An exploratory study on factors that hinder Port Terminal Automation. The case study of Richards Bay

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Plagiarism Declaration

Declaration

Hereby I, Nomonde Zama, declare *An exploratory study on factors that hinder Port Terminal Automation. The case study of Richards Bay* is my original work. All sources have been accurately reported and acknowledged, and this document has not previously in its entirety or part been submitted at any university to obtain an academic qualification.

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Abstract

This study explores the factors influencing the adoption of automation at the Richards Bay port terminal in South Africa. However, the effectiveness of automation at Richards Bay Port remains unevaluated, as the port faces operational performance challenges. The research investigated the underlying limitations in transforming and implementing digitalisation in the maritime shipping industry to identify the factors influencing the adoption of automation in port terminals. Understanding these factors could lead to achieving operational efficiency and cost savings.

Grounded in the Technology-Organisation-Environment (TOE) framework, the research adopted a qualitative, exploratory approach to gain in-depth insights into the organisational, technological, and environmental challenges that affect automation readiness. Data were collected through an online questionnaire comprising both structured and unstructured questions, completed by 13 participants with extensive experience in port operations. A purposive, non-random sampling technique was used to select individuals with relevant operational knowledge. The responses were analysed thematically, and a follow-up semi-structured interview was conducted to enrich and triangulate the findings.

The findings highlighted three social theoretical approaches, analysed at the organisational level, with the existing technologies and the external environment. These factors inhibited the adoption of automation in ports. The study revealed that successful technological innovation requires a robust organisational culture, sound structure, skilled employees, and effective leadership to drive digital transformation strategies.

The recommendations for transforming the port into a smart port included securing funding, training and upskilling employees, engaging stakeholders, and investing in technology. The study contributes to the body of knowledge by indicating how disruptive technologies drive ports to become more intelligent.

Keywords:

TNPA, TPT, ICT, port terminal, Industry 4.0, Logistics 4.0, smart ports, automation, TOE Framework.

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Dedication

I dedicate this study to my late grandparents Mr. Samuel and Mrs. Linah Zama.

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List Of Acronyms And Abbreviations

4IR	Fourth Industrial Revolution
AGV	Automated Guided Vehicles
AI	Artificial Intelligence
ASC	Automated Stacking Cranes
BDA	Big Data Analytics
DOI	Diffusion of Innovations
EDI	Electronic Data Interchange
EDP	Electronic Data Processing
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HPA	Hamburg Port Authority
ICT	Information and Communication Technology
IoT	Internet of Things
IT	Information Technology
LPI	Logistics Performance Index
NDP	National Development Plan
OEM	Original Equipment Manufacturer
RBCT	Richards Bay Coal Terminal (Pty) Ltd
RFID	Radio Frequency Identification
RR	Research Respondent
SA	South Africa
SOE	State-Owned Enterprise
STS	Socio-Technical Systems
TFR	Transnet Freight Rail
TNPA	Transnet National Ports Authority

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TOE	Technological, Organisational, and Environmental
TPT	Transnet Port Terminals
UTAUT	Unified Theory of Acceptance and Use of Technology

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Chapter 1: Introduction And Background To The Study

1.1 Introduction And Study Rationale

Port terminals play an integral role in the transportation logistics chain by enabling trade across the global market. They provide cargo handling services, storage, and warehousing for various stakeholders, including shipping lines, freight forwarders, and cargo owners (Mazibuko, 2020; Transnet Port Terminals, 2022). According to Transnet Port Terminals (TPT), in South Africa (SA), port terminals ensure year-round connectivity of the economy with key trading partners in the region and globally (Transnet Port Terminals, 2022).

The port terminal operations in SA comprise four business segments: containers, dry bulk, break-bulk, and automotive. The TPT division operates 16 terminals with 68 berths across seven ports along the South African coastline (Transnet Port Terminals, 2022). Therefore, it is essential to improve the reliability and efficiency of port operations through holistic business innovations and cost-reduction strategies.

On a global scale, ports are associated with maritime trade, locations from and to which cargo is transported via ships (Henesey, 2006). Ports are process-driven, focusing on delivering specified services rather than tangible products. According to Mazibuko (2020), port operations aim to maximise efficiency by minimising vessel turnaround time, achieving optimal economic utilisation, and enhancing environmental sustainability through energy consumption reduction strategies. Services must be performed on agreed-upon dates and meet all service-level agreements.

However, competition is intensifying as the operational environment evolves. Having the right equipment is no longer sufficient (Mazibuko, 2020). Organisations must leverage the use information and communication technology (ICT) to integrate systems, analyse available data, and make predictions that optimise port activities. Technology innovations can fast-track the process of automation and transforming the cargo industry by offering enhanced supply chain tools including the efficient shipping processes that add value to the logistics chain. ICT plays a pivotal role in driving transformation and implementing digitalisation (Choi & Park, 2020; Wang & Pettit, 2016). Digital supply chain software tools are becoming faster, more agile, and more intelligent, enabling the creation of tailor-made products and services.

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1.2 Background

SA is ranked 19th according to a report by the World Bank, which utilises the latest global Logistics Performance Index (LPI) to gauge countries' trade and logistics performance (Freightnews, 2023). Productivity, efficiency, cost, and competitiveness are considered when assessing performance (Misra, 2021). Therefore, the ever-changing business environment of the ports requires advanced technological innovation to increase competitiveness. High visibility across the value chain can be achieved with automation as trade with the global market is predominantly conducted via seaports in SA (Thomas, 2018). Globally, approximately 80% of cargo by tonnage is transported by sea-going vessels, with the remaining 20% utilising land-based modes, including airline transportation (Transnet SOC Ltd, 2016).

SA's ports are state-owned enterprises (SOE) managed by the Transnet National Ports Authority (TNPA), the landlord and sole provider of marine services across the eight commercial ports along the coastline (Transnet National Ports Authority, 2022). The TNPA owns the land Transnet utilises and has adopted a property owner model, leasing large tracts of land to private sector entities (Misra, 2021). These entities include companies related to the maritime sector, such as shipbuilding and ship repair companies, as well as those unrelated to maritime operations.

One of the TNPA's key improvement areas listed in the 2022 report is to digitise business processes to minimise manual processes and enhance general performance and security (Transnet National Ports Authority, 2022). Consequently, the port authority is responsible for making decisions regarding implementing digitalisation, automation, and port system regulation (Sithole, 2022). Therefore, this research, focuses on the port of Richards Bay, specifically investigating the lack of automation of operational processes within the port terminal. Richards Bay has two terminal operators: TPT, owned by Transnet, and the Richards Bay Coal Terminal (RBCT), privately owned (Department of Transport, n.d.; Richards Bay Coal Terminal, 2022; Transnet SOC Ltd, 2016).

1.3 Research Problem

The research problem is the most difficult and important part of the research process, constructed to depict the nature of the problem and leads to the need for a study (Creswell, 2009; Ellis & Levy, 2008; Kerlinger & Lee, 2000). In this study, the primary research problem is identified as the insufficient automation of operational processes within port terminals. This

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study identifies the insufficient adoption of automation within the operational processes at Richards Bay Port, South Africa's largest bulk port, as a significant problem impacting operational efficiency.

Evidence from the 2022 Transnet Port Terminals (TPT) report indicates that Richards Bay Port has been underperforming due to multiple challenges, including ageing infrastructure and equipment, adverse weather conditions, and fire incidents in 2021, all of which have disrupted service delivery (Transnet Port Terminals, 2022). In addition, industry representatives have highlighted the port's lack of real-time visibility and inadequate systems for monitoring traffic volumes, which hinder effective management of truck congestion (Pillay, 2023).

While partial automation has been implemented, it remains insufficient, contributing to operational challenges and limited visibility across the supply chain. These issues collectively affect the port's efficiency and throughput. However, it is important to recognise that factors such as economic fluctuations, port management practices, labor relations, and infrastructure constraints also significantly influence operational performance (Transnet Port Terminals, 2022; National Ports Authority, 2023).

1.4 Research Objectives

The primary objective of the study is to identify factors that affect the automation of the operational processes at the port terminal. There is lack of adoption of technology by the port to improve and fast track operational processes. The secondary objectives are:

- To determine the current challenges and limitations that influence the adoption of automation in port terminals in Richards Bay.
- To analyse technological factors that influence the adoption of automation and the use of ICT in the port of Richards Bay.
- To analyse organisational factors that influence the adoption of automation in the port of Richards Bay.
- To analyse environmental factors that influence the adoption of automation in the port of Richards Bay.
- To recommend possible solutions to address factors affecting port terminal automation in Richards Bay to achieve efficient and effective operations.

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The above objectives are intended to guide the exploration and understanding of the research problem, as well as to clarify the study's purpose. These objectives will be operationalised through the following research questions (Ellis & Levy, 2008).

1.5 Research Questions

The following research questions were formulated to address the research problem and leverage the relevant literature to achieve the study's objectives. The primary research question is: What are the factors that hinder the adoption of automation to enhance the operational processes in Richards Bay terminal port? The secondary research questions are:

- What are the current challenges and limitations that influence the adoption of automation in port terminals in Richards Bay?
- What are the technological factors affecting the adoption of automation in the port terminals in Richards Bay?
- What are the organisational factors affecting the adoption of automation in the port terminals in Richards Bay?
- What are the environmental factors affecting the adoption of automation in the port terminals in Richards Bay?
- What recommendations can be implemented to accelerate automation in Richards Bay?

1.6 Scope Of The Study

This study explores the factors hindering the adoption of automation at the Port of Richards Bay, South Africa's largest bulk port. Richards Bay was selected due to its unique operational profile. The port is specifically designed to handle goods exclusively transported by rail, setting it apart from other rail-based ports such as Saldanha, Durban, and Gqeberha. Its complex logistics, infrastructure constraints, and strategic role in coal exports make it a compelling case for examining automation challenges in port environments.

The study is framed within the broader context of South African ports, many of which face systemic issues such as outdated infrastructure, limited digitisation, and operational inefficiencies. According to a 2022 report by Transnet Port Terminals, Richards Bay Port has experienced ongoing performance challenges, including excessive train turnaround times, delays in truck processing, and disruptions from equipment failures and adverse weather

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conditions (Transnet Port Terminals, 2022). These issues underscore significant potential in exploring automation in the ports.

The research was conducted over twelve months (January–December 2024) and involved 13 participants from key departments, i.e., Supply Chain, ICT, Value and Delivery, and Continuous Improvement. Their insights provide a practical understanding of the adoption challenges. The study is underpinned by the Technology-Organisation-Environment (TOE) framework, which provides a comprehensive lens for analysing how internal and external factors, including technological readiness, organisational capacity, and environmental pressures, impact the implementation of automation technologies in port settings.

By focusing on Richards Bay, this research aims to generate findings that are not only locally grounded but also applicable to other South African ports facing similar automation challenges.

1.7 Contribution Of The Research

This study explores the factors influencing the adoption of automation at Richards Bay Port, with particular emphasis on its unique role as a port designed to handle goods exclusively transported by rail. By focusing on this specific operational context, the research extends the current understanding of port automation beyond what has been addressed in previous studies. It contributes to the existing body of knowledge by identifying both challenges and opportunities related to automation implementation in port terminals. These insights have practical implications for improving operational efficiency and reducing costs, potentially benefiting similar port environments facing comparable issues.

1.8 Theoretical Concept Definitions

According to Creswell (2014), defining key concepts or terms used in research helps the reader to understand the context in which they are applied. Therefore, the key concepts utilised predominantly in this study are defined as follows:

- ICT – utilising technology to enhance organisational processes and efficiencies (Botti et al., 2017; González et al., 2020).
- Industry 4.0 – the Fourth Industrial Revolution (4IR), driven by digitisation and characterised by the use of disruptive technologies and the Internet to increase competitiveness and sustainability (Sithole, 2022).

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- Logistics 4.0 – supports Industry 4.0 by digitising logistics systems, processes, and activities from production to distribution (Radivojević & Milosavljević, 2019).
- Smart Ports – advanced ports that leverage technology to drive digital transformation and enable real-time monitoring of information flows, including inventory management, physical elements, and transaction transparency, as processes and activities are automated and interconnected throughout the network (Al-Fatlawi & Motlak, 2023; González et al., 2020; Heikkilä et al., 2022; Radivojević & Milosavljević, 2019).
- Automation – utilising technology to minimise human input while increasing operational efficiencies (Al-Fatlawi & Motlak, 2023; Bottalico, 2022; Sithole, 2022).
- Robotics – utilising robots to perform human activities (Heilig et al., 2017).

1.9 Thesis Structure

This study comprises five chapters. Chapter One introduces the study. It explains the background, research problem, research objectives, research questions, research contributions, and definitions of key concepts to provide an overview of the investigation. Chapter Two, the literature review, provides a comprehensive insight into automation to highlight its benefits in addressing port inefficiencies. Chapter Three, research methodology, details the research methods and design used for the study, including the theoretical framework. Chapter Four presents the research findings and interpretation. Chapter Five concludes the study by providing recommendations and conclusions.

1.10 Conclusion

This chapter has set the foundation for the study by outlining the background and context of automation challenges at Richards Bay Port. It has identified the core research problem, stated the objectives and research questions, and explained the significance and scope of the investigation. By framing the study within the broader challenges faced by South African ports, this chapter has established the rationale for focusing on automation adoption. The next chapter will build on this foundation by reviewing relevant literature to deepen the understanding of the factors influencing automation in port operations.

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Chapter 2 - Literature Review

2.1 Introduction

This study focused on identifying current issues and future opportunities in adopting automation for port terminals in Richards Bay and the innovative smart port strategies that can assist in alleviating the current turnaround challenges, congestion, delays, and system inefficiencies. Relevant literature from various scholars was reviewed to gain insight into port automation to improve efficiency and reduce operation costs to meet the research objectives. The Fourth Industrial Revolution (4IR) has transformed the maritime industry through disruptive technologies and the Internet, increasing ports' competitiveness and sustainability (Sithole, 2022). As a result, ICT has enabled smart and intelligent ways of conducting business by implementing new business models that drive the integration of systems, processes, and data. When implemented correctly, technology can enable ports to reduce costs, improve performance, and enhance decision-making through predictive analytics, which helps forecast future events (Mukomana, 2018), transitioning from reactive to proactive responses to meet demand.

2.2 Port Inefficiencies

Ports face numerous challenges, as they cannot keep up with demands or take advantage of all production and activity opportunities, resulting in financial losses (Sinay, 2021). Ports cannot plan adequately without technology, as there are no real-time updates or visibility of vessel delays. According to Misra (2021), supply chain companies at the Durban port have complained about the high costs of doing business with the port. The financial implications of delays include paying truck drivers overtime; these drivers spend long hours in unhealthy conditions waiting to pick up containers, resulting in late deliveries (Misra, 2021).

Port infrastructure remains a critical concern, as many ports in developing regions struggle to accommodate larger vessels and rising cargo volumes, often resulting in congestion and the loss of business opportunities (International Association of Ports and Harbors, 2018; Sinay, 2021). Beyond trade facilitation, ports now face a wide range of operational and strategic challenges, including regulatory compliance, safety and security, environmental sustainability, and digital transformation (Lam & Notteboom 2014; Notteboom & Rodrigue 2021; Sinay 2021). These multidimensional pressures highlight the evolving role of ports as complex logistics hubs that require integrated governance and innovation strategies.

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In the African context, port inefficiencies are often linked to systemic issues such as inadequate infrastructure, high truck volumes, long waiting times, and weather-related disruptions (Gidado, 2015; Misra, 2021. In South Africa, the National Development Plan (NDP) 2030 emphasises the need to introduce technology, such as digitalisation and automation, in a way that considers both economic and social development imperatives (Sithole, 2022). Given the country's high unemployment rate of 32.6% (Trading Economics, 2023), technology adoption in ports must be approached cautiously to ensure it does not exacerbate job losses, but instead supports job creation through new roles, upskilling, and increased operational efficiency. Addressing skills shortages and aligning port strategies including labour planning with digital and automation goals is therefore critical. This alignment should be supported by continuous assessment and refinement of relevant policy and legislative frameworks (Mukomana, 2018; Sithole, 2022).

2.3 Disruptive Technologies

Disruptive technologies defined as innovations that alter the foundations of competition by introducing new performance dimensions and enhancing overall competitiveness play a critical role in reshaping port operations (Danneels, 2004). These technologies include the Internet of Things (IoT), big data analytics (BDA), data visualisation, cloud computing, radio frequency identification (RFID), sensors, blockchain, information security systems, robotics, artificial intelligence (AI), machine learning, and virtual and augmented reality (Mukomana, 2018; Notteboom & Rodrigue, 2021; Sinay, 2021). When implemented effectively, such technologies enable ports to reduce operational costs, improve performance, and strengthen decision-making capabilities through predictive analytics, thereby shifting from reactive to proactive operational strategies (Mukomana, 2018). According to Mukomana (2018), disruptive technologies create business value by transforming end-to-end processes in production, logistics, and distribution, while also supporting innovation in underlying business models. These tools serve as enablers of port automation and digital transformation and are explored further in the subsections that follow.

2.3.1 Information And Communication Technology

Information and communication technology (ICT) enables intelligent business practices by implementing new business models and integrating systems, processes, and data. ICT ensures seamless information flows and process integration, promoting visibility and transparency

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(Mukomana, 2018; Misra, 2021; Sithole, 2022). The results include cost reductions, improved customer service, and shorter lag times (World Bank, 2021).

ICT introduces a shift in digital technology. For example, wireless networks, mobile devices, and positioning technologies such as GPS contribute to infrastructure development for daily operations in ports and logistics environments (Rodrigue & Notteboom, 2020). Numerous business models and logistics strategies rely on ICT to enhance performance, responsiveness, and customer satisfaction (Heilig, Schwarze, & Voss, 2017).

Traditional supply chains have evolved to integrate Industry 4.0 technologies such as automation, the Internet of Things (IoT), and advanced analytics, enabling smarter decision-making and real-time process management (Bibby & Dehe, 2018; Hofmann & Rüsch, 2017). However, in many port environments, fundamental processes are still managed using whiteboards, spreadsheets, or paper-based systems, which hinders efficiency and increases the risk of human error (Heilig et al., 2017; Padayachee & Mukomana, 2019).

In contrast, real-time visibility into operations—enabled by ICT tools—allows companies to monitor inventory levels, track shipments, analyse data, reduce lead times, and respond dynamically to market demand (UNCTAD, 2020). Without a strong ICT foundation, the implementation of such capabilities remains limited, exacerbating the challenges already faced by ports in developing economies (Misra, 2021; Sithole, 2022)..

2.3.2 Industry 4.0

According to Radivojević & Milosavljević (2019) and Sithole (2022), technologies such as big data, IoT, AI, drones, wireless sensor networks, robotics and automation, cloud computing, blockchain, augmented reality, and autonomous vehicles drive ports towards digital transformation with the intelligence to integrate manufacturing and industrial processes. These technologies enable seamless integration, real-time decision-making, operational visibility, robustness, agility, flexibility, enhanced operations, improved performance, and increased competitiveness (AL-Shboul, 2023; Misra, 2021; Mukomana, 2018; Okwu et al., 2020; Sithole, 2022). The global supply chain has been revolutionised by Industry 4.0, enhancing production efficiency and optimising distribution networks (Okwu et al., 2020). Traditional supply chains have adapted to Industry 4.0 technologies. Advanced ports, such as Rotterdam and Antwerp, employ digital solutions for container operations, while approximately 80% of ports still rely

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on manual systems prone to errors and inefficiencies (Heikkilä et al., 2022). For example, whiteboards or spreadsheets are used to manage the most fundamental processes.

2.3.3 Logistics 4.0

Logistics 4.0 supports Industry 4.0 by digitalising systems, processes, and activities from production to distribution (Radivojević & Milosavljević, 2019). Real-time visibility into operations allows companies to monitor inventory levels, track shipments, analyse data, reduce lead times, and respond to changing demands. Ports, as logistics and supply chain hubs, rely on digital innovation to reduce costs, increase efficiency, and enhance security and sustainability (Heikkilä et al., 2022). According to Talwar et al. (2021), traditional supply chains must adapt to emerging technologies that will help improve the integration of processes while driving analytical capabilities to remain relevant and competitive. Possible future benefits of Logistics 4.0 are decreased transportation and communication costs (Munholland, 2016). Emerging technologies improve process integration and analytical capabilities, driving economic growth, market entry for new stakeholders, and operational effectiveness.

2.3.4 Smart Ports

Smart ports automate and interconnect processes throughout the logistics network to enable digital transformation, allowing real-time monitoring of information flows, improved inventory management, and enhanced transaction transparency (González et al., 2020; Heikkilä et al., 2022; UNCTAD, 2020). These ports are designed to be adaptive and agile, leveraging emerging technologies and innovative business models to respond effectively to shifting global demands (Al-Fatlawi & Motlak, 2023; Sinay, 2021).

Smart ports are defined as ports that leverage Industry 4.0 technologies—including IoT, big data analytics, cloud computing, AI, data visualisation, and blockchain—to optimise operations, reduce costs, and enhance safety (Al-Fatlawi & Motlak, 2023; Heikkilä et al., 2022; Radivojević & Milosavljević, 2019; Sinay, 2021). Port evolution reflects this progression, from mechanical ports in the 1940s, container ports in the 1960s, and EDI ports in the 1980s to Internet-enabled ports in the early 2000s and now smart, interconnected ports in the 2020s (Mukomana, 2018).

The Port of Hamburg serves as a leading example, where digital transformation has been implemented in strategic phases by the Hamburg Port Authority (HPA), focusing on the

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integration of digital infrastructure to streamline traffic, cargo handling, and environmental management (Heilig, Schwarze & Voss, 2017; HPA, 2022). Infrastructure remains pivotal to enabling efficiency in these smart environments, providing the backbone for integrated, data-driven decision-making.

2.3.5 Automation

According to Goldberg (2012), automation has great impact on the world economy, from being viewed as the workhorse in manufacturing to being implemented in other sectors like healthcare, security, transportation, agriculture, construction, energy and more. Automation focuses more on efficiency, quality, productivity and reliability as systems operate autonomously in structured environments (Goldberg, 2012). In a smart port, automated processes replace manual operations, for example, utilising automated, electrically guided transport platforms instead of traditional trucks (Al-Fatlawi & Motlak, 2023). Port terminals adopt automation to enhance efficiency and productivity. In Germany, the Port of Hamburg implemented automation in the container handling terminal (Hamburger Hafen und Logistik AG - HHLA Container Terminal Altenwerder). It introduced state-of-the-art technology and an electronic data processing (EDP) system to discharge and load large container ships, maximising efficiencies. This automation includes twin lift container gantry cranes, automated guided vehicles, automatic stacking cranes, and an automated control system (Mukomana, 2018). Automated stacking cranes (ASC) are rail-mounted cranes within a terminal utilised to stack and transport containers, providing cost-effective operations by optimising high stacking utilisation. Automated guided vehicles (AGVs) are self-guided vehicles used to transport containers. They are guided by software and sensors to navigate and manage cargo in the terminal (Mukomana, 2018). Therefore, automation optimises port operations and reduces delays and inefficiencies by adopting business intelligence (Mazibuko, 2020). Automation through technology optimises terminal operations, maintenance, and competitiveness (Heikkilä et al., 2022).

2.3.6 Robotics

Robotics incorporates sensors and actuators on systems to drive autonomous or semi-autonomous operations with human cooperation (Goldberg, 2012). According to Harbi (2021), implementing crane robotics can reduce human intervention while increasing workplace safety. Therefore, robotics optimises terminal equipment to enhance competitiveness (Goldberg,

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2012). Numerous container terminals have automated gate operations through robotics (Harbi, 2021). The technology is focused on intelligence and adaptability under unstructured environments (Goldberg, 2012).

2.4 Previous Studies

The literature suggests that globalisation has contributed significantly to the rising flow of goods and trade among countries, thereby placing increasing pressure on port operations (Notteboom & Rodrigue, 2021; UNCTAD, 2020). As a result, cargo and vessels remain at ports for longer durations, leading to operational inefficiencies (Gidado, 2015; Mazibuko, 2020; Misra, 2021; Sithole, 2022).

Misra (2021) studied port congestion in Durban by addressing the innovation lag to identify challenges and highlight solutions to help improve efficiency. Misra (2021) asserts that the existing literature focuses on one stakeholder in the chain instead of assessing the entire port congestion issue; scholars typically focus on container terminals or truck congestion. This segmented approach, while useful for specific interventions, makes it more challenging to fully understand systemic inefficiencies or develop a comprehensive strategy for port management that encompasses both land-side and seaside operations (Misra, 2021).

A similar study by Padayachee and Mukomana (2019), focusing on 4IR, explored factors influencing port terminal automation in Durban. The authors found that technology has the most significant influence on automation (Padayachee & Mukomana, 2019); without adequate technology, the automation of port terminals is not possible. According to a study by Mazibuko (2020), automation is the most effective way for ports to move cargo more rapidly and reduce delays by utilising business intelligence. Therefore, Padayachee & Mukomana (2019), Mazibuko (2020), Heikkilä et al. (2022) agree that the use of technology could optimise terminal port operations, improve maintenance, and increase competitiveness.

Substantial sectors such as retail, automobile, and healthcare are investing in the use of big data (International Association of Ports and Harbors, 2018), where GSM (global system for mobile communications), GPS (global positioning system), and RFID (radio frequency identification) technologies are used to monitor operations remotely and provide real-time information, including temperature and location, to support decision-making and eliminate human errors from manual inventory checks (Knatz et al., 2022). However, Jiang et al. (2023) emphasise that port digitalisation is largely under-researched despite its increasing significance.

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Several ports have been highlighted for taking advantage of Industry 4.0 technologies. For instance, Rotterdam Port uses IoT for repair and maintenance (Sadiq et al., 2021; Sithole, 2022). Salerno Port is viewed as an integrated port supply chain (Botti et al., 2017). Durban Port began using drone and track-and-trace technology as part of a pilot project in 2016, forming part of the TNPA's plans to roll out smart ports (Sithole, 2022). Hamburg Port uses 3D printing applications (Kapkaeva et al., 2021; Sadiq et al., 2021; Sithole, 2022). Singapore Port uses cloud computing and big data, and Antwerp Port employs blockchain technology (Sadiq et al., 2021). In other use cases, sensors have been deployed in smart containers to collect data on geolocation, temperature, pressure, and more (Misra, 2021).

2.5 Benefits Of Automation

Automation aims to improve port supply chain management and logistics by implementing disruptive technologies that have the potential to increase competitiveness and efficiency by integrating operations, including transportation, storage, and container handling within the port terminal (Al-Fatlawi & Motlak, 2023; Misra, 2021; Mukomana, 2018; Sithole, 2022).

Automation contributes to improved operational performance, process visibility, cost efficiency, and reliability, as well as simplified cargo movement and faster container handling (Heikkilä et al., 2022; Misra, 2021). According to Sinay (2021) and the International Association of Ports and Harbors (IAPH, 2018), these technologies enable more responsive and intelligent logistics systems that improve throughput and reduce bottlenecks.

For example, smart ports automate and interconnect operations to enable real-time tracking, inventory monitoring, and better coordination between terminal stakeholders (Heikkilä et al., 2022). This promotes transparency and reduces dependency on manual intervention, which in turn enhances productivity and reduces turnaround times (Mukomana, 2018).

2.6 Conclusion

While various studies have explored automation and congestion management in African ports particularly in Durban (Misra, 2021; Mazibuko, 2020), there appears to be limited peer-reviewed literature specifically focused on automation adoption in Richards Bay Port, especially considering its unique operational model of exclusively accommodating cargo via rail.

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This study seeks to address that gap by investigating terminal and systemic inefficiencies at Richards Bay and assessing the role of disruptive technologies in improving operations. The focus is on understanding how automation may address these inefficiencies, while also acknowledging that broader factors such as infrastructure, labour, and policy, play significant roles in shaping outcomes (National Ports Authority, 2023; Transnet Port Terminals, 2022).

Consequently, the literature review highlights both the potential and limitations of automation in transforming South African ports into smart/intelligent hubs, offering a foundation for future research and policy development..

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Chapter 3 - Research Methodology

3.1 Introduction

This chapter presents the methodology employed in this study, describing the approach utilised to investigate the research questions and achieve the objectives stated in Section 1.4. The chapter further outlines key aspects such as the research instrument, sampling method, data analysis, validity, and reliability. The rationale for the selected research paradigm and design is explained, including the appropriateness of the chosen methodology.

3.2 Research Methodology

Research methodology is a systematic approach to addressing a research problem using various techniques to identify and analyse information (Bouchrika, 2024; Leedy & Ormrod, 2015). The end goal is to interpret the collected data and draw conclusions. This study adopted a qualitative approach, guided by the interpretivist paradigm, and employed mixed data collection techniques, including questionnaires and interviews. The subsequent sections detail the research philosophy, approach, strategy, data collection methods, and data analysis procedures

3.2.1 Research Onion

This study adopted the research onion model to develop its methodology and construct research design techniques. The model, originally proposed by Saunders, Lewis, and Thornhill (2019, p. 128), consists of six key layers, guiding researchers through philosophical positioning, research approach, design, and data techniques. The outer layers consist of the research philosophy and approach, the middle layers include methodological choice, research strategy, and time horizon, and the core involves data collection and analysis (Tengli, 2023). Given the focus and scope of this study, the model was adapted and illustrated in Figure 3.1 to suit the context and structure of this research.

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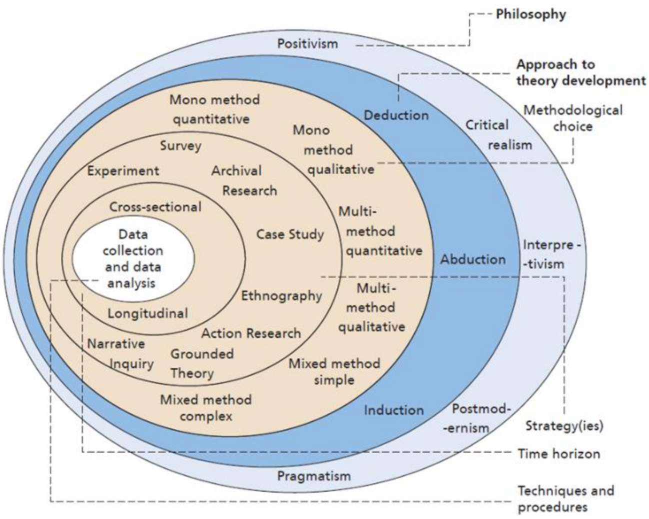

Figure 3.1: Adapted Research Onion Model (Developed by the Researcher, based on Saunders, Lewis & Thornhill, 2019, p. 128)

Positivism, realism, interpretivism, and pragmatism are the research paradigms in the research onion. A paradigm is a set of theories, assumptions, and ideas through which a viewpoint of the world is constructed (Babbie, 2010; Dissanayake, 2023; Rahi, 2017). Understanding these paradigms assists researchers in selecting appropriate research approaches (Mukomana, 2018). Positivists favour the scientific method of generating knowledge, while interpretivists prioritise deep interpretation of the subject to obtain understanding (Mukomana, 2018; Rahi, 2017). The pragmatism paradigm utilises a mixed-method approach, combining elements of qualitative and quantitative research, while realism provides an objective perspective to ascertain the truth (Creswell, 2009; Saunders et al., 2019).

3.3 Research Philosophy

A qualitative, exploratory research is selected as the best method in this study. Therefore, this study will take on the qualitative approach that is accompanied by an interpretivism philosophy (Rahi, 2017; Saunders et al., 2019), to allow the researcher to explore factors that hinder port terminal automation in Richards Bay by obtaining a deep interpretation of the subject through understanding and true knowledge of the concept from targeted respondents' perspectives and experiences.

3.4 Research Approach

The research onion illustrates two primary study approaches: the deductive and the inductive approach. The deductive approach tests existing theories through hypothesis testing and

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follows a more structured framework (Sukamolson, 2007). In contrast, the inductive approach involves gathering rich qualitative data through observation and interaction, enabling the development of new theories grounded in participants' lived experiences (Rahi, 2017)..

This study adopts an interpretivist paradigm, aligned with an inductive approach, which focuses on understanding the subjective meanings, experiences, and social contexts of participants in port operations. Unlike positivism, which assumes an objective reality, interpretivism recognises the complexity of human behaviour and seeks to interpret how individuals make sense of their environment (Park et al., 2020). Therefore, this study emphasises exploring participants' perspectives to develop an in-depth understanding of the factors influencing automation adoption in port terminals.

3.5 Theoretical Framework

The existing theory that underpins the study is technological, organisational, and environmental (TOE) framework employed to explore factors affecting port terminal automation in Richards Bay.

The TOE model integrates internal and external factors in analysing adoption processes, making it more comprehensive and suitable for this study compared to the diffusion of innovations (DOI) theory, unified theory of acceptance and use of technology (UTAUT), and socio-technical systems (STS) theory, as these models do not fully capture organisational and environmental factors (Ahmad, 2014; Minishi-Majanja & Kiplang'at, 2005). The TOE model developed in 1990 by Tornatzky and Fleischer explains technology adoption in organisations and describes how adopting and implementing new technological innovations is influenced by the technological, organisational, and environmental contexts Gholami et al., 2018; Joubert & Jokonya, 2021; Tornatzky & Fleischer, 1990).

Figure 3.2 below displays the TOE framework chosen for this study to understand the factors influencing the adoption of automation in port terminals.

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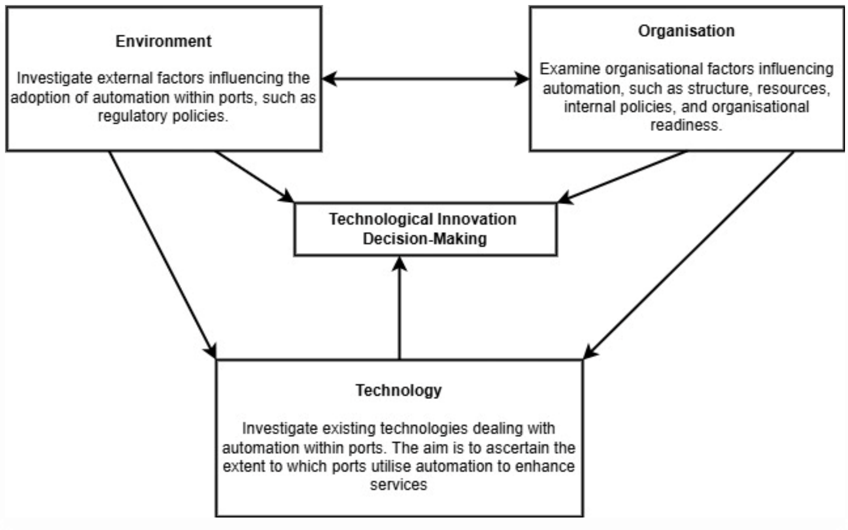

Figure 3.2: TOE Framework (Tornatzky and Fleischer, 1990)

The technological context focuses on the organisation to encompass internal and external technologies, while size, scope, and management structure describe the organisational context (Joubert & Jokonya, 2021; Solomon, 2018). The environmental context addresses how the organisation responds to changes, particularly in the external environment (Bhattacharya & Wamba, 2015). This framework is ideal as it assists organisations in improving process efficiency and supports understanding automation adoption in port terminals (Padayachee & Mukomana, 2019). Understanding these factors is crucial for the successful adoption of technologies by ports to transition to smart ports.

3.6 Research Strategy

This research presents a case study of Richards Bay, exploring factors hindering port terminal automation. Yin (2014) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context" (p. 16). The research for this case study was exploratory, studying the problem in depth to determine its nature, gain a better understanding and clarity, seek new insights, and assess the phenomenon in a new light (Saunders et al., 2009; Yin, 2014). According to Saunders et al. (2009), exploratory research is flexible and adaptable, requiring the researcher to be open to changing directions when presented with discoveries.

3.6 Research Method

A qualitative, exploratory research design was deemed the most suitable method for this study to allow the researcher to explore, understand, and gain insights from data as in-depth details

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on the topic are collected. Qualitative research is, therefore, defined as an approach concerned with understanding and interpreting social phenomena through human experiences, attitudes, opinions, and behaviours (Creswell & Poth, 2018). Such a study seeks to gain a deep and holistic understanding of a subject by collecting nonnumerical data and interpreting the meaning of data. According to Kothari (2004), qualitative research includes interviews, observations, surveys, questionnaires, focused groups, case studies, and life history as people's experiences are explored in detail to help identify issues and understand meanings and interpretations (Hennink et al., 2020; Rahi, 2017). Qualitative research is a flexible method that can be changed and conducted at minimal costs. However, it is subjected to bias as a result, the accuracy of data, needs to be considered as sample data may not represent or reflect the targeted population (Kothari, 2004).

3.7 Time horizon

Cross-sectional and longitudinal studies are the two primary types of time horizons to consider when conducting research. A longitudinal approach involves collecting data over an extended period to observe changes and trends, whereas a cross-sectional study is an observational design conducted at a single point in time (Babbie, 2010; Mukomana, 2018). This study employed a cross-sectional research design, which is particularly suitable for exploratory and descriptive research aimed at understanding the current state of phenomena within a defined population (Babbie, 2010). The cross-sectional approach allows for the efficient collection of data from a representative sample, providing a snapshot of the variables of interest without the complexity and resource demands of longitudinal studies. Given the study's objective to assess terminal and system inefficiencies at a specific point in time, this design enables timely and practical data collection and analysis while maintaining scientific rigor.

3.8 Study Site

This research was based on Richards Bay, a port handling a substantial portion of SA's bulk minerals (Transnet National Ports Authority, 2022). The focus was on the TNPA and TPT. The Port of Richards Bay, located on SA's east coast, is one of the country's largest ports. It serves as the primary hub for coal exports and handles a variety of dry bulk and break-bulk cargoes. Figure 3.3 below is an aerial view of the port, which covers 2,313 hectares, making it the largest port in Africa by land area with the deepest port entrance on the continent.

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Figure 3.3: Richards Bay Port (extracted from Transnet Port Terminals, 2013)

Figure 3.4 below displays berths 609 to 704, 801, and 804, accompanied by the commodities handled at these berths, including magnetite, chrome, coal, mineral sands, woodchips, alumina, coking coal, and sulphur. The capacity is approximately 22.5 million tons per annum (Transnet Port Terminals, 2013).

Figure 3.4: Richards Bay Port Terminals (extracted from Transnet Port Terminals, 2013)

3.9 Target Population

The population for this study comprised employees of the TNPA, TPT, and other operational divisions (ODs), including the supply chain, ICT, value and delivery, and continuous improvement. The targeted employees have extensive knowledge and experience within the port industry.

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3.10 Unit Of Analysis

According to Kumar (2018), the unit of analysis includes individuals, groups, organisations, countries, technologies, and objects, from which the researcher collects data to answer the "what" and "who" questions being studied. Selecting the wrong unit of analysis could lead to incorrect conclusions about the research. The unit of analysis in this research was the organisation. Information was gathered from Transnet employees knowledgeable in container and port terminal operations, as they could provide insights into current system issues and tools utilised in the port terminals. The design of the questions was guided by the TOE model.

3.11 Sampling method

The study employed a purposive sampling technique involving non-random sampling based on the availability and expertise of the participants (Babbie, 2010; Leedy & Ormrod, 2015). The selected participants enabled the researcher to make inferences about the organisation's adoption of automation. Primary data was collected from Transnet staff through a questionnaire and a semi-structured interview. The questions were guided and categorised according to the TOE framework. A purposive sampling technique was used, involving non-random sampling based on participants' availability and expert knowledge Babbie, 2010; Leedy & Ormrod, 2015). The researcher conducted 13 online questionnaires with participants possessing extensive port operation experience from the following operational divisions:

- TPT
- TNPA
- Other

The samples selected through the research strategies were expected to help make inferences about the organisation's adoption of automation.

3.11.1 Sample size

13 online questionnaires were administered with:

i. Top-level managers
ii. Middle-level managers
iii. Operational employees

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Participants were selected based on the data they could provide for the study. One online, follow-up, semi-structured interview was conducted, after which data saturation was attained.

3.12 Data Collection Methods

Data can be gathered utilising various methods and sources. Data collection tools include questionnaires, mail surveys, interviews, and focus group discussions (Babbie, 2010). In this study, data was gathered through an online questionnaire designed to identify initial themes or issues guided by the TOE model, using structured and unstructured questions via Google Forms. Further exploration was conducted through a follow-up, in-depth, semi-structured interview.

3.12.1 Interviews

The researcher adopted a case study design, with a follow-up semi-structured interview conducted to gain an enhanced understanding of factors hindering port terminals from adopting automation to optimise efficiencies. The follow-up interview was conducted online using Microsoft Teams. The interview was recorded and transcribed.

3.12.2 Questionnaire

Information was gathered from Transnet employees knowledgeable in port terminal operations. The questionnaire comprised structured and unstructured questions, guided and categorised according to the TOE framework. The use of questionnaires is associated with the survey strategy (Rahi, 2017; Saunders et al., 2007, 2009). The data was downloaded from Google Forms into an Excel spreadsheet to allow data to be organised and analysed.

3.13 Reliability And Validity Tests

According to Zohrabi (2013), there are various ways of boosting the validity and reliability of the data through different procedures to strengthen data dependability, trustworthiness, and interpretation. When researchers use a variety of instruments to collect data, it becomes important to evaluate the quality and acceptability of the research (Creswell,2014). To enhance trustworthiness, data were triangulated by comparing responses across participants and different question types. The qualitative data were analysed using thematic analysis to identify key patterns and themes (Braun & Clarke, 2006). The use of an online questionnaire allowed

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participants to respond at their convenience, which can improve the depth and authenticity of qualitative responses (Marshall & Rossman, 2016).

3.14 Data Analysis

Raw data were collected from participants through an online questionnaire consisting of both structured and unstructured questions, followed by an online semi-structured interview conducted until data saturation was reached. The Technology-Organisation-Environment (TOE) framework guided the categorisation and interpretation of the qualitative data.

Qualitative data analysis involved coding participants' open-ended responses and interview transcripts to identify meaningful patterns and themes. This process of coding, also known as content analysis, was used to reduce and organise the data, enabling a deeper understanding of the factors influencing the adoption of automation in port terminals (Bhattacherjee, 2012). The themes derived from this analysis provided insights into technological, organisational, and external/environmental factors impacting automation implementation. The integration of findings from the questionnaire and interview further enriched the understanding of these factors, ensuring a comprehensive exploration of the research objectives.

3.15 Assumptions And Limitations

Due to time and resource constraints, the research was limited to landside challenges. Covering a holistic view that includes landside and seaside challenges would pose significant difficulties. Obtaining information from Transnet can take time, with an estimated turnaround of 60 to 90 days (Misra, 2021).

3.16 Ethical Considerations

The researcher ensured that respondents were well informed about the study in advance, and consent was sought before conducting the interview. The study adhered to constitutional requirements by respecting respondents' privacy.

3.17 Conclusion

This chapter discussed the methodology applied in this study, including the research strategy, research design, data collection methods, data analysis techniques, and the plan for gathering, sampling, and processing data.

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Chapter 4 - Research Findings And Discussion

4.1 Introduction

This chapter presents the research findings derived from analysing the data collected through the questionnaire and a single follow-up semi-structured interview. This study focused on factors that hinder port terminal automation in Richards Bay. Although existing literature provides limited insight into current issues and future opportunities in port terminal automation, the data analysis revealed several themes guided by the TOE framework.

According to Kothari (2004), data analysis involves classifying and categorising data into groups through various operations such as coding, tabulation, and statistical inference. Therefore, the data analysis process requires the raw data collected by the researcher to be analysed systematically and grouped into smaller, purposeful, and usable categories.

4.2 Data Collection

An online questionnaire using the Google Forms application was administered to selected key respondents to collect raw data based on the depth of information they could provide and their extensive work experience in port operations. Additionally, an online interview was conducted using Microsoft Teams with a respondent from TNPA, who provided an overview of the research problem and highlighted how technology could enhance operational efficiency within the organisation.

4.3 Description Of The Sample Size

The purposive sampling approach was employed until data saturation was reached. Thirteen respondents (n =13, 100%) participated in the online questionnaire. Of these, two respondents chose not to answer the last two questions on organisational and environmental factors. Additionally, one respondent from the TNPA participated in the follow-up interview to provide in-depth knowledge of the research problem.

The sample structure of the study is depicted in Table 4.1 and Table 4.2 below. Four respondents were from TPT, representing the ICT, supply chain, and engineering departments. Two respondents were from the TNPA, working in the performance, continuous improvement, and supply chain departments. The remaining seven respondents were from other operational

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divisions, including ICT, procurement, supply chain, performance and continuous improvement, and central category management departments.

Table 4.1: Sample Structure Of Respondents

Sample Structure			
Segment of key respondents categorised by operational division	**Number of key research respondents**	**Frequency**	**Percentage**
TPT	Four members from the ICT, supply chain, and engineering departments	4	30.8%
TNPA	Two members from the performance and continuous improvement and supply chain departments	2	15.4%
Other	Seven members from ICT, procurement, supply chain, performance and continuous improvement, central category management departments	7	53.8%
Total		**13**	**100%**

Table 4.2 below depicts respondents' work experience in port operations. Their years of experience are distributed as follows: 38.5% (n=5) have 15 or more years of experience, 38.5% (n=5) have between 10 and 15 years of experience, and 23% have less than five years of work experience. The respondents comprised 15% (n = 2) executive managers, 54% (n = 7) senior managers, and 31% (n = 4) junior managers.

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Table 4.2: Participants

Research Respondents (RR)	Position	Less than 5 Years	5 - 10 years	10 - 15 years	15 years and more
RR 1	Senior Manager			☑	
RR 2	Senior Manager				☑
RR 3	Senior Manager			☑	
RR 4	Senior Manager	☑			
RR 5	Executive Manager				☑
RR 6	Senior Manager			☑	
RR 7	Senior Manager				☑
RR 8	Junior Manager	☑			
RR 9	Senior Manager				☑
RR 10	Junior Manager			☑	
RR 11	Executive Manager				☑
RR 12	Junior Manager	☑			
RR 13	Junior Manager			☑	
	Total	**23%**	**0%**	**38.5%**	**38.5%**
	Accumulative	**23%**	**23%**	**61.5%**	**100%**

4.4 Demographics Data

Demographic data were collected to provide contextual information about the participants and to support the interpretation of qualitative findings. Understanding participants' backgrounds, including gender, age, and professional roles to offer insight into the diversity of perspectives represented in the study. While the sample size was too small to conduct meaningful statistical analysis or determine correlations between demographic factors and responses, the data help to situate the findings within the broader organisational and social context.

Given the qualitative nature of this study, the emphasis is placed on the depth and richness of participants’ experiences rather than on quantifiable comparisons between demographic groups. Therefore, the research respondents’ demographics included 69% (n = 9) males and 31 % (n = 4) females, as depicted in Figure 4.1.

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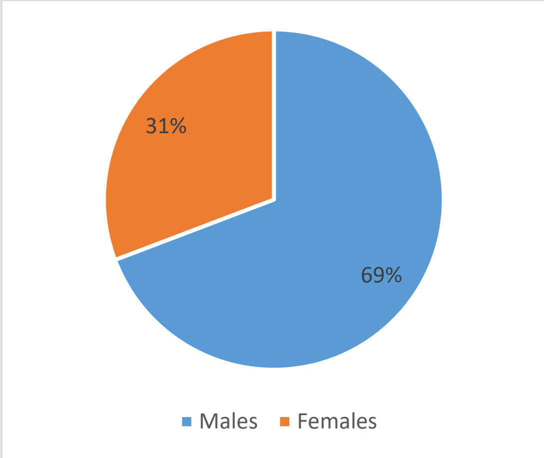

Figure 4.1: Gender

The age categories of the research respondents, as depicted in Figure 4.2, varied as follows: the 30 – 39 years category accounted for 38.5% (n = 5) of respondents, consisting of 23% (n = 3) males and 15% (n = 2) females. The 40 – 49 years category had the smallest sample size at 23% (n = 3), comprising 15% (n = 2) males and 8% (n = 1) females. The 49 years and above category represented 38.5% (n = 5), with 31% (n = 4) males and 8% (n = 1) female.

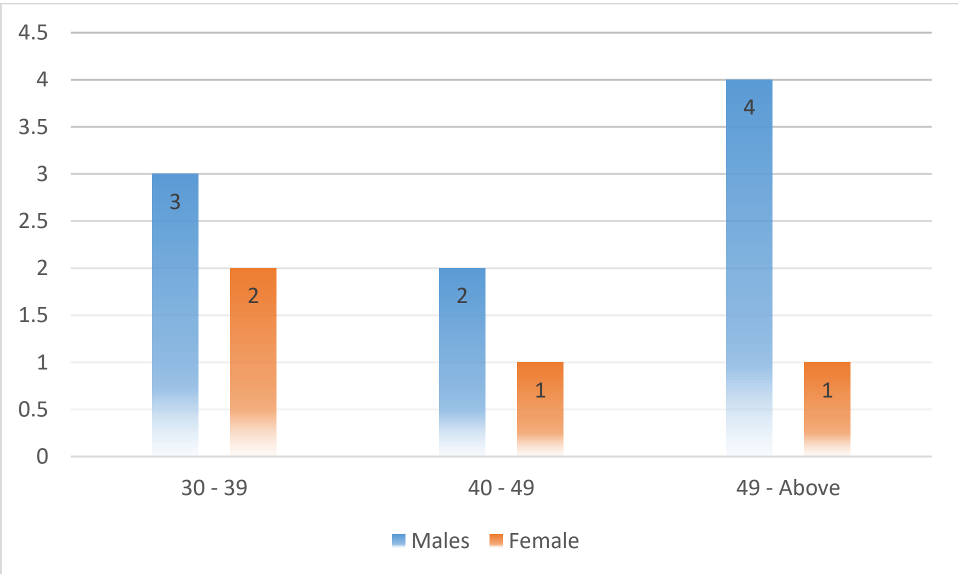

Figure 4.2: Gender By Age Group

Regarding qualifications, 8% (n = 1) of the respondents held a diploma, while 15% (n = 2) held bachelor's degrees. Most of the participants, 54% (n = 7), had honours degrees, and only 23% (n = 3) held master's degrees (see Figure 4.3 below).

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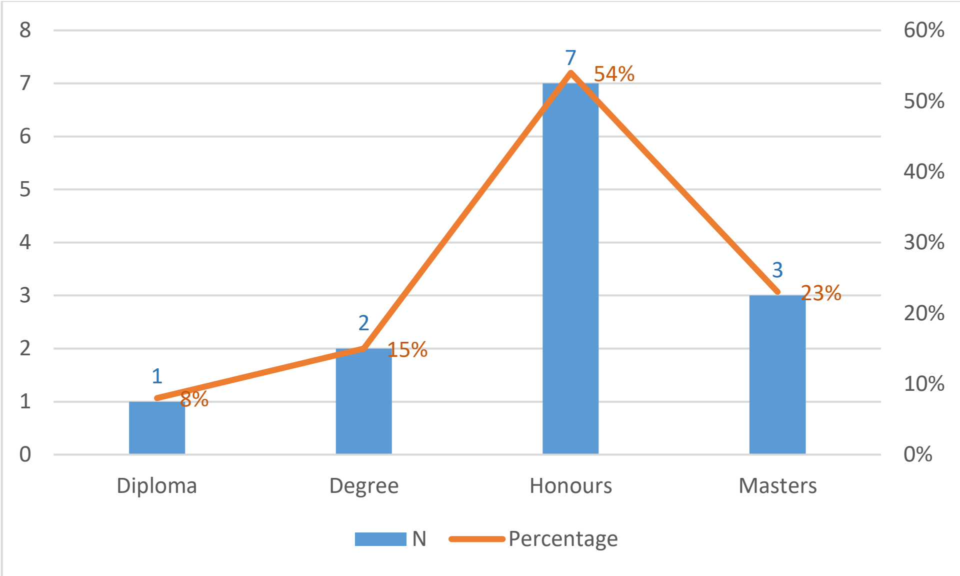

Figure 4.3: Level Of Education

4.5 Data Analysis

4.5.1 Data Transcription

The data collected from the online questionnaire and the follow-up interview were transcribed for analysis. Data from the questionnaire was downloaded into an Excel workbook and cleaned to correct transcription errors and improve accuracy. The interview was recorded and initially transcribed using Microsoft Teams. However, to ensure accuracy, the researcher manually transcribed the recording in Microsoft Word. In this research, coding was performed manually, categorising the data into themes guided by the TOE framework.

4.5.2 Themes

The themes presented in Table 4.3 were developed through an inductive thematic analysis of participants' responses to the following open-ended question in the questionnaire:

What are the current challenges the port is experiencing that hinders the adoption of automation?

This qualitative approach followed Braun and Clarke's (2006) six-step framework for thematic analysis. The process involved, familiarisation with the data, initial coding where segments of text that appeared relevant were manually coded, searching for themes, reviewing themes, defining and naming themes, and producing the report.

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Table 4.3: Themes Mentioned By Participants

				Participants														
No.	Category	Themes	Definition	RR 1	RR 2	RR 3	RR 4	RR 5	RR 6	RR 7	RR 8	RR 9	RR 10	RR 11	RR 12	RR 13	Frequency	Percentage
1	Organisation	Strategy	Lack of strategy to align with what needs to be prioritised to improve stakeholder engagements, processes, policies, procedures, and governance in rolling out automation			X		X	X		X		X	X			6	46%
2	Technology	Infrastructure/Technology	Transnet's ageing IT infrastructure/legacy equipments. Lack of technology to implement automation		X	X	X				X	X				X	6	46%
3	Organisation	Funding	Lack of funds and capital investment to automate	X	X			X		X	X						5	38%
4	Organisation	Skills	Lack of relevant technology skills /employee capability			X					X		X			X	4	31%
5	Organisation	Unions	Union fears that automation will replace human beings and lead to job losses							X		X		X	X		4	31%
6	Organisation	Leadership	New leadership with constant change of personnel to implement automation. Leadership that does not understand or does not know the port value chain					X		X		X	X				4	31%
7	Organisation	Organisational culture	Resistance to change and working in silos		X				X					X	X		4	31%
8	Organisation	Training	Lack of training/lack of well informed effective continuous improvement by terminal departments haunts the port					X								X	2	15%
9	External/Environmental	Politics/Government	External influence			X				X							2	15%
10	Organisation	Procurement process	The problem of delays and slow operation												X		1	8%

The theme "Procurement Process" was raised specifically by Participant RR12, who noted:

Slow procurement process in implementing new systems

Although only one participant mentioned this issue, it was included as a distinct theme due to its significance in the broader organisational context. The themes were analysed using the TOE framework. This analysis aimed to understand the current challenges and limitations to technology adoption and identify potential solutions. No new themes emerged after RR 12, so the data reflects the participants' explanations as provided in the questionnaire. Understanding these key themes is crucial for determining the critical factors influencing port terminal operations. Identifying these themes has clarified the areas that should dominate the discourse regarding implementing automation.

4.6 Research Findings And Research Propositions

The research findings in this study are based on participants' responses to the questions posed through the questionnaire and interview. Research propositions were developed based on these findings. A research proposition is a statement that predicts a relationship between two or more variables (Avan & White, 2001).

4.6.1 Technology

4.6.1.1 Open-ended results

The current challenges are reflected in the themes outlined in Table 4.3. The primary technology related factor is the lack of appropriate technology to drive automation adoption.

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From the open-ended responses, significant improvements and technological advancements are required in the port terminal. This includes the availability of adequate hardware and software to enable automation. Participants highlighted Transnet's ageing IT infrastructure, legacy equipment, and disintegrated systems. RR3 and RR4 further explained the lack of integration between old and new systems as follows:

"Systems are in silos with no integration."

In the follow-up interview, the lack of technology challenge is highlighted as follows:

"Technology at the port terminals is implemented in parts, for example, some parts of the terminals are automated where RBCT is privately owned, and most operations and processes are automated while TPT is yet to implement automation as the stockpile of minerals is done manually. There is a lack of visibility, and one can't track what's on the ground and what needs to be imported and exported"

These insights reflect a broader concern that technology within TPT is fragmented and insufficient to enable intelligent port operations.

4.6.1.2 Closed-ended results

The closed-ended survey results reinforce the qualitative findings. Using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), participants provided ratings on various technology-related statements. Given the small sample size, these results are interpreted descriptively rather than statistically. Mean scores for technology-related items ranged between 2.92 and 3.38, indicating that responses largely hovered around neutrality. This suggests no strong consensus among participants regarding the adequacy of the technological infrastructure.

The statement "The right infrastructure and equipment is deployed within the organisation to increase efficiency" received a mean score of 2.92, indicating slight disagreement, though still near neutral. Similarly, the statement regarding the presence of appropriate IT infrastructure and integrated systems scored a mean of 3.08, suggesting neutrality with a slight tendency towards disagreement. Notably, the statement "The existing technology can reduce operational costs and improve turnaround time" received a mean of 3.38, which, although closer to agreement, still falls within the neutral-to-slight-agreement range. Although the means fall

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within the neutral range, a review of the response distribution adds context, 46% (6 out of 13) of participants disagreed that the organisation has the necessary technology and infrastructure, 23% (3 participants) agreed and 31% (4 participants) remained neutral.

4.6.1.3 Integration of open-ended and closed-ended findings

Across both data sources, the lack of adequate technology and infrastructure emerged as a clear and consistent barrier to automation at TPT in Richards Bay. In the open-ended responses and interview, 46% of participants explicitly identified the absence of integrated systems and modern technology as a major challenge. This theme, "Lack of Technology/Infrastructure" is documented in Table 4.3.

The closed-ended findings align with this narrative. Although mean scores remained close to neutral, the tendency toward disagreement (particularly the 2.92 mean for infrastructure readiness) and the high percentage of participants expressing concern (46%) highlight a broader pattern of technological dissatisfaction. The slightly more favourable score (3.38) for operational efficiency suggests that some technologies may offer benefits, but they are not sufficient in scope or integration to fully enable automation.

This convergence of data underscores the importance of a robust technological foundation. Fragmented systems, ageing infrastructure, and lack of real-time visibility hinder the port's ability to transition to intelligent, automated operations. Therefore, technology plays a pivotal role in enabling automation. Based on these findings, the following research proposition (P) is suggested:

P1: If there is a lack of technology, it is unlikely that automation will be implemented.

4.6.2 Organisation

4.6.2.1 Open-ended results

Participants identified several organisational challenges that hinder the adoption of automation, as outlined in Table 4.3. These include a lack of strategic direction, insufficient funding, inadequate employee skills, limited training, resistance from labour unions, ineffective leadership, and issues with organisational culture. A common concern was that strategic

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initiatives are not well aligned with operational needs, leading to conflicting priorities and unclear direction. Several participants expressed frustration over a lack of investment to support automation, alongside a notable gap in digital and technical skills among employees. They also described existing training programmes as inadequate to prepare staff for the transition to automation. In addition, leadership instability was highlighted as a barrier to progress, with frequent management changes disrupting continuity in strategic planning. Participants also noted that departments often operate in silos, undermining collaboration and contributing to a fragmented organisational culture. Respondent RR9 captured this sentiment by stating:

"There is a lack of understanding of the organisation's needs, especially in operations."

Concerns were also raised by participants regarding labour unions, particularly in relation to potential job losses due to automation. These fears reflect broader anxieties about how digital transformation may affect workforce stability. Their responses provided valuable insights, indicating that automation could lead to the loss of employment and job redundancies.

4.6.2.2 Closed-ended results

The closed-ended responses further contextualise participants' views on organisational readiness. Using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), responses reflected a range of perceptions without clear consensus across most items.The statement *"The current departments and operational divisions are adequate to support port operations"* received a mean score of 3.62, indicating a slight tendency toward agreement, although still within the neutral-to-agree range. In contrast, the *statement "The organisation is positively perceived by external stakeholders"* received a low mean of 2.08, reflecting a clear tendency toward disagreement regarding the organisation's external reputation.

Most other items related to organisational readiness, leadership, training, and communication scored near the midpoint (between 2.80 and 3.20), indicating that participants generally neither strongly agreed nor disagreed with these statements. A closer examination of response distributions reveals additional insights, 8 out of 13 participants (62%) disagreed or strongly disagreed that the organisation is positively perceived by external stakeholders and 7 out of 13 participants (54%) agreed or strongly agreed that the current operational structure supports

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existing port functions. These proportions reflect the mixed but insightful perspectives of participants, and align with qualitative concerns around structure, leadership, and culture

4.6.2.3 Integration of open-ended and closed-ended findings

Organisational challenges emerged consistently across the data. Participants reported a range of internal issues, including lack of strategy (n = 6, 46%), insufficient funding (n = 5, 38%), inadequate skills (n = 4, 31%), labour union resistance (n = 4, 31%), limited training (n = 2, 15%), ineffective leadership (n = 4, 31%), and issues with organisational culture (n = 4, 31%).

The closed-ended responses support these findings by indicating general uncertainty or neutrality on most organisational items. However, there was a notable tendency toward disagreement regarding the organisation's external reputation (mean = 2.08), and moderate agreement about the adequacy of internal operational structures (mean = 3.62). These results reinforce the view that while basic organisational functions are maintained, deeper strategic, cultural, and leadership challenges remain. This analysis gave rise to the following research propositions (P):

P2: If the organisational structure is not coherent, it is unlikely that port automation will be realised.

A coherent organisational structure plays an essential role in implementing technology. In this context, "coherent" refers to organisational units or departments that work collaboratively rather than operating in silos. It also implies that key strategic initiatives aimed at driving digital transformation are supported by top management and communicated effectively throughout the organisation. This approach helps employees feel valued and included in the vision of making the organisation successful. Organisational culture is directly linked to the organisational structure.

P3: If there is a lack of leadership capable of driving digital transformation, the automation of ports is unlikely to be implemented successfully.

Poor management and frequent leadership changes will hinder the successful adoption of automation. These can result in delays and slow operations, as strategies often shift with each change in management.

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P4: If funding is insufficient, it is unlikely that the organisation will be able to implement automation.

Budget availability is essential for implementing automation. Capital investment funds are necessary for IT infrastructure upgrades, including systems, equipment, hardware, and software, as well as providing training budgets to upskill employees. Without sufficient funding, it would not be possible to scope the requirements for implementing automation or to train users effectively.

4.6.3 External/Environmental

4.6.3.1 Open-ended results

The current challenges are reflected in the themes outlined in Table 4.3. External environmental challenges emerged as a notable theme in participant responses, particularly in relation to political interference and government decision-making. Participants described the organisation as being under ongoing political scrutiny, which undermines its ability to operate with autonomy and focus.

Several respondents expressed concern that political actors, particularly those external to the organisation, often make decisions driven by profit motives or broader state interests that do not necessarily align with the operational or technological needs of the port. These decisions were seen as creating uncertainty and instability, with one participant pointing specifically to indecision and lack of transparency in government-related processes.

There was also concern that political interference may be contributing to delays in adopting necessary changes or reforms, particularly as the government continues to explore options related to privatisation. This introduces additional layers of complexity for long-term planning and automation implementation.

4.6.3.2 Closed-ended results

From the closed-ended responses, the one-sample t-test revealed that the research results are not statistically significant, as shown in Table 4.8. However, there is agreement, with a mean score of 3.31, that the organisation adheres to the National Ports Act 12 of 2005, and disagreement, with a mean score of 2.54, that the port adapts well to changes prompted by external pressure.

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4.6.3.3 Integration of open-ended and closed-ended findings

The closed-ended responses offer some additional perspective on participants' views regarding the port's responsiveness to its external environment. Using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), participants generally showed no strong agreement or disagreement with most external factor-related statements.

The statement *"The port adapts well to changes prompted by external pressure"* received a mean score of 2.54, reflecting a tendency toward disagreement, though not strongly expressed. In contrast, the statement *"The organisation adheres to the National Ports Act 12 of 2005"* received a mean score of 3.31, which falls within the neutral-to-slight-agreement range.

4.6.4 Discussion

4.6.4.1 Technology

According to Eveland and Tornatzky (1990), the technological context refers to innovations already in use within an organisation or those available externally but not yet adopted. In the context of this study, port terminal automation represents a technological innovation that remains largely underutilised. The findings from open-ended responses and follow-up interview revealed a shared concern among participants about the inadequacy of current technological systems at the port. A prominent theme was the lack of appropriate IT infrastructure, integrated systems, and automation tools necessary to support a digitally enabled and intelligent port environment.

Participants highlighted that existing systems are fragmented, often operating in silos without integration, which severely limits visibility across the value chain. This lack of end-to-end visibility hampers the ability of decision-makers to monitor operations in real time and respond effectively to operational demands. Specifically, participants pointed to the manual processes involved in the stacking and stockpiling of minerals as a clear example of inefficiency and missed opportunities for automation.

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These findings are supported by existing literature, which emphasises the critical role of information and communication technologies (ICT) in modernising port operations. For example, Misra (2021), Mukomana (2018), and Sithole (2022) argue that advanced ICT tools enable improved information flows, operational transparency, and faster decision-making through access to real-time data. The lack of such technologies at the port undermines not only daily operations but also long-term competitiveness and readiness for digital transformation.

The interviews further revealed that while some parts of the port (e.g., privately operated terminals like RBCT) have adopted automation technologies, Transnet Port Terminals (TPT) continues to lag behind. This creates inconsistency in operations and highlights broader organisational and infrastructural limitations.

In summary, the evidence suggests that the absence of modern technology, including integrated systems and real-time data tools, remains a significant barrier to automation implementation. Addressing this gap is essential for enabling the port to improve turnaround times, reduce costs, and operate more intelligently.

4.6.4.2 Organisation

Eveland and Tornatzky (1990) argue that organisational structure and internal processes play a crucial role in shaping the adoption of technological innovation. The finding aligns with the concept of organisational size, as discussed by scholars (Awa et al., 2017; Awa & Ojiabo, 2016; Eveland & Tornatzky, 1990; Picoto et al., 2021), which supports the implementation of technology. From the open-ended questions and follow-up interview, participants highlighted challenges related to a lack of strategy, organisational culture, including resistance to change when adopting new technology, and frequent leadership changes. Additional challenges mentioned by the participants included a lack of funding, insufficient skills, and the involvement of labour unions. The issue of labour unions is particularly noteworthy, as it reflects concerns about job losses resulting from automation. However, the literature review highlights the benefits of automation, including increased workplace safety. For example, introducing crane robotics reduces human intervention and enhances safety measures (Harbi, 2021).

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4.6.4.3 External/Environmental

An organisation with a sound culture, well-defined structure, appropriate size, and support from top management has the potential to adapt to external pressure and drive technological innovation (Eveland & Tornatzky, 1990; Nacu & Avasilcai, 2015). Participants highlighted that decision-making related to port operations is often influenced by government or political stakeholders who may lack a clear understanding of the operational and technological needs of the port. This misalignment between political priorities and operational realities was seen as a barrier to innovation. Additionally, ongoing conversations around privatisation were described as distracting and destabilising, further complicating long-term planning and investment in automation.

Although some participants acknowledged the organisation’s compliance with regulatory frameworks, such as the National Ports Act 12 of 2005, this adherence does not necessarily translate into agility or adaptability in response to changing external pressures. Instead, there was a sense that bureaucratic procedures and political oversight often slow down or obstruct transformation

4.6.4.4 Recommendations

From the open-ended responses, the participants recommended various solutions to fast-track technology adoption in the organisation. The proposed solutions included securing adequate funding, engaging stakeholders, recruiting skilled employees, ensuring leadership support, and developing policies and processes to enhance organisational efficiency. Therefore. the participants recommended the solutions presented in Table 4.10 to fast-track the adoption of automation within the port.

Table 4.10: Recommendations

Recommendations	Definition	Recommended by Participants
Upskilling & Technology	Employ individuals with appropriate skills and invest in technology. Train employees to utilise new equipment and technologies.	RR 1, RR 3, RR 4, RR 9, RR 11, RR 13
Stakeholder engagement	Outline the process, and relevant policies, standards, and Acts. Investigate all the problem areas to prepare the organisation for automation.	RR 1, RR 2, RR 5, RR 6, RR 7, RR 8
Leadership support	Secure buy-in from top management (leadership) to support automation strategies.	RR 1, RR 10
Funding	Provide funds to finance projects. Budget for adequate funding to implement automation and employ	RR 1, RR 2, RR 5, RR 6, RR 7, RR 8

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	transformation experts. Outsource to original equipment manufacturers (OEMs) or subject matter experts.	
Exclusion of external interference	Discourage political interference. The government must take the lead in optimising state entities and discouraging privatisation.	RR 3, RR 4, RR 9

4.7 Chapter Summary

The discussion of the research results addresses the research questions and objectives. This chapter identified the two terminal operators in Richards Bay: TPT (owned by Transnet) and RBCT (privately owned). The terminals are managed similarly by the TNPA. Although RBCT has already implemented technology to enhance efficiencies, TPT lacks the necessary technology to track the stacking and stockpiling of minerals accurately. There is disagreement, albeit not statistically significant, regarding the organisation’s readiness to fully automate its terminal operations.

The technological factors influencing the adoption of automation include the lack of appropriate technology, IT infrastructure, software, and integrated systems. Organisational factors include leadership, skills, funding, strategy, and the labour force. External or environmental factors include external factors such as political pressure and government interference. An interesting issue raised by a participant was the role of procurement processes. This factor warrants further investigation to understand its impact on technology adoption.

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Chapter 5 - Conclusions And Recommendations

5.1 Introduction

This chapter summarises the research findings and deduces their meaning to understand the factors hindering the adoption of port terminal automation in Richards Bay. Furthermore, this chapter highlights the validity and reliability of the study, its limitations, its contribution to the body of knowledge, and recommendations for future research.

5.2 Summary Of Research Findings

In this study, the TOE framework was utilised as a lens to analyse factors inhibiting the Richards Bay Port from adopting automation. These factors were studied at the organisational level, in existing technologies, and within the external environment. This study was necessitated by the evolving competitive environment in which ports operate. Organisations must leverage ICT to integrate systems, improve efficiency, and optimise port activities by adopting intelligent solutions (Mukomana, 2018). Port terminals play an integral role in enabling trade across the global market in the transportation logistics chain. The evolution of port terminals into intelligent ports has been an ongoing journey (Mukomana, 2018; Sithole, 2022). Consequently, ports are expected to adapt to new technologies and business models that enhance performance, reduce costs, and improve safety in the workplace (Harbi, 2021). This study evaluated the capability of port terminals in Richards Bay to transition into intelligent port terminals, enhancing efficiency and turnaround times. It also identified the factors influencing the adoption of port terminal automation in Richards Bay. Findings from this study reveal several challenges and limitations faced by the Port of Richards Bay, including a lack of strategy, funding, infrastructure, technology, relevant skills, legacy equipment, labour unions and excessive political interference. The challenges are summarised as follows:

Technological challenges: the port lacks essential technology, including appropriate IT infrastructure and integrated systems. Disintegrated systems result in a lack of visibility, hindering the ability to plan, track, and monitor real-time activities. This limitation affects decision-making and operational efficiency.

Organisational challenges: significant challenges include organisational culture, leadership, the absence of a cohesive strategy, resistance from labour unions, insufficient funding, and a lack of relevant skills. Regarding labour unions, the perception is that automation will lead to

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job losses. Awareness and training campaigns should be introduced to address this concern, especially in promoting safer workplaces with reduced human intervention. An interesting organisational factor raised by participants was the role of procurement processes, which have the potential to delay technology adoption. This factor warrants further investigation in future research.

External/Environmental challenges: political and government interference were highlighted as external factors, although they were found to have a less significant influence on automation adoption than internal factors.

The results indicate that Richards Bay is not yet ready to adopt an intelligent port terminal due to technological, organisational, and external challenges. However, addressing these challenges could enable the port to transition into a smart port terminal. The recommendations include securing funding, training and upskilling employees, engaging stakeholders, and investing in technology. Therefore, automating Richards Bay Port requires essential technological investments, including implementing appropriate IT infrastructure, integrated systems, and software. Adequate funding is also crucial to support technological innovation. Achieving this goal further depends on fostering a strong organisational culture and structure, ensuring effective leadership, and establishing a cohesive digital transformation strategy driven by skilled employees.

5.3 Attaining The Research Objectives

The primary objective of this study was to identify the key factors hindering the implementation of automation at the port terminal in Richards Bay. This objective was successfully achieved through the collection and analysis of qualitative data drawn from open-ended survey responses and follow-up interview with key stakeholders. The findings, thematically categorised according to the Technology-Organisation-Environment (TOE) framework, are detailed in Sections 4.6.1 to 4.6.3 and summarised in Table 4.3.

Technological Factors

Participants consistently identified a lack of essential technology, including appropriate IT infrastructure, integrated systems, and automation tools, as a major barrier to automation (see Section 4.6.1.1). For instance, one participant noted, “Systems are in silos with no integration,” while another added, “There is a lack of visibility, and one can’t track what’s on the ground

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and what needs to be imported and exported." These insights are consolidated under the theme "Lack of Technology/Infrastructure" in Table 4.3. These responses support the development of the research proposition:

P1: If there is a lack of technology, it is unlikely that automation will be implemented.

This proposition is grounded not in statistical analysis, but in direct participant accounts and recurring themes drawn from the qualitative data.

Organisational Factors

The second objective was to understand how internal organisational dynamics impact automation readiness. Participants highlighted issues such as a lack of coherent strategy, frequent leadership changes, resistance to change, limited training, and insufficient funding (see Section 4.6.2.1 and Table 4.3). For example, RR9 stated: "There is a lack of understanding of the organisation's needs, especially in operations." Several participants also pointed to the role of labour unions in resisting automation, driven by fears of job losses. These insights informed the following propositions:

P2: If the organisational structure is not coherent, it is unlikely that port automation will be realised.

P3: If there is a lack of leadership capable of driving digital transformation, the automation of ports is unlikely to be implemented successfully.

P4: If funding is insufficient, it is unlikely that the organisation will be able to implement automation.

Each of these propositions is directly linked to qualitative evidence provided by participants and documented in the thematic analysis.

External/Environmental Factors

The final objective related to understanding the external pressures influencing automation. Participants cited political interference, regulatory uncertainty, and misaligned government decision-making as external barriers (see Section 4.6.3.1). For example, several responses indicated that political actors and state ownership create misalignment between operational

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needs and strategic decisions. This is reflected in the theme "Political/Governmental Interference" in Table 4.3. Based on these findings, the following proposition was developed:

P5: If political and external pressures are not managed effectively, the implementation of automation at the port will be significantly hindered.

This proposition is supported by both the qualitative data and the broader literature on state-owned enterprises, which commonly face similar barriers..

5.4 Validity And Reliability

This study used an online questionnaire and interview to collect data and cross-verify findings. To ensure the quality and rigour of this qualitative research, the study followed Lincoln and Guba's (1985) four trustworthiness criteria:

Credibility: Achieved by comparing open-ended survey responses with the follow-up interview. Participant quotes and consistent themes confirmed the findings were grounded in participant experience.

Transferability: Ensured by providing detailed context about the organisation and participants, allowing others to assess relevance to similar settings.

Dependability: Supported through clear documentation of the research process and a consistent approach to thematic analysis using Braun and Clarke's method.

Confirmability: Addressed through triangulation (survey and interview data), and member-checking with the interviewee to confirm interpretations.

Where every participant provided insights, these were validated against other participants' responses and relevant literature, ensuring no individual view was taken out of context.

5.5 Contribution Of Research

This study contributes to the academic discourse on automation adoption by extending the Technology-Organisation-Environment (TOE) framework within the context of a state-owned, rail-linked port terminal. Unlike most previous studies, which have focused predominantly on the Port of Durban or other maritime logistics hubs (e.g., Mazibuko, 2020; Misra, 2021; Sithole, 2022), this research offers unique insights from the Port of Richards Bay, a terminal

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designed to transport goods exclusively by rail. By applying the TOE framework qualitatively, this study deepens our understanding of how technological, organisational, and environmental factors influence automation readiness in a South African rail-port context. Although the study did not directly assess automation within the rail system itself, participant responses indicate that automation at the port is interdependent with rail efficiency. By grounding the findings in participant experiences, it contributes practical and theoretical insights into how automation is resisted or enabled within politically sensitive, unionised, and infrastructure-constrained environments. Future research could build on this study by explicitly exploring the automation of rail-port interfaces, developing an extended TOE framework that includes logistics integration as a sub-domain within the technological dimension.

5.6 Limitations Of The Study

While this study offers valuable insights into the factors influencing automation at the Richards Bay port terminal, several limitations must be acknowledged. Firstly, although the study initially aimed to explore challenges hindering the adoption of automation, the data also revealed several enabling factors, particularly from participant reflections on potential improvements. This shift in focus was not originally incorporated into the study design, and future research could benefit from explicitly balancing both hindering and enabling dimensions in the research instruments. The study was limited to landside operational factors, as reflected in both the research questions and participant focus. Seaside operational challenges, while relevant to port automation, were excluded from the scope of this research. The study encountered resource constraints, particularly in terms of access to additional research sites, travel costs, and the availability of personnel for follow-up engagements. These logistical limitations affected the researcher's ability to gather further data that may have enriched the study, such as additional interviews or perspectives from leadership and rail operators. Despite these limitations, the study provides a meaningful contribution to the discourse on port automation in state-owned, rail-linked terminals and lays the groundwork for future, broader investigations.

5.7 Recommendation For Future Research

Recommendations for future research would include testing the research propositions at a different port within South Africa or other regions to determine if similar results are obtained. Another area to explore is the procurement processes and the role of procurement and supply

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chain management in delaying or facilitating technology acquisition in an organisation. Finally, other factors affecting the adoption of automation could be explored, including combining different models with the TOE framework.

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Appendix A: Ethical Clearance Certificate

UNIVERSITY *of the* WESTERN CAPE

Directorate: DVC: Research and Innovation
Research Development & Postgraduate Support
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

16 October 2024

Ms NB Zama
Information Systems
Faculty of Economics and Management Sciences

HSSREC Reference Number:	HS24/8/24
Project Title:	An exploratory study on factors that hinder Port Terminal Automation. The case study of Richards Bay
Approval Period:	15 October 2024 – 14 October 2025

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology, and ethics of the above-mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit an annual progress report at least two months before expiry date. Failure to submit your annual progress report on time will result in the immediate lapse of your ethics approval and you will have to resubmit an entirely new ethics application.

For permission to conduct research using student and/or staff data or to distribute research surveys/questionnaires at UWC please apply via:
https://sites.google.com/uwc.ac.za/permissionresearch/home

The permission letter must then be submitted to HSSREC for record keeping purposes.

The Committee must be informed of any serious adverse events and/or termination of the study.

Ms Patricia Josias
Coordinator: Research Ethics
University of the Western Cape

NHREC Registration Number: REC-130416-049

University of the Western Cape, Robert Sobukwe Road, Bellville 7535, Republic of South Africa

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Appendix B: Consent Form Questionnaire

Questionnaire (Online)

Consent Form University of the Western Cape

Project Title: *An exploratory study on factors that hinder Port Terminal Automation. The case study of Richards Bay*

Researcher: Nomonde Bridgette Zama

Please <u>tick</u> the boxes to show your agreement and understanding of what is expected for this study.

1. I confirm that I have read and understood the information sheet explaining the above research project and I have had the opportunity to ask questions about the project. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time
without giving any reason and without there being any negative consequences. In addition,
should I wish to withdraw, I may contact the lead researcher at any time to do so. ☐

3. I understand my responses and personal data will be kept strictly confidential. ☐

4. I give permission for members of the research team to have access to my responses without revealing any part of my identity. ☐

5. I understand that my name will not be linked with the research materials, and that I will not be identified or identifiable in the reports or publications that result from the research. ☐

6. I hereby agree that my anonymized responses collected through the questionnaire can be used for this research. ☐

7. I agree for the **anonymized** data collected to be used in future research ☐

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In terms of the requirements of the Protection of Personal Information Act (Act 4 of 2013), personal information will be collected and processed:

☐ I hereby give consent for my personal information to be collected, stored, processed and shared as described in the information sheet.

☐ I do not give consent for my personal information to be collected, stored, processed and shared as described in the information sheet.

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Electronic/online/clickable signatures to be used as needed.

Name of Participant (*or legal representative*)	Date	Signature
Name of person taking consent *(If different from lead researcher)*	Date	Signature
Supervisor	Date	Signature

All participants will receive an information sheet which explains and outlines this project. The information sheet is for you to keep. You will find all contact information and relevant information on the information sheet. A copy of this consent form will be filed and kept in a secure location for research purposes only.

Researcher:

Miss Nomonde Bridgette Zama
Cell: 083 214 3133
Email: 4106309@myuwc.ac.za

Supervisor:

Dr Mziwoxolo Mayedwa
Tel: 021 959 4139
Email: mayedwa@uwc.ac.za

HOD:

Prof Carolien van den Berg
Tel: 021 959 3958
Email: cvanden-berg@uwc.ac.za

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Appendix C: Consent Form Interview

Interview (Online)

Consent Form University of the Western Cape

Project Title: *An exploratory study on factors that hinder Port Terminal Automation. The case study of Richards Bay*

Researcher: Nomonde Bridgette Zama

Please <u>tick</u> the boxes to show your agreement and understanding of what is expected for this study.

1. I confirm that I have read and understood the information sheet explaining the above research project and I have had the opportunity to ask questions about the project. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time
   without giving any reason and without there being any negative consequences. In addition,
   should I wish to withdraw, I may contact the lead researcher at any time to do so. ☐
3. I understand my responses and personal data will be kept strictly confidential. ☐
4. I give permission for members of the research team to have access to my responses without revealing any part of my identity. ☐
5. I understand that my name will not be linked with the research materials, and that I will not be identified or identifiable in the reports or publications that result from the research. ☐
6. I hereby agree that my anonymized responses collected through the questionnaire can be used for this research. ☐
7. I agree for the **anonymized** data collected to be used in future research ☐

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In terms of the requirements of the Protection of Personal Information Act (Act 4 of 2013), personal information will be collected and processed:

☐ I hereby give consent for my personal information to be collected, stored, processed and shared as described in the information sheet.
☐ I do not give consent for my personal information to be collected, stored, processed and shared as described in the information sheet.

Your signature is required in the next section:

Name of Participant (*or legal representative*)	Date	Signature
Name of person taking consent *(If different from lead researcher)*	Date	Signature
Supervisor	Date	Signature

All participants will receive an information sheet which explains and outlines this project. The information sheet is for you to keep. You will find all contact information and relevant information on the information sheet. A copy of this consent form will be filed and kept in a secure location for research purposes only.

Researcher:

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HOD:

Prof Carolien van den Berg
Tel: 021 959 3958
Email: cvanden-berg@uwc.ac.za

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Appendix D: Questionnaire

Factors that hinder the adoption of automation in the port terminal - Questionnaire
This questionnaire is to assist Nomonde Zama who is doing her Master's in the Department of Information Systems at the University of the Western Cape to obtain her degree. The research study focuses on **exploring factors that hinder Port Terminal Automation. The case study of Richards Bay.** Automation is de ned as the use of technology to minimise human input while increasing operational efficiencies. Please answer the questionnaire to the best of your ability. The targeted group is people with vast knowledge and experience within the port industry. Please note, that all the responses will be kept anonymous.

1. What age group do you belong to? * *Mark only one oval.*

- <25 years
- 25-29 years
- 30-39 years
- 40-49 years
- >49 years

2. What is your gender? * *Mark only one oval.*

- Female
- Male

3. Which operational division do you work in? * *Mark only one oval.*

- TPT
- TNPA
- Other

4. Which department do you work in? *

____

5. Which position level do you hold within the business? * *Mark only one oval.*

- Level B - General Manager
- Level C - Executive Manager
- Level D - Senior Manager
- Level E - Senior Specialist/ Manager
- Level F - Junior Manager
- Level G and Below – Junior

6. What is your highest level of education? * *Mark only one oval.*

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Matric

National/ Technical Diploma

Degree

Post Graduate Diploma/ Honors/equivalent

Masters

Doctorate

Other

7. What is the range of your work experience within the port operations? * *Mark only one oval.*

<1 years

1-4 years

5-9 years

10-14 years

15-19

>20 years

Section B - Technological Factors

Please indicate your agreement with the following statements

8. Automation of port terminal operations is already implemented in the organisation. *

Mark only one oval.

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

9. Automation of processes is already implemented in the organisation. *

Mark only one oval.

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

10. Data visualisation tools are available in the organisation to view real-time operations within the port and facilitate * informed decision-making.

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

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11. Systems within the organisation are integrated to provide seamless operations. *

Mark only one oval.

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

12. The right infrastructure and equipment is deployed within the organisation to increase efficiency. *

Mark only one oval.

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

13. The current technology used by the organisation is able to increase efficiency. *

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

14. The current technology used by the organisation is able to achieve great service quality and customer * satisfaction.

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

15. The current technology used by the organisation is able to increase turnaround times. *

Mark only one oval.

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Strongly disagree

Disagree

Neutral

Agree

Strongly agree

16. The current technology used by the organisation is able to decrease operational costs. *

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

17. The latest technology (computers hardware/network/ systems) is used in the organisation to drive the port into * becoming more intelligent.

Mark only one oval.

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

Section C - Organisational Factors

Please indicate your agreement with the following statements

18. The number of employees currently working in the port is adequate to maintain port operations. *

Mark only one oval.

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

19. The current employees currently working in the port have the right skills to maintain port operations. *

Mark only one oval.

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Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

20. The current departments & operational divisions that support the port is adequate to maintain port operations. *

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

Strongly Agree

21. The current processes put in place is adequate to maintain port operations. *

Mark only one oval.

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

22. There is effective communication in the organisation to run operations.

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

23. The organisation communicates its strategies effectively to all stakeholders. *

Mark only one oval.

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Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

24. There is support from top management to improve efficiency.

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

25. Top management provides the right resources when there are operational changes. *

Mark only one oval.

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

26. The organisation is growing its market share. * *Mark only one oval.*

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

27. The organisation has a good reputation from the public. * *Mark only one oval.*

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

Section D - External/Environmental Factors

Please indicate your agreement with the following statements

28. The organisation adapts well to changes from external pressure. *

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Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

29. The organisation adheres to the National Ports Act 12 of 2005. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Adoption of Automation in the port terminal

30. The organisation is ready to full automate its terminal operations. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

31. Please support your answer above. *

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Challenges and limitations in the adoption of automation by port terminals

32. What are the current challenges the port is experiencing that hinders the adoption of automation?

33. What can be done to reduce these challenges?

34. What technological factors do you think hinder the port from automating its processes and operations?

35. What organisational factors do you think hinder the port from automating its processes and operations?

36. What environmental factors do you think hinder the port from automating its processes and operations?

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Appendix E: Interview

DEPARTMENT OF INFORMATION SYSTEMS

Interview Schedule for Richards Bay Port Experts

Introduction

My name is Nomonde Zama. I am pursuing my MCOM in Information Management degree in the Department of Information Systems at the University of the Western Cape, South Africa. My study explores factors that hinder the adoption of port terminal automation. Thank you for agreeing to be interviewed. The interview should take about 10 to 15 minutes. It must be highlighted that the interview is a follow-up to the online questionnaire to allow the researcher to gain further insights into the problem. There are no wrong or right answers to these questions. The purpose is to understand your experiences regarding port terminal automation and get a better understanding of Richards Bay in adopting innovation to increase efficiencies. Before we begin, please note the following:

- This interview is solely for educational purposes.
- The information you give will be confidential and your name will not be associated with anything you say during the interview.
- I will record the discussion.
- You may decline to answer any question or withdraw from the study at any time.

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Body

General demographic information

1. Please tell me about your role in Richards Bay.
2. How long have you been in this position?
3. Please tell me as much as you know about the Port of Richards Bay. What is exported and imported by the port?
4. Can you describe the port's geolocation, such as the connection to mines and the use of trains?
5. What governs the port and how does the Port of Richards Bay adhere to the National Ports Act 12 of 2005?

Current issues

6. What are the current challenges the port is experiencing that hinder the adoption of automation?
7. What can be done to reduce these challenges?

Closing

I appreciate the time you took for this interview. Is there anything else you think would be helpful for me to know so that I can add to the research?

Thank you for taking the time to answer questions.

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Appendix G: Proofreading Certificate

ONE STOP SOLUTION
Professional Editing Services

Proofreading Certificate

It is hereby certified that this thesis has been proofread and edited for spelling, grammar and punctuation by a professional English language editor from www.OneStopSolution.co.za

Client

Nomonde Zama

An exploratory study on factors that hinder Port Terminal Automation. The case study of Richards Bay

Editor

Michele van Niekerk
Name

Signature

31 December 2024
Date

I cannot guarantee that the changes that I have suggested have been implemented nor do I take responsibility for any other changes or additions that may have been made subsequently. The track changes of the language editing will be available for inspection upon enquiry, for a period of one year.

Contact

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