OHSMS adoption, with a focus on leadership and resources.
19	Fernández-Muñiz et al. (2012)	Qualitative analysis of firms certified under OHSAS 18001 in various sectors.	Firms that adopted OHSAS 18001 showed improved safety outcomes, but some continued facing challenges in fully integrating it into daily practices.	Continued commitment to OHSMS post-certification is essential to ensuring sustained safety improvements.	Adds depth to your RQ by highlighting post-certification challenges, especially in fully integrating safety management systems.
20	Singh (2024)	Case study of Indian auto-component producers with multiple certifications (ISO 9001, ISO 14001, OHSAS 18001).	Firms engaged in international markets tended to adopt OHSAS 18001 to meet global standards and improve competitiveness.	Internationalization encourages the adoption of integrated management systems like OHSAS 18001, leading to improved safety and competitiveness.	Relates to your RQ by highlighting how internationalization can drive OHSMS adoption, particularly in the context of global supply chains.

C Interviews

C.1 Exploratory Interviews for Factor Identification

This interview is being conducted as a part of the Master Thesis Project of Sharada Atul Gavade, MSc Management of Technology student at TU Delft. The thesis project is titled "Factors influencing the adoption and implementation of Occupational Health and Safety Standards."

One of the research objectives is to identify and categorize the factors influencing the adoption and implementation of safety standards by reviewing the existing literature and consulting domain experts.

This interview aims to help answer the following sub-research questions

- What factors influence the decision to adopt Occupational Safety Standards?
  Adoption means the internal decision by a company of encompassing
  1. Whether to use or not use a safety standard
  2. Choosing between different available safety standards.

- What are the factors influencing the process of implementation of Occupational Safety Standards?
  Implementation means the process of integrating the chosen safety standard into organizational operations. i.e. integration in the (safety)management systems such that the company complies with the chosen standard.

General Background Questions

1. Can you briefly describe your role and experience in occupational safety management?
2. What safety standards are you most familiar with (e.g., ISO 45001, OSHA 18001, industry-specific standards)?
3. What type of companies have you worked with in implementing safety standards (e.g., manufacturing, construction, healthcare)?

Exploration of factors

1. What external pressures influence the adoption of safety standards?
2. What internal factors within a company influence the decision to adopt safety standards?
3. In your experience, what are the biggest challenges companies face when deciding whether to adopt safety standards?
4. Once a company adopts a safety standard, what are the key challenges in implementing it successfully?
5. What strategies have you seen that lead to successful implementation of safety standards?
6. Are there industry-specific challenges that affect adoption and implementation differently across sectors?

7. Are there any emerging trends or new technologies that are impacting how companies adopt and implement safety standards?
8. If you could give one piece of advice to companies considering adopting a safety standard, what would it be?
9. Is there anything else you believe is important that we haven't discussed?
10. Would you be open to reviewing my findings later to provide further insights?

Table 23: List of Experts Interviewed

Participant ID	Interview Participation	Job Role	No. Years of Experience
P1	Exploratory, Stakeholder	Safety Scientist	13
P2	Exploratory, Stakeholder	Senior EHS Analyst	12
E1	MCDA, Stakeholder	VP Sustainability/ESG	35
E2	MCDA, Stakeholder	Safety Officer	30
E3	MCDA, Stakeholder	HSE Consultant/ Researcher	64
E4	MCDA, Stakeholder	Junior Health & Safety Officer	6
E5	MCDA	Head of Manufacturing	23
E6	MCDA, Stakeholder	Health, Safety & Environment Specialist	15
E7	MCDA	HSEQ Manager	16
E8	MCDA, Stakeholder	HSSE Manager	23

C.2 Why not target a specific industry

Experts consulted have experience in more than one type of industry. Therefore, their answers also included exceptions and caveats from various types of experiences across different industries. The response of the experts cannot be separated from the bias of their experience with the different industries with which they have earlier worked. And finding an expert with only specific industry experience is tough. Hence, the research was not limited to any type of specific industry. Also, this contributes to better generalization of the research.

C.3 MCDA Excel Sheet / Questions

The Excel sheet provided for the Linear BWM-Solver available on the website - https://bestworstmethod.com/software/ was used to form the MCDM problem for the expert interviews. Depending on the number of factors to compare for pairwise comparisons, the sheet was chosen. E.g., for the pairwise comparison of 3 factors, the Sheet C=3 was used to frame the MCDM problem.

C.4 MCDA Consistency Ratios of Expert Responses

The following table represents the consistency ratios of the experts' responses to the BWM pairwise comparisons and the threshold consistency values.

Table 24: CR and Threshold Values for all Expert Responses

	Adoption								Implementation	
	External Pressure		Company Goals		Standard Characteristics		All Adoption Categories		Implementation	
Particpant ID	CR	Threshold	CR	Threshold	CR	Threshold	CR	Threshold	CR	Threshold
E1	0.1250	0.1359	0.1250	0.2958	0.0694	0.1359	0.1250	0.2681	0.1528	0.3337
E2	0.1250	0.1309	0.1250	0.2958	0.0667	0.1330	0.1528	0.2681	0.1528	0.3337
E3	0.0500	0.1354	0.1250	0.2958	0.1190	0.1294	0.1190	0.2457	0.1528	0.3337
E4	0.1250	0.1309	0.1528	0.3062	0.1250	0.1309	0.1190	0.2457	0.1250	0.3154
E5	0.1190	0.1294	0.1190	0.2819	0.0833	0.1121	0.0833	0.1529	0.1528	0.3337
E6	0.0714	0.1294	0.1190	0.2819	0.1250	0.1309	0.1429	0.2521	0.1429	0.3154
E7	0.0238	0.1294	0.1250	0.2958	0.0000	0.1121	0.1786	0.2521	0.1429	0.3154
E8	0.1000	0.1330	0.0500	0.2306	0.0714	0.1294	0.1000	0.1990	0.1190	0.3029

C.5 Stakeholder Influence Interview Questions

Background Information

In the previous interaction, we used the Best-Worst Method (BWM) of Multi-Criteria Decision Analysis (MCDA) to rank the factors influencing the adoption and implementation of safety standards. The results of the interviews with the experts are as follows:

Adoption Factors

Table 25: Ranking and Weights of Adoption Factors

Ranking	Factor	Weight	Category
1	Management Commitment	0.25	Firm Characteristics
2	Regulatory Pressure	0.15	External Influence
3	Value Chain Pressure	0.06	External Influence
4	Safe Working Environment	0.05	Company Goals
5	Compatibility	0.04	Standard Characteristics
6	Resources	0.04	Firm Characteristics
7	Operational Efficiency	0.03	Company Goals
8	Quality of Standard	0.03	Standard Characteristics
9	Cost Savings	0.03	Company Goals
10	Broader Societal Pressure	0.02	External Influence
11	Image	0.02	Company Goals
12	Global Expansion	0.01	Company Goals
13	Cost of Standard	0.01	Standard Characteristics

Implementation Factors

Table 26: Ranking and Weights of Implementation Factors

Ranking	Factors	Weight
1	Commitment	0.35
2	Communication & Trainings	0.17
3	Continuous Improvement Mechanisms	0.13
4	Resources	0.12
5	Compatibility with the Company	0.10
6	Government Support	0.05

Interview Questions

The following questions aim to understand how and by whom the top 2 ranked factors can be influenced.

Adoption Factors

For each of the following factors: Management Commitment and Regulatory Pressure

1. How can this factor be influenced or strengthened?
2. Who are the key stakeholders that can influence it?

Definitions of the above factors

Table 27: Top 2 Adoption Factors

Factor	Definition
Management Commitment	This refers to the dedication of the top management and the leadership to adopt the safety standards. It also deeply roots the policy and culture within the company to promote and consider safety standards adoption as a priority task. It involves all the decision-making moments that management commitment takes toward standards adoption. It also highlights the influence of the parent company on its branches in other locations.
Regulatory Pressure	This refers to the external influence of the laws, policies, or regulatory bodies that compel organizations to decide whether to adopt safety standards. It points to the pressure from government mandates formed to encourage the adoption of safety standards for workplace safety.

Implementation Factors

For each of the following factors: Commitment, Communication & Training

1. How can this factor be influenced or strengthened?
2. Who are the key stakeholders that can influence it?

Table 28: Top 2 Implementation Factors

Factor	Definition
Commitment	This represents the dedication of management, leadership, and employees to allocate resources and prioritize the implementation of safety standards. It reflects the organization's willingness to embrace change and uphold safety standards and systems.
Communication & Trainings	This involves the exchange of information and the education of employees to ensure they understand and effectively implement standards. It includes clear communication from leadership and structured training programs to align everyone with the processes and goals.

C.6 Stakeholder Influence – Coding Results

Table 29: List of Stakeholders and Influences - Adoption Factors

Stakeholder	Influence	Definition
Management Commitment		
Government	External Pressure	Provides external incentives that drive management's commitment to safety through regulations and policies.
Industry Type	–	Management's commitment to safety is influenced by the nature of the industry. For instance, a graphic design firm may not require the same level of safety measures as a petrochemical plant.
Insurance Companies	External Pressure	Exert value chain pressure by highlighting the benefits of adopting safety standards, such as reduced insurance premiums.
Labor Union	Demand Safety	Labor unions advocate for improved safety standards and push management to prioritize worker safety.
Middle Management	Awareness	Acts as a communication bridge between supervisors and top management, promoting awareness of safety issues and influencing decisions.
Mother/Parent Company	Safety Culture	Instills a culture of safety across subsidiaries by promoting safety values and practices from the corporate level down to operational levels.
Safety Officers	Awareness	Emphasize the importance of safety and communicate relevant information to top management to influence safety-related decisions.
Shareholders	Pressure	Influence management to adopt safety standards due to concerns over regulatory compliance, company image, and potential impact on share value and profitability.
Society	External Pressure	Public response to poor safety practices can pressure management to commit to improved safety standards.
Supervisors	Create Awareness	Collaborate with middle management to raise awareness about safety needs and report concerns to top management, influencing their commitment.
Top Management	Image	Management's commitment to safety is shaped by the desire to maintain a positive public image and fulfill corporate social responsibility goals.
Top Management	Resource Availability	The level of commitment is influenced by available resources, as risk management and safety improvements often require financial investment.
Top Management	Safety Culture	Includes individuals such as the Board of Directors, CEOs, CSOs, and HSE Directors who establish the company's vision and mission, define safety priorities, and build a strong safety culture.
Workers	Demanding Safety	Workers can drive management's commitment by actively demanding better safety conditions, particularly in organizations with poor safety records.
Regulatory Pressure		
Industry Associations	Lobbying	Leading industries often form associations that lobby the government to create policies aligned with their interests. These efforts may promote specific standards or push for mandatory adoption, influencing the regulatory landscape and exerting control over the value chain.
Inspection Bodies	Reporting/Data	Data and reports generated by agencies such as labor organizations and government inspection bodies highlight critical safety issues, prompting regulators to prioritize safety in policy agendas.
Insurance Companies	Advising	Insurance companies advise both the government and private organizations on policy adjustments, encouraging the adoption of safety measures through economic and risk-based incentives.
Labor Unions	Lobbying	Labor unions lobby the government to influence political agendas, aiming to implement worker welfare regulations such as mandatory safety laws.
Media	Spreading Awareness	Media raises public awareness by reporting severe accidents. This visibility pressures governments to introduce or revise safety policies in response to public concern.
Policy Makers	Strategy formation	Responsible for formulating regulations based on societal needs, data, and input from various stakeholders, including industries and public institutions
Society	Pressure	In the event of accidents or insufficient safety measures, societal pressure compels the government to update or implement stricter safety regulations.
Standards Organizations	Policy Development	Global standards organizations (e.g., ILO, NEBOSH, ISO, WHO, OSHA, NEN) provide frameworks and guidance that influence national safety policy development, tailoring practices to each country's needs.

Table 30: : List of Stakeholders and Influences - Implementation Factors

Stakeholder	Influence	Definition
Commitment		
Employee	Involvement in All Stages	Employees should be involved in all stages of adoption and implementation of safety standards, ensuring their input is considered from the beginning to tailor practices that are truly effective at the ground level.
Management	Commitment Strategy	Management must formulate clear strategies demonstrating their commitment to safety through planning, communication, and integration into business objectives
Management	Past Experience	Managers may draw on previous experiences—educational, personal, or professional—that influence their dedication to safety, such as past incidents or safety culture in former workplaces.
Management	HSE Policy	The company's HSE (Health, Safety, and Environment) policy is critical in ensuring compliance with standards and is supported through various promotional and monitoring activities.
Management	Resource Availability	Management commitment is demonstrated by allocating necessary resources—financial, technical, and human—to effectively implement safety standards.
Management	Value Chain Commitment	Commitment extends across the value chain, including suppliers, contractors, visitors, and interns. Management's attention to their adherence to safety norms reflects a holistic safety approach.
Middle Management	Encouragement	Middle management plays a pivotal role in motivating supervisors and employees while ensuring optimal use of available resources for safety implementation.
Supervisors	Implementation practices	Supervisors ensure that employees understand and adhere to safety practices, thereby enhancing the effectiveness of safety implementation on the ground.
Top Management	Encouragement	Top management supports safety initiatives by allocating resources such as time, machinery, personnel, funding, and training, thus reinforcing organizational commitment.
Top Management	Stressing Safety Importance	Top management must consistently emphasize the importance of safety through communication, policies, and setting an example, embedding it into the organizational culture.
Communication & Trainings		
Consultancy Agencies	Training Support	External consultancy agencies enhance the effectiveness of a company's communication and training programs by providing expert guidance, structure, and credibility.
Employee	Demographics	Factors such as employees' cultural background, education, age, and gender influence the design and delivery of appropriate training programs.
Employee	Feedback	Encouraging two-way communication where employees can provide feedback ensures engagement and improvement in safety communication practices.
Employees	Trainings	Employees must receive continuous and structured training tailored to their roles to reinforce safety practices.
Government	Providing Guidelines	Government agencies provide safety training frameworks and communication guidelines that organizations must follow.
Management	Clear Communication	Managers at all levels must maintain transparent and clear communication with employees and peers to ensure consistent implementation of safety standards.
Management	Communication Channels	Effective and accessible communication channels should be used across the organization to ensure safety messages reach all employees.
Management	Continuous Training	The Human Resources Department must implement ongoing training initiatives to ensure all employees, including new hires and senior staff, are updated on safety protocols.
Management	Frequent Communication	Safety-related communications from all managerial levels must be consistent and frequent to emphasize the importance of safety standards.
Safety Officers	Awareness	Safety officers play a key role in raising organizational awareness about the value and necessity of safety training programs.
Supervisors	Trainings	Supervisors require proper training themselves to effectively deliver and reinforce safety practices among their teams.
Top Management	Resources	Top management must allocate sufficient resources, including budget and infrastructure, for comprehensive safety training programs.
Top Management	Stressing Safety Importance	Top leaders must consistently emphasize the significance of safety through their words and actions, setting a strong example for the rest of the organization.
Type of Industry	—	Training and communication approaches must be tailored to the specific industry, as different sectors (e.g., healthcare vs. manufacturing) have distinct safety requirements.

D Consent Form

D.1 Exploratory Interview Consent Form

You are being invited to participate in a research study titled Factors influencing the adoption and implementation of Occupational Health and Safety (OHS) Standards. This study is being done by Sharada Atul Gavade under the supervision of Dr. Karolien van Nunen and Dr. Geerten van de Kaa from TU Delft.

The purpose of this research study is identifying factors and stakeholders influencing adoption and implementation of OHS Standards and will take you approximately 60 minutes to complete. We will be asking you to provide your opinion on key factors influencing adoption and implementation of OHS Standards.

With your consent the interview will be recorded and transcribed. The transcript will be sent to you after the interview, and you will be welcome to suggest changes or adjustments to the transcript.

The results of the interviews will be used as a part of a Master Thesis. Only aggregated and anonymous information will be included in the final publication. The data will be used for my MSc thesis which will be publicly available.

All personal data will be stored at TU Delft, accessible only to the TU Delft research team. The data will be handled according to the European Personal data regulation. The data will be preserved for up to 2 years at TU Delft after which it will be deleted. The data may be reused for future scientific or educational activities on the topic of Occupational Safety in Industry. You will be anonymous in any and all outputs. Should we want to do anything else with your personal data, we will reach out to you and ask for your explicit permission.

Your participation in this study is entirely voluntary and you can withdraw at any time. If, for any reason, you wish to withdraw from the research please contact

_____

Participant's name and signature

Contact information of TU Delft researchers

Sharada Atul Gavade	*(Student)*
Karolien van Neun	*(Assistant Professor)*
Geerten van de Kaa	*(Associate Professor)*

D.2 MCDA and Stakeholder Interview Consent Form

You are being invited to participate in a research study titled Factors influencing the adoption and implementation of Occupational Health and Safety (OHS) Standards. This study is being done by Sharada Atul Gavade under the supervision of Dr. Karolien van Nunen and Dr. Geerten van de Kaa from TU Delft.

The purpose of this research study to rank the identified factors influencing adoption and implementation of OHS Standards and will take you approximately 60 minutes to complete. We will be asking you to provide your preferences between alternative choices and the rationale of those choices to rank the importance of the factors influencing adoption and implementation of OHS Standards.

The Best Worst Method Survey results will be noted, and the discussion will be recorded and transcribed. The transcript will be sent to you after the discussion, and you will be welcome to suggest changes or adjustments to the transcript.

The results of the survey will be used as a part of a Master Thesis. Only aggregated and anonymous information will be included in the final publication. The survey results, which only contain your choices and ranking, will be made publicly available in the Master Thesis. The data will be used for my MSc thesis which will be publicly available.

All personal data will be stored at TU Delft, accessible only to the TU Delft research team. The data will be handled according to the European Personal data regulation. The data will be preserved for up to 2 years at TU Delft after which it will be deleted. The data may be reused for future scientific or educational activities on the topic of Occupational Safety in Industry. You will be anonymous in any and all outputs. Should we want to do anything else with your personal data, we will reach out to you and ask for your explicit permission.

Your participation in this study is entirely voluntary and you can withdraw at any time. If, for any reason, you wish to withdraw from the research please contact via emailing to s.a.gavade@student.tudelft.nl or g.vandekaa@tudelft.nl or k.l.l.vannunen@tudelft.nl.

Participant's name and signature

Contact information of TU Delft researchers

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E List of Codes

E.1 Adoption Factors

The following table presents the list of codes generated in ATLAS.ti for the Adoption factors identification from the selected literature and exploratory interview transcripts.

Table 31: List of codes for Adoption Factors

Adoption	
A.1_Regulatory Pressure	**C.3_Safe Working environment**
Adoption_Government Regulations	Adoption_CSR for employees
Adoption_Policy Compliance	Adoption_Employee Training
Adoption_Policy Makers	Adoption_Employee Well-being
Adoption_Regulatory Pressure	Adoption_Hazard identification
A.2_Value Chain Pressure	Adoption_Improve Worker Safety Knowledge
Adoption_Avoid Labour union pressure	Adoption_Incident Statistics Impact
Adoption_Company Culture	Adoption_Preventive Measures
Adoption_Customer Demand	Adoption_Prioritizing Safety
Adoption_External Pressure	Adoption_Reduce Potential Occupational Injuries
Adoption_Industry Leaders pressure	Adoption_Reduce Worker Absenteesim
Adoption_Industry trend following	Adoption_Risk Assessment
Adoption_Insurance Companies	Adoption_Risk Management
Adoption_Market Competition	Adoption_Risk Minimization
Adoption_Organization Culture	Adoption_Safety Performance
Adoption_Peer pressure	Adoption_Safety Promotion
Adoption_Stakeholder Influence	Adoption_Safety Rate
Adoption_Supplier Demand Satisfaction	Adoption_Social Responsibility
A.3_Broader Societal Pressure	Adoption_Worker safety
Adoption_Retain Employees	Adoption_Working Conditions improvement
Adoption_Safety Culture	**C.4_Operational Efficiency**
Adoption_Social Culture	Adoption_Continuous Improvement
B.1_Management Commitment	Adoption_Labor productivity
Adoption_Employee Consultation	Adoption_Long term OHS benefits
Adoption_Internal Motivation	Adoption_Operating Efficiency
Adoption_Internal Policy	Adoption_Performance
Adoption_Leadership Commitment	Adoption_Production Goals
Adoption_Management Awareness	Adoption_Productivity
Adoption_Management Commitment	**C.5_Global Expansion**
Adoption_Management Concern	Adoption_Competitive Advantage
Adoption_Proactive Management	Adoption_Customer Attraction
Adoption_Structure OHS Management	Adoption_Exports
Adoption_Systematic Approach	Adoption_Global Market Expansion
Adoption_Trust in leadership	Adoption_Growth
B.2_Resources	Adoption_Internationalization
Adoption_Company Size	Adoption_Market Confidence
Adoption_Employee Participation	Adoption_Sales Growth
Adoption_Financial Resources	**D.1_Standard Compatibility**

Adoption_Learning Curve	Adoption_Compatibility
Adoption_Resource Availability	Adoption_Effectivness
C.1_Image	Adoption_Implementation Complexity
Adoption_Become industry leader in safety	Adoption_Industry Specific Risks
Adoption_Company Image	Adoption_Relevance
Adoption_Company Promotion	Adoption_Stakeholder Reliability
Adoption_Company Reputation	Adoption_Standard Framework
Adoption_Corporate Goals	Adoption_Standard Specific Requirement
Adoption_Government Relations	Adoption_Strategic Importance
Adoption_Increase bargaining power	Adoption_Technology
C.2_Cost Savings	**D.2_Standard Cost**
Adoption_Accident Cost Saving	Adoption_Certification Cost
Adoption_Cost Benefit	Adoption_Consultant Availability
Adoption_Cost Saving	Adoption_Expert Opinion
Adoption_Financial Performance	**D.3_Standard Quality**
Adoption_Financial Risks	Adoption_Certification Importance
Adoption_Operational Cost reduction	Adoption_Certification Support
Adoption_Potential benefits uncertainty	Adoption_Codified Knowledge
Adoption_Profitability	Adoption_Global Importance
Adoption_Reduce CSR	Adoption_Standard Popularity
	Adoption_Standard Recognition
	Adoption_Visibility

E.2 Implementation Factors

The following table presents the list of codes generated in ATLAS.ti for the Implentation factors identification from the selected literature and exploratory interview transcripts.

Implementation	
1_Commitment	**3_Compatibility with the Company**
Implementaion_Responsibilities	Implementation_Communication
Implementation_Company Culture Resistance	Implementation_Company Size
Implementation_Employee Behaviour	Implementation_Integration with Existing Systems
Implementation_Employee Commitment	Implementation_Operational Intergration
Implementation_Employee encouragement	Implementation_Operational Planning
Implementation_Employee Resistance	Implementation_Operational System Alignment
Implementation_Internal Motivation	Implementation_Organization Structure
Implementation_Leadership Support	Implementation_Relevance
Implementation_Management Involvement	Implementation_Safety Climate
Implementation_Managemeny Committement	Implementation_Safety Culture
Implementation_Morale of Employees	Implementation_Strategic Orientation
Implementation_Practical Efforts	Implementation_Systems
Implementation_Safety Policy	**4_Continuous Improvement**
Implementation_Senior Support	Implementation_Compliance
2_Communication and Training	Implementation_Continuous change
Implementation_Competence	Implementation_Continuous Improvement
Implementation_Consulation	Implementation_Continuous Learning
Implementation_Data Management Challenges	Implementation_Internal Audits

Implementation_Documentation procedures	Implementation_Monitoring
Implementation_Emergency Preparedness	Implementation_Operational Control
Implementation_Employee Age	Implementation_Prevention
Implementation_Employee Awareness	Implementation_Routine
Implementation_Employee Consultation	**5_Government Support**
Implementation_Employee Qualification	Implementation_Government Regulations Mandatory trainings
Implementation_Employee Technology acquaintance	Implementation_Government Support
Implementation_Lack of skilled employees	**6_Resources**
Implementation_Objective Quantification	Implementation_Cost Involved
Implementation_Skill update	Implementation_Employee Involvement
Implementation_Specialized Methods	Implementation_Industry 4.0
Implementation_Technical Guidance	Implementation_Limited Employee Participation
Implementation_Training Programs	Implementation_Psychological Safe Environment
Implementation_Training Quality	Implementation_Resource Allocation
	Implementation_Resource Availability
	Implementation_Role of Quality Management
	Implementation_Technology

E.3 Stakeholders

The following table presents the list of codes generated in ATLAS.ti for the Stakeholder influence of top 2 ranked factors for adoption ana implementation obtained by coding experts' interview transcripts.

Table 32: List of codes from Stakeholder Interviews

Adoption	**Implementation**
ManagementCommitment	**Commitment**
1_Government_ExternalPressure	3_Employee_InvolvementAllStages
1_IndustryType	3_Management_CommitmentStrategy
1_InsuranceCompanies_ExternalPressure	3_Management_Experience
1_LabourUnion_DemandSafety	3_Management_HSEPolicy
1_MiddleManagement	3_Management_ResourceAvailability
1_MotherCompany_SafetyCulture	3_Management_ValueChainCommitment
1_SafetyOfficers_Awareness	3_MiddleManagement_Encouragement
1_Shareholders_Pressure	3_Supervisors_Implementations
1_Society_ExternalPressure	3_TopManagement_Encouragement
1_Supervisors_CreateAwareness	3_TopManagement_StressSafetyImportance
1_TopManagement_Image	**Communication&Trainings**
1_TopManagement_ResourceAvailability	4_ConsultancyAgencies_Support
1_TopManagement_SafetyCulture	4_Employee_Demographics
1_Workers_DemandingSafety	4_Employee_Feedback
RegulatoryPressure	4_Employees_Trainings
2_IndustryAssociations_Lobbying	4_Government_ProvidingGuidlines
2_InspectionBodies_Reportings/Data	4_Management_ClearCommunication
2_InsuranceCompanies_Advising	4_Management_CommunicationChannels
2_LabourUnions_Lobbying	4_Management_ContinuousTraining
2_Media_SpreadAwareness_PressureGov	4_Management_FrequentCommunication

2_PolicyMakers	4_SafetyOfficers_Awareness
2_Society_Pressure	4_Supervisors_Trainings
2_StandardsOrganizations_PolicyDevelopement	4_TopManagement_Resources
	4_TopManagement_StressSafetyImportance
	4_TypeofIndustry