Cape Peninsula
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ANALYSIS OF FACTORS AFFECTING THE IMPLEMENTATION OF HEALTH AND SAFETY MANAGEMENT SYSTEMS IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY WITHIN THE WESTERN CAPE

by

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DECLARATION

I, Rejoice Kunodzia, student number 218290950, declare that the entire body of work contained in this research assignment is my own, original work. I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Cape Peninsula University of Technology will not infringe on any third-party rights. I also do hereby confirm that I have not previously submitted this research entirely or partially for obtaining any qualification.

_____ 10 October 2023

Rejoice Kunodzia Date

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DEDICATION

With complete joy and without reservation, I dedicate this thesis to every girl who devoted her time and effort to pursuing her dreams. With God Almighty, those dreams are achievable.

ABSTRACT

Although notable efforts have been made in the past in the South African construction industry to improve Occupational Health and Safety (OHS), the overall performance has not significantly improved, as high-level injuries, risks, and fatalities continue to occur. Earlier studies conducted have shown that the implementation of an Occupational Health and Safety Management System (OHSMS) ensures a reduction in accidents on-site. However, many challenges arise when trying to implement an OHSMS. This study aimed to analyse the factors affecting the implementation of an OHSMS in the construction industry of the Western Cape, South Africa, by focusing on challenges associated with the implementation thereof. The research objectives were to identify factors that affect the implementation of an OHSMS on construction sites, to analyse the effect of integrating the Plan Do Check Act (PDCA) method on the implementation of OHSMS, to assess the effect of COVID-19 regulations on OHSMS implementation, and to evaluate how risk management is integrated into OHS during the implementation of an OHSMS.

The research questionnaire was structured to obtain opinions about OHSMS implementation in the Western Cape from construction professionals, including safety practitioners. A stratified random sampling method was used. The questionnaires were distributed online, and the reliability of the results was tested using the Cronbach's alpha coefficient reliability test. The quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) software version 27.0, and data were interpreted through frequencies, descriptive statistics, and multi-regression analysis. A multi-regression test was conducted to determine the relationship between internal and external factors and the implementation of OHSMS, including the use of the PDCA method, COVID-19, and the risk management plan.

The findings reveal that both internal and external factors affect OHSMS implementation. The most important internal factors identified are risk control strategies, senior management commitment and support, communication channels, and risk awareness. The most common external factors identified include pressure from clients on project delivery, company reputation, OHS enforcement, and government legislation. Furthermore, the study found that PDCA is the most common method used when implementing an OHSMS, and a risk management plan should be integrated into the OHSMS during the planning stage. Lastly, COVID-19 affected the implementation of the OHSMS and construction organisations operations.

A framework was developed to outline how an OHSMS can be implemented based on the findings from this study. The framework can be adopted by the construction industry to ensure effectiveness when implementing their OHSMS. OHSMS implementation ensures a reduction in accidents on-site.

Keywords and terms: Health and safety management systems, construction sites, risk management, Plan Do Check Act (PCDA), COVID-19 regulations, construction hazards.

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LIST OF ABBREVIATIONS AND MEANINGS

CDC	Centre for Disease Control and Prevention
CIDB	Construction Industry Development Board
ILO	International Labour Organisation
OHS	Occupational Health and Safety
OHSMS	Occupational Health and Safety Management System
PDCA	Plan Do Check Act
SMS	Safety Management System

DEFINITION OF TERMS

Occupational Health and Safety Management System (OHSMS): A management system that specifies requirements for the implementation, maintenance, and improvement of the health and safety performance of an organisation (Yorio et al., 2015).

Construction sites: A construction site is where a variety of construction activities take place (Lingard et al., 2017).

Risk management: Rehacek (2017) defines risk management as the method of explaining how to conduct risk management events for a project.

Plan Do Check Act: Johnson (2016) defines PDCA as a continuous process improvement model that teaches organisations to plan an action, move towards it, check its conformity with the plan, and act on the lessons learned.

COVID-19 regulations: ISO-published guidelines that could be used by organisations using ISO 45001 to integrate the COVID-19 Guidelines into OHSMSs by relating the relevant clauses (Sierra, 2022).

Hazard: An object or something causing harm to humans, animals, property, or the environment (Dadvar, 2020).

CHAPTER 1: INTRODUCTION

1.1 Introduction

The International Labour Organisation (ILO, 2018) estimates that more than 2.78 million people die annually because of occupational accidents or work-related ailments. The organisation further estimates that there are more than 374 million non-fatal work-related injuries each year, resulting in more than four days of absence from work. The economic implication of these losses and injuries represents approximately 3.94% of the world's global gross domestic product annually (ILO, 2018). There is a gross underreporting of occupational accidents and diseases, including fatal accidents, resulting in a false picture of the extent of the problem in the construction industry (Madsen et al., 2020). Although the effect on communities cannot be measured, the impact on the economy is immense (Sadiq, 2019:18). The construction industry sustains the economy, but it is also a high-risk sector prone to occupational risks (Osei-Asibey et al., 2021b).

Arguably, the financial implications of these injuries and deaths can be quite high at organisational, national, and global levels. Occupational Health and Safety (OHS) accidents affect the construction schedule, quality, and cost of the project. They also impact the morale of employees, and the company's reputation (Nnaji & Karakhan, 2020). It has been suggested that organisations adopt an occupational health and safety management system (OHSMS) to identify, control, and reduce occupational accidents. Autenrieth et al. (2015) define OHSMS as a set of organisational policies and procedures that govern workplace health and safety. As outlined in the International Organisation for Standardisation (ISO, 2018) on 45001:2018, an OHSMS helps organisations prevent accidents, injuries, and illnesses at work by providing a safe and healthy working environment by proactive improvement of OHS performance. ISO 45001:2018 is relevant to any organisation regardless of its nature and type (Sadiq, 2019:18).

This research investigated the construction Industry of Western Cape in South Africa, focusing on health and safety issues that occur on-site as well as the problems associated with the implementation of an OHSMS. The intention was to establish whether OHSMS implementation is done solely for compliance with the regulations or incorporated into the organisation to align with its vision and mission. The research provides valuable insights for OHS practitioners such as site agents, project managers and, OHS consultants on internal and external factors affecting OHSMS implementation and how these issues can be addressed.

1.2 Background of the study

Most studies conducted have shown that construction workplaces are potential risk areas where accidents and injuries are prone to occur (Mashwama et al., 2018; Osei-Asibey et al., 2021b). Due to the complex scope of work involved, construction sites are classified as high-risk areas, and the construction industry needs to formulate occupational health and safety management systems (OHSMSs) that consider the risks and changes that occur on sites (Amiri et al., 2016). The ISO 45001 was created to assist organisations in reducing the number of workplace injuries, incidents of ill health, and deaths through the implementation of an OHSMS (Baird, 2005). Organisations differ in conditions, characteristics, strengths, and weaknesses (Sadiq, 2019:22). The OHS challenges and extent of problems in organisations differ from country to country (Sadiq, 2019:22). OHS is a vital part of an organisation and should not be disregarded, regardless of its type (Esterhuyzen, 2019). Arguably, there are many challenges encountered when trying to formulate an OHSMS that suits a specific organisation or project (Rahmi & Ramdhan, 2021).

Rahmi and Ramdhan (2021) conducted a systematic literature review and found that both external and internal factors can affect the implementation of an OHSMS. Their study revealed that internal factors such as risk processes, risk integration into OHS, and risk identification also influence OHSMS implementation. Furthermore, Rahmi and Ramdhan (2021) also found that risk management processes and design of OHS risk control strategies had an effect on the implementation. A comparative study by da Silva and Amaral (2019), through a systematic literature review, also supports that failures in the method of evaluating the construction risks in OHS also affect OHSMS implementation. This is supported by Masi and Cagno (2015), who argue that most organisations lack technical knowledge in conducting risk assessments and they do not prioritise the assessments due to perceived resource-intensive. Micheli et al. (2018), in their empirical analysis of mechanisms and context, found that lack of knowledge about the organisation's risks and failure to consider technological risks further limit the effectiveness of OHSMS implementation. The risk of accidents occurring on construction sites is high due to activities that occur and risk identification with effective risk control and management presents a challenge during the implementation of an OHSMS (Okoye, 2018). Furthermore, individual risk awareness and work demands contribute to challenges faced during OHSMS implementation in South Africa (Mashwama et al., 2018). Additionally, Sousa et al. (2012) argue that for OHSMS implementation to be efficient, effective, and simple, risk management should be incorporated into the system.

Recent studies conducted by Rahmi and Ramdhan (2021) through a systematic literature review have identified additional internal factors such as management commitment,

leadership, and policies aimed at OHS, OHS culture, and OHS communication and consultation as factors affecting OHSMS implementation. Management leadership and commitment to the OHS are the base factors in OHSMS implementation (Rajaprasad & Chalapathi, 2015). McKinnon (2017) observed that OHS is dependent on effective leadership and worker engagement, as this affects the outcome of assessments and reviews. It has been suggested that senior management support and participation in OHS, and OHS resources and training should be part of the implementation of an OHSMS (Agumba & Haupt, 2018). Lee et al. (2020) proposed that OHSMSs be included in management training. Sklad (2019) confirmed that dedicated managers have a positive influence on workers' safety behaviour and participation in safety management. However, poor collaboration among company personnel can present challenges during OHSMS implementation according to Chen et al. (2009). The lack of commitment among managers slows the delivery of planned OHS actions (Masi & Cagno, 2015). This aligns with Micheli et al. (2018) who found in their empirical analysis of mechanisms and contextual factors that internal factors such as lack of training skills in management affect OHSMS implementation in small and medium enterprises.

Additional factors such as employee involvement, employee morale, safe behaviour of workers, and internal incentives affect OHSMS implementation (Rahmi & Ramdhan, 2021). Sadly, Musonda and Haupt (2009) found that most clients did not commit to OHS and the allocation of resources to ensure OHS improvement and this affected OHSMS implementation. According to Kim et al. (2019), regardless of how well an OHSMS is designed, it is people who guarantee its effective implementation and performance to produce better outcomes.

According to da Silva and Amaral (2019), difficulties in the functioning of the OHS control and certification systems, difficulty in defining the suitable management indicators in OHS, and lack of upper management support regarding OHS were found to influence OHSMS implementation. Additionally, factors such as the lack of worker involvement regarding the importance of OHS, problems with the integration of different standards, attribute to the company culture and the difficulties in changing the company policy and culture also affect OHSMS implementation (Rajaprasad & Chalapathi, 2015).

Recent studies have highlighted the high cost of OHSMS implementation coupled with a lack of resources significantly affects implementation (Da Silva & Amaral, 2019; Masi & Cagno, 2015). The lack of senior management support through constrained resource allocation has an impact on implementation (Masi & Cagno, 2015). Moreover, the financial performance of an organisation affects the budget allocation for an OHSMS (Rahmi & Ramdhan, 2021).

According to De Merich et al. (2020), there are fewer resources allocated and less time dedicated to promoting OHS culture, due to cost-effectiveness constraints which present challenges to management during implementation.

Additionally, Masi and Cagno (2015) reported a lack of information, ongoing change management, performance goals cultures, OHS and environmental indicator tools unsuited to some work settings, and guidance on assessing interventions for compliance with the OHSMS.

Sadiq (2019:39) and Khalid et al. (2021) noted that there are also external factors such as legislation, environmental issues, technological changes, the reputation of an organisation, and social community factors that affect OHSMS implementation.

Most of the regulations have intricate requirements which present challenges during implementation (Masi & Cagno, 2015). Micheli et al. (2018) found that interpreting regulations can pose challenges. The recent development of COVID-19 introduced new regulations that need to be factored in (Amoah & Simpeh, 2021). Construction sites is temporary in nature and mostly often have a complex scope of work. The practical feasibility of factoring in the impact of changes such as Covid regulations considering the nature of construction sites presents a challenge during implementation as the latest regulations will need to be implemented (Stiles et al., 2021). Arguably, the construction safety risks must be balanced with the output delivered (Amoah & Simpeh, 2021). Nonetheless, many construction projects are still working on the standard delivery dates, even though production would have decreased due to the on-and-off lockdowns and confined workspaces attributed to COVID-19 regulations (Stiles et al., 2021). This results in problems formulating the OHSMS, as clients value time, cost, and quality above anything else (Stiles et al., 2021). Strict schedules and production demands priority over the implementation of appropriate OHS procedures and most employees do not fully comprehend the risks present on sites (Othman, 2012). Nevertheless, the OHSMS should still factor in the latest regulations (Stiles et al., 2021). According to Amoah and Simpeh (2021:7), the implementation of the new COVID-19 regulations affects the implementation of OHSMS.

Rahmi and Ramdhan (2021) further note that external factors such as OHS support and authority, problems in external assessment certification, external motivations, pressure from clients, market competition, and international trends are challenges faced when implementing an OHSMS. The OHS legislation should be strictly monitored and enforced on sites to ensure compliance (Adeyemo & Smallwood, 2017). An organisation's decision regarding the type of OHSMS system to implement depends on the needs and the system's capabilities of continual improvement and effectiveness (Ligade & Thalange, 2013). In the construction industry, the

Plan Do Check Act cycle (PDCA) is frequently used to monitor safety performance on a continuous basis (Ligade & Thalange, 2013).

1.3 Problem statement

Although noteworthy efforts have been made in the past in the construction industry to improve OHS, the overall performance has not improved significantly, and high-level injuries and fatalities continue to occur (Windapo et al., 2018). Accidents are more common at construction sites due to the type of activities that occur on sites (Okoye, 2018). Haupt and Pillay (2016) found that construction accidents in South Africa resulted in greater costs due to their high occurrence when compared with other sectors. Through the implementation of an OHSMS, ISO 45001 enables companies to reduce workplace injuries and incidents, but the implementation is riddled with problems (Sadiq, 2019:161). There are external and internal factors that affect the implementation of OHSMS in the construction industry worldwide (Gomes et al., 2016; Micheli et al., 2018). It is possible that these factors, if not accounted for, lead to a poor OHSMS which results in injuries, accidents, and fatalities on-site (Sadiq, 2020). Recent studies have shown that the construction industry worldwide face obstacles such as a lack of public guidelines aimed at OHS conditions, non-compliance with strict legislation, and lack of accountability during OHSMS implementation (Gomes et al., 2016). Mashwama et al. (2018) further state that the OHS performance of the construction industry in South Africa remains lower than that of developed countries. The 2018 report from the Department of Labour in South Africa reported that the construction industry's compliance rate with OHS regulations was below 50% (Esterhuyzen, 2019). The 2018 report from the Department of Labour in South Africa also recorded that most construction companies still did not have an OHSMS in place. Compliance with OHS regulations prevents and controls OHS risks (Salguero-Caparrós et al., 2020). Non-compliance with OHS regulations can result in penalties, fines, and compromised credibility of an organisation (Esterhuyzen, 2019). The articles reviewed indicate that the factors affecting OHSMS implementation in the construction industry in South Africa have not been adequately studied.

1.4 Research aim

The aim of the study is to analyse factors affecting OHSMS implementation in the construction industry in the Western Cape, South Africa.

1.6 Research objectives

The research objectives are:

i) To identify factors that affect OHSMS implementation on construction sites.

ii) To analyse how the Plan Do Check Act (PDCA) method is used as a method to implement an OHSMS.
iii) To assess the effect of COVID-19 regulations on OHSMS implementation.
iv) To evaluate how risk management is integrated into OHS during OHSMS implementation.

1.7 Research questions

The research questions are:

i. What are the internal and external factors that affect OHSMS implementation?
ii. How is the PDCA method used to implement an OHSMS?
iii. To what extent have the COVID-19 regulations affected OHSMS implementation?
iv. How is risk management integrated into an OHSMS during implementation?

1.8 Significance of research

The study presented a list of internal and external factors affecting OHSMS implementation in the construction industry in Western Cape, South Africa. This can benefit OHS practitioners such as site agents, project managers OHS consultants, and stakeholders on how internal and external factors affect OHSMS implementation and how these factors can be addressed. It shows how risk management is integrated into an OHSMS during implementation. Furthermore, the study was able to explain how the PDCA can be effectively used to implement the OHSMS. This can be beneficial to stakeholders that are responsible for the implementation as it also incorporates the risk management plan. Another significance of the study was to explain how the COVID-19 regulations affected the OHSMS implementation This can be useful on for future related pandemics should they occur.

1.9 Context of the research

Occupational accidents and diseases, including fatal accidents, are grossly underreported, resulting in a false picture of the extent of the problem in the construction industry (Madsen et al., 2020). Although the effect on communities cannot be measured, the impact on the economy is immense (Sadiq, 2019:39). The construction industry sustains the economy, but it is also a high-risk sector prone to occupational risks (Osei-Asibey et al., 2021b).

The financial implications of these injuries and deaths can be quite high, at organisational, national, and global levels. OHS accidents affect the construction schedule, quality, and cost of the project. It also impacts the morale of employees, and the company's reputation (Nnaji & Karakhan, 2020). Most organisations adopt an OHSMS to identify, control, and reduce occupational accidents. OHSMS is described by Autenrieth et al. (2015) as a combination of policies and procedures that specify how an organisation manages workplace health and

safety. As outlined in ISO (2018) on 45001:2018, OHSMS is described as a tool to assist organisations in providing safe, healthy workplaces by reducing work-related injuries and illnesses and by proactively improving OHS performance. ISO 45001:2018 is relevant to any organisation regardless of its nature and type (Sadiq, 2019:16).

This research investigated the construction industry of the Western Cape, South Africa, by focusing on health and safety issues that happen on-site as well as the problems associated with OHSMS implementation.

1.10 Theoretical framework

Different frameworks have been developed over the years for the implementation of an OHSMS. A conceptual framework was developed by Makin and Winder (2008) to ensure that an OHSMS would be specifically customised to the organisation's needs. The purpose was to streamline the implementation process and increase the recognition of OHSMS benefits. The research findings emphasised that each organisation should identify its operations and determine factors that influence OHS, compliance with audits, and safety performance. The framework requires the identification of hazards and risks as well as planned solutions with measured outcomes. The risk assessments would be conducted by competent persons and assessments of solutions would be recorded to improve the system. According to the framework, an OHSMS should understand an organisation's risk profile by using and coordinating suitable prevention and control policies, so that compliance audits are conducted against existing policies, plans, and procedures.

According to Badri (2015), the integration of OHS with an organisation's risk is a complex challenge, and many organisations face problems with such an integration. Badri proposed a conceptual approach designed to integrate the OHS with the organisation's risk. Using case studies in mining projects in Quebec, the approach was based on applying research methods to complex industries. The approach aimed to identify hazards and calculate their concentration regarding unforeseeable events. The knowledge gap in this study was to combine both frameworks, which allowed the research to identify risks, formulate a risk management plan and integrate the risk management plan into OHSMS implementation.

Sánchez et al. (2018), in their study to assess how construction organisations in Columbia comply with requirements of the OHS management system through a survey given to OHS professionals, showed that most construction organisations had an OHS policy and structure to implement an OHSMS. Through surveys and the stages of the Deming Cycle's PDCA (Plan Do Check Act), Sánchez et al.'s (2018) research aimed to recommend a way to identify OHS situations in the construction industry that could be applied to other sectors by adapting follow-

up procedures accordingly. Their study concluded that the provision of personal protective equipment (PPE) and assigning safety staff could enhance safety. Furthermore, their study recommended that managers be equipped with knowledge of compliance with the OHSMS. This study assessed the purpose of the PDCA approach in OHSMS implementation. The PDCA will also be used to assess the improvement in compliance in the construction industry.

According to Lee et al. (2020) and Rahmi and Ramdhan (2021), there are internal and external factors that affect OHSMS implementation. However, their study mostly focused on global factors, and it did not explain how an OHSMS could be implemented. Furthermore, the global factors identified were not specific to any industry. One of the main objectives of this study is to analyse both internal and external factors and to determine which ones applied to the construction industry in the Western Cape, South Africa in order of priority from most to least importance**.**

When implementing an OHSMS, internal factors such as risk management need to be taken into consideration (Micheli et al., 2018). According to Górny (2019), the PDCA method can be used to link risk assessment to the OHSMS. The PDCA process was used to implement OHS, as it allowed the identification of all risk factors during the planning phase, OHSMS implementation, the measurement of safety compliance, and continuous improvement (Ligade & Thalange, 2013).

According to the findings of Stiles et al. (2021), there is knowledge of COVID-19 risk management but little knowledge on how best to implement it. The study further suggested that COVID-19 regulations be incorporated into the OHSMS and advanced within a general risk management approach. The knowledge gap in this study was the integration of COVID-19 regulations into the OHSMS.

1.11 Limitations

This study focused only on construction sites within the Western Cape Government in South Africa. The construction sites were limited to residential and commercial. The research focused only on the current challenges that are faced when implementing an OHSMS in organisations. Furthermore, the study was able to recommend that future research be done on how the COVID-19 regulations can be integrated into the OHSMS.

1.12 Assumptions

Construction organisations often face challenges when implementing an OHSMS on sites. It was assumed that relevant respondents would provide information that address the aim and objective of this research.

1.13 Ethical considerations

Ethical clearance was obtained from the university to conduct this research. The data were not falsified nor collected fraudulently. The names of organisations or persons have not been published, and their views remain anonymous. Formal consent was requested from companies to use their data.

1.14 Data treatment, interpretation, and use

Data analysis refers to the systematic application of statistical and logical techniques to describe, illustrate, and evaluate data (Savenye et al., 2004). The quantitative data obtained was analysed and summarised using descriptive analysis. The descriptive analysis describes the nature and extent of sensory characteristics in an objective way (Kemp et al., 2018). A validation test was used to analyse quantitative data obtained from each survey and was checked for accuracy. According to Sireci (2007), a validation test refers to the use of a test for a particular purpose and how accurately a method measures what it intends to measure. To test the reliability of the data, a Cronbach's alpha test was used. The Cronbach's alpha coefficient can be used to measure how closely related groups of items are, as well as scale reliability, or the coefficient of consistency (Tavakol & Dennick, 2011). Data were collected through online questionnaires. The Statistical Package for Social Sciences (SPSS) software version 27.0 was used to analyse the data and test factors affecting implementation in order of most importance and how they affect implementation.

1.15 Outline of study

Chapter One – Introduction: Sub-sections in this chapter include a background of the study, problem statement, aims and objectives, research questions, significance of the study, research methodology, and limitations of the study.

Chapter Two – Theoretical and conceptual frameworks: In this chapter, the introduction, theoretical framework section covering the design of the framework, knowledge gap, variables, anticipated model, and chapter summary are discussed in depth.

Chapter Three – Research methodology and Design: This chapter discusses the tools and methods used for data gathering and analysis. An introduction, explanation of the research approach, justification for it, methodology, data sources, population and sampling methods, design of the survey, administration of the survey, and analysis of the survey results.

Chapter Four – Data Collection, Analysis, and Findings: This chapter provides a report on the data collected and analysed, presenting the results in graphical and tabular form.

Chapter Five – Discussion of findings: The chapter includes introduction, discussions based on findings and description of the validity and reliability of the study.

Chapter Six – Summary, Conclusion, Limitations, Future Recommendations: The chapter includes accomplishment of the project objectives, limitations of the study, conclusions, contributions to the field, and areas for further research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The literature reviewed in this is chapter includes the factors affecting OHSMS implementation, accidents on construction sites in developed and developing countries, risk management on construction sites, how the PDCA method is used with OHSMS implementation, and the challenges of COVID-19 with OHSMS implementing.

2.2 Basic terms of OHS

It is necessary to clarify some basic terms to comprehend the principles of this research.

Risk refers to a potential event that has not occurred but may occur in the future (Shrivastava, 2012). It may also be described as any future uncertain event that can have an impact if it occurs (PMI, 2013:309).

Occupational health and safety (OHS): According to the International Labour Organisation (ILO, 2018), OHS refers to the promotion and maintenance of the total well-being of individuals in all occupations. Additionally, ILO refers to it as the science involved in anticipating, recognising, evaluating, and controlling situations at work that pose health and safety hazards to employees, and considering the ramifications on surrounding communities.

Hazard can be defined as any event, phenomenon, process, situation, or activity that could have a detrimental effect on the population, society, or environment (Dadvar, 2020).

Accident: According to Bird and Germain (1966), an accident is a situation that happens unintentionally or without planning, and that may or may not result in property damage, injury, work process disruption, work interference, or any combination of these conditions under conditions that may cause harm.

Incident, as defined in OHSAS 18001 (ohsas-18001-occupational-health-and-safety.com, n.d.), is any work-related incident(s) that resulted in an injury (regardless of severity), ill-health (irrespective of severity), or death. This can be an accident or a near miss.

2.3 Accidents on construction sites in developed and developing countries

The Construction Industry Development Board (CIDB, 2021), in its construction health and safety report, estimates that the global OHS performance of the construction industry in 2020 recorded sixty fatal accidents and there was an accident every ten minutes. Additionally, for every six work-related, one in every six work-related fatal accidents occurred on a construction

site (CIDB, 2021). ILO (2019) further reports that as many as 25%–40% of work-related deaths occur on construction sites in industrialised countries despite only employing 6%–10% of the entire labour force and those non-fatal accidents are 50% more likely to occur among workers aged 15–24 years. A comparison conducted by CIDB (2021) in their OHS report showed that highly skilled manual workers and workers in construction, manufacturing, and agriculture, had more accidents reported than in other industries in South Africa. This can be attributed to the fact that these construction sites are classified as high-risk because of the complex scope of work involved (Amiri et al., 2016). It is estimated that more than 2.78 million people die annually because of occupational accidents or work-related ailments (ILO, 2019).

Additionally, there are more than 374 million non-fatal work-related injuries annually, resulting in more than four (4) days of absence from work (ILO, 2019). The economic implication of these deaths and injuries on the global gross domestic product (GDP) each year is 3.94% according to the (ILO, 2019) report. Compared to other sectors, the construction industry has the highest number of recorded fatal injuries (Van Heerden et al., 2018); Winge et al., 2019) as shown in Figure 2.1. Among the inherent and unique risks associated with construction projects, Aminbakhsh et al. (2013) observe that the industry is characterised by a fairly high injury and death rate in comparison to other industries.

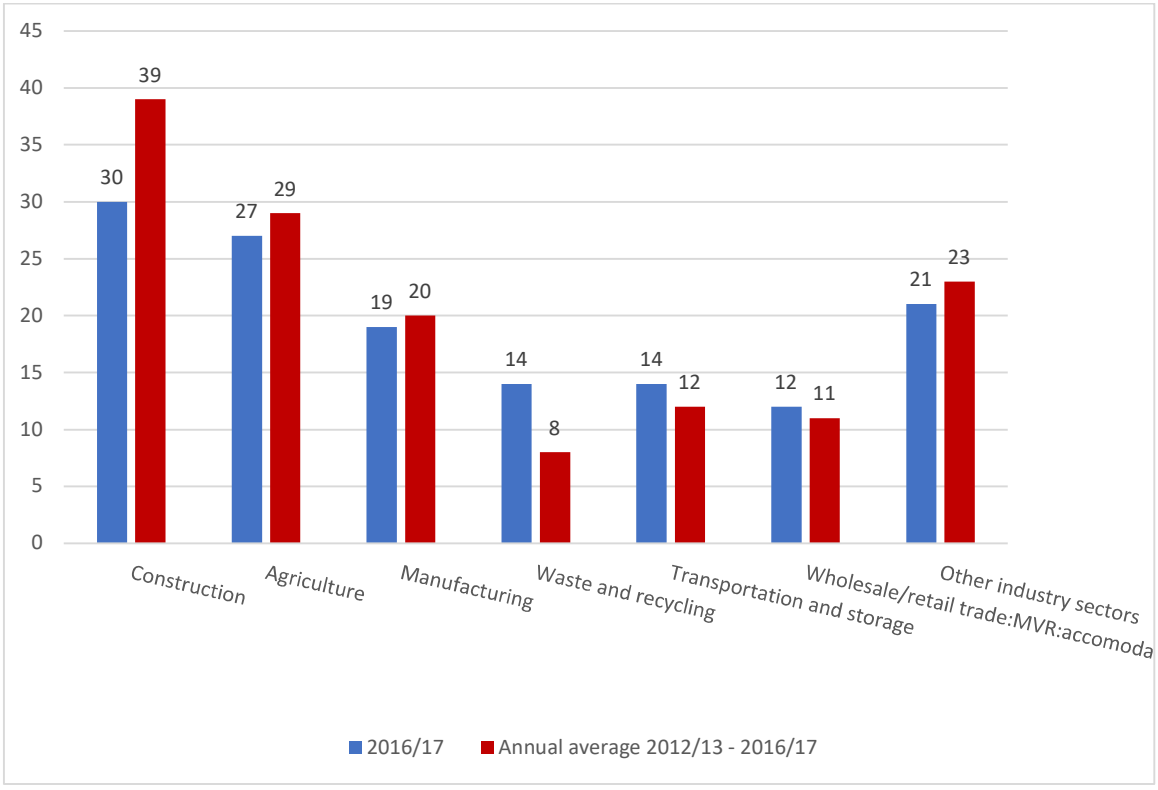

Figure 2.1: Number of fatal injuries by Industry (Van Heerden et al., 2018)

Construction sites remain plagued by safety concerns as the fatality and injury records in the industry continue to rise (Wu et al., 2010). A study by Hamid et al. (2008) found that accidents on Malaysian construction sites were caused by worker negligence, failure to follow safety procedures, working at high elevations, operating equipment without safety features, poor site management, working in harsh conditions, low worker skill levels, failure to use personal protective equipment, and a poor attitude toward safety among workers. Khodabandeh et al. (2016) list the top hazards at construction sites as falls, being caught between objects, electrocutions, and being struck by objects.

Developed nations have indeed succeeded in reducing accident numbers, but the same cannot be said for developing countries (Van Heerden et al., 2018). The construction industry within the Gauteng Province incurred accidents, as shown in Table 2.1. The number of workdays lost due to accidents were highest in the year 2013, and the lowest in 2015. However, the average cost of accidents continued to rise even though there was a reduction in lost days. One of the reasons that organisations have reduced accidents is because they realise the importance of implementing OHS in their work practices through handling risks at work and providing PPE (Van Heerden et al., 2018).

Table 2.1: Construction H&S statistics–as of May 2016 (Van Heerden et al., 2018)

Year of accidents	No. of accidents	Lost days	Average cost per accident
2012	3870	44945	25642
2013	3942	36763	27264
2014	3642	29212	27087
2015	3767	22163	31869

In Ghana, the occupational injury rate was 4.7% in the construction industry in 2015. The accident frequency rate of the construction industry was 65 compared with the national indicator of 43, a percentage of 151% higher (Osei-Asibey et al., 2021b).

The 2021 report by CIDB, as per Table 2.2, indicates that the fatality rate and accident rates in developed countries are less than that of developing countries. The fatality rate in South Africa was 19.1 per 100,000 workers and the accident rate was 14.626 per 100,000 workers. Their fatality rate was lower than that in Asia and, as well as sub-Saharan Africa.

Table 2.2: Occupational accidents by regions (CIDB, 2021)

Region	Fatality rate (per 100 000 workers)	Accident rate (per 100 000 workers)
Established Market Economies: EME	4.2	3240
Former Socialistic Economies: FSE	12.9	9864
Other Asia and Islands (excluding China and India): OAI	21.5	16434
Sub-Saharan Africa (including South Africa): SSA	21	16012
Latin America and the Caribbean: LAC	17.2	13192
Middle Eastern Crescent: MEC	18.6	14218
Singapore	9.8	7452
South Africa	19.2	14626

2.4 The global cost implications of construction accidents

In addition to reducing productivity and competitiveness, occupational accidents can significantly diminish the reputation of an organisation (Bayram & Ünğan, 2020). According to Allison et al. (2019), research suggests that employers frequently underrate the true financial effect of accidents on construction sites.

Accidents and their related costs negatively affect overall project productivity, time, quality, and profit (Haupt & Pillay, 2016). Osei-Asibey et al. (2021b) found that accidents result in setbacks on construction projects, lead to cost overruns, diminish the reputation of the organisation and reduce confidence among employees. This may result in discontent among shareholders, monetary costs due to property damages and penalties from OHS authorities (Osei-Asibey et al., 2021b). The impacts of accidents and hazards on construction sites are usually identified as a reduction in production rate, an increase in the cost of the project, and poor performance of work (Osei-Asibey et al., 2021b). Yiu et al. (2018) support this by adding that construction accidents result in compensation and legal liability. Moreover, accidents result in salary loss, hospitalisation expenses, idle loss, material loss, equipment loss, and loss in the salary of others among others (Yiu et al., 2018).

Construction accidents have a significant impact on the economic performance of a project (Sun & Zou, 2010). The construction industry has had a long history of workplace injuries, which is costly since the industry contributes significantly to national economic growth, and provides ample job opportunities (Haupt & Pillay, 2016). According to Haupt and Pillay (2016), the sector has been recognised as a national asset by the South African government, due to its potential contribution to the economical enhancement of the state. As a proportion of the total gross domestic product (GDP) in 2020, the industry contributed R134.bn (2.7%) to the

South African economy. Allison et al. (2019) found that the construction industry in Australia contributes 8% of the country's GDP and 9% of the Australian workforce comes from construction sector. Whilst the Ghanaian construction sector contributes 13.7% to the GDP (Osei-Asibey et al., 2021b).

The construction sector has grown rapidly in developing and underdeveloped countries in recent years, resulting in a rise in occupational fatalities (Khodabandeh et al., 2016). Accidents on construction sites affect the cost of a project. According to Allison et al. (2019), construction injuries cost AUD$2,040 to AUD$6,024,517 which narrates to 10% of the overall yearly cost of work-related injuries in Australia. The employer, on average, paid the highest percentage of accident costs for short-term absences, while the community bore the greatest percentage of the cost for long-term absences or full-time, incapacity accidents (Allison et al., 2019).

Construction accidents are mainly financed by four different factors which are:

- Sick pay
- Administration costs
- Recruiting costs
- Compensation and insurance costs (Haupt & Pillay, 2016).

In their study, Haupt and Pillay (2016) analysed the costs of construction accidents in a sample of 100 construction firms and estimated the cost of construction accidents to the employer for 2015 as R32,981,200 in South Africa. According to Umar (2021), Saudi Arabia's accident costs were estimated at US$ 91,940, and the economic impact was US$ 261.11 million/year.

Accident costs can be classified as direct or indirect, which combined represent the total cost of accidents (CoA). Although the CoA is used as an outcome measure, it is significant to all stakeholders as it can be expressed as a percentage of revenue or value of construction completed projects by the organisation (Olanrewaju et al., 2022).

Direct costs: Normally, these are costs that are associated with compensation offered to treat and injured personnel (Haupt & Pillay, 2016).

Indirect costs: Refers to costs that are carried by contractors, including reduced productivity for both the returned workers and the workforce, clean-up costs, stand-by costs, and so forth (Haupt & Pillay, 2016). A breakdown of direct and indirect costs is presented in Table 2.3.

Table 2.3: Types of costs (CIDB, 2021)

Direct Costs	Indirect Costs
• Wages: 84% • Medical expenses: 16%	• Pain and suffering: 58% • Incident investigations: 12.6% to 17.3% • Production loss and process delays: 8.4% • Overtime: 9.1% • Consumables, legal fees, funeral, and compensation due to fatalities: 20%
• Contribution to CoA: 27%	• Contribution to CoA: 73%

2.5 OHSMS in context

The ISO 45001 standard specifies requirements for an OHSMS, along with guidelines for its use, so that an organisation is proactively able to improve its OHS performance in preventing injury and illness (Sadiq, 2019:18). Its requirements are intended to be integrated into an organisation's management processes, regardless of the size, type, or nature of the organisation (Sadiq, 2019:26). It enables an organisation, through its OHS management system, to integrate other aspects of health and safety, such as the worker's wellbeing (ILO, 2001).

OHSMS is defined by Yorio et al. (2015) as a set of institutionalised correlating and relating tactical elements designed to achieve occupational OHS objectives. Sadiq (2019:18) defines a management system as several processes that work together to create the desired output. This view is supported by Almost et al. (2018), who define OHSMS as a combination of planning and reviewing consultative measures, and specific programme elements that are combined in a manner to improve OHS performance. Mohammadfam et al. (2006) and Autenrieth et al. (2015) further state that OHSMS is a set of policies, strategies, procedures, measures, and controls applied to work activities to minimise risks and maximise safety.

Furthermore, Yoon et al. (2013) state that OHSMS has been recognised not only as a moral reference but as a method to improve the transparency, productivity, and competitiveness of an organisation. This aligns with ILO (2001), which adds that the OHSMS should establish OHS policy to achieve OHS objectives. An article on ISO (2018) showed that the OHSMS is a useful tool for the promotion of continual improvement of OHS performance at an organisation level. According to Rantanen et al. (2020:3351), the elements of an OHSMS, as outlined by the ILO, should consist of the organisation's policy, planning and implementation, evaluation, and action for improvement. In addition, Bianchini et al. (2017) suggest that an OHSMS should distinguish between predictable and unpredictable events. The objective of

the OHSMS, according to ISO 45001, is to motivate employees to constantly improve OHS performance. Autenrieth et al. (2015) posit that OHSMS elements consist of an OHS policy, hazard detection and correction procedures, safety training, techniques for worker participation, and management review.

2.6 Key elements of the OHSMS

It is becoming increasingly common for organisations to consider the implementation of an OHSMS as a tool for promoting their sustainability because it provides a systematic framework for managing OHS risks and opportunities (Pramono et al., 2023). According to ILO (2001), the scope and complexity of OHSMSs may vary, depending on the severity of the hazards in the workplace, including the nature of the work performed. OHSMS implementation varies from one organisation to another, even for organisations operating in the same industry (Dolo & Mafini, 2023). Furthermore, ILO (2001) notes that an OHSMS should consist of the following elements:

Policy and development: As part of an OHSMS, the organisation must have a clear direction, as well as be committed to continuous improvement (ILO, 2001). ILO further adds the importance of meeting stakeholder, shareholders, employees, and customers' expectations. Developing an effective OHSMS policy requires a comprehensive approach that meets international standards as well as contributing towards the organisation performance (Darabont et al., 2017). An organisation's policy must be specific and should encompass the procedures required to ensure a safe and healthy work environment (ILO, 2001). Efforts must be made to achieve a safe and healthy working environment while reducing financial losses and liabilities through the activities implicated by the OHSMS (Darabont et al., 2017). The OHSMS represents a strategic plan for the organisation (Rahmadani & Modjo, 2022).

Planning: According to ILO (2001), an OHSMS enables organisations to plan how to comply with their OHS policies. Furthermore, to successfully implement a policy, careful planning and coordination is required. A checklist is used to identify the items the organisation factory's initial inspection which is followed by the development of plans, procedures, and priorities based on relative risks (ILO, 2001). Furthermore, ILO (2001) adds that management needs to establish realistic timetables and set performance standards with baseline which will enable the organisation to measure the future standards and minimise risks to OHS.

Implementation and operation: Rahmadani and Modjo (2022) states that the OHSMS should outline how an organisation plans to implement its system and meet its objectives and targets. According to ILO (2001), the plan should outline how it will motivate its employees to work safely, avoidance of OHS accidents, and protection of employee health in the long run.

The OHSMS should assist an organisation in areas such as encouraging employee participation in OHS processes and how assessment methods can be used to reduce risks (ILO, 2001). Arguably, although risks cannot be eliminated entirely, measures to minimise risks should be implemented.

Measuring performance: According to Rahmadani and Modjo (2022), the OHSMS should outline how the organisation plans to measure, monitor, and evaluate safety and health performance. Additionally, they state that the system should state if active self-monitoring or reactive monitoring will be used to prevent accidents and illnesses. The organisation should measure, monitor, and evaluate OHS performance (Darabont et al., 2017). Arguably, when performance is measured against agreed standards it helps identifying areas for improvement. ILO (2001) outlines that Investigating accidents, ill health, or incidents that could have caused harm or loss should be the first step in reactive monitoring when controls fail.

Auditing and reviewing performance: An organisation should explain how it plans to ensure that its OHSMS is constantly reviewed and improved. According to ILO (2001), a comprehensive employment system includes legal responsibilities, critical performance indicators, and comparisons with competitors' performance. By preparing and implementing their safety statements, companies can report on their accomplishments on worker safety and health in their annual reports (ILO, 2001). Darabont et al. (2017) add that items such as continual improvement, identifying new technologies to improve OHS, recommendations from OHS managers, new knowledge and understanding of OHS issues should form part of this process. Subsequently, organisations with good OHS records can regularly assess their safety performance.

2.7 Aspects that affect OHSMS implementation

According to studies conducted by Osei-Asibey et al. (2021b), construction sites are potentially hazardous areas that are prone to accidents and injuries. According to Amiri et al. (2016), considering the high levels of risk associated with construction sites, organisations must implement an OHSMS to address risks and changes that may occur on-site. However, there are still several challenges encountered when formulating an OHSMS relevant to a particular organisation or project (Rahmi & Ramdhan, 2021). All these factors can be grouped as either external or internal factors that impact OHSMS implementation in the construction industry (Gomes et al., 2016; Micheli et al., 2018). According to ISO 45001, the implementation and maintenance of an OHSMS and its ability to accomplish its envisioned results, are determined by several main components such as top management leadership, and commitment among others (Darabont et al., 2017). A company's OHSMS will differ in detail, complexity, and extent

based on several factors such as the organisation's framework, the scope of the OHSMS, and the nature of the activities and the OHS risks associated with its activities (Darabont et al., 2017).

2.7.1 Internal factors

The term internal factor refers to anything within the organisation that is under the control of the organisation, whether that is tangible or intangible (Shatilo, 2019). These factors can further be grouped into the strengths and weaknesses of the company (Rahmi & Ramdhan, 2021). Rahmi and Ramdhan (2021) address factors that influence OHSMS implementation by reviewing literature and identifying obstacles such as errors on decision making by management, the absence of OHS information, and prioritising production over safety among others. The study also used a sociotechnical approach, where the factors were divided into three systems, i.e., social, technical, and the external subsystem as per Figure 2.2.

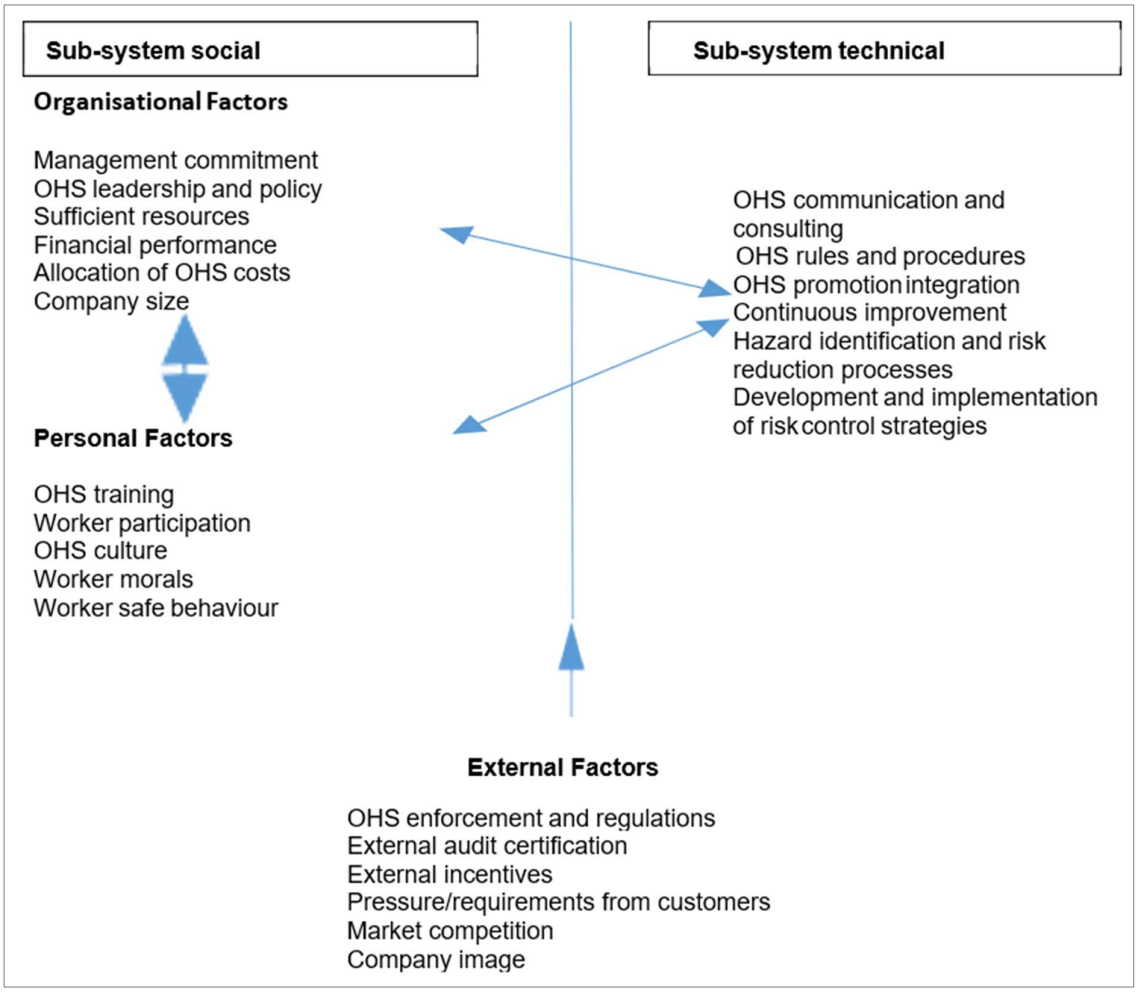

Figure 2.2: Factors affecting OHSMS implementation using the sociotechnical systems approach (adapted from Rahmi & Ramdhan, 2021)

Organisational factors were identified as management commitment, OHS policies, OHS cost allocation, financial performance, company size, internal incentives, and sufficient resources (Rahmi & Ramdhan, 2021).

Personal factors included OHS training, employee involvement, OHS culture, worker morale, manager competence, proactive and proactive behaviour, fear of punishment, pressure from workers, and trade unions (Rahmi & Ramdhan, 2021).

In addition, **technical factors** included OHS communication, OHS regulations and procedures, OHS promotion, system integration, continuous improvement, and uncertainty in reporting systems, identification and risk reduction processes, and development and implementation of risk control strategies (Rahmi & Ramdhan, 2021).

However, Rahmi and Ramdhan (2021) did not find any physical factors related to hardware or software. A workplace needs to consider the technology and hardware within its organisation. If safety aspects are not taken into consideration during the initial design phase and unsafe conditions are present, it is difficult to change the design, technology, or hardware. In addition to the lack of labour inspectors to oversee OHSMS implementation, their research found that the government is not providing any special instruments for monitoring OHSMS implementation. It is critical to measure the OHSMS's performance and activity to ascertain whether the system is operating according to its standards and to help assess its overall effectiveness. Compliance audits and performance evaluations are performed to assess the general effectiveness of the OHSMS. Although the research by Rahmi and Ramdhan (2021) identified both internal and external factors, there were global factors that affected many industries, primarily Indonesia. Their research did not take into consideration the construction sector.

Similar research was conducted by da Silva and Amaral (2019) through a systematic review of literature based on the protocol *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA). Da Silva and Amaral (2019) described the PRISMA method as an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. The aim of their research was to find out whether an OHSMS already existed, the indicators that were used for OHS management, the results expected from implementing the OHSMS, and the difficulties in implementing the OHSMS. The study reviewed articles from 2007 up to 2018, and a total of 88 articles remained appropriate for analysis with the research mainly focused on OHS in Europe and Asia. Da Silva and Amaral (2019) found that there were mandatory OHSMSs arising from government legislation and their use is enforced through inspections, while voluntary OHSMS arise from private enterprises, employer groups,

government and its agencies, insurance carriers, professional organisations, and standards associations are not directly tied to regulatory requirements. Furthermore, the study noted that voluntary OHSMSs are not requirements from governments; instead, incentives are sometimes offered by governments or insurance carriers to organisations that voluntarily accept the OHSMS. Da Silva and Amaral (2019) found that in Spain and Sweden where the use of OHSMS was properly implemented, it resulted in improved working conditions and reduced accidents for firms. They concluded that companies, safety managers, and workers' compensation agencies should consider implementing a simplified and prevention-based management system.

Da Silva and Amaral (2019) concluded that further internal factors such as understanding the importance of integrated management and problems with the integration of different standards affected implementation affects implementation of an OHSMS. Furthermore, their study showed that difficulty in defining the appropriate management indicators in OHS, and the complexity of changing the company policy and culture affected the implementation process. The study confirmed that when operating integrated management systems, most organisations face difficulties such as the complexity of internal management, and the subsequent reduction of efficiency in management, which may incite discordancy with the organisational culture, and even hostility among the employees and increase management costs. Supplementary findings indicated that the high cost of the implementation and management of an OHSMS was a barrier to implementation.

There were several limitations to da Silva and Amaral's (2019) study, such as the absence of comparison groups, the use of cross-sectional studies, and the lack of consideration or control of confounding factors as study was more descriptive than analytical. The study also failed to explain to key individuals directly involved in OHSMS implementation and management how they can incorporate data, through which OHS will be communicated on how to assess and manage existing risks.

A similar study to that of da Silva and Amaral (2019) was conducted by Khalid et al. (2021) to mitigate the factors affecting OHS performance in construction projects. Khalid et al. (2021) found that effective safety performance could only be attained through effective implementation of OHS regulations, leadership, safety planning, safety compliance, performance measurement, risk assessment, safety inspection, and safety culture. Through a systematic literature review, this study explored the key factors affecting OHS management practices in a construction project; analysed and classified those factors under different groups

based on empirical analysis techniques; and developed a safety management system (SMS) framework that manages and mitigates all hazards related to OHS.

Khalid et al. (2021) grouped the factors in their study into six clusters: organisational, managerial, legislative, social, environmental, and personnel. This is similar to the study done by Rahmi and Ramdhan (2021) which also grouped the organisational and personal factors. Khalid et al. (2021) showed that the clusters are interlinked. The organisational cluster would consist of factors such as structure, responsibility, policy design, and resource management among others. The managerial factors include safety management, safety culture, risk assessment, and communication. Other clusters of legislation include compliance, safety policy, and regulation enforcement plan. The social clusters are of social culture and safety perception. The environmental cluster comprises construction sites, safety hazards, and an unsafe climate among others. The last cluster comprises of training, hazard perception, education, risk awareness, and attitude.

Figure 2.3: H&S management clusters (Adapted from Khalid et al., 2021)

Upon grouping their factors into clusters, the study produced a framework presented in Figure 2.4. The top tier of the framework (safety administrative) route, emphasises safety policy development and assurance, while the IT adoption would oversee risk management and safety promotions. The framework notes elements similar to the study of (Rajaprasad & Chalapathi, 2015) such as safety policy, safety assurance, risk management, and safety promotion were the main elements of an SMS. Furthermore, the framework assumes that

safety management should be from the top level of the organisation. The main limitation of this research was that it was purely exploratory based only on a literature review and the framework was not tested in any industry.

Upon grouping their factors into clusters, Khalid et al. (2021) produced the framework presented in Figure 2.4.

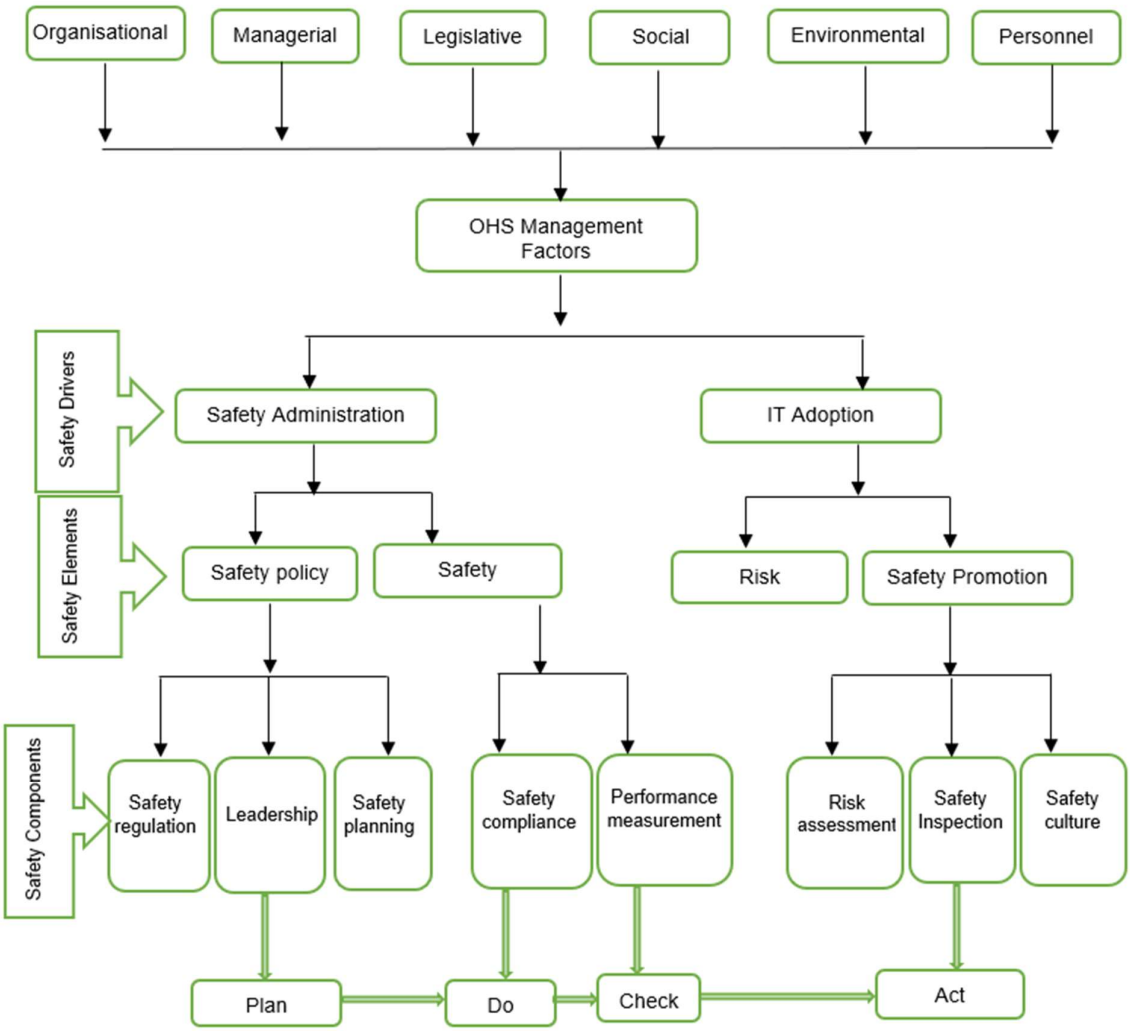

Figure 2.4: Safety Management System (SMS) Framework (adapted from Khalid et al., 2021)

Yiu et al. (2019) conducted a study on the benefits and obstacles of OHSMS implementation in construction projects in Hong Kong. Their study adopted a literature review and structured questionnaires through interviews with experienced safety practitioners in Hong Kong. It was found that the benefits of an SMS are:

- Accident reduction and risk elimination through reduced accident rates.

- Safety awareness and perceptions through enhancement of individual safety understanding.
- Profit maximisation through less material damage, and fewer accidents.
- Operational efficiency through project team with essential OHS roles and responsibilities.
- Recognition of compliance with safety standards and profit maximisation through reduced accidental costs.

From the literature that they reviewed the following obstacles were identified by Yiu et al. (2019):

- Project management and leadership due to a lack of drive for continuous improvement, insufficient resources, and lack of motivation.
- Project constraints and system limitations due to not prioritising safety because of cultural differences, an inactive contribution for the SMS implementation by the project team members, and non-availability of suitable construction resources.
- Competency profile of the stakeholder due to poor OHS attitude by the project team and lack of competent workers.

The results of Yiu et al. (2019) also indicated a potential between the implementation of SMS and project management. Yiu et al. (2019) recommended that further studies be conducted on the crucial elements of SMS implementation to continually improve OHS in the construction sector. However, as the existing research was conducted in a developed country, the results might differ from a developing country such as South Africa.

Kajiki et al. (2020) also conducted a similar study to develop a global OHSMS model for Japanese companies by gathering information from nine countries with information on both site and headquarters. Their target company was a manufacturing firm with branches in Asia, Europe, and the USA. They surveyed by visiting all nine countries and conducting interviews at ISO, the labour department, and accreditation bodies. Thereafter, a brainstorming session was conducted by the research team, who developed a model hypothesis.

The third step was testing and verifying the effects, and the following findings were used to improve the model:

- By implementing the pilot programme, the team was able to confirm that the industry should improve risk assessment education, provide comprehensive OHS training, and hire security experts who are experienced with OHS.
- Headquarters support endorsing the universal OHSMS model.

- To build a regular business reporting line to the organisation's OHS head office.
- To use specialised OHS resources, such as safety officers.
- Increase workers' safety awareness.
- Top management support.
- The framework also introduced ISO 45001 as the framework for the OHSMS.

The study conducted by Kajiki et al. (2020) only focused on developed countries and their research was based on only one company located in nine different developed countries. Furthermore, the industry chosen was manufacturing, which differs from construction. A study carried out by Ghahramani (2016) aimed to identify any areas of improvement based on the experience and perceptions of managers who have worked in companies that have adopted the OHS assessment series 18001 standards in Iran. Semi-structured interviews were conducted with the managers using a qualitative study design based on a grounded theory approach to gather data. Their study found that eleven factors affected implementation, which were further grouped into internal and external factors, as shown on Figure 2.5.

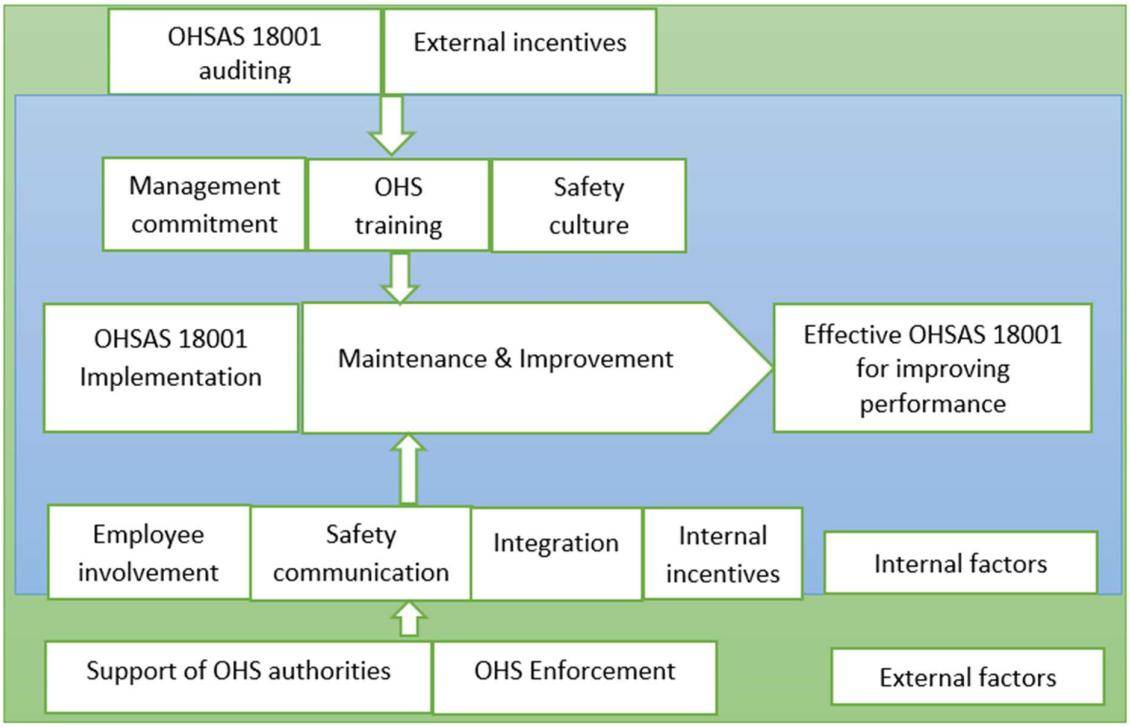

Figure 2.5: Factors influencing the effectiveness of OHSAS 18001 (Ghahramani, 2016)

The study as shown in Figure 2.5 grouped internal factors as:

- **Management commitment:** Senior management of Iranian organisations did not give adequate priority to OHS compared with production as they did not prioritise OHS in the companies (Ghahramani, 2016).
- **Safety communication:** There was lack of communication between managers and employees in the organisation concerning OHS/OHSAS 18001 practices and managers did not share OHS information with the employees (Ghahramani, 2016).
- **Employee involvement:** Employees did not participate in essential systems to minimise the OHS risks in the companies such as hazard identification and risk assessment. Limited participation was also a result of insufficient awareness of OHS/OHSAS 18001, lack of knowledge of the need for OHS participation, inadequate information about the positive impacts of participation in OHS, and a poor attitude about OHS/OHSAS 18001, inadequate motivation, and little job satisfaction (Ghahramani, 2016).
- **Training:** OHS training is a continuous process; the organisations lacked the use of different training methods (Ghahramani, 2016).
- **Integration:** There was a lack of integration of OHSAS 18001 into organisational frameworks because OHSAS 18001 practices were perceived as extra tasks compared with their routine work activities (Ghahramani, 2016).
- **Safety culture:** Inadequate steps to improve the level of safety culture (Ghahramani, 2016).
- **Internal incentives:** There was a lack of internal incentives, and the implementation of incentive programmes could inspire the employees to execute their OHS/OHSAS 18001 tasks safely (Ghahramani, 2016).

The main limitation of Ghahramani's (2016) study was that it was conducted in Iran, and it did not specify the type of industry that the study was based on. Factors for construction sector in South Africa may differ. Ghahramani (2016) further requested that more studies be conducted to identify relevant evidence about the model that they developed.

In a similar study Rajaprasad and Chalapathi (2015) studied the factors that influence Occupational Health Safety Assessment Series (OHSAS) 18001 implementation in Indian construction organisations using the Interpretive Structural Modelling Approach (ISMA). The study identified several variables such as: safety culture, continual improvement, and employee morale that affected the implementation of OHSAS. A structural self-interaction matrix (SSIM) system was developed by examining relationships between the variables. Based on their findings, a model was developed as depicted in Figure 2.6.

Rajaprasad and Chalapathi's (2015) findings from the study showed that management commitment had the highest driving power and a major influence on the other factors, followed by safety policy. However, the study's limitation was that it was based on theoretical frameworks, and results may differ in real settings.

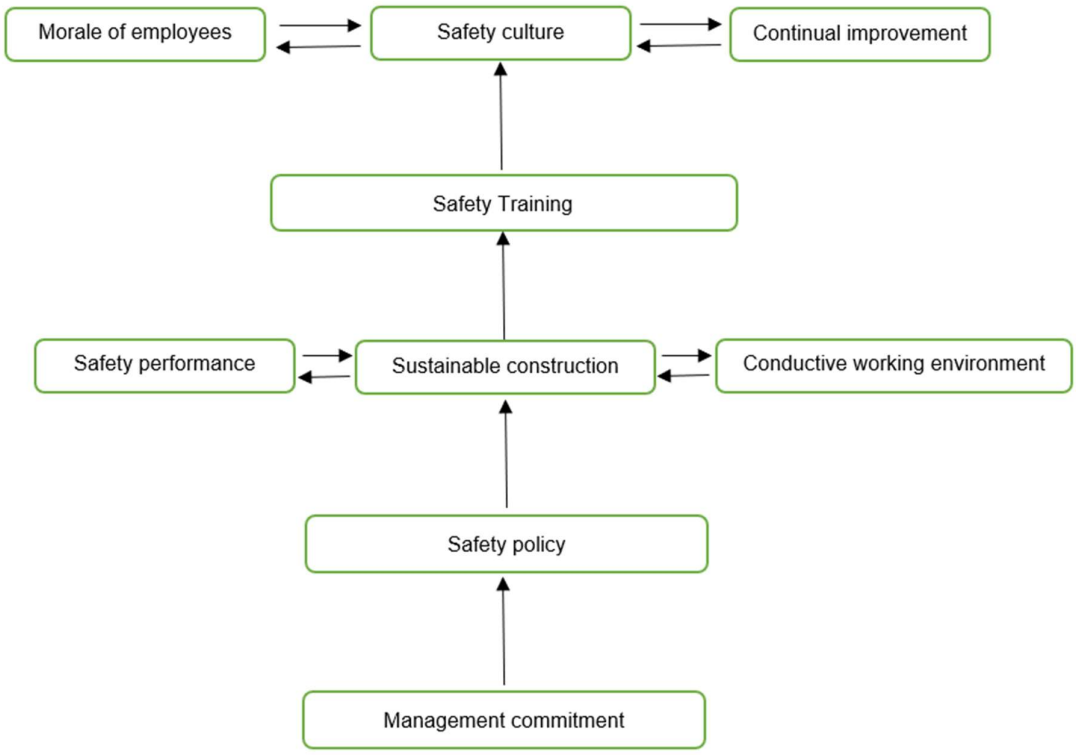

Figure 2.6: ISM-based implementation of OHSAS 18001. ISM, interpretive-structural-modelling, OHSAS (adapted from Rajaprasad & Chalapathi, 2015)

Another factor of concern is the cost-benefit analysis of implementing an OHSMS on a site. In their study, Ligade and Thalange (2013) compared the relationship between safety and cost using a case study of a construction company in Mumbai India. Their work evaluated the costs of averting accidents and the costs of OHS failures in the construction industry. A comparison between the record of accidents that occurred prior and after OHSMS implementation was conducted. They concluded that the cost of the project increased by 7% due to accidents before the implementation of the OHSMS Model, while the implementation cost of the OHSMS Model itself was 3% of the project cost. Therefore, the company savings were 4% of the total project costs due to the implementation of the OHSMS model.

A cross-sectional study of factors influencing OHS management practices in companies was conducted by (Nordlöf et al., 2017). The data from Swedish manufacturing companies were

used for the study, and generalised estimating equations were used to conduct an ordinal regression analysis. Nordlöf et al. (2017) found that company size, safety culture, and creditworthiness were associated with both better and worse OHSM practices in companies. Furthermore, the study found that smaller companies found it difficult to have a functional OHSMS without support. However, their study was conducted in the manufacturing industry in a developed nation. It would be valuable to explore the outcomes in the construction industry of a developing country like South Africa.

Garnica and Barriga (2018) conducted a comparative study to determine the main barriers to OHSMS implementation in small Brazilian enterprises from the perspectives of owners/managers, labour auditors, and OHS consultants. The study conducted surveys with stakeholders who influence the OHS. The data were collected with research mainly focused on industrial and agricultural sectors. The data were analysed by splitting it into two perspectives, from Internal and external stakeholders.

In order of the highest to the least importance, results from Garnica and Barriga (2018) on both internal and external stakeholders showed that the most common factors were:

- Behaviour of personnel that is systematically incorrect
- Strict legal requirements
- Lack of employee involvement in OHS activities
- Bureaucracy
- Ineffective data compilation system
- Systematically inappropriate behaviour of management
- Lack of understanding of OHS relevance by workers
- Absence of information
- Ineffective communication
- Prioritisation of production over safety
- Difficulty in obtaining authorisations by management
- Lack of organisational coherence and flexibility
- Lack of technical resources
- Inadequate dedication to economic resources
- Inadequate OHS policy
- Lack of knowledge on the effect of the interventions

Furthermore, the study focused on most common factors between the internal and external stakeholders and found that the following were common on both sides: systematically wrong behaviour of management; absent or ineffective information; ineffective communication; and

prioritisation of production over safety. A key problem with the results was that the common factors reflected the lack of information from owners about OHS. Garnica and Barriga's (2018) study had limited territorial coverage and prioritised industrial and agriculture sectors; however, the construction industry also constituted a high rate of accidents.

2.7.2 External factors

Shatilo (2019) defined external factors as elements outside and beyond the company's control. These external elements consider various criteria, including the current economic situation, laws, infrastructure, and customer demands, which are among the most significant and defining factors.

Due to the constant changes in work-related accident legislation, employers have become liable for the OHS of their employees, and companies are striving to improve their work environment (Cervi et al., 2015). The importance of continuous workplace hazard analysis and its control is arguably increasing in the organisation's health and safety at work performance metrics. Therefore, considering new work legislation and other more demanding legislation, organisations are considering the implementation of a more efficient HSW management system (Cervi et al., 2015).

The 2018 OHS report by the Department of Labour in South Africa acknowledged that most of the construction industry did not have an OHSMS in place (Mashwama et al., 2018). Mashwama et al. (2018) noted that legal factors were an issue as at least 50% of the construction industry in South Africa do not meet the legal requirements and are not compliant.

In an Iranian study conducted by Ghahramani (2016), possible areas for improvement were identified based on the experiences and opinions of the leaders of companies adopting OHS assessment series 18001 standards. The study found that there were external factors such as:

- **OHS enforcement:** The study found that there is adequate OHS legislation in Iran, and the main problem lies with the enforcement policy to implement OHS requirements. Additionally, the OHS agencies lacked a system for inspecting the quality of the implemented policy.
- **OHS authorities' support:** There was a lack of support from OHS authorities, and many organisations required financial assistance, OHS training, as well as guidance, and consultation regarding OHS issues (Ghahramani, 2016). The OHS authorities did not communicate clearly and did not offer suggestions for areas of improvement for the organisation's safety.

- **Auditing:** The audits were conducted by third-party companies, and they conducted superficial audits on the certified companies. Furthermore, third-party auditors lacked technical expertise about the special OHS issues involved in industrial operations at the audited companies, as well as their auditors' qualifications.
- **External incentives:** There were no incentives offered for good OHS practices.

Similarly, Musonda and Pretorius (2015) conducted a study on the effectiveness of economic incentives on clients' participation in health and safety programmes. By seeking expert opinions from fifteen panellists with relevant experience, the Delphi study technique method was used to study the impact and relevance of economic incentives on OHS performance among clients. Their study established that economic incentives had a significant impact on client OHS performance and that clients were more likely to implement OHS elements when economic incentives were offered over other factors like political influence. Furthermore, results indicated that without economic incentives, clients may consider themselves not critical OHS stakeholders, thereby preventing them from taking part in the implementation process effectively. Economic incentives had almost the same impact on OHS performance as legislation; however, it was observed that using legislation alone to influence clients to implement OHS elements might not achieve the desired results. Generally, it was not the legislation itself that was ineffective, but rather its enforcement that was ineffective in most parts of the world. The limitation of the study was that it did not clarify ways in which incentives could be implemented.

2.7.2.1 OHS enforcement and compliance with legislation and regulations

OHS compliance is undeniably an important factor in achieving optimum workplace safety, but unfortunately the levels of compliance are low (Umeokafor et al., 2014). The main goal of OHS regulation is to prevent accidents and their outcomes, such as injury, disabling conditions, fatalities in the workplace, and workplace illnesses. According to the CIDB (2021) report, the construction industry continues to have a disproportionate number of deaths and injuries compared to other industrial sectors. Additionally, the CIDB's (2021) report notes that South Africa continues to have a low level of compliance with OHS Legislation in general, and specifically with the Construction and other OHS Regulations. The report further shows that at a legislative level, South Africa does not lack an OHS framework. The report further shows that construction regulations should be modified to promote optimal OHS throughout all phases of the project, particularly during the concept, initiation, and detailed design phases. Furthermore, the report indicates that the OHS Inspectorate is understaffed and lacks the expertise to enforce the regulations. According to the CIDB (2021) report from the

Compensation Commissioner, the OHS in South Africa is hampered by a lack of available statistics to show the full extent of accidents.

According to Salguero-Caparrós (et al., 2020), the management of legal compliance in organisations has become a complex task. They conducted a study to explain the difficulties faced by organisations when complying with OHS legislation and managing the process effectively. The study found that OHS regulations restrict the innovation and development of OHS due to the bureaucratic culture of compliance, and that the impact of legal non-compliance is rarely explored in organisations. In the CIDB (2021) OHS report, laws and regulations are cited as examples of invisible barriers that when correctly implemented, enable companies to prevent, control, and even lessen the impact of OHS. The study found that self-regulation is an effective method of reducing existing regulatory obligations and the substantial administrative burden associated with OHS. However, management and control of self-regulation can be a complex task. Salguero-Caparrós et al. (2020) concluded that other than monitoring how non-compliance with legal obligations affects daily performance, companies should also assess how effectively they are adhering to OHS legislation by implementing safety programmes as well as their efficacy in anticipating, preventing, and controlling risks. Their research does not specifically explain the effects of non-compliance to regulations on organisations, but their recommendations include that research should be conducted on how organisations can have access to tools and methodologies that provide expertise on OHS standards and their suitability. One limitation of this study is that it did not specify whether the construction industry was included as part of the study.

According to Windapo (2013), industries often fail to comply with regulations because regulators imposed unachievable or costly standards. Furthermore, government regulations in the construction industry reflect legal efforts that are heavily influenced by social and political factors, assessed against the conditions of the process, and often enacted to minimise the likelihood of adverse results in terms of quality, safety, and health. Windapo (2013) conducted a study to investigate the role of statutory OHS regulations in managing construction project risks in South Africa. The study also examined whether contractors' decisions on compliance with regulations, compliance costs, and savings in OHS-regulated requirements are affected by the level of risk that the regulations attempt to reduce. The study used both qualitative and quantitative techniques by obtaining data from private, national, and international companies operating in South Africa. According to the findings of the study, every contractor who complied with OHS regulations was motivated by the perception that compliance would save them money. Moreover, Windapo (2013) found that cost savings were influenced by the

likelihood of an accident occurring, which represents the degree of risk being controlled or prevented by the regulation (see Figure 2.6).

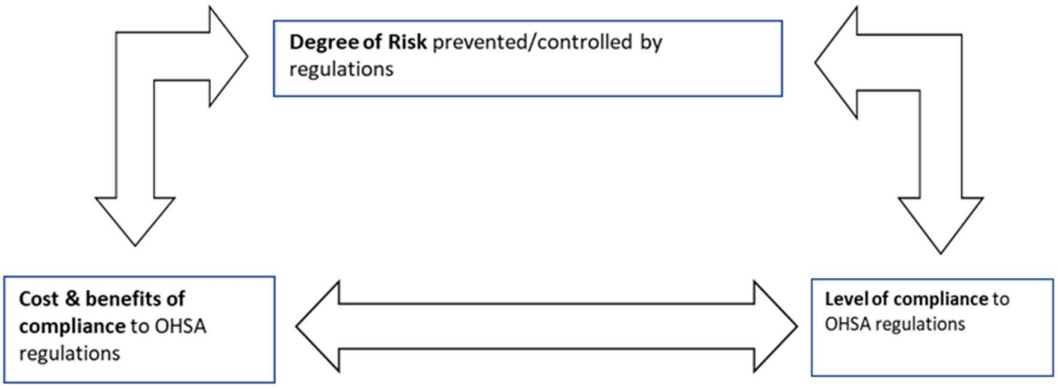

Figure 2.7: Research Framework (adapted from Windapo, 2013)

Windapo (2013) concluded that a contractor's tendency to conform with OHS regulations decreases as the cost of compliance increases and does not increase as the degree of risk or perceived cost savings increases. to the study's further results indicated that contractors are not complying with OHS regulation requirements due to cost concerns, leading to hazardous work conditions on construction sites. Additionally, the results suggested that certain elements of the OHS regulations were viewed by contractors as unnecessary, costly, and time-consuming, hence were ignored resulting in noncompliance with regulations. Due to the contractors' cost-saving mindset, the study found that accident rates will continue to rise on construction sites, and this should be of great concern to both public and private clients. The main limitation of the study was that it found no connection between compliance with standards and the perceived levels of risk that may result from non-compliance with OSHA requirements.

In their study to examine the determinants of OHS regulations compliance in Nigeria's construction industry, Umeokafor et al. (2014) identified the key factors as "culture, client influence, inadequate legislation, the informal sector's activities, beliefs, the enforcement of OHS regulations, bribery, and corruption". The research concluded that despite insufficient regulations and a lack of government support, stakeholders in the construction industry and trade unions have the power to improve worker safety. The authors suggested that local councils' building planning divisions get involved in OHSMS implementation, participate in tender selection, and give preference to building contractors with a solid safety record. Umeokafor et al. (2014) furthermore found that the major issues to ensuring OHS compliance in the Nigerian construction industry could be attributed to socio-cultural, institutional/legal,

organisational, socio-economic, and industrial issues, with the informal industry playing a significant role. The research focused on the Nigerian construction organisations which may differ from South African industries.

2.7.2.2 South African legislation and regulations on OHSMSs

The primary Acts that impact the construction of OHS in South Africa are the OHS Act No. 85 of 1993 (OHS Act) and the complementary Compensation for Occupational Injuries, Construction regulations guidelines (2014) and Diseases Act No. 130 of 1993 (COID Act) (South Africa, 2014). The main characteristics of the 2003 OHS legislative framework in South Africa as published in Gazette 2014 consist of the following:

- The transition from the conventionally strict “deemed-to-comply” or “command and control method” to a performance-based strategy where no compliance criteria is set.
- Shifting the responsibility of construction OHS from the contractor, who had been held solely accountable, to all parties involved, including the client and end-user.
- The mandatory inclusion of health and safety management into almost all construction projects.
- Identification and assessment of construction hazards to reduce, eliminate or eliminate at the very least perceived risks.
- OHS issues are to be considered throughout the project life cycle from inception to completion.
- An OHS representative who liaises with all the other participants and submits documents on clients’ behalf to facilitate better OHS management on construction projects.
- A mandatory OHS specification and plan as an instrumental means of sharing and communicating OHS issues between all contributors involved in the construction process.
- Compilation of an OHS file by the contractor for delivery to the client upon completion.

However, merely formulating OHS laws is not sufficient, as compliance is crucial to realising the goals of the laws (Umeokafor et al., 2014). Mashwama et al. (2018) in their study on challenges affecting OHS among small and medium-sized enterprise contractors in South Africa found that factors such as inadequate routine inspections on sites and the unfamiliarity of regulatory obligations resulted in non-compliance. The study also noted that non-compliance to OHS regulations was due to a lack of resources and less awareness on the costs of non-compliance. It was more difficult to implement OHS policies in smaller companies because employee representatives frequently were not appointed.

A study conducted by Agumba and Haupt (2009) on the construction OHS culture in South African small and medium enterprises concluded that there was a limited commitment to compliance with OHS to small and medium enterprises (SMEs) due to the high cost of implementation and maintaining them. The study further noted that while SMEs may provide protective clothing, they struggle to maintain tools due to the associated expenses, often viewing safety equipment as a luxury. Strict schedules and production take priority over the implementation of appropriate OHS procedures and most employees do not comprehend fully the risks present on sites (Othman, 2012). Nevertheless, the OHSMS should still factor in the latest regulations (Stiles et al., 2021). According to Simpeh et al. (2021), the implementation of the new COVID-19 regulations affects OHSMS implementation.

2.8 Risk management and OHSMS on the construction site

2.8.1 Definition of risk

Construction sites are hazardous places where injury or death or illness are prone to happen and there are many risks involved (Purohit et al., 2018). Khalid et al. (2021) posit that when developing an OHSMS, there were connected factors such as risk management that should be realigned to improve OHS. This notion was supported by da Silva et al. (2019) in their study, who reports that failures in the process of assessing the risks of OHS adds to challenges when implementing an OHSMS. This section endeavoured to explore in detail what risk management is and how it can be integrated into an OHSMS through the Plan do Check Act (PDCA).

In construction projects, ambiguity can arise from various factors, including the performance of construction parties, resource availability, and contractual relationships. As a result, construction projects suffer from problems that delay their completion times (Cooper et al., 2021). Risk refers to an event or condition that could negatively or positively affect a project's objectives (Cooper et al., 2021). The nature of construction projects makes risk management a crucial process, and all steps in the risk management process need to be considered during the implementation stage. According to Ramos et al. (2014), risk management can be considered an integral part of the OHS of an organisation and can be applied to develop and implement OHSMS policy and manage the associated risks. Effective risk management increases the productivity and competitiveness of enterprises while contributing to the sustainability of social protection systems by reducing the cost of accidents and occupational diseases. Cooper et al. (2021) further illustrate risk management as an endless process throughout the whole project life cycle. However, to take advantage of its full potential, risk management should be implemented at the earliest stage, the feasibility design, and the construction stage. It can be argued that there are various risk management models and

processes within the construction Industry, regarding managing the risks in various projects. Doval (2019) explains risk management as an iterative process, where each aspect of risk management should be planned and observed in each phase of the project. This process includes four steps: risk identification, risk analysis or assessment, risk management, and risk control (Lavanya & Malarvizhi, 2008). However, the core principle of risk management is the same, but they differ depending on the industry and organisation. Figure 2.7 shows the components of the risk management plan.

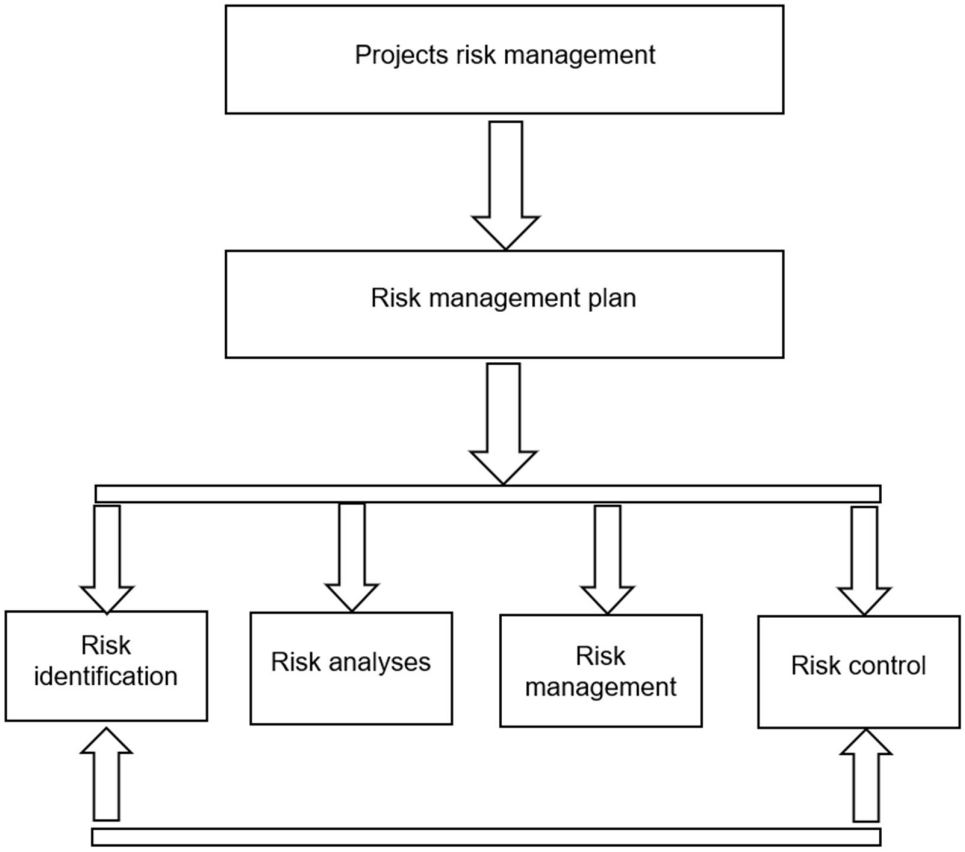

Figure 2.8: The risk management process (Lavanya & Malarvizh, 2008)

Srinivas (2019) explains that risk management is a model that many construction organisations have not previously considered , although risks can be easily controlled if they are identified, and a mitigation strategy is in place from the outset. By managing risk, the stakeholders can ensure their obligations are met and their adverse effects on the project are minimised. The success of any construction project is attributed by time, cost, and quality outcomes (Srinivas, 2019).

Furthermore, with the construction industry being vulnerable, more prone to risk and uncertainties than any other industry it is important to manage the risks associated with that (Srinivas, 2019). A recent study by Haslam et al. (2005) found that construction accidents were mostly attributed to workers mistakes, flaws in the risk management plan among other factors. The management of risk is a key success factor for the construction industry (Okudan et al., 2021).

KPMG (2014) recommends the following elements as part of a comprehensive project risk management approach:

- Strategy and planning
- Risk identification
- Analysis (quantitative and qualitative)
- Response planning
- Monitoring and control

The goal of risk management should be to increase the likelihood and effect of favourable events while lowering the likelihood and effect of adverse events (PMI, 2013:310). Construction companies have been implementing risk management for a considerable period to identify risks, estimate the probability of uncertain events, generate response strategies, and finally monitor the risks throughout the project companies (Okudan et al., 2021).

2.8.2 Risk management planning on a construction site

The cornerstone of a company's risk management programmes is its strategy and planning activities, which determine the success of the programme. During this phase, an organisation can outline how risks will be addressed and managed (KPMG, 2014). According to PMI (2013:309), risk management processes must be planned to ensure that the degree, type, and visibility of risk management are proportional to the risks and importance of the project. Rehacek (2017) defines the risk management plan as the technique that explains how to conduct risk management events for a project. Furthermore, planning ensures the provision of sufficient resources establishment of a common basis for evaluating risk (Rehacek, 2017). As part of the project initiation process, the risk management framework of the organisation is reviewed and adapted to define the project risk management plan (Doval, 2019). However, careful and proper planning increases the likelihood of success for the other five risk management processes (PMI, 2013:313).

Schieg (2006) proposed incorporating risk management into the planning phase to identify and reduce potential risks to a project. Doval (2019) asserts that risk management plans

include a list of possible sources of risk, an impact and probability matrix, a risk reduction and action plan, a risk intervention plan, and thresholds and risk values. PMI (2013:312) outlines the planning of risk management into three (3) guidelines, which are as follows: inputs, tools and techniques, and outputs. Figure 2.8 shows an overview of project risk management.

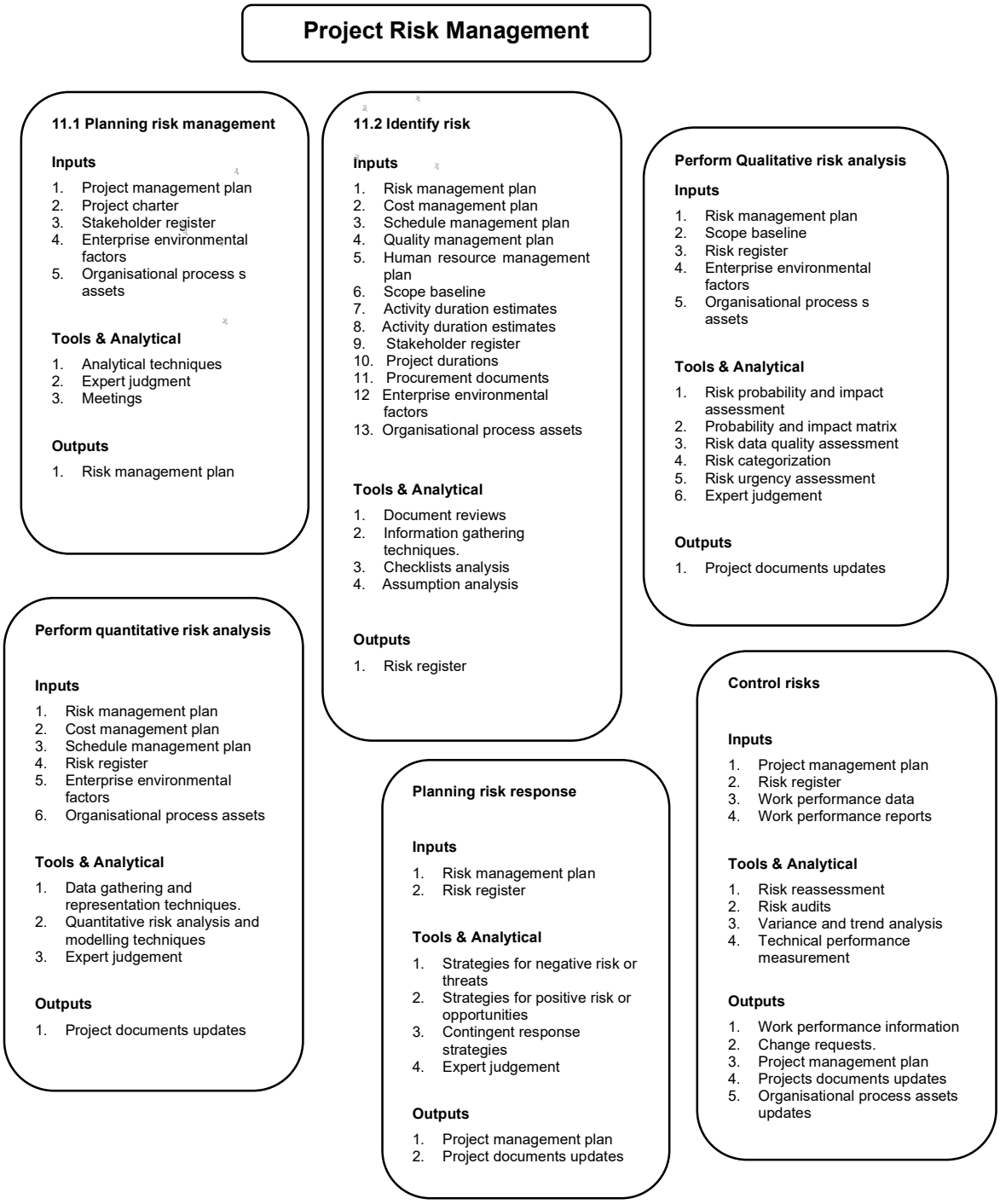

Figure 2.9: Project risk management overview (PMI, 2013:312)

2.8.2.1 Inputs of risk management planning

According to (KPMG, 2014), the input of risk management follows the following stages:

- **Project Scope Statement:** Comprises a comprehensive overview of the project's scope and deliverables as well as a framework for determining how important the risk management effort may be eventually.
- **Cost Management Plan:** This is the process of accounting for and accessing risk budgets, contingencies, and management reserves.
- **Schedule Management Plan:** This plan will explain how contingencies will be scheduled, reported, and assessed.
- **Communications Management Plan:** It specifies how the project will be communicated, as well as who will be available to share information about various risks and responses at various times (and locations). Thus, defines preferred reporting and communication procedures and the organisation's strategic objectives (KPMG, 2014).
- **Enterprise Environmental Factors:** Enterprise environmental factors such as risk attitudes and risk tolerances can affect the risk planning process.
- **Organisational Process Assets:** Risk management planning processes should consider influential factors such as risk categories, common definitions of concepts and terms, risk statement formats, standard templates, roles and responsibilities, decision-making authority levels, and stakeholder registers.

2.8.2.2 Tools and techniques of planning risk management

During planning meetings, project teams develop a risk management plan with the participation of project managers, project team members, stakeholders, and anyone in the organisation who is responsible for managing risk planning and execution (Whitaker, 2016:353-404). High-level plans for carrying out risk management operations are defined during these sessions, together with risk management cost elements and schedules, which are, accordingly, incorporated in the project budget and schedule (KPMG, 2014). Approaches for applying risk contingency reserves may be determined or assessed, and risk management responsibilities will be allotted (PMI, 2013:314-316). Each project will have its own customised strata templates for risk categories and definitions of terminology on risk levels, probabilities on type of risk, and impact by type of target. If existing templates for the steps of the process do not exist, new steps maybe created during these meetings (PMI, 2013:314–315). The outputs of these activities are summarised in the risk management plan below.

2.8.2.3 Outputs of planning risk management

The risk management plan describes how risk management will be structured and carried out on the project, and it includes the following elements (PMI, 2013:315–318):

- **Methodology:** Outlines the approaches, tools, and data sources that may be used to conduct risk in the project (PMI, 2013:316).
- **Roles and responsibilities:** These are related to risk management tasks, identifying, and defining requirements for project stakeholders regarding risk management actions (KPMG, 2014).
- **Timing:** This document specifies when, where, and how risk management will be conducted throughout the project life cycle, establishes protocols for utilising schedule contingency reserves, and details risk management activities to be included within the project schedule (PMI, 2013:316).
- **Risk categories:** KPMG (2014) states that categories can either be based on common industry risks or the organisation's risk categories such as construction, financial, operations and governance. In addition to developing a risk matrix and assigning risk scores, the risk matrix must define risk ratings based on probability and impact by considering the organisation's risk tolerance (PMI, 2013:317).

2.8.3 Risk identification on construction sites

Despite significant advancements in knowledge of traditional workplace risks, the changes in the workplace environment and the labour market have created new hazards, psychosocial risks are more prevalent, OHSMSs have produced mixed results (Gallagher & Underhill, 2012). To implement an OHSMS in an organisation, occupational hazards must first be identified (Niciejewska & Kiriliuk, 2020). Rehacek (2017) describes risk identification as identifying possible risks to the project and documenting their characteristics. The first phase in the risk management process is risk identification, which is done in a variety of methods depending on the organisation and project team (Srinivas, 2019). Despite the difficulties in eliminating risks and threats, once they have been identified, acting, and holding them in check becomes much easier (Srinivas, 2019).

Nonetheless, Doval (2019) contends that risks should be recognised and dealt with as early as the feasibility stage during the project lifespan, with an emphasis on the crucial phases. However, Rehacek (2017) views the process of identifying risks as a repetitive process since new risks develop as the project moves through its lifecycle. The frequency and participation in the cycle may arguably fluctuate depending on the scope of work involved. To facilitate effective analysis and response development, each risk statement should be presented consistently to ensure that the risks are understood clearly and unambiguously (Rehacek, 2017). The capacity to analyse the relative impact of one risk versus others on the project should be supported by the risk declaration (Doval, 2019). To instil a sense risk ownership and responsibility, the project team should be involved in the risk identification and analysis

process (Doval, 2019). Therefore, identifying risks at early stages though it may require a combination of tools and techniques, the positive effect will be risk identification of specific challenges (Srinivas, 2019).

Mhetre (2016) and PMI (2013:325–327) outlines risk identification methods and techniques as follows:

i) **Brainstorming:** Brainstorming aims to achieve a complete list of project risks. The project team usually conducts brainstorming, often in conjunction with experts from different disciplines who are not members of the team (Mhetre, 2016). As part of a framework, such as a risk breakdown structure, risks are identified and categorised based on their type (PMI, 2013:325–327).

ii) **Delphi Technique**: The goal of this technique is to reach a consensus among experts anonymously (PMI, 2013:325–327). As part of a risk assessment process, the organiser uses a questionnaire to obtain ideas from participants for the key project risks (Mhetre, 2016). The results are summarised and then distributed to the experts for additional comments to reach a consensus with participants (Mhetre, 2016). The Delphi technique reduces bias and protects individuals from undue influence (Mhetre, 2016).

iii) **Interview/Expert Opinion**: This involves interviewing experienced project team and stakeholders identify risks of the project (Mhetre, 2016). Participants or relevant persons in the project can be interviewed to identify factors influencing risk (PMI, 2013:325–327).

iv) **Experience**: An analogy may be created for the identification of the components using experience from a project of the same type (PMI, 2013:325–327). While comparing projects, the characteristics will give insight into the similar elements (Mhetre, 2016).

v) **Checklists**: Risk identification checklists may be created using information gathered from previous comparable projects and other sources (PMI, 2013:325–327). While a checklist is fast and easy, constructing an exhaustive one is impossible (Mhetre, 2016). The team should investigate items that are not on the checklist as part of project closing, and the checklist should be refreshed to include any new lessons discovered.

vi) **SWOT Analysis**: With this method, the project's strengths, weaknesses, opportunities, and threats (SWOT) viewpoints to identify internal risks (Mhetre, 2016). The technique involves identifying the strengths and flaws of the organisation, either within the project organisation or across the organisation (PMI, 2013:325–327). According to Mhetre (2016), SWOT analysis uses brainstorming to identify these factors. Using SWOT analysis, the project's potential opportunities are identified as well as potential threats.

SWOT analysis also evaluates how threats and opportunities serve to offset an organisation's weaknesses (PMI, 2013:325–327).

vii) **Expert Judgment**: This ensures that risks be identified directly by experts with appropriate experience in similar projects (PMI, 2013:325–327). The project manager often chooses the experts based on their prior work history and areas of specialisation from other projects of a similar nature (Mhetre, 2016).

However, a study conducted by Garrido et al. (2011) found that a checklist, followed by a flowchart and brainstorming were the most common techniques to identify risk within the Brazilian construction industry. This aligns with Morgan et al.'s (2014) study, which noted that a checklist was the most often used technique in the construction industry, followed by flowcharts and brainstorming.

The Delphi Technique was identified as one of the least used, even though in literature it is frequently mentioned. Rehacek (2017) identified three perspectives of risk identification as illustrated in Figure 2.9.

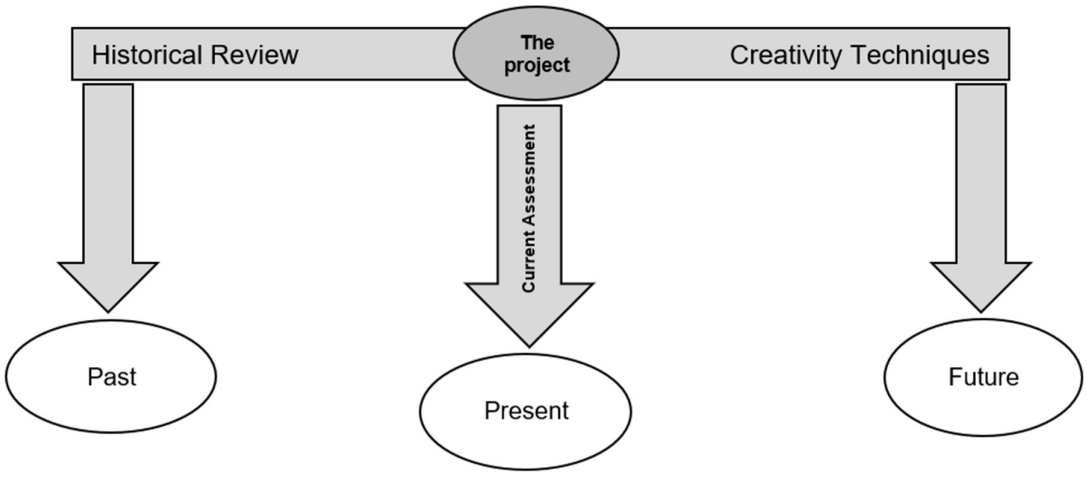

Figure 2.10: Three perspectives of risk identification (Rehacek, 2017)

According to Rehacek (2017), historical reviews draw inspiration from the experiences of the past, whether that be similar projects in the same organisation or comparable projects elsewhere. In past reviews, only relevant risks from the past are considered and only similar cases are carefully selected and filtered. Each project considers the historical risks and situation, and then assess the probability in occurrence of those risks in the current project (Rehacek, 2017).

The study further states that the main objective of current evaluations is to identify unsolved uncertainties by comparing a project's features to predetermined frameworks and models. Unlike historical review methodologies, modern evaluation strategies concentrate on the project itself rather than making references to other sources (Rehacek, 2017).

According to Rehacek (2017), the following data are gathered during the risk identification phase and made available to various project and risk management processes:

- **List of identified risks**: A structure for describing risks can be used, for example, an event may occur causing impact (Rehacek, 2017). The study further adds that together with the list of recognised risks, the fundamental causes of those risks may become clearer. The fundamental reasons should be documented and utilised to help identify potential risks for this and other future initiatives (Rehacek, 2017).
- **List of potential responses**: During risk identification, it is important to identify potential responses to risk as that would need to be included in the planning of the risk responses (Rehacek, 2017).

The OHSMS must adapt to multi-employer workplaces, more diversified workforces, and the identification and management of psychosocial hazards (Gallagher & Underhill, 2012). Additionally, there is a need to observe processes linked to the development, maintenance, and implementation of effective OHSMSs, future models of employee contribution and representation, as well as the barriers and enablers of effective OHS integration into broader workplace systems and management (Gallagher & Underhill, 2012). Hazards can be grouped into physical hazards, biological hazards, chemical hazards, and neuropsychological hazards (Niciejewska & Kiriliuk, 2020).

2.8.4 Risk assessment/analysis on construction sites

According to Doval (2019), risk analysis or assessment entails analysing how the outcomes of the project's objectives changes because of the risk event. Doval (2019) noted that after the risks are identified, they are analysed to identify the qualitative and quantitative effect on a project to ensure suitable steps can be taken to lessen the effect. As a further means of ensuring continuous improvements in the OHSMS, risk assessments are also useful for assessing and achieving the intended outcomes of system deployment (Górny et al., 2019). Risk assessment comprises both quantitative and qualitative risk assessment (Srinivas, 2019).

Qualitative risk analysis: According to Rehacek (2017), this is the process of prioritising risks for supplementary analysis by evaluating and combining their likelihood of occurrence and impact. Qualitative risk assessment approaches are based on descriptive scales and are used

to describe the odds and effect of risk (PMI, 2013:332). For small and medium-sized projects, these relatively simple techniques work well for quick evaluations. Moreover, this method is often used in cases where the numerical data are inadequate or where resources are limited (Mhetre, 2016).

Risk probability and impact assessment: This is an evaluation on the likelihood of occurrence of a specific risk (PMI, 2013:330). The effect of risk on a project's objectives is also assessed regarding the positive impacts that it has on opportunities, as well as the negative effects it has on threats. It is necessary to define the probability and impact and tailor that to a specific project. This guarantees that precise scale definitions are established, and that project scope may be determined based on the nature, standards, and goals of the project (PMI, 2013:330).

Probability/impact risk rating matrix: Prioritising risks according to their ratings can make it easier for them to be dealt with quantitatively. Organisations often specify these rating criteria ahead of time and incorporates them into the organisational process assets (PMI, 2013:331). According to Purohit et al. (2018), the risk rating is one of the most basic forms of risk assessment as its rates rise as high, medium, or low, depending on the activity's probability to cause harm and the seriousness of that harm. Even though low-risk items might not affect the entire project, they still need to be accounted for (PMI, 2013:332). Under the specified regulated settings, harm is extremely unlikely to happen, and even if it does, the harm would be very little. With Medium risk items, there is a low likelihood that these risks would cause project disruptions, but they may cause issues in a project. High-risk should be prioritised may cause project failure (PMI, 2013:332). Purohit et al. (2018) explain that presenting an analysis of risks in a matrix can effectively illustrate the distribution of risks around a project. An example of a risk ranking matrix is shown in Table 2.4.

Table 2.4: Risk Ranking Matrix (Purohit et al., 2018)

RISK ASSESSMENT MATRIX				
SEVERITY / PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional I	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable I	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

The matrix in Table 2.4 is based on research conducted on a construction site. Hazards were identified and grouped into high, medium, and low depending on their effects and likelihood of occurrence. The high risks activities in red colour were deemed as high with an emphasis on avoiding them or reducing the likelihood of occurrence (Purohit et al., 2018). The risks shown in yellow were found manageable with attempts to decrease risk without incurring costs that are significantly disproportionate to the value received. The risks marked in green were deemed as low with no need to take extra action. According to Purohit et al. (2018), Hazard identification and risk analysis (HIRA) is an activity used to identify and evaluate potential hazards at a facility, throughout its life cycle, as well as control any risks the organisation is willing to accept. They further assert that HIRA aims to incorporate the project analysis, objective, life cycle stage, available information, and resources when identifying risks.

Risk categorisation and risk urgency assessment: Risk categorisation is a strategy for systematising risks based on their origins to identify project areas that are most prone to those risks (PMI, 2013:332–333). Work breakdown structure (WBS) and risk breakdown structure (RBS) are tools that may be employed in this strategy, and their job is to produce effective risk responses (PMI, 2013:309–315). WBS divides big tasks into small, manageable components, resulting in a linked, categorised chain of separate occurrences, whereas RBS categorises risks and demonstrates their relationships, leading in the creation of effective risk responses (PMI, 2013:314). Risk Urgency Assessment is a method used to prioritise risks based on how quickly they require responses (Mhetre, 2016). Priority indicators may include the time it takes to stimulate a risk response, symptoms and warning signals, and the risk rating (Mhetre, 2016). To generate a final risk severity rating, risk urgencies can be coupled with likelihood and effect matrix ratings (PMI, 2013:333).

Quantitative risk analysis: This is the process analysing the effect of identified risks on the project objectives (PMI, 2013:333–340). According to Srinivas (2019), the goal is to quantify the effect of a risk on a project scope, schedule, budget, and quality. Moreover, complex, and larger projects require more in-depth analysis in comparison to small projects (PMI, 2013:333–340). Mhetre et al. (2016) further outline Quantitative analysis tools and techniques as follows:

Sensitivity Analysis: The aim of this is to identify those aspects of the project that have the most impact on its outcome. After creating a risk model, a sensitivity analysis is conducted to test its sensitivity to project outcomes. As a result, each variable is altered one at a time, with the effect on the project being assessed afterwards (Mhetre et al., 2016).

Scenario Analysis: Using scenario analysis, one can analyse the effect of a different outcome of a project. Following this analysis, it can be determined what option will result in less loss or hazards, and that can be chosen (Mhetre et al., 2016).

Decision Trees: Decision trees are very beneficial for both formulation of the problem and the evaluation of options. The analysis uses graphical models to show the effects of any decision taken on project (Mhetre et al., 2016).

2.8.5 Risk plan response on the construction site

Risks planning entails developing how to organise and identify risks, performing qualitative and quantitative analyses, planning responses to risks, monitoring risks, and controlling risks throughout the project lifecycle cycle (Taghipour et al., 2015). PMI (2013:309) defines risk planning responses as the process of creating alternatives and measures to enhance opportunities and lessen hazards to project objectives. Doval (2019) adds that this step includes designing the risk response, identifying risk triggers, and designating the person accountable for risk resolution. Doval (2019) points out that some risks may need to be carefully handled over longer periods and that there may not be simple fixes to decrease or remove all the hazards that a project confronts. According to Mhetre et al. (2019), the response strategy and method chosen depends on the type of risks involved, and the risk response tactics are as follows:

Risk Avoidance: Project management plan can be altered to eliminate or relieve the threat, such as extending the schedule or decreasing the scope, but still in pursuit of project objectives (Mhetre et al., 2019).

Risk Transfer: This entails locating another party that can willingly accept responsibility and be accountable should the risk occurs. Even after a threat is transferred, it continues to exist and is still controlled by the new owner. This can be an effective method of dealing with things like financial risk exposure since as it guarantees that risk is owned and managed by the entity most suited to deal with it (Mhetre et al., 2019).

Risk Mitigation/Reduction: This involves reducing to acceptable level the impact of the risk. A proactive approach reduces the likelihood and/or impact of risk more effectively than attempting to repair the damage after it has passed (Mhetre et al., 2019).

Risk Exploitation: In this strategy, upside risk is exploited to reduce the ambiguity associated with it (Mhetre et al., 2019). An example is to assign the most capable resources of the

company to the project to reduce the duration of project or provide at a lesser cost than initially planned.

Risk Share: This involves assigning risk ownership to another party who experienced in maximising the likelihood of occurrence. This increases the potential benefits should this risk occur. Threat transfer and sharing opportunities are similar because a third party is used, the third party takes on the risk, and the third party receives the benefits from the sharing (Mhetre et al., 2019).

Risk Acceptance: This strategy is used when other strategies cannot address the problem, or when a response is not justified by the magnitude of the problem. Acceptance of a risk by the project team is done the moment they agree to address the risk when it happens (Mhetre et al., 2019).

Contingency Plan: This involves having a backup plan should a risk occurs and can also be in the form of costs set aside to deal with unknown risks (Mhetre et al., 2019).

Although risk is perceived as a negative term, in theory it has two dimensions (Mhetre et al., 2016). Arguably, professionals in the construction industry are using methods described above relating to risk management but may not be aware of it.

2.8.6 Monitoring and control of risk management for construction sites

Creating a risk response plan, tracking risks, observing residual hazards, identifying new risks, and assessing how well risks are managed are all examples of monitoring and control (PMI, 2013–355). The key advantage of this procedure is that it enhances the efficiency of the risk approach throughout the project life cycle by constantly improving the risk responses (Rehacek, 2017). During the life cycle of a project, planned risks are addressed as written in the risk register, but the project is continually monitored for new, changing, and obsolete risks (PMI, 2013–355). According to Whitaker (2016:365), the methodologies used in the control risks process, such variance and trend analysis, call for the usage of performance data produced during project execution. To control risks, it is important to ensure that alternative strategies are chosen, a fall-back plan is executed, corrective action is taken, and project management plan is modified (Whitaker, 2016:365).

Sousa et al. (2012) suggest that monitoring and review can be implemented at different stages of the construction project level and may be attained by using different tools like framework-risk management manual and process risk management plan. Sousa et al. (2012) also accentuate the importance of evaluating the efficacy of the risk management plan in terms of

overall project performance using proactive and reactive key performance indicators, and these outcomes can be used as input for continuous risk management improvement. According to Rehacek (2017), the outcomes of monitoring and evaluations should be documented and communicated externally and internally, contributing to the assessment of the risk management framework.

Regarding the risk register, Doval (2019) emphasises the documentation of triggers for each risk. He further adds that triggers warning signs that indicate when a risk occurs or is about to occur. The project managers take full responsibility for managing all risks and is named in the risk register as the owner of the risk (Doval, 2019). The risk owner is monitors and manages the risk triggers and are responsible for reporting to management any change in the status of risk triggers and implementing the defined countermeasure (Doval, 2019).

2.8.7 Integration of risk management into the OHSMS on construction sites

To be efficient, effective, and simple, Sousa et al. (2012) argue that risk management should be integrated into management practices and systems that are already familiar to construction organisations. It is reasonable to assume that most construction firms already have management processes in place that address quality, environment, OSHA, and social responsibility (Sousa et al., 2012).

According to Badri (2015), integrated risk management refers to an integrated collection of activities that take place in an organisation to detect, assess, evaluate, and adjust the likelihood of occurrence of certain events affecting one or more entities as well as the effect of those events. Sousa et al.'s (2012) study offered a risk management framework for the construction industry, considering the characteristics of construction-related organisations and projects seeking to integrate risk management into their overall management systems. Sousa et al. (2012) developed a framework that would be suitable for the construction industry. They suggested that while the framework's general concept is based on well-established management standards, models, and practices, it can be adapted to other industries and business sectors. It describes the top management the operational divisions or departments that make up the organisations, and the inputs and outputs that are produced by the organisations.

Figure 2.10 depicts the framework for integrating risk management into the overall management framework (through the risk management framework) and the management processes (through the risk management process) of construction organisations (Sousa et al., 2012). The framework is based on the PDCA process, which is often embraced by top management within construction organisations. According to the study, the integration of

different management processes can be carried out simultaneously by communicating, consulting, monitoring, and review.

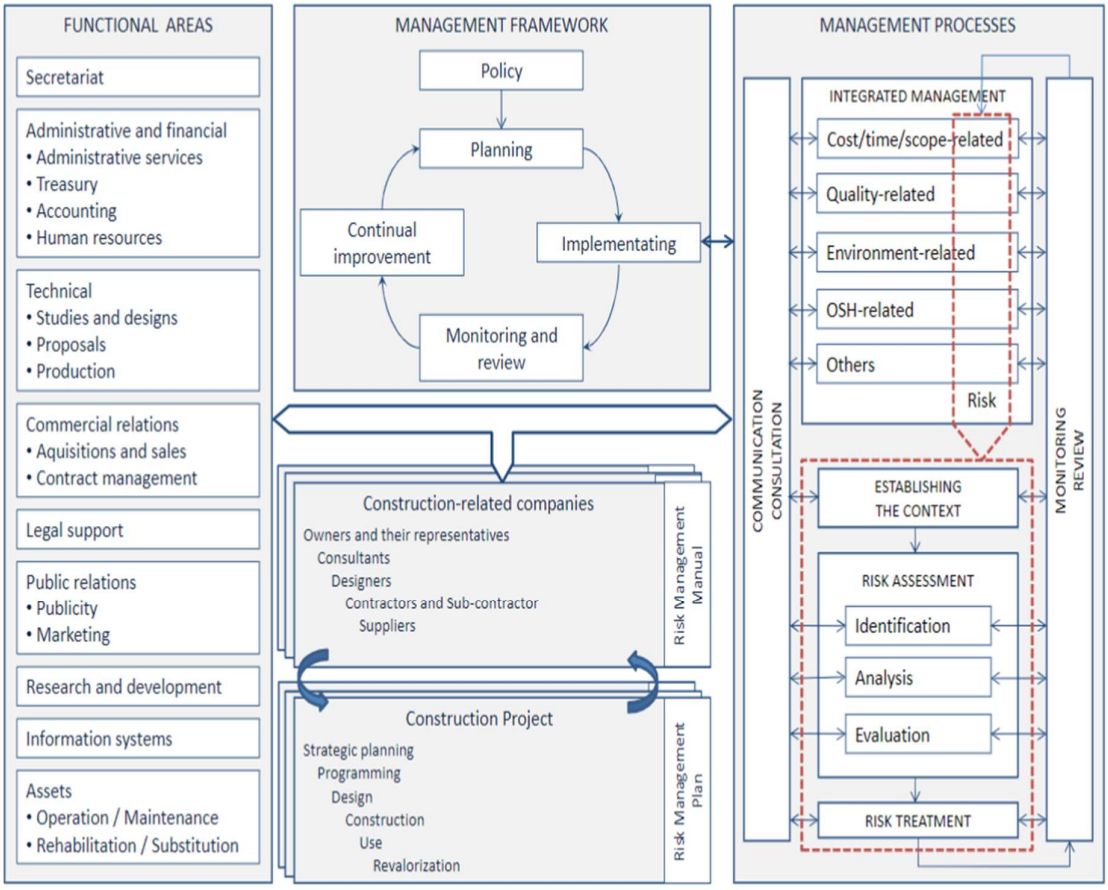

Figure 2.11: Integration of risk management into construction organisations (Sousa et al., 2012)

Referring to Sousa et al.'s (2012) broad framework, it has been pointed out that the risk management strategy should not only have an influence on the internal operations and procedures of construction businesses; it should also become a component of the construction projects associated with these enterprises. The main limitation of Sousa et al.'s (2012) study is that it only focused on the risk management framework. Little attention is given to using this framework because it requires considerable support to be implemented within the construction industry. In contrast to other industries, construction projects incorporate a variety of organisations with various core expertise and goals, e.g., real estate investors and engineering firms, interacting to differing degrees over various phases, including design, building, and operation. Sousa et al.'s (2012) research framework emphasises the importance of integrating risk management into construction project management plans, management manuals, and procedures.

Badri (2015) researched the challenges of integrating OHS into industrial project risk management in mining industries in Canada. The study identified four elements as the main challenge of integration, as depicted in Figure 2.11. The project management elements identified are:

- Project complexity because of scale duration, budget, the number of activities and the number of suppliers.
- Variety within the project due to diversification of team, experience, skills, management methods, and tools used.
- Interdependencies within the project due to team relationships and organisational environment and industrial or business context for example cooperation, competition, work environment, legal and regulatory framework, and culture.

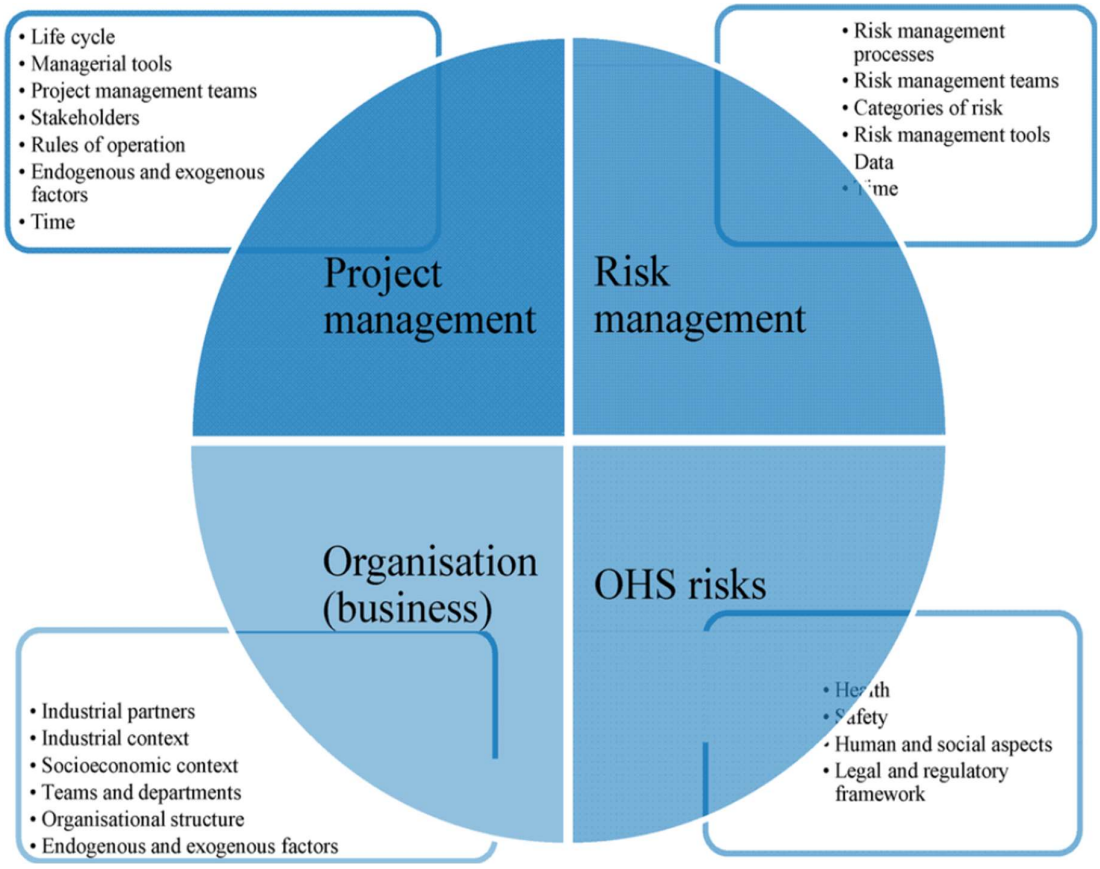

Figure 2.12: The four principal aspects of the OHS integration challenge (Badri, 2015)

The study further identified other constraints on risk management at construction sites, such as competition, reduction of project lifecycles, and restrictions on the availability of human resources and materials.

It can be argued that this present study might yield different results for the South African construction industry, which is a developing country compared to Canada. Furthermore, regarding OHS risks, Badri's (2015) study found that to analyse the OHS risks associated with an industrial project properly, all potential hazards must be taken into consideration. Their study emphasised the importance of understanding the objectives, type, and organisational structure, style, and structure. However, the main limitation of the conceptual model is that it was based on two mining firms in Canada, which is a developed country with the highest regulated mining industries in the world. Moreover, Mhetre et al. (2016) state that risk management is a method that should be used inside an industry to fulfil the sector's goals, and consequently, there must be an increase in knowledge and interest in the usage of risk management in the industry.

In their study, Mohammadfam et al. (2006) noted that many approaches can be used for OHS integration, such as the standard approach, systems approach, Total Quality Approach (TQA), and Plan Do Check Act (PDCA) approach. The choice of integration approach was dependent on the size and type of industry, the culture of the organisation, and availability of resources (Mohammadfam et al., 2006). Their study found that regardless of the approach used, the critical success factors for OHS integration were management commitment and leadership, resources management, stakeholder support, education, and training. Studies conducted by Górny (2019) found that risk assessment and management could be done using the PDCA method to effectively improve the management of an OHSMS, as shown in Table 2.5.

Table 2.5: Measures taken to improve the effectiveness of systemic management in the PDCA cycle (Górny, 2019)

Stages of the PDCA cycle associated with ISO 45001 requirements	Sample measures taken to improve the effectiveness of OHS management systems at various stages of the PDCA cycle
PLAN Intention	- Formulate policy and set safety goals, - Assess current safety level, - Define options to solutions for improving occupational safety, - Eliminate hazards and risks in areas covered by systemic requirements, - Identify improvement measures and processes essential for achieving desired outcomes.
DO Support and act	- Implement processes in accordance with the adopted action plan.
CHECK Verify	- Monitor and measure the results of actions, - Monitor and measure the results of processes adopted in keeping with policy tenets, - Report outcomes to help assess improvement opportunities.
ACT Correct, Improve	- Take action to continually improve the performance of occupational safety systems and that of the existing OHS management system.

2.9 Applying the PDCA cycle when implementing the OHSMS plan

There is no specific standard system for implementing an OHSMS, and the decision on the choice of system is dependent on the type of organisational needs (Ligade & Thalange, 2013). Companies must select an appropriate method to integrate their management systems based on factors such as size, industry, business culture, and resources available (Mohammadfam et al., 2006). Mohammadfam et al. (2006) identified various ways of integrating management systems, including the standard approach, systems approach, total quality approach, and PDCA approach.

Ligade and Thalange (2013) found that the system frequently used to continually monitor and implement the OHSMS in the construction industry is the PDCA. This system was popularised by W. Edwards Deming (Moen & Norman, 2010). The PDCA applies to all types of organisations and all groups and levels as it provides a framework for the application of enhancement techniques and allows project plans to adjust as learning happens (Moen & Norman, 2010).

According to Johnson (2016), the PDCA model is a continuous process improvement model that teaches organisations to plan an action, move towards it, check its conformity with the plan, and act on the lessons learned. The PDCA cycle is also known as the Shewhart cycle and the Deming cycle (Johnson, 2016). The PDCA concept was first discussed by Walter A. Shewhart in his 1939 book called Statistical Method from the Viewpoint of Quality Control. Deming was the one who created the name “Shewhart cycle” for PDCA, having named it after his mentor at Bell Laboratories in New York (Johnson, 2016).

Additionally, Deming referred to the PDCA cycle as the PDSA cycle (“S” for study) as a primary method to attain CPI.5. Deming is credited with encouraging the Japanese to adopt PDCA in the 1950s due to their eager embrace of PDCA and other quality concepts. As a gesture of gratitude, they refer to the PDCA cycle as the Deming cycle (Isniah et al., 2020).

Isniah et al. (2020) conducted a PDCA literature study to explain the link between theoretical and practical gaps in the use of the PDCA technique. Their study noted that PDCA in the manufacturing industry when applied reduced waste on waiting time, idle, failure, and defects. Isniah et al. (2020) concluded that the PDCA cycle produced numerous actions to correct corrective through, lasting actions by removing the main cause and interim measures to remedy problems. The PDCA could provide controlled problem-solving for a process through provision of added value (Isniah et al., 2020).

In addition, the PDCA can be efficient under these conditions:

- When continuous improvement and sustainable development methods are applied, improvements occur (Isniah et al., 2020).
- When a process is carried out continually, new solutions and improvements will be identified (Isniah et al., 2020).
- It is possible to explore new solutions to fix several issues and improve remedies while testing with control implementation (Isniah et al., 2020).

By using the PDCA procedures, Isniah et al. (2020) found that waste can be eliminated in workplaces by reducing things like lead and idle times, energy consumption, machine failure, losses, defects among others therefore increasing efficiency and quality improved. However, with the PDCA method commitment is deemed essential as the technique continuously implements a cycle. The study suggests that further research will be necessary to update the methodology used to see if its implementation was successful. OHSMS per PDCA aims to provide a management tool to lower the risk of OHS injuries and fatalities (Manuele, 2020). According to Górny (2019), the PDCA method is linked with risk assessment and the OHSMS. When applied to OHS, the PDCA translates into five key elements of successful OHSMS which are planning, organising, implementation, measuring, and reviewing performance.

2.9.1 Planning phase

According to Johnson (2016), the planning stage involves recognising an opportunity and planning the change. Ligade and Thalange (2013) add that it encompasses creating an OHS policy, allocating resources, providing skills, developing the organisation of the system, and identifying hazards and risks. Roberts (2015) further explains that this is when planning is done through the identification and prioritisation of problems, deficiencies, and opportunities for improvement. The process should also include the design of the process to deliver results per the targeted goals, identifying measurable criteria for utilising the goals, the data collection methods, and finally, the methodology and types of data to be collected should simplify the evaluation of the results (Roberts, 2014). During the planning process, it is essential to implement a framework for reviewing the relevant information to identify the issues relating to OHS performance (Roberts, 2014).

2.9.2 Doing phase

Ligade and Thalange (2013) explain that the doing phase refers to the actual implementation of the OHSMS. This aligns Johnson's (2016) explanation of the stage where the implementation and management of the OHS system are done. The doing phase also involves risk identification assessment and the hierarchy of risk controls as the first two effective components in an organisation's OHSMS (Roberts, 2015).

2.9.3 Check phase

The check stage involves reviewing the test, analysing the results, and identifying 'learn-things' (Johnson, 2016). The check involves measuring the active and responsive performance of the system (Ligade & Thalange, 2013).

2.9.4 Act phase

Ligade and Thalange (2013) explain this stage as the final step to close the cycle with an evaluation of the system through continual improvement and the preparing the system for the next cycle. Roberts (2015) further explains this stage where analysis is done to look for differences between the actual and projected results. It includes determining the main causes for the differences, identifying the changes required to improve performance, and developing corrective actions to effect the changes (Roberts, 2014).

Roberts (2014) conducted a study on the integration of OHSMS and risk-management principles into electrical safety. The study found that for a management system to be functional, it should have at least six key elements, namely: leadership, policy, plan, do, check, and act. It is expected that a complete cycle of PDCA steps will identify areas for improvement (Roberts, 2014). He further added that should that not happen, steps such as policy refining, refining the method of data collection, and attention to all stages of the process can be attained.

Roberts (2014) identified the benefits of using PDCA as:

- PDCA can be used to manage any risk category and it facilitates the integration of all risks on safety.
- The management of risk is integrated into the daily operations of an organisation, rather than as an independent task.
- A PDCA cycle can help an organisation reduce risks and maintain operational excellence.
- The regularity of a management system approach enables the sustainability of results.

From Roberts' (2014) study, the design of the framework for managing risk and risk integration into the OHSMS was done during the planning stage of the PDCA. Table 2.6 offers a comparison of the key OHSMS and risk assessment principles contained in the Standards as per Iso 31000-2009.

Table 2.6: Comparison of key OHSMS and risk assessment elements in the Standards (Roberts, 2015)

Elements	ANSI Z10-2012 OHSMS	NFPA 70E-2015 (pending)	ISO 31000-2009
Leadership	3.1.1 Top management directs the organization to establish, implement and maintain an OHSMS that integrates health & safety into the daily functions of the business	110.1 (A) Establish, implement and document an electrical safety program that is part of the employer's OHSMS, when one exists	4.0 Framework 4.2 Mandate and commitment
Policy	3.1.2 Establish, document and communicate an OHS policy that states: (1) The organization's commitment to maintaining an effective OHSMS (2) The principles the OHSMS is founded on	110.1(D) Identify the principles upon which the electrical safety program is based, including: (1) De-energizing if possible (2) Job planning (3) Maintenance (4) Auditing	4.3.2 Establish a risk management policy that clearly states the organization's objectives for, and commitment to, risk management
Plan	4.0 Identify and prioritize hazards and the associated risk, management system deficiencies and opportunities for improvement 4.1 Establish a process to gather information regarding the effectiveness of the OHSMS in achieving the stated objectives	110.1 (A) Establish, implement and document an electrical safety program that directs activity appropriate to the risk associated with electrical hazards	4.3 Design of framework for managing risk 5.0 Risk Management Process 5.3 Establishing the context
Do	5.0 Implementation and Operation 5.1.1 Risk Assessment 5.1.2 Hierarchy of Controls E5.1.2 "The hierarchy provides a systematic way to determine the most effective feasible method to reduce risk associated with a hazard to an acceptable level"	110.1(G) Establish a risk assessment procedure to: (1) Identify hazards; (2) Assess risks; (3) Implement risk control according to a hierarchy of methods (See hierarchy of controls in ANSI Z10) 110.1(H) Job briefing before starting each job to discuss hazards, procedures, energy source controls, etc. 110.2(D)(b)(4) Qualified workers must be able to: (1) Perform job safety planning; (2) Identify electrical hazards (3) Assess the associated risk; (4) Select appropriate risk control methods from the hierarchy of controls	5.4 Risk Assessment 5.4.2 Risk identification 5.4.3 Risk analysis 5.4.4 Risk evaluation 5.5 Risk treatment 5.5.1 Risk treatment options
Check	6.0 Evaluation and Corrective Action 6.1 Monitoring, Measurement, and Assessment (E6.1: Evaluate the performance of the management system by measuring its effectiveness in controlling and reducing risk)	110.1(I) Auditing of: (1) The electrical safety program (3 years) (2) Field work (annually)	5.5 Monitor & review 4.5 Monitoring and review of the framework
Act	7.0 Management Review	Audit results used to revise the program, training or procedures to ensure: (1) compliance with the Standard (2) the principles and procedures are followed	4.6 Continual improvement of the framework

2.10 COVID-19 and OHSMS on construction sites

2.10.1 COVID-19 in context

According to World Health Organisation, COVID-19 is an infectious disease caused by the SARS-CoV-2 virus (Sierra, 2022). COVID-19 is an abbreviation for Corona Virus disease. The agent causing the disease is called SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) (Sierra, 2022). While the virus typically causes mild to moderate respiratory

diseases, some people may develop more severe symptoms and need medical attention (Sierra, 2022). Infected individuals can transmit the virus by coughing, sneezing, speaking, or breathing microscopic liquid particles (Suharsono, 2022). Initially starting in Wuhan (China), the outbreak is now regarded as a major threat to human health (Sierra, 2022). According to the WHO, in addition to efforts to prevent and manage COVID-19 in workplace settings, steps should be taken to safeguard the physical and emotional well-being of employees as well as their safety (Sierra, 2022). Construction employees are at a higher risk of infection due to the COVID-19 pandemic (Amoah & Simpeh, 2021).

In a joint policy brief produced by the WHO and ILO in 2021, the evidence for COVID-19 transmission in the workplace is summarised, and recommendations for preventing and mitigating COVID-19 and protecting health and safety at work during a pandemic are given (Suharsono, 2022). The WHO and ILO recommend a wide range of preventative measures for COVID-19, such as remote work advice, limiting entry to key workers to prevent transmission, physical distancing, routine screening, isolation of infected persons, contact tracing and quarantining, regular worksite disinfection (especially of high touch surfaces), hand hygiene, environmental monitoring, and appropriate personal protection equipment (Sierra, 2022).

Apart from keeping COVID-19 out of workplaces, policies that prevent its spread may lead to other health and safety risks, such as prolonged use of PPE, the effects of remote work on the psychosocial and ergonomic profile of employees, lack of maintenance of systems during lockdowns, and chemical exposure from increased levels of disinfection (Suharsono, 2022). Outbreaks of COVID-19 have been identified in several different work environments, including the construction sector (Sierra, 2022). Several studies linked high customer density and prolonged visitation with an increase in cumulative COBID-19 diseases. To design recommendations for workplaces and national policies on how to prevent SARS-CoV-2 transmission at work, it is crucial to evaluate the effectiveness of workplace interventions (Suharsono, 2022).

In other research studies, the participation and consultation of workers' representatives on OHS issues are linked to a decrease in work-related injuries and accidents in the workplace (Sierra, 2022). The report also recommended that public health authorities and labour inspectorates oversee workplace health and safety measures to prevent the transmission of SARS-CoV-2.

2.10.2 Guidelines for OHS during COVID-19 as per ISO 45005 regulations

ISO (2020) published guidelines that can be used by organisations using ISO 45001 to integrate the COVID-19 guidelines into the OHSMS by relating the relevant clauses to the PDCA cycle through:

- planning measures to be taken by the organisation to work safely,
- do what the organisation has planned to do,
- checking if the system is working, and
- act by fixing problems and look for ways to ensure effective ways of conducting work in organisations.

The ISO (2020) guidelines further outline the planning and assessment of COVID-19 risks through:

- understanding the risks to employees and effects of these risks to other people such as visitors, customers, service users, and the public,
- assessing external issues such as local, regional, national, and international circumstances, and related legal requirements and guidance,
- assessing external issues such as the type of organisation and related activities,
- leadership and worker participation,
- assessment of physical workplaces,
- working in multiple locations or mobile workplaces,
- roles,
- site activities,
- emergency preparedness and response, and
- planning for changes to restrictions.

The ISO (2020) guidelines also outline the management of suspected or confirmed cases of COVID-19 through:

- managing illness in a physical workplace,
- testing, contact tracing, and quarantine, and
- psychological health and well-being.

ISO (2020) also added other issues to be incorporated into the OHSMS, which include inclusivity through employee participation, determination of resources required, proper communication channels, promotion of personal hygiene, use of personal protective equipment, masks and face coverings, general operations of the organisation, use of common areas, management review, incidents and reporting, monitoring and evaluation, and meetings and visits to the workplace.

2.10.3 Challenges of implementing COVID-19 regulations into the OHSMS

In their studies, Stiles et al. (2021) conducted informal observations and found that there was knowledge about Covid 19 risk management, but there was limited knowledge of how to implement it for medium-scale construction projects in the United Kingdom. The study suggested that COVID-19 regulations should be incorporated and advocated within a general risk management approach. They found that the challenging part of working under COVID-19 in construction organisations was the implementation and procedures of OHS. Stiles et al. (2021) note that sites have had to adapt to social distancing, implement new hygiene and PPE policies, and accommodate more working from home for roles not critical to the front line. In a sector with multiple hazards, all of this has been accomplished while maintaining conventional safety practices. Therefore, it is imperative that construction get back to work quickly, safely, and flexibly so that it can withstand future lockdowns, future waves, or even future pandemics (Stiles et al., 2021). It is evident that the construction industry requires careful balancing of safety hazards with the demands of production and delivery.

One of the trials associated with working under COVID-19 has been putting guidance into practice and understanding what is feasible when implementing processes such as cleaning (Stiles et al., 2021). While there is awareness of new standards, Stiles et al. (2021) found that it is not always evident how these should be included into the OHSMS. The study also noted that the understanding of what is required to cause infection is changing and that the application of these modifications is unprecedented, with no standards for sharing good practices. The limitation of the study was that it generalised the construction industry and the geographic location as it did not explain if the findings applied to any country.

Amoah and Simpeh (2021) conducted a similar study to investigate the precautions taken at building project sites to prevent the spread of COVID-19 among workers. The research findings revealed that most construction firms had implemented recommended and practical steps to prevent the spread of COVID-19 on-site. Many construction organisations developed new protocols and took additional steps to reduce the spread of COVID-19 in their workplaces (Amoah & Simpeh, 2021). However, a few companies did not comply with some of the recommended measures (Amoah & Simpeh, 2021). Furthermore, the study revealed that some construction organisations lacked basic provisions required to mitigate the spread of COVID-19. Study limitations included the inability to explain why some organisations failed to implement COVID-19 basics.

Simpeh et al. (2021) conducted a study to determine factors affecting the implementation of COVID-19 safety regulations at construction sites in Ghana as per legislature set out in the

ILO and ISO through open-ended questionnaires by using the purposive and snowball sampling method showed that six factors affected the implementation of COVID-19 regulations into the OHSMS. The barriers were as follows:

- The cost of implementing the COVID-19 regulation is high as it was an unplanned cost of a project. Before COVID-19, most construction companies lacked funds to implement an OHSMS and with coronavirus costs for aspects such as safety masks, regular testing of workers, sanitisers, and extra manpower to do the daily checks for covid symptoms had to be allocated (Simpeh et al., 2021).
- Lack of compliance was identified as another challenge in implementation as most workers refused to wear safety masks and keep social distancing and failed to report symptoms due to stigmatisation (Simpeh et al., 2021).
- Lack of knowledge was also identified as a barrier and superstition around COVID-19 as most respondents believed that COVID-19 did not exist (Simpeh et al., 2021).
- The study also revealed that pilferage of COVID-19 materials meant to help workers' safety was also a factor that affected implementation (Simpeh et al., 2021).
- The final barrier was the lack of PPE supply (Simpeh et al., 2021).

Simpeh et al. (2021) conducted a study on small construction companies, focusing on medium and large companies in the Western Cape, South Africa. It was recommended that further studies should be conducted to investigate why construction organisations fail to adhere to guidelines and how the challenges of COVID-19 affect project delivery and OHSMS implementation.

Amoah and Simpeh (2021) conducted a similar study to examine challenges faced by construction firms in terms of implementing COVID-19 safety measures on construction sites in South Africa. Data were obtained from 19 construction professionals by means of interviews. The researchers found that challenges such as the lack of knowledge about COVID-19, the lack of PPE, a lack of compliance, a lack of awareness of risk factors, and complexity in sharing tools and equipment affected the implementation of COVID-19 regulations into the OHSMS. The study proposed measures of transforming a safety culture by deducting wages of non-compliant workers. However, currently, South African labour laws do not allow a deduction of wages due to non-compliance.

2.10.4 Effects of COVID-19 on OHS in the construction industry

A study conducted by Ayat and Kang (2023) explored the impact and changes caused by COVID-19 on the construction industry and proposed mitigation strategies to minimise their effects. The study found that COVID-19 had negative impacts on the construction industry,

including interruption of the supply chain, unavailability of competent workers, materials, and equipment, and interruption of planning. Ayat and Kang (2023) also identified challenges in adhering to COVID-19 safety guidelines such as lack of funds due to high cost of implementation, difficulties in shared tools and equipment and shortage of quality PPE identified. Construction workers were particularly affected since the sector heavily relies on labour-intensive practices, making them more susceptible to risks on construction sites (Ayat & Kang, 2023). Government support, improved methods and processes, and strict compliance with safety protocols are needed to help the construction sector recover from this pandemic or adapt to the "new normal" (Ayat & Kang, 2023). The main limitation of Ayat and Kang's (2023) study was that the samples were based on data and evidence from developed countries and regions, which may be problematic for developing countries such as South Africa. Additionally, the study did not compare the situation between developing and developed countries.

Sierra (2022) conducted a similar research study on challenges incurred during the construction stage due to COVID-19 in the UK to create an evaluation framework. The study highlighted seven obstacles, namely on-site occupational health and safety, economic expenses, legal exposures, personnel availability, unstable supply chains and subcontractors, and uncertainty due to the pandemic's rapid and unexpected development. It was observed that the magnitude of each challenge varied depending on the size of the contractor, local regulations, and the sector in which the contractor operates. However, to meet project deadlines, a large on-site workforce is required during construction (Sierra, 2022). Thus, COVID-19 has significantly impacted contractor's ability to work on-site (Gümüşburun Ayalp & Çivici, 2022).

2.11 Chapter summary

The literature review was summarised in Appendix D. This enabled the identification of gaps in different journals, the types of research methodology used for each journal, type of study conducted, response rates etc. This information was important as it provided a benchmark when comparing the results of this study with previous studies.

Based on the reviewed literature, it is evident that safety remains a serious issue in the construction industry. As the construction industry has grown rapidly in developing and underdeveloped countries in recent years, occupational accidents and fatalities have increased (Khodabandeh et al., 2016). However, challenges are encountered when formulating an OHSMS in organisations (Rahmi & Ramdhan, 2021). Internal and external factors were identified. However, some of the studies conducted only listed global factors with

no specific industry. While Rami and Ramdhan (2021) and da Silva and Amaral (2019) listed internal factors, their study lacked comparison groups, lacked consideration or control of confounding factors (through design or statistical adjustments), and was generalised with no reference to a particular industry. Additionally, da Silva and Amaral (2019) failed to explain to key individuals directly involved in OHSMS implementation and management.

Additionally, da Silva and Amaral's (2019) study did not indicate how data can be incorporated and communicated to proactively assess and manage existing risks. Khalid et al. (2021) designed a framework on factors affecting OHSMS implementation, but the research was purely exploratory, based on a literature review, and the framework had not been tested in any industry. Similarly, Kajiki et al. (2020) conducted a similar study to develop a global OHSMS model for Japanese companies, the main weakness being it only focused on developed countries, and the research was based on one company located in nine different developed countries. Also, the industry was manufacturing which differs from construction. Therefore, it is crucial to identify and assess the factors affecting the South African construction industry when implementing an OHSMS.

Based on the literature reviewed, it is noted that non-compliance with regulations remains a challenge. However, Salguero-Caparrós et al. (2020) endeavoured to explain the difficulties that industries face when attempting to comply with regulations, their study failed to explain the effects of non-compliance with regulations on organisations. Salguero-Caparrós et al.'s (2020) study further requested that research be conducted on how organisations can have access to tools and methodologies that provide knowledge regarding OHS standards, and their applicability. One limitation of this study was that it did not specify if the study included the construction industry. In a related study, Umeokafor et al. (2014) discovered that the informal sector's activities were a significant factor in the socio-cultural, institutional/legal, organisational, socio-economic, and industrial issues that posed the greatest challenges to the Nigerian construction industry's compliance with OHS regulations. Umeokafor et al.'s (2014) research focused on the Nigerian construction industry which may differ from South African industries. Although Windapo (2013) researched the South African construction industry to establish reasons for non-compliance, the study found no connection between compliance with standards and the perceived levels of risk that may result from non-compliance with OSHA requirements. It would be important to further expand on this finding, especially considering the effect of COVID-19 non-compliance and risks.

According to Lavanya and Malarvizhi (2008), the core principles of risk management can be the same but may differ depending on the organisation. For risk management to be efficient,

effective, and simple, it should be incorporated into management practices and systems that are already familiar to construction organisations (Sousa et al., 2012). There are challenges encountered when integrating OHS into project risk management (Badri, 2015). Although Badri (2015) found that Canadian construction organisations faced challenges regarding risk management issues such as competition, the shortening of industrial project lifecycles, and restrictions on the availability of human resources and materials, the study may have different outcomes for South African construction companies. Canada has one of the most developed and regulated industrial mining sectors globally, compared to developing countries such as South Africa. Mohammadfam et al. (2006) found various ways of integrating management systems, including the standard approach, systems approach, TQA approach and PDCA approach. Whilst several methods can be used as a basis for OHSMS integration, PDCA remains the most common method (Mohammadfam et al., 2006). Although Roberts (2014) conducted a study on the integration of OHSMS and risk-management principles into electrical safety, it will be worthwhile to explore how this can be implemented in the South African construction industry.

The agile environment where the construction industry operates must adapt to constant changes that may result in new risks. COVID-19 posed a major challenge to the industry. Based on informal observations, Stiles et al. (2021) found that there does exist knowledge about COVID-19 risk management, but there is little knowledge about how to implement it for medium-scale construction projects in the United Kingdom. Stiles et al. (2021) concluded that the understanding of what causes infection is evolving, but the application of these mitigations is unprecedented and there are no standards for sharing good practices. Additionally, the challenges associated with working under COVID-19 have been putting guidance into practice and knowing what is practicable when implementing procedures (Simpeh & Amoah, 2021). However, the study was generalised, and the geographic location did not explain whether the findings applied to any specific country. Sierra (2022) conducted a similar study and found that the magnitude of each challenge varied depending on the size of the contractor, local regulations, and the sector in which the contractor operates. It can be beneficial to further explore the challenges as well as their effect on operations and the measures that can be put in place to increase safety on construction sites.

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

In this chapter, the research design and methodology are presented. A mixed method approach, comprising both qualitative and quantitative approaches, was adopted. The following items are discussed: research approach and rationalisation, research methodology, research strategy, questionnaire design, sources of data, population and sampling, data analysis, and a summary of the chapter.

3.2 Research approach and rationalisation

3.2.1 Inductive approach

According to Burney and Saleem (2008), inductive reasoning aims to develop a theory when there is little to no-existing literature on a topic. They further explain that the inductive approach comprises three stages, which are observation, observing a pattern, and developing a theory or general (preliminary) conclusion.

Elo and Kyngäs (2008) explain that an inductive technique enables flexible data gathering, allowing for the introduction of new questions as well as the modification of existing ones as the researcher grows accustomed to the study's setting. The drawback of this strategy is that conclusions reached through an inductive approach can never be proven, but they can be disproven (McCaig & Dahlberg, 2010).

3.2.2 Deductive approach

According to Armat et al. (2018), deductive reasoning tries to test an existing theory, making it impossible to undertake deductive research in the absence of a theory. The deductive research approach consists of four stages, including creating a problem statement based on existing theory, formulating a falsifiable hypothesis based on existing theory, collecting data to test the hypothesis, analysing data, and finally deciding whether to reject the null hypothesis (Elo & Kyngäs, 2008). Inductive reasoning can only be accurate if all the conditions set in the inductive study are met and the terms are clearly defined (McCaig & Dahlberg, 2010).

Figure 3.1 shows the difference between the deductive and inductive approach.

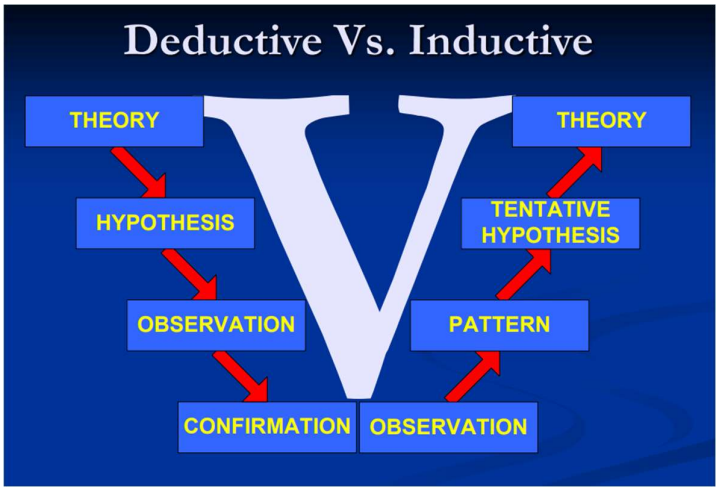

Figure 3. 1: Distinction between deductive and inductive approaches (Burney & Saleem, 2008)

3.2.3 Mixed method approach

The mixed method approach is a scientific collection of data with an inductive and deductive theoretical drive and comprises qualitative and/or quantitative core and supplementary components (Morse, 2016). In this study, a mixed method approach was adopted as this method helps resolve contradictions between qualitative and quantitative results (Morse, 201.There are many different types of mixed methods research designs that researchers can use, depending on the research question, the available data, and the resources available (Creswell & Plano Clark, 2018). The most common types are:

Sequential Explanatory Design: In this design, the researcher collects and analyses quantitative data first, and then uses qualitative data to explain or elaborate on the quantitative findings. (Creswell & Plano Clark, 2018).

Sequential Exploratory Design: This design involves collecting qualitative data first, analysing it, and then collecting and analysing quantitative data to confirm or refute the qualitative findings (Schoonenboom & Johnson, 2017).

Convergent Parallel Design: "The intent of integration in a convergent design is to develop results and interpretations that expand understanding, are comprehensive and are validated and confirmed" (Creswell & Plano Clark, 2018, p. 221)

3.2.4 Quantitative method approach

Quantitative research enables researchers to identify issues that may be overlooked in qualitative analysis or in circumstances where a qualitative survey might be difficult to conduct (Rao & Woolcock, 2003).The advantages of this method are that it is easily verifiable, data is

collected anonymously, data can easily be duplicated (Hughes (2012). The current research used the quantitative method.

3.2.5 Justification of the approach used

The quantitative method approach was chosen because the processes don't need direct observation which saves time (Henn et al., 2005).The quantitative method was used to collect data from construction-related professionals such as site managers, and safety officers, among others, to gain insight into the factors that affect OHSMS implementation in order of importance, the effect of COVID-19 on the OHSMS, and the integration of a risk management plan into the OHSMS.

3.3 Research methodology and design

Research methodology is the utilisation of various methods that can be used to conduct, describe, and predict a phenomenon, and explain research in the form of tests, experiments, and surveys to systematically solve the research problem (Goundar, 2012). The research design is the approach the researcher selects to combine the many components of the study logically and coherently, thereby ensuring the successful addressing of research questions (Goundar, 2012). According to Morse (2016), research design defines the overall framework for the research study. Many variables, including the phenomenon being examined, the study respondents, the survey setting, and the researcher's survey expertise, must be taken into consideration when developing or choosing an appropriate research design for a study (Morse, 2016). This study adopted the quantitative method research.

3.3.1 Quantitative research

Quantitative research has disadvantages in that it tends to concentrate on numbers at the expense of the bigger picture and are difficult to set up. Ramona (2011) indicates that errors in the setup, bias on the part of the researcher, or errors in execution might lead to results being invalidated. Hughes (2012) notes that quantitative research offer the advantages of accuracy, control through sampling and design, and the ability to derive causal relationships through controlled experiments and statistical techniques that can be replicated. By incorporating quantitative research with a set of identifying conditions, generalisations can be made for large populations (Rao & Woolcock, 2003). Furthermore, quantitative research can help establish the causality of events that impact project results, and (in principle) they enable other researchers to corroborate the original results by repeating the analysis independently (Rao & Woolcock, 2003).In this study, quantitative research was adopted, using questionnaires containing both open and close ended structured questions that were used to obtain the data. Data were obtained through survey questionnaires by looking into research

questions such as methods used to implement the OHSMS, risk perceptions, and effects of COVID-19, among others.

3.3.2 Qualitative research

Qualitative research uses distinctive techniques and philosophies to collect data (Hughes, 2012). Data are collected through observations, interviews, life stories, and historical studies (Rao & Woolcock, 2003). The downside is that some researchers dismiss qualitative findings as anecdotal information due to interpreted conclusions and the lack of scientific control over numerical data (Hughes, 2012). Qualitative research enables the researcher to further investigate the internalisation of safety values, employee involvement through roles, accountabilities, and communication about safety issues (Hughes, 2012). The strengths and weaknesses of both qualitative and quantitative research result in obtaining the best answers to research questions (McCaig & Dahlberg, 2010).

Table 3.1 shows the distinct differences between the qualitative and quantitative research.

Table 3. 1: The differences between quantitative and qualitative research (Surbhi, 2018)

Basis for comparison	Qualitative Data	Quantitative data
Nature	Holistic	Particularistic
Approach	Subjective	Objective
Research type	Exploratory	Conclusive
Reasoning	Inductive	Deductive
Data	Verbal	Measurable
Inquiry	Process-oriented	Result oriented
Hypothesis	Generated	Tested
Elements of analysis	Words, pictures, and objects	Numerical data
Objective	To explore and discover ideas used in the ongoing processes	To examine cause and effect relationships between variables
Methods	Non-structured techniques such as In-depth interviews, group discussions, etc.	Structured techniques such as surveys, questionnaires, and observations
Result	Develops initial understanding	Recommends final course of action

3.4 Research strategies

3.4.1 Survey research

Survey research is defined as the process of gathering data through questionnaires from a variety of individuals, eliciting their characteristics, attitudes, lifestyles, or opinions (Visser et al., 2000). The purpose of surveys is not merely to describe populations, but also to test some

conclusions (Visser et al., 2000). The survey method can be used for descriptive, exploratory, or explanatory research through open-ended and/or closed questions (Reja et al., 2003). In this study, survey research was conducted using open-ended and closed questions.

3.4.1.1 Open-ended questions

According to Reja et al. (2003), open-ended questions require more explanation than a simple *yes* or *no* answer. With open-ended questions, the respondents can provide open-ended answers based on their complete knowledge, feeling, and understanding, without being limited to a set of options (Reja et al., 2003). For example, the open-ended questions were used to collect in-depth information, for example, information on the type of methods used for OHSMS implementation and additional ways to integrate risk management plans into the OHSMS.

3.4.1.2 Closed question

According to Reja et al. (2003), only one option can be used to answer a question, such as multiple-choice questions with a single-word response, *yes* or *no*, or a rating scale. In a normal scenario, closed questions are used to gather quantitative data from participants (Reja et al., 2003). Respondents cannot select unique or unexpected answers for each question type, rather, they are required to choose from pre-selected options (Reja et al., 2003). Closed questions were used in this research to gather quantitative data. This enabled questions such as the list of internal and external factors affecting OHSMS implementation by ensuring that data were measurable and comparable, and it was easier for the respondents to get guidelines on how to provide responses applicable to their organisations.

3.4.2 Interviews

Interviews are a qualitative research method that entails “doing in-depth individual interviews with a limited number of respondents to examine their viewpoints on a certain idea” (Boyce & Neale, 2006:3). One advantage of interviews is the ability to get comprehensive data on research questions (Boyce & Neale, 2006:4). In addition, this method allows researchers complete control over the process flow, as well as the opportunity to address any issues that may arise (Boyce & Neale, 2006:4). The downsides are the need for extra time and the difficulty in organising interviews with participants in the intended sample group at a favourable time (Boyce & Neale, 2006:4).

3.4.3 Experimental designs

Experimental research aims to determine the impact of a specific treatment on an outcome (Bryman, 2016:39). The researcher evaluates this by administering a specific treatment to one group while withholding it from another, and then comparing the outcomes of both groups (Bryman, 2016:40). An experiment can either be a real experiment where individuals are

assigned to treatment conditions at random or a quasi-experiment where the treatment conditions are not randomised. In experimental research, two sets of variables are used to measure the variances of the second set, with the first variable serving as a constant.

3.4.4 Case study

According to Yin (2014), a case study is an empirical research method that explores a current phenomenon in its actual setting, particularly when the distinction between phenomenon and context is unclear. The advantages of case study include the ability to investigate things that are hard to replicate in a lab, the ability to collect a lot of data, the possibility of gathering information on rare or unusual cases, and the ability to formulate hypotheses that can be tested experimentally (Yin, 2014). However, case studies have many disadvantages, including the fact that they cannot be generalised to the greater population, cannot demonstrate cause and effect, and may not be scientifically rigorous (Yin, 2014).

3.5 Questionnaire design

This research questionnaire was created following the study objectives and data from the questions of the reviewed literature. The questionnaire consisted of five sections, with each section addressing an objective. Table 3.2 illustrates the sections and research objectives.

Table 3. 2: Questionnaire design

Section	Section Title	Objective
A	Biographical information	
B	Factors that affect the implementation of the Occupational Health and Safety Management System (OHSMS) on construction sites.	1
C	How risk management is integrated into Occupational Health and Safety Management System (OHSMS) during implementation	2
D	How the PDCA method is used in implementing the Occupational Health and Safety Management System (OHSMS)	3
E	The extent to which COVID-19 regulations have affected OHSMS implementation	4

Section A of the questionnaire consists of the biographical detail of each participant.

Section B of the questionnaire consists of internal and external factors that affect OHSMS implementation in order of least to most important. In addition, the sub-section aims to answer how each factor affects implementation.

Section C of the questionnaire entails how risk management is integrated into the OHSMS. It consists of four (4) parts comprising methods of risk identification, strategies used for risk

planning, risk assessment, and risk perception and awareness within the participant s organisation.

Section D aim to ascertain if the respondents' organisation uses the PDCA method when implementing an OHSMS and how it has improved their OHSMS.

Section E seeks to answer if the participant's organisation is aware of COVID-19 regulations and how these regulations have affected their organisation.

3.6 Sources of data

McKim (2017) describes data collection practices as evaluating various sources of information for a research study. Marshall and Rossman (2014:111) state that the two fundamental types of data collection in a research project are primary and secondary data. In this study, different types of data were considered, whilst at the same time, sources of data were determined that best attain the approach's purpose. The study's findings include a framework that resulted from the secondary and primary data. The data compiled from surveys were then statistically interpreted to draw relevant research conclusions. There are several methods used to conduct survey such as:

- **Online/ Email:** This is a popular survey method that involves an online survey with minimal costs and the responses gathered are highly accurate.
- **Phone:** This survey is conducted telephonically and is both costly and time-consuming.
- **Face-to-face:** When a challenging topic needs to be handled, the survey is conducted face-to-face and in-depth with participants, which results in the highest response rate however it is the most expensive method.

The present study used the online survey method to distribute the questionnaire as it was faster and less costly compared to other survey methods.

3.6.1 Primary data

According to Rabianski (2003), primary data are facts that are compiled exclusively for the study at hand. Online questionnaires were administered to specifically selected survey respondents to collect primary data for this study. The questionnaires were administered to respondents electronically via Microsoft forms.

3.6.2 Secondary data

A secondary data set is made up of facts and information that is gathered for a purpose other than that of the immediate study (Rabianski, 2003). As sources of information, textbooks,

journals, articles, conference proceedings, and this research's own data were used for the literature review.

3.7 Population and sampling method

According to Barreiro and Albandoz (2001), the population size can defines the number of individuals living in a particular geographic location. The sample size is the number of participants or observations included in a research study (Sharma, 2017). According to Barreiro and Albandoz (2001), for a sample to be determined, the sampling method to be used, sample size, the reliability degree of the conclusions that can be obtained, and estimation of the error (in terms of probability) need to be clearly defined. Since the construction industry is vast, respondents were selected from construction companies in the Western Cape with specific respondents targeted who implement OHSMSs and manage it daily. The sample size consisted of respondents holding construction supervisory positions. Positions consisted of project managers, contracts managers, site foremen, site agents, health and safety officers, and site agents.

3.7.1 Sampling methods

According to Sharma (2017), sampling is the method of analytically selecting a moderately small number of symbolic items or individuals from a pre-specified population to serve as a data source for analysis or experimentation. Sapsford (2007) describes sampling as a method to select and analyse a subset of members of a population from which you can infer characteristics of the entire population. In research, sampling consists of two types of probability sampling and non-probability sampling (Etikan & Bala, 2017).

Non-probability sampling: In this method, the sample is not fixed or predefined, and the researcher selects members based on convenience or other criteria, making data collection easier (Etikan & Bala, 2017). Consequently, it is difficult to include all elements of a population in the sample equally. Research studies conducted with non-probability sampling derive their hypothesis after completing the study and the sampling is entirely biased, thus the results are biased too, making the research speculative (Acharya et al., 2013).

Probability sampling is a method for selecting members of a population by selecting a few criteria and randomly choosing them from each of the groups (Etikan & Bala, 2017). The random selection allows the researcher to make strong statistical inferences about the whole group and resulting in unbiased and conclusive results. In probability sampling, there is a primary hypothesis before the research commences and the objective is to prove the hypothesis (Acharya et al., 2013). The study used the probability sampling technique as there

was an assumption that there are both internal and external factors that affect OHSMS implementation.

3.7.2 Types of probability sampling

Simple random sampling: Gagnon (1986) define this technique as a reliable method for obtaining information where all members of a population are chosen as random subjects by chance, saving time and resources. Simple random sampling allows for the calculation of sampling error and minimises bias in the sample (Westfall, 2009). The advantage of random sampling is that it is an easy and direct method of probability sampling. However, this method of sampling could result in not choosing enough people who have your desired attribute, especially if it is a rare one (Gagnon, 1986). Since most sample units would be dispersed throughout a large geographic area, it might also be challenging to establish an exhaustive sampling frame.

Cluster sampling: According to Westfall (2009)**,** this method involves dividing the entire population into groups or clusters, which are usually in geographic areas or districts such as villages, schools, or blocks. Cluster sampling can provide us with a lot of information, but unless the clusters are randomly selected and a large number are sampled, generalisations cannot be made about the entire population (Acharya et al., 2013). While cluster sampling can be more effective when a study spans a large geographic area than simple random sampling, bias could occur if the clusters selected are not representative of the population, which can lead to increased sampling errors (Bhardwaj, 2019).

Systematic sampling: As stated in Bhardwaj (2019), this is a more sophisticated version of simple random sampling, requiring periodic checks of all the available data on the population's sample members. This sampling method has a predefined range, it is the least time-consuming type of sampling, and individuals are selected periodically from the sampling frame, with the intervals decided to ensure a sufficient sample size. When compared to pure random sampling, systematic sampling is frequently more practical and simpler to administer. However, the sampling technique could be biased if there are underlying patterns in the order of the individuals in the sample frame, especially if it coincides with the periodicity of the underlying patterns (Acharya et al., 2013).

Stratified sampling method: Stratification involves splitting the population into subsets (or strata), all of which share a similar characteristic, and is used when the measurement of interest is likely to vary between the subgroups, and we wish to ensure that all subgroups are represented. (Gagnon,1986). It is applied when we believe that the measurements of interest will differ between the subgroups, and we want to ensure that we have a presentation from all

the subgroups (Taherdoost, 2016). Stratified sampling increases the accuracy and representativeness of results by minimising sampling bias (Etikan & Bala, 2017). In this study, the stratified random sampling method was used. Stratified random samples minimise the potential for human influence in choosing cases for inclusion in the study and provide us with a sample that is well-represented in the population being examined (Sharma, 2017). The respondents consisted of people in supervisory positions both male and female, who possessed adequate experience or qualifications in the construction industry. As most of the literature indicated that the research objectives were carried out in different trades and sectors, such as mining, agricultural, etc, the current research considered the construction industry as a strata that could be used to compare data from other industries as provided in journals where similar research was conducted.

3.8 Data analysis of the study

Data analysis is the systematic use of logical and statistical methods to define, present, and assess data (Savenye et al., 2004). Data is everything in today's fast global market, and individuals are increasingly motivated to use computer software for any type of data analysis (Rahman & Muktadir, 2021). The retained questionnaires of the study were analysed using the social science statistics program (SPSS) version 27.0.

3.8.1 Analysis through Statistical Package for the Social Sciences (SPSS)

Data analysis is a statistical approach for analysing numerical data obtained from surveys, polls, and other forms of online or offline research, as well as by considering existing statistical data more mathematically with the aid of computational algorithms (Rahman & Muktadir, 2021). Quantitative analysis is performed to establish the relationship between an independent variable and a dependent variable (Milovanović & Perišić, 2020). The (SPSS) is a data analysis software that was initially developed by Nie and co-workers in 1968 and the software programme was later acquired by IBM in 2009 and is now called IBM SPSS (Rahman & Muktadir, 2021).

3.8.1.1 Advantages of SPSS

- SPSS has the advantage of dealing with a large set of data and multiple variables, making data analysis quick and easy since there is no programming involved (Milovanović & Perišić, 2020).
- In addition to being compatible with Windows, macOS, and LINUX, SPSS allows you to create variables from existing information (Rahman & Muktadir, 2021).
- The entire analytical process, including data management, preparation, analysis, and reporting, is covered by SPSS. In addition to automating the detection of anomalies,

the programme provides statistical transformations to deal with outliers when they arise (IBM, 2022). Additionally, it is appropriate for projects of all ranges and levels of complexity and improves efficiency and minimises risk (Rahman & Muktadir, 2021). Along with text analysis, open-source extensibility, data integration, and advanced statistical analysis, it also offers a sizable library of machine learning methods (IBM, 2022).

3.8.1.2 Disadvantages of SPSS

- A major disadvantage of the programme is its commercial license, which can be very expensive for students (Milovanović & Perišić, 2020).

3.8.2 Descriptive statistics

Using concise descriptions of the sample and the measurements, descriptive statistics are used to describe the primary characteristics of the data in a study (Trochim & Donnelly, 2001). In conjunction with simple graphics analysis, they form the foundation for virtually all quantitative data analysis (Kemp et al., 2018). This research used SPSS for the descriptive statistics. A descriptive analysis describes the nature and extent of sensory characteristics in an objective way (Kemp et al., 2018). The standard deviation (SD) provides a more comprehensive picture than the mean alone can by indicating how near the data values are to the mean value (Rodrigues et al., 2017). Due to its ability to incorporate scores from all the subjects in the study, the mean is an important measure. Descriptive statistics were used to describe data, making it easy to understand and interpret the data.

3.8.3 Content analysis

Sireci (2007) defines content analysis as the process of constructing systematic, credible, and valid inferences from texts. Researchers can use content analysis to quantify and examine the meanings, and connections of particular words, topics (Sireci, 2007). The advantages of content analysis include discreet data collection, transparency and replicable, and high flexibility as content analysis can be conducted at any time, in any location, and cheaper (Stemler, 2000). This research provides an outline of the content in the recorded data obtained from the respondents, omitting insignificant data in the process of reporting.

3.8.4 Validity of the data and research

A validation test will also be used to analyse quantitative data obtained from each questionnaire and ensure its accuracy. Sireci (2007) defines a validation test as a test used for a particular purpose and a method that measures what it is intended to measure accurately. The validity of the research was done through the following actions:

- Choosing the appropriate sample method to ensure adequate representation of the target group
- Ensuring that questionnaires were distributed to experienced construction personnel
- Ensuring that data were collected timeously
- Choosing the best data collection method in this case online questionnaire
- Testing for the reliability of data

3.8.4.1 Construct validity

Construct validity concerns how well a set of indicators represent or reflect a concept that is not directly measurable (Cronbach and Meehl, 1955). Assessing construct validity is especially important when you are researching something that cannot be measured or observed directly, such as intelligence, self-confidence, or happiness (Borsboom et al., 2009. However, construct validity was not used in this research as most of the research objectives and questions were measurable. Furthermore, the literature on the research objective supported the objectives that were proposed.

3.8.5 Reliability of the data

The Cronbach alpha coefficient is used to measure how closely related groups of items are, as well as scale reliability, or the coefficient of consistency. (Tavakol & Dennick, 2011). Arguably, a survey design should show accuracy so that if someone else uses the same measuring tools they would obtain similar results. Reliability is the degree to which repeated measurements produce consistent results within a comparatively brief period during which change would not be anticipated (Sapsford, 2007). The Cronbach alpha coefficient can be used to measure how closely related groups of items are, as well as scale reliability, or the coefficient of consistency (Tavakol & Dennick, 2011). Generally, a Cronbach alpha coefficient is to 1, the more reliable the survey instrument is, with the best value being 1 (Cronbach,1951:297–334). To evaluate the reliability, quality, accuracy and consistent of the research questions, the study used the Cronbach alpha test.

3.8.6 Confidence Interval (CI)

A confidence interval for the mean is a way of estimating the true mean of the population and the percentage of values that contain it is given as a percentage (Cocks & Torgerson, 2013). Additionally, the authors state that the 95% confidence interval (CI) is the most reported CI, which is a range derived from an unknown sample with an upper and lower number. According to Poole (1987), the CI represents the mean of your estimate plus and minus the variation in that estimate, the range of values that one expects their estimate to fall between if they redo the test, within a certain level of confidence This research used confidence intervals to

measure true mean of the population sample variable. As it is cumbersome to study every individual in a population, this study's selected a sample size. CI was therefore used to measure how well this sample represented the population in the study.

3.8.7 Multiple regression

Multiple regression refers to the analysis of the relationship between multiple independent variables and a single dependent variable, as defined by Ngo and la Puente (2012). According to them, multiple regression analysis is used to predict one dependent value using the independent variables with known values and that allows the investigator to account for all these potentially important factors in one model. The method offers the benefit of a more precise interpretation of the association between each factor and the outcome. In contrast to linear regression, which only allows one dependent and one independent variable, it prevents our reliance on a single variable (Ngo & La Puente, 2012). A multi-regression analysis was performed on the variables to identify the variables from a much larger set of predictors, thereby reducing the number of variables and removing unnecessary predictors, simplifying data, and increasing predictive accuracy. Furthermore, multivariate regression was conducted to test the relationship of OHSMS implementation with PDCA, the risk management plan and COVID-19 regulations.

3.9 Chapter summary

The research methodology used in this study was outlined in this chapter. The study objectives were achieved using a mixed method research approach that involved both quantitative and qualitative methods. The questionnaire was structured to obtain opinions from construction professionals, such as safety officers, project managers, etc. regarding OHSMS implementation in Western Cape. A literature review and questionnaires were used to collect the primary and secondary data for this research. The questionnaires were distributed online, and to ensure validity, content analysis was used to examine the qualitative data collected and verify precision for respondent validation. The reliability of results was assessed using the Cronbach alpha coefficient test. The quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) software. The quantitative and qualitative analytical results will be presented and discussed in the next chapter.

CHAPTER 4: DATA COLLECTION, DATA ANALYSIS AND FINDINGS

4.1 Introduction

In this chapter, the study findings are presented. The data were analysed using SPSS version 27, at a 95% confidence Interval, and interpreted at a 5% significance level for the inferential statistics. The frequency tables for all variables, by section, followed by descriptive statistics in the form of means and standard deviations, are presented. Following this, inferential statistics are presented in the form of multivariate regression to test which external and internal factors are predictors in OHSMS implementation in the construction industry.

4.2 Questionnaire survey

Quantitative and qualitative data were collected using an online questionnaire survey. A total of 114 questionnaires were distributed to construction professionals in the Western Cape Province of South Africa, including project managers, site managers, safety officers, and quantity surveyors. As part of the procedure, an electronic Microsoft online form was used to circulate the questionnaires to the respondents. Of the 114 questionnaires sent out, 50 were returned and could be compiled and analysed which is a response rate of 44%.

4.3 Section A: Biographical information of respondents

4.3.1 Type of organisation of respondents

Figure 4.1 indicates the type of organisation represented.

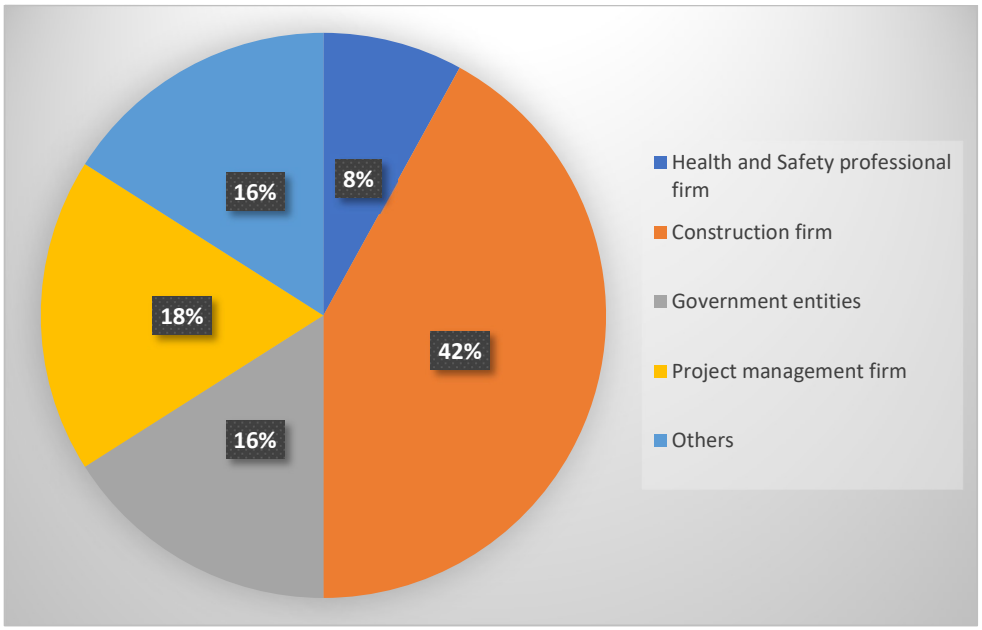

Figure 4. 1: Type of organisation

The 16% of others constitute respondents from energy utilities, insurance companies, nongovernmental, and municipality organisations.

4.3.2 Gender of respondents

The analysed data in Figure 4.2 indicate that there were more male respondents in this sample as compared to females.

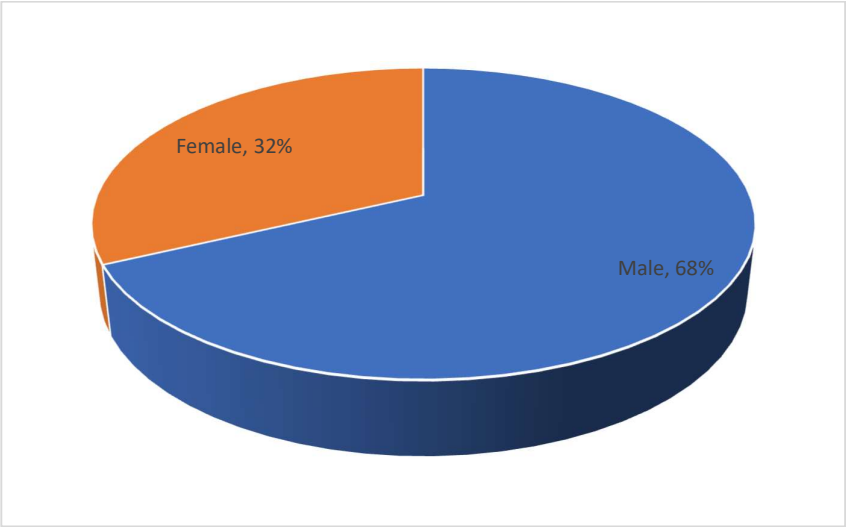

Figure 4. 2: Gender of respondents

4.3.3 Age group of respondents

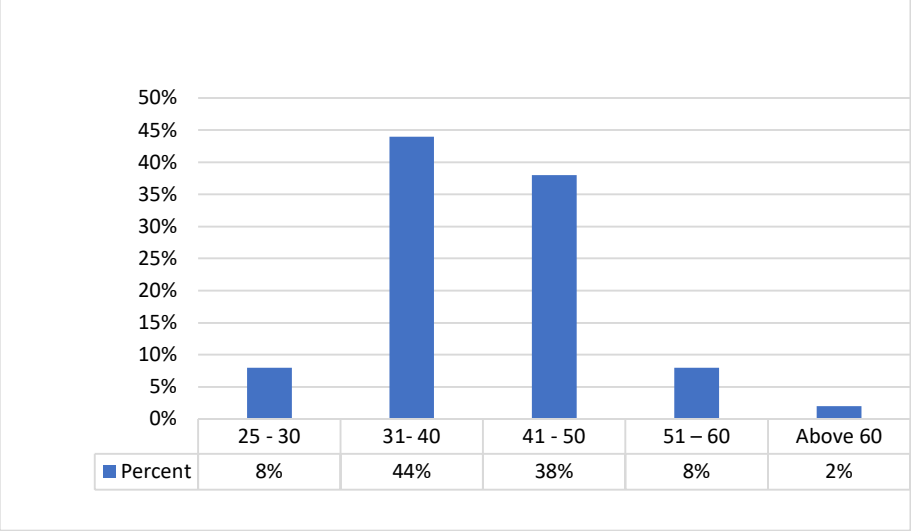

Figure 4. 3: Age groups

The results in Figure 4.3 shows that 44% of the respondents were aged 31–40 years, and 8% were aged 25–30 years. Furthermore, the results indicate that 38% of the respondents were aged between 41–50 years, 8% were aged 51–60 years, and only 2% were aged above 60 years.

4.3.4 Level of qualification of respondents

Figure 4.4 indicates that half of the respondents had a bachelor or honours degree (50%), a fifth (22%) had master's degrees, and fewer had a diploma (18%). Very few respondents had matric (6%) or tradesman certificates (4%) in this sample.

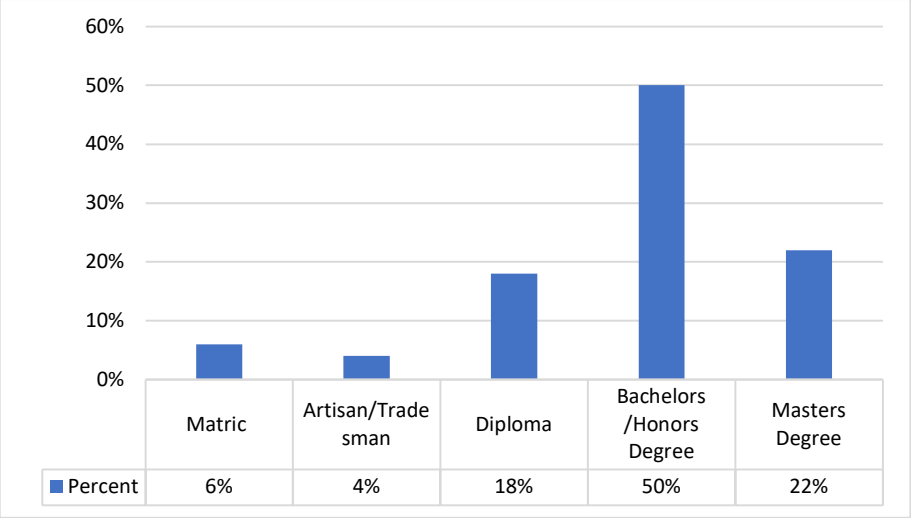

Figure 4. 4: Respondents' level of qualifications

4.3.5 Profession of respondents

Table 4. 1: Respondents' profession

Respondents' profession	Frequency	Percent
Construction Project Manager	13	26%
Quantity Surveyor	11	22%
Other positions	11	22%
Health and Safety Manager	3	6%
Health, and Safety Officer	3	6%
Site Manager	2	4%
Architect	2	4%
Site Foreman	2	4%
Construction Health and Safety Officer	2	4%
Contracts Manager	1	2%
Total	50	100%

The results in Table 4.1 shows that 26% of respondents were project managers and 22% were quantity surveyors and other professionals respectively. Additionally, both health & safety managers and officers occupied 6%. Roles such as site manager, professional health and safety agent, architect, and foreman has 4%. Lastly, contract managers were 2% of the respondents.

4.3.6 Work experience of respondents

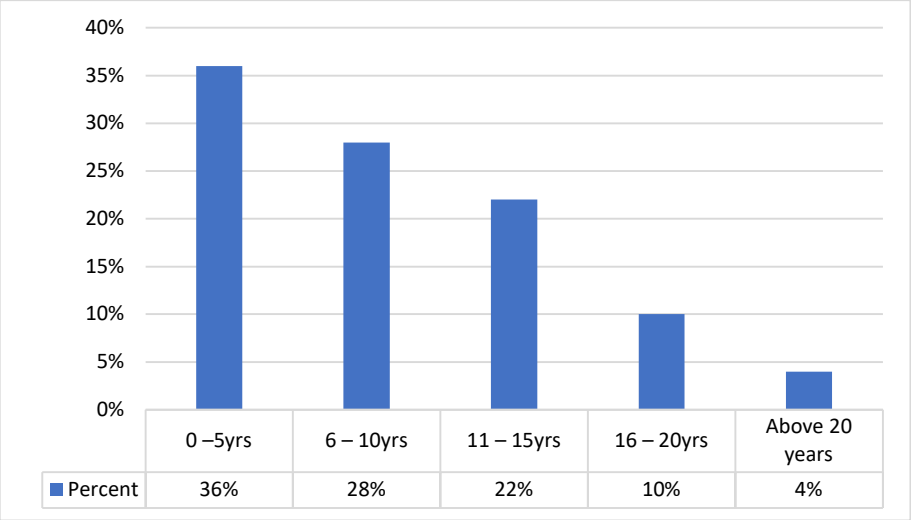

Figure 4. 5: Work experience

Figure 4.5 indicates that 36% of the respondents had been working for up to 5 years and 28% had been working for 6–10 years. 22% had been working for 11–15 years, while 4% had 16–20 years' experience. Lastly, 4% had more than 20 years of work experience.

4.4 Section B: Internal and external factors

4.4.1 How internal factors affect organisations during OHSMS implementation

According to the results in Figure 4.6 indicate that 66% of the respondents believed that their firms allocated sufficient resources toward OHSMS implementation, whilst 32% disagreed and 2% were unsure. In addition, 70% established that employees in their firms participate in OHSMS implementation, 30% opposed, 82% agreed that their organisations offer training in OHS, with positive results, however, 16% disagreed and 2% were unsure. The results indicate that 60% felt that clients did not accept the high costs of implementation of OHSMS, and 40% disagreed. Although 70% felt that there were existing risk management plans in their organisations, 24% were unsure and 6% differed with this. Furthermore, 62% of the respondents agreed that the risk management plan had been integrated into the OHSMS,16% disagreed and 22% were unsure. Although 68% of the respondents were positive that a risk management plan was monitored, reviewed, and reported in their organisation, 30% opposed and 2% doubted it. Lastly, 86% of the respondents agreed that external and internal forces impact the risk management process in their organisation, while 14% disagreed.

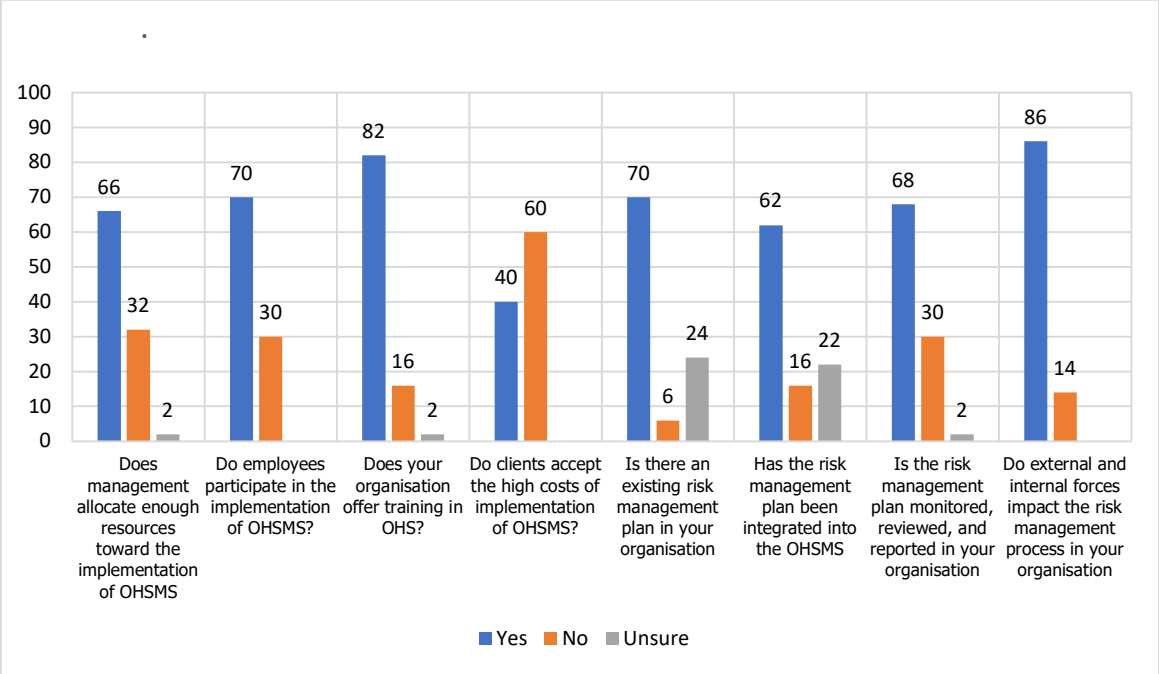

Figure 4. 6: The effect of internal factors on organisations during OHSMS implementation

4.4.2 Internal factors affecting OHSMS implementation

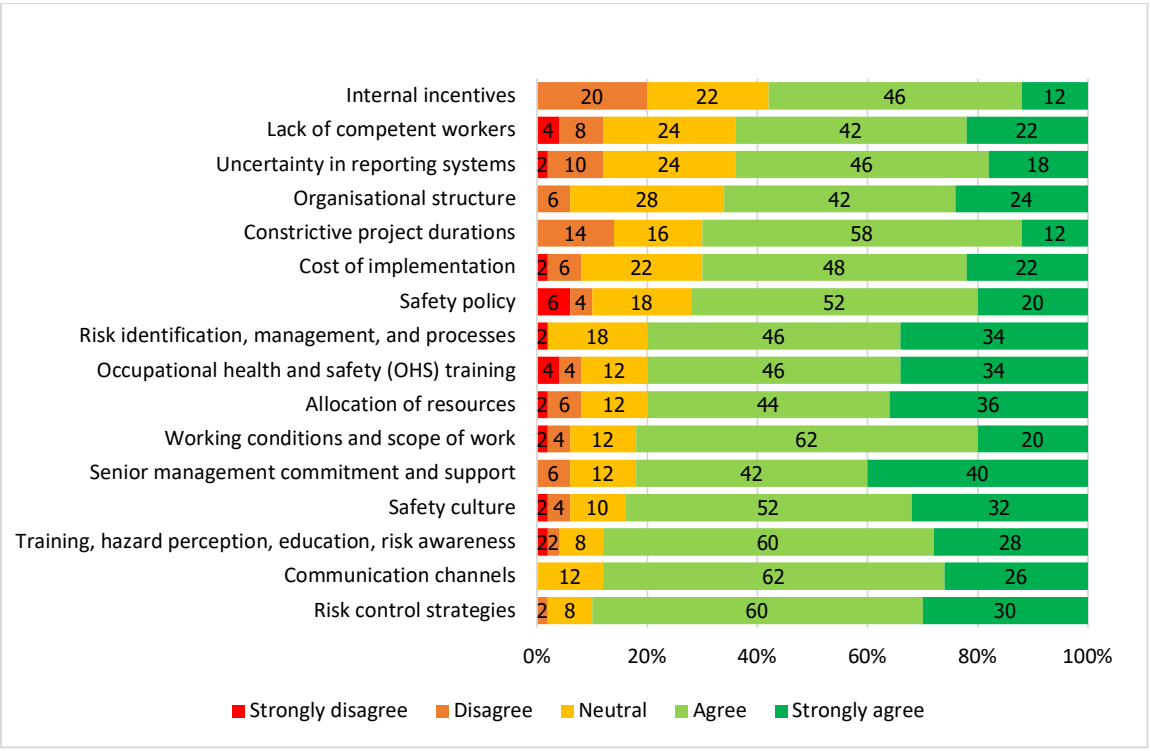

Figure 4. 7: Internal factors affecting OHSMS implementation

As shown in Figure 4.7, the percentages of Likert scale ratings indicate the impact each factor is considered to have on the implementation of OHSMS in respondents' organisations. Most

respondents agreed that the internal factors have an effect on OHSMS implementation as per shaded green colour.

4.4.3 How external factors affect the organisation during OHSMS implementation

Figure 4.8 shows the effect of external factors on organisations during OHSMS implementation.

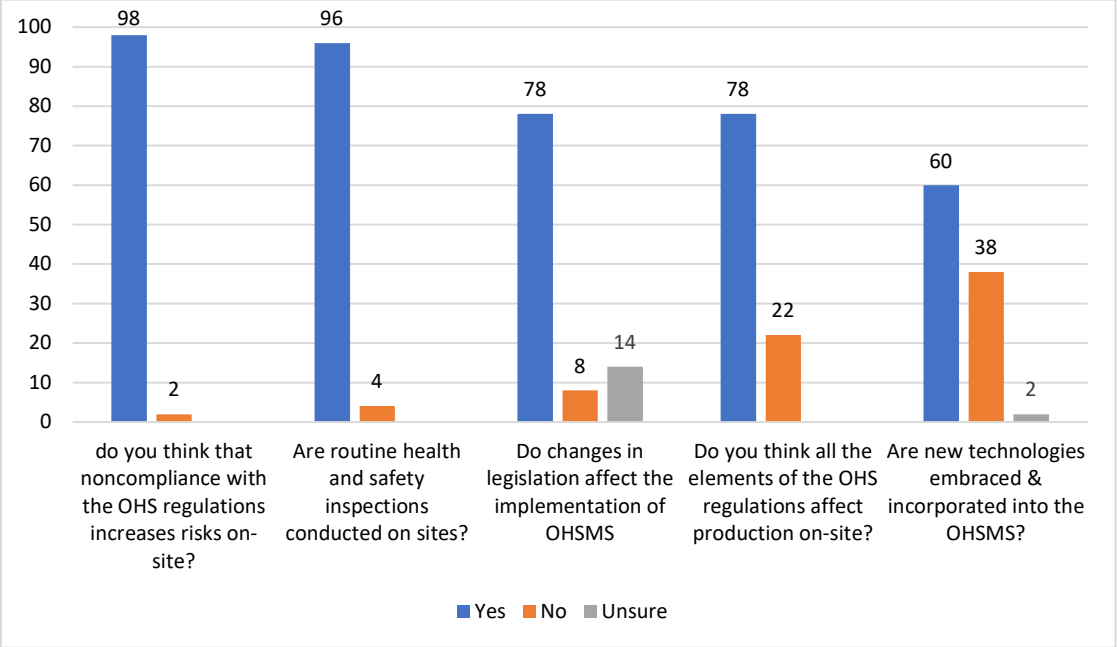

Figure 4. 8: The effect of external factors on organisations during OHSMS implementation

As shown in Figure 4.8, almost all (98%) of the respondents agreed that non-compliance to OHS regulations results in accidents whilst 2% did not agree. Additionally, 96% of respondents felt that routine OHS inspections were conducted at their organisations whilst 4% opposed them. Seventy-eight per cent (78%) agreed that changes in legislation affected OHSMS implementation, whilst 8% did not agree and 16% were unsure. Moreover, 78% of respondents agreed that elements of OHS regulations had an impact on production whilst 22% differed. Lastly, the results indicate that 60% of the respondents believe that new technology was embraced into the OHSMS, while 38% disputed this view, and 2% were unsure.

4.4.4 External factors affecting OHSMS implementation

As shown in Figure 3.9, the percentages of Likert scale ratings indicate the impact each factor is considered to have on the implementation of OHSMS in respondents' organisations. Most respondents agreed that the external factors have an effect on OHSMS implementation as per shaded green colour.

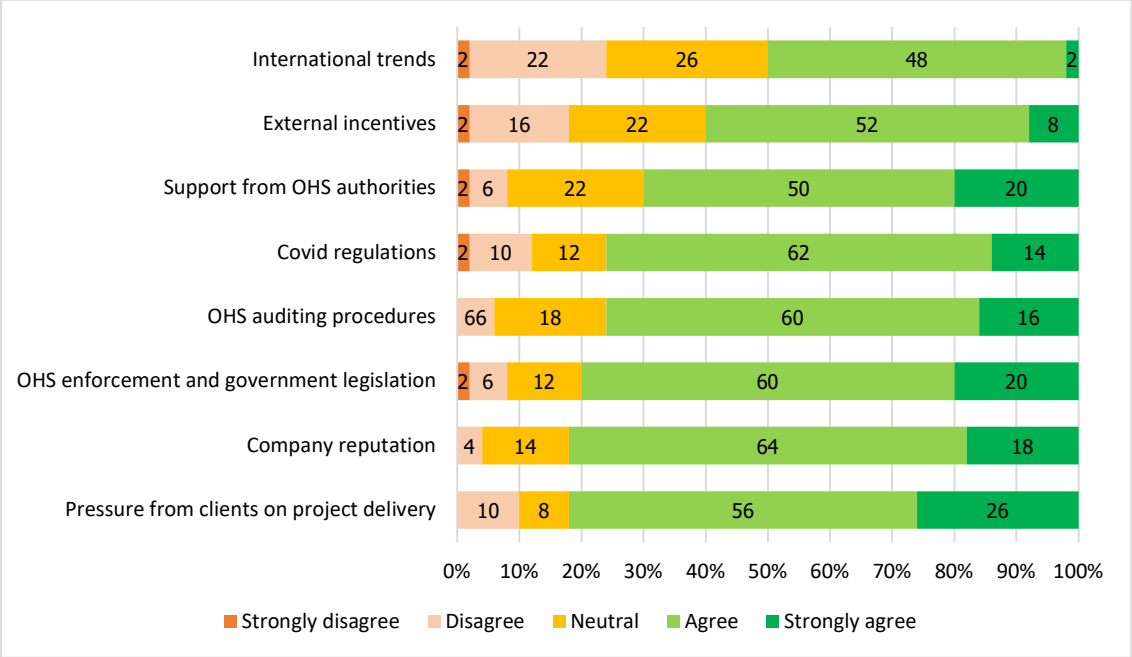

Figure 4. 9: External factors affecting OHSMS implementation

4.5 Section C: Integration of risk management plan into OHSMS on construction site

4.5.1 Common methods used during the risk identification process

Table 4. 2: Methods used to identify risk

Method	Frequency	Percent
Checklist	24	21%
Experience	22	19%
Brainstorming	19	16%
Expert judgment	19	16%
Swot analysis	13	11%
Interviews	10	9%
Delphi technique	6	5%
Others	3	3%

Table 4.2 shows the most common methods used in organisations during the risk identification process on-site in order of importance from the highest to the lowest. Checklist was the most common method with the highest frequency.

4.5.2 Most common strategies used during risk planning

Table 4.3 shows the most common strategies used in organisations during the risk planning process in order of importance from highest to lowest. Risk mitigation/reduction was the most common method used, whereas risk exploit had the lowest frequency of 3%.

Table 4. 3: Methods used during risk planning

Method	Frequency	Percent
Risk mitigation/ reduction	22	24%
Risk avoidance	18	19%
Contingency plan	17	18%
Risk acceptance	13	14%
Risk transfer	10	11%
Risk sharing	10	11%
Risk exploit	3	3%

4.5.3 Risk assessment in organisations

Table 4.4 shows the results of the most common methods used during risk assessment. The majority of the respondents agreed that they used the quantitative risk analysis although 20% rarely and never used it. On the use of risk categorisation as an assessment method, most of the respondents confirmed that they used this method with 18% confirming that they rarely used this method. The risk probability method also received a high response with only 10% rarely using it. The probability/impact risk rating matrix through the risk rating method had a high usage rate as well as per the results. Lastly, the decision trees method was rarely used by the respondents.

Table 4. 4: Methods used during risk assessment

Factor	Never	Rarely	Sometimes	Often	Always	Total %
Quantitative risk analysis through assessment of risk to determine the effect on time, cost, and duration of the project	2	18	22	36	22	100
Risk categorisation and Risk Urgency Assessment through identification of threats	4	18	22	40	16	100
Risk probability and impact assessment through evaluation of the likelihood of occurrence of specific risk and impact of the risk	4	10	34	42	10	100
Probability/impact risk rating matrix through risk rating e.g., high, medium, or low	2	16	30	36	16	100
Qualitative risk analysis through the probability and impact of risk	6	22	28	30	14	100
Decision Trees	18	24	28	18	12	100

4.5.4 Rating the degree of risk perception and awareness

Table 4. 5: Percentage rating of risk perception and awareness

Factor	Poor	Fair	Good	Very good
Risk awareness	2	30	34	34
Risk perception	4	34	38	24

Table 4.5 indicates the ratings of risk awareness and risk perception. The level of risk awareness was good at 34%, while 30% rated it as fair and 2% indicating that it was poor in their organisations. On the risk perceptions, 24% and 38% agreed that it was very good and good respectively, while 34% rated it as fair, and 4% indicating that it was poor.

4.6 Section D: Applying the PDCA method when implementing the OHSMS plan

4.6.1 Using PDCA when implementing the OHSMS

Figure 4.10 indicates that 82% of the respondents believed their organisation used the Plan Do Check Method when implementing OHSMS, while 18% did not use this method.

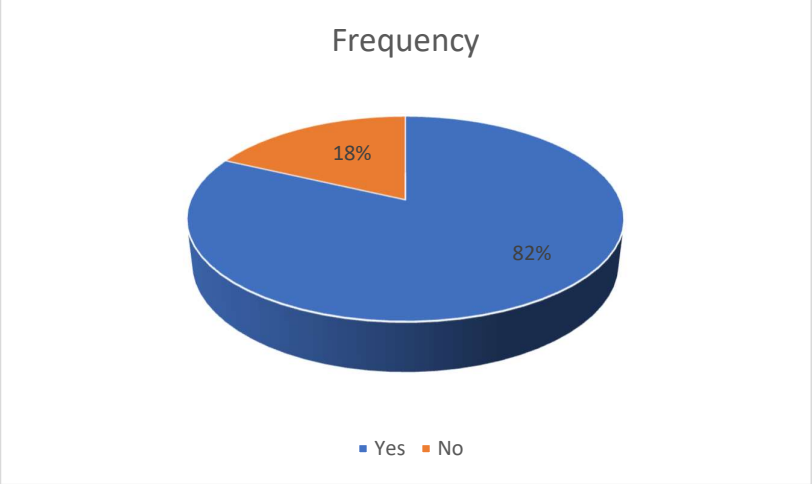

Figure 4. 10: Organisations that use the PDCA method

Of the 18% of respondents who did not use this method, 6% were unsure about the method their organisation used, 9% confirmed that their organisations had no specific method, and 3% used the risk assessment method to implement the OHSMS.

4.6.2 How the PDCA has improved OHSMS implementation

Table 4.6 shows that there was continual improvement in the OHSMS (88%), the identification of gaps and corrective actions in OHSMS improved in the organisations (86%), and the health and safety checklists and audits improved (86%). The percentage of respondents that believed that risk planning, identification, analysis, and risk management improved was 82%, 84%

agreed that the actual implementation of the OHSMS through identifying risk assessment improved, and 84% agreed that exploration of solutions to accidents on-site improved.

Table 4. 6: Effects of using PDCA on OHSMS

	Yes %	No %
If yes, have the risk planning, identification, analysis, and risk management improved?	82	18
Has the doing phase of actual implementation of OHSMS through identifying risk assessment improved?	84	16
Has the exploration of solutions to accidents on-site improved?	84	16
Have the health and safety checklists and audits improved?	86	14
Have the identification of gaps and corrective actions in OHSMS improved?	86	14
Is there continual improvement of the OHSMS?	88	12

4.7 Section E: Effects of COVID-19 on OHSMS implementation

Table 4.7 indicates that nearly a quarter (24%) strongly agreed that COVID-19 regulations had affected OHSMS implementation in their organisations, with 36% agreeing. However, 20% did not express any opinion about this, while another (20%) believed that COVID-19 regulations had not affected OHSMS implementation in their organisations.

Table 4. 7: Effects of COVID-19 on the OHSMS

Effect of Covid regulations	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
COVID-19 regulations have affected the implementation of an OHSMS in your organisation	12	8	20	36	24

Table 4.8 indicates that (92%) reported that their organisation had a COVID-19 safety regulation plan in place. Additionally, 90% of the respondents reported that COVID-19 regulations had affected their project costs, duration, and efficiency on-site, and (10%) did not believe so. Furthermore, 84% of respondents believed that their organisation conducted training regarding COVID-19 working conditions. They also reported that COVID-19 restrictions had a negative impact on their project deliverables and affected the supply of manpower on-site. The frequency on effect of sharing tools was 64%. Lastly, adherence to compliance with COVID-19 regulations had a 56% frequency.

Table 4. 8: COVID-19 effects on organisations

	Yes %	No %
Does your organisation have COVID-19 safety regulations plan in place	92	8
Has COVID-19 regulations affected your project costs, duration, and efficiency on-site	90	10
Does the organisation conduct training regarding COVID-19 working conditions	84	16
Has COVID-19 restrictions affected your project deliverables negatively	84	16
Has COVID-19 regulations affected your supply of manpower on site	84	16
Has the sharing of tools and equipment affected your organisation due to COVID-19 restrictions	64	36
Do your employees find it easy to adhere and comply with working conditions under COVID-19 restrictions	56	44

4.8 Descriptive statistics

Mean (M) and Standard deviation (SD) where used to determine the average values and variability of data.

4.8.1 Internal and external factors

4.8.1.1 Internal factors

The results in Table 4.9 showed that most of the respondents agreed that there were internal factors that affected the implementation of OHSMS. The factors with the highest mean were considered to imply that most of the respondents agreed that the factor had an effect to a greater extent towards implementation of OHSMS. The results also managed to rank in order of importance the factors that affected the implementation by adding the agree and strongly agree Likert percentages .

Confirming the ranking, the results showed that the highest ranked internal factors were as follows: risk control strategies (90%), senior management commitment and support (82%), communication channels (88%), among others. The least rated factors were internal incentives (58%) which had the lowest ranking followed by lack of competent workers (64%) and uncertainty in reporting systems (64%).

Table 4. 9: Internal factors ranking

Factors	Effect of factor response %						Ranking Agree+ Strongly agree	Mean	Std, Dev.
	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5	Agree+ Strongly agree %			
Risk control strategies		2	8	60	30	**90**	**1**	4.18	0.66
Communication channels			12	62	26	**88**	**2**	4.14	0.61
Training, hazard perception, education, risk awareness	2	2	8	60	28	**88**	**3**	4.10	0.79
Safety culture	2	4	10	52	32	**84**	**4**	4.08	0.88
Senior management commitment and support		6	12	42	40	**82**	**5**	4.20	0.87
Working conditions and scope work	2	4	12	62	20	**82**	**6**	3.94	0.82
Risk identification, management, and processes	2		18	46	34	**80**	**7**	4.10	0.84
Allocation of resources	2	6	12	44	36	**80**	**8**	4.06	0.96
OHS training	4	4	12	46	34	**80**	**9**	4.02	0.99
Safety policy	6	4	18	52	20	**72**	**10**	3.76	1.02
Cost of implementation	2	6	22	48	22	**70**	**11**	3.82	0.92
Constrictive project durations		14	16	58	12	**70**	**12**	3.68	0.87
Organisational structure		6	28	42	24	**66**	**13**	3.84	0.87
Uncertainty in reporting systems	2	10	24	46	18	**64**	**14**	3.68	0.96
Lack of competent workers	4	8	24	42	22	**64**	**15**	3.70	1.04
Internal incentives		20	22	46	12	**58**	**16**	3.50	0.95

4.8.1.2 External factors

Table 4.10 shows that the top-ranked external factors that were deemed to contribute the most to the implementation of OHSMS were, in descending order: pressure from clients on project delivery (82%), company reputation (82%), and OHS enforcement and government legislation (80%). Two noticeable least rated external factors that influence the implementation of OHSMS in the construction sites, were: external incentives (60%) and international trends (50%).

Table 4. 10: External factors ranking

Factors	Effect of factor response %						Ranking Agree+ Strongly agree	Mean	Std, Dev.
	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5	Agree+ Strongly agree %			
Pressure from clients on project delivery		10	8	56	26	**82**	**1**	3.98	0.87
Company reputation		4	14	64	18	**82**	**2**	3.96	0.70
OHS enforcement and government legislation	2	6	12	60	20	**80**	**3**	3.90	0.86
OHS auditing procedures		6	18	60	16	**76**	**4**	3.86	0.76
Covid regulations	2	10	12	62	14	**76**	**5**	3.76	0.89
Support from OHS authorities	2	6	22	50	20	**70**	**6**	3.80	0.90
External incentives	2	16	22	52	8	**60**	**7**	3.48	0.93
International trends	2	22	26	48	2	**50**	**8**	3.26	0.90

4.8.2 Integration of risk plan into OHSMS during implementation – Risk assessment

For an OHSMS to be efficient, effective, and simple, Sousa et al. (2012) argue that risk management should be incorporated. Table 4.11 shows the ranking of types of risk assessment methods used and that decision trees were least rated, and rarely conducted as they had the lowest mean ranking.

Table 4. 11: Descriptives on risk assessment methods

	Mean	Std. Dev.	Ranking
Quantitative risk analysis through assessment of risk to determine the effect on time, cost, and duration of the project	3.36	0.85	1
Risk probability and impact assessment through evaluation of the likelihood of occurrence of specific risk and impact of the risk	3.34	0.82	2
Probability/impact risk rating matrix through risk rating e.g., high, medium, or low	3.32	0.82	3
Risk categorisation and Risk Urgency Assessment through identification of threats	3.30	0.91	4
Qualitative risk analysis through the probability and impact of risk	3.10	0.95	5
Decision Trees	2.70	1.09	6

Table 4.12 indicates that risk awareness was (M=3.00) and risk perception was (M=2.82) in most organisations represented by the respondents.

Table 4. 12: Descriptives on risk awareness and perception

	Mean	Std. Dev.	Ranking
Risk awareness	3.00	0.86	1
Risk perception	2.82	0.85	2

4.9 Multiple regression analysis

When predicting the value of a variable based on the values of two or more other variables, researchers often employ multiple regression (Ngo & La Puente, 2012). The variable used to predict, in this case, is called the dependent variable OHSMS implementation (internal and external factors). The variables used to predict the value of the dependent variable in this case are COVID-19 effects, Risk analysis, PDCA, and demographics.

Beta coefficients (β) are used to measure the association between the predictor variable and the outcome i.e., the degree of change in the outcome variable for every one (1) unit of change in the predictor variable. If the β is positive, it indicates the existence of a relationship.

4.9.1 How the PDCA method is used in OHSMS implementation

Table 4.13 shows the relationship between PDCA methods and OHSMS implementation. The results indicate that planning seemed to have a positive influence on internal factors (β=0.04) and external factors (β=0.18).The doing phase showed potential positive effects on both internal (β=0.19) and external (β=0.12). Furthermore, an improved exploration of solutions to accidents on-site was likely to result in positive contributions to both internal (β=0.17) and external (β=0.21) OHSMS implementation.

Additional results indicate that the check stage resulted in positive contributions to both internal (β=0.17) and external (β=0.03) OHSMS implementation. Improved identification of gaps and corrective actions in the OHSMS was likely to negatively influence both internal (β=-0.64) and external (β=-0.35) OHSMS implementation. Lastly, continuous improvement in the OHSMS was likely to result in positive contributions to internal (β=0.27) and negative influences on external (β=0.18) OHSMS implementation.

Table 4. 13: Regression analysis of PDCA

	OHSMS Implementation					
	Internal factors			External factors		
	Coef. (β)	[95% Conf. Interval]		Coef. (β)	[95% Conf. Interval]	
Risk planning, identification, analysis, and risk management	0.04	-0.40	0.48	0.18	-0.22	0.58
Doing phase of actual implementation of OHSMS through identifying risk analysis	0.19	-0.39	0.77	0.12	-0.41	0.65
Exploration of solutions to accidents on sites	0.17	-0.39	0.74	0.21	-0.31	0.72
Has the Health and safety checklists and audits improved	0.17	-0.40	0.73	0.03	-0.49	0.55
Identification of gaps and corrective actions in OHSMS	-0.64	-1.45	0.18	-0.35	-1.09	0.35
Continual improvement on OHSMS	0.27	-0.40	0.93	-0.18	-0.78	0.42

β – the unstandardised beta Coefficient

4.9.2 Effects of the COVID-19 regulations on OHSMS implementation

Table 4.14 shows the multivariate regression effect of that COVID-19 regulations. The results show that covid regulations affected the project costs, duration, and efficiency on-site, as both coefficients on internal factors (β=0.42) and external (β=0.46) had positive values. Furthermore, the results show that sharing of tools and equipment had a negative influence on external factors (β=-0.03) whilst it had a positive relationship with external factors (β=0.11).

Table 4. 14: Regression analysis of COVID-19

	OHSMS Implementation					
	External			External		
	Coef. (β)	[95% Conf. Interval]		Coef. ((β)	[95% Conf. Interval]	
Has COVID-19 regulations affected your project costs, duration, and efficiency on-site	0.42	-0.11	0.95	0.46	-0.03	0.94
Has sharing of tools and equipment affected your organisation due to COVID-19 restrictions	-0.03	-0.37	0.30	0.11	-0.20	0.42
Does the organisation conduct training regarding COVID-19 working conditions	-0.19	-0.65	0.26	-0.22	-0.64	0.20
Do your employees find it easy to adhere and comply with working conditions under COVID-19 restrictions	-0.11	-0.42	0.20	0.03	-0.25	0.32
COVID-19 regulations affected your supply of manpower on-site	0.31	-0.23	0.85	-0.19	-0.69	0.31
COVID-19 restrictions effects project deliverables	-0.60	-1.20	-0.01	0.01	-0.54	0.56

Training regarding COVID-19 working conditions showed a negative influence on both internal (β-0.19) and external (β=-0.22) factors. Additionally, adherence and compliance with working conditions under COVID-19 restrictions negatively affected internal controls for OHSMS implementation (β=-0.11) and positively impacted external OHSMS implementation controls (β=0.03).

The effect of COVID-19 regulations on the supply of manpower on-site showed positive effects on internal factors (β=0.31) and conversely negative effects on external (β=-0.19) factors. Lastly, the effects of COVID-19 restrictions on project deliverables seemed to have positive effects on external OHSMS implementation factors (β=0.60) and negative effects on internal factors., although the results are not significant (β=0.01).

4.9.3 With demographics

In Table 4.15, when analysing the confidence intervals between demographics and factors, the results showed that gender did not determine whether male (β=-0.12) or female (β=-0.33) affected implementation, as both genders had negative results.

In the analysis of respondents' age, results show that all the age groups had a negative effect on both internal and external factors, except for ages between 41–50, which had a positive effect (β=0.18) on external factors.

In terms of the highest formal qualification, the results show qualifications had a negative effect on both internal and external factors.

Regarding experience, there was a positive relationship with internal factors, but there was a negative effect on all external factors, except for those above 20 years (β=3.41), which had a positive relationship with external factors.

Table 4. 15: Regression analysis of demographics

	OHSMS Implementation					
	Internal factors			External factors		
	Coef. (β)	[95% Conf. Interval]		Coef. (β)	[95% Conf. Interval]	
Please indicate your gender						
Female	-0.12	-0.53	0.29	-0.33	-0.65	- 0.01
Please indicate your age group						
31- 40	-0.51	-1.14	0.11	-0.14	-0.63	0.34
41 – 50	-0.22	-0.91	0,47	0.18	-0.35	0.72
51 – 60	-1.88	-3.42	-0.34	-2.48	-3.68	-1.28
Above 60	-0,97	-2.79	0.85	-0.92	-2.34	0.49
Highest formal qualifications						
Artisan/Tradesman	-1.66	-3.21	-0.12	-1.69	-2.89	- 0.49
Diploma	-0.27	-1.34	0.81	-0.54	-1.38	0.30
Bachelors /Honours Degree	-0.63	-1.72	0.46	-0.56	-1.41	0.29
Master's Degree	-0.65	-1.77	0.47	-0.66	-1.53	0.21
How long have you been working						
6 – 10yrs	0.21	-0.25	0.66	-0.24	-0.59	0.12
11 – 15yrs	0.28	-0.27	0.84	-0.17	-0.61	0.26
16 – 20yrs	0.08	-0.59	0.75	-0.65	-1.17	-0.13
Above 20 years	2.66	0.52	4.81	3.41	1.74	5.08
_cons	4.68	-3.31	6.05	4.57	3.50	5.63

*Significant at 5% level **Significant at 10% level

4.10 Reliability of data

To determine the reliability of the respondents' information, a reliability test was conducted. Cronbach Alpha (α) was used as an index to objectively measure the reliability of a questionnaire instrument based on the data collected (Tavakol & Dennick, 2011). The acceptable values of α for consistency range between 0.70 and 0.95 (Tavakol & Dennick, 2011). Table 4.15 shows that Cronbach α reliability score was higher than the minimum 0.70 range hence research tool used was deemed reliable.

Table 4. 16: Reliability test

Sections	Cronbach's Alpha
Internal factors	0.84
Effects of internal factors	0.79
External factors	0.79
Effects of external factors	0.79
Integration of risk management plan	0.87
PDCA method when implementing OHSMS	0.84

4.11 Chapter summary

The results were presented along with an explanation of the methodology used to collect the empirical data. The empirical data were mainly gathered through an online Microsoft form survey. Frequencies, descriptive statistics, and regression analysis were conducted to present and interpret the data. The response rate from the number of distributed questionnaires was (44%), and the number of respondents used was 50 respondents out of 114 to produce significant findings as required for computing statistical analyses.

CHAPTER 5: DISCUSSIONS OF FINDINGS

5.1 Introduction

Various authors such as Sadiq (2019:18) and Autenrieth et al. (2015) posit that the use of an OHSMS reduces work-related risks and continuously improve conditions at work. The study was conducted to obtain answers to the following research questions:

i. What are the internal and external factors that affect OHSMS implementation?
ii. How is the PDCA method used to implement an OHSMS?
iii. To what extent have the COVID-19 regulations affected OHSMS implementation?
iv. How is risk management integrated into an OHSMS during implementation?

The results from the current research show that there are both internal and external factors affecting OHSMS implementation. Furthermore, most construction companies use the PDCA method when implementing an OHSMS, and there is a strong relationship between PDCA and internal and external factors. In addition, the COVID-19 pandemic has affected the OHS regulations significantly. Lastly, the results show that there are various ways to integrate risk management into OHSMS.

5.2 Internal and external factors that affect OHSMS implementation

5.2.1 Internal factors and their implications on OHSMS implementation

5.2.1.1 List of internal factors in order of importance

The findings from **Table 4.9** listed internal factors in descending order of importance based on the Likert scale for respondents who agreed and strongly agreed on the extent to which that factor had on the implementation of OHSMS. The mean findings also showed that most of the respondents agreed that the internal factors affected implementation. To obtain an accurate assessment of OHSMS factors, each factor should be monitored and measured with appropriate criteria and indicators. Focusing on just one aspect factor of OHSMS can be misleading and ineffective, as highlighted by (Mohammadfam et al., 2016).The internal factors in order of importance, from highest to lowest as:

- Risk control strategy
- Communication channels
- Training, hazard perception, education, risk awareness; risk identification, management, and processes
- Safety culture
- Senior management commitment and support
- Risk identification, management, and processes

- Working conditions and scope of work
- Allocation of resources
- OHS training
- Safety policy
- Cost of implementation
- Constrictive project durations and internal incentives
- Organisational structure
- Uncertainty in reporting systems
- Lack of competent workers
- Internal incentives

To obtain an accurate assessment of OHSMS factors, each factor should be monitored and measured with appropriate criteria and indicators. Focusing on just one aspect of the OHSMS can be misleading and ineffective, as highlighted by (Mohammadfam et al., 2016).

Risk control strategy: Contrary to expectations, risk control strategy was found to be the leading factor, even though the study by da Silva and Amaral (2019) did not list it as one of their top five factors. There are several possible explanations for this result one of them being that their study was purely theoretical and was generalised, with no reference to a particular industry, whereas current study was an empirical focusing on construction sector within the Western Cape in South Africa. Additionally, the results from this study showed that 70% of organisations had an existing risk management plan that was monitored and reviewed. Hence, risk control was something that most organisations valued as an important factor that would affect OHSMS implementation.

Communication channels: Findings showed that communication channels were an important factor, which was consistent with the empirical findings of (Yiu et al., 2019) who asserts that communication remains an essential success factor attribute. The communication challenge can also be attributed to the language barrier that exists in South Africa as there are eleven official languages and some OHS terms can be difficult to explain and translate into the vernacular language of the unskilled labourer. Therefore, proper communication channels must be established. Furthermore, equipment design and improved work practices that promote proper communication procedures result in an improved safety environment (Ismail et al., 2012).

Training, hazard perception, education, and risk awareness: Although many respondents agreed that their organisations had made great positive strides toward training, hazard

perception, education, and risk awareness on OHS, it was still ranked as a leading factor that affect OHSMS implementation. These findings are consistent with Garnica and Barriga's (2018) survey who found that the systematically inadequate behaviour, the inadequate involvement in OHS activities, and the lack of awareness of the relevance of OHS employees made it difficult to implement the OHSMS. Risk identification, management, and processes are critical factors. This is evidenced by the results of the study in **Figure 4.6** which showed that more than 30% agreed that the risk management plan was not monitored and a further 24% were unsure of whether their organisation had a risk management plan. This shows that construction organisations in Western Cape still needs to continue addressing risk when implementing an OHSMS. There is a lack of adequate implementation of risk assessment and risk reduction. When implementing an OHSMS, it is crucial to reinforce risk assessment education (Kajiki et al., 2020). A safety management system's effectiveness requires continuous monitoring and improvement (Khalid et al., 2021).

Safety culture: In this study, this factor was found to be significant. An organisation's safety culture is determined by its values, attitudes, perceptions, and competencies, which determine its commitment to OHS, and its style and proficiency in managing it. Da Silva and Amaral (2019) made the same observations that it was important for the workers to understand the importance of managing the OHS, different standards, attributes, and observing to the company culture. This is also consistent with the findings of Mohammadfam et al.'s (2016) empirical study who found that employees create safe conditions through actions, such as participation in safety training, voluntary OHS activities, and OHS-related decision makings. Although the findings from this current study did not rank safety culture in its top 3, Pramono et al.'s (2023) findings showed that employees' ignorance or negative attitudes on OHS, a lack of safety culture, and employee participation were the most important factors. However, this may be because their study was sorely based on a literature review.

Senior management commitment and support: Regarding the importance of senior management commitment and support, the results of this study were consistent with that of the empirical study by Yiu et al. (2019), and the theoretical study by da Silva and Amaral (2019) as they both regarded this factor as a key driver construct when implementing an OHSMS. Management leadership and commitment towards OHS are the base factors when implementing OHSMS (Rajaprasad & Chalapathi, 2015). An important issue emerging from these findings was that most employees participated in OHSMS implementation. The success of a safety management system depends on the type of leadership and employee involvement (Khalid et al., 2021). Management commitment has a positive impact on worker safety behaviour and participation in safety management (Sklad, 2019). Similarly, Zhang et al. (2019)

found that senior management support should cover safety meetings, safety training, personnel protection, on-site inspection, performance assessment, incentive, and other major safety management affairs. Management commitment has the maximum driving power. Top management obligations should go beyond, involving expertise in OHS hazards and a responsibility to ensure that management practices stimulate safety and health at work.

Working conditions: Construction workplaces were confirmed as potential risk areas where accidents and injuries are more likely to occur (Mashwama et al., 2018; Osei-Asibey et al., 2021b). However, the findings of this study, did not classify working conditions and scope of work as its most important factors. A plausible explanation for this argument may be that a lot of effort has been made over the years to secure safe working conditions on-site, as attributed by the results in **Figure 4.6** that showed most organisation had risk management plans in place which would therefore, result in safe working conditions.

Allocation of resources: The results in **Figure 4.6** showed that the allocation of resources is a significant factor, with 32% of respondents agreeing that their organisations did not allocate sufficient resources towards OHS issues. The finding aligns with the observations of Yiu et al. (2019) who found that project constraints and system limitations due to the unavailability of suitable construction resources affected OHSMS implementation. Most resources are channelled over towards production, and the high costs associated with OHS further makes it difficult to implement an OHSMS, especially in SMEs.

OHS training: There are similarities in the present study's results on the OHS training factor with that of Kajiki et al. (2020). The findings of the current study also showed that organisations that offered training in OHS had good positive results on their OHSMS as per **Figure 4.6**. Currently, senior managers and supervisors on construction sites are not mandated by the Department of Labour in South Africa to have an OHS qualification. This presents challenges when implementing an OHSMS, as would a lack of training and knowledge in OHS. Incompetent employees result in poor management decisions, and approval of incomplete procedures and instructions. This is attributed to the failure to provide necessary training to employees (Sklad, 2019). Although the results showed that 82% of respondents agreed that their organisations offer training in OHS, it does not mean that the training was compulsory. Safety training should be used to increase the safety awareness and knowledge of both management staff and workers (Zhang et al., 2019).

Safety Policy: Rajaprasad and Chalapathi (2015) found that a safety policy was the second most influential factor in their findings. However, this study found that it was among the least important factors. This could be because this study was mainly oriented on the construction

industry in South Africa, whereas their study was conducted in India. Safety policy ensures employee participation, and this was confirmed in **Figure 4.6** which showed that 70% agreed that employees in their firms participate in OHSMS implementation.

Cost of implementation: One important issue emerging from these findings is the cost of implementing an OHSMS. The results showed that the majority of clients did not accept the high costs related to OHS. This is because OHS is viewed by most clients as part of company overheads. These findings were consistence with that the study of da Silva and Amaral (2019). Furthermore, the results in **Figure 4.6** indicated that the cost of OHS must be carried by the contractor making it difficult to successfully implement an OHSMS especially when the contractor is a small and medium enterprise with low capital. However, most clients argue that the OHS-related costs should only be charged to the client where the client has included specifications in the tender document. However, it is important to note that although the cost of implementation of an OHSMS can be high, there is a significant company saving due to a decrease in accidents (Ligade & Thalange, 2013).

Constrictive project durations: Often strict schedules and production take priority over the implementation of appropriate OHS procedures, and many employees may not fully comprehend the risks present on construction sites (Othman, 2012). Constrictive project durations were found to be among the least important factors. Most construction sites operate on strict schedules to meet deadlines, and there are penalties involved if practical completion is not achieved, Therefore, OHS usually takes the least priority. This was validated by (Yiu et al., 2019).

Type of organisational structure: This study further validated the previous claim made by Rahmi and Ramdhan (2021) that the organisational structure was a factor that had an impact on OHSMS implementation. The OHS structure in organisations enables all employees to be given responsibilities and functions which would allow accountability. The organisational structure also affects the risk and safety culture of the organisation. Nordlöf et al. (2017) found that large companies generally had a low-risk and positive safety culture as compared to smaller ones as more resources were available to invest in an OHSMS, hence lower risks. Therefore, the type of organisational structures has an impact on OHSMS implementation.

Uncertainty in the reporting systems: As such, this study showed the same results as da Silva and Amaral (2019) and Kajiki et al. (2020) that uncertainty in the reporting systems remains a major obstacle. OHSMSs need to be designed with technology or hardware in mind in the initial design phase which clearly outlines the reporting system. Nowrouzi et al. (2016) found that the lack of an ineffective information collection system tool posed a major challenge.

To successfully implement an OHSMS and improve safety performance, construction companies must ensure that the reporting system is clear. Findings from Garnica and Barriga (2018) emphasise the importance of a proper incident reporting and analysing structure as an important tool in OHSMS implementation. Retaining qualified internal auditors who are willing to address nonconformities and offer advice and suggestions is crucial. Therefore, non-conformities should be probed, and corrective actions should be proposed, whilst the potential for improvement should be identified (Sklad, 2019).

Lack of competent workers: Another factor emerging from these findings was the lack of competent workers. Lack of knowledge about safety issues remains a big weakness of an OHSMS (Sánchez et al., 2018). However, the results from this study had it under least rated factors this could be attributed by that most construction organisations usually subcontract specific trades to different third parties, such as paintworks, plastering, etc. Because these subcontractors are appointed on a short-term basis, this does not result in continuous training. Although this saves on training costs, it results in a lack of competent workers that have knowledge of OHS. This aligns with da Silva and Amaral's (2019) findings on the lack of competent workers. For construction tasks to be completed smoothly, safely, and with good production quality, workers need to have strong safety awareness, professional skills and experience (Zhang et al., 2019).

Internal incentives: The least important factor from these findings is that of internal incentives. Ghahramani's (2016) studies had similar findings in this regard. The lack of internal incentives and the implementation of incentive programmes could inspire employees to execute their OHS tasks safely. Additionally, Zhang et al. (2019) found that if management staff and workers receive a reward for good safety performance, they may be motivated to improve safety on sites. Construction companies must provide safety incentives and integrate them into all aspects of their safety management systems to train and enhance safety performance. As part of this, subcontractors can be included in safety meetings and training, and everyone involved can be given responsibility and authority.

5.2.2 External factors and their implications on OHSMS implementation

5.2.2.1 List of external factors in order of importance

The findings from **Table 4.10** listed external factors in order of most to least importance based on the Likert scale on respondents who agreed and strongly agreed on the extent to which that factor had on the implementation of OHSMS. The mean findings also showed that most of the respondents agreed that the external factors affected implementation

The factors in order of highest to least importance are:

- Pressure from clients on project delivery
- Company reputation
- Enforcement and government legislation
- Auditing procedures
- Support from OHS authorities
- COVID-19 regulations
- External incentives
- and international trends

Pressure from clients: Often strict schedules and production take priority over the implementation of appropriate OHS procedures (Othman, 2012). The findings from the study showed that pressure from clients on project delivery was the biggest factor when implementing an OHSMS. Most construction projects are categorised with heavy penalties attached to late completion of the works and OHS is usually regarded as time-consuming. The findings were consistent with that of Rahmi and Ramdhan (2021) who found that elements of OHS regulations had an impact on production and coupled with pressure from clients on project delivery. Results from this study showed that 78% of respondents agreed that elements of OHS regulations had an impact on production. Often production is prioritised over safety (Kim et al., 2019). This poses a great challenge when implementing an OHSMS, as this usually results in non-compliances. Furthermore, this study found that non-compliance with OHS regulations results in accidents on-site.

Company's reputation: Further findings in this study classified the company's reputation as an important factor that would affect OHSMS implementation. Usually, smaller companies find it difficult to have a functional OHSMS without support, as they need to build on their reputation first (Nordlöf et al., 2017).

OHS enforcement and government legislation and OHS auditing procedures: The findings showed that enforcement, government legislation, and auditing procedures were critical factors in implementing an OHSMS. This observation was also reported by Nowrouzi et al. (2016). Rigorous legislation and bureaucracy had a significant effect on OHS. The high level of prerequisites by the regulations and the large number of documentations required was found to be difficult to meet, especially in small and medium organisations (Gomes et al., 2016). Research indicates that even though the South African Construction Regulations of 2014 impose a high level of requirements on clients, the desired benefits may not be realised without financial incentives due to the low fines and lack of enforcement (Musonda & Pretorius, 2015).

OHS auditing procedures: The findings are consistent with that of Mashwama et al. (2018) and Salguero-Caparrós et al. (2020) who reported that the lack of awareness resulted in non-compliance to regulations. This is further supported by earlier work by Agumba and Haupt (2009) that there was limited commitment to compliance with small and medium enterprises (SMEs) in South Africa due to the high cost of implementation and maintaining them. Findings by Salguero-Caparrós et al. (2020) explain the difficulties that industries face when attempting to comply with regulations. Their study failed to explain the effects of non-compliance with regulations on organisations. However, the findings of this study were able to establish that non-compliance to regulations resulted in accidents on-site, as per results of **Figure 4.8** where 98% of respondents were in agreement. This aligned with Windapo (2013), whose findings showed that non-compliance with standards resulted in unsafe working conditions, injuries, and fatalities on construction sites.

Support from OHS authorities: An important issue emerging from these findings was the support from OHS authorities. The findings show that even though routine OHS inspections were conducted at their organisations, there was still a need for support from OHS authorities. As such, this study had same results as that of Rahmi and Ramdhan (2021) that the lack of labour inspectors to oversee and inspect OHSMS implementation, and the government not providing any special instruments for monitoring OHSMS implementation were crucial factors when implementing an OHSMS. To assess the general effectiveness of OHSMSs, compliance audits and performance evaluations should be performed. However, findings from this study confirmed that most organisations conducted routine OHS inspections, as per **Figure 4.8,** although the inspections were not specified as external or internal. According to the CIDB (2021) report, the OHS in South Africa is hampered by a lack of available statistics to show the full extent of accidents from the Compensation Commissioner. Findings were also consistent with those of Mashwama et al. (2018) who found that factors such as inadequate routine inspections on sites and, the unfamiliarity with regulatory obligations resulted in non-compliance.

COVID-19 regulations: The findings from this study revealed that the COVID-19 pandemic resulted in a change in the legislature. The Department of Employment and Labour had to amend the legislation to include the Occupational Health and Safety Act, Act 85 of 1993 in particular the Hazardous Biological Agents Regulations governing workplaces. This supports the findings from Simpeh et al. (2021) that the implementation of the new COVID-19 regulations affects OHSMS implementation. These factors had a significant effect on OHSMS implementation as they changed several working conditions on sites.

External incentives: External incentives affects OHSMS implementation as shown from research results. With economic incentives, clients were all likely to implement an OHSMS on construction sites. Likewise, Musonda and Pretorius (2015) found that economic incentives had a critical impact significance on client OHS performance. Clients may continue to view themselves as non-essential OHS stakeholders in the absence of financial incentives, preventing them from effectively participating in OHSMS implementation.

International trends: The least important factor in the present study was that of international trends. Although a similar study from Lis and Nowacki (2019) found that trends and standards have the status of non-compulsory standards and constitute national regulations for the development of an OHSMS and the performance of work related to the assessment of occupational risk, it did not class rank this factor. International standards such as ISO 45001:2018 play a significant role when implementing an OHSMS (Rahmi & Ramdhan, 2021).

5.3 Using the PDCA method to implement an OHSMS

Although several methods can be applied as a basis for integrating management systems, the PDCA remains the most common (Mohammadfam et al., 2006). This aligns with the results from this study, as per Figure 4.11, which showed that most construction organisations used the PDCA method. Similar findings from Roberts (2014) confirmed the method as a common one, although it was used in the Electrical industry setting.

Plan: The results in **Table 4.13** indicated that in the planning stage, risk planning, identification, analysis, and risk management seemed to have a positive influence on both internal and external factors. This is because the PDCA links with risk assessment (Górny, 2019). Results in **Table 4.6** also showed an improvement in risk assessments when the PDCA method was used to implement the OHSMS. This can be attributed to the fact that a risk management plan is produced during the planning stage. Hence, all risks would have been identified and planned for.

Do: The findings in the present study showed that the actual implementation of the OHSMS through the identification of risk analysis showed a potentially positive effect on both internal and external factors. This is because this stage involves the actual implementation of the OHSMS (Johnson, 2016).

Check: An important issue emerging from these findings at the check stage was that there was also a positive relationship between both factors. This is because at this stage, an

exploration of solutions to accidents is verified and OHS checklists and audits are conducted (Johnson, 2016). However, no evidence of improved identification of gaps and corrective actions was detected as the results showed a negative influence on both internal and external OHS implementation factors. The findings suggest that at this stage, OHSMS implementation would have been completed in the doing phase. Hence, those factors would only impact on the doing stage.

Act: Lastly, the findings indicated that continuous improvement in OHSMS was likely to result in positive contributions to both internal and external OHS implementation. This is supported by the findings of Roberts (2015) that during this stage analysis is done to identify the differences between the actual and projected results. This includes determining the main causes for the variations, identifying the changes required to improve performance, and developing corrective actions to implement the changes.

5.4 Effects of COVID-19 regulations on OHSMS implementation

In examining the relationship between COVID-19 regulations and OHSMS implementation as per **Table 4.14**, the results showed that due to the change in regulations, there was a positive relationship between the project costs, duration, and efficiency on-site on both internal factors and external construction sites. This can be attributed to COVID-19 regulations that required additional PPE, which had an impact on project costs. Furthermore, only a limited number of people could work in particular areas, and this resulted in extended project durations and reduced efficiency on-site. Also, isolation issues meant that labour on-site would be reduced. Similarly, Ayat and Kang (2023) showed that COVID-19 had negative impacts on the construction sector, including interruption of the supply chain, shortage of suitable workers, materials, and equipment, and interruption of planning. The findings are similar to those of Stiles et al. (2021), although his study was generalised and not specific to any country. However, results from Sierra's (2022) theoretical study showed that the magnitude of the effect of each challenge varied according to the size of the contractor, local regulations, and sectors in which the organisation operates.

The present findings showed that sharing of tools and equipment on COVID-19 restrictions had a positive influence on external factors and a negative influence on internal factors. This suggests that since COVID-19 regulations were part of an external factor, it would not affect the internal factors when implementing the OHSMS.

Contrary to expectations, this research did not find a significant relationship between internal and external factors when looking at training on COVID-19 working conditions. It is possible that at the time of the research, great strides had already been made in COVID-19 awareness

and most organisations had already taken precautionary measures. However, the opinion from the study by Sierra (2022) was that COVID-19 is a constantly evolving pandemic. However, this is not the case anymore, but the contractor must invest time in training and communication with the employees on the new hazards and controls should the need arise.

The present study also showed that adherence and compliance with working conditions under COVID-19 restrictions positively impacted external OHSMS implementation controls. This can be attributed to the fact that regulations are implemented by the government, the construction sector needs government support, improved methods and processes, and strict compliance with safety protocols to adjust to changes (Ayat & Kang, 2023). However, results showed a negative effect on the internal factors. This would require further analysis as working conditions are part of internal factors.

Present results on COVID-19 regulations' effect on the supply of manpower on-site had positive effects on internal and conversely negative effects on external OHSMS implementation factors. This suggests that since manpower is part of internal factors, COVID-19 had negative impacts on the construction sector as evidenced by the shortage of suitable workers (Ayat & Kang, 2023). Due to COVID-related sick leave, the number of qualified construction workers have been reduced on-site, affecting stakeholders such as contractors, subcontractors, suppliers, and manufacturers.

Lastly, the effects of COVID-19 restrictions on project deliverables seem to have positive effects on external factors and negative effects on internal factors. Construction project costs are driven principally by time, and COVID-19 disrupted project schedules by delaying the implementation of new OHS procedures (Sierra, 2022). Most schedules had to be pushed back due to shortages in materials and this influenced the schedule.

5.5 Integrating risk management into the OHSMS during implementation

To be efficient, effective, and simple, risk management should be incorporated into management practices and systems in construction organisations (Sousa et al., 2012). Based on the findings gathered from the analysis of integrating a risk management plan into the OHSMS, results showed that the external and internal forces had an impact on the risk management processes.

Firstly, it is important to identify occupational hazards in an organisation before implementing the OHSMS (Niciejewska & Kiriliuk, 2020). The results from the present study indicate that risk identification could be implemented using different methods. The most common methods used in organisations during the risk identification process on-site in order of importance from

the highest to the lowest were found to be a checklist, experience, brainstorming, expert judgment, swot analysis, interviews, Delphi technique, and others as per **Table 4.2**. The results were consistent with those of Garrido et al. (2011) who found that a checklist, followed by a flowchart and brainstorming were the most common techniques used to identify risk within Brazilian construction industry. Morgan et al. (2014) found that the Delphi Technique was one of the least used, even though in literature it is frequently mentioned. This suggests that since Morgan et al. (2014) results were solely based on literature and with no specific industry as a reference, they could differ from the findings for the construction industry.

The findings showed that the most common strategies used in organisations during the risk planning process in order of most to least important were risk mitigation/reduction, risk avoidance, contingency plan, risk acceptance, risk transfer, and risk sharing as per **Table 4.3**. These are consistent with Mhetre et al.'s (2019) findings where their study did not group the results in order of importance. This could be because the response strategy and approach chosen is dependent on the type of risk involved (Mhetre et al., 2019). As the present study was focused on construction industry, this may explain why the findings differed.

The present findings showed that quantitative risk analysis was the most common method often used during risk assessment, as shown in **Table 4.4.** Risk assessment for a project in terms of scope, time, cost, and quality is required on complex and larger projects for more in-depth analysis, as compared to small projects of (Srinivas, 2019). This suggests that most respondents in the present study were from larger organisations or were involved in large complex projects. Additionally, the results showed a significant number of contractors used the method of risk categorisation. This could be because most organisations aim to develop effective risk responses (PMI, 2013:310).

The findings are consistent with those of Mhetre (2016) whose found that risk prioritisation ensures quick risk responses. Risk urgencies could also be combined with probability and impact matrix scores to determine a final risk severity rating (PMI, 2013). That would explain why the present study found that both the risk probability method and the probability/impact risk rating matrix through the risk rating method were 3rd in ranking. There is a need to define the probability and impact and tailor that to a specific project. This ensures that clear definitions of scale are drawn up and project scope can be derived depending on the project's nature, criteria, and objectives (Purohit et al., 2018). Lastly, results showed that qualitative risk analysis and decision trees were the least preferred methods. As the results showed qualitative risk analysis as the least preferred method, this suggests that most of the respondents worked in larger organisations, as Mhetre (2016) found it a common method used

in small and medium-sized projects due to its relativity simple techniques when seeking quick evaluations.

The findings also showed that awareness was good, while the risk perception was low in most organisations represented by the respondents.

5.6 Respondents demographics

When comparing the factors affecting OHSMS implementation with biographical information in **Table 4.15**, the results showed that the gender and ages of respondents did not affect OHSMS implementation. This could be because OHS does not discriminate, as it affects everyone. However, the ILO (2018) revealed that young individuals were more likely than older adults to experience a serious workplace accident due to exposure to unhealthy working circumstances, which can cause occupational illnesses to manifest either early in life or later in life.

In terms of the highest formal qualification, results showed that qualifications had a negative effect on both internal and external factors. This result is in contrast with Raghupathi and Raghupathi (2020) whose study showed that adults with higher educational attainment had a better understanding, and better health as compared to their less-educated peers. The difference in results may be because Raghupathi and Raghupathi's (2020) study was focusing on the health comparison whilst this study focused on OHSMS implementation.

Lastly, the present study showed that there was a positive relationship between internal factors and a negative effect on all external factors except for those older than 20 years which had a positive relationship with external factors. Experience plays a significant role when implementing an OHSMS. This is also supported by ILO (2018), which views experience as a contributing factor.

5.7 Validity of the research outcome

According to Sireci (2007), validation assurance refers to the use of a test and process of checking research to show how accurately the results were obtained, applied, and interpreted. As part of the validity check, the following factors were considered:

Research population and experience of respondents: Professionals working in the construction sector in South Africa's Western Cape Province made up the population sample for this study. The population sample was found to achieve reliable results (section 3.7). Expert professionals within the construction industry were pursued (sections 4.3.4 & 4.3.5).

Sampling technique: This study used the stratified random sampling method to minimise the potential for human influence in choosing cases for inclusion in the study (Sharma, 2017). The respondents consisted of people in supervisory positions both male and female with adequate experience or qualifications in the construction industry.

Data collection and analysis instruments: The most accurate data collection tool was adopted using the online method and data were analysed using SPSS (section 3.8.1). The response rate from the number of distributed questionnaires was 44% and the number of respondents used was 50 respondents out of 114 to generate meaningful results as required for computing statistical analyses. This was deemed to be fair as it was in line with similar studies conducted below:

- Ghahramani's (2016) objective was to Identify the factors that influence the effectiveness of OHSAS 18001 based on the perspective of the respondents in the adopting companies. Their study conducted interviews with 32 respondents from different companies with managerial roles.
- Yiu et al. (2019) in their study to identify the key driver constructs of Safety Management System implementation collected data from four companies.
- The objective of the study by Mashwama et al. (2018) was to assess the management strategy success factors for the improvement of OHS performance by SSCs in Zambia's electricity industry. Their study had 42 respondents and descriptive statistical analysis was used to interpret the data.
- Ligade and Thalange (2013) in their study to develop an OHSMS model for the construction Industry focused on a case study using one construction site.
- Badri (2015) in their study to determine the challenges of integrating OHS into Industrial Project Risk Management focused on a case study of two organisations.
- Lastly, Simpeh et al. (2021) on the effects of COVID-19 had 31 respondents.

Cronbach's alpha coefficient analysis: The Cronbach's alpha coefficient analysis was to test the reliability of the quantitative research question (section 4.10). The measure of reliability showed a high level of reliability, indicating consistent responses. Accordingly, it is possible to generalise results from this study to the South African construction industry.

5.8 Operational Framework for the implementation of an OHSMS

Figure 5.1 in Appendix C presents an operational framework for OHSMS implementation on South African construction industry. The adequate application of the recommendations presented in this study should improve OHSMS implementation. Based on the findings, both internal and external factors are listed in order of importance. It can also be noted that COVID-

19 regulations, considered as external factors, would have had an impact on the implementation. The ranking of factors will enable organisation on identifying factors that they need to prioritise. Once these factors have been identified and taken into account, and prepared for, implementation can start. The framework further shows that the implementation is conducted using the PDCA method. Since risk management is a part of the OHSMS, the risk management plan had to be integrated into OHSMS during the planning stage of the PDCA. Once the risk management is integrated, the Do, Check and Act steps can commence. Lastly, once the OHSMS has been implemented, it needs to be checked to ensure compliance with regulations, which compliance is an external factor. The framework shows that OHSMS implementation is interconnected with the factors, risks and PDCA. There is an interdependency on all the objectives outlined in this research.

5.9 Chapter summary

The findings of this study from both quantitative and qualitative analysis were provided in this chapter. The purpose was to explain the methodology used during the empirical data-gathering and present the results that followed. A web survey method was used to gather empirical data as it permitted the respondents to complete the questionnaire more quickly than they would by completing a Microsoft Word document or a hard copy. Based on the respondents' gender, age, qualifications, and experience, the demographic data revealed that they had sufficient expertise in the construction sector and were educated about the topic.

According to the existing literature, the data were analysed using SPSS software, and descriptive statistical analysis and regression analysis were utilised in the research to analyse the data acquired. The research findings were reviewed and interpreted. In the following five categories, the research findings are presented:

- Factors affecting OHSMS implementation
- Using the PDCA to implement the OHSMS
- Integration of risk management plan
- Effects of COVID-19 regulations on OHSMS implementation
- Biographic information of respondents

Chapter 6 of the study consists of the conclusions and recommendations.

CHAPTER 6: SUMMARY, CONCLUSION, AND RECOMMENDATIONS FOR FUTURE RESEARCH

6.1 Summary

6.1.1 Introduction

This chapter covers various aspects of the study, including validity and reliability, achievement of research objectives, conclusions, contributions to the body of knowledge, recommendations for further research, and summary of conclusions.

6.1.2 Achievement of research objectives

An analysis and discussion of the data derived from a quantitative and qualitative survey concerning the causes and effects of OHSMS implementation in South Africa were presented. Based on the outcomes obtained, conclusions were drawn, and suggestions were offered. The study aimed to analyse factors that affect OHSMS implementation in South African construction industry. The objectives in this study were as follows:

i) To identify factors that affect OHSMS implementation on construction sites.
ii) To analyse how the Plan Do Check Act (PDCA) method is used as a method of implementing an OHSMS.
iii) To assess the effect of COVID-19 regulations on OHSMS implementation.
iv) To evaluate how risk management is integrated into OHS during OHSMS implementation.

This was further explained by the operational framework for OHSMS implementation, as shown in **Figure 5.1.** The addendum attached explains all the factors in order of importance and how OHSMS can be implemented.

6.2 Conclusion

Construction workplaces are potential risk areas where accidents and injuries are prone to occur due to the complex scope of work involved (Osei-Asibey et al., 2021b). Therefore, implementing an OHSMS on construction sites is essential as it reduces injuries on sites. This research aimed to analyse factors affecting OHSMS implementation in the construction industry in the Western Cape, South Africa. The results of the study showed that many organisations faced difficulties with OHSMS implementation, which can be attributed to both internal and external factors to various degrees.

i) Factors affecting OHSMS implementation

The most important internal factors were identified as risk control strategies, senior management commitment and support, communication channels, training, hazard perception, education, risk awareness, risk identification, management, and processes safety culture. It was also evident that most clients did not accept the high costs that comes with OHSMS implementation, and most organisations found it difficult to embrace new technologies when implementing their OHSMS.

The most important external factors were identified as pressure from clients on project delivery, company reputation, OHS enforcement, and government legislation. Often production is prioritised over safety on most sites to achieve project deliveries or risk penalties from the client. Furthermore, this study found that non-compliance with OHS regulations results in accidents on-site.

ii) Using the PDCA method to implement and integrate risk management plan with OHSMS implementation

The results show that the PDCA is the most commonly used method for OHSMS implementation, mainly because it incorporates the risk management plan. This study also found that both external and internal factors affected the risk management plan. When formulating the risk management plan, the most common method used in organisations during the risk identification process on-site was found to be a checklist. In risk planning, the most common strategy used in organisations was risk mitigation/reduction, while on the risk assessment, the present findings showed that often quantitative risk analysis was the most common method used during risk assessment. The findings also showed that awareness was good, while the risk perception was low in most organisations of the respondents.

iii) Effect of COVID-19 regulations on OHSMS implementation

Lastly, it is apparent that the COVID-19 regulations affected OHSMS implementation, as the regulations had to be amended during the pandemic. This impacted project costs, project deliveries, and efficiency. The COVID-19 regulations resulted in non-compliance, as adherence to regulations while working under COVID-19 restrictions was difficult. The rigorous legislation and bureaucracy associated with COVID-19 had a significant effect on the OHSMS.

6.3 Limitations and recommendations for further study

6.3.1 Limitations

This study focused specifically on construction sites within the Western Cape Government in South Africa and the construction sites. The data collection from construction professionals was a cumbersome due to the demanding schedules of the respondents as construction

projects tend to have tight schedules. Hence, the response and participation took longer to receive, which is a presumptive known fact in the construction industry.

6.3.2 Recommendations for further study

Based on the results from this study, it is evident that the construction industry continues to encounter challenges with OHSMS implementation. Hence, the current research focused on the current challenges faced when implementing an OHSMS in organisations. To best manage OHSMS factors, each should be monitored and measured according to appropriate criteria and indicators. Therefore, focusing only on one aspect of the OHSMS can be misleading. Further research could be conducted on how to implement, maintain, and improve the OHSMS. This could be supported by identifying different steps that organisations take when implementing an OHSMS as the framework is not generic, but it depends on organisational needs (Sadiq, 2019:23). Future research could also be conducted on ways to navigate and plan for these factors and support the organisations so that the industry can reduce the challenges they face with OHSMS implementation. This could be beneficial especially to SMEs that tend to have resource challenges when implementing an OHSMS. This study recommends using the PDCA method with OHSMS implementation as this method allows for the integration of the risk management plan. The risk management plan is an important component as construction sites are high risk areas where accidents are prone to occur (Amiri et al., 2016). Lastly, this study could be expanded by adding research strategies such as interviews as they add to qualitative research findings.

6.3.3 Contributions

The knowledge gap was to identify and list in order of importance the factors that affected OHSMS implementation in the construction industry within the Western Cape. The research accomplished this by evaluating whether organisations were considering these factors. The literature reviewed contained mostly theoretical studies, where factors were global, and not specific to the construction industry. This research successfully ranked the factors applicable to the construction industry in the Western Cape.

Previous studies done by a few authors such as Mohammad et al. (2006) and Ligade and Thalange (2013) did not conclude which methods could be used to implement an OHSMS for construction organisations. The results from the current study showed that the PDCA was the most preferred method as it would also integrate the risk management plan during the planning stage. This could assist other organisations to apply the PDCA with OHSMS implementation as research confirms that it is the most preferred method.

The most common methods used during risk identification, assessment, planning and monitoring when producing a risk management plan. This could assist organisations that do not have a risk management plan in place to adopt the most common methods.

Lastly, it is evident that COVID-19 regulations affected OHSMSs during the pandemic. The contractor must devote time to educating and informing the workforce about the increased risks and controls.

6.3.4 Concluding summary

It is evident that the construction industry remains a high risk where OHS accidents are prone to occur. OHSMS implementation is essential to address the poor workplace conditions and risks that the construction industry continue to encounter. However, there are many barriers that should be identified and taken into consideration to successfully implement the system.

The objective of the research was to identify factors that affect OHSMS implementation in the construction sector within the Western cape and rank them in order of most important to least important. The data gathering was conducted through an online survey that was circulated to construction professionals in Western cape companies. The data were captured using SPSS to run frequencies, descriptive statistics and inferential statistics test using the Multi regression analysis.

After analysing all research objectives and interpreting the findings, the conclusions were developed in a meaningful way. The study's validity was explained, claiming that findings could be generalised to the South African construction industry. Furthermore, a framework was developed that outline all the factors needed for OHSMS implementation. In the conceptual conclusion, the empirical data findings were recapped, and a framework was proposed for OHSMS implementation. The framework produced could assist the South African construction industry with the factors that they need to prioritise when implementing an OHSMS as this is applicable to them.

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APPENDIX A: ETHICS APPROVAL CERTIFICATE

Cape Peninsula University of Technology

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

On **05 October 2021**, the Engineering and Built Environment Ethics Committee of the Cape Peninsula University of Technology granted ethics approval to **KUNODZIA, REJOICE** student number **218290950** for research activities related to her research proposal at the Cape Peninsula University of Technology.

	Leadership styles adopted by health andsafety practitioners towards successful implementation of health and safety management system.

Comments:

Data collection permission is required
Permission letter to collect data attached

	05 October 2021
Dr A Raji **Chairperson (Acting) – Faculty Research Ethics Committee Meeting**	**Date**

2021FEBEREC-STD-141

APPENDIX B: QUESTIONNAIRE

QUESTIONNAIRE SURVEY

Analysis of factors affecting the implementation of health & safety management system in Construction industries in Western Cape South Africa

Dear Sir/Madam,

PARTICIPATION IN A SURVEY

I kindly request your participation in a research project for my Master's in Construction Management in the Department of Construction Management at the Cape Peninsula University of Technology. The aim of the research is to analyse factors affecting the Implementation of Health & Safety Management System (OHSMS) in Construction industries in Western Cape South Africa.

Please read all questions carefully and answer all questions. The survey will take about 15 minutes to complete. The completed questionnaire should be returned before the 31st of July 2022. Alternatively, you can complete the questionnaire online on the following web link below.

All information provided in this study will be strictly **CONFIDENTIAL** and information obtained from survey will only be used for research purposes. This research study has been undertaken for academic purposes, your participation in the survey will not bear any consequence to the reputation of your organisation or your professional career.

Rejoice Kunodzia
E-mail: 218290950@mycput.ac.za
Department of Construction Management
Mobile: +27 (0) 749022103

Thanks for your cooperation and participation.

SECTION A: Personal Details (circle the most appropriate response)

1. Please, cross or tick as appropriate (x or √) to indicate your opinion

1.1 Kindly indicate which best describes your company:

Health and Safety professional firm	
Construction firm	
Government establishment firm	
Project management firm	
Others (Specify)	

If other, please specify…….

1.2 Please indicate your gender:

Male	
Female	

1.3 Please indicate your age group:

Below 25	25–30	31–40	41–50	51–60	Above 60

1.4 Please indicate your highest formal qualification:

Matric Certificate	Artisan Tradesman	Diploma	Bachelor's/ Honour's degree	Master's degree	Doctorate degree	Other

If other, please specify…….

1.5 Kindly indicate your present position in your firm.

Project Manager	
Site Manager	
Contracts Manager	
Professional Health and Safety Agent	
Health and Safety Manager	
Health, and Safety Officer	

Quantity Surveyor	
Architect	
Site Foreman	
Other	

If other, please specify…….

1.6 How long have you been working in this position?

0–5yrs	6–10yrs	11–15yrs	16–20yrs	Above 20yrs

<u>Section B:</u> Factors that affect the implementation of the Occupational Health and Safety Management System (OHSMS) on Construction sites.

2. To what extent do you agree that the following internal factors affect the implementation of an OHSMS in your organisation? **Please indicate your answer using the following 5 – 1 scale: Where 5=Strongly agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly disagree.**

Factor	**5**	**4**	**3**	**2**	**1**
Allocation of resources					
Senior management commitment and support					
Organisational structure					
Occupational health and safety (OHS) training					
Communication channels					
Uncertainty in reporting systems					
Risk identification, management, and processes					
Risk control strategies					
Safety policy					
Training, hazard perception, education, risk awareness					
Lack of competent workers					
Safety culture					
Internal incentives					
Cost of implementation					
Working conditions and scope of work					
Constrictive project durations					

Please indicate if the following applies to your organisation**. Please, cross or tick as appropriate (x or √) to indicate your opinion.**

Item	Factor	Yes	No	Unsure
1	Does management allocate enough resources toward the implementation of an OHSMS?			
2	Do employees participate in the implementation of an OHSMS?			
3	Does your organisation offer training in OHS?			
4	Do clients accept the high costs of OHSMS implementation?			
5	Is there an existing risk management plan in your organisation?			
6	Has the risk management plan been integrated into the OHSMS?			
7	Is the risk management plan monitored, reviewed, and reported in your organisation?			
8	Do external and internal forces have an impact on the risk management process in your organisation?			

To what extent do you agree that the following external factors affect the implementation of an OHSMS in your organisation? **Please indicate your answer using the following 5 – 1 scale: Where 5=Strongly agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly disagree.**

Factor	5	4	3	2	1
OHS enforcement and government legislation					
Support from OHS authorities					
External incentives					
OHS auditing procedures					
Covid regulations					
Pressure from clients on project delivery					
International trends					
Company reputation					

Please indicate if the following applies to your organisation**. Please, cross or tick as appropriate (x or √) to indicate your opinion.**

Item	Factor	Yes	No	Unsure
1	Do changes in legislation affect the implementation of an OHSMS?			
2	Are new technologies embraced and incorporated into the OHSMS?			
3	Are routine health and safety inspections conducted on sites?			

4	In your view, do you think all the elements of the OHS regulations affect production on-site?			
5	In your view do you think that non-compliance with the OHS regulations increases risks on-site?			

Section C: How risk management is integrated into Occupational Health and Safety Management System (OHSMS) during implementation.

Kindly indicate from the list below the most common methods used in your organisation during the risk identification process on-site: **Please, cross or tick as appropriate (x or √) to indicate your opinion.**

Brainstorming	
Swot analysis	
Delphi technique	
Checklist	
Expert judgment	
Experience	
Interviews	

If other, please specify…….

From the list below, please indicate the most common strategies used in your organisation during risk planning onsite: **Please, cross or tick as appropriate (x or √) to indicate your opinion.**

Risk avoidance	
Risk transfer	
Risk mitigation/reduction	
Risk exploitation	
Risk sharing	
Risk acceptance	
Contingency plan	

If other, please specify…….

How often are the following analysis conducted at your organisation during risk assessment? **Please indicate your answer using the following 5 – 1 scale: Where 5=Always, 4=Often, 3=Sometimes, 2=Rarely, 1=Never.**

Factor	5	4	3	2	1
Qualitative risk analysis through the probability and impact of risk.					
Risk probability and impact assessment through evaluating the likelihood of occurrence of a specific risk and impact of the risk.					
Probability/impact risk rating matrix through risk rating e.g., high, medium, or low.					
Risk categorisation and Risk Urgency Assessment through identification of threats.					
Quantitative risk analysis through assessment of risk to determine the effect on time, cost, and duration of the project.					
Decision Trees.					

How do you rate the degree of risk perception and awareness within your organisation? **Please indicate your answer using the following 5 – 1 scale: Where 5=Excellent, 4=Very good, 3=Good, 2=Fair, 1=Poor.**

Factor	5	4	3	2	1
Risk awareness					
Risk perception					

<u>Section D:</u> How is the PDCA method used in implementing the Occupational Health and Safety Management System (OHSMS)

10. Please indicate if the following applies to your organisation:

Item		Yes	No	Unsure
1	Does your organisation use the Plan Do Check Method when implementing an OHSMS?			

10.1 If **No**, please indicate the method used …….

10.2 If **yes**, please indicate from the list below if the use of PDCA has improved the following items during the implementation of an OHSMS.

Item	How the PDCA is used to implement OHSMS	Yes	No	Unsure
1	Have the risk planning, identification, analysis, and risk management improved?			
2	Doing phase of actual implementation of OHSMS through identifying risk assessment.			

3	Exploring solutions to accidents on sites.			
4	Health and safety checklists and audits.			
5	Identification of gaps and corrective actions in OHSMS.			
6	Continual improvement of OHSMS.			

Section E: To what extent have the COVID-19 regulations affected the implementation of OHSMS

11. Please indicate if the following applies to your organisation

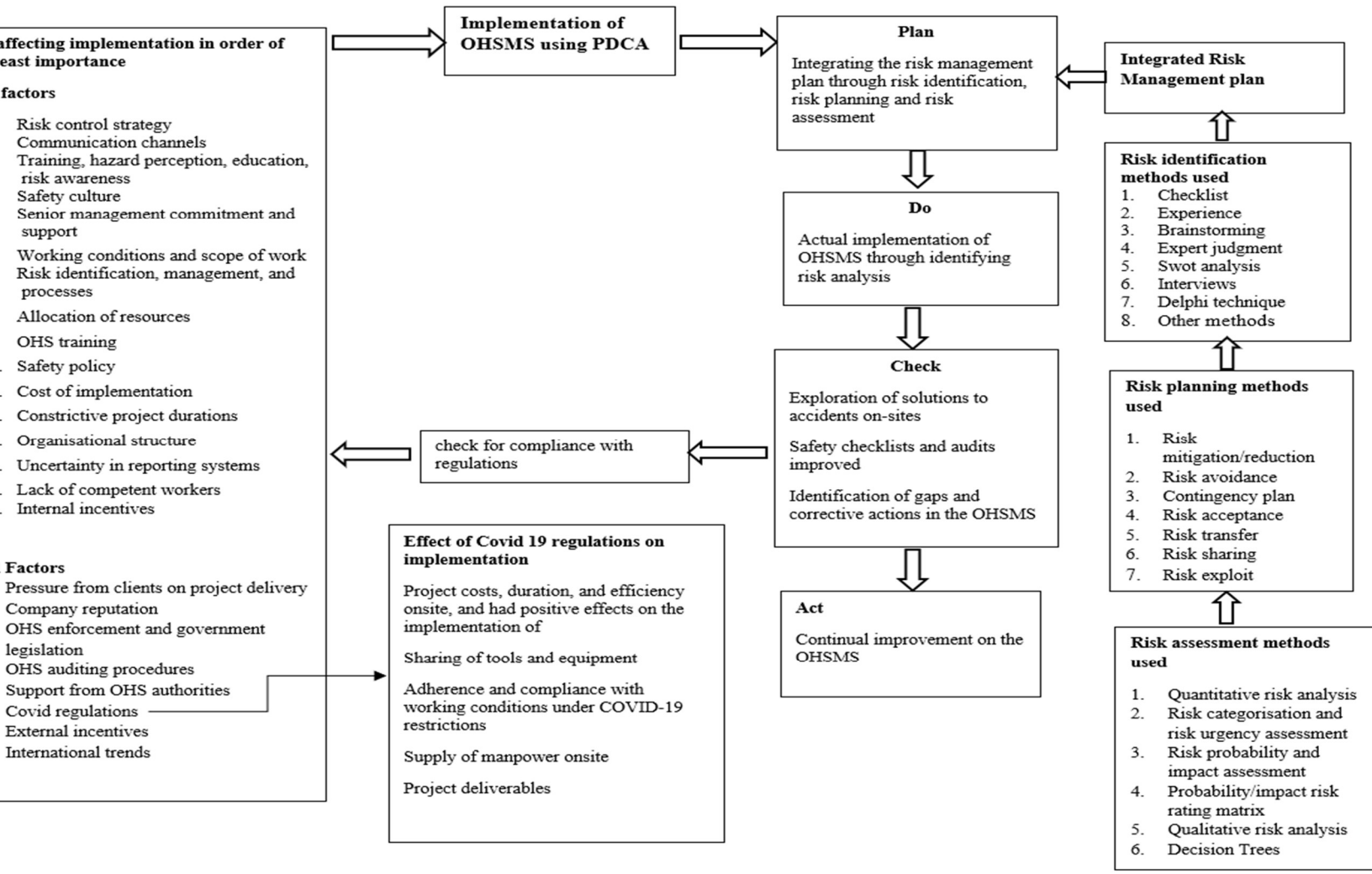
Item		Yes	No	Unsure
1	Does your organisation have a COVID-19 safety regulations plan in place?			
2	Have the COVID-19 regulations affected your project costs, duration, and efficiency on-site?			
3	Does your organisation conduct training on COVID-19 working conditions?			
4	Has the sharing of tools and equipment affected your organisation due to COVID-19 restrictions?			
5	Do your employees find it easy to adhere and comply with working conditions under COVID-19 restrictions?			
6	Have the COVID-19 restrictions affected your project deliverables negatively?			
7	Have the COVID-19 regulations affected your supply of manpower on-site?			

12. To what extent do you agree or disagree with the statement that COVID-19 regulations have affected the implementation of OHSMS in your organisation? **Please indicate your answer using the following 5 – 1 scale: Where 5=Strongly agree, 4=Agree, 3=Neutral, 2=Disagree,1=Strongly disagree.**

Effect of Covid regulations	5	4	3	2	1
COVID-19 regulations have affected the implementation of OHSMS in your organisation.					

YOUR PARTICIPATION AND COOPERATION IS MUCH APPRECIATED!

APPENDIX C: OPERATIONAL FRAMEWORK FOR IMPLEMENTATION OF OHSMS



APPENDIX D: JOURNAL COMPARISONS USED FOR LITERATURE REVIEW

COMPARISONS OF JOURNALS USED

	Research Topic	Author	No of respondents	Objectives	Type of tests conducted	Results
	Implementation of Safety Management System for Improving Construction Safety Performance: A Structural Equation Modelling Approach	Yiu et al. (2019)	334 (from 4 construction firms)	The purpose of current study is to identify the key 'driver' constructs, i.e., SMS implementation and safety proxies of construction project.	Likert scale, the Partial Least Square Structural Equation model (PLS-SEM).all path links were found significant at the 1% level (Rule 5, with t-statistic all greater than 2.58 for two-tailed test). This implied that all the paths between the latent constructs and concerned factor attributes of the proposed Structural model were valid.	Results indicated the relationship between SMS implemen positive project outcomes, based on the empirical data. Sinc implementation and operational/safety proxies are latent, a model was set out. Results indicated that the five motivation SMS implementation could contribute to the improveme operational and safety performance, as revealed by six attributes. This suggested that the existing SMS framework enhanced by incorporating a number of relevant incenti institutional cooperation among clients, engineers, and contrac be essential, given the constraints of financial budget, and contractual obligation. Findings also implied the optimal allocation could be established for sustained improvement in c and safety performance of the construction sector, abovementioned constraints. More importantly, more institutional reviews could be stimulated on the safety ma practice, project operation, and safety education and training p the authority.
	Developing a global occupational health and safety management system model for Japanese companies	Kajiki et al. (2020)	9 countries with 9 interviews of each site s management.	To develop and validate a global occupational health and safety management system (OHSMS) model for Japanese companies.	Formulated a model.	2 issues concerning the functioning of the headquarters were the need to establish a reporting system to the headquarte need to support the improvement of specialised human resou it was deemed necessary to clarify the reporting mechanism the company headquarters to better understand and co situation at each site. Second, the local professionals appointed lacked sufficient knowledge and experience in rela hygiene and health sectors.
	Factors that influence the maintenance and improvement of OHSAS 18001 in adopting companies: A qualitative study	Ghahramani (2016)	16 managers of 16 different companies	Identify the factors that influence the effectiveness of OHSAS 18001 based on the perspective of the respondents in the adopting companies.	The interview-format was pre-tested in two pilot interviews, which were excluded from further analysis; content analysis.	**Int** 1. Senior management commitment to safety. 2. Lack of in external safety communication. 3. Employee involvement. integration of OHSAS. 5. OHS training. 6. Safety culture. incentives. **Ext** 1. OHS enforcement. 2. OHS authorities' s Quality of third-party audits. 4. External incentives.

COMPARISONS OF JOURNALS USED

	Research Topic	Author	No of respondents	Objectives	Type of tests conducted	Results
	Occupational Health and Safety Management Model for Construction Industry	Ligade and Thalange (2013)		The objective of this study is too imperative that the Construction is a high-risk industry for clients, contractors and workers alike.	Theoretical	Accident records and cost is an important aspect for pro OHSMS model.
	Relationship between degree of risk, cost and level of compliance to occupational health and safety regulations in construction	Windapo (2013)	4 construction sites in Western Cape	Investigates the role of statutory (H&S) regulations in managing construction project risks. The study examines whether the decision made by contractors to comply with the regulations, the cost of compliance and savings of H&S regulatory requirements is influenced by the degree or level of risk, which the regulations are trying to prevent.	mixed method research approach; frequency analysis, percentage scores, risk matrix analysis, composite risk index (see Ciobanu and Mazilu), cost of compliance and savings relative importance index and Pearson Product Moment Correlation and Regression analysis, which was used to test the relationship between the variables. Test for Reliability.	The study established that the level of a contractor's compl H&S regulatory requirements is significantly related to perc savings and unrelated to the degree of risk, which the regulati to prevent. The study findings also reveal that OHSA com considered by contractors to be unnecessarily costly and time to implement and as a result, a contactor perceives that high compliance requires more money. It also emerged in the stud savings are positively related with probability of accident which is a component of the degree of risk.
	Evaluating Occupational Health and Safety Management Strategy Success Factors for Small-Scale Contractors in Zambia	Mambwe et al. (2021)	246 - 70.3% response rate	Assess the management strategy success factors for the improvement of OH&S performance by SSCs in Zambia's electricity industry.	Descriptive and inferential statistics; simple random sampling; correlation; Kaiser-Meyer-Olkin (KMO) and Bartlett's test of specificity for squared correlation between variables.	**1.** OH&S policy, monitoring and supervision of OH&S, perm systems were ranked highest success factors to the impro OH&S performance at projects. However, integrating O management functions, involvement of stakeholders and e and management commitment and accountability were ranke **2.** Most highly ranked factor was Development of OH&S polic by monitoring and supervising of OH&S. The least ranke factors indicate, Integrating OH&S with management Involvement of stakeholders and employees and Ma commitment and accountability as last. **3.** Compliance and processes was the first component; Policy and Human Development; Leadership and Structure.

COMPARISONS OF JOURNALS USED

	Research Topic	Author	No of respondents	Objectives	Type of tests conducted	Results
	Occupational health and safety challenges among small and medium sized enterprise contractors in South Africa	Mashwama et al. (2018)	42	Study examined the OHS challenges among SME's Contractors in Gauteng Province, South Africa.	Descriptive statistical analysis.	**1.Level of Implementation of OHS in SME's Contractors importanc**e: Lack of regular inspections and audits; management/supervision/information flow; Poor mate components; Lack of management commitment; Lack of equi tools; Poor communication; Lack of employees involvemer training and risk education; Lack of skilled workforce; Work ar Poor work/jobsite conditions; Lack of subcontractors involver of incentive for good performance; Lack of investigations assessments**.** **2.Challenges Facing SME's Contractors Order of importa** of knowledge of pricing document; Communication shortfall H&S education; Infrequent inspections; Poor technical s ignorance of regulatory obligation; Ignorance of contractual ri of internal H&S competence; Inadequate H&S training; Sl promoting OHS; In competent employees; Reporting shortfal managerial skills; Lack of resources, time and money; Lack skills; Lack of qualified safety officers on site; Inadequate atter to OHS; Higher compliance.
	Construction health and safety culture in South African small and medium enterprises.	Agumba and Haupt (2009)	16	Investigate the H&S culture in SMEs.	Descriptive survey using semi-structured and structured questionnaire, and non-probability sampling.	Commitment to H&S, support of health and safety, goal s review of H&S, creating structure and process that promote reviewing leaders' performance/self-improvement are part of H of SMEs. Internal and external communication is also used t health and safety issues.
of	The Challenge of Integrating OHS into Industrial Project Risk Management: Proposal of a Methodological Approach to Guide Future Research (Case of Mining Projects in Quebec, Canada)	Badri (2015)	Case study on 2 mining companies	How to integrate OHS into project risk management and achieve simultaneous evaluation of all of the risks identified.	A conceptual and methodological approach is proposed to guide future research focused on meeting this challenge.	Using the new "concentration of hazards" concept and m evaluation, the new approach developed was applied to hazards and calculating their concentrations relative to each u event identified.

COMPARISONS OF JOURNALS USED

	Research Topic	Author	No of respondents	Objectives	Type of tests conducted	Results
on e on	Barriers to the implementation of COVID-19 safety regulations: insight from Ghanaian construction sites	Simpeh et al. (2021)	31	Barriers to the implementation of COVID-19 safety regulations: insight from Ghanaian construction sites.	Qualitative research method using an open-ended questionnaire. Data were analysed by means of the thematic analysis technique.	Barriers when implementing OHSMS are: Cost of implementir 19 safety measures; lack of compliance and ignorance were id the most hindering factors, whereas superstition, lack of protective equipment supply and theft of COVID-19 mate reported by fewer respondents.
g nal ent n s	Factors influencing occupational health and safety management practices in companies	Nordlöf (et al., 2017). A cross-sectional study of factors influencing occupational health and safety management practices in companies.	280	investigate whether factors such as company size, safety culture, and different measures of financial performance are associated with OHSM practices in companies.	Ordinal regression analysis.	Company size, safety culture, and creditworthiness were fo associated with better, as well as worse, OHSM practices in c (depending on directionality).Being a large company and positive safety culture as well as low risk in creditworthiness w to be protective factors for better OHSM practices as compare a small one.
g atio S on ons ve	Factors Influencing Implementation of OHSAS 18001 in Indian Construction Organisations: Interpretive Structural Modelling Approach	Rajaprasad and Chalapathi (2015). Factors influencing implementation of OHSAS 18001 in Indian construction organisations: Interpretive Structural Modelling Approach.		Theoretical framework to identify factors and using an interpretive structural modelling approach to identify factors. (MICMAC) analysis.	Theoretical framework to identify factors and using an interpretive structural modelling approach to identify factors; (MICMAC) analysis.	Management commitment has the maximum driving power an influential factor is safety policy, which clearly states the com top management towards occupational safety and health.
the on nal l ent	Assessing the impact of processes on the Occupational Safety and Health Management System's effectiveness	Sklad (2019). Assessing the impact of processes on the Occupational Safety and Health Management System's	Theoretical	Theoretical using the Fuzzy Cognitive Maps.		It was finally proven that safety performance increased most s under the influence of improvement of the leadership pro proves that among all processes in the system, leadershi greatest positive impact on its effectiveness.

COMPARISONS OF JOURNALS USED

	Research Topic	Author	No of respondents	Objectives	Type of tests conducted	Results
ess	using the fuzzy cognitive maps approach	effectiveness using the fuzzy cognitive maps approach.				
al ent s.	Barriers to occupational health and safety management in small Brazilian enterprises	Garnica and Barriga (2018). Barriers to occupational health and safety management in small Brazilian enterprises.	56	To determine main barriers to the implementation of occupational health and safety management systems OHSMS in the context of small Brazilian enterprises from the perspectives of owners/managers, labour auditors, and OHS consultants.	Survey with three different perspectives on small Brazilian enterprises.	Owners/managers tend to blame employees and the gover difficulty in implementing OHSMS, and external actors tend management and resource allocation. Opinions con inappropriate management behaviour, ineffective inform communication and production prioritisation.
g an to d e ess S	The study offers this approach as a tool to evaluate and promote the effectiveness of OHSAS 18001 standard.	Mohammadfam et al. (2016)	Theoretical	To develop an integrated decision making approach to assess and promote the effectiveness of occupational health and safety management systems.		The most influential factors to be considered to improve the eff of OHSAS 18001 standard are management commitment participation, allocation financial resources, training, risk as definite responsibility, communication and dissemination of oc health and safety results and activities.
g atio ty ent on	Factors influencing the implementation of a safety management system for construction sites	Ismail et al. (2012). Factors influencing the implementation of a safety management system for construction sites.	275	Objective of the study: determine the influential safety factors that governed the success of a safety management system for construction sites.	Self-administered three-part questionnaire among the workers and interviews with industry experts involved in brick-laying, concreting and in related assorted trades.	the most influential safety factor was personal awareness closely by communication.

COMPARISONS OF JOURNALS USED

	Research Topic	Author	No of respondents	Objectives	Type of tests conducted	Results
of nal l ent an on s	To propose a way of diagnosing the current situation in occupational safety and health in the construction industry	Sanchez et al. (2018)	SWOT analysis. A survey of 25 questions with 209 respondents	To perform a comprehensive diagnosis of the implementation of the requirements of the Colombian Technical Standard NTC - OHSAS 18001 in Colombian construction companies through a SWOT analysis.	SWOT analysis. A survey of 25 questions with 209 respondents	The findings show that a lack of commitment and a lack of k about safety are the main weaknesses. On the other hand, the of occupational health and safety (OHS) staff and the promoti by Occupational Risk Administrators (ORA) are the main streng this data alternatives for improving OHS are proposed, such investment in builders, increasing organisational culture and monitoring by the State.
nal ent al s: A e tor	To analyses the level of maturity of the occupational health and safety (OHS) management system in municipal waste companies in Italy.	Battaglia et al. (2015). Occupational health and safety management in municipal waste companies: A note on the Italian sector.		To analyses the level of maturity of the occupational health and safety (OHS) management system in municipal waste companies in Italy.		The results show that the training and involvement of emplo operational activities are the most developed aspects, while C and performance measurements need further improvemen companies have a sufficiently developed level of maturity in ter OHS management system. An analysis of contextual factors re organisational factors are more correlated with the OHS ma system maturity level than external factors. Companies loca south of Italy have a low level of maturity in terms of OHS ma Audits by public authorities exercise a punitive role and pressure is not considered by all the companies as a key fact development.

12 July 2023

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CERTIFICATE - EDITING OF MASTER'S THESIS

I, the undersigned, herewith confirm that the editing of the Master's thesis of **Rejoice Kunodzia**, *"ANALYSIS OF FACTORS AFFECTING THE IMPLEMENTATION OF HEALTH AND SAFETY MANAGEMENT SYSTEMS IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY WITHIN THE WESTERN CAPE"* has been conducted and concluded.

The finalised thesis was submitted to Me Kunodzia on 12 July 2023.

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Sincerely

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