Analysing knowledge management frameworks for an explosives manufacturing company in South Africa

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Mini-dissertation accepted in partial fulfilment of the requirements for the degree *Master of Business Administration* at the North-West University

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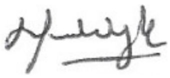
Graduation: June 2025

DECLARATION

I hereby declare that the mini-dissertation submitted herewith to the North-West University in partial fulfilment of the requirements for the Master of Business Administration (MBA) degree is my own original work. It has been text-edited following professional communication standards and has not been previously submitted to any other institution for evaluation purposes.



Derick Johannes van Wyk

40267946

20 October 2024

ACKNOWLEDGEMENTS

First and foremost, I would like to thank and praise my Father in heaven, our God Almighty, for His unwavering guidance, strength, and grace throughout my MBA journey. His presence has been a constant source of encouragement and inspiration during the challenges of the past two years, enabling me to persevere and complete this dissertation.

I am profoundly grateful to my devoted wife, Esta van Wyk, for her unwavering patience, understanding, and support during my MBA studies. I am so grateful to have you by my side because your support and faith in me have been my anchor.

I am also grateful to my supervisor, Professor Nelda Mouton, for her insightful guidance, constructive feedback, and unwavering support throughout the research study. Your expertise and encouragement have been instrumental in shaping this mini-dissertation.

I want to thank Professor Stéphan van der Merwe, my lecturer in research methodology, whose guidance and advice provided a solid foundation for my study. Your insights into the intricacies of research methodology were of great value and helped steer me in developing a research study that is of academic value to the Explosives industry of South Africa.

My appreciation also extends to Dr Shawn Liebenberg, who assisted with analysing the quantitative data for this study. Your support and expertise in navigating the complexities of the data analysis were essential to the results and findings of this study.

Finally, I want to express my sincere gratitude to Professor Neels van Heerden, who offered invaluable advice during the final stages of the review. Your attention to detail and thoughtful feedback contributed significantly to refining this dissertation.

To all of you, my deepest thanks. Without your support, this achievement would not have been possible.

ABSTRACT

The explosives manufacturing industry in South Africa is small, diverse and highly competitive. Knowledge Management (KM) is vital in maintaining a competitive advantage in this industry by transforming tacit knowledge into explicit knowledge.

The main benefit of a KM framework is that it assists an organisation in implementing a process to convert tacit knowledge into explicit knowledge. The first component of a KM framework comprises Critical Success Factors (CSFs) and their associated KM enablers, which provide the supporting structure for KM implementation in an organisation. The second component of a KM framework comprises KM practices that assist with knowledge transfer in an organisation.

This study focused on developing a KM framework for an explosives manufacturing company in South Africa by identifying and testing four CSFs and their associated KM enablers. The study further identified and tested fifteen KM practices under five KM adoption approaches.

The research employed a quantitative, deductive approach to evaluate the importance of KM enablers and practices in an explosives manufacturing company in South Africa. The study's sample included 1,054 employees across four production sites in three South African provinces. An online survey questionnaire collected the data.

Structural Equation Modelling (SEM) analysed the relationships between the independent variables (KM enablers and KM practices) and the dependent variable (KM implementation and Knowledge transfer).

Based on the study's findings, a conceptual KM framework was developed for an explosives manufacturing company in South Africa.

Key terms: Knowledge Management, Critical Success Factors, KM Enablers, KM Practices, KM Adoption Approaches

LIST OF ABBREVIATIONS

BI	Business Intelligence
CB-SEM	Covariance-based SEM
CoP	Community of Practice
CSF	Critical Success Factor
ERP	Enterprise Resource Planning
HF	Human-orientated Factor
HRM	Human Resources Management
ICT	Information and Communication Technology
IT	Information Technology
KM	Knowledge Management
KMAT	Knowledge Management Assessment Tool
KMMAM	Knowledge Management Maturity Assessment Matrix
KMMAQ	Knowledge Management Maturity Assessment Questionnaire
MA	Management Aspects
NCACC	National Conventional Arms Control Committee
NWU	North-West University
OA	Organisational Aspects
PLS-SEM	Partial Least Squares SEM
POPIA	Protection of Personal Information Act
R&D	Research and Development
SEM	Structural Equation Modelling
SME	Small and Medium-sized Enterprise
SOE	State-Owned Enterprise
SPSS	Statistical Package for the Social Sciences
TA	Technology-orientated Aspects

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Knowledge Management (KM) is a business process that regulates the management and use of intellectual and information assets in an organisation. It includes explicit knowledge (in documents, databases, and procedures) and known but unstored tacit knowledge (such as worker expertise and experience). Scholars define KM as an integrated approach to creating, transforming, storing, retrieving and sharing knowledge inside the business to support and enhance operational performance (Gartner, 2024; McInerney & Koenig, 2011:1; Usman *et al*., 2021:4; Weru, 2023:13).

Manufacturing firms comprise of employees, processes, and technology. Since most explosives manufacturing companies employ similar production processes and technology, a company can achieve a competitive advantage by extracting value from the employees' competencies and capabilities (Abraham, 2021:292; Fivaz & Pretorius, 2015:1). Companies acknowledge that knowledge is essential for sustaining a competitive advantage and therefore regard employees who generate new knowledge as a vital asset of the organisation (Lee & Choi, 2003:179; Singh *et al*., 2022:12193; Usman *et al*., 2021:3).

In South Africa, there are two military explosives manufacturers, four major commercial explosives manufacturers, and several smaller commercial explosives manufacturers (Sivhabu, 2018:9; Verster, 2014:11). The mining sector is the biggest user of commercial explosives in South Africa. Mining companies use commercial explosives to extract minerals from the ground (Sivhabu, 2018:8). Commercial explosives differ from military explosives in several ways: Commercial explosives are less expensive, have a lower velocity of detonation and produce higher volumes of gas during detonation, making it suitable for rock breaking during mining operations (Verster, 2014:20). The commercial explosives market in South Africa is very competitive and price-sensitive, and by 2015, the South African mining explosives market was worth $530.7 million. In 2023, the Middle East and African mining explosives market was valued at $769 million and is expected to grow to $1.0 billion by 2030 (Frost & Sullivan, 2017; Joshi, 2023). Ammunition manufacturers in South Africa fill ammunition components with explosives, which are produced locally or imported (Verster, 2014:21). According to the annual report of the National Conventional Arms Control Committee (NCACC), ammunition accounted for R1.6 billion of South Africa's defence exports in 2022 (Martin, 2023). In 2023, the NCACC approved R4.9 billion worth of defence exports, of which ammunition was a significant component (Martin, 2024).

Since knowledge provides companies with a competitive advantage, successful companies can transform tacit knowledge into explicit knowledge (Abraham, 2021:291; McInerney & Koenig, 2011:19; Nonaka, 1991:162-163). According to Abraham (2021:291), KM is the organisation's ability to transform tacit knowledge into useful explicit knowledge to benefit the company. Publications on KM systematically increased from 1987 to 2006. However, in 2007, there was a sudden surge in publications indicating that KM became a topic of interest under management scholars (Akhavan *et al*., 2016:7). According to Akhavan *et al*. (2016:15), by 2012, operational research and management science were among the major research areas for KM.

This study explored suitable KM practices for an explosives manufacturing company by testing fifteen KM practices grouped under Singh *et al*.'s (2022:12206) five KM adoption approaches: (1) Knowledge acquisition (knowledge documents, hierarchies and piers), (2) Knowledge sharing (job rotation, people contact, databases, teams, forums), (3) Training and mentoring (formal training, mentoring), (4) KM technology (technical solutions, human-centred information technology), (5) KM environment (fairs, best practices repositories, knowledge-sharing culture, networking). The study also tested ten KM enablers grouped under four Critical Success Factors (CSFs) of KM identified by Heisig (2009:14): (1) Human-orientated factors (culture, people, leadership), (2) Organisational aspects (structure, processes), (3) Management aspects (strategy, goals, measurement), (4) Technology-orientated aspects (infrastructure, applications).

The study investigated an explosives manufacturing company with four production sites in South Africa.

1.2 Background to study

Michael Polanyi, in 1966, classified human knowledge into two categories: Explicit knowledge (codified knowledge) and tacit knowledge (Abraham, 2021:291; McInerney & Koenig, 2011:45; Nonaka, 1994:16).

Liew (2007:5) states that knowledge resides within an individual's mind, and it is the ability to recognise ("know-what"), being able to act ("know-how") and understand ("know-why"). According to Davenport and Prusak (1998:16), a large part of a company's knowledge resides in the minds of its employees (Liew, 2007:5). Sumbal *et al*. (2019:631) argue that critical knowledge resides in the minds of employees with years of experience. Leonard and Swap (2006:329) refer to employees with tacit knowledge and first-hand experience as "deep smarts". Deep smarts are regarded as knowledge assets because these employees possess the "know-what", "know-how", and "know-why". Scholars argue that tacit knowledge develops over time and is shaped by individual beliefs and social interaction (Liew, 2007:5; Leonard & Swap, 2006:329). Tacit knowledge is difficult to formalise and communicate within the organisation (Abraham, 2021:291; Nonaka, 1991:165). The tacit-orientated level focuses on gaining and sharing organisational knowledge through personal interaction (Choi & Lee, 2002:406; Piorkowski *et al*., 2012:2177).

According to Nonaka (1991:165), explicit knowledge is official and systematic information a person can document and communicate to other employees (e.g., product specifications, standard operating procedures). Choi and Lee (2002:406) argue that explicit knowledge can be easily formalised, documented, stored, and shared through databases and Information Technology (IT) systems. The explicit-orientated level focuses on codifying and storing organisational information to allow easy access and use for employees (Abraham, 2021:291; Choi & Lee, 2002:406).

According to Phaladi (2022:1), the resource-based view theory (a firm's competitiveness depends on valuable resources) and the knowledge-based view theory (knowledge is a scarce and valuable source) require knowledge-intensive organisations to invest in organisational capabilities (e.g., culture, structures, processes, systems) to safeguard the company's human and knowledge capital assets. Research over the years has verified that organisational culture and structure influence knowledge transfer and retention in a company (Kunthi *et al*., 2017:30; Phaladi, 2022:2). According to Weru (2023:23), Information and Communication Technology (ICT) is an essential element of KM in a manufacturing company to ensure information is communicated to all personnel as quickly as possible.

Choi and Lee (2002:406) categorise KM into four styles: Passive, system-orientated, human-orientated, and dynamic (Piorkowski *et al*., 2012:2176). The passive style refers to companies that show no interest in KM and do not exploit knowledge through culture, structure, and information technology (Choi & Lee, 2002:403; Piorkowski *et al*., 2012:2176). Companies with a system-oriented style use IT systems to codify and share information. Knowledge is managed and communicated formally, leading to faster customer response. Training programmes within such companies enhance management capabilities (Choi & Lee, 2002:403; Kunthi *et al*., 2017:31; Piorkowski *et al*., 2012:2176). Companies with a human-oriented style focus on acquiring and sharing tacit knowledge. Tacit knowledge resides in personal experience and social networks; therefore, communication and trust are essential within such organisations (Choi & Lee, 2002:403; Piorkowski *et al*., 2012:2176). Companies with a dynamic style manage both tacit knowledge and explicit knowledge. Dynamic-style organisations depend on encultured knowledge and the use of ICT to support group work. Research indicates that companies with dynamic KM styles have the highest performance (Choi & Lee, 2002:403; McInerney & Koenig, 2011:16; Piorkowski *et al*., 2012:2177).

Successful companies continuously seek to implement KM methods (tools) to improve business performance, competitiveness and profitability (Choi & Lee, 2002:403; Kunthi *et al*., 2017:29; Usman *et al*., 2021:4). Recent studies showed that KM assists companies in adopting and implementing Enterprise Resource Planning (ERPs) and Business Intelligence (BI) systems quickly, allowing the organisation to remain competitive during the Industry 4.0 transformation era. The study emphasises that managers must contemplate executing strategies to manage emerging knowledge and skills that stem from structured performance programs and establish transparency policies that prioritise a human-centric approach (Lara-Pérez *et al*., 2024:9-10).

According to Shao *et al*. (2024:1), manufacturing firms must utilise digital KM to obtain and incorporate external innovative resources, explore collaboration opportunities with outside stakeholders, and establish a mutually advantageous innovation knowledge network, thus enhancing technological innovation capacities. Furthermore, manufacturing companies should motivate employees to learn digital technologies and foster an environment that supports learning and innovation (Shao *et al*., 2024:1)

Implementing a practical KM framework gives manufacturing companies a competitive advantage (Fivaz & Pretorius, 2015:1). The KM framework enables the company to handle knowledge at an operational level and allows managers to make informed decisions and achieve better results (Heisig, 2009:5). Scholars agree that there is no standardised framework for measuring KM success (Kruger & Johnson, 2013:1). This study relied on different theories and concepts that are essential for the effective management of tacit knowledge in an explosives manufacturing company.

1.3 Problem statement

The explosives market in South Africa is small, highly competitive, and mainly dependent on the mining industry. While commercial explosives manufacturers produce the final explosive products used by the mining industry (e.g., detonators), military explosives manufacturers in South Africa produce and supply commercial manufacturers with high and low explosives to fill their products. Military explosives manufacturers in the country are primarily State-Owned Enterprises (SOEs) (Verster, 2014:21).

Phaladi and Ngulube (2022:6) state that KM practices in most SOEs in South Africa are inadequate, affecting knowledge retention and transfer. The lack of effective KM practices in most SOEs is heightened by the absence of structured coaching and mentoring programmes (Phaladi & Ngulube, 2022:6).

According to Naicker (2023:1856), it takes time for employees to gain the necessary knowledge, and the biggest challenge faced by South African companies is employee turnover. Research indicates that the emigration of skilled professionals in South Africa continues to increase (Kaplan & Höppli, 2017:512). Mlambo and Adetiba (2019:3) state that more than 300 engineers leave the country annually. The loss of knowledge and experience in SOEs can be attributed to voluntary and involuntary personnel turnover (Phaladi & Ngulube, 2022:6). Rijamampianina (2015:251) states that employee turnover rates for South African companies negatively affect their operational and financial performance. Employee turnover in explosives manufacturing companies results in the loss of explicit and tacit knowledge crucial to operational and financial performance.

Bessick and Naicker (2013:7) argue that knowledge retention is necessary to secure knowledge in an organisation and found that the main determinants that affect barriers in KM are organisational commitment, job satisfaction, job characteristics and talent management.

The knowledge and skills of explosives production processes reside with a small group of explosives scientists, engineers, and technicians in the explosives industry of South Africa (i.e., these individuals possess the critical explicit and tacit knowledge of explosives production processes) (Verster, 2014:1-3). The industry faces a significant risk as many experts in the explosives industry of South Africa are nearing retirement (Oliveira, 2015:1). At the same time, younger skilled professionals seek employment abroad, leading to a brain drain (Mlambo & Adetiba, 2019:1).

Knowledge management is the only solution to bridging the knowledge gap in the explosives industry of South Africa (Oliveira, 2015:1). There is no tested KM framework for an explosives manufacturing company. Fivaz and Pretorius (2015:8) developed and tested a KM framework for manufacturing firms in South Africa, but their research findings are untested in an explosives manufacturing company.

The problem this study aims to address is the identification of effective knowledge transfer practices to mitigate the risks of tacit knowledge loss experienced by explosives manufacturers in South Africa due to voluntary employee turnover, including job change, retirement, and emigration.

1.4 Research questions

1.4.1 Primary research question

What KM practices can effectively mitigate the risks of tacit knowledge loss caused by employee turnover in South Africa's explosives manufacturing industry?

1.4.2 Secondary research question

The following secondary questions answer the primary research question:

- SQ1: Which CSFs of KM are deemed essential by employees to support knowledge transfer within an explosive manufacturing company?
- SQ2: Which KM practices are deemed essential by employees to mitigate tacit knowledge loss within an explosive manufacturing company?
- SQ3: How do training, mentoring and job rotation contribute to transferring tacit knowledge from individuals to other employees within an organisation?
- SQ4: What KM frameworks are employed in the manufacturing industry within South Africa and globally?

1.4.3 Hypotheses

1.4.3.1 **Hypothesis 1**

Heisig (2009:14) identified and grouped the most frequently used KM enablers under four CSFs of KM after analysing 160 KM frameworks: Human-orientated factors (people, culture, leadership), Organisational aspects (structure, processes), Management aspects (strategy, goals, measurement), and Technology-orientated aspects (infrastructure, applications).

Fivaz and Pretorius (2015:1) investigated several CSFs that promote knowledge creation, use and transfer within the South African manufacturing environment. Their study focused on the three KM enablers under Human-orientated factors (people, culture, leadership) and two KM enablers under Management aspects (strategy, measurement) (Fivaz & Pretorius, 2015:8-9).

Kunthi *et al*. (2017:31-33) investigated CSFs that influence the implementation of KM in an organisation. The study focused on two KM enablers under Human-orientated factors (people, culture), one KM enabler under Organisational aspects (structure), three KM enablers under Management aspects (strategy, goals, measurement), and one KM enabler under Technology-orientated aspects (infrastructure) (Kunthi *et al*., 2017:31-33).

Piorkowski *et al*. (2012:2176) investigated CSFs that influence the implementation of KM in a high-value manufacturing industry. The study focused on two KM enablers under Human-orientated factors (people, culture) and one KM enabler under Technology-orientated aspects (infrastructure) (Piorkowski *et al*., 2012:2178).

Numerical data were collected and used to test the hypothesised relationship between multiple KM enablers (independent variables) and KM implementation (dependent variable):

- H^{1a}: People have a positive effect on the implementation of KM.
- H^{1b}: Organisational culture has a positive effect on the implementation of KM.
- H^{1c}: Leadership in the organisation has a positive effect on the implementation of KM.
- H^{1d}: Organisational processes have a positive effect on the implementation of KM.
- H^{1e}: Organisational structure has a positive effect on the implementation of KM.
- H^{1f}: Management's strategy has a positive effect on the implementation of KM.
- H^{1g}: Management's goals have a positive effect on the implementation of KM.
- H^{1h}: Management's performance measurement has a positive effect on the implementation of KM.
- H^{1i}: Information technology infrastructure has a positive effect on the implementation of KM.
- H^{1j}: Information technology applications have a positive effect on the implementation of KM.

Figure 1.1 illustrates the relationship between the variables tested for Hypothesis 1.

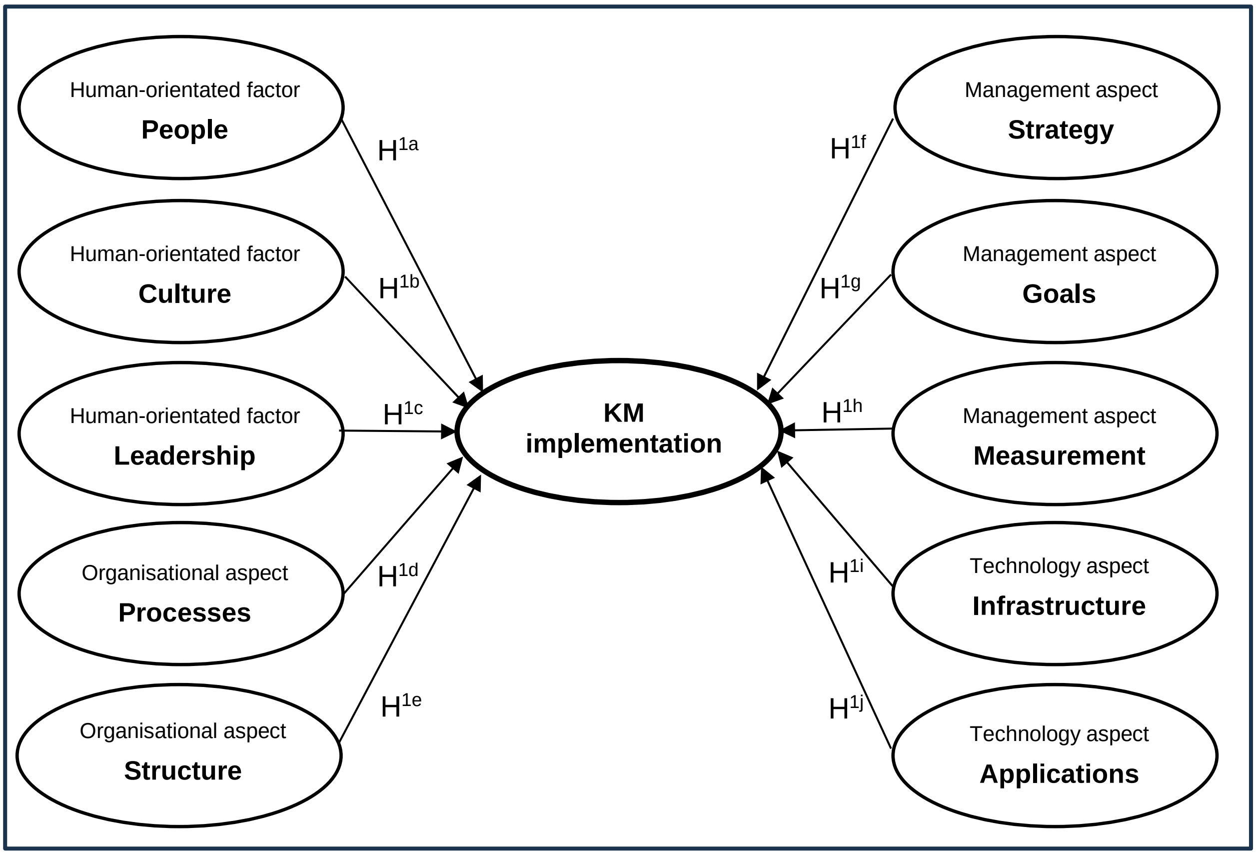

Figure 1.1: Conceptual framework 1. (Source: Adapted from Heisig, 2009:14)

1.4.3.2 **Hypothesis 2**

Singh *et al*. (2022:12206) studied the effectiveness of KM practices in an organisation. The study explored KM approaches such as knowledge-sharing and acquisition techniques, training and mentoring, and technical solutions for transferring knowledge (Singh *et al*., 2022:12206).

Numerical data were collected and used to test the hypothesised relationship between multiple KM practices (independent variables) and knowledge transfer (dependent variable):

- H^{2a}: Fairs in the organisation is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2b}: Best practice repositories are an effective KM practice to transfer and share knowledge within an organisation.
- H^{2c}: Creating a knowledge-sharing culture is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2d}: Strong networking among employees is an effective KM practice to transfer and share knowledge within an organisation.

- H^{2e}: The rotation of people is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2f}: People-to-people contact is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2g}: Documents and databases are an effective KM practice to transfer and share knowledge within an organisation.
- H^{2h}: Cross-functional and self-organising teams are an effective KM practice to transfer and share knowledge within an organisation.
- H^{2i}: Discussion forums are an effective KM practice to transfer and share knowledge within an organisation.
- H^{2j}: Formal training is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2k}: Formal mentoring is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2l}: Technical solutions are effective KM practices to transfer and share knowledge within an organisation.
- H^{2m}: Human-centred information technology is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2n}: Knowledge documentation is an effective KM practice to transfer and share knowledge within an organisation.
- H^{2o}: Hierarchies and peers are an effective KM practice to transfer and share knowledge within an organisation.

Figure 1.2 illustrates the relationship between the variables tested for hypothesis 2.

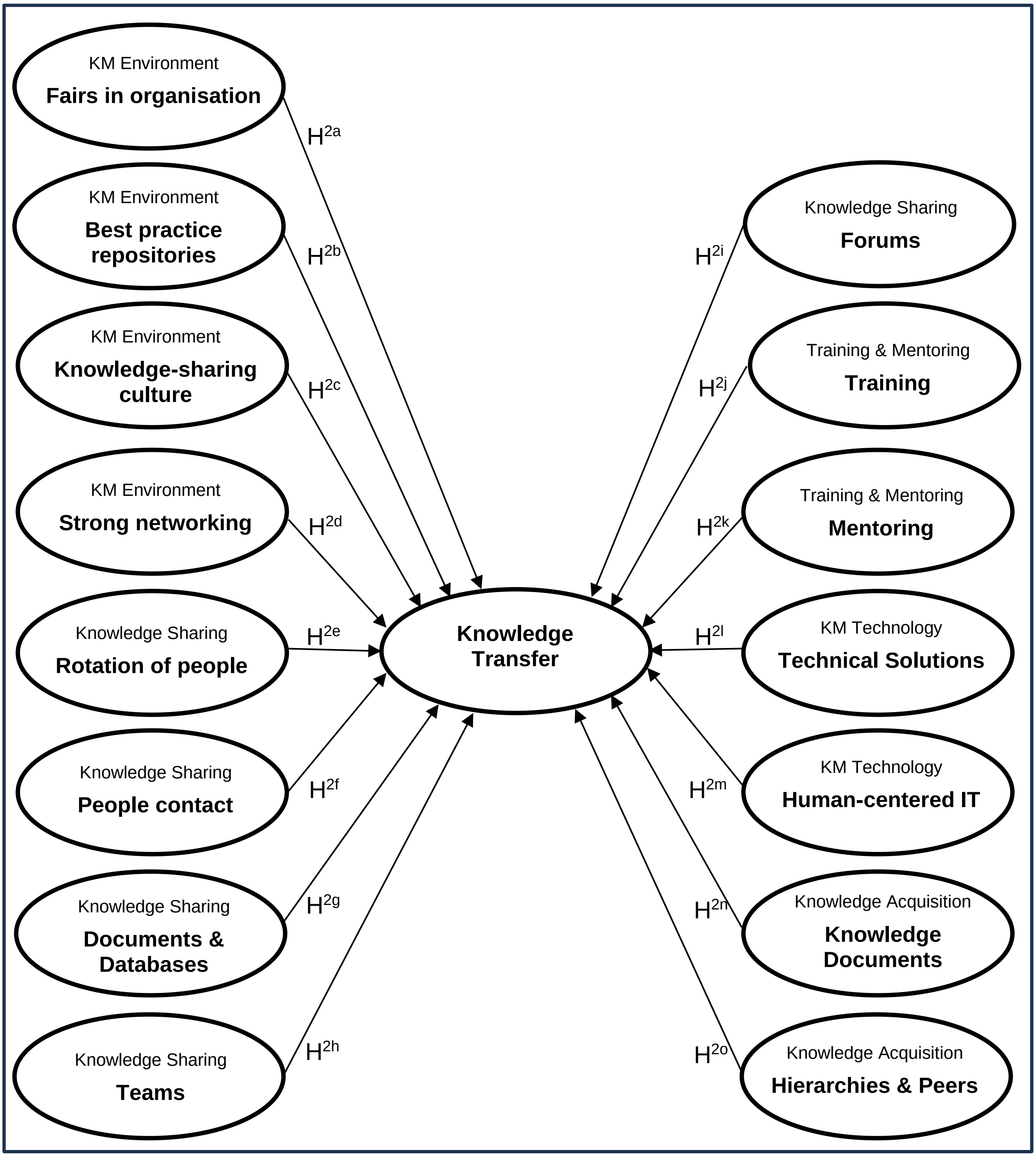

Figure 1.2: Conceptual framework 2. (Source: Adapted from Singh *et al*., 2022:12206)

1.5 Scope of the study

This study contributes to implementing KM practices to retain tacit knowledge essential to an explosives manufacturing company's product development and manufacturing processes. The purpose of KM practices in a company is to connect employees who require technical or managerial knowledge with those individuals who possess tacit knowledge. The research area for the study was operations research because transferring knowledge to new or less experienced employees is essential for maintaining successful operations.

1.5.1 Field of study

According to Adhikari (2016:128), social science includes the study of relationships between micro-type variables, such as how people behave and interact. Sociology is one field that falls under social science studies (Adhikari, 2016:128). The sociology of knowledge examines whether human participation in social life and events influences knowledge (Vasegh & Mohammadi, 2021:4720).

According to Swidler and Arditi (1994:306), the new sociology of knowledge examines how a network of relationships between individuals and social groups (known as a social organisation) makes whole orderings of knowledge possible. This study established which interaction methods between individuals effectively contribute to knowledge transfer and sharing in an explosives manufacturing company.

1.5.2 Industry under investigation

The research investigated the Explosives and Chemical industry of South Africa because the researcher aimed to develop a KM framework for an explosives manufacturing company that assists with retaining tacit knowledge.

1.5.3 Geographical demarcation

The geographical coverage for this study included multiple production sites of an explosives manufacturing company located in four well-known towns in South Africa: Boksburg (Gauteng), Potchefstroom (North West), Wellington and Somerset West (Western Cape).

Figure 1.3 illustrates the locations of the towns in South Africa.

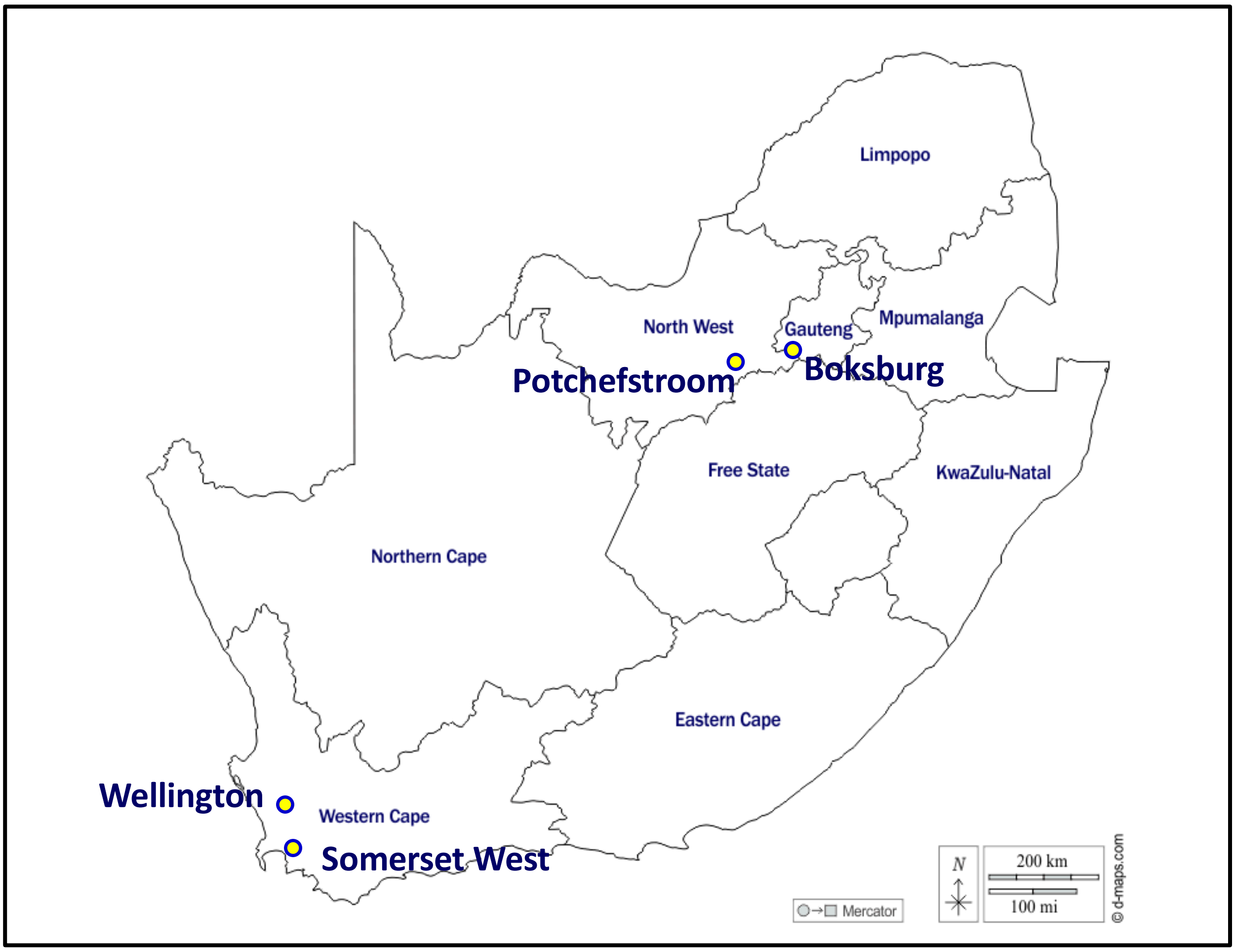

Figure 1.3: Map of South Africa. (Source: Adapted from D-maps.com, 2024)

1.6 Research methodology

The study followed a quantitative and deductive approach. The research study comprises two sections: a literature study and an empirical one. A literature review was conducted first to understand and distinguish between various KM terminologies that form the components of a KM framework. The literature review familiarises the reader with manufacturing companies' CSFs and KM practices. The research methodology applied in this study involved examining and analysing literature and internet sources. The data for the literature review was obtained by consulting various academic sources and relevant published citations, which were sourced from the North-West University Library and Google Scholar.

The purpose of empirical research can be to test a specific idea or to validate a complex theory (Babbie, 2016:113). The empirical study examined and tested which CSFs and KM practices employees in an explosives manufacturing company deem essential for knowledge transfer. The population comprised 2,239 employees in all the departments of a well-known explosives manufacturing company in South Africa. A sample of 1,054 was drawn.

1.7 Study layout

The mini-dissertation comprises five chapters: introduction, literature review, research methodology, results and findings, and the conclusion and recommendation chapter.

Chapter 1 provides a comprehensive introduction to the research, covering key foundational elements that guide the study. The chapter begins by exploring the background of the research problem and outlining aspects relevant to KM. The problem statement is articulated, identifying the main issues and challenges the research aims to address. Both primary and secondary research questions are defined, and clear goals for the study are set. Key KM terms are introduced to ensure clarity and consistency throughout the research.

Chapter 2 provides a detailed literature review that forms the theoretical foundation for the study. The chapter explores key terms and concepts relevant to the research, such as CSFs, KM enablers, KM adoption approaches, and KM practices. The chapter delves into the effectiveness of ten KM enablers and fifteen KM practices within KM frameworks for manufacturing companies.

Chapter 3 presents the research methodology employed in the study and outlines the framework used to address the research questions and objectives. The chapter begins by describing the research design, detailing the quantitative approach followed, explicitly emphasising the philosophical underpinnings of the radical structuralist paradigm, which guides the study's methodological approach. Additionally, the data collection instrument used for data collection is explained in detail. The chapter also provides an overview of the data analysis process, including the methods for verifying and validating the data to ensure accuracy and reliability. Ethical considerations, which ensure the integrity and ethical soundness of the research, are also discussed.

Chapter 4 focuses on the presentation and analysis of the data collected during the research. The chapter begins by outlining the response rates, and an in-depth analysis of the data gathered through an online survey questionnaire. This chapter is the foundation for drawing meaningful findings based on the data collected during the research.

Chapter 5 is the final chapter, and based on the results, conclusions and recommendations were made and outlined. The research objectives are assessed, and the research questions are answered. Based on findings relating to the research objectives, a KM framework was drawn up for the explosives manufacturing company.

1.8 Summary

Chapter 1 introduces the concepts of explicit and tacit knowledge, KM, CSFs of KM, KM enablers, KM adoption approaches, and KM practices. The chapter highlights the growing global market for explosives and outlines the significance of KM in retaining critical knowledge, particularly as the workforce ages and faces emigration. The study examines how KM enablers and KM practices can mitigate knowledge loss risks in an explosives manufacturing company. The problem statement addresses the need for a practical KM framework in explosives manufacturing companies, as South Africa experiences high levels of skilled employee turnover. The chapter concludes with the research questions and hypotheses, setting the stage for the empirical investigation.

Chapter 2 builds on the KM terminologies introduced in this chapter and provides an in-depth overview of several components of a KM framework for a manufacturing company: (1) CSFs and their associated KM enablers, (2) KM adoption approaches and their associated KM practices.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

The previous chapter introduces the conceptual framework for the study and clarifies the problem under investigation, the purpose of the study, and the research questions to be investigated. This chapter comprises a comprehensive literature study on KM techniques within an organisation. An in-depth study on KM practices in manufacturing companies, including KM enablers, forms the core of the literature review. Multiple KM frameworks are analysed, and the effectiveness of two key framework components are investigated: KM enablers and KM practices.

2.2 Knowledge management methods, styles, enablers, and practices

Ikujiro Nonaka coined the term "Knowledge Management" in 1991 (Kruger & Johnson, 2013:1) and has since been regarded as one of the most prominent theorists in the KM domain. Nonaka's theory on tacit knowledge (Abraham, 2021:291; Singh *et al*., 2022:12193) and the knowledge-creating company (Abraham, 2021:290; Phaladi & Ngulube, 2022:2) serve as the foundation of literature reviews in most scholars' research studies on KM. According to Nonaka (1991:162), successful companies can withstand external forces (e.g., market shifts and technology changes) by generating new knowledge and sharing it within the organisation to develop new production techniques. This internal process defines the "knowledge-creating" company. The knowledge-creating company aims to stimulate innovative thinking (McInerney & Koenig, 2011:6; Nonaka, 1991:162; Weru, 2023:14).

Research indicates that good KM practices encourage and support both product and process innovation (Weru, 2023:23). In successful companies, managing the creation of new knowledge is not restricted to the Research and Development (R&D) department; instead, such organisations regard all employees as entrepreneurs, which allows the company to respond to customer requirements and new markets quickly. In the knowledge-creating company, individuals' knowledge is shared continuously at all levels through socialisation (McInerney & Koenig, 2011:20; Nonaka, 1991:165).

Nonaka (1991:165-166) states that knowledge within the organisation is shared in four ways: tacit-to-tacit, tacit-to-explicit, explicit-to-explicit, and explicit-to-tacit (Abraham, 2021:291). Tacit-to-tacit knowledge transfer means an employee shares knowledge and skills through interpersonal action with another employee (e.g., mentoring). Tacit-to-explicit knowledge transfer is when an employee documents his tacit knowledge to share it within the group or company. Explicit-to-tacit is when individuals use the explicit knowledge shared in the company to broaden their knowledge. Explicit-to-explicit knowledge transfer involves combining separate pieces of explicit knowledge into a new form of information (e.g., production plan) (Abraham, 2021:291; Choi & Lee, 2002:403; Nonaka, 1991:165-166).

Renowned scholars Heeseok Lee and Byounggu Choi in the field of KM found that the performance of companies in various types of industries (e.g., manufacturing, financing, services) differ due to the KM style (e.g., human-orientated, system-orientated, dynamic, and passive style) adopted by the respective company (Choi & Lee, 2002:406). Studies show that the corporate performance of manufacturing companies with a human-orientated style is higher than those with a system-orientated style. Companies with a system-orientated style invest heavily in information technology (i.e., explicit knowledge transfer methods). In contrast, companies with a human-orientated style invest more in Human Resources Management (HRM) activities, such as mentoring and training programmes (i.e., tacit knowledge transfer methods), as seen in Figure 2.1. Companies with a dynamic style focus on tacit and explicit KM methods and invest heavily in IT and human resources. Finally, companies with a passive style are not concerned about KM and do not invest much in IT and human resources (Choi & Lee, 2002:413).

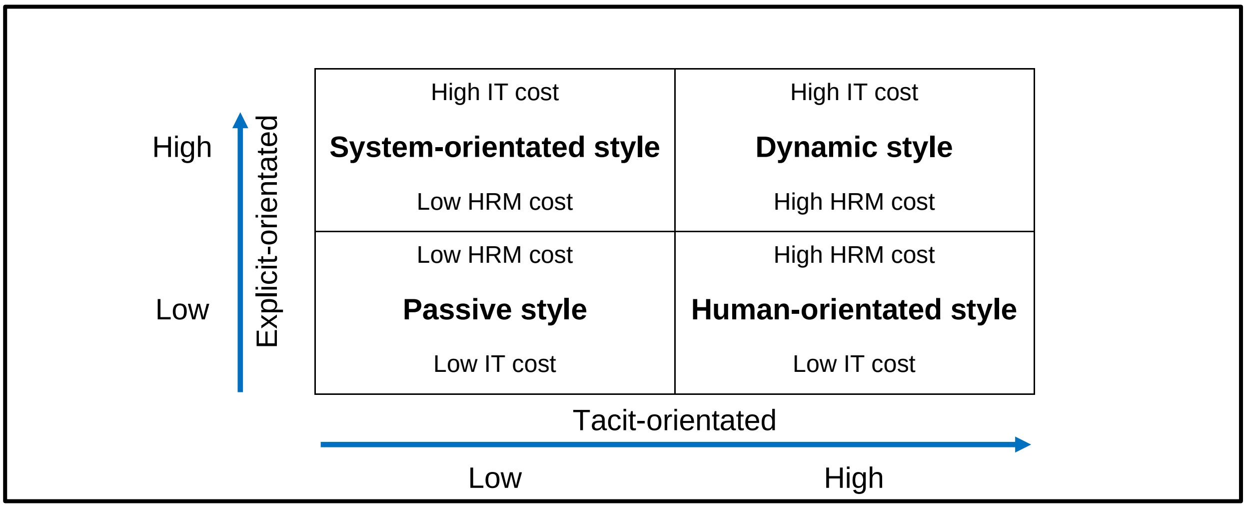

Figure 2.1: KM styles. (Source: Adapted from Choi & Lee, 2002:406)

An increase in the development of KM frameworks for organisations led to a wide range of terminology (Heisig, 2009:4). Researchers identified three significant factors that affect KM: enablers, practices, and organisational processes. KM enablers (or influencing factors) provide the infrastructure for fostering knowledge and allow an organisation to increase the efficiency of KM processes to facilitate knowledge creation, sharing and application (Lee & Choi, 2003:181; Usman *et al*., 2021:6). Over the years, KM enablers identified and tested by scholars include organisational culture, leadership, people, structure, processes, managements' support, KM strategy, performance evaluation, training, information and communication technology (Bessick

& Naicker, 2013:3; Karami *et al*. 2015:186; Lee & Choi, 2003:188; Sanjit *et al*., 2021:16; Usman *et al*., 2021:3).

Heisig (2009:12) identified 170 different terms for KM enablers from 160 KM frameworks and grouped the most frequently used KM enabler terms under four CSFs: (1) Human-orientated factors (culture, people, leadership), (2) Organisational aspects (structure, processes), (3) Management aspects (strategy, goals, measurement), (4) Technology-orientated aspects (infrastructure, applications).

According to Sanjit *et al*. (2021:16), KM practices differ among companies and assist a company in enhancing its capabilities to achieve innovation and performance excellence. Singh *et al*. (2022:12206) grouped fifteen KM practices under five KM adoption approaches: (1) Knowledge environment (fairs, best practices, knowledge sharing culture, networking), (2) Knowledge sharing (job rotation, people contact, documents and databases, teams, forums), (3) Training and mentoring, (4) KM technology (technical solutions, human-centred IT), (5) Knowledge acquisition (knowledge documentation, hierarchies and peers).

Some scholars classify "*Training*" as a KM enabler (Karami *et al*., 2015:188; Sanjit *et al*., 2021:20; Usman *et al*., 2021:12), while other scholars regard "*Training*" as a KM practice (Fivaz & Pretorius, 2015:7; Mageswari *et al*., 2015:18; Singh *et al*., 2022:12206). Similar to training, scholars regard "*Information Technology*" either as a KM enabler (Heisig, 2009:15; Karami *et al*., 2015:186; Lee & Choi, 2003:188; Usman *et al*., 2021:12) or a KM practice (Sanjit *et al*., 2021:18; Singh *et al*., 2022:12206).

Sanjit *et al*. (2021:17) describe KM practices as the drivers of an organisation's KM process. The KM process comprises multiple KM activities and provides the structure to manage knowledge effectively in an organisation (Lee & Choi, 2003:181). Heisig (2009:10) identified 166 different terms for KM activities from 160 KM frameworks and ranked the most frequently used terms in the KM process from one to five: (1) Using, (2) Identifying, (3) Creating, (4) Sharing, (5) Storing (Sanjit *et al*., 2021:18).

This study used the KM terminology seen in Figure 2.2. The literature review discusses variables for Hypotheses 1 and 2 in detail.

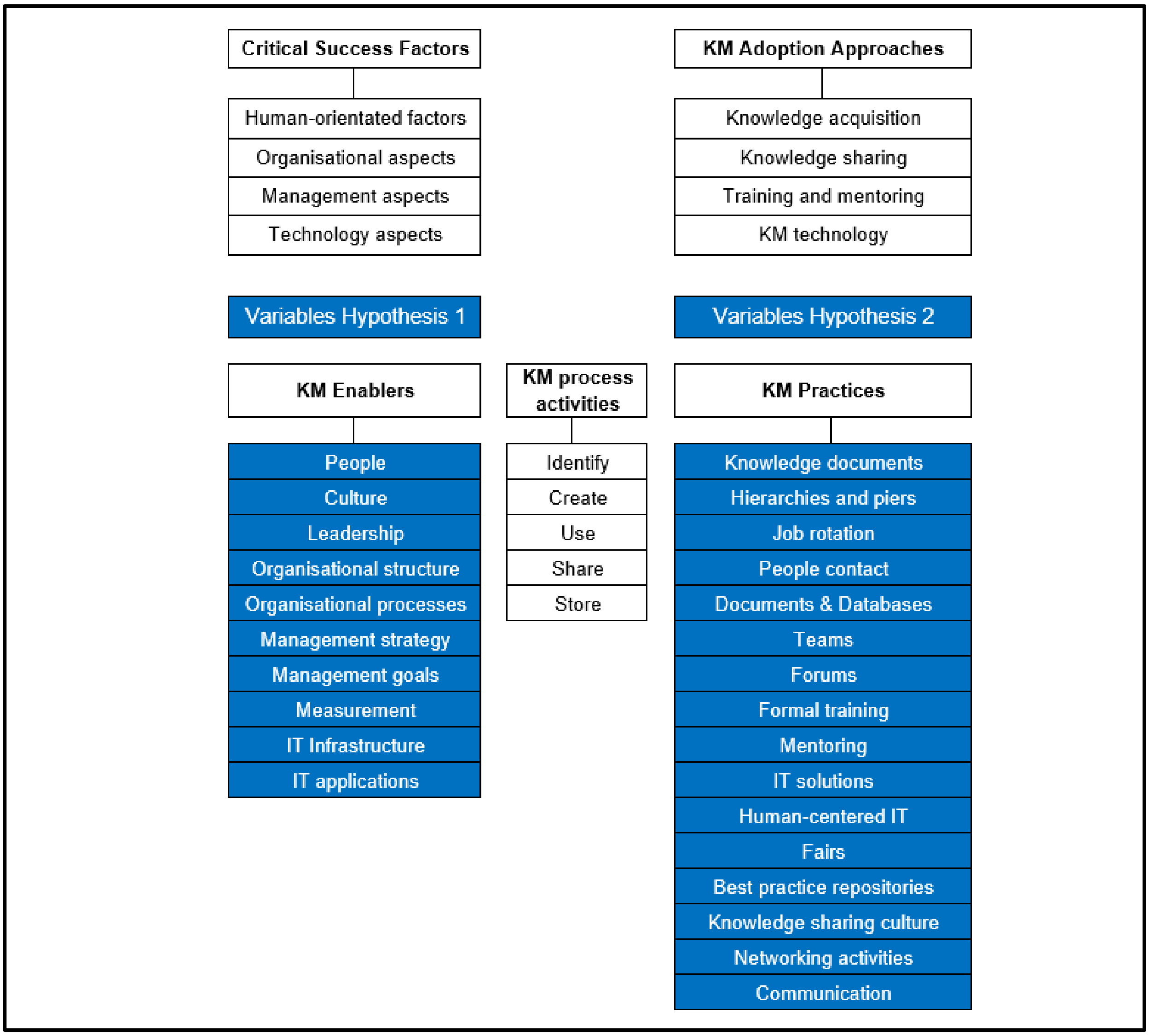

Figure 2.2: KM terminology for this study. (Source: Adapted from Heisig, 2009:10-15; Sanjit *et al*., 2021:18; Singh *et al*., 2022:12206)

2.3 Components of a KM framework

The main benefit of a KM framework is that it assists an organisation in implementing a process to convert tacit knowledge into explicit knowledge (Abraham, 2021:291). The KM framework (in Figure 2.3) was developed from multiple scholars' research studies and used as a guide for this study.

The conceptual KM framework in Figure 2.3 comprises two essential components: (1) CSFs and their associated KM enablers provide the supporting structure for implementing KM in an explosives manufacturing company, and (2) KM approaches and their associated KM practices assist with transferring explicit and tacit knowledge among employees in an explosives manufacturing company.

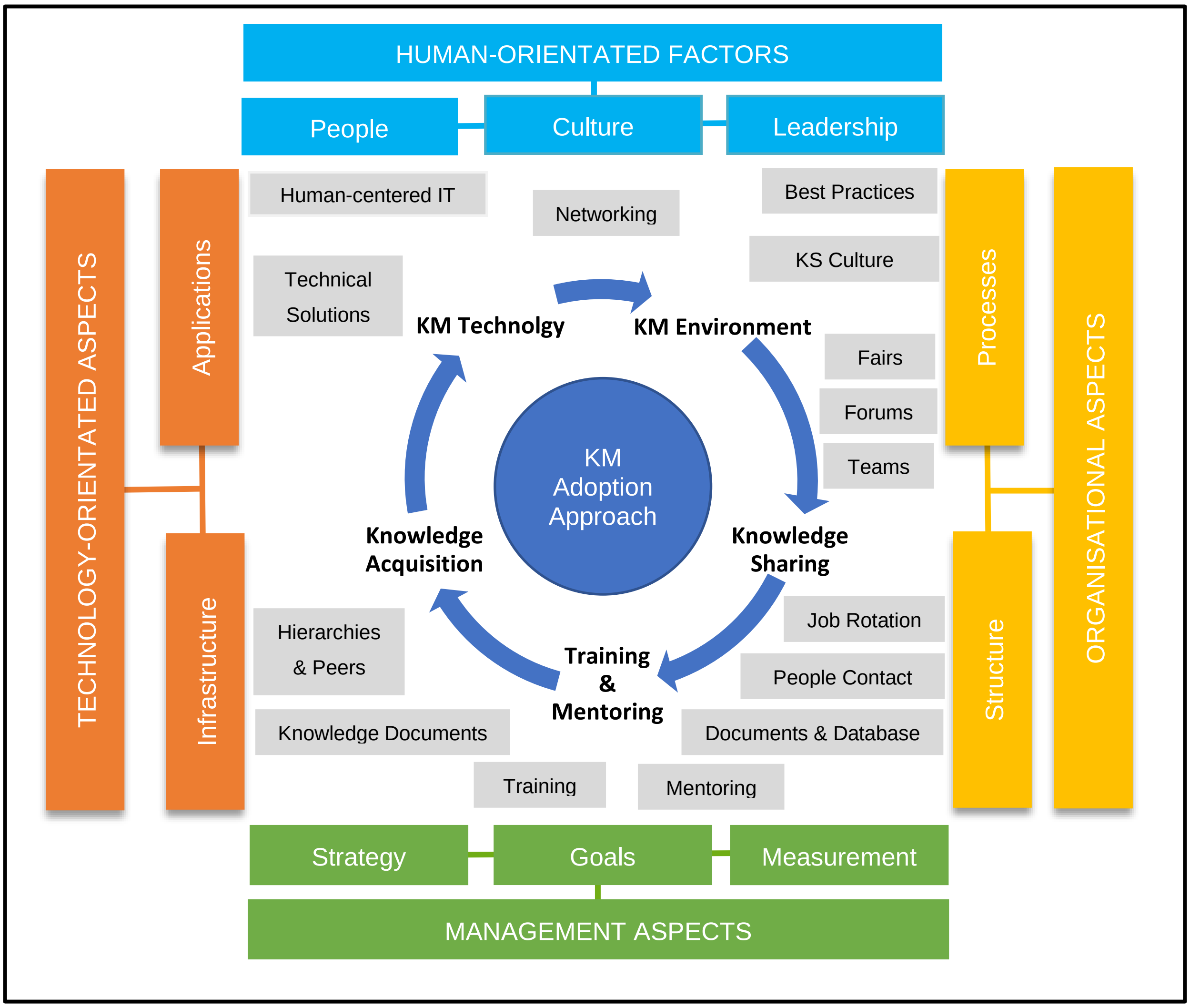

Figure 2.3: KM framework for this study. (Source: Adapted from Heisig, 2009:14; Singh *et al*., 2022:12206)

2.3.1 Framework component 1: CSFs and associated KM enablers

The success of KM in an organisation depends on four CSFs: (1) Human-orientated factors, (2) Organisational aspects, (3) Management aspects, (4) Technology-orientated aspects (Heisig, 2009:14; Fivaz & Pretorius, 2015:4; Weru, 2023:17).

The study of Heisig (2009:10) revealed that CSFs were mentioned explicitly in 119 of the 160 KM frameworks he analysed (i.e., 74% of the KM frameworks). Table 2.1 provides a breakdown of each CSF count in KM frameworks. Variables under each sub-category were used as a guide to analyse KM frameworks of manufacturing companies and industries for this study.

Table 2.1: CSF count in KM frameworks.

Critical Success Factor	Count	Frameworks	Sub-category	Variable count
1 Human-orientated factors 84.0% (n=119)	149	100	***1.1 People*** *51.3% (n=119)*	People (23)
				Employees, (organisational) personnel (10)
				Skills, employees' skills, employees' knowledge and experience, personal characteristics, personal knowledge, personal knowledge capabilities (13)
				Human (8)
				Human resources (3)
				Motivation and qualification (4)
			1.2 Culture *52.1% (n=119)*	Culture, corporate culture, knowledge culture, knowledge-oriented culture, knowledge-sharing culture, culture and power, culture of learning, cultural and social factors (58)
				Value system, values and norms, values (4)
			1.3 Leadership *21.8% (n=119)*	Leadership, knowledge leadership, leadership and support (18)
				Top management support, senior management support (5)
				Knowledge-oriented management, management (3)
2 Organisational aspects 69.7% (n=119)	99	83		Organisation (35)
			2.1 Processes *35.3% (n=119)*	Processes, organisational processes, process organisation (40), business processes (2)
			2.2 Structures *18.5% (n=119)*	Structures, organisational structures, organisational design, organisational infrastructure (22)

Critical Success Factor	Count	Frameworks	Sub-category	Variable count
3 Management aspects 51.3% (n=119)	80	61	***3.1 Strategy*** *42.9% (n=119)*	Strategy (33)
				Vision, direction (8)
				Knowledge-based strategy (3)
				Strategic behaviour (2)
				Mission (2)
				Long-term vision and medium and short strategies (1)
				Planning (1)
				Policy (1)
			3.2 Goals *7.6% (n=119)*	Goals, organisational goals, concrete and measurable goals (9)
			3.3 Measurement *16.8% (n=119)*	Measurement (12)
				Knowledge controlling (3)
				Knowledge controlling and learning (1)
				Metrics (1)
				Measurement criteria (1)
				KM-performance measurement (1)
				Performance indicators (1)
4 Technology-orientated aspects 79.0% (n=119)	96	94	***4.1 Infrastructure*** *31.1% (n=119)*	Technology (39), Technological infrastructure (14)
				Information and communication technology (23)
			4.2 Applications *16.8% (n=119)*	Applications and tools (12)
				Technological systems (5)
				KM technologies (3)

Source: Adapted from Heisig (2009:11)

2.3.1.1 **CSF 1: Human-orientated factors**

The first CSF dimension focuses on human-orientated factors and is regarded as the most significant and includes sub-categories such as people, culture and leadership, as seen in Figure 2.3 (Heisig, 2009:11; Phaladi, 2022:9). Human-orientated factors is the largest of the four dimensions and count for 149 terms in 100 KM frameworks (84%) analysed by Heisig (2009:11) as seen in Table 2.1.

Botha and Fouche (2002:18) evaluated KM enablers in South Africa's business sector and found a strong correlation between knowledge leadership and organisational culture. Phaladi (2022:8) states that a KM culture, leadership, and structures are necessary for an organisation to retain and transfer tacit knowledge. A study performed by Sanjit *et al*. (2021:19) in multiple manufacturing industries in India revealed that managers deemed leadership to be the second most important KM enabler, followed by organisational structure in third place, and organisational culture as the sixth most important KM enabler in a manufacturing company.

Fivaz and Pretorius (2015:8) analysed and tested a KM framework for manufacturing firms in South Africa and found that human-orientated factors (people, culture, leadership) positively affect a manufacturing plant's strategy, performance and need for knowledge. There are several ways how a manufacturing plant can obtain knowledge: Appoint a person with the required knowledge, create it internally, request assistance from a similar plant in the company, or make use of a subject matter expert who will share the knowledge required (Fivaz & Pretorius, 2015:4).

A Knowledge Management System (KMS) is an IT system that allows a company to share important information and decisions, thereby enhancing the intellectual capacity of the company. Research indicates that organisational culture and people significantly influence the success of KMS in companies (Abu-Alsondos, 2023:1534).

2.3.1.1.1 Sub-category 1 of CSF 1: People

The study by Heisig (2009:27) revealed that in 61 of the 119 KM frameworks containing CSFs, "*People factors*" are critical for implementing KM within an organisation. The human-orientated factor, "*People*", is the second most used factor (51.3%) in KM frameworks (Heisig, 2009:11).

Piorkowski *et al*. (2012:2179) state that people are the most important KM enabler in a dynamic KM framework because, without employees and their experience, there is no knowledge in an organisation, only data and information. According to Abu-Alsondos (2023:1534-1535), creating a supportive organisational culture and clarifying the role of people is critical for the effective implementation of KM practices in an organisation. Usman *et al*. (2021:13) argue that KM activities (e.g., knowledge creation and sharing) depend on senior managers to provide support and insight into the KM strategy of the company to functional managers who must guide the implementation of KM initiatives. Research showed that people significantly affect the performance of a manufacturing plant; therefore, the competencies and capabilities of employees do provide a manufacturing company with a competitive advantage (Fivaz & Pretorius, 2015:8). Employees create and share knowledge; therefore, effective management of willing employees is essential for KM within the organisation (Lee & Choi, 2003:188).

Piorkowski *et al*. (2012:2179) state that motivation is a crucial aspect of the dynamic KM framework because the success of KM in an organisation and the overall performance of the organisation depends on well-motivated employees. Management from multiple manufacturing industries in India regards employee motivation (ranked 5th) as a key KM enabler for achieving organisational performance (Sanjit *et al*., 2021:19).

2.3.1.1.2 Sub-category 2 of CSF 1: Culture

Knowledge management becomes part of an organisation's culture when tacit knowledge is transferred from experienced employees to other employees (Tacit-to-Tacit, known as Socialisation), followed by the conversion of tacit knowledge into explicit knowledge through documenting learned knowledge (Tacit-to-Explicit, known as Externalisation), then combining explicit knowledge from various sources to create new concepts and products (Explicit-to-Explicit, known as Combination), and finally absorbing explicit knowledge from documents and other sources of information for future use (Explicit-to-Tacit, known as Internalisation). This process is known as Nonaka's Spiral of Knowledge or SECI Cycle concept illustrated in Figure 2.4 (Abraham, 2021:291).

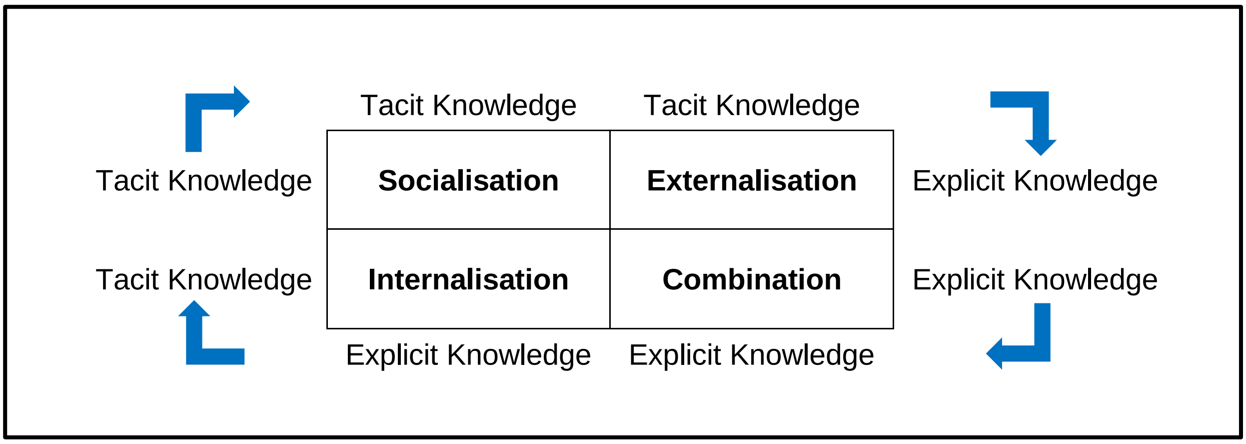

Figure 2.4: The SECI cycle. (Source: Adapted from Abraham, 2021:291)

The study by Heisig (2009:27) revealed that in 62 of 119 KM frameworks containing CSFs, "*Culture factors*" are critical for implementing KM within an organisation. The human-orientated factor, "*Culture*", is the most frequently used (52.1%) in KM frameworks (Heisig, 2009:11).

Studies revealed that employees are more willing to share knowledge in those organisations where a high level of trust and openness exists. Therefore, management must implement a culture that encourages employees to create and share knowledge within the organisation (Lee & Choi, 2003:188; Sanjit *et al*., 2021:20; Usman *et al*., 2021:6). Research indicates that culture forms the vital link between organisational processes, strategy and technology. The success of knowledge exchange in a company depends on building a supportive culture aligned with management's strategic goals and available KM technology (Abu-Alsondos, 2023:1534). Research also showed that culture affects both the company's and manufacturing plant's strategy and performance (Fivaz & Pretorius, 2015:8). Organisational culture (ranked 6th) is regarded as a key KM enabler in the manufacturing industries of India (Sanjit *et al*., 2021:19-20). On the other hand, the automotive industry in Iran regards organisational culture as the most important CSF for implementing a KMS (Karami *et al*., 2015:194).

2.3.1.1.3 Sub-category 3 of CSF 1: Leadership

The study by Heisig (2009:27) revealed that in 26 of 119 KM frameworks containing CSFs, "*Leadership factors*" are critical for implementing KM within an organisation. The human-orientated factor, "*Leadership*", is the sixth most frequently used (21.8%) in KM frameworks (Heisig, 2009:11).

Leadership in an organisation provides direction and determines the company's vision and strategy. Research studies showed that leadership significantly affects the company's and its manufacturing plants' strategy and performance (Fivaz & Pretorius, 2015:6). Managerial staff (ranging from senior management to supervisory level) in multiple manufacturing industries in India regard leadership (ranked 2nd) to be a key KM enabler in a manufacturing company (Sanjit *et al*., 2021:19-20).

2.3.1.2 **CSF 2: Organisational aspects**

The second CSF dimension focuses on organisational aspects and comprises processes and structures (Heisig, 2009:12). The study by Botha and Fouche (2002:18) indicated a strong correlation between knowledge leadership and organisational structure.

Organisational aspects are the third largest of the four dimensions and count for 99 terms in 83 KM frameworks (69.7%), as analysed by Heisig (2009:11). (See Table 2.1).

2.3.1.2.1 Sub-category 1 of CSF 2: Organisational processes

The study by Heisig (2009:26) revealed that in 42 of 119 KM frameworks containing CSFs, "*Process factors*" are critical for implementing KM within an organisation. The organisational factor, "*Processes*", is the fourth most used factor (35.3%) in KM frameworks (Heisig, 2009:12).

Abu-Alsondos (2023:1534) found that organisational processes do not significantly influence the KMS of a company. Knowledge within an organisation is fragmented and distributed among employees, processes, products and services. Therefore, the organisation's performance and success depend on collecting, capturing and sharing knowledge (Mageswari *et al*., 2015:14). The KM process in a company assists employees in creating, using, storing, sharing, and identifying knowledge. Top management must clearly define the KM process of the company to manage and control the flow of knowledge efficiently (Usman *et al*., 2021:13).

According to Abu-Alsondos (2023:1529), the KM process refers to the policies, procedures and techniques used to direct the creation, utilisation and sharing of knowledge within the organisation. The KM process comprises five basic KM activities, as seen in Figure 2.5.

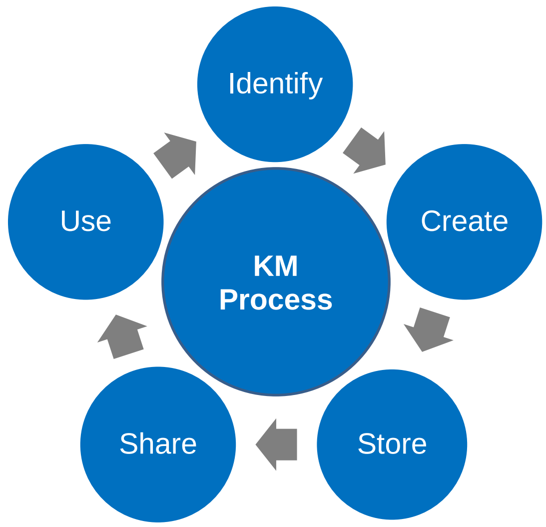

Figure 2.5: KM process. (Source: Adapted from Heisig, 2009:15)

In 117 KM frameworks analysed by Heisig (2009:10), the KM activity "*Share*" appeared in 82% of the frameworks, the term "*Create*" in 74% of the frameworks, followed by the terms "*Use"* with 65%, "*Store*" with 52%, and "*Identify*" with 51%.

Fivaz and Pretorius (2015:9) refer to the terms "*Knowledge creation*", "*Knowledge sharing*", and "*Knowledge use*" as knowledge manipulation activities that overarch the main KM processes of the organisation. These three KM activities are defined as the "How" of KM by Fivaz and Pretorius (2015:9). Fivaz and Pretorius (2015:7) found that formal training, mentoring, direct people contact, and promoting teamwork assist with "*Knowledge creation*", "*Knowledge sharing*", and "*Knowledge use*" in a manufacturing company.

- Knowledge identification (need): Companies understand the value of knowledge and that it is developed over time and, therefore, tend to hire employees for their experience rather than qualifications (Davenport & Prusak, 1998:10). According to scholars, not all the required knowledge is always available within the organisation. Therefore, it is essential to identify and acquire knowledge from sources outside the organisation. Scholars refer to learning as a knowledge acquisition process involving formal training, mentoring, working with research institutes, and forming strategic alliances (Lee & Choi, 2003:191-192; Mageswari *et al*., 2015:14).
- Knowledge creation: Knowledge creation is the ability of an organisation to create new knowledge and apply it in such a manner that it improves systems, products and services (Mageswari *et al*., 2015:14). Lee & Choi (2003:205) found that collaboration, trust, learning, and decentralised organisational structures create a work environment where employees participate in knowledge creation processes more effectively. According to Nonaka (1991:164), the creation of new knowledge is the responsibility of every employee within the organisation.
- Knowledge storage: IT networks and applications allow companies to create knowledge repositories by storing individual and organisational knowledge on a central system. Employees who retire, resign or are retrenched can leave a knowledge gap in the organisation. Knowledge repositories allow for tacit-to-explicit knowledge transfers and are the process whereby employees document their tacit knowledge to share it within a group or the company (Mageswari *et al*., 2015:14).
- Knowledge-sharing: According to Davenport and Prusak (1998:10), studies have shown that managers obtain two-thirds of their knowledge from face-to-face interaction (i.e., tacit-to-tacit transfer) and only one-third from documentation (i.e., explicit-to-tacit transfer). Research indicates that the average employee in an organisation tends to consult a knowledgeable person when seeking expert advice (Davenport & Prusak, 1998:10). Knowledge-sharing is regarded as the most challenging element of the KM process because it is voluntary. The knowledge-sharing process involves transferring knowledge between individuals, from individuals to groups and vice versa, and between groups. Standard knowledge-sharing practices include mentoring, consultation, team building, training, information technology networking, and communities of practice. According to scholars, popular methods for

transferring tacit knowledge include job shadowing, teamwork, and communities of practice (Mageswari *et al*., 2015:14-15).

- Knowledge use: Nonaka (1991:162) found that the only sure source of competitive advantage is knowledge, and therefore, manufacturing companies must understand how to use knowledge to their advantage (Fivaz & Pretorius, 2015:2). The effectiveness of "*Knowledge use*" is reflected in the performance of the manufacturing plant and therefore can be measured (Fivaz & Pretorius, 2015:4).

2.3.1.2.2 Sub-category 2 of CSF 2: Organisational structure

The study by Heisig (2009:26) revealed that in 22 of 119 KM frameworks containing CSFs, "*Structure factors*" are critical for implementing KM within an organisation. The organisational factor, "*Structure*", is the seventh most used factor (18.7%) in KM frameworks (Heisig, 2009:12).

A company must implement a structure that promotes an organisational culture that facilitates knowledge creation and employee sharing. Studies found that employees participate more freely in knowledge-creation processes when working in a decentralised organisational structure because a centralised structure tends to obstruct interdepartmental communication and knowledge sharing (Usman *et al*., 2021:7). Organisational structure (ranked 3rd) is regarded as a key KM enabler in the manufacturing industries of India (Sanjit *et al*., 2021:19-20).

2.3.1.3 **CSF 3: Management aspects**

The third CSF dimension is management aspects, including strategy, goals, and measurement (Heisig, 2009:11-12). Management aspects are the least mentioned of the four dimensions and count for 80 terms in 61 KM frameworks (51.3%) Heisig (2009:11) analysed (see Table 2.1). The business perspective of KM involves implementing a strategy, policies, and procedures to maximise the utilisation of intellectual assets in an organisation (Abraham, 2021:291).

According to scholars, management's support and commitment are the key to KM success in the organisation (Kruger & Johnson, 2013:10; Usman *et al*., 2021:8). Fivaz and Pretorius (2015:4) found that a manufacturing plant's strategy and performance determine the knowledge needed in the plant. Management then determines whether a knowledge gap exists and, if so, which knowledge is required to fill the gap and from where to acquire the knowledge (Fivaz & Pretorius, 2015:4).

2.3.1.3.1 Sub-category 1 of CSF 3: Strategy

Scholars refer to KM strategies as a process that involves planning and projecting the company's goal regarding KM initiatives. A good KM strategy links with the organisation's culture and policies to achieve both process outcomes and organisational outcomes (Usman *et al*., 2021:15). According to Abu-Alsondos (2023:1535), strategic planning is essential to support KM activities in the service industry.

The study by Heisig (2009:26) revealed that in 41 of 119 KM frameworks containing CSFs, "*Strategy factors*" are critical for implementing KM within an organisation. The management factor, "*Strategy*", is the third most used factor (42.9%) in KM frameworks (Heisig, 2009:12).

2.3.1.3.2 Sub-category 2 of CSF 3: Goals

The study by Heisig (2009:26) revealed that in 9 of 119 KM frameworks containing CSFs, "*Goal factors*" are critical for implementing KM within an organisation. The management factor, "*Goals*", is the tenth most used factor (7.6%) in KM frameworks (Heisig, 2009:12).

Karami *et al*. (2015:194) categorised CSFs for implementing a KMS in the automotive industry of Iran into five primary dimensions and twenty-six sub-factors. Goals and strategies were grouped under a single dimension and were regarded by the automotive industry as the fourth most crucial dimension for implementing a KMS (Karami *et al*., 2015:194).

2.3.1.3.3 Sub-category 3 of CSF 3: Measurement

Scholars refer to performance and evaluation as determining employee relationships within a company. To successfully measure the performance of employees in terms of KM initiatives, management must develop and implement formal procedures and processes in the company clarifying the roles and responsibilities of employees regarding the implementation of KM initiatives (Usman *et al*., 2021:8). Sanjit *et al*. (2021:19-20), found that manufacturing industries in India regard KM audits (ranked 10th) as a critical KM enabler that assist management to implement appropriate KM strategies for the company.

The study by Heisig (2009:26) revealed that in 20 of 119 KM frameworks containing CSFs, "*KM-performance measurement factors*" are critical for implementing KM within an organisation. The management factor, "*Measurement*", is the ninth most used factor (16.8%) in KM frameworks (Heisig, 2009:12).

2.3.1.4 **CSF 4: Technology-orientated aspects**

The fourth CSF dimension emphasises the importance of technology. This dimension is divided into two subcategories: infrastructure and applications. Technology-orientated aspects are the second largest of the four dimensions and count for 96 terms in 94 KM frameworks analysed by Heisig (2009:11), as seen in Table 2.1.

According to Abraham (2021:291), the technology perspective of KM focuses on storing and disseminating data in an organisation to enable effective decision-making. Research studies found that information technology in an organisation plays a vital role in knowledge creation and is not limited to the transfer of explicit knowledge (Lee & Choi, 2003:193).

The study by Heisig (2009:27) revealed that "*Technology factors*" are considered critical for implementing KM in 39 of 119 KM frameworks and "*Information technology factors*" in 23 of 119 KM frameworks. The technology factor, "*Infrastructure*", is the fifth most used factor (31.1%) in KM frameworks, and "*Applications*" is the eighth most used factor (16.8%) (Heisig, 2009:12).

IT infrastructure refers to the equipment, systems and software the organisation uses to store and share content. Content (referred to as “documented knowledge”) is the general term used for a collection of physical documents, files, data and information shared by IT systems (or KMS). Poor IT infrastructure can cause employees to struggle with information retrieval and tend to cause frustration and distrust in a KMS. User-friendly technology assists employees in accessing the correct information at the right time, improving KM adoption and thereby enhancing the performance of the company (Bessick & Naicker, 2013:3; Piorkowski *et al*., 2012:2180-2181; Usman *et al*., 2021:13; Weru, 2023:17).

IT infrastructure is a technical KM enabler and is critical to supporting KM activities in a company. Information and Communication Technology (ICT) assists organisations to transform knowledge from tacit-to-tacit, tacit-to-explicit, explicit-to-explicit, and explicit-to-tacit knowledge (Abu-Alsondos, 2023:1535; Lee & Choi, 2003:188; Usman *et al*., 2021:9).

According to some scholars (Abu-Alsondos, 2023:1529; Kruger & Johnson, 2013:9), large organisations deem processes and technology more important than small businesses that tend to adopt a more personal approach to KM. Research by Abraham (2021:291) supports this argument and found that Small and Medium-sized Enterprises (SMEs) in European manufacturing industries tend not to rely on technology for KM and, therefore, do not possess adequate explicit knowledge repositories.

Management from multiple manufacturing industries in India regards information technology (ranked 8th) as a key KM enabler to support the implementation of KM practices in a company (Sanjit *et al*., 2021:19-20).

Botha and Fouche (2002:17) found that most South African companies regard their IT infrastructure as adequate to support KM practices, with less than a third implementing KM application software. According to Kruger (2008:5), ICT and information management are well institutionalised within the South African industry (Naicker, 2013:1850).

Table 2.2: CSFs of knowledge management.

Critical success factors	KM Enablers	Scholars
1. Human-orientated factors	***1.1 People***	Abu-Alsondos, 2023:1529 Fivaz & Pretorius, 2015:8 Heisig, 2009:11 Lee & Choi, 2003:188 Piorkowski *et al*., 2012:2179 Usman *et al*., 2021:13
	1.1.1 Motivation	Piorkowski *et al*., 2012:2179 Sanjit *et al*., 2021:18
	1.2 Culture	Abu-Alsondos, 2023:1530 Fivaz & Pretorius, 2015:8 Heisig, 2009:11 Karami *et al*., 2015:194 Lee & Choi, 2003:188 Sanjit *et al*., 2021:18 Usman *et al*., 2021:6
	1.3 Leadership	Fivaz & Pretorius, 2015:8 Heisig, 2009:11 Sanjit *et al*., 2021:18
2. Organisational aspects	***2.1 Processes***	Abu-Alsondos, 2023:1529 Heisig, 2009:12 Usman *et al*., 2021:14
	2.2 Structure	Heisig, 2009:12 Lee & Choi, 2003:188 Sanjit *et al*., 2021:18 Usman *et al*., 2021:7
3. Management aspects	***3.1 Strategy***	Abu-Alsondos, 2023:1529 Heisig, 2009:12 Karami *et al*., 2015:194 Usman *et al*., 2021:8
	3.2 Goals	Heisig, 2009:12 Karami *et al*., 2015:194

Critical success factors	KM Enablers	Scholars
	3.3 Measurement	Heisig, 2009:12 Sanjit *et al*., 2021:18 Usman *et al*., 2021:8
4. Technology-orientated aspects	***4.1 Infrastructure***	Abu-Alsondos, 2023:1530 Heisig, 2009:12 Lee & Choi, 2003:188 Piorkowski *et al*., 2012:2181 Sanjit *et al*., 2021:20 Usman *et al*., 2021:13
	4.2 Applications	Heisig, 2009:12 Piorkowski *et al*., 2012:2178
	4.2.1 Content	Karami *et al*., 2015:188 Piorkowski *et al*., 2012:2180 Usman *et al*., 2021:14

Source: Adapted from Usman *et al*. (2021:10)

2.3.2 Framework component 2: KM adoption approaches and associated KM practices

While KM enablers provide the support structure for implementing KM initiatives in an organisation (Usman *et al*., 2021:6), KM practices promote knowledge creation, sharing and use in a manufacturing environment (Fivaz & Pretorius, 2015:7).

Singh *et al*. (2022:12192) developed a KM framework to determine whether adopting KM approaches depends on the characteristics of an organisation (e.g., type of business, organisation size, team dispersion). The study supports previous research and found no relationship between KM, the type of business or the organisation's size (Singh *et al*., 2022:12198). Research performed by scholars over the years reaffirms that KM applies to all organisations (Kruger & Johnson, 2013:9).

However, research conducted by Mageswari *et al*. (2015:23) on small and large manufacturing companies revealed that the size of a company determines which KM practices the organisation adopts and implements. The study found that larger manufacturing companies' understanding of KM practices is better; therefore, they are more effective in adopting KM practices (Mageswari *et al*., 2015:23). On the other hand, team distribution (co-locations versus distributed teams) does affect KM in an organisation (Singh *et al*., 2022:12206).

A study performed by Fivaz and Pretorius (2015:7) within the South African manufacturing environment revealed that formal training, face-to-face interaction with people, promoting teamwork, and mentoring systems assist with knowledge creation and sharing in an organisation.

Formal training and face-to-face interaction with people also help employees with knowledge use (Fivaz & Pretorius, 2015:7).

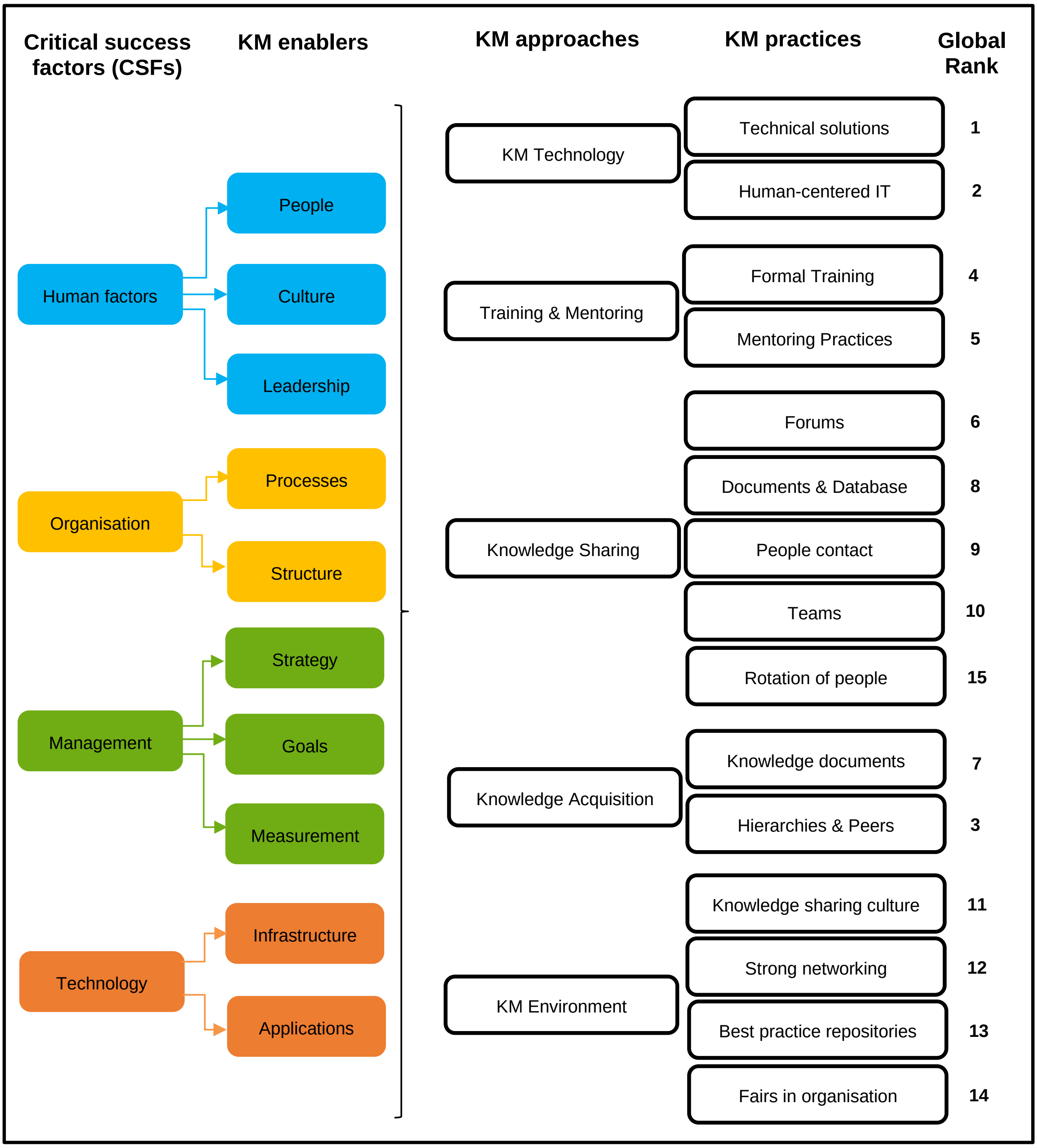

Figure 2.6: Global ranking of KM practices. (Source: Adapted from Heisig, 2009:14; Singh *et al*., 2022:12206)

According to Phaladi and Ngulube (2022:4), organisations can use several KM practices to mitigate tacit knowledge loss in a company: coaching and mentoring, job shadowing, job rotation, succession planning, and knowledge harvesting.

The research study performed by Singh *et al*. (2022:12206) focused on five KM adoption approaches, as seen in Figure 2.6 and Table 2.3: (1) Knowledge acquisition, (2) Knowledge sharing, (3) Training and mentoring, (4) KM technology, (5) KM environment. The key KM approaches underlined by other scholars include knowledge acquisition, distribution and responsiveness (Weru, 2023:13).

Table 2.3: Ranking of KM practices.

KM Adoption Approach	Relative Preference Weight and Rank		KM practices	Relative Preference Weight and Rank		Global Preference Weight and Rank	
KM Technology	0.313	1	Technical solution for transferring knowledge	0.577	1	0.1806	1
			Human-centered information technology	0.423	2	0.1324	2
Training and Mentoring	0.230	2	Formal training	0.355	1	0.0817	4
			Formal mentoring practices	0.334	2	0.0768	5
			Transfer of knowledge	0.331	3	0.0715	6
Knowledge Sharing	0.202	3	Discussion forums	0.312	1	0.0630	7
			Documents and database for knowledge sharing	0.237	2	0.0479	9
			Direct people-to-people contact	0.210	3	0.0424	10
			Cross-functional and self-organising teams	0.167	4	0.0337	11
			Rotation of people among projects	0.075	5	0.0152	17
Knowledge Acquisition	0.138	4	Knowledge Documentation	0.362	1	0.0500	8
			Knowledge acquisition through hierarchies and peers	0.638	2	0.0880	3
KM Environment	0.117	5	Knowledge sharing culture	0.227	1	0.0266	12
			Strong networking activities	0.212	2	0.0248	13
			Best practice repositories	0.210	3	0.0246	14
			Fairs within the organisation	0.190	4	0.0222	15
			Open spaces to encourage communication	0.161	5	0.0188	16

Source: Adapted from Singh *et al*. (2022:12206)

According to Singh *et al*. (2022:12205) and other scholars (Weru, 2023:23), the sub-criteria technological solution for transferring knowledge is the most important factor for successfully implementing KM in organisations. The study by Singh *et al*. (2022:12205) further indicated that formal training and mentoring are regarded as the second most important approach. Knowledge shared directly from people (e.g., forums, documents, direct people contact, teams, job rotation) was the third most effective KM adoption approach, followed by knowledge acquisition through hierarchies and peers. The KM environment was found to be the least practical KM adoption approach for implementing KM in agile organisations (Singh *et al*., 2022:12205).

Mageswari *et al*. (2015:18-22) tested four KM adoption approaches in manufacturing firms: (1) knowledge acquisition, (2) knowledge sharing, (3) knowledge creation, (4) knowledge storing. The KM practices grouped under each KM adoption approach by Mageswari *et al*. (2015:18-22) slightly differ from those tested by Singh *et al*. (2022:12206).

Mageswari *et al*. (2015:18) grouped networking activities, formal training and job rotation under knowledge acquisition, as seen in Figure 2.7. In contrast, Singh *et al*. (2022:12205) grouped the same three KM practices under different KM adoption approaches (Training and mentoring, Knowledge sharing, KM environment), as seen in Table 2.3.

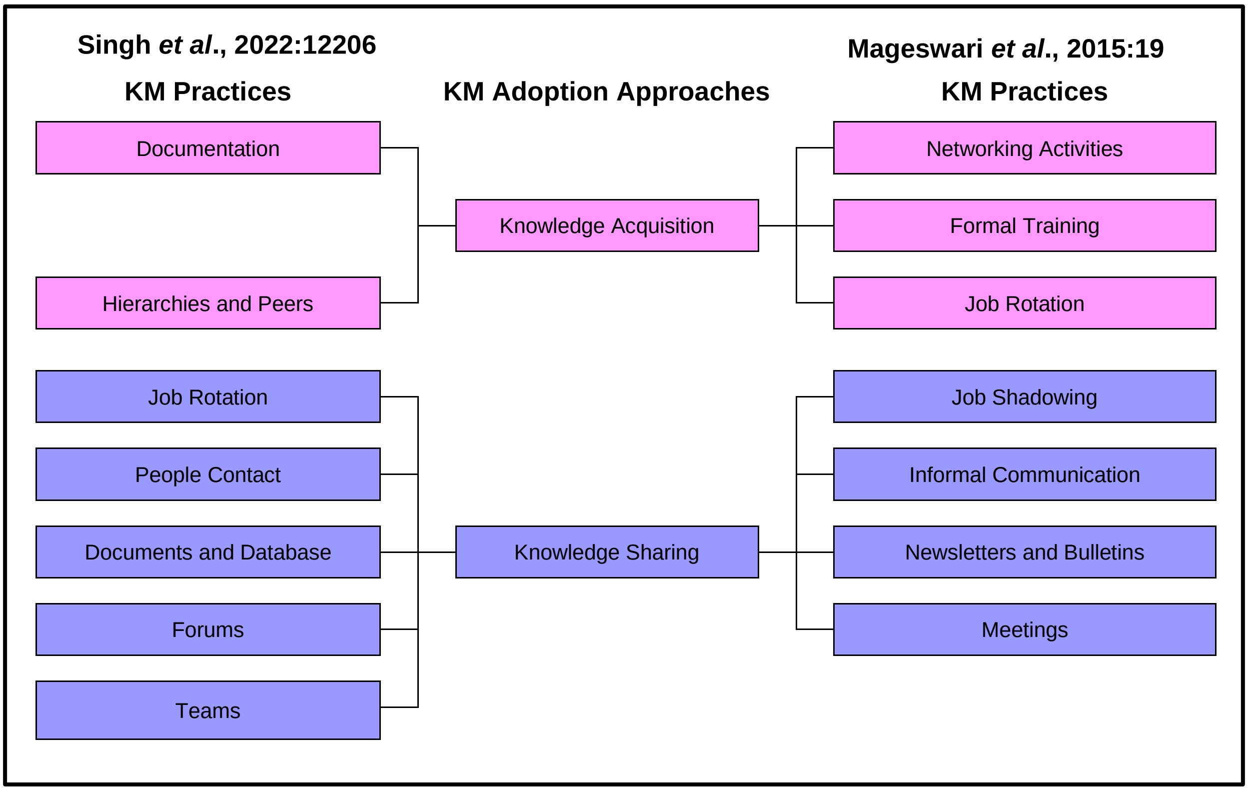

Figure 2.7: KM practices. (Source: Adapted from Mageswari *et al*., 2015:18-20; Singh *et al*., 2022:12206)

2.3.2.1 **KM adoption approach 1: KM technology**

The first KM adoption approach, "*KM technology*", incorporates two KM practices: Technological solution for transferring knowledge and human-centred information technology (Singh *et al*., 2022:12206). Research by scholars (Kunthi *et al*., 2017:33; Sanjit *et al*., 2021:20; Usman *et al*., 2021:4; Weru, 2023:18) reaffirms that information technology positively affects KM implementation strategies, enhances innovation performance, and improves production processes.

Companies with a system-orientated style (e.g., financial and insurance companies) invest heavily in information technology (e.g., group software, communication systems, KM repositories) to codify, capture, share and manage explicit knowledge, enabling them to quickly respond to customers' needs (Choi & Lee, 2002:412). Research shows that businesses in the service industry (Abu-Alsondos, 2023:1535) and the software industry (Singh *et al*., 2022:12205) regard technology as a key KM practice for adopting and implementing a KMS within an organisation.

Choi and Lee (2002:414) found that in manufacturing companies, such as petrochemical companies, the KMS typically focuses on capturing explicit knowledge because most of a petrochemical company's critical knowledge resides in its mechanical and instrumental drawings, technical data, and operating manuals. During the study, the management of Korea's leading petrochemical company acknowledged that, despite their KMS's capability, the organisation did not fully achieve organisational learning because they did not invest enough in knowledge-sharing, evaluation and reward mechanisms (Choi & Lee, 2002:414). Choi and Lee (2002:414) found that synergy between explicit and tacit knowledge mechanisms is required for a company's KM system to be effective.

2.3.2.2 **KM adoption approach 2: Training and mentoring**

"*Training and Mentoring*" is the second KM adoption approach for transferring tacit knowledge in an organisation (Singh *et al*., 2022:12206). Knowledge creation in an organisation depends on a deeply ingrained learning culture, which is achieved by investing in employees' education, training and mentoring (Lee & Choi, 2003:191; Usman *et al*., 2021:9). Next to information technology, training and mentoring are the most common knowledge-sharing practice reported in research studies. According to Singh *et al*. (2022:12206), formal training and mentoring are ranked globally as the fourth and fifth most effective KM practice for organisations (Singh *et al*.,2022:12206).

The manufacturing industry in India regards training as the most critical KM practice for achieving organisational performance (Sanjit *et al*., 2021:20), and the Indian software industry regards training and mentoring as the second most important KM practice for enabling KM in agile organisations (Singh *et al*. (2022:12205). Mageswari *et al*. (2015:19) found that small and large manufacturing firms regard formal training (e.g., studies and courses) as an effective KM practice. According to research studies, knowledge transfer in SMEs in European manufacturing industries is predominantly through socialisation (tacit-to-tacit), while internalisation (explicit-to-tacit) occurs through apprenticeship-based training (Abraham, 2021:291).

Fivaz and Pretorius (2015:7) analysed and tested 33 identified KM practices to establish their relationship with three activities in the KM process: knowledge creation, sharing, and use. The study revealed that formal training significantly impacts knowledge creation and use in an organisation but not knowledge sharing (Fivaz & Pretorius, 2015:7).

Organisations that require radical learning abilities or knowledge acquisition from experts (i.e., the exchange of tacit knowledge) tend to use one-on-one mentoring or informal training programmes (Choi & Lee, 2002:413). Fivaz and Pretorius (2015:7) found that mentoring and coaching systems assist with knowledge creation and sharing in an organisation but not with knowledge use.

2.3.2.3 **KM adoption approach 3: Knowledge-sharing**

The third KM adoption approach, known as "*Knowledge Sharing*", comprises five KM practices: Rotation of people, Direct people contact, Documents and databases, Teamwork, and Forums (Singh *et al*., 2022:12206).

Rotating employees between distinct business units or departments is a KM practice that helps them understand the business from multiple perspectives (Nonaka, 1991:169; Nonaka, 1994:29). Research indicates that job rotation, as a key KM practice, is lacking in state-owned enterprises in South Africa and is not made available to employees to increase their knowledge and experience across business units or departments (Phaladi & Ngulube, 2022:6). Job rotation is one reason for knowledge loss and social network disruptions in manufacturing companies globally (Sumbal *et al*., 2019:635). Mageswari *et al*. (2015:19) found that some companies used job rotation to maintain productivity during employees' absence instead of enhancing knowledge and skills. SMEs in the Indian software industry deem "*Rotation of people*" the seventeenth most effective KM practice and are also ranked seventeenth globally (Singh *et al*., 2022:12206).

According to research studies, direct people-to-people contact is ranked tenth globally, while cross-functional and self-organising teams are the eleventh most effective KM practice for organisations (Singh *et al*., 2022:12206). Fivaz and Pretorius (2015:7) found that face-to-face meetings with people and promoting teamwork assist with knowledge creation, sharing, and use in an organisation.

Documents and databases contain technical knowledge and are regarded as information assets in manufacturing companies (Sumbal *et al*., 2019:643; Usman *et al*., 2021:5). A well-structured database is critical in a company that makes use of a system-orientated style of KM. Knowledge management in an organisation requires that employees communicate with each other during meetings and use IT systems to create, update, and share documents and other content (Piorkowski *et al*., 2012:2176, 2181). SMEs in the Indian software industry deem documents and databases the ninth most effective KM practice and are ranked ninth globally (Singh *et al*., 2022:12206).

Discussion forums as a KM practice form part of a concept known as Community of Practice (CoP), a knowledge-sharing model not restricted to a department or even a single organisation. During these discussion forums, which can be in person or virtually, experienced trainers and guest speakers share their knowledge with employees with similar interests or practices (McInerney & Koenig, 2011:27). While communities of practice provide a natural knowledge-sharing platform within a company, periodical discussion forums can be scheduled for employees to learn from each other (McInerney & Koenig, 2011:43). Research indicates that majority of state-owned entities in South Africa apply communities of practice as a KM practice, while expert forums proofed to be a popular KM strategy in many SOEs (Phaladi & Ngulube, 2022:5-6). SMEs in the Indian software industry deem discussion forums the seventh most effective KM practice and are also ranked seventh globally (Singh *et al*., 2022:12206).

2.3.2.4 **KM adoption approach 4: Knowledge acquisition**

"*Knowledge acquisition*" is the fourth KM adoption approach of Singh *et al*. (2022:12206) and comprises two KM practices: Knowledge documentation and knowledge acquisition through hierarchies and peers. Employees can acquire knowledge in an organisation from documentation (explicit-to-tacit) and peers in self-organised and cross-functional teams (tacit-to-tacit) (Singh *et al*., 2022:12205). In a manufacturing company, documents can explain processes, but technical knowledge, management knowledge, and knowledge of supplier networks and relationships are acquired from colleagues and peers with years of experience (Sumbal *et al*., 2019:647).

Research showed that SMEs in the Indian software industry deem knowledge acquisition through hierarchies and peers the most effective KM practice and are ranked third globally. Research showed that manufacturing firms in South Africa regard trust and openness between peers as an essential KM activity for both knowledge creation, use and sharing (Fivaz & Pretorius, 2015:7). Knowledge documentation is regarded as the fourth most effective KM practice and is ranked eighth globally (Singh *et al*., 2022:12206).

2.3.2.5 **KM adoption approach 5: KM environment**

The fifth KM adoption approach, "*KM Environment*", comprises four KM practices: Fairs within the organisation, Best practice repositories, Knowledge-sharing culture, and Networking among employees (Singh *et al*., 2022:12206).

Research showed that SMEs in the Indian software industry deem networking activities the eleventh most effective KM practice and are ranked thirteenth globally (Singh *et al*., 2022:12206). In manufacturing companies with a human-orientated style, knowledge is gained from social networks rather than knowledge repositories or databases. Good networking among employees is an essential KM practice for manufacturing companies with a human-orientated style because employees acquire and share their tacit knowledge and personal experience through interaction (Choi & Lee, 2002:406; Lee & Choi, 2003:210). Knowledge in an organisation is created through networks of people who meet, work, and share content and information, ultimately developing into the organisation's knowledge network. Information technology and software applications make social networking easy and improve knowledge sharing and exchange within an organisation (McInerney: 2002:1014; McInerney & Koenig, 2011:63; Nonaka, 1994:14). Networks of practice are informal networks that link people working in similar companies or industries to share common knowledge. While all companies, regardless of their size, use internal networking activities to share content and information, the study by Mageswari *et al*. (2015:19) revealed that small, medium and large manufacturing companies do not use networks of practice to share and acquire knowledge from external sources.

Documented knowledge (known as content) within a manufacturing company is created from previous lessons learned, project experience, problem-solving methods and creative processes, which are difficult to replicate. Content and information from both informal and organised internal knowledge sources are documented, captured and organised in best practice repositories (databases) by specially appointed personnel (Fivaz & Pretorius, 2015:1; McInerney & Koenig, 2011:31; Weru, 2023:18). According to McInerney & Koenig (2011:40), some organisations regard the phrase "*Best practice*" as being too restrictive (i.e., can be interpreted that there is only one best practice for a situation), and instead use the phrase "*Lessons learned*" which are broader and more inclusive. An organisation's well-implemented best practice (lessons learned) system facilitates teamwork and collaboration and eliminates the cost and burden of obtaining external expertise and knowledge. Best practices and mentoring programs are well-known techniques employed by organisations to increase their tacit knowledge base (McInerney, 2002:1016; Usman *et al*., 2021:14; Weru, 2023:19). SMEs in the Indian software industry deem best practice repositories (databases) to be the twelve most effective KM practice and are ranked fourteenth globally (Singh *et al*., 2022:12206).

Heisig (2009:26) found that in 58 of the 119 KM frameworks on CSFs he analysed, cultural factors (e.g., knowledge-sharing culture, knowledge culture) are considered critical for KM. Research by well-known scholars in the knowledge management field, such as Davenport & Prusak (1998:14), proved that IT systems merely provide a means to distribute, share and store knowledge but do not create knowledge, nor do IT systems guarantee knowledge generation in an organisation that does not embrace a knowledge-sharing culture. Trust exists in an organisation with a good knowledge-sharing culture; therefore, all employees share and exchange information more freely. The employees' tacit knowledge level grows from this information in an organisation; hence, careful oversight of information is necessary (McInerney: 2002:1016; McInerney & Koenig, 2011:39; Usman *et al*., 2021:6). Some scholars (Phaladi, M. 2022:8; Phaladi & Ngulube, 2022:3), found "knowledge-sharing culture" to be an essential KM practice for retaining tacit knowledge in state-owned enterprises in South Africa. Research showed that SMEs in the Indian software industry deem a "knowledge-sharing culture" the tenth most effective KM practice and are ranked twelve globally (Singh *et al*., 2022:12206).

The least mentioned KM practice in research studies is KM fairs. The effectiveness of fairs in an organisation for sharing knowledge is globally ranked fifteenth. SMEs in the Indian software industry deem networking activities the thirteenth most effective KM practice for sharing knowledge in a company (Singh *et al*., 2022:12206).

2.4 Analysing KM frameworks

This literature review section analyses research and KM frameworks developed for various industries and companies. Without a KM framework for an explosives manufacturing company, the CSFs and KM practices in multiple KM frameworks were used as a guide to develop a conceptual framework for an explosives manufacturing company in South Africa.

2.4.1 Research framework to test the impact of technology capabilities on KM success in South African organisations

The research framework in Figure 2.8 was developed by Naicker (2013:1851) to determine whether IT capabilities directly affect the success of KM in South African organisations. The study's hypothesis was that: “KM status, KM culture, KM problems and KM strategy have a significant positive effect on KM technical capabilities” (Naicker, 2013:1851).

The framework developed by Naicker (2013:1851) incorporates three of the four CSFs identified by Heisig (2009:12): (1) Human-orientated factors, (2) Management aspects, (3) Technology-orientated aspects. The KM framework in Figure 2.8 includes three KM enablers tested for this study: culture, strategy, and IT infrastructure.

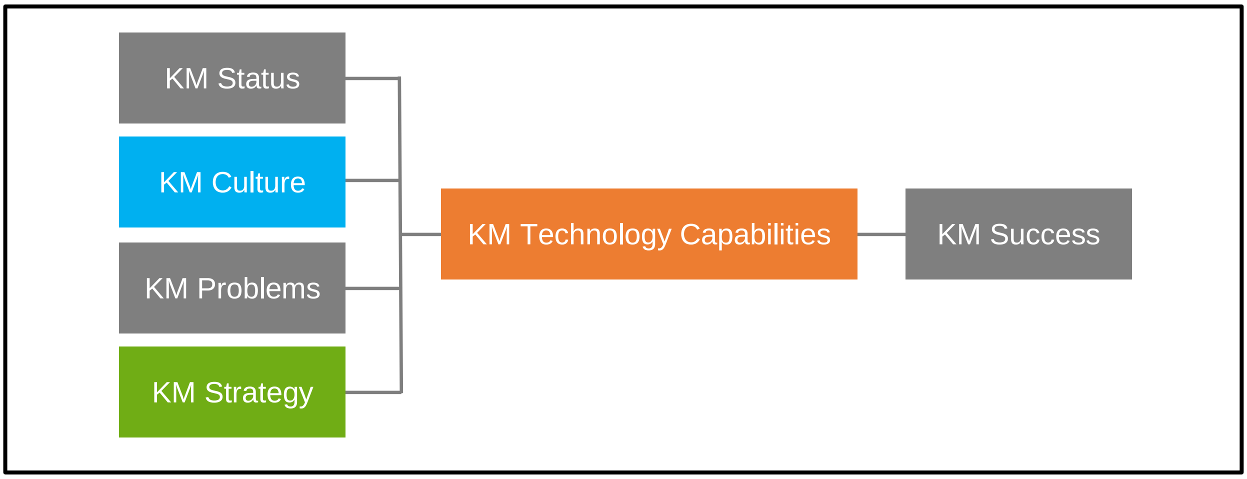

Figure 2.8: Research framework on KM Technology capabilities. (Source: Naicker, 2013:1852)

The study found that only one of the four constructs in Figure 2.8, namely "*KM Status*", was a significant predictor of KM Technology capabilities required to ensure KM success in the organisation (Naicker, 2013:1857). According to Naicker (2013:1856), organisational culture and management strategy do not determine the IT infrastructure needed to ensure knowledge management success.

2.4.2 Research framework on CSFs for implementing a KMS

The research framework in Figure 2.9 was developed by Abu-Alsondos (2023:1531) to determine which effect culture had on the relationships between multiple KM Enablers and a KMS in the service industry. The study included several hypotheses: (H1) Strategy has a positive impact on KMS; (H2) People have a positive impact on KMS; (H3) Process has a positive impact on KMS; (H4) Technology has a positive impact on KMS; (H5) Culture moderates the relationship between strategy and KMS; (H6) Culture moderates the relationship between people and KMS; (H7) Culture moderates the relationship between process and KMS; (H8) Culture moderates the relationship between technology and KMS; (H9) Culture has a positive impact on KMS (Abu-Alsondos, 2023:1529-1531).

The framework developed by Abu-Alsondos (2023:1531) incorporates all four CSFs identified by Heisig (2009:12): (1) Human-orientated factors, (2) Organisational aspects, Management aspects, (4) Technology-orientated aspects. The KM framework in Figure 2.9 includes five KM enablers tested for this study: people, culture, organisational processes, strategy, and IT infrastructure.

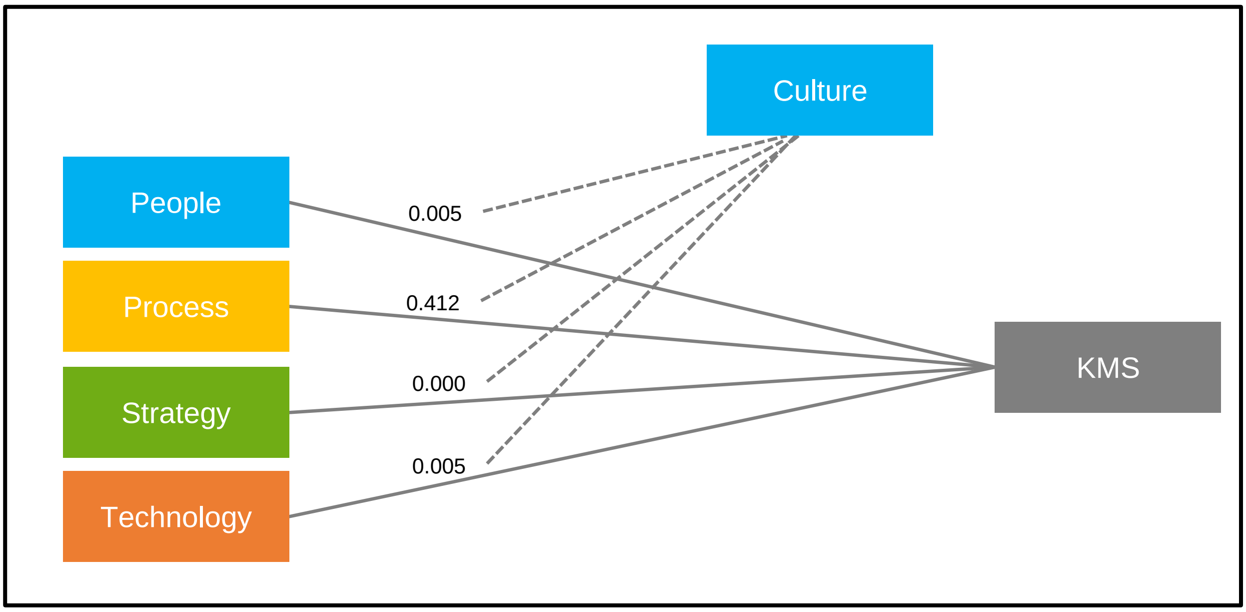

Figure 2.9: Research framework on CSFs. (Source: Abu-Alsondos, 2023:1533)

The study by Abu-Alsondos (2023:1531) revealed that organisational culture, people, strategy and technology significantly influence KMS. The study further revealed that culture moderates the link between processes, technology, strategy and KMS. In contrast, culture did not significantly influence the link between people and KMS (Abu-Alsondos, 2023:1534-1535).

2.4.3 KM framework on CSFs for implementing knowledge management in a company

The KM framework in Figure 2.10 was developed by Kunthi *et al*. (2017:33) to determine which CSFs influence the implementation of KM in a company. The study included several hypotheses: (H1) Organisational culture has a positive effect on KM implementation; (H2) Organisational structure has a positive effect on KM implementation; (H3) Information technology has a positive effect on KM implementation; (H4) Top management support has a positive effect on KM implementation; (H5) Human resource has a positive effect on KM implementation (Kunthi *et al*., 2017:32-33).

The KM framework developed by Kunthi *et al*. (2017:30-31) incorporates three critical success factors identified by Heisig (2009:12): (1) Human-orientated factors, (2) Organisational aspects, (3) Technology-orientated aspects. Heisig (2009:11) groups the KM variable "*human resources*" under the sub-category "*people*" and the KM variable "*top management support*" under the sub-category "*leadership*" of human-orientated factors, as seen in Table 2.1. The KM framework in Figure 2.10 includes five KM enablers tested for this study: people (human resources), culture, leadership (top management support), organisational structure, and IT infrastructure.

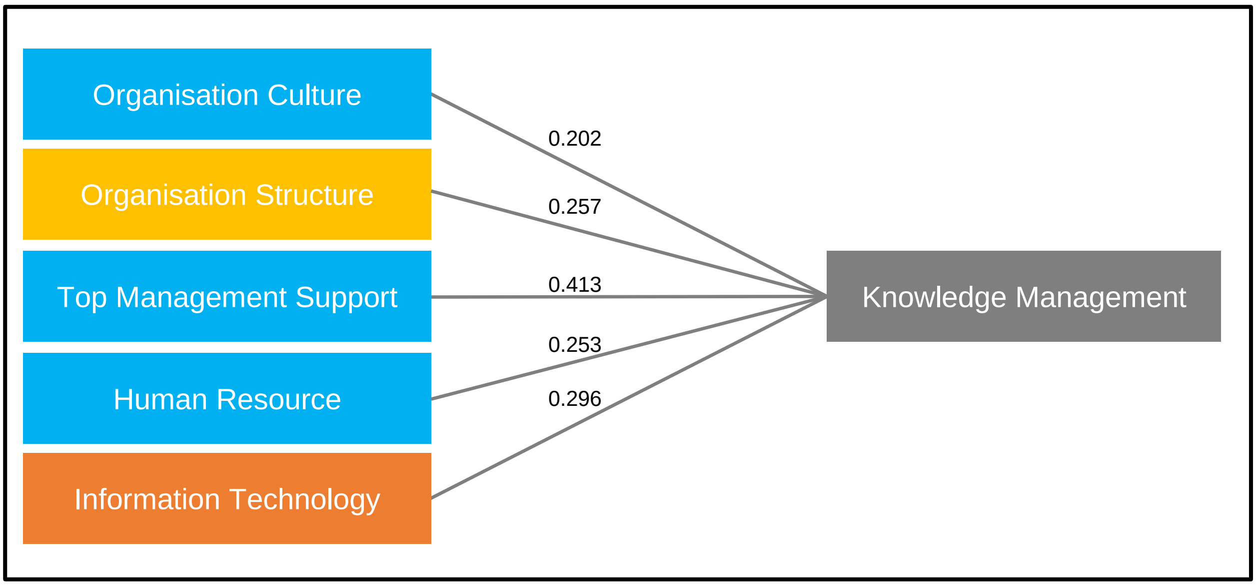

Figure 2.10: CSFs for knowledge management. (Source: Kunthi *et al*., 2017:31)

The study by Kunthi *et al*. (2017:34) revealed that support from top management (e.g., motivating employees, providing opportunities, measurements and rewards) is the most influential factor in implementing KM. IT infrastructure was the second most important factor, followed by organisational structure and culture (Kunthi *et al*., 2017:33-34).

2.4.4 KM framework for a high-value manufacturing industry

The dynamic KM framework in Figure 2.11 was developed by Piorkowski *et al*. (2012:2178) for the high-value manufacturing industry to support organisational learning and to reward employees who create profit.

The KM framework developed by Piorkowski *et al*. (2012:2178) incorporates only two CSFs identified by Heisig (2009:12): (1) Human-orientated factors, (2) Technology-orientated aspects. Heisig (2009:11) groups the KM variable "*motivation*" under the sub-category "*people*" of human-orientated factors, as seen in Table 2.1. In contrast, Piorkowski *et al*. (2012:2178) regard both KM variables, "*People*" and "*Motivations*", as cultural aspects. The KM variable "*Content*" is regarded by both Heisig (2009:27) and Piorkowski *et al*. (2012:2178) as a CSF and is grouped under technological factors.

The KM framework in Figure 2.11 includes three KM enablers tested for this study: culture, people, and IT infrastructure.

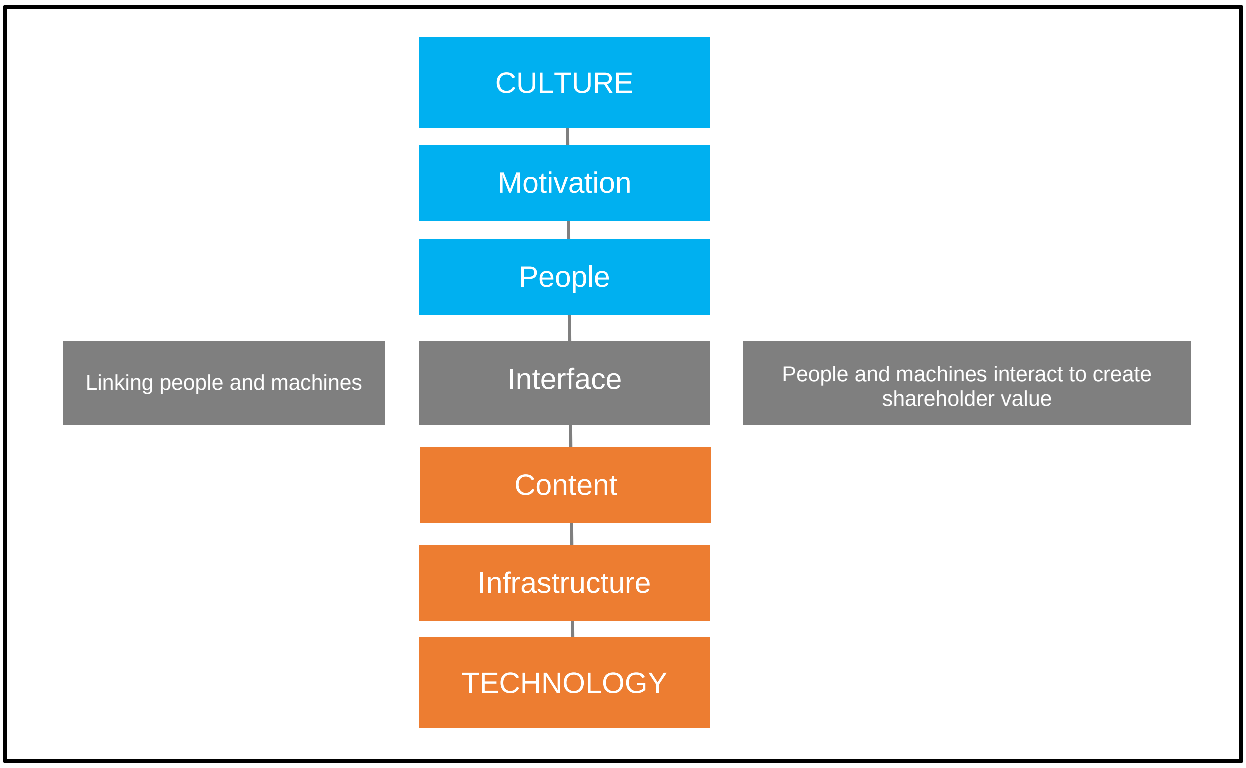

Figure 2.11: Dynamic KM framework. (Source: Piorkowski *et al*., 2012:2178)

According to Piorkowski *et al*. (2012:2176), dynamic KM combines cultural and technological factors because employees must work with machines in harmony to create profit for the company. The KM framework's cultural aspect focuses on people, how they work together, and their motivations. Piorkowski *et al*. (2012:2178) group individuals, teams and organisational structure under the KM enabler "*People*". The technological factor includes content (e.g., documents, files, data, information) and infrastructure (e.g., equipment, systems, software, services) (Piorkowski *et al*., 2012:2178).

Dynamic KM integrates employees and machines to achieve organisational goals. The framework supports organisational learning and internal decision-making processes (Piorkowski *et al*., 2012:2184).

2.4.5 KM framework for a manufacturing company in South Africa

The KM framework in Figure 2.12 was developed by Fivaz and Pretorius (2015:1) to test which KM activities within the South African manufacturing environment promote knowledge creation, use and transfer.

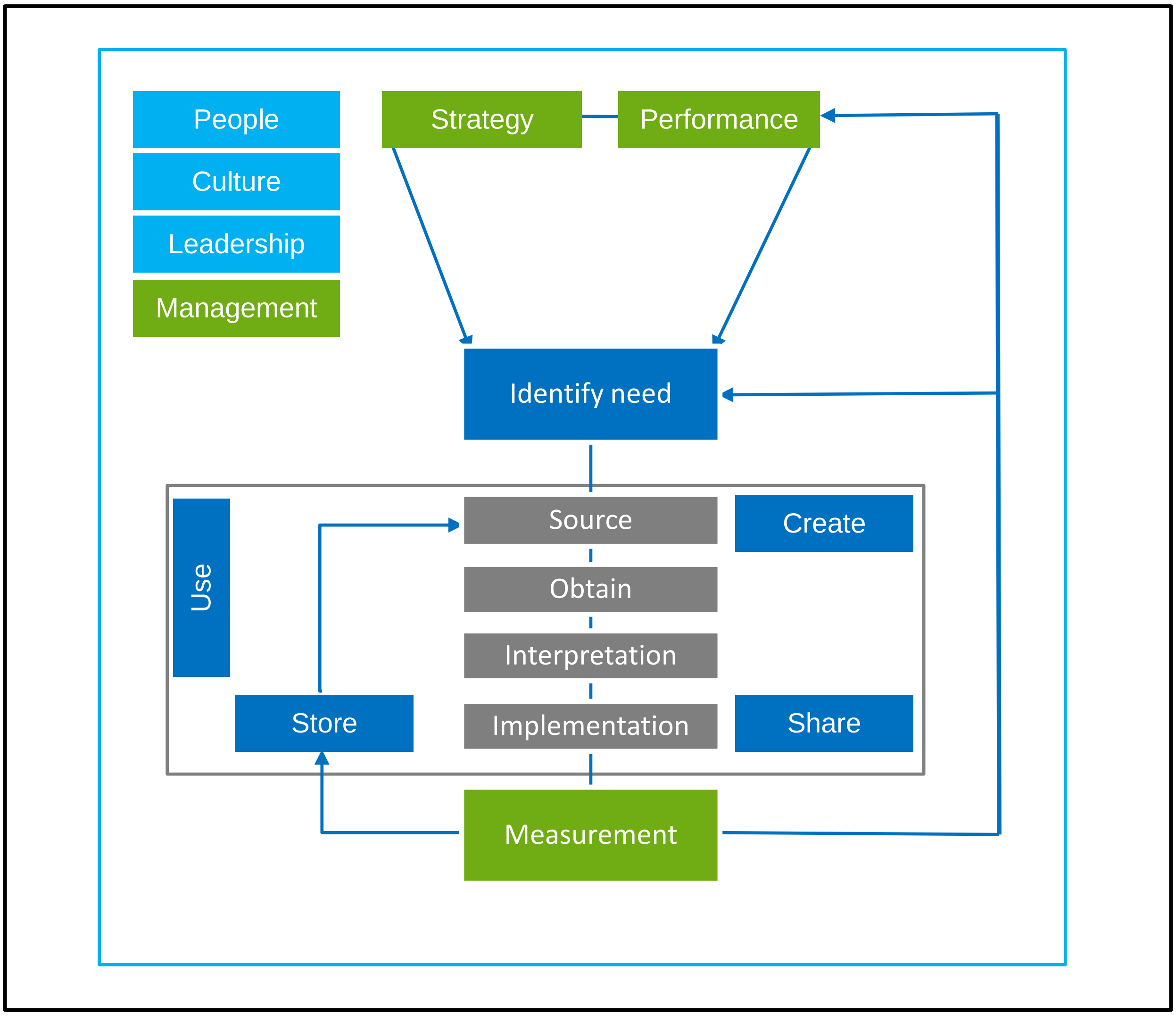

Figure 2.12: KM framework for manufacturing firms in South Africa. (Source: Fivaz & Pretorius, 2015:5)

The KM framework developed by Fivaz and Pretorius (2015:1) incorporates only two CSFs identified by Heisig (2009:12): (1) Human-orientated factors, (2) Management aspects. The KM framework in Figure 2.12 includes five KM enablers tested for this study: People, culture, leadership, strategy and KM-performance measurement.

Similar to the KM framework of Kunthi *et al*. (2017:31), the KM framework of Fivaz and Pretorius (2015:5) incorporates all the KM enablers (people, culture, leadership) under the human-orientated factor but not any technology-orientated aspects. Instead, the KM framework regards managerial elements such as strategy and KM-performance measurement as CSFs. Fivaz and Pretorius (2015:5) found that people, culture, management, and leadership affect an organisation's strategy, performance, and need for knowledge.

2.4.6 KM framework for the automobile industry

The KM framework in Figure 2.13 was developed by Karami *et al*. (2015:187) to identify CSFs for implementing KM in the automobile industry. The study included several research questions: (1) What are the CSFs for KM system implementation?; (2) What conceptual model can be proposed for KM system critical success factors in the automobile industry?; (3) Which factors have a higher priority compared with other factors in the company?

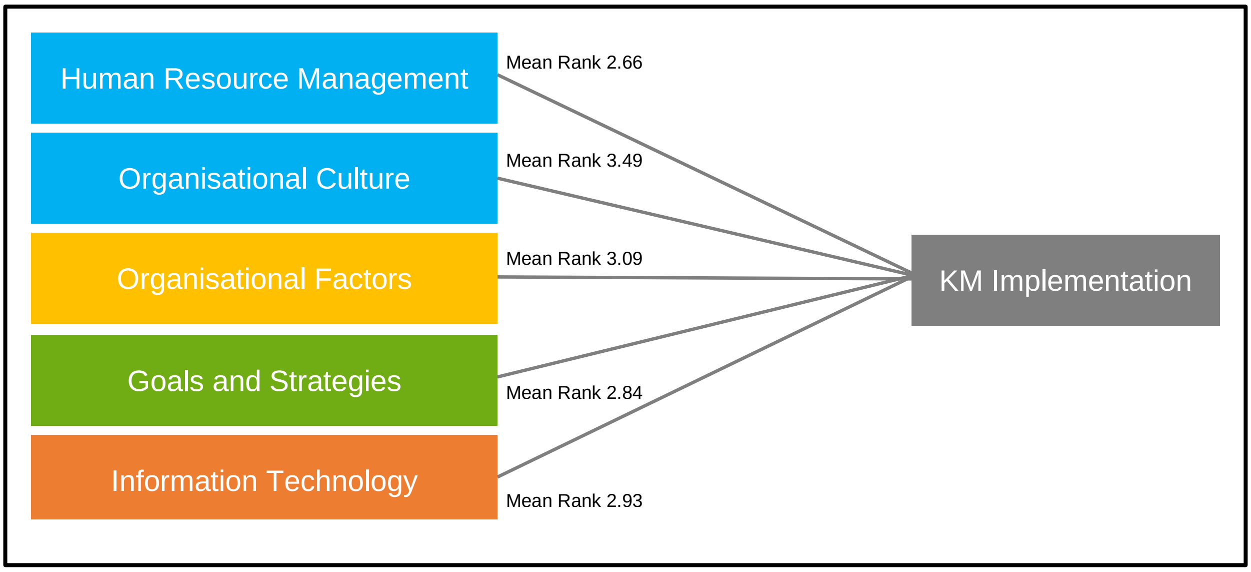

Figure 2.13: KM framework for the automobile industry. (Source: Karami *et al*., 2015:187)

The KM framework developed by Karami *et al*. (2015:187) incorporates all four CSFs identified by Heisig (2009:12): (1) Human-orientated factors, (2) Organisational aspects, (3) Management aspects, (4) Technology-orientated aspects. The "*human resource management*" dimension in the KM framework of Karami *et al*. (2015:188) comprises appraisal system factors, rewards and motivation, training, and human resources. The "H*uman resource management*" dimension can grouped under the sub-category "*People*" of human-oriented factors in Table 2.1. The "*Organisational factors*" dimension of the KM framework in Figure 2.13 comprises organisational infrastructure, activities and processes (Karami *et al*., 2015:188). Therefore, the KM framework in Figure 2.13 includes five KM enablers tested for this study: people, culture, strategy, goals, and IT infrastructure.

Organisational culture was the most critical dimension for implementing KM in an automotive manufacturing company, followed by organisational factors (2nd), information technology (3rd), goals and strategies (4th), and human resources management dimension (5th) (Karami *et al*., 2015:194).

2.4.7 KM framework for manufacturing SMEs

Most manufacturing SMEs do not possess formal KM processes and have minimal access to sophisticated resources (e.g., IT infrastructure and applications). In general, SMEs are owner-operated and are characterised by a flat hierarchy structure, informal interaction and procedures between management and staff (Abraham, 2021:291).

Abraham (2021:295) developed a KM framework for manufacturing SMEs focusing on knowledge acquisition from experts and other sources. The KM framework, however, does not prescribe specific CSFs, KM enablers or KM practices for manufacturing SMEs (Abraham, 2021:294).

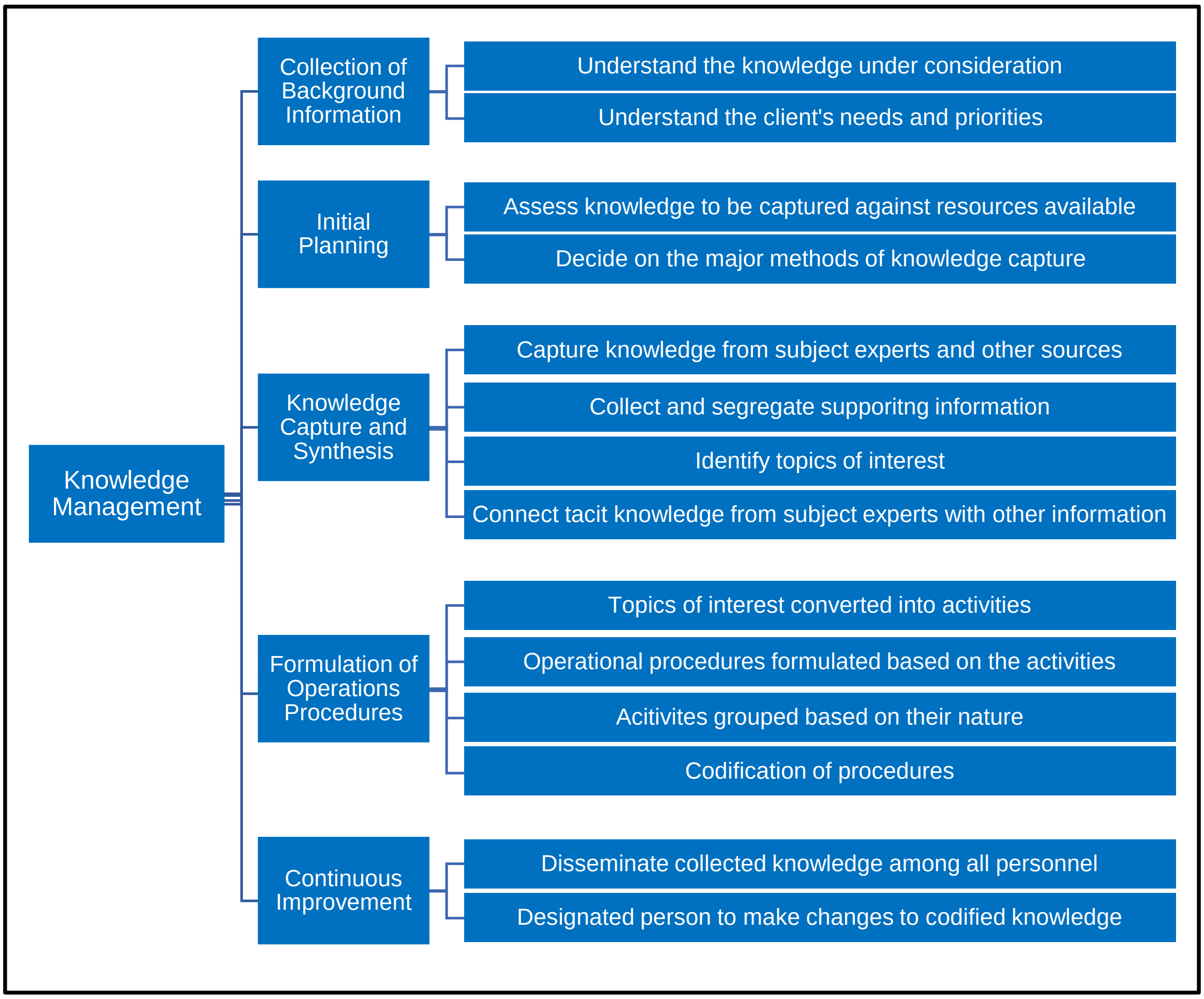

Figure 2.14: KM framework for manufacturing SMEs. (Source: Abraham, 2021:294)

According to Abraham (2021:291), knowledge creation and transfer in European manufacturing SMEs occur in the socialisation mode (tacit-to-tacit) and internalisation mode (explicit-to-tacit) of the SECI cycle. KM practices associated with socialisation include tacit knowledge acquisition through hierarchies and peers, formal mentoring practices, direct people-to-people contact, and good networking among employees. KM practices related to the internalisation mode (to gain tacit knowledge from explicit knowledge sources) include formal training, reading documents and studying sources on a database containing explicit knowledge (Singh *et al*., 2022:12206).

2.4.8 KM framework for small, medium and large organisations

Singh *et al*. (2022:12195) developed a KM framework that categorises KM practices into small, medium and large organisations. As seen in Figure 2.15, the KM framework guides managers on the type of KM practices that should be adopted based on the type, size and geographical dispersion of the organisation and the core area of the organisation.

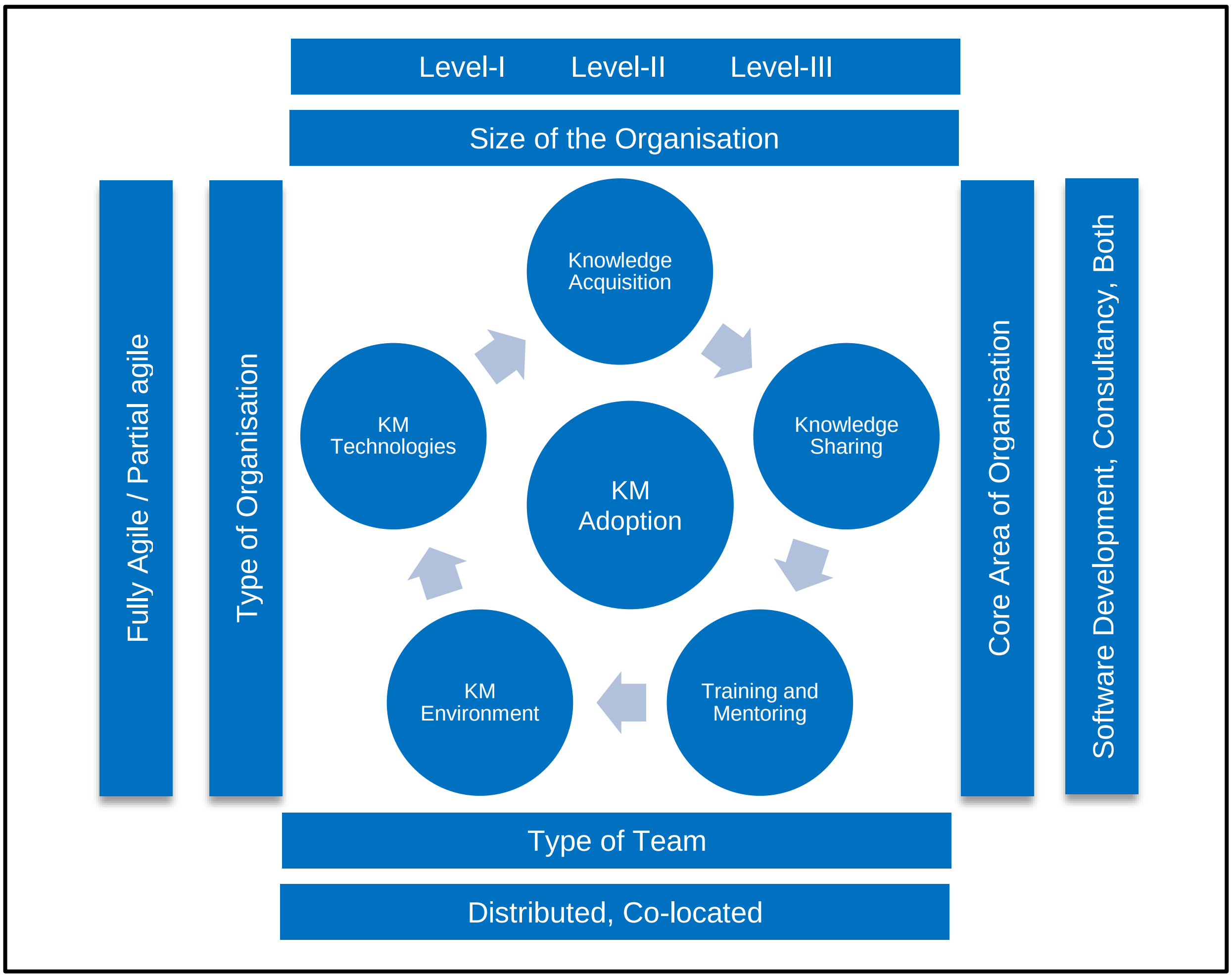

Figure 2.15: KM adoption methods. (Source: Singh *et al*., 2022:12196)

The KM framework in Figure 2.15 includes thirteen KM practices tested for this study. Singh *et al*. (2022:12205) found that software engineering companies regard KM practices such as knowledge acquisition through hierarchies and peers (relative rank = 1, global rank = 3), technical solutions (relative rank = 2, global rank = 1), human-centred IT (relative rank = 3, global rank = 2), formal training (relative rank = 4, global rank = 4), and formal mentoring practices (relative rank = 5, global rank = 5) as practical techniques to transfer knowledge among employees. Rotation of people among projects is the least effective KM practice (relative rank = 17, global rank = 17).

Research studies identified three reasons why small and medium-sized enterprises are hesitant to adopt KM practices in their day-to-day work environment: (1) the tacit nature of knowledge, (2) common knowledge of the organisation shared by every employee, (3) shortage of human and financial resources (Singh *et al*., 2022:12195).

2.4.9 Limitations of KM frameworks analysed

The primary limitation of the KM frameworks examined in this study lies in the fact that most incorporate only CSFs of knowledge management, with the exception of one KM framework in Figure 2.15 that focuses on KM practices. While CSFs are essential in identifying KM enablers that support KM initiatives, frameworks that focus solely on CSFs often fail to provide effective methods for creating and sharing knowledge in the workplace. For example, these frameworks may highlight the importance of leadership, organisational culture, or technology as KM enablers but lack detailed practices that assist with knowledge transfer in an organisation.

The basis for this research study is the lack of a KM framework for a manufacturing company that integrates both CSFs and their associated KM enablers with KM practices.

2.5 Summary

Chapter 2 provides a comprehensive literature review on KM within manufacturing organisations. It traces the origins of KM, referencing Nonaka's foundational work on tacit and explicit knowledge and the development of KM frameworks over time. The chapter investigates sixteen KM practices and the critical role of ten KM enablers. Several KM styles are discussed, highlighting their varying impacts on company performance, from human-oriented to system-oriented approaches. The effectiveness of KM is linked to innovation, process efficiency, and competitive advantage, as demonstrated in multiple studies. The chapter concludes by examining how KM enablers and practices can be effectively implemented within the manufacturing industry, providing a framework for understanding KM’s role in organisational success.

The next chapter provides an overview of the research methodology employed for this study to answer the research questions.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The literature review in the previous chapter familiarises the reader with mechanisms to adopt and implement KM within a company. The objective was to determine which CSFs and KM practices worked for successful companies, develop a conceptual KM framework and then test which CSFs and KM practices employees in an explosives manufacturing company deemed essential for KM within their company (Fivaz & Pretorius, 2015:1).

The information for the literature review was obtained by consulting various academic sources and relevant published articles, which were sourced from the North-West University Library and Google Scholar.

This chapter provides a detailed overview of the research methodology employed for this study and forms the first part of this chapter, followed by the study's ethical considerations, contributions and limitations.

3.2 Research methodology

According to Schindler (2022:604), primary data refers to the raw and unprocessed data collected by the researcher to answer the research question. This study's primary source of information was employees working at an explosives manufacturing company in South Africa. Therefore, the primary data required for this study was collected using an online survey questionnaire. The survey questionnaire was tailored to obtain the primary data required to answer the hypotheses under investigation.

The research design of this study's empirical investigation comprises several sections: Research paradigm, research approach, methodological choice, research strategy, time horizon, study population and sampling, data collection and statistical analysis.

The research onion in Figure 3.1 depicts the research philosophy, approach, data collection choice and strategy and was used as a guide to develop the research design and organise the research for the study (Saunders *et al*., 2016:162).

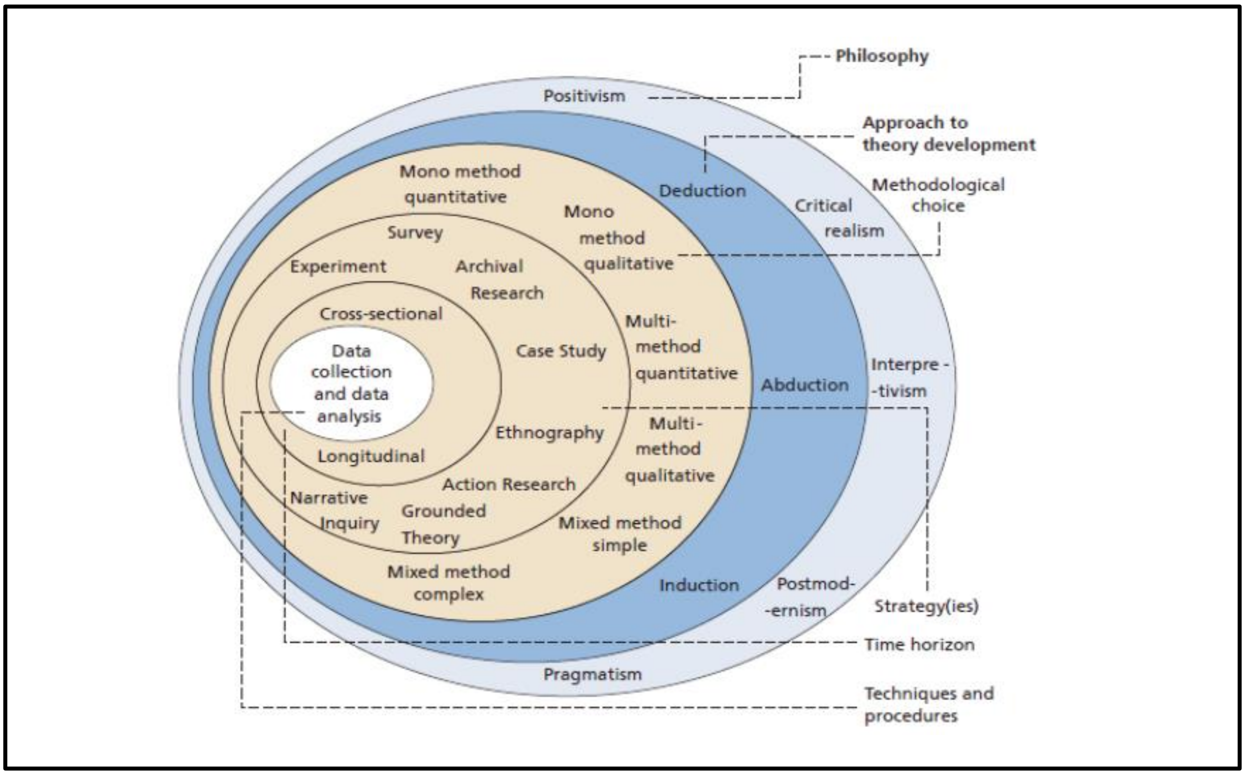

Figure 3.1: The research onion. (Source: Saunders *et al*., 2016:124)

3.2.1 Research paradigm

Burrell and Morgan's (1979:455) paradigm model on organisational theory comprises the objectivism, subjectivism and ideological dimensions (Saunders *et al*., 2016:128). The ideological dimension of the model has two opposing poles, as seen in Figure 3.2: sociology of regulation (the interpretative and functionalist paradigm) and sociology of radical change (the radical humanist and structuralist paradigm). Research aimed at determining how things are done in an organisation intending to bring change would be conducted within the radical change perspective (Saunders *et al*., 2016:132).

	Sociology of Radical Change		
Subjective (Nominalism)	Radical humanist	Radical structuralist	Objective (Realism)
	Interpretive	Functionalist	
	Sociology of Regulation		

Figure 3.2: Paradigm model of Burrell and Morgan. (Source: Adapted from Burrell and Morgan, 1979:455; Saunders *et al*., 2016:133)

The radical structuralist paradigm is quantitative research because it is conducted from a realist position, epistemologically positivist and tends to be determinist in human nature and nomothetic in methodological assumption, as seen in Figure 3.1 and Figure 3.2 (Gunbayi & Sorm, 2018:70).

The study examined whether an explosives manufacturing company's organisational structure and culture are critical for implementing KM. The researcher adopted objectivism from an ontological perspective because an organisation and its culture are social entities external to individual employees and affect how knowledge is transferred (Creswell & Creswell, 2018:28).

3.2.2 Research approach

According to Rahi (2017:2), theory allows the researcher to explain the relationship between two or more variables. Hirschsohn (2021:22) states that the term "*theory*" is used to explain observed patterns of association. In research, there are two levels of theory: inductive theory approach and deductive theory approach (Hirschsohn, 2021:22; Rahi, 2017:2).

According to Hirschsohn (2021:24), the deductive research approach is commonly associated with the positivist paradigm and is used to establish the relationship between theory and data. This study involved developing a research question from the theory and then collecting and analysing data on KM practices to answer the research question.

3.2.3 Methodological choice

Quantitative research is associated with positivism and the deductive approach (Saunders *et al*., 2016:166). This study adopted a quantitative research design to determine which KM practices are most effective within an explosives manufacturing company (Saunders *et al*., 2016:164). The research study tested objective theories by examining the relationship between variables (Creswell & Creswell, 2018:41).

According to Saunders *et al*. (2016:166), a mono-method quantitative research study uses a single data collection technique, such as a questionnaire. The mono-method, quantitative research was the most suitable methodological choice for collecting data and achieving the research objectives of this study. Statistical tools such as descriptive statistics (e.g., mean, median, standard deviation) and software programs (e.g., Statistical Package for the Social Sciences) were vital for this research study to derive meaningful insights from the quantitative data, ensuring the formulation of valid conclusions.

3.2.4 Research strategy

According to Saunders *et al*. (2016:181), the survey strategy is used with a deductive research approach. The research design used for this study was "survey-based research," which entailed collecting numerical data, analysing it, and interpreting it. The research aimed to find solutions for retaining knowledge in an explosives manufacturing company. A survey-based research approach was followed because inputs from employees in an explosives manufacturing company were used to design and develop a conceptual KM framework (Hofstee, 2006:122).

A survey strategy was used to collect quantitative data and allowed the researcher to establish reasons for specific relationships between variables and to develop a model for these relationships (Saunders *et al*., 2016:182). The study aimed to develop a holistic framework by establishing the links between KM practices and knowledge transfer (Fivaz & Pretorius, 2015:5).

3.2.5 Time horizon

Melnikovas (2018:34) states that the time horizon layer of the research onion defines the time frame for the study and can involve collecting data at a specific point of time (i.e., cross-sectional study) or collecting data continually over an extended period (i.e., a longitudinal study). Saunders *et al*. (2016:200) refer to cross-sectional studies as a "*snapshot*" time horizon because it involves studying a particular phenomenon at a specific time. Longitudinal research is regarded as the "*diary*" perspective of the time horizon because data is collected over a long period (Saunders *et al*., 2016:200).

According to Saunders *et al*. (2016:200), a cross-sectional study is associated with survey research. This study used a cross-sectional research design because data were collected on a series of variables at a single point in time (Faasen & Hirschsohn, 2021:108).

3.2.6 Study population and sampling

According to Babbie (2016:116), the population of a study is the group of people from whom you want to conclude. According to Schindler (2022:39), determining the target population is the first step in planning the sampling design and should include people with the desired information to answer the research question. This study's population (N) comprised 2239 employees of an explosives manufacturing company in South Africa.

Senior management of a well-known explosives manufacturing company in South Africa permitted the researcher to conduct the study in their workplace; therefore, access to the population (N=2,239) and sample (n=1,054) group was possible.

According to Faasen (2021:209), a sampling frame refers to a list of all the people forming the population from which the sample can be selected. The researcher is an employee of the explosives manufacturing company under investigation, and the company's email address book was used as a sampling frame. A single-stage sampling procedure was followed because the researcher, with the assistance of the IT department, had access to the respondents' contact details and could sample the participants directly from the company's email address book (Creswell & Creswell, 2018:212). The research study adhered to the Protection of Personal Information Act (POPIA), and respondents' personal information was treated with confidentiality.

The study required participants to share specific characteristics to ensure a good study sample; therefore, participants had to comply with the inclusion and exclusion study criteria defined in this paragraph (Creswell & Creswell, 2018:224). The sample (n=1,054) comprised permanent and fixed-term contract employees from each functional department (see Table 3.1). Participants for the study had to have an official company email address since the survey was done on the company's internal network.

Table 3.1: Applying stratified sampling.

Department	**Proportionate stratified sample**	
	(N)	**(n)**
Finance	36	17
Human Resources (HR)	14	7
Information Technology (IT)	31	15
Internal services	10	5
Manufacturing	1458	685
Managing Directors (MDs) office	13	6
New Business Development & Sales (NBD&S)	21	10
Operational Risk and Management	55	26
Other departments not mentioned	57	27
Plant Engineering (PE)	97	46
Product Development (PD)	109	51
Project Management	27	13
Quality, Health, Safety, Environmental (QHSE)	250	117
Supply Chain & Services	61	29
Total	**2239**	**1054**

Source: Adapted from Faasen (2021:216)

The probability sampling technique was used because a survey strategy was applied for the research study (Faasen, 2021:213). According to Faasen (2021:209-213), the probability sampling technique provides the researcher with a representative sample since every unit in the population has an equal chance of being selected. A representative population sample, as seen in Table 3.1, was essential to generalise findings derived from the participants' answers to that of an explosives manufacturing company (Faasen, 2021:209-213). The stratified random sampling method was applied to ensure the sample contained a proportional representation of each company department. Strata were essential to the study as participants' opinions on knowledge transfer techniques might differ according to the functional departments (Faasen, 2021:215).

The calculation of the sample size (n_h) for each department (stratum) is illustrated below to ensure the resulting sample is distributed in the same manner as the population in terms of the stratified criterion (Faasen, 2021:214):

<u>The sample size for the stratum</u>:

$$\mathrm{n}_h = \frac{\mathrm{n}^a}{N}$$

$$\mathrm{n}_h = \frac{1054}{2239}$$

$$\mathrm{n}_h = 0.4707$$

$$\mathrm{n}_h = 47\%$$

<u>Example</u>:

$$Supply\ Chain\ \&\ Services = \mathrm{n}_h \times N$$

$$Supply\ Chain\ \&\ Services = 47\% \times 61$$

$$Supply\ Chain\ \&\ Services = 28.6$$

$$Supply\ Chain\ \&\ Services = 29$$

where "n^a“ is the sample size required,
"N" is the population size,
"n_h" is the sample size for stratum h.

According to Saunders *et al*. (2016:279), the sample size in probability sampling is a compromise between the accuracy of the findings and the amount of time and money the researcher spends collecting and analysing data. Therefore, the decision on the study's sample size depended on how much sampling error the researcher was willing to tolerate.

According to Faasen (2021:229), a larger sample size must be used when the heterogeneity of the population is enough to affect the results. The population in the study can be regarded as heterogeneous because participants' opinions on KM techniques were expected to differ according to the functional department. Another factor to consider when deciding on the sample size is that the response rates for email surveys tend to be low, and it is recommended to send three to six times as many questionnaires as the sample size required (Faasen, 2021:229).

Regression analysis is the statistical method used to show the relationship between variables and generally requires a minimum of 100 samples (Memon *et al*., 2020:2). The response rates for email surveys range between 15% and 30% (Faasen, 2021:230). The sample (n) size of 1054 in Table 3.1 at a 15% response was sufficient to obtain a minimum of 100 samples (responses) for this study. Calculation of expected minimum sample size from 1054 participants (Saunders *et al*., 2016:283):

$$\mathrm{n}^{a} = \frac{\mathrm{n} \times 100}{\mathrm{re}\%}$$

$$1054 = \frac{\mathrm{n} \times 100}{15}$$

$$\mathrm{n} = 158.10$$

where "n^{a}" is the sample size required,
"n" is the minimum sample size,
"re%" is the estimated response rate.

3.2.7 Designing the measuring instrument

This study employed a cross-sectional research design and used an email survey questionnaire to collect quantitative data (Du Toit, 2021:237). According to Saunders *et al*. (2016:452), when developing questions, the researcher can adopt questions used in other validated questionnaires or develop his/her own questions.

The Knowledge Management Assessment Tool (KMAT) developed by Arthur Andersen and the American Productivity & Quality Center (APQC, 2023:1), as well as the Knowledge Management Maturity Assessment Questionnaire (KMMAQ) developed by Kruger (2008:203), assist organisations in measuring the effectiveness of its KM practices. The KMAT and KMMAQ questionnaires were used as a guide to develop a survey questionnaire to determine which CSFs and KM practices employees in a manufacturing company deemed essential for sharing tacit knowledge (see Appendix B).

3.2.7.1 **Section A: Demographical information**

This section comprised four closed-ended questions built on a multiple-choice single-response scale (Du Toit, 2021:248; Schindler, 2022:267). In this section of the survey questionnaire, respondents had to indicate their functional department, management level (e.g., operational level, middle management, senior management), and years of service. The demographical information assisted the researcher with the statistical data analysis by comparing the inputs from different functional departments. Knowledge resides with employees with years of experience; therefore, a high average of participants' years of service will contribute to the validity of the research.

Previous scholars did not conclude that other demographic information of participants, such as gender or race, was required; therefore, no respondents' personal information was needed.

3.2.7.2 **Section B: Assessment of critical knowledge in the organisation**

This section comprised two closed-ended questions built on a multiple-choice single-response scale (Du Toit, 2021:248; Schindler, 2022:267). Close-ended questions in this section assisted the researcher in comparing respondents' answers to establish which knowledge is critical in the organisation (Du Toit, 2021:248).

The questions for this section were developed from insight gained from the literature review (Choi & Lee, 2002:406; Nonaka, 1991:165-166; Nonaka, 1994:16; Sumbal *et al*., 2019:640-646).

3.2.7.3 **Section C: Assessment of CSFs of knowledge management**

This section comprised ten closed-ended questions built on a five-point Likert scale (Du Toit, 2021:248; Schindler, 2022:268). Close-ended questions in this section assisted the researcher in testing the relationship between variables and comparing them with previous studies (Du Toit, 2021:248). This section assessed which CSFs of KM were deemed essential by respondents in the explosives manufacturing environment.

The questions for this section were developed from insight gained from the literature review and previously validated questionnaires such as the KMAT and KMMAQ knowledge management assessment tools (APQC, 2023; Heisig, 2009:14).

3.2.7.4 **Section D: Assessment of KM practices**

This section comprised of 15 closed-ended questions built on a five-point Likert scale (Du Toit, 2021:248; Schindler, 2022:268). This section assessed which KM practices respondents regarded adequate for knowledge transfer and sharing in their organisation.

The questions for this section were developed from insight gained from the literature review and previously validated questionnaires such as the KMAT and KMMAQ knowledge management assessment tools (APQC, 2023; Heisig, 2009:14; Phaladi & Ngulube, 2022:4; Singh *et al*., 2022:12192).

3.2.8 Collection of data

In deductive research, data collection is used to evaluate the hypothesis related to an existing theory (Saunders *et al*., 2016:145). Data were collected using a self-administered questionnaire distributed to respondents through email (i.e., email survey). According to Schindler (2022:213), email surveys provide more anonymity than any other method of distributing self-administered questionnaires. Another advantage of a self-administered questionnaire is that the researcher cannot influence the respondents (Saunders *et al*., 2016:442). Since the respondents work at four different geographical locations, an email survey was the most cost-effective method to gather data. An email survey also allowed respondents to answer questions at their own time and pace with easy online submission (Du Toit, 2021:239). However, the risk of self-completed questionnaires is that the respondent can discuss the answers with colleagues within his/her functional department, possibly contaminating the response (Saunders *et al*., 2016:442).

A well-trained survey team at the IT department of the respective explosives manufacturing company assisted the researcher in emailing the survey questionnaire link to company employees. The survey team conducts regular internal surveys for the HR department and successfully executed the survey on behalf of the researcher for one month. There was no need for the researcher to assist with uploading and distributing the survey to company employees during the 30 days, and there was also no interaction between the researcher and the respondents.

The survey platform within the explosives manufacturing company provides complete confidentiality to participants, and not even the IT survey team can see which employees have completed the survey. However, the survey team could provide the researcher with a weekly status report on how many completed surveys were received, as seen in Figure 3.3. The survey platform automatically sends weekly reminders to those employees who have not yet completed and submitted the survey during the 30 days. Partial responses in Figure 3.3 mean that 52 participants opened the survey link but never completed all the survey questions when the survey closed.

The survey team of the explosives manufacturing company downloaded the survey data at the end of the month and forwarded the data directly to the North West University (NWU) Statistical Consultation Services department for analysis.

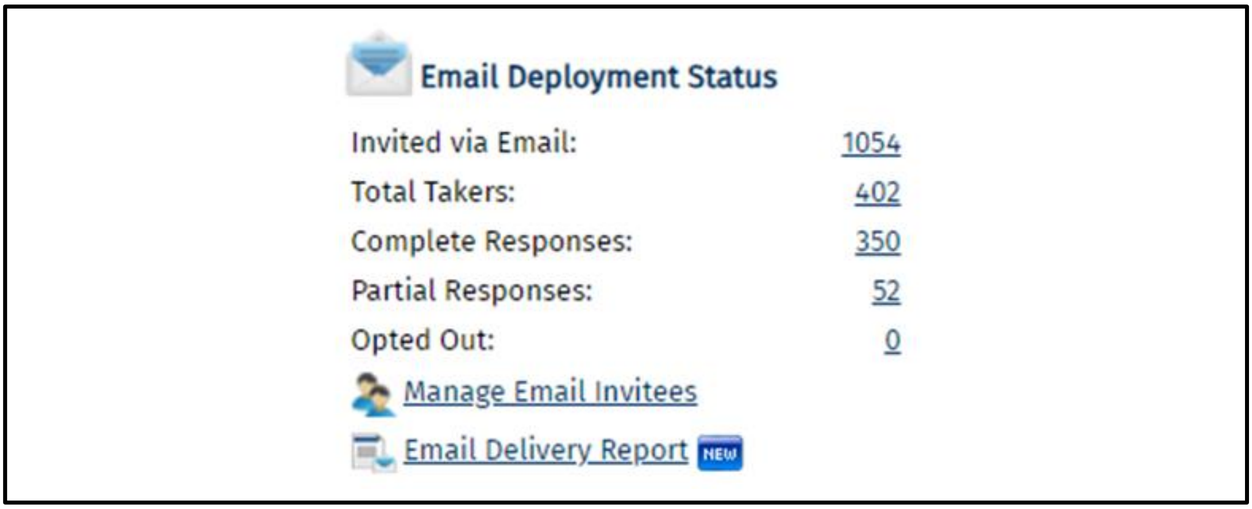

Figure 3.3: Weekly survey status report (Source: RDM, 2024)

3.2.9 Statistically analysis

In an unprocessed form, quantitative data has little meaning to readers, so data must be processed to turn it into useful information (Saunders *et al*., 2016:496). The primary data collected from the survey questionnaire was analysed using statistical analysis computer software, IBM's Statistical Package for the Social Sciences (IBM SPSS, Version 29), while the structural modelling used IBM's AMOS (Version 29) (Quesada & Masenge, 2021:411). Since the self-administered survey questionnaire was distributed to participants via company email (i.e., on the company's intranet), data was automatically saved on a server at the IT department using predefined codes (Saunders *et al*., 2016:501). The NWU Statistical Consultation Services analysed the survey data.

The survey tested participants' opinions on the variables summarised in the conceptual framework in Figure 2.3, meaning that categorical data required codification. Categorical data in the study comprised dichotomous and nominal variables to establish the number of occurrences for each variable (Saunders *et al*., 2016:500).

3.3 Reliability and validity (trustworthiness)

Three criteria are used to evaluate the quality of business research: reliability, replication, and validity. Reliability is important in quantitative research and refers to whether or not the results of a study can be repeated (Hirschsohn, 2021:42). According to Babbie (2016:146), reliability implies that the same results are obtained when the same technique is applied repeatedly to an object. Saunders *et al*. (2016:202) state that a study is considered reliable if the researcher can duplicate an earlier research design and achieve the same findings. Reliability depends on three prominent factors: stability, internal reliability, and inter-rater reliability (Van Aardt & Hirschsohn, 2021:53).

One technique to test the reliability of the self-administrating questionnaire will be to apply the test re-test technique.

The test re-test technique involves administering the email survey to the same or similar group of respondents at different points in time and comparing the results (Saunders *et al*., 2016:451). Since few respondents would have re-done the survey questionnaire, a possible solution was to let the remaining respondents in each functional department complete the same email survey, but due to time constraints, the re-test technique was not applied.

Validity is a crucial criterion and is concerned with the integrity of the conclusions (Hirschsohn, 2021:43). According to Saunders *et al*. (2016:202), validity refers to the appropriateness of the measures used (i.e., does the instrument measure what it was intended to), how accurate the analysis of the results are and whether the findings can be generalised. The main types of validity are measurement, internal, and external validity. Measurement validity concerns whether the measures reflect the concepts they are supposed to capture. Measurement validity is associated with face, construct, content, and predictive validity. Internal validity is concerned with whether or not the independent variable is responsible for the variation in the dependent variable (i.e., whether there is a relationship between two or more variables). External validity concerns generalising the results (Hirschsohn, 2021:43-44).

One technique to test the face validity of the self-administered questionnaire is to let experts read through the questionnaire to evaluate whether the questions effectively capture the topic under investigation. The survey questionnaire was sent to the NWU Statistical Consultation Services department before the survey for face validity. The reliability and validity of the mail survey were ensured by defining the research questions and objectives as clearly and precisely as possible.

The research design adopted for this study is summarised in Table 3.2.

Table 3.2: Summary of empirical study.

Category	Used in the Study
Dimension	Sociology of Radical Change
Research approach	Objective approach (Objectivism)
Ontology	Realism
Epistemology	Positivism (Positivist)
Approach to theory development	Deductive research
Methodological choice	Mono method quantitative
Strategy	Survey

Time horizon	Cross-sectional study
Study population	Employees of an explosives manufacturer
Sampling	Probability sampling technique Stratified random sampling method
Data collection	A self-administered questionnaire via email
Statistical analysis	SPSS software

3.4 Ethical considerations

According to Hirschsohn and Faasen (2021:160), in business research, there are four important ethical principles to consider: (1) Whether there is a lack of informed consent, (2) whether there will be harm to participants, (3) whether there is an invasion of privacy, and (4) whether there is deception. The researcher adhered to the specified ethical guidelines while compiling the research proposal and preempted several ethical issues before the commencement of the research proposal. Firstly, written approval was obtained from senior management of a well-known explosives manufacturing company in South Africa to conduct research in the workplace (Creswell & Creswell, 2018:148; Hirschsohn & Faasen, 2021:160). Secondly, the researcher decided not to conduct a study on the KM maturity in the explosives manufacturing company as this might be detrimental to the image of the company (Hirschsohn & Faasen, 2021:160). Instead, the research study aimed to establish and recommend good KM practices based on participants' inputs, which can be applied by explosives manufacturers in South Africa. Lastly, the study was of such a nature that it did not harm participants or impose on their privacy (Hirschsohn & Faasen, 2021:160).

The researcher commenced with the empirical study after obtaining ethical clearance from the North-West University’s Economic and Management Sciences Research Ethics Committee. The researcher conducted the study under the supervision of an experienced academic supervisor, and potential ethical issues during the data collection and analysis phase were pre-empted.

According to Section 11 of the Protection of Personal Information Act (POPIA, 2023:1), the researcher can only process a participant's personal information if consent is given to the processing. The online survey contained a consent form, and participants could only continue with the survey after selecting the "Agree to participate" link on the electronic consent form. By participating in the survey, the participant granted consent to the researcher to use the data in the questionnaire. The employees' emails in the explosives manufacturing company are password protected, and the IT department can provide an electronic mail trail if required. Data for the research could only be collected from participants who provided their informed consent.

Participation in the study was entirely voluntary. The researcher did not have contact with any participants before or during the online survey and, therefore, could not coerce anyone to participate (Creswell & Creswell, 2018:149; Hirschsohn & Faasen, 2021:165).

The POPIA Act (POPIA, 2023:1) defines personal information (data) as any information relating to a person in terms of "race, gender, sex, pregnancy, marital status, ethnicity, colour, sexual orientation, age, culture, language, religion, health status, and disability" which are generally used for demographic purposes in research studies (Hirschsohn & Faasen, 2021:162-165). The research study did not require any of the above-mentioned personal information from participants. Demographic information focused on the participant's functional department and years of service. The results of previous research studies on KM focused on the functional department or type of organisation and not on any specific demographic information of individuals.

Section 19 to 22 of POPIA requires that the responsible party (i.e., researcher) ensure that personal information collected is kept secure and stored at a secure location to prevent data from being copied and used by third parties (i.e., maintain confidentiality and integrity) (Hirschsohn & Faasen, 2021:171-172). The researcher, supervisor and the NWU Statistical Consultation Service department handled the survey data. The data file is password-protected and is stored at a secure location. The data will not be retained longer than necessary, as Section 14 of POPIA prescribes. The prescribed data storage duration of three years will be applied.

Respecting participants' privacy and protecting anonymity are essential (Creswell & Creswell, 2018:152; Hirschsohn & Faasen, 2021:170). Contact between the researcher and participants during the online survey was not required because the company's IT department facilitated the survey process, and participants worked at four locations. The researcher ensured data collection and analysis were conducted appropriately and professionally. The researcher dissociated the names of respondents from the results during the coding process. The researcher treated the study's findings so that it did not taint the image of any participant or the company (Creswell & Creswell, 2018:152; Hirschsohn & Faasen, 2021:170).

According to Creswell and Creswell (2018:152), the data analysis of quantitative research should reflect the statistical tests and should not be underreported. The appointed academic supervisor reviewed the results to prevent the researcher from withholding essential results.

3.5 Summary

Chapter 3 outlines the research design and methodology employed to investigate KM practices in a South African explosives manufacturing company. The study follows a quantitative, deductive approach using the radical structuralist paradigm to assess CSFs and KM practices. A cross-sectional survey, distributed via email, was used to collect primary data from a stratified random sample of 1,054 full-time employees. The data collection instrument was designed from existing KM questionnaires, such as KMAT and KMMAQ, and data was analysed using SPSS software. The chapter also addresses reliability, validity, and ethical considerations, including adherence to the Protection of Personal Information Act (POPIA). Limitations include the focus on a single company and the absence of testing the effectiveness of KM practices over time.

The next chapter provides a detailed analysis of the quantitative data collected for this study.

CHAPTER 4 DATA ANALYSIS, RESULTS, AND INTERPRETATION OF FINDINGS

4.1 Introduction

This chapter comprises the analysis, presentation and interpretation of the quantitative data collected to answer the research questions and test the hypotheses. The findings presented in this chapter sought to provide answers to the following research questions:

- Which CSFs of knowledge management are deemed essential by employees to support knowledge transfer within an explosive manufacturing company?
- Which KM practices are deemed essential by employees to mitigate tacit knowledge loss within an explosive manufacturing company?

The primary data for this study were sourced through an online survey questionnaire distributed to employees of an explosives manufacturing company in South Africa.

4.2 Data analysis

The data analysis section comprises two parts: response analysis and data analysis for sections A to D. Data were interpreted using descriptive statistics and frequency counts. Frequency counts involve adding the responses from participants for each question to find the highest frequency of occurrence, with the final result presented as a percentage in tabular form.

4.2.1 Response analysis

From the 1054 survey questionnaires distributed via email to employees in the company, 350 fully completed questionnaires and 52 partially completed questionnaires were returned by participants (Total response = 402).

A partial response implies that the respondent did not complete all the questions when the online survey closed. The study analysed and interpreted data from 402 questionnaires, as illustrated in Table 4.1.

The study's overall response rate was 38.1%; this exceeds the expected response rate of 15% to 30% for email surveys (see Table 4.2).

Table 4.1: Response rate for each section of the online survey.

Section	Question	Complete responses		Partial responses		Total responses	
		Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Section A	Question 1 - 4	400	99.5	2	0.5	402	100.0
Section B	Question 5 - 6	381	94.8	21	5.2	402	100.0
Section C	Question 7 - 16	356	88.6	46	11.4	402	100.0
Section D	Question 17 - 31	350	87.1	52	12.9	402	100.0

4.2.2 Section A: Demographic profile of respondents

The demographic characteristics of the respondents from Section A of the survey are summarised in the data analysis section below.

4.2.2.1 **Comments on respondents' functional departments**

Table 4.2 presents the functional departments where the respondents work, as obtained from Question 1 of the survey questionnaire.

Table 4.2: Functional department of respondents.

Functional Department	Responses (n=402)	
	Freq	Perc
Finance	15	3.7
Human Resources	6	1.5
Information Technology	14	3.5
Internal Services	3	0.7
Manufacturing	132	32.8
Managing Directors’ (MDs) Office	3	0.7
New Business Development (NBD) and Sales	9	2.2
Operational Risk and Management	19	4.7
Other departments not mentioned	20	5.0
Plant Engineering	42	10.4
Product Development (PD)	45	11.2
Project Management	10	2.5
Quality, Health, Safety, and Environment (QHSE)	57	14.2
Supply Chain and Services	25	6.2
No response	2	0.5
Total	**402**	**100.0**

4.2.2.1.1 Key findings

- Manufacturing: 32.8%
- Quality, Health, Safety, and Environment (QHSE): 14.2%
- Product Development: 11.2%
- Plant Engineering: 10.4%
- Rest of departments: 31.4%

4.2.2.1.2 Analysis and interpretation:

Most respondents work in departments that are critical in ensuring compliance and safety in explosives manufacturing processes. The distribution of respondents across functional departments, as presented in Table 4.2, provides the study with a representative data sample. Data obtained in this regard is important as it allows for identifying KM practices specific to a department and developing tailored KM strategies.

4.2.2.2 **Comments on respondents' years of service**

Table 4.3 presents the years of service of respondents in both their department and the company as obtained from Questions 2 and 3 of the survey questionnaire.

Table 4.3: Respondents' years of service.

Years of service	Years in department		Years in company	
	Freq	Perc	Freq	Perc
0-5	161	40.0	133	33.1
6-10	107	26.6	110	27.4
11-15	40	10.0	41	10.2
16-20	27	6.7	22	5.5
21-25	23	5.7	33	8.2
26-30	16	4.0	18	4.5
31-35	14	3.5	21	5.2
>36	12	3.0	22	5.5
No response	2	0.5	2	0.5
Total	**402**	**100.0**	**402**	**100.0**

4.2.2.2.1 Key findings

- Ten years of service or less: 60.4%
- More than 30 years of service: 10.7%

4.2.2.2.2 Analysis and interpretation

The distribution of years of service suggests that a significant portion (60.4%) of employees have been with the company for ten years or less. This indicates a relatively young workforce in terms of tenure. The lower proportion (10.7%) of respondents with more than 30 years of service highlights the scarcity of long-term experience, possibly flagging the need for structured knowledge retention practices to avoid knowledge loss when these experienced employees leave the organisation.

Table 4.3 offers valuable insights for research on knowledge management by highlighting the tenure distribution within the company. This data can be used to investigate knowledge retention, transfer, and creation mechanisms.

4.2.2.3 **Comments on respondents' job designation level**

Table 4.4 presents the job designation level of respondents as obtained from Question 4 of the survey questionnaire.

Table 4.4: Job designation level of respondents.

Job designation level	**Frequency**	**Percentage**
Executive or Senior Management	43	10.7
Middle Management	65	16.2
First-level Management	65	16.2
Technical Staff	115	28.6
General Staff	112	27.9
No response	2	0.5
Total	**402**	**100.0**

4.2.2.3.1 Key findings:

The majority of the respondents (56.5%), comprising"*Technical staff*" (28.6%) and "*General staff*" (27.9%), do not occupy managerial positions in the explosive manufacturing company.

4.2.2.3.2 Analysis and interpretation:

A significant proportion of the workforce (56.5%) comprises technical and general staff; this provides the viewpoint of employees on how knowledge flows in a department and between hierarchical levels.

4.2.3 Section B: Types of knowledge

The results from Section B of the online survey are discussed in this section. The type of knowledge the respondents regarded as critical to function effectively and efficiently in their position is summarised in Tables 4.5 and 4.6.

4.2.3.1 **Comments on explicit and tacit knowledge**

Table 4.5 presents the type of knowledge respondents regard essential to function effectively in their current position, as obtained from Question 5 of the survey questionnaire.

Table 4.5: Explicit knowledge versus tacit knowledge.

Type of knowledge	Frequency	Percentage
Both explicit and tacit knowledge	302	75.1
Explicit knowledge	54	13.4
Tacit knowledge	25	6.2
No response	21	5.2
Total	**402**	**100.0**

4.2.3.1.1 Key findings

Most respondents (75.1%) regarded explicit and tacit knowledge as essential to function efficiently and effectively within an explosives manufacturing company.

4.2.3.1.2 Analysis and interpretation:

The recognition of explicit and tacit knowledge as essential by the majority (75.1%) highlights the importance of these two types of knowledge within an explosives manufacturing organisation.

4.2.3.2 **Comments on critical knowledge**

Table 4.6 presents the type of knowledge respondents regard as critical to function effectively in their current position, as obtained from Question 6 of the survey questionnaire.

Table 4.6: Critical knowledge to function in a position.

Critical knowledge	Frequency	Percentage
Knowledge of customer and supplier networks	73	18.2
Management knowledge	86	21.4
Technical knowledge	222	55.2
No response	21	5.2
Total	**402**	**100.0**

4.2.3.2.1 Key findings

The majority of the respondents regard Technical knowledge (55.25%) as the most important, followed by Management knowledge (21.4%), and finally, knowledge of customer and supplier networks (18.2%).

4.2.3.2.2 Analysis and interpretation:

The findings highlight that technical knowledge is the most important within an explosives manufacturing company. Since technical knowledge is considered more critical than management or networking knowledge, KM systems can be tailored to reflect this prioritisation.

4.2.4 Section C: CSFs of knowledge management

This data analysis section shows the results of Section C of the survey questionnaire (Question 7 to Question 16). Section C of the survey questionnaire tested ten KM enablers (independent variables) grouped under the four identified CSFs.

4.2.4.1 **Reliability test values for Section C (KM enablers)**

A reliability test was used to measure the internal consistency and reliability of the data collected from Questions 7 to 16.

4.2.4.1.1 Comments on the overall reliability values in Table 4.7 for Section C

Table 4.7 presents the overall Cronbach's Alpha coefficient for Section C. Cronbach's Alpha is a common way of assessing internal consistency and reliability (Hair *et al*., 2021:80; Van Aardt & Hirschsohn, 2021:54).

Table 4.7: Reliability statistics for Section C.

Cronbach's Alpha	Cronbach's Alpha based on Standardised items	N of items
0.913	0.915	10

- Cronbach's Alpha coefficient for Section C:

1. Cronbach's Alpha: The overall Cronbach's Alpha coefficient in Table 4.7 for the ten items under Section C of the measuring instrument is 0.913. The coefficient of 0.913 exceeds the generally accepted threshold of 0.70 by far, indicating high internal consistency among the items in Section C. This suggests that the items reliably measure the same underlying construct (Hair *et al*., 2021:80; Van Aardt & Hirschsohn, 2021:54).
2. Cronbach's Alpha based on Standardised items: The slightly higher value of 0.915 after standardisation confirms the robustness of the internal consistency measure. The slight difference between the two values is expected and indicates that the items' reliability remains strong even after standardisation (Hair *et al*., 2021:96).

- Interpretation of reliability results:

The minimum Cronbach's Alpha coefficient allowed is 0.70 (or 0.60 for exploratory research). A Cronbach's Alpha coefficient above 0.70 is generally considered acceptable, with values above 0.80 indicating good reliability and those above 0.90 suggesting excellent reliability (with a maximum of 0.95 to avoid indicator redundancy, which could compromise content reliability) (Hair *et al*., 2021:80; Van Aardt & Hirschsohn, 2021:54). The reported values (0.913 and 0.915) fall into the excellent range, indicating that the questions in Section C are highly consistent in their measurement.

The high Cronbach's Alpha values indicate that the questions were well formulated and clearly understood by all the respondents. High reliability suggests that the respondents likely interpreted the questions consistently, which is crucial for ensuring valid and reliable responses (Hair *et al*., 2021:80; Van Aardt & Hirschsohn, 2021:54).

- Number of items:

The ten items used in Section C are a reasonable number for assessing reliability. While more items can improve reliability, having ten items with a high Cronbach's Alpha suggests that they effectively capture the construct of interest without being redundant (Hair *et al*., 2021:12).

4.2.4.1.2 Comments on the construct reliability values in Table 4.8 for the KM enablers

Table 4.8 presents the item reliability values for each KM enabler tested for this study.

Table 4.8: Item reliability statistics for KM enablers.

CSF	KM Enabler	N	Cronbach's Alpha	Corrected Item-Total Correlation	Mean	Std Dev
Human-orientated Factors (HF)	People (Individuals)	356	0.909	0.615	4.42	0.745
	Organisational culture	356	0.904	0.701	4.43	0.734
	Leadership	356	0.904	0.702	4.45	0.740
Organisational Aspects (OA)	Organisational processes	356	0.899	0.782	4.41	0.709
	Organisational structure	356	0.904	0.701	4.15	0.870
Management Aspects (MA)	Strategies	356	0.901	0.744	4.27	0.759
	Goals	356	0.904	0.694	4.14	0.756
	Measurement	356	0.909	0.629	4.01	0.869
Technolgy-orientated Aspects (TA)	Technology infrastructure	356	0.908	0.622	4.20	0.795
	Technology applications	356	0.906	0.611	4.22	0.715

- Cronbach's Alpha values of KM enablers:

The Cronbach's Alpha values range from 0.899 to 0.909 across the different KM enablers, which indicates high internal consistency within each category. Values above 0.90 generally denote excellent reliability, showing that the items within each enabler consistently measure the intended construct (Hair *et al*., 2021:80; Van Aardt & Hirschsohn, 2021:54).

- Corrected Item-Total correlation:

The Corrected Item-Total Correlation values are high, ranging from 0.611 to 0.782. These values indicate that each item has a strong relationship with the overall scale, suggesting that the items are well-aligned with the construct they intend to measure (Field, 2009:678; Field, 2017:826).

- Mean and Standard Deviation:

The item Mean values ($\dot{X}$) in Table 4.8 range from 4.01 to 4.45. This suggests a generally positive perception among respondents regarding these KM enablers. The Standard Deviation values (σ) vary from 0.709 to 0.870, reflecting some variability in responses but not excessively high, indicating that most respondents' views are somewhat consistent (Field, 2009:38; Field, 2017:78; Schindler, 2022:366; Quesada & Masenge, 2021:418).

- Comparison between KM enablers:

"*Human-orientated factors*" have high Cronbach's Alpha values (0.904 to 0.909) and high Corrected Item-Total Correlations, showing strong reliability. "*Organisational aspects*" also show high reliability, with a slightly lower Cronbach's Alpha for "*Organisational processes*" (0.899) but still within the acceptable range. "*Management aspects*" and "*Technology-orientated aspects*" maintain high reliability with Cronbach's Alpha values around 0.901 to 0.909.

- Interpretation of results:

The consistently high Cronbach's Alpha values across different categories suggest that the instrument used to measure KM enablers is reliable. This implies that the items within each enabler reliably measure the same underlying concept.

It is important to note that while high Cronbach's Alpha indicates good internal consistency, it does not guarantee validity (i.e., whether the items measure what they are supposed to measure). Thus, discussing validity measures to provide a comprehensive assessment of the instrument's quality later in this document is beneficial (Schindler, 2022:247).

- Potential improvements:

While the reliability statistics are strong, it is important to consider the items' validity and ability to capture the full range of each KM enabler's construct. Suggested improvements include reviewing the items with lower Mean values or higher Standard Deviation values to ensure they align with respondents' perceptions and that no items negatively impact the reliability. If further refinement is needed, one could investigate individual item performance or consider expanding the number of items to improve reliability.

- Conclusion:

The reliability statistics from Table 4.7 and Table 4.8 of the measuring instrument indicate high internal consistency. The Cronbach's Alpha values are well above the acceptable threshold, suggesting that the questions are likely well-formulated and consistently interpreted by respondents. The high Cronbach's Alpha values and strong Corrected Item-Total Correlations indicate that the items effectively measure the intended constructs. However, complementing these findings with an assessment of validity provides a more complete evaluation of the instrument's effectiveness.

4.2.4.2 **Validity test values for Section C (KM enablers)**

A validity test determined whether Section C (i.e., Questions 7 to 16) of the instrument actually measured what it was designed to measure (Field, 2009:11; Field, 2017:15).

4.2.4.2.1 Comments of validity test values for Section C (KM enablers):

Table 4.9 presents the validity test values for Section C of the survey questionnaire.

Table 4.9: Validity test values for Section C.

Goodness of Fit (GoF) measure		**Standard**	**Calc**	**Description**
Ratio of chi-square to degrees of freedom	CMIN/DF	≥2.0 to ≤3.0	4.483	Poor fit
Normed fit index called Delta 1	NFI	≥0.9 to ≤1.0	0.936	Reasonable fit
Relative fit index called rho1	RFI	≥0.9 to ≤1.0	0.878	Reasonable fit
Incremental fit index	IFI	≥0.8 to ≤1.0	0.949	Good fit
Tucker-Lewis index called rho2	TLI	≥0.9 to ≤1.0	0.903	Reasonable fit
Comparative fit index	CFI	≥0.9 to ≤1.0	0.949	Good fit
Root mean square error	RMSEA	≤0.05 to ≤0.1	0.093	Borderline

Notes: Fit Parameters					
CMIN/DF		NFI, RFI, IFI, TLI, CFI		RMSEA	
Perfect fit	=1.0	Perfect fit	=1.0	Good fit	≤0.05
Good fit	≥2.0 to ≤3.0	Good fit	≥0.95 to ≤0.99	Acceptable fit	≥0.05 to ≤0.08
Poor fit	≥3.0	Reasonable fit	≥0.90 to ≤0.94	Borderline	≥0.08 to ≤0.1
		Acceptable fit	≥0.80 to ≤0.89	Poor fit	≥0.1

Source: Adapted from Miljko (2020:1)

- Pearson's chi-square test (Field, 2009:808; Field, 2017:1000):

1. Chi-square value (X^2): 129.997
2. Degrees of freedom (*df*): 29
3. Critical value (α = 0.05, *df* = 29): 42.56
4. Significance: Pearson's chi-square value (129.997) exceeds the critical value (42.56), indicating a statistically significant difference between observed and expected distributions ($p < 0.05$). This allows for rejecting the null hypothesis (Field, 2017:840).

- Indices indicating "Poor Fit":

1. Ratio of Chi-Square to Degrees of Freedom (CMIN/DF): 4.483

a Interpretation: This index indicates a "*Poor Fit*" as the value is significantly higher than the ideal range of 2.0 to 3.0. A high CMIN/DF value suggests that the model may be overly complex or that there is a misfit between the model and the observed data (Miljko, 2020:3).

b Possible improvements:

(i) Model simplification: Consider simplifying the model by reducing the number of parameters or variables. Overly complex models can lead to poor fit indices (Hair *et al*., 2011:144).

(ii) Model re-specification: Re-evaluate the theoretical framework and ensure the model is correctly specified. Mis-specification can lead to poor fit.

2. Relative Fit Index (RFI): 0.878

a Interpretation: This value is below the ideal threshold of ≥0.90, suggesting a reasonable but not optimal fit. The RFI measures the improvement of the model over a null model (Miljko, 2020:7-8).

b Possible improvements: Review the model to identify potential areas for improvement. Adding or adjusting parameters based on theoretical considerations might improve the RFI.

3. Tucker-Lewis Index (TLI): 0.903

a Interpretation: This is on the borderline of the ideal range. A TLI below the ideal threshold indicates that the model may not be significantly better than a null model (Miljko, 2020:7-8).

b Possible Improvements: Enhance model fit by investigating and addressing potential model mis-specifications or omitted variables that could improve the TLI.

4. Root Mean Square Error of Approximation (RMSEA): 0.093

a Interpretation: RMSEA values below 0.08 are ideal, while values between 0.08 and 0.10 are considered borderline. A value of 0.093 suggests that the model fits the data reasonably well, but there is room for improvement (Peugh & Feldon, 2020:3; Miljko, 2020:14).

b Possible improvements: Model adjustment to reduce RMSEA. For example, to add or modify the parameters. This could help achieve a better fit and bring RMSEA below 0.08 and even 0.05.

- Indices indicating "Reasonable" or "Good Fit":

1. Normed Fit Index (NFI): 0.936

a Interpretation: This value falls within the acceptable range, indicating a reasonable fit. NFI is useful for comparing the fit of the proposed model to a null model (Miljko, 2020:7).

2. Incremental Fit Index (IFI): 0.949

a Interpretation: This index shows a good fit, indicating that the model explains the data well relative to a null model (Miljko, 2020:8).

3. Comparative Fit Index (CFI): 0.949

b Interpretation: This value also indicates a good fit, suggesting that the model performs well compared to the null model (Peugh & Feldon, 2020:3; Miljko, 2020:9).

4.2.4.2.2 Analysis and interpretation

- Pearson chi-square test: The Pearson's chi-square test result indicates a significant discrepancy between the observed and expected data. While this suggests some misfit, the chi-square test is susceptible to sample size. Even minor deviations can result in significant chi-square values in a large sample (n = 356). Thus, chi-square alone might not entirely reflect model adequacy.
- Fit indices:

1. CMIN/DF: At 4.483, this value indicates a poor fit. Ideally, the ratio should be between 2.0 and 3.0, suggesting that the model may not fit the data well.
2. NFI and RFI: Both indices are close to the upper end of the acceptable range (0.936 and 0.878, respectively). While not ideal, they suggest a reasonable fit, though improvements could be made.
3. IFI and CFI: Both indices are in the good fit range (0.949), indicating that the model has an acceptable fit according to these metrics.
4. TLI: At 0.903, it is slightly below the ideal threshold but still in the reasonable fit category.
5. RMSEA: At 0.093, this value is borderline (below 0.1 but above 0.08), indicating a fit on the edge of being acceptable. Ideally, it should be below 0.08.

4.2.4.2.3 Summary and recommendations

- Model fit: The overall fit of the model, as indicated by the good values of IFI and CFI, suggests that while some aspects of the model fit are acceptable, some areas need improvement. Specifically, the high CMIN/DF and borderline RMSEA indicate potential issues with the model's fit to the data.

- Model refinement: The poor fit indices suggest that there may be model complexity or specification issues. To enhance the model fit, consider evaluating and revising the model specifications, adding or removing variables, or re-assessing the structure of the model. Improving the fit indices, particularly the CMIN/DF and RMSEA, would enhance the model's overall validity.

- Parameter review: Examine the parameters and their relationships to ensure they align with theoretical expectations and adjust where necessary.
- Further analysis: Conduct additional analyses or sensitivity tests to explore alternative model specifications that might improve the fit indices.
- Consultation: Consult with experts in structural equation modelling (SEM) to get tailored advice on improving model fit based on specific context and data.
- Validity assessment: While the chi-square test and some fit indices point to areas of concern, the overall pattern of fit indices suggests that the model performs reasonably well in capturing the KM enablers' construct, but it is not without limitations.

Improving the fit of a model involves a combination of theoretical understanding and empirical testing. Addressing the areas where the indices indicate poor or borderline fit can enhance the overall validity and reliability of the model.

4.2.4.2.4 Conclusion

The validity test results indicate that Section C of the instrument has both strengths and weaknesses. The significant chi-square value and some borderline fit indices highlight areas where the model might need refinement. Despite these concerns, specific fit indices show a reasonable or good fit, suggesting that the KM enablers' model is relatively reliable but could benefit from further adjustments to achieve an optimal fit.

4.2.4.3 **Descriptive analysis for Section C (KM enablers)**

4.2.4.3.1 Comments on frequencies in Table 4.10 for KM Enablers

Table 4.10 presents the distribution of responses from 356 participants across various KM enablers (Questions 7 to 16), detailing their agreement levels on statements about each enabler. The frequencies and percentages for each response category (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) are provided for ten different KM enablers under four categories: Human-orientated factors (HF), Organisational aspects (OA), Management aspects (MA), and Technology-orientated aspects (TA).

Table 4.10: Frequencies for KM enablers.

CSF	KM Enabler	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
		Freq	Perc	Freq	Perc	Freq	Perc	Freq	Perc	Freq	Perc
HF	People (Individuals)	4	1.0	5	1.2	16	4.0	142	35.3	189	47.0
	Organisational Culture	4	1.0	4	1.0	16	4.0	144	35.8	188	46.8
	Leadership	3	0.7	8	2.0	11	2.7	137	34.1	197	49.0
OA	Organisational Processes	4	1.0	3	0.7	13	3.2	158	39.3	178	44.3
	Organisational Structure	5	1.2	12	3.0	45	11.2	155	38.6	139	34.6
MA	Strategies	4	1.0	7	1.7	22	5.5	178	44.3	145	36.1
	Goals	2	0.5	6	1.5	50	12.4	180	44.8	118	29.4
	Measurement	4	1.0	15	3.7	64	15.9	165	41.0	108	26.9
TA	Technology Infrastructure	2	0.5	14	3.5	30	7.5	176	43.8	134	33.3
	Technology Applications	2	0.5	5	1.2	33	8.2	188	46.8	128	31.8

- Key findings:

1. Human-orientated Factors (HF):

a People (Individuals): The majority of respondents show strong agreement (47.0%) and agreement (35.3%) that "*People*" are a crucial KM enabler.

b Organisational culture: Responses are similarly positive, with 46.8% strongly agreeing and 35.8% agreeing on the importance of "*Organisational culture*".

c Leadership: The KM enabler, "*Leadership*", is highly valued, with 49.0% strongly agreeing and 34.1% agreeing.

2. Organisational Aspects (OA):

a Organisational processes: Viewed as the most critical KM enabler, with 44.3% strongly agreeing and 39.3% agreeing.

b Organisational structure: The responses are more varied, with 34.6% strongly agreeing and 38.6% agreeing.

3. Management Aspects (MA):

a Strategies: A significant portion of respondents (44.3% agreeing and 36.1% strongly agreeing) see "*KM strategies*" as vital.

b Goals: The KM enabler, "*Goals*", is seen as less critical than other enablers, with 44.8% agreeing and 29.4% strongly agreeing.

c Measurement: This enabler receives less consensus, with only 26.9% strongly agreeing.

4. Technology-orientated Aspects (TA):

a Technology infrastructure: 43.8% agree, and 33.3% strongly agree, suggesting a strong, though slightly less emphatic, recognition of its importance.

b Technology applications: Viewed positively, with 46.8% agreeing and 31.8% strongly agreeing.

- Descriptive analysis summary:

1. Critical KM enablers: Respondents perceive "*Organisational processes*" (83.6%) and "*Leadership*" (83.1%) as the most critical KM enablers, reflecting their significant impact on KM effectiveness.
2. Technology Aspects: "*Technology applications*" (78.6%) and "*Technology infrastructure*" (77.1%) are also viewed positively but are ranked lower compared to organisational and leadership factors.
3. Least critical enablers: "*Measurement*" (67.9%) and "*Organisational structure*" (73.1%) are seen as less critical in comparison to other enablers.

- Implications:

1. Focus areas for improvement:

a High priority: The high percentages for organisational processes, leadership, and organisational culture suggest that these areas are crucial for effective KM. Enhancing these aspects could significantly improve KM practices.

b Technology integration: Although important, technology is ranked lower than organisational and leadership factors. Efforts should focus on integrating technology with human-centric and organisational aspects to boost KM effectiveness.

2. Potential Areas for Development:

a Measurement and Goals**:** The lower ratings for measurement and KM goals indicate that these aspects might require further development or clearer alignment with the organisation's KM strategy.

3. Strategic Planning:

a Leadership and Culture**:** The strong emphasis on leadership and organisational culture suggests that initiatives to strengthen these areas could substantially improve KM practices.

- Conclusion:

The descriptive analysis reveals that while "*organisational processes*", "*leadership*", and "*culture*" are seen as the most critical KM enablers, technology-related aspects are also important but not as central. "*Measurement*" and "*goals*" appear to be areas with room for improvement. The data provides valuable insights into where organisations might focus their efforts to enhance KM practices effectively.

4.2.4.3.2 Comments on the ranking of CSFs and KM Enablers in Table 4.11

Table 4.11 presents a ranking of CSFs and KM enablers based on their frequencies and relative ranks. The table breaks down the significance of various dimensions and enablers within these dimensions for implementing KM in an explosives manufacturing company.

Table 4.11: Ranking of CSFs and KM enablers.

Critical Success Factors (CSFs)	Freq N=356	Perc N=356	Relative Rank	KM Enabler	Freq N=356	Perc N=356	Relative Rank
Human-orientated factors (HF)	332	93.4	1	People	331	82.3	4
				Culture	332	82.6	3
				Leadership	334	83.1	2
Organisational aspects (OA)	315	88.5	2	Processes	336	83.6	1
				Structures	294	73.1	9
Management aspects (MA)	298	83.7	4	Strategy	323	80.3	5
				Goals	298	74.1	8
				Measurement	273	67.9	10
Technology-orientated aspects (TA)	313	87.9	3	Infrastructure	310	77.1	7
				Applications	316	78.6	6

- Critical Success Factors (CSFs):

1. Human-orientated Factors (HF):

a Frequency: 332 (93.4%)

b Relative Rank: 1

c Components:

(i) Leadership: 81.3%

(ii) Organisational Culture: 82.6%

(iii) People: 82.3%

d Commentary:

(i) Significance: “*Human-orientated factors*” are ranked as the most essential CSFs. This suggests that factors related to leadership, organisational culture, and people are considered vital for the success of KM implementation.

(ii) Insight: High frequencies for "*Leadership*," "*Organisational culture*," and "*People*" indicate that these elements are central to fostering an environment conducive to effective knowledge management. Leadership is particularly highlighted, showing a strong perception of its importance in guiding KM efforts.

2. Organisational Aspects (OA):

a Frequency: 315 (88.5%)

b Relative Rank: 2

c Components:

(i) Organisational Processes: 83.6%

(ii) Organisational Structures: 73.1%

d Commentary:

(i) Significance: “*Organisational aspects*” are highly valued, with “*Processes*” being the most significant KM enabler. Effective organisational processes are essential for implementing KM in an explosives manufacturing company.

(ii) Insight: The relatively lower frequency for "*Organisational structures*" compared to "*Processes*" suggests that processes might be viewed as more directly impactful on KM success than structural considerations.

3. Technology-orientated Aspects (TA):

a Frequency: 313 (87.9%)

b Relative Rank: 3

c Components:

(i) Technology Applications: 78.6%

(ii) Technology Infrastructure: 77.1%

d Commentary:

(i) Significance: "*Technology-oriented factors*" are also considered important, though slightly less so than human-orientated and organisational factors. The KM enabler, "*Technology applications,*" is seen as more critical than "*Technology infrastructure*".

(ii) Insight: The emphasis on technology applications reflects that the practical use of technology is more crucial for KM implementation than the underlying infrastructure.

4. Management Aspects (MA):

a Frequency: 298 (83.7%)

b Relative Rank: 4

c Components:

(i) KM Strategies: 80.3%

(ii) KM Goals: 74.1%

(iii) KM Measurement: 67.9%

d Commentary:

(i) Significance: "*Management aspects*" are ranked last among the four dimensions but are still significant. "*KM strategies*" and "*KM goals*" are more highly regarded than "*KM measurement*".

(ii) Insight: The lower emphasis on "*KM measurement*" suggests that while strategies and goals are essential, there may be less focus on how KM efforts are quantitatively assessed.

- Overall insights and recommendations:

1. Human-orientated factor dominance: The high importance assigned to human-orientated factors underscores the need for strong leadership and a supportive organisational culture

to drive KM initiatives. Organisations should focus on developing leadership skills and fostering a culture that promotes knowledge sharing.

2. Organisational processes: The emphasis on organisational processes highlights the need for streamlined and effective processes that support KM. Organisations should invest in improving their processes to facilitate better knowledge flow.

3. Technology's role: While it is important, it is secondary to human-orientated and organisational factors. Ensuring that technology applications are user-friendly and effectively integrated with KM practices is crucial.

4. Management Focus: Although management aspects are considered essential, the relatively lower frequency indicates that other dimensions might require more immediate attention. However, developing robust KM strategies and setting clear goals remain important for the overall success of KM initiatives.

- Conclusion:

Table 4.11 ranks the importance of various CSFs and KM enablers, reflecting the priorities for implementing KM in the organisation. The data suggests that a balanced approach, addressing human, organisational, technological, and management aspects, is essential for successful KM implementation. The focus should be on enhancing leadership, organisational culture, and processes while ensuring the effective use of technology and strategic management practices.

4.2.4.4 **Correlation analysis for Section C (KM enablers)**

4.2.4.4.1 Comments on correlation analysis between KM enablers and CSFs

The correlation and regression analysis for Section C of the KM enablers provides insights into the strength and nature of relationships between various KM enablers and CSFs. The analysis includes standardized regression coefficients (Beta coefficients), squared multiple correlations (R^2), and Spearman's rho correlation coefficients.

Table 4.12: Correlation analysis for KM enablers and CSFs.

Relationship			**Standardised Regression Weight**	**Squared Multiple Correlation**	**Spearman's rho**
			β	R^2	r
People (Individuals)	<---	HF	0.713	0.508	0.834**
Organisational culture	<---	HF	0.765	0.585	0.847**
Leadership	<---	HF	0.759	0.576	0.789**
Organisational processes	<---	OA	0.814	0.663	-

Relationship			Standardised Regression Weight	Squared Multiple Correlation	Spearman’s rho
			β	R^2	r
Organisational structure	<---	OA	0.726	0.527	-
Strategies	<---	MA	0.809	0.655	0.813**
Goals	<---	MA	0.769	0.592	0.847**
Measurement	<---	MA	0.657	0.432	0.841**
Technology infrastructure	<---	TA	0.807	0.652	-
Technology applications	<---	TA	0.856	0.733	-

- Key Metrics:

1. Standardised Regression Weight (Beta Coefficient, β):

a Interpretation**:** The Beta coefficient (β) measures the strength of the relationship between a predictor variable (KM enabler) and an outcome variable (CSF). A Beta coefficient greater than 0.5 indicates a strong relationship (Field, 2009:781; Field, 2017:497).

b Findings:

(i) People (Individuals): β = 0.713

(ii) Organisational Culture: β = 0.765

(iii) Leadership: β = 0.759

(iv) Organisational Processes: β = 0.814

(v) Organisational Structure: β = 0.726

(vi) Strategies: β = 0.809

(vii) Goals: β = 0.769

(viii) Measurement: β = 0.657

(ix) Technology Infrastructure: β = 0.807

(x) Technology Applications: β = 0.856

c Commentary: The Beta coefficients are greater than 0.5, indicating a strong relationship between each KM enabler and its corresponding CSF. This suggests that each KM enabler significantly impacts the respective CSF it is associated with.

2. Squared Multiple Correlation (R^2):

a Interpretation: The R^2 value represents the proportion of variance in the dependent variable explained by the independent variable in the regression model. It ranges from 0 to 1, with higher values indicating a better fit of the model (Fernando, 2024a; Fernando, 2024b; Field, 2009:637; Field, 2017:788; Frost, 2024).

b Findings:

(i) People (Individuals): R^2 = 0.508

(ii) Organisational Culture: R^2 = 0.585

(iii) Leadership: R^2 = 0.576

(iv) Organisational Processes: R^2 = 0.663

(v) Organisational Structure: R^2 = 0.527

(vi) Strategies: R^2 = 0.655

(vii) Goals: R^2 = 0.592

(viii) Measurement: R^2 = 0.432

(ix) Technology Infrastructure: R^2 = 0.652

(x) Technology Applications: R^2 = 0.733

c Commentary: The R^2 values indicate that the regression models explain a significant proportion of the variance in the dependent variables. For most KM enablers, R^2 values are above 0.5, showing a substantial fit. However, "*KM measurement*" has a lower R^2 value of 0.432, indicating a weaker fit compared to other KM enablers.

3. Spearman's rho (*r*):

a Interpretation: Spearman's rho (*r*) measures the strength and direction of the association between two variables, with values between 0 and 1 indicating a positive relationship (Field, 2009:783; Field 2017:1011).

b Findings:

(i) People (Individuals): *r* = 0.834**

(ii) Organisational Culture: *r* = 0.847**

(iii) Leadership: *r* = 0.789**

(iv) Strategies: *r* = 0.813**

(v) Goals: *r* = 0.847**

(vi) Measurement: *r* = 0.841**

(vii) Technology Applications: *r* = 0.731** c Commentary: The Spearman's rho values show strong positive correlations between most KM enablers and their corresponding CSFs, with values indicating a strong relationship where statistically significant ($p < 0.01$). "*Technology applications*" has a slightly lower rho value but still reflects a positive relationship.

- General Observations:

1. Strong relationships: The strong Beta coefficients and high R^2 values for most KM enablers reflect their significant impact on the respective CSFs. This highlights the effectiveness of these enablers in contributing to the success of KM implementation.
2. Weaker fit: The lower R^2 value for "*KM measurement*" suggests that while it is still a vital enabler, its impact on the CSF might be less straightforward or more variable than other KM enablers.
3. Statistical significance: The significance of Spearman's rho values supports the validity of the observed relationships, as indicated by the p-values.

- Recommendations for improvement:

1. Focus on measurement: Given the lower R^2 for the KM enabler, "*Measurement*", further investigation may be needed to understand why this enabler has a weaker explanatory power. It might involve reassessing how KM measurement is conducted or its integration into the overall KM framework.
2. Model refinement: The analysis suggests that while most enablers have strong relationships with CSFs, refining the model to address any potential discrepancies in the KM enabler, "*Measurement*", and ensuring that all relevant variables are considered could improve the overall fit.
3. Further validation: Additional validation studies or alternative analytical methods could help confirm these findings and ensure the robustness of the relationships identified.

In summary, the correlation and regression analyses demonstrate that most KM enablers have a strong and statistically significant relationship with their corresponding CSFs, supporting their critical role in KM implementation. However, attention should be given to the areas with lower explanatory power to enhance the overall effectiveness of the KM framework.

4.2.4.4.2 Comments on correlation analysis between KM enablers and KM implementation

Table 4.13 provides a detailed correlation analysis between various KM enablers and KM implementation (Factor C).

Table 4.13: Correlation analysis for KM enablers and KM implementation.

Relationship			**Spearman's rho**
			r
People (Individuals)	<---	Factor C_KM implementation	0.700**
Organisational culture	<---	Factor C_KM implementation	0.718**
Leadership	<---	Factor C_KM implementation	0.704**
Organisational processes	<---	Factor C_KM implementation	0.781**
Organisational structure	<---	Factor C_KM implementation	0.770**
Strategies	<---	Factor C_KM implementation	0.807**
Goals	<---	Factor C_KM implementation	0.743**
Measurement	<---	Factor C_KM implementation	0.735**
Technology infrastructure	<---	Factor C_KM implementation	0.706**
Technology applications	<---	Factor C_KM implementation	0.715**

- Key findings:

1. Correlation coefficients and significance:

a Positive relationships: The Spearman's rho values for all KM enablers are positive and statistically significant ($p < 0.01$), indicating a strong positive association between each KM enabler and KM implementation. This suggests that as the presence or effectiveness of these KM enablers increases, so does the level of KM implementation.

b Strength of relationships: The correlation coefficients range from 0.700 to 0.807, which are high and indicate a substantial positive relationship. For example, the KM Enabler, "*Strategies*" ($r = 0.807$), shows the strongest correlation with KM implementation among the enablers, reflecting its critical role in facilitating KM practices.

2. KM enabler-specific insights:

a People and Leadership: Both KM enablers, "*People*" ($r = 0.700$) and "*Leadership*" ($r = 0.704$) show strong correlations with KM implementation. This aligns with the importance of human factors in successful KM practices, as effective leadership and engaged individuals are essential for KM success.

b Organisational Culture and Structure: The KM enablers, "*Organisational culture*" ($r = 0.718$) and "*Organisational structure*" ($r = 0.770$) also show strong positive correlations. This suggests that a supportive culture and appropriate structural arrangements are vital for effectively implementing KM in an organisation.

c Management Aspects: The KM enablers under "*Management aspects*" (Strategies, Goals, and Measurement) all show high correlation coefficients, with "*Strategies*" (r = 0.807) being the strongest. This underscores the significance of well-defined strategies and goals and effective measurement practices in enhancing KM implementation.

d Technology Aspects: Both KM enablers, "*Technology infrastructure*" (r = 0.706) and "*Technology applications*" (r = 0.715), demonstrate strong correlations with KM implementation, indicating that robust technological support is crucial for effective KM.

3. Comparative analysis with previous tables:

a Human-oriented Factors: As noted in Table 4.12, "*Organisational culture*" has the highest correlation with the "*Human-orientated factor*" dimension (r = 0.847), making it a significant contributor within this dimension. This aligns with its strong relationship with KM implementation, as shown in Table 4.13.

b Management Aspects: The KM enablers, "*Strategies*" and "*Goals*", exhibit high correlations with the "*Management aspect*" dimension (r = 0.813 and r = 0.847 respectively), reflecting their critical role in successful KM implementation as shown in Table 4.13.

4. Overall impact:

a Comprehensive impact: The correlation analysis demonstrates that effective KM implementation is strongly associated with each KM enabler listed. The highest correlations are with "*Organisational processes*" and "*Strategies*," indicating these factors are particularly influential in driving successful KM practices.

b Dimensional influence: The significant correlations between the CSF dimensions, "*Human-orientated factor*" and "*Management aspect*", and KM implementation (r = 0.864 and r = 0.894, respectively) suggest that these broader dimensions also play a crucial role in supporting KM efforts.

5. Conclusion

The analysis confirms that each KM enabler has a substantial and statistically significant positive impact on KM implementation. The strong relationships highlight the importance of various factors (human, organisational, management, and technological) in achieving successful KM. This comprehensive understanding can guide future improvements in KM strategies and practices, ensuring that all critical enablers are addressed effectively.

4.2.4.4.3 Comments on correlation analysis between CSFs and KM implementation

Table 4.14 presents the correlation analysis between CSFs and KM implementation, providing both standardized regression weights (*β*) and Spearman's rho (*r*) for the Human-oriented Factor (HF) and Management Aspects (MA) dimensions.

Table 4.14: Correlation analysis for CSFs and KM implementation.

Relationship			**Standardised Regression Weight**	**Spearman's rho**
			β	*r*
Human-orientated factors (HF)	<---	Factor C_KM implementation	0.484	0.864**
Management aspects (MA)	<---	Factor C_KM implementation	0.564	0.894**

- Key findings:

1. Strength of relationships:

a Human-Oriented Factors (HF):

(i) Standardized Regression Weight (*β*): 0.484

(ii) Spearman's rho (*r*): 0.864**

The standardized regression weight of 0.484 indicates a moderate to strong influence of "*Human-oriented Factors*" on "*KM implementation*". The Spearman's rho value of 0.864**, which is statistically significant ($p < 0.01$), shows a strong positive correlation. This suggests that Human-oriented factors, including elements such as leadership, culture, and people, play a significant role in the effectiveness of KM implementation.

b Management Aspects (MA):

(i) Standardized Regression Weight (*β*): 0.564

(ii) Spearman's rho (*r*): 0.894**

The standardized regression weight of 0.564 implies a substantial impact of "*Management Aspects*" on "*KM implementation*". The Spearman's rho of 0.894**, which is also statistically significant (p < 0.01), reflects an even stronger positive correlation compared to "*Human-oriented Factors*". This indicates that aspects such as KM strategies, goals, and measurement are crucial for successful KM implementation.

2. Model fit:

a Fit Indices: The fit indices reported for the model are exceptional:

(i) Normed Fit Index (NFI): 1.0

(ii) Incremental Fit Index (IFI): 1.0

(iii) Comparative Fit Index (CFI): 1.0

These indices fall within the "*Perfect fit range*", suggesting an excellent model fit. This indicates that the model accurately represents the relationships between the CSFs (HF and MA) and KM implementation.

b Root Mean Square Error of Approximation (RMSEA):

(i) Value: Between 0.5 and 0.8

According to the given range, the RMSEA value indicates an acceptable fit. However, typically, values below 0.05 are preferred for a better fit. An RMSEA between 0.5 and 0.8 suggests that while the model fits reasonably well, there is room for improvement.

3. Overall implications:

a Human-oriented Factors vs. Management Aspects: Both dimensions are strongly associated with KM implementation, but Management Aspects show a slightly stronger correlation. This suggests that while human-oriented factors are critical, management-related aspects might significantly impact KM's success.

b Fit quality: The "*perfect fit*" indices and acceptable RMSEA highlight the robustness of the model. However, further improvements to achieve a RMSEA closer to the ideal value of ≤0.08, could enhance the model's precision.

- Conclusion

Table 4.14 effectively demonstrates the strong influence of both “*Human-oriented Factors*” and “*Management Aspects*” on “*KM implementation*”, supported by high correlation values and excellent fit indices. The analysis underscores the importance of both dimensions in achieving successful KM outcomes while noting that management aspects might have a slightly more substantial impact. The model's fit is robust, though minor refinements could improve the RMSEA value for an even better fit.

4.2.4.4.4 Comments on the model fit for Section C

Table 4.15 provides a summary of model fit indices for the relationship between "*Factor C: KM implementation*" and two CSF dimensions: Human-Oriented Factors (HF) and Management Aspects (MA). The fit indices reported include the Normed Fit Index (NFI), Relative Fit Index (RFI), Incremental Fit Index (IFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA).

Table 4.15: Model fit summary for Section C.

Model			**NFI**	**RFI**	**IFI**	**TLI**	**CFI**	**RMSEA**
			Delta 1	**rho1**	**Delta2**	**rho2**		
HF	<---	Factor C_KM implementation	1	-	1	-	1	0.712
MA	<---	Factor C_KM implementation	1	-	1	-	1	0.712

Notes: Fit Parameters			
NFI, RFI, IFI, TLI, CFI		RMSEA	
Perfect fit	=1.0	Good fit	≤0.05
NFI, RFI, IFI, TLI, CFI		RMSEA	
Good fit	≥0.95 to ≤0.99	Acceptable fit	≥0.05 to ≤0.08
Reasonable fit	≥0.90 to ≤0.94	Borderline	≥0.08 to ≤0.1
Acceptable fit	≥0.80 to ≤0.89	Poor fit	≥0.1

Source: Adapted from Miljko (2020:1)

- Key findings:

1. Fit indices analysis:

a NFI, IFI, CFI:

(i) Values: 1.0 for both HF and MA.

(ii) Interpretation: These indices indicate a "*Perfect fit*" according to the fit parameters. A value of 1.0 for NFI, IFI, and CFI suggests that the model perfectly fits the data. This is an ideal outcome, demonstrating that the model accurately captures the relationship between the CSF dimensions (HF and MA) and KM implementation.

b RMSEA:

(i) Value: 0.712 for both HF and MA.

(ii) Interpretation: The RMSEA value indicates a "Borderline" fit according to the given range (≥0.08 to ≤0.1). While this suggests that the model is not ideal, it is still within an acceptable range. An RMSEA of 0.712 signifies room for improvement in model fit, as lower values are preferred for a better fit. Ideally, RMSEA should be ≤0.05 for a good fit (Peugh & Feldon, 2020:3; Miljko, 2020:14).

2. Overall Model Fit

a Strengths:

(i) The perfect fit indices (NFI, IFI, CFI) highlight the robustness of the model in terms of how well it fits the data. This suggests that the model's structure is sound and that the relationships between the KM enablers (HF and MA) and KM implementation are well represented.

b Weaknesses:

(ii) The RMSEA value indicates a borderline fit, which implies that while the model is acceptable, there is a potential for improvement. This borderline value suggests that the model may not fully capture the complexities of the data, and adjustments might be necessary to improve the fit.

- Conclusion

The model fit summary in Table 4.15 demonstrates that the model is robust with perfect fit indices for NFI, IFI, and CFI, indicating a strong alignment between the CSF dimensions (HF and MA) and KM implementation. However, the RMSEA value of 0.712 points to a borderline fit, suggesting that while the model is generally acceptable, there is an opportunity for refinement. Addressing the RMSEA value could enhance the model's overall fit and accuracy.

4.2.4.5 **Structural Equation Model (SEM) for Section C**

Figure 4.1 presents a Structural Equation Modelling (SEM) model for analysing the relationships between CSFs, KM enablers, and KM implementation. SEM is highlighted as a second-generation multivariate technique that allows for the testing of complex interrelationships among multiple variables, as opposed to first-generation techniques like multiple regression, logistic regression, and analysis of variance (Hair *et al*., 2021:3-4).

4.2.4.5.1 Comments:

- SEM Overview:

1. Strengths of SEM:

a Complex relationships: SEM is advantageous for examining complex relationships among multiple dependent and independent variables. Unlike first-generation techniques, which often handle variables in isolation or with limited interactions, SEM can model intricate relationships simultaneously, providing a more comprehensive understanding of the data (Hair *et al*., 2021:4).

b Latent variables: SEM allows for including latent variables, which are not directly observed but inferred from other measured variables (Hair *et al*., 2021:4). This ability to model latent constructs adds depth to analysing theoretical concepts like CSFs and KM enablers.

2. CB-SEM vs. PLS-SEM:

c Covariance-Based SEM (CB-SEM): This method focuses on fitting the model to the covariance matrix and is typically used when the goal is to confirm or test a theory or model (Hair *et al*., 2021:8).

d Partial Least Squares SEM (PLS-SEM): This method is more flexible and is used for prediction and theory development, often when the model is complex or when the sample size is relatively small (Hair *et al*., 2021:8).

- Model representation in Figure 4.1:

1. CSFs and KM Enablers: Figure 4.1 visually represents the relationships between CSFs and KM enablers and their impact on KM implementation. This visualisation aids in understanding how various factors and enablers interact and contribute to KM implementation outcomes.

2. Integration with SEM: Using SEM, the model depicted in Figure 4.1 can simultaneously assess the direct and indirect effects of CSFs and KM enablers on KM implementation. This holistic view is crucial for understanding the overall effectiveness and interrelationships among different factors.

- Importance of SEM:

3. Enhanced Analysis: SEM enhances the analysis by allowing researchers to test complex theoretical models and assess multiple pathways of influence (Hair *et al*., 2021:11-13). This capability is particularly valuable in studies involving multiple constructs and interactions, as seen in the analysis of CSFs and KM enablers.

4. Model Testing: SEM provides a framework for model testing and validation, which can help ensure that empirical data support the hypothesised relationships (Hair *et al*., 2021:7). This is crucial for building robust theories and practical insights into KM implementation.

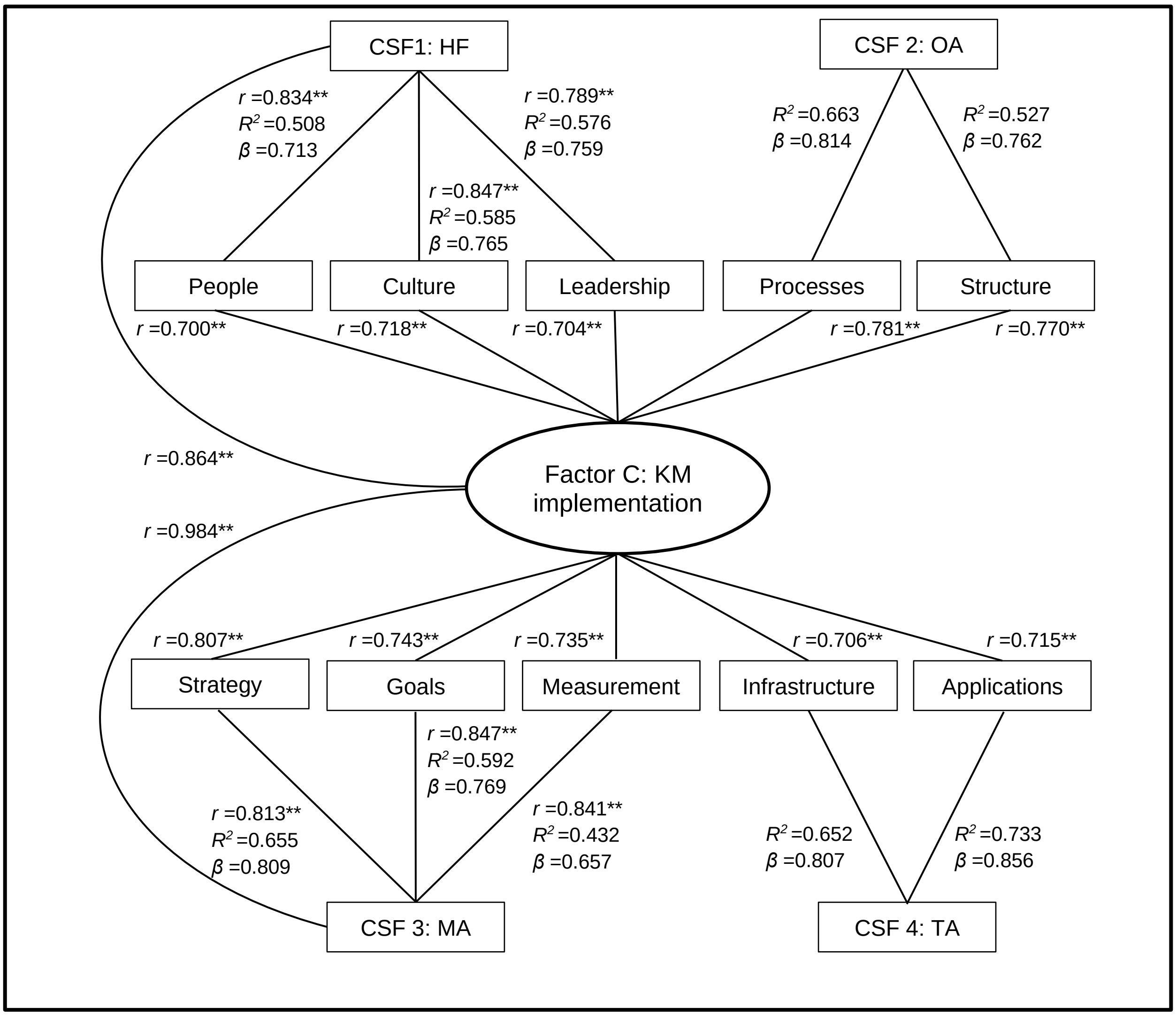

Figure 4.1: Measurement model for CSFs and KM enablers.

- Conclusion

Figure 4.1 effectively illustrates the application of SEM to explore the relationships between CSFs, KM enablers, and KM implementation. SEM's ability to handle complex relationships and latent variables provides a more nuanced understanding of the data than first-generation techniques. CB-SEM and PLS-SEM should align with the study's objectives, whether confirming a theoretical model or exploring new developments. This approach enhances the robustness of the analysis and supports more informed conclusions about the factors influencing KM implementation.

4.2.5 Section D: KM practices

This data analysis section shows the results of Section D of the survey questionnaire (Questions 17 to 31). Section D of the survey questionnaire tested fifteen KM practices (independent variables) grouped under the five KM adoption approaches.

4.2.5.1 **Reliability test values for Section D (KM practices)**

Like Section C, a reliability test was used to measure the internal consistency and reliability of the data collected from Questions 17 to 31.

4.2.5.1.1 Comments on the overall reliability values in Table 4.16 for Section D

Table 4.16 presents the overall Cronbach's Alpha coefficient for Section D.

Table 4.16: Reliability statistics for Section D.

Cronbach's Alpha	Cronbach's Alpha based on Standardised items	N of items
0.925	0.929	15

- Cronbach's Alpha coefficient:

1. Cronbach's Alpha. The overall Cronbach's Alpha coefficient in Table 4.16 for the fifteen items under Section D of the measuring instrument is 0.925, indicating very high internal consistency among the fifteen items. This suggests that the items used to measure KM practices reliably capture the intended constructs (Hair *et al*., 2021:80; Van Aardt & Hirschsohn, 2021:54).
2. Cronbach's Alpha is based on Standardised items. The slightly higher value of 0.929 after standardisation confirms the robustness of the internal consistency measure. The small difference between the two values is expected and indicates that the items' reliability remains strong even after standardisation (Hair *et al*., 2021:96).

- Interpretation of reliability results:

The high Cronbach's Alpha values indicate that the questions were well formulated and clearly understood by all the respondents. High reliability suggests that the respondents likely interpreted the questions consistently, which is crucial for ensuring valid and reliable responses.

- Number of items:

The fifteen items used in Section D are a reasonable number for assessing reliability. While more items can improve reliability, having fifteen items with a high Cronbach's Alpha suggests that they effectively capture the construct of interest without being redundant (Hair *et al*., 2021:12).

4.2.5.1.2 Comments on the construct reliability values in Table 4.17 for the KM practices:

Table 4.17 presents the item reliability values for each KM practice tested for this study.

Table 4.17: Item reliability statistics for KM practices.

KM Adoption Approach	KM Practice	N	Cronbach's Alpha	Corrected Item-Total Correlation	Mean	Std Dev
KM Environment (KME)	Fairs	350	0.924	0.561	3.77	0.903
	Best practices repositories	350	0.919	0.701	4.16	0.735
	Knowledge-sharing culture	350	0.921	0.643	4.45	0.653
	Networking	350	0.921	0.650	4.37	0.689
Knowledge Sharing (KS)	Rotation of people	350	0.925	0.533	4.01	0.968
	Direct people contact	350	0.920	0.666	4.17	0.748
	Documentation and database	350	0.920	0.662	4.30	0.714
	Teams	350	0.919	0.708	4.19	0.752
	Forums	350	0.921	0.625	3.99	0.836
Training and Mentoring (TM)	Formal training	350	0.919	0.716	4.36	0.715
	Mentoring	350	0.920	0.685	4.46	0.675
KM Technology (KMT)	Technical solutions	350	0.918	0.730	4.10	0.761
	Human-centered IT	350	0.921	0.624	3.92	0.813
Knowledge Acquisition (KA)	Knowledge documentation	350	0.918	0.741	4.10	0.687
	Hierarchies and peers	350	0.923	0.574	3.99	0.774

- Cronbach's Alpha values:

The Cronbach's Alpha values range from 0.918 to 0.925 across the different KM practices, indicative of high internal consistency within each category. Values above 0.90 generally denote excellent reliability, showing that the items within each enabler consistently measure the intended construct (Hair *et al*., 2021:80; Van Aardt & Hirschsohn, 2021:54).

- Corrected Item-Total correlation:

All item-total correlation values are well above 0.4, which is a good indicator of reliability (Field, 2009:678; Field, 2017:826). High item-total correlations suggest that each item contributes meaningfully to the overall measure of the KM practices.

- Mean and Standard Deviation:

Most of the Mean values in Table 4.17 are close to or exceed 4.0, indicating that respondents generally agree or strongly agree with the KM practice statements. This reflects a strong positive sentiment towards the measured KM practices. The Standard deviation values range from 0.675 to 0.968, suggesting moderate variability around the mean. This range indicates that while there is some variability in responses, the data are relatively consistent (Field, 2009:38; Field, 2017:78; Schindler, 2022:366; Quesada & Masenge, 2021:418).

- Interpretation of results:

The consistently high Cronbach's Alpha values across different categories suggest that the instrument used to measure KM practices is reliable. This implies that the items within each enabler reliably measure the same underlying concept.

- Conclusion:

The reliability statistics for Section D of the measuring instrument indicate high internal consistency. The Cronbach's Alpha values are well above the acceptable threshold, suggesting that the questions are likely well-formulated and consistently interpreted by respondents. The high Cronbach's Alpha values and strong Corrected Item-Total Correlations indicate that the items effectively measure the intended constructs. However, complementing these findings with an assessment of validity would provide a more complete evaluation of the instrument's effectiveness.

4.2.5.2 **Validity test values for Section D (KM practices)**

Like Section C, a validity test was used to determine whether Section D (i.e., Questions 17 to 31) of the instrument measured what it was designed to measure (Field, 2009:11; Field, 2017:57).

4.2.5.2.1 Discussion of validity test values for Section D (KM practices):

Table 4.18 presents the validity test values for Section D of the survey questionnaire.

Table 4.18: Validity test values for Section D.

Goodness of Fit (GoF) measure		**Standard**	**Calc.**	**Description**
Ratio of chi-square to degrees of freedom	CMIN/DF	≥2.0 to ≤3.0	3.546	Poor fit
Normed fit index called Delta 1	NFI	≥0.9 to ≤1.0	0.889	Reasonable fit
Relative fit index called rho1	RFI	≥0.9 to ≤1.0	0.848	Acceptable fit
Incremental fit index	IFI	≥0.8 to ≤1.0	0.925	Reasonable fit
Tucker-Lewis index called rho2	TLI	≥0.9 to ≤1.0	0.886	Acceptable fit
Comparative fit index	CFI	≥0.9 to ≤1.0	0.924	Reasonable fit
Root mean square error	RMSEA	≤0.05 to ≤0.1	0.08	Good fit
Notes: Fit Parameters				
CMIN/DF	NFI, RFI, IFI, TLI, CFI		RMSEA	
Perfect fit =1.0	Perfect fit =1.0		Good fit ≤0.05	

Goodness of Fit (GoF) measure		Standard		Calc.	Description
Good fit	≥2.0 to ≤3.0	Good fit	≥0.95 to ≤0.99	Acceptable fit	≥0.05 to ≤0.08
Poor fit	≥3.0	Reasonable fit	≥0.90 to ≤0.94	Borderline	≥0.08 to ≤0.1
		Acceptable fit	≥0.80 to ≤0.89	Poor fit	≥0.1

Source: Adapted from Miljko (2020:1)

- Pearson's chi-square test (Field, 2009:808; Field, 2017:1000):

1. Chi-square value (X^2): 283.671
2. Degrees of freedom (*df*): 80
3. Critical value ($\alpha = 0.05$, $df = 80$): 101.88
4. Significance: Pearson's chi-square value (283.671) exceeds the critical value (101.88), indicating a statistically significant difference between observed and expected distributions ($p < 0.05$). This allows for rejecting the null hypothesis (Field, 2017:840).

- Indices indicating "Poor Fit":

1. The ratio of Chi-Square to Degrees of Freedom (CMIN/DF): 3.546

a Interpretation: This index indicates a poor fit as the value is significantly higher than the ideal range of 2.0 to 3.0. A high CMIN/DF value suggests that the model may be overly complex or that there is a misfit between the model and the observed data (Miljko, 2020:3).

b Possible improvements:

(i) Model simplification: Consider simplifying the model by reducing the number of parameters or variables. Overly complex models can lead to poor fit indices (Hair *et al*., 2011:144).

(ii) Model re-specification: Re-evaluate the theoretical framework and ensure the model is correctly specified. Mis-specification can lead to poor fit.

2. Normed Fit Index (NFI): 0.889

a Interpretation: This value is below the ideal threshold of ≥0.90, suggesting a reasonable but not optimal fit. NFI is useful for comparing the fit of the proposed model to a null model (Miljko, 2020:7).

3. Relative Fit Index (RFI): 0.848

a Interpretation: This value is below the ideal threshold of ≥0.90, suggesting a reasonable but not optimal fit. The RFI measures the improvement of the model over a null model (Miljko, 2020:7-8).

b Possible improvements. Review the model to identify potential areas for improvement. Adding or adjusting parameters based on theoretical considerations might improve the RFI.

4. Tucker-Lewis Index (TLI): 0.886

a Interpretation: This value is below the ideal threshold of ≥0.90. A TLI below the ideal threshold indicates that the model may not be significantly better than a null model (Miljko, 2020:7-8).

b Possible Improvements: Enhance model fit by investigating and addressing potential model mis-specifications or omitted variables that could improve the TLI.

5. Root Mean Square Error of Approximation (RMSEA): 0.08

a Interpretation: RMSEA values between 0.05 and 0.10 are considered borderline. A value of 0.08 suggests that the model fits the data reasonably well, but there is room for improvement (Peugh & Feldon, 2020:3; Miljko, 2020:14).

b Possible improvements: Model adjustment to reduce RMSEA (such as adding or modifying parameters). This could help achieve a better fit and bring RMSEA below 0.05.

- Indices indicating “Reasonable” or “Good Fit”:

1. Incremental Fit Index (IFI): 0.925

a Interpretation: This index shows a good fit, indicating that the model explains the data well relative to a null model (Miljko, 2020:8).

2. Comparative Fit Index (CFI): 0.924

a Interpretation: This value also indicates a good fit, suggesting that the model performs well compared to the null model (Peugh & Feldon, 2020:3; Miljko, 2020:9).

4.2.5.2.2 Analysis and interpretation

- Pearson chi-square test: The Pearson’s chi-square test result indicates a significant discrepancy between the observed and expected data. While this suggests some misfit, the chi-square test is susceptible to sample size. Even minor deviations can result in significant chi-square values in a large sample (n = 350). Thus, chi-square alone might not entirely reflect model adequacy.

- Fit indices:

1. CMIN/DF: At 3.546, this value indicates a poor fit. Ideally, the ratio should be between 2.0 and 3.0, suggesting that the model may not fit the data well.

2. NFI and RFI: Both indices are close to the upper end of the acceptable range (0.889 and 0.848, respectively). While not ideal, they suggest a reasonable fit, though improvements could be made.

3. IFI and CFI: Both indices are in the good fit range (0.928 and 0.924, respectively), indicating that the model has an acceptable fit according to these metrics.

4. TLI: At 0.886, it is slightly below the ideal threshold but still in the reasonable fit category.

5. RMSEA: At 0.08, this value is borderline, indicating a fit on the edge of being acceptable. Ideally, it should be below 0.08 for an acceptable fit.

4.2.5.2.3 Summary and recommendations

- Model fit: The overall fit of the model, as indicated by the good values of IFI and CFI, suggests that while some aspects of the model fit are acceptable, some areas need improvement. Specifically, the high CMIN/DF and borderline RMSEA indicate potential issues with the model's fit to the data.
- Model refinement: The poor fit indices suggest that there may be model complexity or specification issues. To enhance the model fit, consider evaluating and revising the model specifications, adding or removing variables, or re-assessing the structure of the model. Improving the fit indices, particularly the CMIN/DF and RMSEA, would enhance the model's overall validity.
- Parameter review: Examine the parameters and their relationships to ensure they align with theoretical expectations and adjust where necessary.
- Further analysis: Conduct additional analyses or sensitivity tests to explore alternative model specifications that might improve the fit indices.
- Consultation: Consult with experts in structural equation modelling (SEM) to get tailored advice on improving model fit based on specific context and data.
- Validity assessment: While the chi-square test and some fit indices point to areas of concern, the overall pattern of the fit index suggests that the model performs reasonably well in capturing the KM enablers' construct, but it is not without limitations.

Improving the fit of a model involves a combination of theoretical understanding and empirical testing. Addressing the areas where the indices indicate poor or borderline fit can enhance the overall validity and reliability of the model.

4.2.5.2.4 Conclusion

The validity test results indicate that Section D of the instrument has strengths and weaknesses. The significant chi-square value and some borderline fit indices highlight areas where the model might need refinement. Despite these concerns, specific fit indices show a reasonable or good fit, suggesting that the KM practices model is relatively reliable but could benefit from further adjustments to achieve an optimal fit.

4.2.5.3 **Descriptive analysis for Section D (KM practices)**

4.2.5.3.1 Comments on frequencies in Tables 4.19 and 4.20 for KM practices

Table 4.19 presents the distribution of responses from 350 participants across various KM practices (Questions 17 to 31), detailing their agreement levels on statements about each practice. The frequencies and percentages for each response category (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) are provided for fifteen different KM practices under five categories: KM Environment (KME), Knowledge-Sharing (KS), Training and Mentoring (TM), KM Technology (KMT), and Knowledge Acquisition (KA).

Table 4.19: Frequencies for KM practices.

KM Adpt. App.	KM Practice	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
		Freq	Perc	Freq	Perc	Freq	Perc	Freq	Perc	Freq	Perc
KME	Fairs	6	1.5	16	4.0	109	27.1	142	35.3	777	19.2
	Best practices	1	0.2	9	2.2	38	9.5	188	46.8	114	28.4
	KS culture	1	0.2	2	0.5	19	4.7	143	35.6	185	46.0
	Networking	1	0.2	2	0.5	30	7.5	150	37.3	167	41.5
KS	Rotation of people	3	0.7	26	6.5	66	16.4	125	31.1	130	32.3
	Direct people contact	1	0.2	8	2.0	43	10.7	177	44.0	121	30.1
	Documents and database	2	0.5	4	1.0	28	7.0	168	41.8	148	36.8
	Teams	2	0.2	8	2.0	36	9.	180	44.8	124	30.8
	Forums	3	0.7	16	4.0	57	14.2	178	44.3	96	23.9
TM	Formal training	2	0.5	2	0.5	31	7.7	149	37.1	166	41.3
	Mentoring	2	0.5	2	0.5	18	4.5	140	34.8	188	46.8
KMT	Technical solutions	2	0.5	8	2.0	49	12.2	184	45.8	107	26.6

KM Adpt. App.	KM Practice	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
		Freq	Perc	Freq	Perc	Freq	Perc	Freq	Perc	Freq	Perc
	Human-centered IT	2	0.5	13	3.2	80	19.9	172	42.8	83	20.6
KA	Knowledge documentation	1	0.2	3	0.7	52	12.9	199	49.5	95	23.6
	Hierarchies and peers	1	0.2	13	3.2	61	15.2	188	46.8	87	21.6

- Descriptive Statistics:

1. Frequency distribution:

a Knowledge-sharing culture: Respondents overwhelmingly rated the knowledge-sharing culture as the most effective KM practice, with 81.6% of respondents agreeing or strongly agreeing. This high percentage suggests a strong positive perception of the role of culture in facilitating knowledge sharing.

b Mentoring: Equally rated at 81.6%, mentoring also shows a high level of agreement, reflecting its perceived effectiveness in knowledge transfer.

c Networking: With 78.9% agreeing or strongly agreeing, networking is recognized as an effective practice, highlighting the importance of connections and relationships in knowledge transfer.

d Documents and database: At 78.6%, this KM practice also receives strong support, indicating that organized documentation and databases are valued for knowledge transfer.

e Formal training: This practice is endorsed by 78.4% of respondents, underscoring its importance in knowledge transfer.

2. Relative rankings:

a KM Environment (KME): The most favoured KM practices within this category are the knowledge-sharing culture (81.6%) and networking (78.9%). This reflects that KM practices foster a supportive environment, and interactions are highly valued.

b Knowledge-Sharing (KS): The practices of documents and databases (78.6%) and teams (75.6%) are rated highly, indicating that structured information and team collaboration are seen as essential.

c Training and Mentoring (TM): Formal mentoring and training are highly ranked (81.6% and 78.4%, respectively), signifying their critical role in knowledge transfer.

d KM Technology (KMT): Technical solutions (72.4%) are perceived as effective, though human-centred IT (63.4%) receives slightly lower support, suggesting a focus on technology solutions over user-centric IT.

e Knowledge Acquisition (KA): Knowledge documentation (73.1%) and hierarchies and peers (68.4%) are valued, highlighting the importance of structured and relational approaches to acquiring knowledge.

Table 4.20: Ranking of KM adoption approaches and KM practices.

KM Adpt. App.	Freq N=350	Perc N=350	Relative Rank	KM Practice	Freq N=350	Perc N=350	Relative Rank
KME	292	72.5	2	Fairs	219	54.5	15
				Best practices	302	75.1	7
				KS culture	328	81.6	1
				Networking	317	78.9	3
KS	289	72.0	3	Rotation of people	225	63.4	13
				Direct people contact	298	74.1	8
				Documents and database	316	78.6	4
				Teams	304	75.6	6
				Forums	274	68.2	12
TM	322	80.0	1	Formal training	315	78.4	5
				Mentoring	328	81.6	2
KMT	273	67.9	5	Technical solutions	291	72.4	10
				Human-centered IT	225	63.4	14
KA	275	68.3	4	Knowledge documentation	294	73.1	9
				Hierarchies and peers	275	68.4	11

4.2.5.3.2 Comments on the KM adoption approaches in Table 4.20

- Effectiveness of KM Adoption Approaches

1. Training and Mentoring (TM):

a Most Effective Approach: Rated at 80.0%, this is seen as the most effective KM adoption approach for knowledge transfer in the survey context, emphasizing the significance of structured learning and personal development in KM.

2. KM Environment (KME):

a Second Place: With 72.5%, this approach is valued for fostering a conducive environment for knowledge sharing and interaction.

3. Knowledge Sharing (KS):

a Third Place: Rated at 72.0%, this approach is appreciated for facilitating the exchange and dissemination of knowledge.

4. Knowledge Acquisition (KA):

a Fourth Place: With 68.3%, it highlights the importance of acquiring and documenting knowledge systematically.

5. KM Technology (KMT):

a Fifth Place: Rated at 67.9%, this approach is recognized but slightly less emphasized compared to others, reflecting that while technology is important, it may not be seen as the primary driver of KM effectiveness.

- Interpretation of findings:

1. Strong Positive Sentiment: The high percentages of agreement for most KM practices indicate a strong positive sentiment among respondents, reflecting their recognition of these practices' value to knowledge transfer and sharing.
2. Varied Emphasis: Different KM practices are valued differently, with training, mentoring, and knowledge-sharing cultures receiving the highest endorsements. This suggests a nuanced view where KM's interpersonal and technical aspects are important but prioritized differently.
3. Practical Implications: The findings suggest that organizations should enhance their knowledge-sharing culture, invest in mentoring and training, and ensure robust documentation practices to improve their KM systems.

- Conclusion

The descriptive analysis provides a clear picture of the effectiveness of various KM practices. Training and mentoring emerge as the most effective approaches, emphasising creating a supportive environment for knowledge-sharing. The results highlight the varied importance of different KM practices and suggest practical areas for improvement in KM strategies.

4.2.5.4 **Correlation analysis for Section D (KM practices)**

4.2.5.4.1 Comments on correlation analysis between KM practices and KM approaches

The correlation analysis in Section D examines the relationships between KM practices and KM adoption approaches, as seen in Table 4.21. This analysis is essential for understanding how different KM practices influence the effectiveness of KM approaches and the overall knowledge transfer within the organisation.

Table 4.21: Correlation analysis for KM practices and KM adoption approach.

Relationship			Standardised Regression Weight	Squared Multiple Correlation	Spearman's rho
			β	R^2	r
Fairs	<---	KME	0.566	0.320	0.740**
Best practices	<---	KME	0.764	0.583	0.807**
KS culture	<---	KME	0.768	0.589	0.746**
Networking	<---	KME	0.734	0.538	0.758**
Rotation of people	<---	KS	0.574	0.329	0.761**
Direct people contact	<---	KS	0.715	0.511	0.762**
Documentation and database	<---	KS	0.723	0.522	0.718**
Teams	<---	KS	0.759	0.577	0.791**
Forums	<---	KS	0.651	0.424	0.752**
Formal training	<---	TM	0.764	0.584	-
Mentoring	<---	TM	0.753	0.567	-
Technical solutions	<---	KMT	0.801	0.642	-
Human-centered IT	<---	KMT	0.670	0.449	-
Knowledge documentation	<---	KA	0.843	0.710	-
Hierarchies and peers	<---	KA	0.654	0.428	-

- Key Findings:

1. Standardised Regression Coefficients (Beta Coefficients):

a The standardised regression coefficients (Beta) in Table 4.21 are above 0.5 for most practices, suggesting a strong relationship between the KM practices and the KM adoption approaches.

b For instance, "*Best practices*" (β = 0.764), "*KS culture*" (β = 0.768), and "*Technical solutions*" (β = 0.801) demonstrate a robust influence on their respective KM adoption approaches.

2. Squared Multiple Correlation (R^2):

a The R^2 values range from 0.3 to 0.7, indicating that the KM practices account for a significant proportion of the variance in the KM adoption approaches.

b For example, "*Best practices*" (R^2 = 0.583) and "*Technical solutions*" (R^2 = 0.642) have relatively high R^2 values, showing that these practices explain a considerable portion of the variation in KM adoption approaches.

3. Spearman's Rho Correlation Coefficients:

a Spearman's rho values in Table 4.22 reveal strong positive correlations between KM practices and knowledge transfer, with coefficients ranging from 0.628 to 0.749 (Quesada & Masenge, 2021:421).

b For instance, "*Teams*" (*r* = 0.749) and "*Formal training*" (*r* = 0.753) show significant positive relationships with knowledge transfer, indicating their effectiveness in facilitating knowledge flow.

4. Statistical Significance:

a The p-values for Spearman's rho coefficients with double asterisks (**) are less than 0.01, indicating statistically significant relationships between KM practices and knowledge transfer. This significance underscores the reliability of the observed relationships (Schindler, 2022:379-380).

5. Model Fit Summary:

a The model fit indices in Table 4.24 demonstrate that the relationships between "KM Environment" and "Knowledge Transfer" and between "Knowledge Sharing" and "Knowledge Transfer" fall within the "Perfect fit range" (NFI = 1.0; IFI = 1.0; CFI = 1.0). The RMSEA value of 0.720 is within the acceptable range, suggesting a good model fit for the analysis.

Table 4.22: Correlation analysis for KM practices and KM transfer.

Relationship			**Spearman's rho**
			r
Fairs	<---	Factor D_Knowledge transfer	0.643**
Best practices	<---	Factor D_Knowledge transfer	0.716**
KS culture	<---	Factor D_Knowledge transfer	0.628**
Networking	<---	Factor D_Knowledge transfer	0.645**
Rotation of people	<---	Factor D_Knowledge transfer	0.639**
Direct people contact	<---	Factor D_Knowledge transfer	0.694**
Documentation and database	<---	Factor D_Knowledge transfer	0.683**
Teams	<---	Factor D_Knowledge transfer	0.749**
Forums	<---	Factor D_Knowledge transfer	0.708**

Relationship			Spearman's rho
			r
Formal training	<---	Factor D_Knowledge transfer	0.753**
Mentoring	<---	Factor D_Knowledge transfer	0.696**
Technical solutions	<---	Factor D_Knowledge transfer	0.736**
Human-centered IT	<---	Factor D_Knowledge transfer	0.685**
Knowledge documentation	<---	Factor D_Knowledge transfer	0.745**
Hierarchies and peers	<---	Factor D_Knowledge transfer	0.643**

- Detailed Insights:

1. KM Environment (KME):

a The KM practice, "*KS culture*", is the highest contributing practice to the "*KM Environment*" approach (β = 0.768). The strong correlation (r = 0.746) and R^2 value (0.589) indicate that a knowledge-sharing culture is crucial for knowledge transfer.

2. Knowledge Sharing (KS):

a The KM practice, "*Teams*", is the largest contributor to the "*Knowledge Sharing*" approach (β = 0.759). The high Spearman's rho (r = 0.791) and R^2 value (0.577) suggest that team-based approaches are highly effective in promoting knowledge sharing.

3. Training and Mentoring (TM):

a Both "*Formal training*" (β = 0.764) and "*Mentoring*" (β = 0.753) are significant contributors, with "*Formal training*" showing a strong correlation (r = 0.753) with knowledge transfer.

4. KM Technology (KMT):

a The KM practice, "*Technical solutions*" (β = 0.801), is the strongest contributor, with a high correlation (r = 0.736), emphasising the role of technological solutions in enhancing knowledge transfer.

5. Knowledge Acquisition (KA):

a The KM practice, "*Knowledge documentation*" (β = 0.843), has the highest impact, with a significant correlation (r = 0.745) with knowledge transfer, indicating its importance in knowledge acquisition.

- Conclusion:

The analysis confirms that various KM practices strongly relate to KM adoption approaches and knowledge transfer. The high Beta coefficients and strong Spearman's rho values suggest that practices such as fostering a knowledge-sharing culture, implementing effective teams, and employing robust technical solutions significantly enhance KM effectiveness. The model fit indices further validate the robustness of these relationships, providing a solid basis for strategic KM implementation in the organisation.

Table 4.23: Correlation analysis for KM adoption approach and Knowledge transfer.

Relationship			**Standardised Regression Weight**	**Spearman's rho**
			β	r
KM Environment (KME)	<---	Factor D_Knowledge transfer	0.462	0.853**
Knowledge Sharing (KS)	<---	Factor D_Knowledge transfer	0.585	0.903**

4.2.5.4.2 Comments on the model fit for Section D

Table 4.24 provides a summary of model fit indices for the relationship between "*Factor D: Knowledge transfer*" and two KM Adoption Approaches: KM Environment (KME) and Knowledge Sharing (KS). The fit indices reported include the Normed Fit Index (NFI), Relative Fit Index (RFI), Incremental Fit Index (IFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA).

Table 4.24: Model fit summary for Section D.

Model			**NFI Delta 1**	**RFI rho1**	**IFI Delta2**	**TLI rho2**	**CFI**	**RMSEA**
KME	<---	Factor D_Knowledge transfer	1	-	1	-	1	0.720
KS	<---	Factor D_Knowledge transfer	1	-	1	-	1	0.720

Notes: Fit Parameters			
CMIN/DF, NFI, RFI, IFI, TLI, CFI		RMSEA	
Perfect fit	=1.0	Good fit	≤0.05
Good fit	≥0.95 to ≤0.99	Acceptable fit	≥0.05 to ≤0.08
Reasonable fit	≥0.90 to ≤0.94	Borderline	≥0.08 to ≤0.1
Acceptable fit	≥0.80 to ≤0.89	Poor fit	≥0.1

Source: Adapted from Miljko (2020:1)

- Key findings:

1. Fit indices analysis:

a NFI, IFI, CFI:

(i) Values: 1.0 for both KME and KS.

(ii) Interpretation: These indices indicate a "*Perfect fit*" according to the fit parameters. A value of 1.0 for NFI, IFI, and CFI suggests that the model perfectly fits the data. This ideal outcome demonstrates that the model accurately captures the relationship between the KM approaches (KME and KS) and Knowledge transfer.

b RMSEA:

(i) Value: 0.720 for both KME and KS.

(ii) Interpretation: The RMSEA value indicates a "*Borderline*" fit according to the given range (≥0.08 to ≤0.1). While this suggests that the model is not ideal, it is still within an acceptable range. An RMSEA of 0.720 signifies some room for improvement in model fit, as lower values are preferred for a better fit. Ideally, RMSEA should be ≤0.05 for a good fit.

2. Overall Model Fit

a Strengths:

(i) The perfect fit indices (NFI, IFI, CFI) highlight the robustness of the model in terms of how well it fits the data. This suggests that the model's structure is sound and that the relationships between the KM adoption approaches (KME and KS) and Knowledge transfer are well represented.

b Weaknesses:

(i) The RMSEA value indicates a borderline fit, which implies that while the model is acceptable, there is a potential for improvement. This borderline value suggests that the model may not fully capture the complexities of the data, and adjustments might be necessary to improve the fit.

- Conclusion

The model fit summary in Table 4.24 demonstrates that the model is robust with perfect fit indices for NFI, IFI, and CFI, indicating a strong alignment between KM adoption approaches (KME and KS) and Knowledge transfer. However, the RMSEA value of 0.720 points to a borderline fit, suggesting that while the model is generally acceptable, there is an opportunity for refinement. Addressing the RMSEA value could enhance the model's overall fit and accuracy.

4.2.5.5 **Structural Equation Model (SEM) for Section D**

Figure 4.2 presents a Structural Equation Modelling (SEM) model for analysing the relationships between KM Adoption Approaches, KM practices, and KM transfer.

4.2.5.5.1 Comments:

- Model representation in Figure 4.2:

1. KM Adoption Approaches and KM Practices: Figure 4.2 visually represents the relationships between KM Adoption Approaches and KM practices and their impact on KM transfer. This visualisation aids in understanding how various factors and practices interact and contribute to knowledge transfer outcomes.
2. Integration with SEM: By using SEM, the model depicted in Figure 4.2 can simultaneously assess the direct and indirect effects of KM Adoption Approaches and KM practices on knowledge transfer. This holistic view is crucial for understanding the overall effectiveness and interrelationships among different factors.

- Importance of SEM:

1. Enhanced Analysis: SEM enhances the analysis by allowing researchers to test complex theoretical models and assess multiple pathways of influence (Hair *et al*., 2021:11-13). This capability is particularly valuable in studies involving multiple constructs and interactions, as seen in the analysis of KM Adoption Approaches and KM practices.
2. Model Testing: SEM provides a framework for model testing and validation, which can help ensure that empirical data support the hypothesised relationships (Hair *et al*., 2021:7). This is crucial for building robust theories and practical insights into KM implementation.

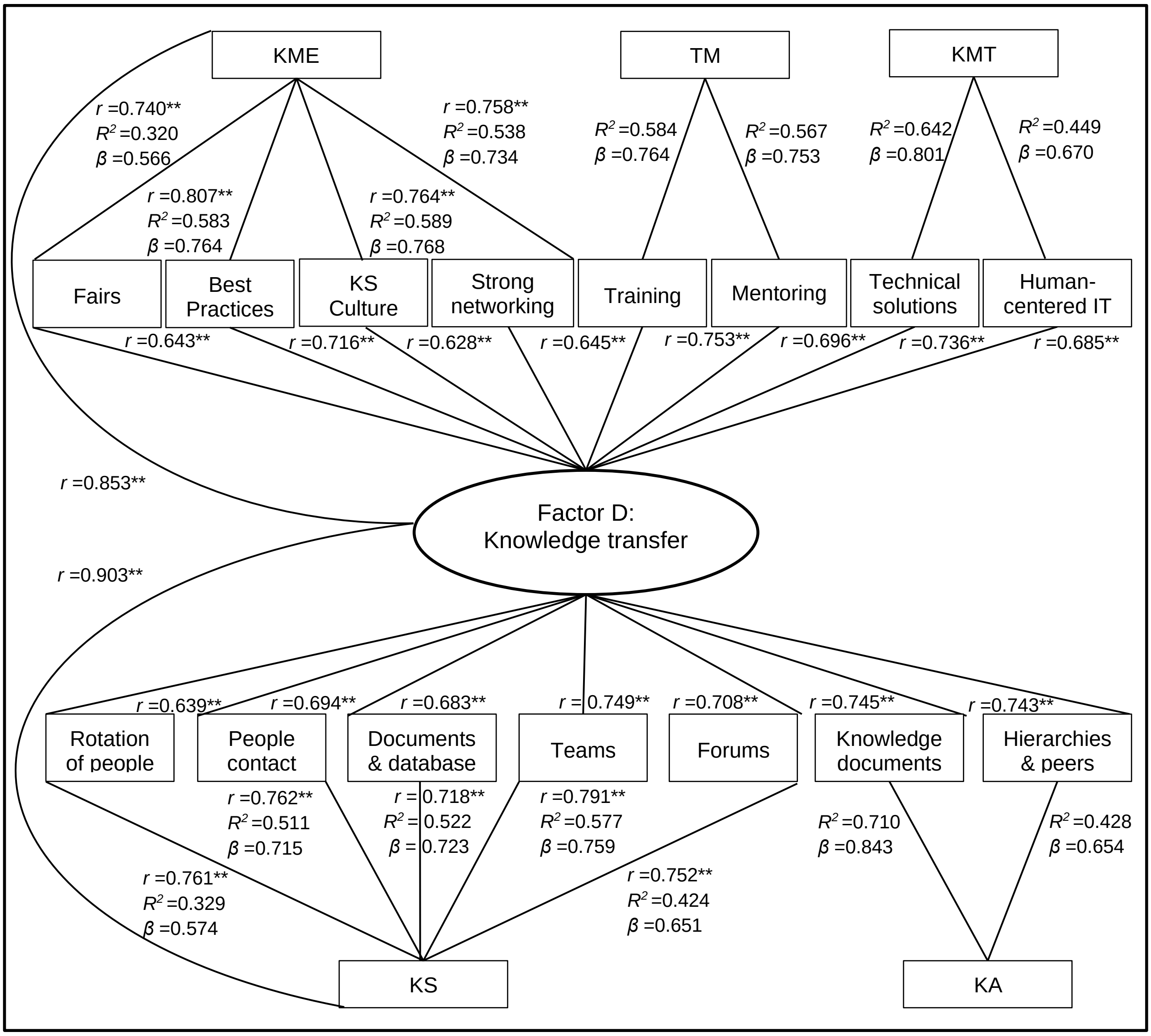

Figure 4.2: Measurement model for KM adoption approaches and KM practices.

- Conclusion

Figure 4.2 effectively illustrates the application of SEM to explore the relationships between KM adoption approaches, KM practices, and Knowledge transfer. SEM's ability to handle complex relationships and latent variables enhances the robustness of the analysis and supports more informed conclusions about the factors influencing Knowledge transfer.

4.3 Discussion of results and findings

The study findings are categorised under the two essential components of a KM framework: CSFs and associated KM enablers and KM adoption approaches with associated KM practices.

The respondents deem explicit knowledge (available in codified form) and tacit knowledge (resides in individuals' heads) essential for employees to function efficiently and effectively within an explosives manufacturing company. The aforementioned implies that an explosives manufacturing company should adopt a dynamic style and implement explicit- with tacit-orientated KM practices, as suggested by Choi and Lee (2002:413).

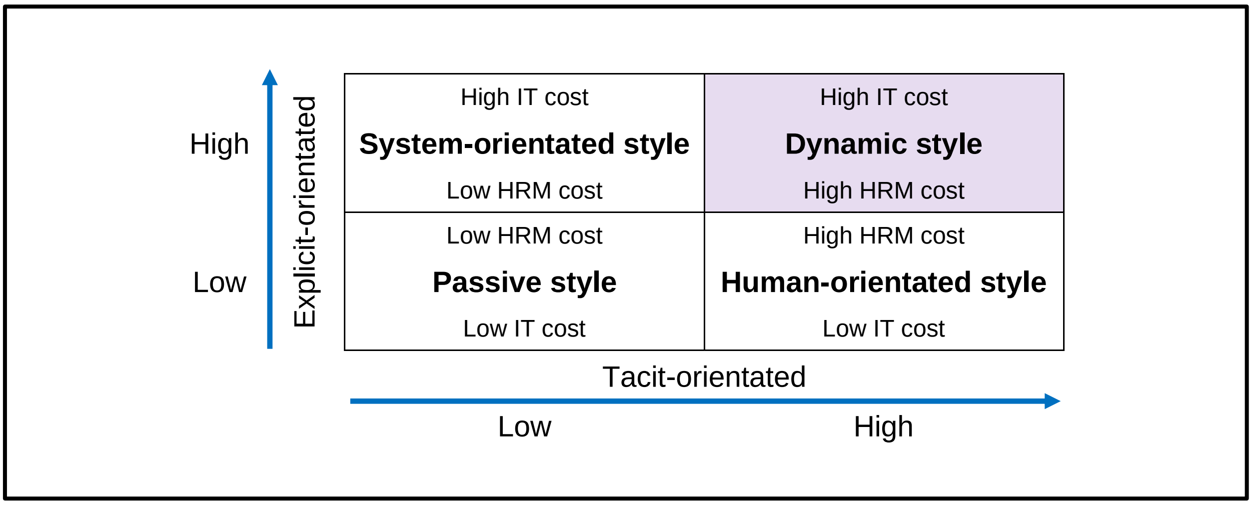

Figure 4.3: KM styles. (Source: Adapted from Choi & Lee, 2002:406)

Technical knowledge is regarded as the most important type of knowledge for an explosives manufacturing company and supports the findings of Sumbal *et al*. (2020:642) within a manufacturing environment.

4.3.1 CSFs and associated KM enablers

Developing a conceptual KM framework first requires identifying those CSFs essential for implementing KM in an explosives manufacturing company in South Africa.

The CSF dimension, "*Human-orientated factors*", is the most important of the four dimensions, with "*Management aspects*" being the least important CSF dimension, and corresponds with the findings of Heisig (2009:12).

The KM enabler, "*Organisational processes*", under the organisational aspect dimension, is regarded overall as the most important KM enabler for an explosives manufacturing company and supports the study of Heisig (2009:26) and Usman *et al.* (2021:12).

The KM enabler, "*Leadership*", under the human-orientated factor dimension, is the second most important KM enabler and corresponds with the findings of Sanjit *et al*. (2021:19-20) for companies in the manufacturing industry. The survey results reiterate the important role of

"*Leadership*" when implementing KM in an organisation and support the study of Fivaz and Pretorius (2015:8).

The KM enabler, "*Organisational culture*", under the human-orientated factor dimension, is the third most important KM enabler and supports the study of Abu-Alsondons (2023:1534), Fivaz and Pretorius (2015:8), Karami *et al*., (2015:192-193), Kunthi *et al*. (2017:32-34), and Sanjit *et al*. (2021:19-20).

The KM enabler, "*People*", under the human-orientated factor dimension, is the fourth most important KM enabler for an explosives manufacturing company and supports the study of Abu-Alsondons (2023:1534), as well as of Fivaz and Pretorius (2015:8).

The survey results support the study of Fivaz and Pretorius (2015:8) and Phaladi (2022:8) by reaffirming that South African employees regard all three human-orientated factors, "*People*", "*Culture*", and "*Leadership*" as essential for effectively implementing KM within an organisation.

The management aspect, "*Measurement*", is the respondents' least important KM enabler for an explosives manufacturing company. The survey results support the study of Botha and Fouché (2002:17), Fivaz and Pretorius (2015;9), and Heisig (2009:12) in this regard.

Hypothesis 1. The design of the data collection instrument (i.e., survey questionnaire) was sufficient to test the statistically significant relationship between each independent variable (KM enablers) and the dependent variable (Factor C: KM implementation).

H^{1a}: People have a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*People*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.700$). Therefore, hypothesis H^{1a} can be accepted for this study.

H^{1b}: Organisational culture has a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*Organisational culture*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.718$). Therefore, hypothesis H^{1b} can be accepted for this study.

H^{1c}: Leadership in the organisation has a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*Leadership*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.704$). Therefore, hypothesis H^{1c} can be accepted for this study.

H^{1d}: Organisational processes have a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*Organisational processes*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.781$). Therefore, hypothesis H^{1d} can be accepted for this study.

H^{1e}: Organisational structure has a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*Organisational structure*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.770$). Therefore, hypothesis H^{1e} can be accepted for this study.

H^{1f}: Management's strategy has a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*KM strategy*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.807$). Therefore, hypothesis H^{1f} can be accepted for this study.

H^{1g}: Management's goals have a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*KM goals*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.743$). Therefore, hypothesis H^{1g} can be accepted for this study.

H^{1h}: Management's performance measurement has a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*KM measurement*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.735$). Therefore, hypothesis H^{1h} can be accepted for this study.

H^{1i}: Information technology infrastructure has a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*IT infrastructure*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.706$). Therefore, hypothesis H^{1i} can be accepted for this study.

H^{1j}: Information technology applications have a positive effect on the implementation of knowledge management. The survey data shows a statistically significant relationship between "*IT applications*" and "*Factor C: KM implementation*" ($p < 0.01$; $r = 0.715$). Therefore, hypothesis H^{1j} can be accepted for this study.

4.3.2 KM adoption approaches and KM practices

The next aspect to consider when developing a conceptual KM framework is identifying the KM practices needed to transfer and share tacit knowledge in an explosives manufacturing company.

The KM approach, "*Training and Mentoring*", is the most important criterion for enabling KM in an explosives manufacturing company, whereas Singh *et al*. (2022:12205) found "*Training and Mentoring*" to be the second most important criterion for enabling KM in agile organisations. Sanjit *et al*. (2021:20) also found "*Training*" to be the most important criterion for enabling KM in manufacturing industries.

The sub-criteria "*Formal mentoring practices*" under the KM approach, "*Training and Mentoring*", is the most important practice for transferring and sharing knowledge, followed by "*Formal training*", and supports the findings of Fivaz and Pretorius (2015:7) in a manufacturing environment. In contrast, Singh *et al*. (2022:12205) found "*Formal training*" to be the best sub-criteria for sharing knowledge in agile organisations, followed by "*Formal mentoring practices*".

The KM approach, "*KM Environment*", is the second most important criterion for enabling KM in an explosives manufacturing company, whereas Singh *et al*. (2022:12205) found the "*KM Environment*" to be the least important criterion for enabling KM in agile organisations.

The sub-criteria "*Knowledge sharing culture*" under the KM approach, "*KM Environment*", is deemed to be the best practice for transferring and sharing knowledge and corresponds with the findings of Singh *et al*. (2022:12205-12206).

The KM approach, "*Knowledge Sharing*", is the third most important criterion for enabling KM in an explosives manufacturing company and corresponds with the finding of Singh *et al*. (2022:12205), who also found "*Knowledge Sharing*" to be the third most important criterion for enabling KM in agile organisations.

The sub-criteria "*Rotation of people*" under the KM approach, "*Knowledge Sharing*", is the least important practice for transferring and sharing knowledge and corresponds with the findings of Singh *et al*. (2022:12205).

The KM approach, "*Knowledge Acquisition*", is the fourth most important criterion for enabling KM in an explosives manufacturing company and corresponds with the finding of Singh *et al*. (2022:12205), who also found "*Knowledge Acquisition*" to be the fourth most important criterion for enabling KM in agile organisations.

The KM approach, "*KM Technology*", is found to be the least important criterion for enabling KM in an explosives manufacturing company, whereas Singh *et al*. (2022:12205) found "*KM Technology*" to be the most important criterion for enabling KM in agile organisations.

The sub-criteria "*Technical solutions for transferring knowledge*" under the KM approach, "*Knowledge Technology*", is deemed the most important practice and corresponds with the findings of Singh *et al*. (2022:12205-12206).

Hypothesis 2. Similar to Hypothesis 1, the design of the data collection instrument (i.e., survey questionnaire) was sufficient to test the statistically significant relationship between each independent variable (KM practice) and the dependent variable (Factor D: Knowledge transfer).

H^{2a}: Fairs in the organisation are an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Fairs within the organisation*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.643$). Therefore, hypothesis H^{2a} can be accepted for this study.

H^{2b}: Best practice repositories are an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Best practice repositories*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.716$). Therefore, hypothesis H^{2b} can be accepted for this study.

H^{2c}: Creating a knowledge-sharing culture is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Knowledge-sharing culture*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.628$). Therefore, hypothesis H^{2c} can be accepted for this study.

H^{2d}: Strong networking among employees is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Strong networking among employees*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.645$). Therefore, hypothesis H^{2d} can be accepted for this study.

H^{2e}: The rotation of people is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Rotation of people*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.639$). Therefore, hypothesis H^{2e} can be accepted for this study.

H^{2f}: People-to-people contact is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*People-to-people contact*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.694$). Therefore, hypothesis H^{2f} can be accepted for this study.

H^{2g}: Documents and databases are an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Documents and database*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.683$). Therefore, hypothesis H^{2g} can be accepted for this study.

H^{2h}: Cross-functional and self-organising teams are an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Cross-functional and self-organising teams*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.749$). Therefore, hypothesis H^{2h} can be accepted for this study.

H^{2i}: Discussion forums are an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Discussion forums*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.708$). Therefore, hypothesis H^{2i} can be accepted for this study.

H^{2j}: Formal training is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Formal training*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.753$). Therefore, hypothesis H^{2j} can be accepted for this study.

H^{2k}: Formal mentoring is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Formal mentoring*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.696$). Therefore, hypothesis H^{2k} can be accepted for this study.

H^{2l}: Technical solutions are effective KM practices to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Technical solutions*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.736$). Therefore, hypothesis H^{2l} can be accepted for this study.

H^{2m}: Human-centered information technology is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Human-centered IT*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.685$). Therefore, hypothesis H^{2m} can be accepted for this study.

H^{2n}: Knowledge documentation is an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Knowledge documentation*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.745$). Therefore, hypothesis H^{2n} can be accepted for this study.

H^{2o}: Hierarchies and peers are an effective KM practice to transfer and share knowledge within an organisation. The survey data shows a statistically significant relationship between "*Knowledge acquisition through hierarchies and peers*" and "*Factor D: Knowledge transfer*" ($p < 0.01$; $r = 0.743$). Therefore, hypothesis H^{2o} can be accepted for this study.

4.4 Summary

Chapter 4 presents the analysis, results, and interpretation of the data collected from an online survey distributed to employees of a South African explosives manufacturing company. The study examined CSFs and KM practices crucial for knowledge implementation and transfer. The survey had a response rate of 38.1%, and data were analysed using descriptive statistics, correlation, and regression analysis. Key findings indicate that human-oriented factors, such as people, leadership and organisational culture, are vital for KM implementation. Similarly, KM practices, such as knowledge-sharing culture, mentoring, networking, and training, are critical for mitigating knowledge loss.

The chapter also validates the positive relationship between KM enablers and KM implementation, supporting the hypothesis that these elements significantly influence the implementation of KM in an explosives manufacturing company. The relationship between KM practices and knowledge transfer is also validated, supporting the hypothesis that these elements significantly influence knowledge transfer. The results offer a foundation for developing a conceptual KM framework tailored to the needs of the explosives manufacturing industry.

The last chapter deals with the study's conclusions, recommendations and limitations.

CHAPTER 5 CONCLUSIONS, RECOMMENDATIONS, LIMITATIONS AND CONTRIBUTION OF THE STUDY

5.1 Introduction

This study focused on identifying and analysing KM practices and CSFs that can support knowledge transfer within an explosives manufacturing company in South Africa.

The concept of "*Knowledge Management*" and its essentiality within the business environment is emphasised in Chapter 1 of this study. Chapter 2 familiarises the reader with various knowledge management terminologies and includes an in-depth analysis of KM framework components. The research methodology applied for this study is summarised in Chapter 3 and encompasses the techniques employed by the researcher to collect the data. The research data and findings of this study are summarised in Chapter 4.

The primary objective of this study was to identify which KM practices assist with knowledge transfer within an explosives manufacturing company, thereby mitigating the risks inherent in tacit knowledge loss. This final chapter comprises the study's conclusions, recommendations, limitations, and contributions.

5.2 Conclusions

This study explored KM practices for transferring knowledge, including CSFs with associated KM enablers required to implement and support knowledge management in a company, to develop a conceptual KM framework for an explosives manufacturing company in South Africa. Most research studies in the field of knowledge management focus either on KM enablers or KM practices, which makes this study unique as it includes both KM implementation and transfer factors of a KM framework.

The literature study shows that the KM process is a standardised process for all types of organisations comprising five KM activities: (1) Identifying the type of knowledge required by the organisation, (2) creating new knowledge, (3) storing, (4) sharing, and (5) using knowledge through IT infrastructures and applications.

The CSF dimensions illustrated in Figure 5.1 provide a supporting framework for KM implementation in an explosives manufacturing company. The study revealed that all ten KM enablers positively affect KM implementation and give the KM infrastructure for fostering knowledge in an explosives manufacturing company. The strong emphasis on *Leadership*", "*Culture*", "*People*", and "*Organisational processes*", suggests that initiatives aimed at strengthening these areas could substantially improve the efficiency of the KM process to facilitate knowledge creation, sharing and use in the company, as illustrated in Figure 5.1.

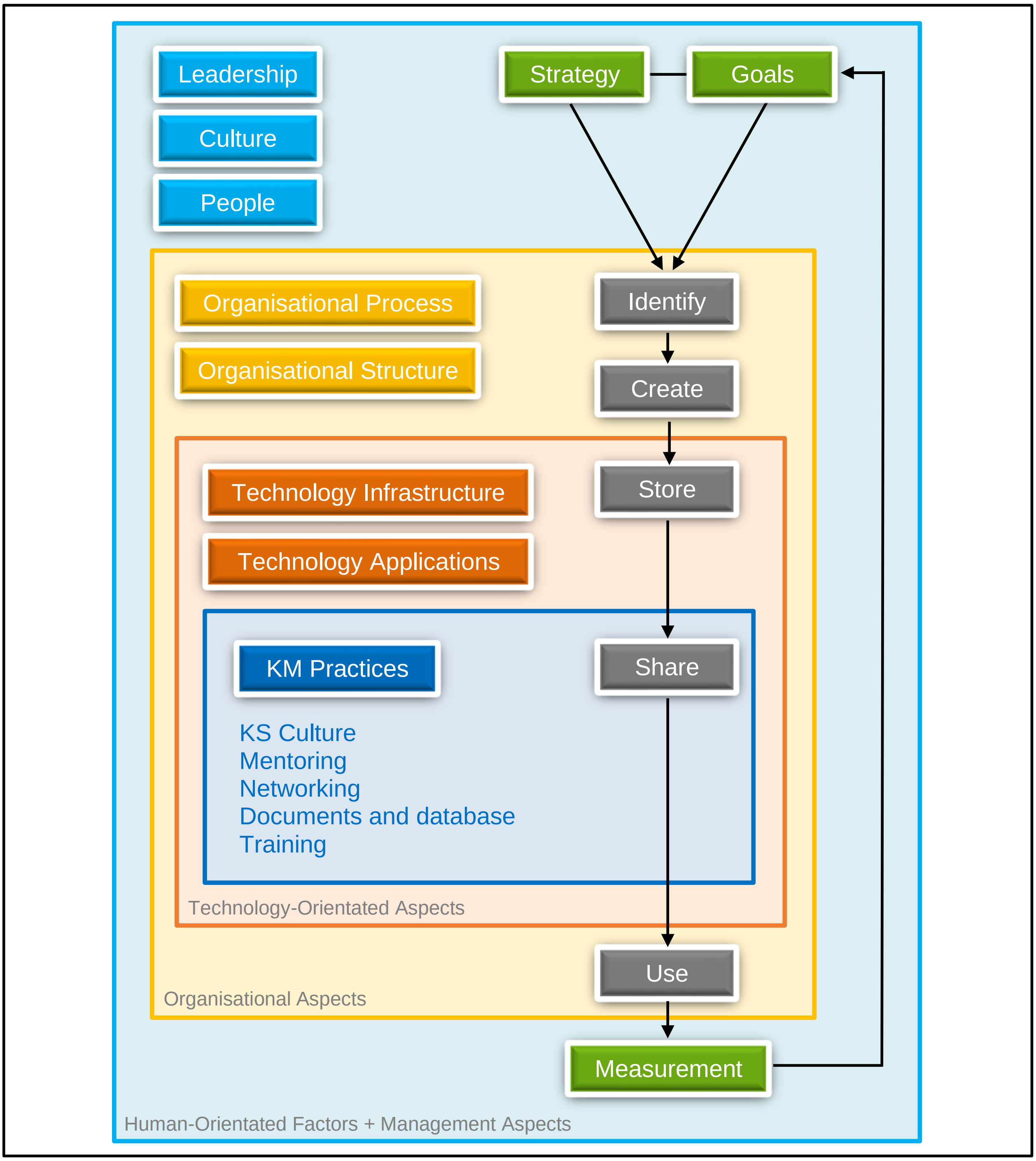

Figure 5.1: Conceptual KM framework for an explosives manufacturing company.

The KM practices, "*Knowledge-sharing culture*", "*Mentoring*", "*Networking*", "*Documents and database*", and "*Training*", illustrated in Figure 5.1, are regarded as the most effective practices for transferring tacit knowledge among employees in an explosives manufacturing company.

Interestingly, employees consider both "*Organisational culture*" as a KM enabler and "*Knowledge Sharing culture*" as a KM practice as essential for knowledge management in an explosives manufacturing company.

The phrase by renowned management consultant Peter Drucker, "*Culture eats strategy for breakfast*", implies that no matter how well-designed or robust a strategy is, it will fail unless employees share the appropriate culture. A strategy might outline the path to success, but the strategy is likely to fail if an organisation's culture is unaligned (Conney, 2024). Therefore, implementing KM strategies will only succeed if employees embrace a culture of knowledge sharing within the organisation.

5.3 Recommendations

The survey questionnaire is a practical data collection instrument that all types of organisations can use to develop a KM framework. However, during the data analysis process, it was established that a minimum of three independent variables must be tested under each CSF dimension to determine whether a statistically significant relationship exists between the "*CSF dimension*" and "*KM implementation*" (see Figure 5.2).

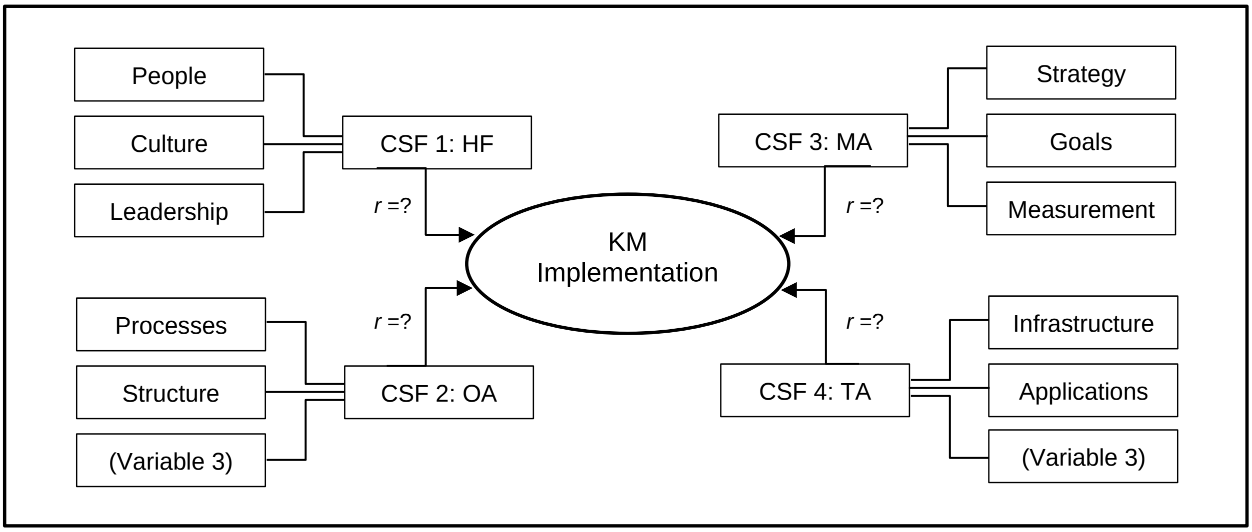

Figure 5.2: Independent variables under each CSF.

Similar to the CSF dimensions, each "*KM Adoption Approach*" in Figure 5.3 must have a minimum of three KM practices to determine whether a statistically significant relationship exists between the "*KM Adoption Approach*" and "*Knowledge transfer*".

Secondly, testing whether a statistically significant relationship exists among the "*KM Adoption Approaches*" requires an equal number of variables under each "*KM Adoption Approach*", as seen in Figure 5.3.

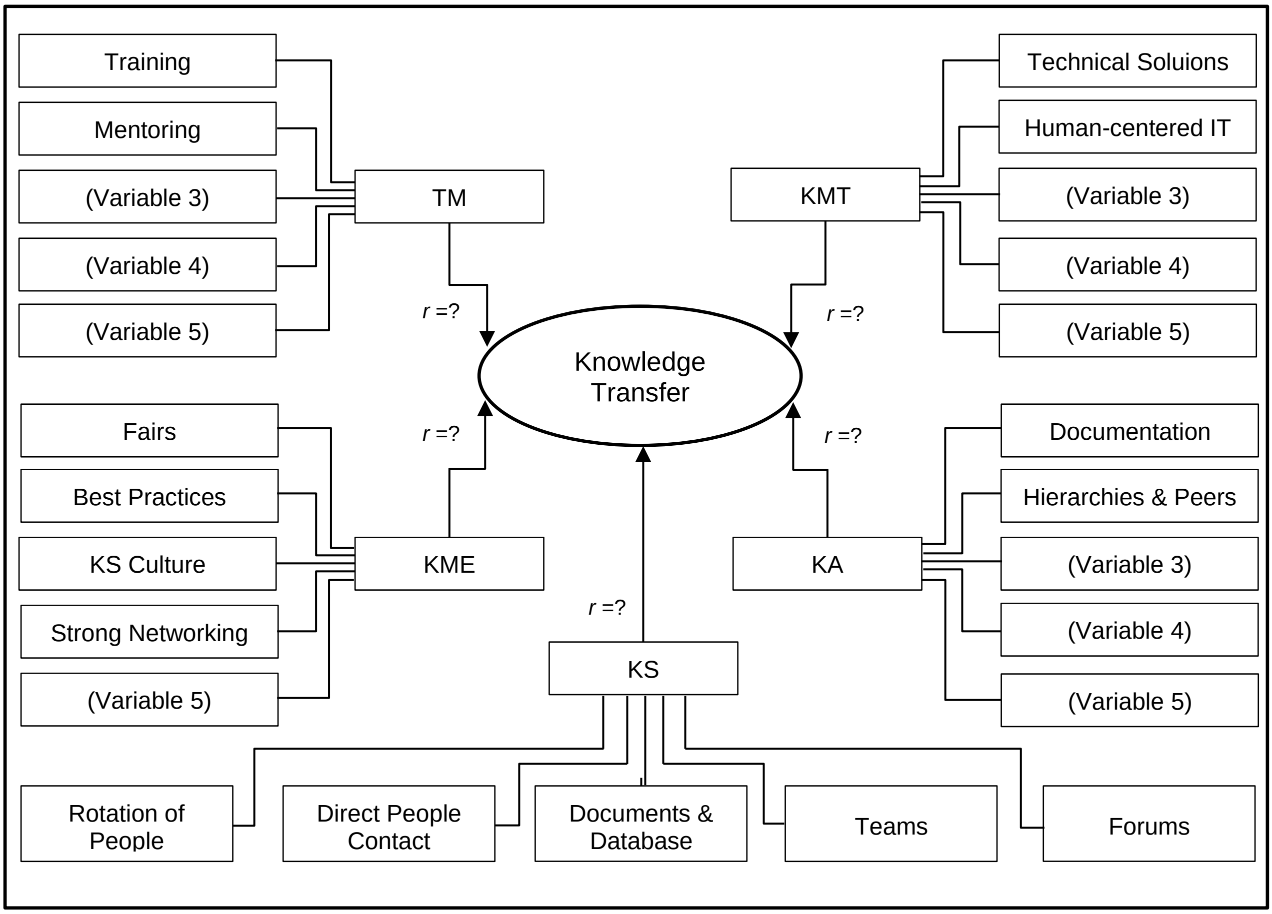

Figure 5.3: Independent variables under each KM adoption approach.

The KM framework proposed in this study (Figure 5.1) can be adapted for other companies in the industry by customising the KM enablers and KM practices in the framework. Managers can customise the KM framework to align with the KM strategy and goals of the company. Furthermore, the number of KM enablers and KM practices in the framework can be reduced for smaller companies.

5.4 Limitations of this study

A limitation of the study was that it was based solely on a single explosives manufacturing company in South Africa. Replicating this study in the rest of the chemical and explosives industry (including other manufacturing industries) of South Africa would be most informative. Therefore, a survey involving more explosives manufacturing companies in South Africa to obtain a larger sample size is recommended for future studies.

A second constraint identified was using a 5-point Likert scale in the KM survey questionnaire, as it may not be sensitive enough. Expanding the number of possible responses might provide more accurate data on KM practices specific to a functional department in a manufacturing company.

Another significant limitation is that the study focused on identifying suitable KM practices but did not test the effectiveness of each practice over an extended time, as this will require a longitudinal study.

Lastly, the KM survey questionnaire was not designed to test the last aspect of a KM framework: How KM enablers and practices promote knowledge creation, use and transfer in a manufacturing company.

5.5 Contributions of the study

This study's primary contribution is that it provides a conceptual framework summarising the CSFs and KM practices for implementing knowledge management in an explosives manufacturing company to mitigate tacit knowledge loss. The findings from the study offer South African explosives manufacturers insights into KM resources, processes and practices in which they can invest to enhance their KM systems.

Although the results specifically focus on the South African explosives sector, they are relevant on a broader scale as they address common obstacles in managing and preserving critical knowledge within high-risk, knowledge-driven industries. These findings can guide knowledge management strategies across various fields, including global mining, defence, and advanced manufacturing industries, especially where retaining tacit knowledge retention is vital for maintaining operations and fostering innovation.

From the perspective of theoretical contributions, this study provides researchers with more insights into KM practices for high-value manufacturing and contributes to the science of knowledge management. From a practical viewpoint, the research can guide knowledge practitioners in customising and implementing a dynamic KM framework for a manufacturing company.

5.6 Summary

This chapter summarises the study's key findings, conclusions, and recommendations. It highlighted the importance of human-related factors such as leadership, culture, and processes in supporting KM implementation and knowledge transfer. Although technology plays a supporting role, the study emphasised that successful KM initiatives such as networking, training and mentoring rely heavily on culture and leadership. The study's limitations offer opportunities for future research, while the conceptual KM framework presented here contributes significantly to both the theoretical and practical understanding of KM in manufacturing industries.

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ANNEXURES A: ETHICS APPROVAL LETTER OF STUDY

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Senate Committee for Research Ethics
Tel: 018 299-484
Feziwe.Mseleni@nwu.ac.za

24 November 2023

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Economic and Management Sciences Research Ethics Committee (EMS-REC)** on, 24/11/2023 the Economic and Management Sciences Research Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-REC) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Analysing knowledge management frameworks for and explosives manufacturing company in South Africa

Study Leader/Supervisor (Principal Investigator)/Researcher): Prof N Mouton

Student: D van Wyk (40267946)

N	W	U	-	0	1	9	5	9	-	2	3	-	A	4
Institution				Study Number						Year			Status	

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type:
Commencement date: 24/11/2023 **Risk:** **Minimal**
Expiry date: 24/11/2024

Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable):

-

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The study leader/supervisor (principle investigator)/researcher must report in the prescribed format to the EMS-REC:*
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the EMS-REC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*

n the interest of ethical responsibility, the NWU-SCRE and EMS-REC reserves the right to:

- *request access to any information or data at any time during the course or after completion of the study;*
- *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
- *withdraw or postpone approval if:*
  - *any unethical principles or practices of the study are revealed or suspected;*
  - *it becomes apparent that any relevant information was withheld from the EMS-REC or that information has been false or misrepresented;*
  - *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
  - *new institutional rules, national legislation or international conventions deem it necessary.*

The EMS-REC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the EMS-REC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely,

Prof Diana Viljoen Bezuidenhout
Chairperson: NWU Economic and Management Sciences Research Ethics Committee

ANNEXURES B: DATA COLLECTION INSTRUMENT

QUANTITATIVE RESEARCH: QUESTIONNAIRE

ANALYSING KNOWLEDGE MANAGEMENT FRAMEWORKS FOR AN EXPLOSIVES MANUFACTURING COMPANY IN SOUTH AFRICA

CONFIDENTIAL

Student: DJ van Wyk (Tel: 072 212 5577)

Supervisor: Prof. N Mouton (Tel: 073 590 9431)

Note: All responses are confidential, and neither the individual nor the organisation will be identified in any report or release.

Knowledge Management Assessment Questionnaire

GENERAL INSTRUCTIONS

The questionnaire will take approximately 20 minutes to complete. The questionnaire is divided into four sections: demographical information, types of knowledge, critical success factors, and knowledge management practices.

Please complete Section A to Section D in the questionnaire. All questions should be answered by ticking (x) the relevant block.

Please complete every question/statement to ensure the validity and reliability of the study.

Section A: Demographical Information

The following information is needed to help the researcher with the statistical data analysis for comparisons among the different interest groups. We appreciate your assistance in providing this vital formation. The purpose of collecting the data is to form a profile of the participants working in the organisation and will not be used to make comparisons between groups or for further statistical analysis.

Please answer the questions by marking the applicable block with a cross (X). Please answer **ALL** the questions in Section A.

1	**Indicate in which functional department you work.**		
	MDs Office	QHSE	Finance
	1	2	3
	Manufacturing	Product Development	Plant Engineering
	4	5	6
	Supply Chain & Services	Ops Risk Management	Project Management
	7	8	9
	Information Technology	Human Resources	Internal Services
	10	11	12
	NBD & Sales	Other	
	13	14	

2	**How many years have you been working in your department?**							
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36+
	1	2	3	4	5	6	7	8

3	**How many years have you been working for the company?**							
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36+
	1	2	3	4	5	6	7	8

4	**What is your Job Designation level?**		
	Executive or Senior Management	Middle Management	First-level Management
	1	2	3
	Technical staff	General staff	
	4	5	

Section B: Types of Knowledge

This section of the questionnaire aims to determine which types of knowledge are essential to the participating business. Please read every statement carefully and thoroughly and decide how you feel about it before selecting.

Please answer the questions by marking the applicable block with a cross (X). Please answer **ALL** the questions in Section B.

TYPES OF KNOWLEDGE

Explicit knowledge is official and systematic information that a person can document and communicate to other employees.

Tacit knowledge resides with individuals, which they gain through experience and technical skills and is difficult to formalise and communicate in an organisation (i.e., "know-how").

5	**What knowledge do you consider essential to function efficiently and effectively in your position?**		
	Explicit knowledge	Tacit knowledge	Both
	1	2	3

6	**What knowledge do you consider critical for your position?**		
	Management knowledge	Technical knowledge	Knowledge of customer /supplier networks
	1	2	3

Section C: Critical Success Factors of Knowledge Management

The following statements concern your opinion regarding the critical success factors of knowledge management. Please read every statement carefully and thoroughly, and decide how you feel about it before selecting.

Please rate the extent to which you agree or disagree with the statements by marking an "X" over the appropriate number on the 1-to-5-point scale next to the statement. Please answer **ALL** the questions in Section C.

Please use the following codes to indicate your preference:

SCALE	TERM USED
1	Strongly disagree
2	Disagree
3	Neither agree nor disagree (Neutral)
4	Agree
5	Strongly agree

KNOWLEDGE MANAGEMENT

Knowledge management is a business process that regulates the management and use of intellectual and information assets and incorporates explicit knowledge (e.g., databases, documents, procedures) and tacit knowledge that is known but not stored (e.g., worker expertise and experience). Knowledge management is an integrated approach to creating, transforming, storing, retrieving and sharing knowledge inside the business to support and enhance operational performance.

	STATEMENT	SCALE				
	Construct 1: Human-orientated factors.					
7	The involvement and commitment of individuals within an organisation significantly impact the successful implementation of knowledge management initiatives.	1	2	3	4	5
8	Organisational culture, including values, attitudes, and behaviours related to knowledge sharing and collaboration, is crucial in successfully implementing knowledge management practices.	1	2	3	4	5
9	Effective leadership is essential to implement knowledge management initiatives within an organisation successfully.	1	2	3	4	5
	Construct 2: Organisation					
10	The alignment and optimisation of organisational processes, such as information flow, documentation, and knowledge-sharing procedures, are essential for the successful implementation of knowledge management within an organisation.	1	2	3	4	5

	STATEMENT	SCALE				
11	The organisational structure, including hierarchy, roles, and reporting relationships, significantly impacts the successful implementation of knowledge management initiatives within an organisation.	1	2	3	4	5
	Construct 3: Management-processes					
12	The inclusion of knowledge management strategies as an integral part of the overall management process is crucial for the successful implementation of knowledge management within an organisation.	1	2	3	4	5
13	The incorporation of specific knowledge management goals and objectives as an integral part of the overall management processes is essential for the successful implementation of knowledge management within an organisation.	1	2	3	4	5
14	The incorporation of robust measurement and performance evaluation mechanisms as an integral part of the overall management processes is essential for the successful implementation of knowledge management within an organisation.	1	2	3	4	5
	Construct 4: Technology					
15	The adequacy and sophistication of the technology infrastructure, including software tools and systems, are essential for the successful implementation of knowledge management initiatives within an organisation.	1	2	3	4	5
16	The choice and effective utilisation of technology applications, such as knowledge repositories, collaboration tools, and search capabilities, are essential to ensure the success of knowledge management initiatives within an organisation.	1	2	3	4	5

Section D: Knowledge Management Practices

The following statements concern your opinion regarding knowledge management practices. Please read every statement carefully and thoroughly and decide how you feel about it before selecting.

Please rate the extent to which you agree or disagree with the statements by marking an "X" over the appropriate number on the 1-to-5-point scale next to the statement. Please answer **ALL** the questions in Section D.

Please use the following codes to indicate your preference:

SCALE	TERM USED
1	Strongly disagree
2	Disagree
3	Neither agree nor disagree (Neutral)
4	Agree
5	Strongly agree

	STATEMENT	SCALE				
	Construct 5: Knowledge Management Environment					
17	Fairs within the organisation can be an effective knowledge management practice for transferring and sharing knowledge in your organisation.	1	2	3	4	5
18	Best practices and lessons learned repositories can be effective knowledge management practices for transferring and sharing knowledge in your organisation.	1	2	3	4	5
19	Creating a knowledge-sharing culture can be an effective knowledge management practice for transferring and sharing knowledge in your organisation.	1	2	3	4	5
20	Strong networking among employees can be an effective knowledge management practice for transferring and sharing knowledge in your organisation.	1	2	3	4	5
	Construct 6: Knowledge Sharing					
21	The rotation of personnel, such as job rotations or cross-functional assignments, can be an effective knowledge management practice for transferring and sharing knowledge in your organisation.	1	2	3	4	5
22	Interpersonal interactions and direct contact among employees can be an effective knowledge management practices for transferring and sharing knowledge in your organisation.	1	2	3	4	5
23	Effective documentation practices and databases can be effective knowledge management practices for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
24	The formation and operation of cross-functional or knowledge-sharing teams can be an effective knowledge management practice for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
25	The utilisation of forums, discussion boards, or online platforms is an effective knowledge management practice for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
	Construct 7: Training and Mentoring					
26	Formal training programs and educational initiatives can be effective knowledge management practices for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
27	Mentoring practices, where employees guide and transfer knowledge to less experienced colleagues, can be an effective knowledge management practice for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
	Construct 8: Knowledge Management Technology					
28	Technical solutions, such as knowledge management software or digital platforms, can be an effective knowledge management practice for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
29	Human-centred information technology can be an effective knowledge management practice for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
	Construct 9: Knowledge Acquisition					

	STATEMENT	SCALE				
30	The utilisation of knowledge documentation can be an effective knowledge management practice for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5
31	The utilisation of hierarchies and peer-to-peer interactions is an effective knowledge management practice for facilitating the transfer and sharing of knowledge in your organisation.	1	2	3	4	5

ANNEXURES C:TURNITIN REPORT

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This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

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Analysing knowledge management frameworks for an explosives manufacturing company in South Africa

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Mini-Dissertation submitted for the degree **Master of Business Administration (MBA)** at the North-West University

Supervisor: Prof N. Mouton

Examination: November 2024

Student number: 40267946

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ANNEXURES D: ENGLISH LANGUAGE EDITING LETTER

Dynamic Language & Translation Specialists

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Cell: 082 878 5183
Language@dlts.co.za
CC No: 1995/017794/23

Tuesday, 15 October 2024

To whom it may concern

Re: Confirmation of language edit, typography and technical precision

The MBA mini-dissertation "Analysing knowledge management frameworks for an explosives manufacturing company in South Africa" by DJ van Wyk (40267946) was edited for language and technical precision. Referencing and citations were checked to comply with the Harvard guidelines specified by the 2024 NWU Reference Guide.

Final, last-minute corrections remain the responsibility of the author.

Antoinette Bisschoff

BA Languages (UPE – now NMU); MBA (PU for CHE – now NWU); Translation and Linguistic Studies (NWU)

Officially approved language editor of the NWU since 1998
Member of SA Translators Institute (no. 100181)

Precision ... to the last letter