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Factors Influencing Digital Technology Adoption in the South African Freight Transport Sector

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A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business

Johannesburg, 2024

ABSTRACT

Considered essential to the functioning of the economy, the South African freight transport sector has experienced a decline in performance, negatively impacting South Africa's global competitiveness and economic growth. Through benefit realisation, digital technology adoption has the potential to improve competitiveness and ultimately, enhance economic growth. With slow technology adoption rates observed in the South African freight transport sector, the research aimed to understand internal and external influencing factors of digital technology adoption, from an organisational context, within the sector. Furthermore, the influence of government support as a moderating factor was investigated. A combined theoretical framework was used for the study, consisting of the Technology Acceptance Model (TAM) and Technology-Organisation-Environment (TOE) framework. The quantitative research study utilised a survey to electronically collect data from freight transport organisations in South Africa, specifically in rail, port, pipeline and road industries. A stratified random sampling method was used, with sample size of 374. Key findings observed that perceived relative advantage, perceived ease of use of digital technologies and knowledge absorption capability were positively influencing internal factors, whereas competitive pressure and government support positively influenced the intention to adopt digital technologies from an external perspective. In addition, perceived ease of use of digital technologies mediated the relationship between perceived relative advantage and the intention to adopt digital technologies. Furthermore, government support as a moderator dampened the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies. The intention was to provide recommendations to enhance digital technology adoption for benefit realisation in the South African freight transport sector.

Keywords: Digital technology, digital technology adoption, South African Freight Transport Sector, government support, supply chain and logistics, TAM-TOE

DECLARATION

I, ___Sharday Jaiswar___, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Sharday Jaiswar Signature:

Signed at … MIDRAND……

On the …29….. day of …FEBRUARY…… 2024..

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LIST OF ACRONYMS

AI	Artificial Intelligence
ANN	Artificial Neural Networks
AVE	Average Explained Variance
BDA	Big Data Analytics
CFA	Confirmatory Factor Analysis
CPS	Cyber-physical systems
DOI	Diffusion of Innovation Theory
FTS	Fleet Telematics System
GDP	Gross Domestic Product
ICT	Information and Communications Technology
IoT	Internet of Things
IT	Information Technology
LPI	Logistics Performance Index
PLS-SEM	Partial Least Squares Structural Equation Modelling

QR Code	Quick Response Code
RFA	Road Freight Association
RFID	Radio Frequency Identification
SCM	Supply Chain Management
SCT	Social Cognitive Theory
SME	Small to Medium Enterprises
SPSS	Statistical Package for the Social Sciences
SVM	Support Vector Machines
TAM	Technology Acceptance Model
TOE	Technology-Organisation-Environment
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
WEF	World Economic Forum
WSN	Wireless Sensor Network

CHAPTER 1. INTRODUCTION

1.1 Statement of purpose

The quantitative research study aimed to explore factors influencing digital technology adoption in the South African freight transport sector, while also investigating the influence of government support as a moderator on the intention to adopt digital technologies.

1.2 Background of the study

1.2.1 Supply chain; transport and logistics

Supply chains involve entire systems and processes that convert raw products to final products that reach an end user. Supply chain systems are composed of logistics and transportation, where logistics include storage, packaging and inventory, and transportation refers to the movement of goods between different locations (Sudan & Taggar, 2021). A supply chain is considered sustainable when it has efficient and cost-effective transport and logistics (Attaran, 2020). The freight transport sector is essentially composed of road, rail, port, pipeline and air industries.

Transport systems are considered the “life-blood and backbone of local, national and the global economy” (Chakwizira, 2022, p.127). The complex geographical positioning of transport sectors encourages growth and development through the strategic movement of goods, commodities and people (Chakwizira, 2022). Transport sectors are considered critical in sustaining human livelihoods and activities as it is an enabler of commodity flows, communication linkages and supply lines (Ataguba, 2020). Freight transport and logistics ensure that the

movement of goods and materials occur seamlessly across supply chains (Wang & Sarkis, 2021).

During challenging economic periods, transport and logistics organisations often operate ineffectively as these organisations are directly linked to the economic state of a country (Luke, 2020). Inefficient and incomplete transport networks impact entire value chains, which in turn have adverse effects on food security and economic development (Elavarasan & Pugazhendhi, 2020).

It has been observed that new technologies have improved processes in the logistics and transport sector globally (Sudan & Taggar, 2021). Adewole and Struthers (2019) suggest that investments in transport infrastructure, such as new transport technology, have the potential to enhance supply chain network design, which leads to improved competitiveness and ultimately, enhanced economic growth. This linkage is observed in Figure 1.

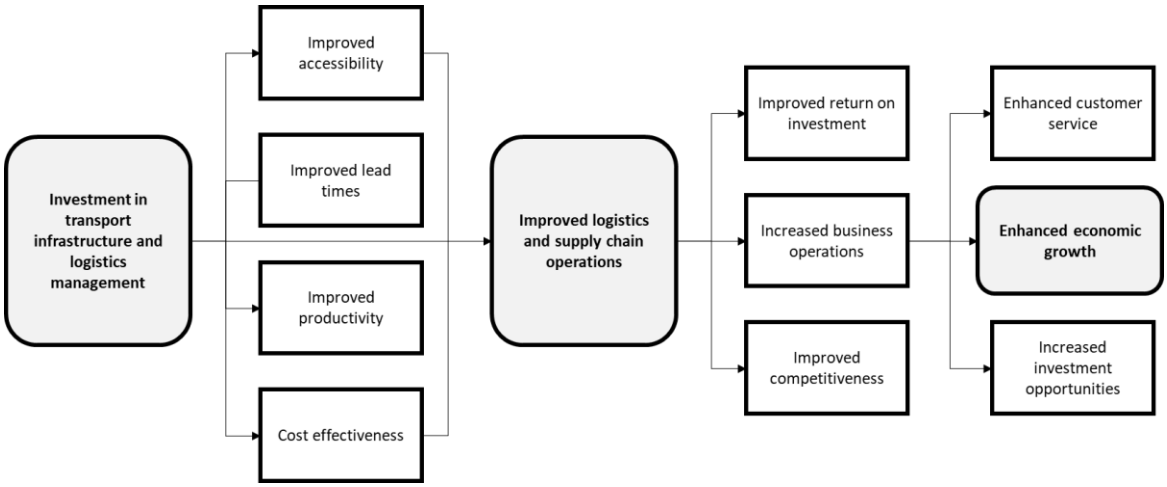

Figure 1: Link between investment in transport infrastructure and enhanced economic growth (Adewole & Struthers, 2019, p. 84)

1.2.2 Digital technology adoption in freight transport and logistics

According to Wang and Sarkis (2021), the freight transport and logistics sector is undergoing digitalisation. Digitalisation utilises digital technologies, for its innovative opportunities offered, to better enable and manage innovation in the sector (Heinbach et al., 2022). Digital technologies utilise numeric codes for information and include electronic devices, information and communication technologies (ICT), emerging technologies and applications (Chinoracky et al., 2021). Digitisation occurs when digital technologies are used to convert parts of a process from analogue to digital forms, whereas digitalisation refers to the conversion across the entire process or system (Chinoracky et al., 2021). Digital transformation refers to a strategic transformation and change that requires digital technology implementation and organisational changes, such as cultural shifts and changes to business models (Chinoracky et al., 2021). Hence, digital technologies, supported by strategic transformative initiatives, can transform entire supply chain business models, which enables sources of competitive advantage (Attaran, 2020).

The adoption of advanced digital technologies differs according to different economic sectors (Akpan et al., 2022). Adopting a digital technology refers to introducing and using a new and innovative technological product, way of work or process that has not been used in the organisation before (Hammed et al., 2012). Benefits, such as economic growth, from implementing new digital technologies can only be realised when the new digital technology is seen as useful to people and industries and are widely diffused and adopted by users (Lakhwani et al., 2020). Adoption and application of digital technologies within different logistics operations assists in achieving competitive advantage, with digital technologies considered critical in providing essential logistics and transport services (Moldabekova et al., 2021).

a. *Benefits of digital technology in freight transport and logistics*

Transportation use will continue to intensify due to increasing customer demand, and since it is considered a large portion of the overall cost of logistics, it is vital to implement solutions for its performance optimisation (Modica et al., 2021). Challenges experienced in the transport sector include management complexities due to multiple stakeholders across different touchpoints and coordination efforts throughout the value chain (Attaran, 2020). New advanced digital technologies have the potential to alleviate challenges in transport and logistics, and enhance competitive advantage through improved visibility, flexibility and resource efficiency (Attaran, 2020). Competitive advantage can further be achieved through digital technology adoption as the newly adopted technologies form the foundation for dynamic capability formation (Belitski et al., 2022). Dynamic capabilities assist in redefining and creating relevant and innovative business models (Carillo et al., 2021). Performance can ultimately improve through increased cost efficiency, improved service levels and sustainability outcome achievement (Modica et al., 2021). Hence, through effective digital technology adoption and use by users, improvement in an organisation's effectiveness and productivity is possible, which positively impacts the overall supply chain (Lashitew, 2023).

The concept of Industry 4.0 relates to improving business processes through the integration of digital technologies (Ghadge et al., 2020). Logistics 4.0 is related to Industry 4.0 but with key principles of automation, integration and intelligence in logistics (Modica et al., 2021). According to Wang and Sarkis (2021), major supply chain technologies include artificial intelligence (AI), edge computing, big data analytics (BDA), blockchain, Internet of Things (IoT) and digital twins. Additional digital technology solutions in the freight transport sector include cloud computing, Quick Response Code (QR Code), Radio Frequency Identification (RFID), digital platforms and fleet telematics (Attaran, 2020). These digital

technologies support supply chain management through robust digital connectivity, integrative support for collaboration and effective capitalisation on insights generated (Wang & Sarkis, 2021). The application, adoption and benefits of these technologies are observed in different industries of the freight transport sector that include road, rail, port, pipeline and air.

In road freight transport, digital technologies in Germany include advanced road fleet management techniques, such as fleet telematics systems (FTS). These systems enable real-time communication and data transfer between assets for the management of entire fleets, thereby, improving fleet operations optimisation and compliance of vehicles and drivers (Heinbach et al., 2022). Furthermore, big data combined with advanced techniques, such as artificial intelligence, provide insights in the areas of descriptive, predictive and prescriptive analytics. These analytic techniques enable delivery schedule optimisation and prediction of energy consumption for fuel efficiency as seen in South Korea (Shoman et al., 2023).

Digital technologies have been observed to improve safety in rail freight transportation as discussed by Arslan and Tiryaki (2020), in which data collected from railway switch points in Istanbul were analysed using machine learning methods; this allowed for better prediction and communication of failures (Arslan & Tiryaki, 2020). In the United Kingdom, railway safety was improved using a Wireless Sensor Network (WSN) Platform and IoT to send predictive alerts, allowing repair of faults before it resulted in potential hazardous failures such as derailments (Brezulianu et al., 2020).

In the port environment, a study performed in Taiwan proposed a cloud cargo image system using QR codes, that essentially reduced the cost associated with manual unpacking examinations of export containers; the result was a 32% increase in overall examination performance (Chang et al., 2020). In the Port of Houston and the Port of Virginia, RFID has been shown to improve security in

cargo containers and shipments, enable data accuracy and completeness, and improve employee time utilisation (Barro-Torres et al., 2010).

In a study performed by Aba et al. (2021), an IoT analytics platform was used for monitoring and detection of petroleum pipeline damage in real-time. Thereby, enabling a shift from reactive to proactive pipeline management and improving operational efficiency by minimising unplanned faults (Aba et al., 2021). Furthermore, to enhance the prediction capability of oil pipelines, a computerised digital twin based on machine learning was used for risk probability estimation; the risk probability rate of the system was determined to reinforce security for fault identification by quantifying the hazard likelihood rate (Priyanka et al., 2021).

According to Yadav et al. (2022), the challenge associated with delayed payments during air cargo transportation was reduced using smart contracts, which allowed for privacy and security features and consensus of multiple nodes, further improving trust among stakeholders. Furthermore, by using a blockchain platform, with IoT and smart contract capability, a reduction in cargo time spent in airports was observed as the platform improved financial and information management in operational processes (Poleshkina, 2021).

1.2.3 Barriers to digital technology adoption in freight transport and logistics

Benefits from implementing digital technologies can only be realised when the new digital technology is seen as useful to people and industries and are widely adopted by users (Lakhwani et al., 2020). A noticeable inhibitor to digital technology adoption is the high-cost factor, with majority of organisations in need of financing for innovative technology implementation, including maintenance costs (Baimukhanbetova et al., 2023). With regards to internal organisational factors, the lack of innovation, digital skills and specialists further inhibit digital technology adoption, whereas a low level of automation restricts expansion of services and cooperation (Baimukhanbetova et al., 2023). From an external

organisational perspective, barriers to adoption include the political environment influencing the transport organisation or lack of critical resource availability (Baimukhanbetova et al., 2023).

Digital technology adoption challenges in road freight transport, specifically for big data from an internal organisational perspective, include a lack of leadership interest and support in data-driven decision-making, with top managers absent from championing data analytics (Shoman et al., 2023). From a technical perspective, to effectively leverage big data analytics, big data must be effectively cleaned and extracted. However, the absence of technical standards and poor technical analysis can impact quality and governance of big data (Shoman et al., 2023). From an external organisational perspective, political oversight and data privacy issues inhibit meaningful contribution of big data gathering and sharing (Shoman et al., 2023).

In rail freight transport in India, IoT adoption is low due to the constraints associated with the emerging country. From a technological perspective, inhibitors include lack of internet availability and connectivity, limited bandwidth and overall infrastructure challenges (Singh & Roy, 2020). From an internal-organisational perspective, the high cost associated with IoT enabled systems and devices is a challenge, as well as data security concerns (Singh & Roy, 2020). Lastly, from an external-organisational perspective, the lack of vendor activity also poses a challenge (Singh & Roy, 2020).

For port freight transport, specifically blockchain, challenges in adopting the digital technology include uncertainty surrounding the confidentiality of data exchange and inadequate technology infrastructure, such as appropriate back-end systems, among port authorities and forwarders to connect to the blockchain technology (Tan & Sundarakani, 2020). It has also been argued that even though blockchain emphasises decentralisation, it may concentrate power in selected entities in the supply chain (Tan & Sundarakani, 2020). This technology is also complex and requires the cooperation of all stakeholders in the value chain for

benefits to be effectively realised. Also, the increased financial risk in shipping management requires specialists in cryptocurrency and blockchain literacy (Tan & Sundarakani, 2020).

Adoption barriers in the oil and gas industry, specifically the use of machine learning in pipeline freight transport, include a risk-averse culture, bureaucratic approaches and intense governance processes in innovative product and service development and deployment (Hajizadeh, 2019). Also, since quality and accuracy directly impact machine learning results, poor quality of field data and a siloed and fragmented data storage approach may also pose a weakness to machine learning adoption in pipeline transportation (Hajizadeh, 2019).

Multiple stakeholders in air freight cargo transport inhibit adoption of blockchain due to the difficulty in securing adequate financing and intense coordination requirements between different nodes; low transparency is created across multiple nodes and high coordination efforts are expensive (Sahoo & Tiwari, 2022). There are also significant geopolitical risks associated with transporting freight across international borders, with all global stakeholders' involvement and support required for optimal effectiveness of blockchain. Further concerns affecting blockchain adoption relate to reluctance towards paperless trade adoption, data security and privacy (Sahoo & Tiwari, 2022).

Implementation of new digital technologies may also disrupt the daily routine of users, causing resistance to change. This, in turn, creates process delays in the customer response time and negatively impacts employee and customer satisfaction in the transport sector. Overall business performance can be negatively impacted if users do not adopt digital technology as effort, time and investment is essentially wasted (Lakhwani et al., 2020).

1.2.4 Digital technology adoption in South African freight transport and logistics

a. *South African freight transport and logistics sector*

In South Africa, freight transportation includes rail, civil aviation, maritime, pipeline and road transport (Transport, 2023). Rail, pipeline and road transport are considered land transport, with maritime transport referred to as water transport and civil aviation considered air transport. Considered to be one of the leading countries in Information and Communications Technology (ICT) and transport infrastructure (Adjei Kwakwa et al., 2022), South Africa aligns transport and digital communications as network industries that are vital to economic growth and creating a globally competitive economy (System, 2022). According to Statistics South Africa, in 2022, the industry value added for transport, storage and communication was R 364 billion, which constituted 7,9% of total Gross Domestic Product (GDP). In addition, this sector had the highest growth rate of 8,3% against GDP growth rate of 1,9%, further highlighting the importance of the sector (Africa, 2023).

b. *Digital technologies in South African freight transport*

Digital technologies are observed in the South African context across land, maritime and air transport. For example, per train trip in the rail industry, optimisation algorithms have led to improved time efficiencies at railway level crossings along the corridors of Western Cape Metrorail (Tshaai et al., 2022). In maritime, cloud computing related to modernisation of ports in South Africa has been observed to improve business continuity before and after disaster scenarios (Ochara et al., 2022). The airline industry in South Africa, specifically Cape Town International Airport, has seen significant adoption of e-gates to improve security challenges (Habiyaremye et al., 2023).

c. *Challenges in South African freight transport*

Historical lack of investment, leading to high operational costs, has been observed in South Africa's freight transport sector (Teuteberg & Aina, 2021). Over the past 20 years, South Africa's rail volume grew 30% in comparison to international rail market growth of 80%, with a 35% decline in rail volumes observed over the past 5 years (Transport, 2023). In addition, a 2020 World Bank evaluation of African ports showed that South Africa's ports were ranked among the bottom of the 351 evaluated ports (Transport, 2023). Over the past five years, a significant portion of freight traffic has moved to roads due to noticeable deterioration in the freight rail network, leading to further deterioration of road network quality (Fraser, 2023). In addition, infrastructure investment is largely funded by government, with the effects of over 30 years of underinvestment and underfunding in rail infrastructure currently experienced (Transport, 2023). Furthermore, with regards to the ports, South Africa is ranked lower than its global competitors in terms of port productivity and is considered to have comparatively higher tariffs to be paid by vessels; other constraints are associated with customs procedures and inland linkages (Joynt, 2019). Further impacting challenges include rigid labour policies, poverty, unemployment, lack of skills and knowledge, as well as severe power shortages and tariff increases (Godongwana, 2023).

According to Joynt (2019), the condition of South Africa's transport infrastructure has a definite impact on the country's global competitiveness. The Quality of Infrastructure Index, an annual World Economic Forum (WEF) report, represents the quality of transport infrastructure in a particular country (Forum, 2023).

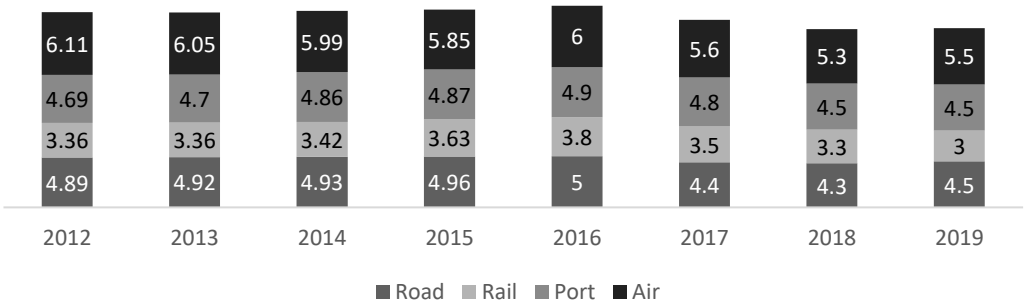

Figure 2: Quality of Infrastructure Index in South Africa; 1 (low) – 7 (high) (Forum, 2023)

A declining trend is observed in Figure 2 across road, rail, air and port infrastructure quality from 2016. This declining trend negatively influences South Africa's competitiveness, thereby, increasing logistics costs and negatively impacting South Africa's ability to offer diverse logistics services (Forum, 2023).

Furthermore, South Africa's Logistics Performance Index (LPI) Score and Ranking has been erratic over the past decade as shown in Figure 3, which indicates instability in performance on trade logistics.

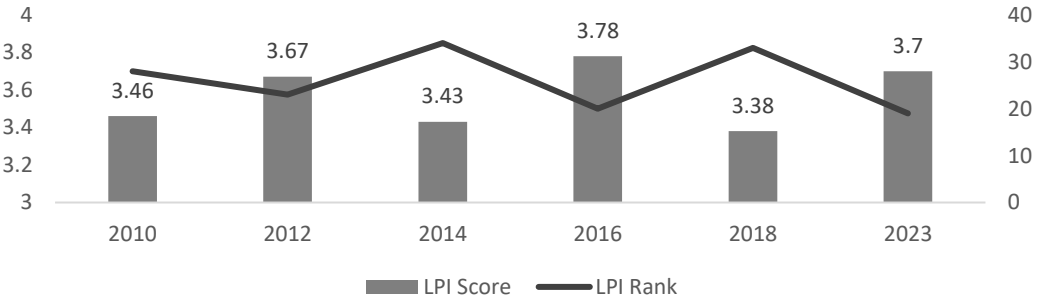

Figure 3: Logistics Performance Index Score and Rank for South Africa (Bank, 2023)

The LPI, managed by the World Bank, measures a country according to key parameters of infrastructure quality, logistics services quality, timeliness and

customs performance (Bank, 2023). The logistics performance of a country is considered vital to economic growth and an erratic logistics performance, which represents inconsistency in timeliness, service and infrastructure quality, may indicate unreliability and lack of cost effectiveness in accomplishing import and export activities (Bank, 2023).

These increasing challenges and infrastructure bottlenecks have caused South Africa to no longer be considered the only gateway to Africa (Transport, 2017). In the coming years, system constraints experienced on key corridors and transport nodes that transport key goods of economic importance, could negatively impact economic growth and development (Chakwizira, 2022).

d. *Digital technology adoption challenges in South Africa*

In a study by Adenigbo et al. (2023), slow technology adoption rates have been observed in the freight transport sector of South Africa in comparison to the passenger transport sector, with suboptimal adoption observed across organisations. In the South African transport sector, Kreusch et al. (2021) related artificial intelligence adoption challenges to a fragmented focus on the expansion of transportation, unreliable transportation information systems, poor digital literacy, political interference, inadequate funding and lack of knowledge and innovation. Kreusch et al. (2021) also emphasised the need for government support in the development of a comprehensive data management strategy, enablement of systems to attract key skills in the sector, development of structures to sustain technology adoption and promotion of self-development policies in technology education. In the South African air cargo logistics industry, Adenigbo et al. (2023) identified challenges in technology innovation adoption as high costs associated with acquiring new technologies, reluctance to change as demonstrated by negative attitudes, ineffective data management systems and difficulties in understanding the outcome of digital technology adoption prior to solution implementation. In the adoption of IoT in improving last mile distribution (LMD) transport systems in South Africa, challenges in adoption related to lack

of regulation, inadequate bandwidth, issues regarding cybersecurity and ineffective collection and processing of data (Kafile, 2023). Furthermore, in the adoption of e-procurement systems in the South African transport and logistics sector, lack of policies and strategic planning in the sector noticeably impacted the introduction of new technologies, as well as difficulty in comprehending benefits realisation further challenged the adoption of new technologies (Maepa et al., 2023). In a study performed by Chinomona et al. (2023), challenges with optimising supply chain effectiveness in South Africa related to difficulty in harnessing competitive advantages through agility and adaptability provided by digital technologies, as well as difficulties managing competitive pressure in the market.

1.3 Research problem

The South African transport sector is considered essential to proper functioning of the economy (Luke, 2020). Slow technology adoption rates have been observed in the South African freight transport sector, with suboptimal adoption observed across organisations (Adenigbo et al., 2023). In addition, the South African freight transport sector is currently experiencing a decline in transport infrastructure quality as well as an unstable Logistics Performance Index, which according to Joynt (2019), has a definite impact on the country's global competitiveness and economic growth. Economic growth, through benefit realisation, can be achieved when new digital technologies are effectively adopted within the transport sector (Maepa et al., 2023). The absence of digital technology adoption by users negatively impacts overall business performance (Lakhwani et al., 2020). Rapidly adopting digital technologies could provide South African freight transport organisations with a competitive advantage as it positions it for market growth (Adewole & Struthers, 2019, p. 84). Literature suggests that there are various factors influencing intention to adopt digital technologies, both internal and external to organisations. Internal factors relate to agility and adaptability (Chinomona et al., 2023), understanding the benefits

associated with digital technologies (Maepa et al., 2023) and reliable management systems (Kafile, 2023). External influencing factors that are highlighted in the South African context are the impact of government's contribution in providing an enabling regulatory environment (Kreusch et al., 2021) and the ability to manage pressure from competitors (Chinomona et al., 2023). Emphasis has been placed on the impact of policies, funding and strategic planning from government (Kafile, 2023; Kreusch et al., 2021; Maepa et al., 2023). As such, the research aims to further understand internal and external influencing factors of digital technology adoption in organisations within the South African freight transport sector across road, rail, port and pipeline industries, including the influence of government support as a moderating factor. The intention is to provide recommendations to enhance digital technology adoption for benefit realisation in the sector.

1.4 Research objectives

The study aims to investigate the following:

1. To investigate the internal factors that influence the intention of South African freight transport organisations to adopt digital technologies.
2. To investigate the external factors that influence the intention of South African freight transport organisations to adopt digital technologies.
3. To investigate how government support moderates the intention of South African freight transport organisations to adopt digital technologies.

1.5 Rationale

Literature supports benefits associated with digital technology adoption globally (Aba et al., 2021; Arslan and Tiryaki, 2020; Chang et al., 2020; Heinbach et al., 2022) and in the South African freight transport sector (Adenigbo et al., 2023; Kafile, 2023; Maepa et al., 2023). Digital technology adoption has been linked to

benefits that improve business operations and competitiveness, enhancing customer service and ultimately leading to enhanced economic growth (Adewole & Struthers, 2019, p. 84). Since the transport sector is considered a vital contributor to economic growth, the efficiency and competitiveness of the sector is of utmost importance (Chakwizira, 2022). However, slow technology adoption rates (Adenigbo et al., 2023), a declining infrastructure quality index (Forum, 2023) and erratic logistics performance index (Bank, 2023) suggests that the sector could benefit from digital technology adoption.

Literature in the South African supply chain and transport sector has mainly focused on the Technology-Organisation-Environment (TOE) theoretical framework, with either a single digital technology investigated, such as AI (Kreusch et al., 2021) and IoT (Kafile, 2023), or a specific industry considered (Adenigbo et al., 2023). Research has also indicated that the sector requires key skills, knowledge and innovation (Kreusch et al., 2021) as well as the need to act with agility and adaptability (Chinomona et al., 2023). Furthermore, research has indicated that a noticeable factor to adoption is the need to understand the benefits and outcome of adopting digital technologies (Maepa et al., 2023). Hence, the study aims to add to the existing body of knowledge by considering the TOE framework but with the addition of the Technology Acceptance (TAM) model, which combined, includes factors associated with knowledge absorption capability, perceived relative advantage and perceived usefulness. The combined frameworks also allow for the consideration of technological factors and external-environmental factors.

Furthermore, considering the emphasis of government support (Kafile, 2023; Kreusch et al., 2021; Maepa et al., 2023) on digital technology adoption, the study seeks to contribute to literature by investigating government support as a moderating variable on the intention to adopt digital technologies, as well as its direct effect on the intention to adopt digital technologies. Hence, the outcome of the study aims to provide government officials and representatives with empirical

evidence supporting freight transport organisations' behavioural intention to adopt digital technologies, which can be used to inform regulatory requirements and new frameworks regarding digital technology adoption in the freight transport sector; this could help to realise intended benefits in the sector.

Knowledge of internal-organisational and external-environmental factors that influence digital technology adoption can assist senior executives and leadership in freight transport organisations in developing effective digital strategies and forming strategic initiatives to support benefit realisation. Furthermore, in understanding key drivers to digital technology adoption, subject matter experts and specialists could develop policies and operating procedures for elevating effective digital technologies that support competitive advantage in freight transport organisations in South Africa.

1.6 Delimitations of the study

The delimitations of the research study were as follows:

i. The study did not focus on all supply chain digital technologies, but rather only on the transport component.
ii. The study did not focus on passenger transportation but rather the focus was on freight transportation.
iii. The study did not focus on factors influencing employee adoption outside of the direct workplace environment, such as social influence, but focus was on organisation or firm level adoption.
iv. The study did not focus on all digital technologies, but rather on those that facilitate smart transport; namely, blockchain, cloud computing, internet of things, artificial intelligence, big data analytics and digital platforms.
v. The study did not focus on the air freight industry, but rather on road freight, rail freight, port freight and pipeline freight industries.

1.7 Definition of terms

- Digital technologies – Electronic devices and applications that use information in the form of numeric codes (Chinoracky et al., 2021).

- Technology adoption – The adoption of technology is a process that results in the introduction and use of a product, process or practice that is new to the adopting organisation (Hammed et al., 2012).

1.8 Assumptions

The following assumptions were made:

- Respondents provided open and unbiased responses and answered to the best of their knowledge, standard perspectives and experiences.
- The level of participant comprehension of what was asked of them in the questionnaire was sufficient to respond effectively.
- Respondents had a fair understanding, at minimum, of what digital technologies were and what it related to in their work environment.
- Respondents had access or exposure to digital technologies in their work environments.
- The organisations, which respondents were from, had implemented and invested, or were considering investing in digital technologies with the intention to realise benefits for the organisation.

1.9 Chapter Outline

Chapter one provided an overview of digital technologies prevalent in the freight transport sector, including associated benefits and challenges in the different industries of road, rail, pipeline, port and air. From a South African transport perspective, the challenges associated with digital technology adoption was also

discussed. In concluding the chapter, the research problem and objectives were defined, rationale explained and delimitations highlighted.

CHAPTER 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

The aim of the literature review was to explore possible academic research on the proposed research objectives regarding factors influencing digital technology adoption. Internal factors were explored for the first research objective, where constructs relating to intention to adopt digital technologies, perceived usefulness of digital technologies, perceived ease of use of digital technologies, technological context (perceived relative advantage and compatibility) and organisational internal context (knowledge absorption capability) were investigated and hypotheses derived. Thereafter, the second research objective on external factors influencing digital technology adoption was investigated, with constructs related to the external environmental context (competitive pressure and government support). Lastly, government support as a moderator was investigated on the relationships between perceived usefulness of digital technologies and intention to adopt digital technologies, as well as perceived ease of use of digital technologies on the intention to adopt digital technologies, and hypotheses derived. The combined TAM-TOE theoretical framework has been applied in forming the conceptual model for this study, which accounts for both internal organisational and external organisational contexts.

2.2 Background of factors influencing digital technology adoption

According to Kadlubek (2022), digitisation and industrialisation will impact transport services significantly, with solutions in the field of digitisation enhancing competitive advantage by “lowering operating costs, adapting services to changing customer needs and implementing solutions with high added value.”

Realising these potential benefits from digital technologies requires effective technology diffusion and adoption. Technology diffusion refers to three different sets of factors in identifying variations in technology adoption and utilisation, which include demand and supply conditions (Lashitew, 2023). Digital technology attractiveness is influenced by demand or pull conditions, whereas industry level conditions, such as infrastructure availability and appropriate digital solutions, refer to supply or push factors (Lashitew, 2023).

According to Cirillo et al. (2023), drivers of adoption include supply-side factors, demand related factors, internal firm characteristics, differences in services, and external and institutional context factors. Supply-side factors include improvements that lead to gradual innovation and changes in technology use, whereas demand related factors relate to complementary behaviour between producers and users from a technological perspective (Cirillo et al., 2023). Internal firm characteristics include the size, age and management practices specific to an organisation, whereas the external context factors refer to the operational environment that is external to the organisation (Ajigini, 2023). The organisation's sources of competitive advantage are essentially shaped by the coevolution of its internal organisational capabilities and the external economic environment it operates in (Cirillo et al., 2023).

2.3 Internal factors that influence the intention of organisations to adopt digital technologies

Factors that are internal to an organisation that influence its intention to adopt digital technologies include behavioural intentions of the individuals that constitute the organisation (intention to adopt digital technologies, perceived usefulness of digital technologies, perceived ease of use of digital technologies), technological factors (perceived relative advantage, compatibility) and the organisational-internal context associated with the firm (knowledge absorption capability) (Vang & Lind, 2023). Constructs related to behavioural intentions

relate to TAM theoretical framework, whereas organisational-internal and technological context constructs relate to TOE theoretical framework (Taherdoost, 2018).

2.3.1 Intention to adopt digital technologies

The two main constructs associated with the TAM model, which relates to the intention to use or adopt a specific technology, are the perceived usefulness and ease of use of the system (Katebi et al., 2022). The actual use of the technology is essentially influenced by the intention to adopt a technology (Katebi et al., 2022). Intention represents an individual's willingness to participate and engage in a particular behaviour, with it representing the final process step in decision making (Sheeran et al., 2005). The intention to adopt has been investigated in supply chain and logistics, including different factors influencing the behavioural intention to adopt digital technologies based on the environment investigated (Kamble et al., 2020; Wamba et al., 2020; Wong et al., 2020).

2.3.2 Perceived usefulness of digital technologies

Perceived usefulness can be described as the benefits a user or organisation can achieve by adopting technology (Venkatesh & Davis, 2000). Ramkumar et al. (2019) stated that perceived usefulness is when benefits and usefulness are associated with a new technology, such as performance improvement and effectiveness, to the adopting organisation. According to Arumugam et al. (2022), there is a higher possibility for a new technology to be implemented in an organisation when it is perceived as having more comparative advantages. A study by Katebi et al. (2022) in manufacturing firms observed that perceived usefulness significantly impacted the intention to adopt AI. In a supply chain management context, Kamble et al. (2021) and Chowdhury et al. (2023) further observed that perceived usefulness was an essential predictor of the intention to adopt blockchain technology. Hence, the following null hypothesis was proposed:

$H1_0$ = Perceived usefulness of digital technologies does not have a positive influence on the intention to adopt digital technologies.

2.3.3 Perceived ease of use of digital technologies

The degree of effort in adopting a new technology is generally referred to as perceived ease of use (Venkatesh & Davis, 2000). The term is also related to the perception that a technology is effortless and simple to use (Balci, 2021). In a study performed on digital technology adoption in the manufacturing sector by Arumugam et al. (2022), perceived ease of use was associated with provision of relevant organisational resources, such as ease of connectivity. Kamble et al. (2021) derived that in the supply chain management (SCM) context, intention to adopt blockchain technology was predicted by perceived ease of use. Mishra et al. (2023) further supported that perceived ease of use significantly influences the intention to adopt blockchain technology, with Smit et al. (2018) observing the same outcome but for self-service application adoption in the South African airline industry. In addition, Berg and Lingen (2019) found that perceived ease of use had a positive influence on perceived usefulness for enterprise applications in South Africa. Also, for blockchain technology adoption in developing countries, a study by Ullah et al. (2022) supported the positive influence of perceived ease of use on perceived usefulness. Therefore, the following null hypotheses were proposed:

$H2_0a$ = Perceived ease of use of digital technologies does not have a positive influence on the intention to adopt digital technologies.

$H2_0b$ = Perceived ease of use of digital technologies does not have a positive influence on the perceived usefulness of digital technologies.

2.3.4 Technological context

Technological context is related to existing organisational technologies, such as ICT skills, infrastructure and tools, as well as those not yet in use within the organisation but are available externally (Hamadneha et al., 2023). Existing technologies are important in the adoption process, with it having a potential impact on limiting the rate of technological change of an organisation (Hamadneha et al., 2023).

a. ***Perceived relative advantage***

The perception that a particular technology has superior benefits in comparison to an alternative technology is referred to as perceived relative advantage (Rogers, 2010). The term also refers to the amount of effort required from an organisation in adopting a new technology to achieve the intended benefits (Wong, et al., 2020). According to Bhattacharya and Wamba (2018), relative advantage represents an important role in the adoption of a new technology in supply chain management (SCM). With Tasnim et al. (2023) acknowledging that the SCM process can benefit from the adoption of digital technologies, such as blockchain.

As observed by Kamble et al. (2019) and supported by Wong et al. (2020), the probability that adoption in an organisation occurred was higher if a digital technology, such as blockchain, was understood to have superior benefits or advantages relative to another technology. Puklavec et al. (2018) further support that perceived relative advantage has a considerable role to play in the adoption of IT innovation, especially in areas such as big data for logistics, SCM and business intelligence systems. As observed by Lin (2023), there is a higher propensity for organisations to adopt a digital technology if there is an element of perceived relative advantage. Furthermore, studies by Hussein et al. (2019) and Al-shanableh et al. (2024) observed the significant influence of perceived relative advantage on perceived usefulness of digital technologies, with evidence of a

positive influence of perceived relative advantage on perceived ease of use in a study by David et al. (2023). Hence, the following null hypotheses were derived:

$H3_0a$ = Perceived relative advantage does not have a positive influence on perceived usefulness of digital technologies.

$H3_0b$ = Perceived relative advantage does not have a positive influence on perceived ease of use of digital technologies.

$H3_0c$ = Perceived usefulness of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies.

$H3_0d$ = Perceived ease of use of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies.

b. ***Compatibility***

According to Rogers (1995), when an adopting organisation effectively integrates a new technology with its existing methods, characteristics and requirements, it is referred to as compatibility. In SCM systems, new technology compatibility is enhanced when it is considered compatible with organisational IT resources that already exist (Chittipaka et al., 2022).

In developing countries, particularly the adoption of ICT for small and medium enterprises (SME), Shahadat et al. (2023) observed that a noticeable aspect for promoting organisational technology adoption was compatibility; where ICT adoption related to infrastructure, operational processes and routines that exist in the organisation. An organisational environment has a higher inclination to adopt innovations and new technologies if it is considered compatible with current processes (Rogers, 2010). For the adoption of big data analytics, Sharma et al. (2023) suggested that ensuring adequate resources to enable compatibility with

systems could lead to improved accuracy and better integration. Furthermore, Al-shanableh et al. (2024) observed a significant influence of compatibility on perceived usefulness in the adoption of big data analytics in Jordan, with a study by Qin (2020) showing a positive influence of compatibility on perceived ease of use. A study performed on maritime transport in Greece confirmed the positive influence of compatibility on perceived usefulness and perceived ease of use (Sideri et al., 2021). Therefore, the following null hypotheses were derived:

$H4_0a =$ Compatibility does not have a positive influence on the perceived usefulness of digital technologies.

$H4_0b =$ Compatibility does not have a positive influence on the perceived ease of use of digital technologies.

$H4_0c =$ Perceived usefulness of digital technologies does not mediate the relationship between compatibility and intention to adopt digital technologies.

$H4_0d =$ Perceived ease of use of digital technologies does not mediate the relationship between compatibility and intention to adopt digital technologies.

2.3.5 Organisational-internal context

In adopting a new technology, an organisation's abilities and competencies that enable adoption are referred to as the organisational-internal context; with it relating to the structure and size of an organisation, competencies of resources, as well as intra-organisation characteristics (Wong et al., 2020).

a. *Knowledge absorption capability*

According to Dehghani et al. (2022), knowledge absorption capability is closely linked to dynamic capabilities, which relates to an organisation's ability to transform external knowledge into new capabilities, mainly due to its routines, processes and configuration. It is observed that the absence or lack of required

knowledge and skills for a particular digital technology, means that the organisation is less willing to adopt the digital technology (Dehghani et al., 2022).

Dynamic capabilities, or the ability to transform external knowledge, associated with big data analytics and digital platform capability are enhanced with knowledge absorption capabilities. With established dynamic capabilities, an organisation can enhance its agility and innovation performance (Khan & Tao, 2022). In supply chain, transport and logistics, Kamble et al. (2020) described enabling factors for adopting new technology as relevant skills, knowledge of employees and availability of training to aid in using and identifying the benefits of digital technologies. Also related to supply chain, transport and logistics, Wamba and Queiroz (2022) identified a major reason for delayed adoption of the digital technology blockchain as the lack of employee knowledge and skills, with Papathanasiou et al. (2020) noting that knowledge and skills are needed in the assimilation of external knowledge. According to Mahmood and Mubarik (2020), knowledge absorption capability improves the adaptability of an organisation, which assists in digital technology adoption. Through literature analysis, Lin (2023) identified that knowledge absorption capability can ultimately enable organisational change and the stronger the capability, the more responsive an organisation is to market changes and supply chain partners. Lin (2023) also observed the significant positive influence that knowledge absorption capability had on perceived usefulness in the maritime industry, with a study by Mayeh et al. (2016) supporting the significant relationship of knowledge absorption capability on perceived ease of use. Hence, the following null hypotheses were derived:

$H5_0a =$ Knowledge absorption capability does not have a positive influence on perceived usefulness of digital technologies.

$H5_0b =$ Knowledge absorption capability does not have a positive influence on perceived ease of use of digital technologies.

2.4 External environmental factors that influence the intention of organisations to adopt digital technologies

External driving factors influencing an organisation's intention to adopt refers to factors outside the organisation or factors that the organisation does not have direct control over and are known as the external-environmental context in the TOE theoretical framework (Vang & Lind, 2023).

2.4.1 Competitive pressure

According to Ali et al. (2023), competitive pressure is a noticeable stimulant of innovation adoption and relates to industry pressure from competitors felt by the adopting organisation. Chittipaka et al. (2022) further support the notion that competitive pressure significantly influences new technology adoption. Competitive pressure can be described as the internal pressure experienced within an organisation, motivating the use of new technologies for gaining a competitive advantage (Shi & Yan, 2016). The competitive pressure felt by an organisation assists in shifting its focus towards competitive strategy development and anticipating the impact associated with new technology adoption (Allen & Iano, 2019).

According to Shahadat et al. (2023), in the ICT adoption of SMEs, the firm's adoption rate was impacted due to the need to enhance its performance because of increased industry competition. The competitiveness of an organisation was increased through the competitive advantage and enhanced strategic performance that arose through effective technology adoption. Further observations by Shahadat et al. (2023) suggest that technology adoption enhanced dynamic capability, which made it necessary for firm survival as it assisted the organisation in adapting to changing competitive environments. Therefore, industry competition is observed to positively affect digital technology adoption in organisations (Hussain et al., 2020). Studies performed by Malik et

al. (2021) and Kiu and Chan (2023) support the significant influence of competitive pressure on the intention to adopt blockchain and data analytics, respectively. Hence, the following null hypothesis was stated:

$H6_0 =$ Competitive pressure does not have a positive influence on the intention to adopt digital technologies.

2.4.2 Government Support

According to Chiu and Shih (2023), government support in the form of developing an enabling regulatory environment, encourages the acceptance of innovations. This was observed in the study by Chiu and Shih (2023) on the adoption of RFID in Taiwan, which recommended that policymakers develop promotive policies for technology adoption. Therefore, it is suggested that government support, through shaping of enabling regulation, could influence the use of technology, thereby leading to potential benefit realisation.

Hussain et al. (2020) described support from government as IT, availability of infrastructure and willingness to enable technology adoption, whereas Christiansen et al. (2022) demonstrate that government policy and information system initiatives positively affect the adoption of cloud computing. Chittipaka et al. (2022) refer to government support as the shaping of government regulation and policy for new technology use, which essentially impacts innovation diffusion. In SCM, the regulatory environment is a significant determinant impacting blockchain technology, especially due to unestablished digitalised recording authorities and rights to access (Sharma et al., 2020). Especially with adopting emerging technologies, such as blockchain, legal requirements are important considerations for maritime and multinational business (Li et al., 2020).

In the aviation industry in Korea, Li et al. (2021) observed a positive influence of regulatory governance and industry standards on the intention to adopt digital technologies. In a study on the adoption of blockchain, maritime organisations

were prone to adopt the digital technology when relevant incentives, legislation and technical standards were in place (Lin, 2023). Similarly, low adoption rates were observed for digital technology in unstable regulatory environments. Likewise, as supported by Gokalp et al. (2022), an enabling, legitimate government support structure encouraged organisational adoption. Hence, the derived null hypothesis:

$H7_0 =$ Government support does not have a positive influence on the intention to adopt digital technologies.

2.5 Government support as a moderator on the intention of organisations to adopt digital technologies

The usefulness and ease of use of technology are considered important criteria in technology adoption. In a study on RFID technology adoption in United Kingdom logistics, government support significantly moderated the relationship between RFID usability and the intention to adopt the technology (Ramanathan et al., 2014). Ramanathan et al. (2014) observed that strong government support, in the context of UK logistics, led to increased benefit maximisation of RFID usability by UK logistics organisations. In the study on RFID adoption, government support was related to funding, training programmes, assistance in research and development and regulatory support.

In the manufacturing sector, Ngisau and Ibrahim (2022) found that government support moderated the relationship between technology and environment context and technological innovation adoption, respectively. However, the moderating effect of government support on the relationships between independent variables, complexity, compatibility and organisation context, and dependent variable, technological innovation adoption, was not supported (Ngisau & Ibrahim, 2020). In the context of developing countries, government support was considered essential and related to support in purchasing critical machinery and

equipment, registration of patents, improving productivity and innovation, as well as tax-exemption incentives, innovation grants and duty-free imported equipment (Ngisau & Ibrahim, 2020).

Furthermore, in the adoption of mobile-government services, perceived government support was found to be significant when moderating the relationship between independent variables, performance expectancy, facilitating conditions and trust, and dependent variable, behavioural adoption of m-government services (Mensah et al., 2022). However, the moderating effect of perceived government support was not supported on the relationships between security, privacy and information quality, and behavioural adoption of m-government services. Mensah et al. (2022) described government support as dedicated, adequate human and financial resources to drive technology adoption and develop enabling infrastructure, policies and protective laws that enable ease of use. Hence, the following null hypotheses were derived:

$H8_0a =$ Government support does not moderate the relationship between perceived usefulness of digital technologies and the intention to adopt digital technologies.

$H8_0b =$ Government support does not moderate the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies.

2.6 ANALYTICAL FRAMEWORK

This section provides an overview of the theoretical framework selected and the conceptual framework derived from the analysis of literature.

2.6.1 Theoretical Framework

According to Taherdoost (2018), different frameworks are used to understand user acceptance and new technology adoption. Each model introduces factors that could influence user adoption and acceptance. Some of these models include Technology Acceptance Model (TAM), Diffusion of Innovation theory (DOI) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Taherdoost, 2018). Investigation and studies into technology adoption at an organisational level generally use the Technology-Organisation-Environment (TOE) framework, with different studies having used these traditional frameworks individually or combined with other models and some with the addition of new constructs (Taherdoost, 2018).

TAM focuses on user motivation based on the three factors of perceived usefulness, perceived ease of use and attitude toward use, which in turn influences behavioural intention to adopt (Lin et al., 2011). According to Taherdoost (2018), TAM is limited in applications beyond the work environment as it does not consider social influence on technology adoption and may require the addition of external variables. Another limitation includes the absence of intrinsic motivations, which makes it difficult to apply in a customer context for use of technology and to fulfil emotional needs (Taherdoost, 2018). ETAM was proposed with the intention to improve the explanatory power and specificity on TAM (Maillet et al., 2015) by adding the constructs of social influence and cognitive, especially to improve the predictive power to form TAM2 (Taherdoost, 2018).

Eight different models were compared for similarities and differences, which led to the development of UTAUT (Venkatesh & Bala, 2008). The constructs of UTAUT are effort expectancy, performance expectancy, social influence and facilitating conditions, with four moderating variables of gender, experience, age and voluntariness of use (Taherdoost, 2018). Compatibility beliefs were then

integrated into the model to improve its explanatory power, with the addition of hedonic motivation, habit and price value (Sharma et al., 2017).

TOE focuses on three components that impact technological innovation, which include technology, organisational and environmental context (Bryan & Zuva, 2021). Developed by Tornatzky and Fleischer in 1990, three components are related to an enterprise's context (Oliveira & Martins, 2011). The internal technologies and technologies external to the firm form part of the technological context, whereas internal firm characteristics such as managerial structure and size relate to organisational context and finally, environmental context refers to the external business environment in which the firm operates in (Oliveira & Martins, 2011). Both the internal and external characteristics of the organisation are considered drivers for innovation within the organisation (Oliveira & Martins, 2011). However, the addition of the environment context assists in further explaining innovation diffusion within the firm itself (Hsu et al., 2006).

The study aimed to understand both internal and external factors that influence digital technology adoption of South African freight transport organisations, hence the focus was mainly at a firm level. Therefore, TOE was selected as the primary theoretical framework due to its relevance in understanding adoption at an organisational level. The following combination of models were compared to derive the most comprehensive theoretical framework for the study.

a. ***UTAUT-TOE***

Li and Cheng (2021) combined the UTAUT and TOE models to investigate the adoption willingness of IoT technology of large and specialised farmers in China. UTAUT was selected as the theoretical model for usage behaviour and its explanatory power being as high as 70% (Li & Cheng, 2021). It was observed that UTAUT was limited in understanding users in an organisational context, which are based on organisational rules (Wang, 2019). Hence, TOE was integrated to consider the characteristics of large and specialised vegetable

farmers and IoT technology, specifically for its organisational context. A study performed by Park (2020) on the usage intention of blockchain in logistics and supply chain management organisations, also demonstrated the use of UTAUT and TOE, in which UTAUT was selected based on wide use when confirming the intention to adopt logistics systems (Dulle & Minishi-Majanja, 2011). TOE was selected based on the three constructs that influence the process of IT adoption in a firm (Park, 2020).

b. ***TAM-TOE***

TAM and TOE integration was observed in a study to quantitatively investigate factors influencing precast concrete components (PCC) adoption; this was from an individual and organisational perspective (Katebi et al., 2022). TAM focused on the attitudes of innovation acceptance of individuals, whereas TOE had precision in assessing organisational acceptance of technology (Katebi et al., 2022). In a study in the manufacturing environment, AI adoption was observed utilising TOE and TAM. TAM was selected due to its common application in information systems, its applicability in predicting the acceptance of different technologies and its explanation capability of at least 40% (Chatterjee et al., 2021). TOE was integrated due to its ability to explain different technologies in the modern context, with regards to socioenvironmental and technological environments (Hossain & Quaddus, 2011), and the adoption of various digital technologies considered successful in its application (Chatterjee et al., 2021).

Based on the assessed integrated theoretical frameworks, the most applicable combination for this study was the TAM-TOE integrated model, especially due to majority focus being at an organisational level but still accounting for core acceptance beliefs of behavioural intention at an individual level.

2.6.2 Conceptual Framework

The proposed conceptual model consisted of five TOE-based variables related to technological context (perceived relative advantage, compatibility), organisational-internal context (knowledge absorption capability) and external-environment context (competitive pressure, government support), whereas intention to adopt digital technologies, perceived ease of use of digital technologies and perceived usefulness of digieral technologies were three TAM-based constructs. Government support was introduced as a moderating variable. Figure 4 illustrates the proposed research model.

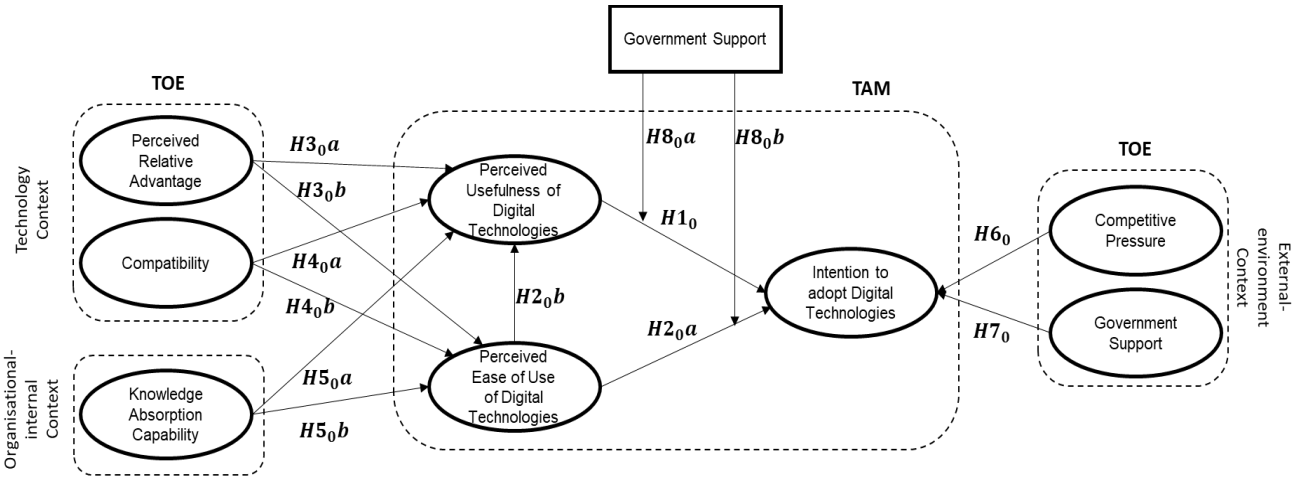

Figure 4: Conceptual TAM-TOE model

2.7 Conclusion of Literature Review

By performing a literature review, critical factors related to digital technology adoption from an organisational perspective were derived. Relevant technology adoption models were assessed for applicability in the context of an internal and external organisational perspective. Based on the findings, the combined TAM-TOE model was selected as an appropriate model. Furthermore, the importance of government support was observed and its influence on the intention to adopt

digital technologies. Hence, the following null hypotheses were derived and summarised.

2.7.1 Hypotheses regarding internal factors influencing intention to adopt digital technologies

$H1_0$ = Perceived usefulness of digital technologies does not have a positive influence on the intention to adopt digital technologies.

$H2_0a$ = Perceived ease of use of digital technologies does not have a positive influence on the intention to adopt digital technologies.

$H2_0b$ = Perceived ease of use of digital technologies does not have a positive influence on the perceived usefulness of digital technologies.

$H3_0a$ = Perceived relative advantage does not have a positive influence on perceived usefulness of digital technologies.

$H3_0b$ = Perceived relative advantage does not have a positive influence on perceived ease of use of digital technologies.

$H3_0c$ = Perceived usefulness of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies.

$H3_0d$ = Perceived ease of use of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies.

$H4_0a$ = Compatibility does not have a positive influence on the perceived usefulness of digital technologies.

$H4_0b$ = Compatibility does not have a positive influence on the perceived ease of use of digital technologies.

$H4_0c$ = Perceived usefulness of digital technologies does not mediate the relationship between compatibility and intention to adopt digital technologies.

$H4_0d$ = Perceived ease of use of digital technologies does not mediate the relationship between compatibility and intention to adopt digital technologies.

$H5_0a$ = Knowledge absorption capability does not have a positive influence on perceived usefulness of digital technologies.

$H5_0b$ = Knowledge absorption capability does not have a positive influence on perceived ease of use of digital technologies.

2.7.2 Hypotheses regarding external factors influencing intention to adopt digital technology

$H6_0$ = Competitive pressure does not have a positive influence on the intention to adopt digital technologies.

$H7_0$ = Government support does not have a positive influence on the intention to adopt digital technologies.

2.7.3 Hypotheses regarding the moderating effect of government support on the intention to adopt digital technology

$H8_0a$ = Government support does not moderate the relationship between perceived usefulness of digital technologies and the intention to adopt digital technologies.

$H8_0b$ = Government support does not moderate the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies.

CHAPTER 3. RESEARCH METHODOLOGY

This chapter describes the methodological research approach that was followed to address the hypotheses that arose from the literature review in Chapter 2. The chapter focused on the research design, the population and sample selection, as well as the research instrument. In addition to the above, the data collection procedure, data analysis and interpretation method, including the limitations of the study, were discussed.

3.1 Research approach

The study used the quantitative research approach to gather and interpret respondents' feedback. According to Mulisa (2021), a quantitative study is based on numerical data and statistical analysis methods, whereas, qualitative research focuses on exploratory methods, which is guided by dialectics. The intention of the study was to investigate the internal and external factors influencing digital technology adoption, hence the testing of derived hypotheses and measurement of relationships among the constructs were required for the study. The study was aimed at confirmatory purposes, rather than exploratory, using surveys and statistical methods in order to ascertain the strength of relationships between factors in the conceptual research model (Mulisa, 2021). These requirements were considered the characteristics of quantitative research (Mulisa, 2021).

It is understood that other considerations, such as the research paradigm, can influence the decision of an appropriate research approach. Johnson and Christensen (2014) describe a research paradigm as a worldview that governs research based on shared values, assumptions and practices. This study made use of a positivism paradigm. According to Turner (1992), positivism focuses on the "process of gathering data, observing regularities and extracting laws", whereas Sale and Brazil (2004) argue that "all phenomena can be reduced to empirical indicators which represent the truth." Aliyu et al. (2014) further state that

the positivist paradigm generally supports methodologies such as deduction and confirmatory analysis. Hence, the support of the positivist paradigm for the quantitative research approach.

3.2 Research design

A survey design, specifically a cross-sectional design, was used for data collection; the cross-sectional design indicated the collection of data at a specific point in time, rather than over a specific period (Acharya et al., 2013). The study utilised a quantitative research approach, which allowed the primary data for the study to be collected using a structured online questionnaire. An online questionnaire was applicable as it allowed the respondent to complete the questionnaire during an appropriate, convenient time. In addition, the questionnaire allowed for anonymity, unlike face-to-face engagements, which encouraged respondents to answer fairly and honestly. Furthermore, it was considered cost effective and appropriate for increased geographic reach.

The structured questionnaire made use of a seven-point Likert scale, where ‘1’ represented strongly disagree and ‘7’ represented strongly agree. It has been observed that respondents using a five-point Likert scale were more likely to interpolate (Finstad, 2010). Finstad (2010) supported that a seven-point Likert scale was more accurate in measuring a participant’s evaluation for electronically distributed questionnaires, especially in an unsupervised environment. Hence, a seven-point Likert scale was preferred to a five-point Likert scale. Advantages of Likert scales include ease of use in understanding and answering questions, as well as responses being easier to code for data collection (Heo et al., 2022). Further advantages include the convenience associated with constructing and modifying responses (Li, 2013). In terms of disadvantages, depending on the individual, the interpretation of the Likert scale rating may have a different meaning, as well as encourage avoiding selection of extreme scale options (Heo et al., 2022).

3.3 Data collection methods

The Qualtrics system was used to create the questionnaire, which was distributed to participants electronically via email. The group studied was from the freight transport sector in South Africa, which required the use of an electronically distributed questionnaire for increased geographic reach and objectivity (Apuke, 2017). The aim was for generalisation in the freight transport sector to potentially assist in explaining the adoption of digital technologies of organisations in this sector. The online questionnaire was distributed to organisations in the South African freight transport sector, specifically in road, rail, pipeline and port industries. The method used allowed for increased reach across the different industries, especially since the different organisations were spread across the country and across different operational environments. The broad coverage of this technique was faster and more economical considering the diversity of the population.

3.4 Population and sample

3.4.1 Target Population

The target population in the context of the study referred to organisations in the freight transport sector, including freight rail, port terminals, pipelines and the Road Freight Agency as shown in Appendix A: Table 14. The total target population was 13 627. The research assumed respondents were over the age of 18, which is within the legal age of employment in South Africa.

3.4.2 Sample and sampling method

The sampling method used was stratified random sampling as the population was heterogenous and there were clear subgroups or strata observed within the population (Acharya et al., 2013); these strata referred to the different industries

of road, rail, port and pipeline. The sample was not limited by geographic location or income, but rather by industry type within the sector.

Based on the sampling size criteria with a 5% level of precision (Singh & Masuku, 2014), a confidence level of approximately 95% and target population size as detailed in Appendix A: Table 14, the total sample size was 374; this consisted of strata sample sizes of 251 in rail, 101 in port, 19 in pipeline and 4 in road. The raosoft online sample size calculator was used to calculate the sample size. The total responses obtained was 234, which was a 63% response rate.

3.5 The research instrument

The conceptual model and the hypotheses were validated through data obtained via a survey, which entailed preparing an online questionnaire via Qualtrics. The questionnaire was created using constructs derived from the literature review. The structured questionnaire made use of a seven-point Likert scale, where ‘1’ represented strongly disagree and ‘7’ represented strongly agree. The online questionnaire was advantageous in this study’s context due to its convenience, cost-effectiveness and geographic reach.

A random table method was used to randomly select strata samples to ensure objectivity. Personal information was not requested during completion of the questionnaire to maintain anonymity. Measurement items were adapted from previous studies to maintain validity. The questionnaire used can be located in Appendix B.

3.6 Procedure for data collection

The survey, represented by the Qualtrics email link, was sent to randomly selected individuals in organisations in the different industries. The Road Freight Agency (RFA) is a lobbying and negotiation body that supports member

companies in the trucking industry, whereas key rail, port and pipeline owners and operators were selected for strategic significance and footprint in South Africa. Before commencement of the questionnaire, the participant was provided with a written explanation of the purpose of the survey and was assured that their identification would remain anonymous. The introductory explanation clearly stated that all potential participants had the right to decline from participating in the survey. The Participant Information Sheet and Participant Agreement Form are attached in Appendix C and D, respectively.

3.7 Data analysis strategies and interpretation

An integrated approach of the TAM and TOE framework was used for this study. For data analysis, the software Statistical Package for the Social Sciences (SPSS) was used to clean the data, observe outliers and test for normality. The data was then imported to SmartPLS 4, a software used for latent variable modelling, specifically for Partial Least Squares Structural Equation Modelling (PLS-SEM) (SmartPLS, 2024). The use of PLS-SEM, a non-parametric method, was selected as the analysis technique for the study. The analysis technique consisted of two models referred to as the measurement model and the structural model (Hair Jr et al., 2019). PLS-SEM was selected due its ability to handle complex models, which was applicable to the study's model of more than one independent variable in the prediction of the dependent variable, with multiple mediators and a moderator. Furthermore, PLS-SEM's high statistical power and multivariate non-normality capability deemed it applicable for the study. Descriptive statistics was also used to analyse the demographic characteristics and general responses of the sample.

3.8 Possible limitations and challenges of the study

- The survey and study was limited to select freight transport organisations in South Africa. Therefore, the findings of this research should be tested

in the context of a wider selection of freight transport organisations, as well as in other developing countries.

- The research involved cross-sectional data gathering whereas a longitudinal study is generally more suited for observing behavioural intention to adopt over a period of time.
- The study omitted the air industry due to limitations in accessing its population.
- Furthermore, the total sample size was not achieved, with the lowest response rate obtained from the rail industry; it was noted that this may have introduced sampling bias due to underrepresentation of rail in comparison to port, pipeline and road industries.
- Covariance-based Structural Equation Modelling (CB-SEM) was initially considered for model testing, using IBM SPSS AMOS software. However, multivariate normality, which is a requirement for maximum likelihood estimation in CB-SEM in AMOS, was not achieved satisfactorily even while using Bollen-Stine bootstrapping method.

3.9 Quality Assurance

3.9.1 External validity

According to Findley et al. (2021), external validity refers to the extent that the inferences drawn from a sample can be applied to a wider population or to other settings. Hence, the sample considered the major industries that constitute freight transport in South Africa, namely road, rail, port and pipeline. Furthermore, participants were not selected by gender, role or experience, but were represented by industry. Based on random sampling of participants from the diverse population and the contextualisation of research questions not particular to the transport sector, generalisability (Findley et al., 2021) was consistent and credible for the context of the research.

3.9.2 Internal validity

The conceptual model developed and research model tested was based on a valid theoretical framework and was supported by an extensive literature review. A pilot study was conducted for quality control prior to official commencement of the survey. Furthermore, indicators of each construct were adapted from pre-existing surveys that were supported by literature. For measuring convergent and discriminant validity, the average variance extracted (AVE) was evaluated in explaining the variance of items and heterotrait-monotrait ratio (HTMT) of correlations was used, respectively (Hair Jr et al., 2019).

3.9.3 Reliability

According to Sürücü and Maslakçı (2020), reliability is an indicator of the stability and consistency of the measuring instrument under different contexts and at different times. Internal consistency, which is related to reliability, was accounted for using Cronbach alpha, with indicators selected based on a Cronbach alpha coefficient greater than 0.7, therefore indicating the scale had internal consistency (Sürücü & Maslakçı, 2020). Furthermore, to weight the individual indicators, composite reliability was used (Hair Jr et al., 2019).

3.9.4 Objectivity

Objectivity was ensured by minimising conceptual and theoretical bias. This was achieved as the hypotheses formulated were based on analysis of literature and were formed based on the researched theoretical framework. In addition, data was not gathered from the questionnaire and used for hypothesis formulation. Furthermore, with reference to sample bias, the sample was selected based on researched representation of the population structure and features and not assumed criteria of the researcher. The online survey link was distributed to

participants at random and not according to a pre-planned selection of specific individuals.

3.10 Ethical considerations

Firstly, no data was collected from potential respondents before ethical clearance was obtained from Wits Business School Ethics Committee and permission letters obtained from the respective organisations. Once ethics clearance was obtained, the research process commenced and the online survey was distributed to potential respondents. Before beginning the survey, participants were informed of the anonymity and confidentiality of responses and that completion of the survey was voluntary. Only respondents older than 18 years of age were required to complete the survey. The details surrounding this information was contained in the Participant Information Sheet, which was provided to respondents prior to commencement of the questionnaire. There was no discrimination in respondent selection and the selection process was randomised. Once data was gathered, it was not falsified or misrepresented, neither was information fabricated for research purposes. As best as possible, objectivity was applied in data analysis and biasness minimised.

CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

The results in this chapter are first introduced as an overview and thereafter, each hypothesis is focused on. Furthermore, the overview and subsequent hypotheses are summarised into two main subsections, the measurement model assessment and the structural model assessment. The measurement model assessment addresses confirmatory factor analysis results, whereas the structural model assessment addresses structural equation modelling. Each subsection further discusses characteristics and statistical indicators specific to the relevant subsection.

4.1.1 Demographic Characteristics

The demographic information of respondents is depicted in Table 1. In total, there were 234 respondents across the different transport industries in South Africa, namely road, rail, port and pipeline; 52.1% of respondents were from the rail industry, which was expected considering the stratified random sampling used. Out of the 234 respondents, 48.3% were considered competent in their experience of digital technologies, with 76.1% having used digital technologies daily. Of the respondents, 64.5% had over a decade of experience in the transport sector, with 44.4% holding a mid-level management position. In terms of qualifications, 35.0% and 34.6% of respondents held a diploma and bachelor's degree, respectively.

Table 1: Respondent demographic information

Characteristic	Item	Frequency	Percentage
Industry	Road	5	2,1%
	Rail	122	52,1%

Characteristic	Item	Frequency	Percentage
	Port	83	35,5%
	Pipeline	24	10,3%
Transport Experience (Years)	1-10	83	35,5%
	11-20	115	49,1%
	21-30	28	12,0%
	31-40	7	3,0%
	>40	1	0,4%
Experience in DT	Novice	28	12,0%
	Advanced beginner	47	20,1%
	Competent	113	48,3%
	Proficient	39	16,7%
	Expert	7	3,0%
Frequency of DT Use	Daily	178	76,1%
	Weekly	32	13,7%
	Monthly	12	5,1%
	Quarterly	1	0,4%
	Annually	1	0,4%
	Less often than annually	10	4,3%
Job Position/Level	Junior	62	26,5%
	Mid-Level	104	44,4%
	Senior	29	12,4%
	Executive	5	2,1%
	Specialists	19	8,1%
	Other	15	6,4%
Highest Qualifications	<Matric	1	0,4%
	Matric	50	21,4%
	Diploma	82	35,0%
	Bachelors	81	34,6%
	Master's Degree	20	8,5%

4.1.2 Measurement Model Assessment

The first major step of complete structural equation modelling was assessing the measurement model. In this step, construct reliability and validity were assessed by observing the relationship between constructs and the respective indicators. The initial measurement model, depicted in Figure 5, was assessed according to factor loading criteria and model fit indices. The constructs in the measurement model are Perceived Relative Advantage (PRA), Compatibility (C), Knowledge

Absorption Capability (KAC), Competitive Pressure (CP), Government Support (GS), Perceived Usefulness of Digital Technologies (PUDT), Perceived Ease of Use of Digital Technologies (PEUDT) and Intention to Adopt Digital Technologies (DTA).

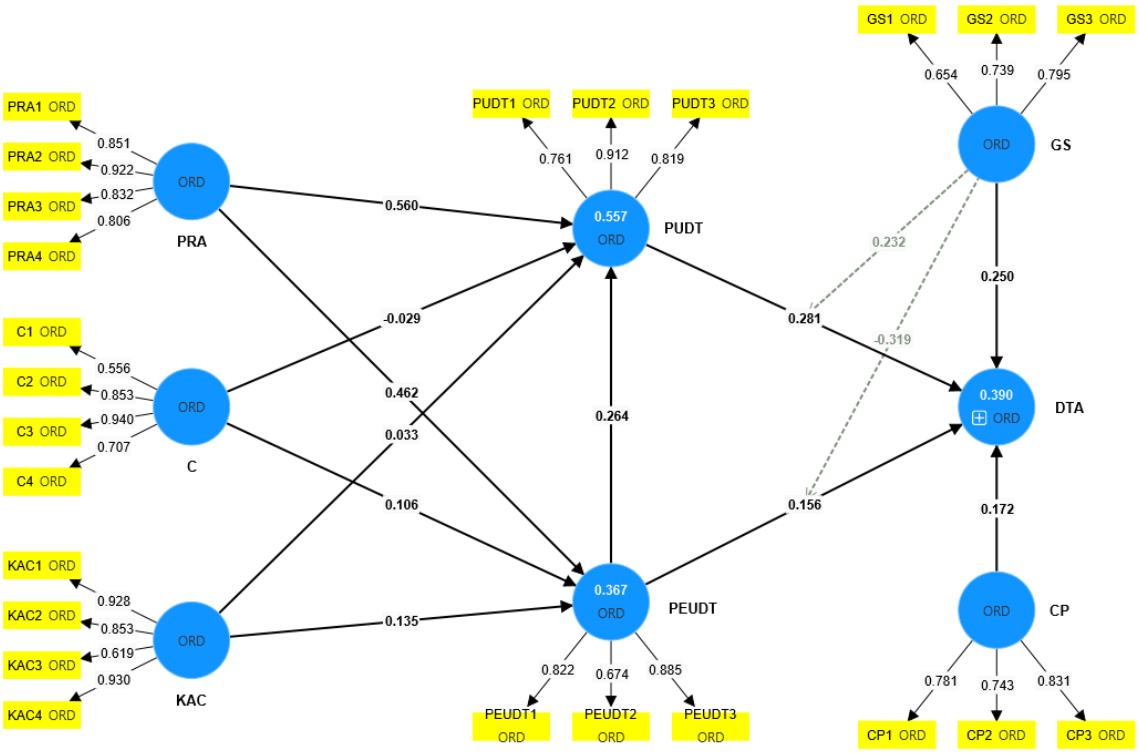

Figure 5: Initial PLS Measurement Model

a. *Indicator Loading*

According to Hair et al. (2019), factor loadings should ideally be greater than 0.7. However, Sarstedt et al. (2017) discuss that factor loadings below 0.7, but above 0.4, should only be removed if it improves composite reliability and construct validity. Based on the evaluation of the factor loadings, indicators C1 was removed from construct C and KAC3 from construct KAC. After these factors were removed, a final model was achieved, as can be seen in Figure 6.

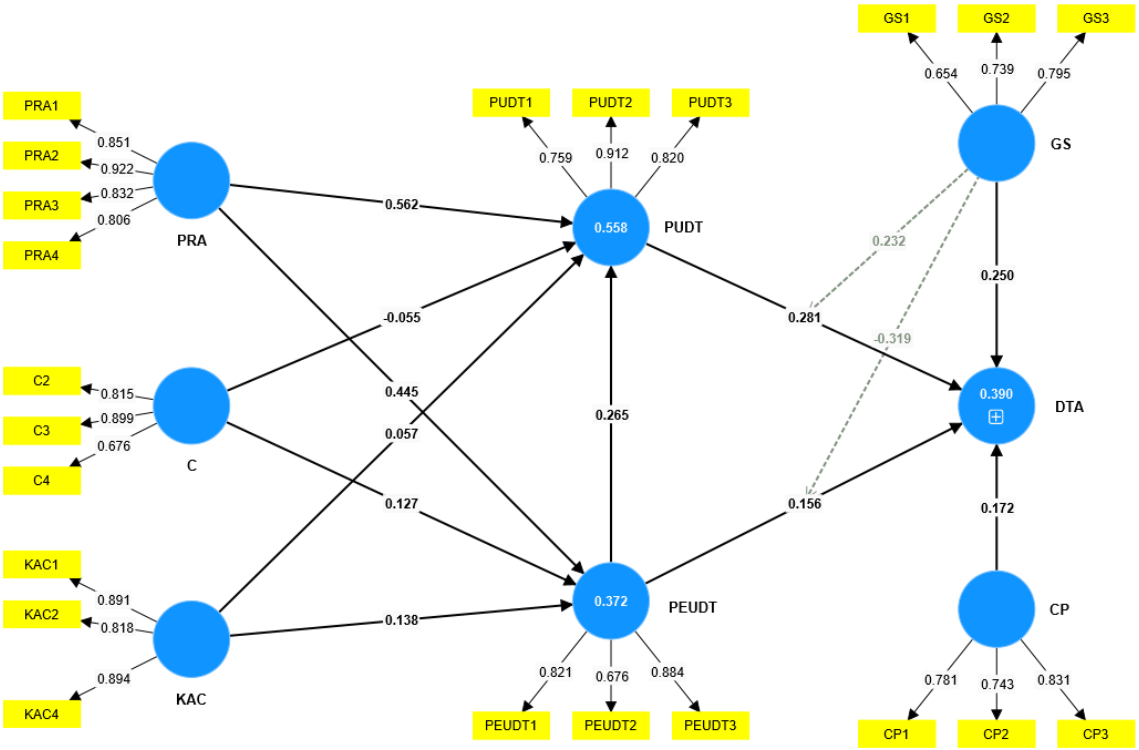

Figure 6: Final PLS Measurement Model

b. *Construct Reliability and Validity*

A Cronbach alpha greater than 0.7 was considered acceptable and confirmed the internal consistency and reliability of the measurement model (Haenlein & Kaplan, 2004). However, based on the limitations associated with Cronbach alpha, a Composite reliability (CR) criterion, also above 0.7, was recommended for reliability confirmation (Hair Jr et al., 2019). Average variance extracted (AVE) criterion above 0.5 was considered acceptable, which confirmed the accuracy of the measurement model (Haenlein & Kaplan, 2004). Furthermore, to confirm convergent validity, CR values were greater than AVE values (Haenlein & Kaplan, 2004). Table 2 details the results for cronbach alpha, composite reliability and average variance extracted for each measured construct. The results confirmed construct reliability and validity based on the recommended thresholds.

Table 2: Construct reliability and validity criteria

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
C	0.841	0.856	0.842	0.643
CP	0.830	0.831	0.829	0.618
DTA	0.792	0.828	0.790	0.564
GS	0.782	0.780	0.774	0.535
KAC	0.901	0.904	0.902	0.754
PEUDT	0.841	0.851	0.839	0.638
PRA	0.916	0.917	0.915	0.729
PUDT	0.868	0.878	0.871	0.694

c. ***Discriminant Validity***

Discriminant validity is generally measured by observing the Fornell-Larcker criterion, the heterotrait-monotrait (HTMT) ratio and cross-loadings (Apuke, 2017). A high discriminant validity represents clear distinction and uniqueness among constructs (Hair Jr et al., 2019). Table 3, 4 and 5 depict the Fornell-Larcker criterion, the heterotrait-monotrait (HTMT) ratio and cross-loadings, respectively.

Initial evidence of discriminant validity was provided by the Fornell-Larcker criterion. An indication of discriminant validity was observed when the square root of the AVE values, in bold in Table 3, was greater than the off-diagonal correlations (Hair Jr et al., 2019). Hence, discriminant validity was achieved as the requirements for the Fornell-Larcker criterion were satisfied.

Table 3: Fornell-Larcker Criterion

	C	CP	DTA	KAC	LE	PEUDT	PRA	PUDT
C	**0.802**							
CP	0.498	**0.786**						
DTA	0.443	0.468	**0.751**					

	C	CP	DTA	KAC	LE	PEUDT	PRA	PUDT
GS	0.500	0.263	0.363	**0.731**				
KAC	0.649	0.338	0.573	0.556	**0.868**			
PEUDT	0.443	0.428	0.452	0.323	0.432	**0.798**		
PRA	0.508	0.706	0.499	0.245	0.476	0.575	**0.854**	
PUDT	0.385	0.624	0.475	0.219	0.403	0.588	0.713	**0.833**

For PLS-SEM, the preferred method for assessing discriminant validity was the HTMT test; a threshold of below 0.85 was recommended (Hair Jr et al., 2019). The satisfaction of the recommended threshold is observed in Table 4 and provided evidence of strong discriminant validity.

Table 4: Heterotrait-Monotrait Ratio

	C	CP	DTA	GS	KAC	PEUDT	PRA	PUDT	GS x PUDT	GS x PEUDT
C										
CP	**0.496**									
DTA	0.459	**0.441**								
GS	0.514	0.248	**0.392**							
KAC	0.655	0.333	0.596	**0.556**						
PEUDT	0.443	0.414	0.451	0.319	**0.436**					
PRA	0.506	0.703	0.478	0.233	0.475	**0.566**				
PUDT	0.384	0.624	0.457	0.216	0.401	0.582	**0.713**			
GS x PUDT	0.158	0.282	0.160	0.120	0.104	0.122	0.295	**0.406**		
GS x PEUDT	0.081	0.166	0.155	0.110	0.066	0.025	0.144	0.117	**0.473**	

Cross-loading provides an indication of a variable that has more than one significant loading (Apuke, 2017). Table 5 depicts that each indicator had larger outer loadings in comparison to its cross-loadings with other constructs. Furthermore, the outer loading of each indicator was greater than 0.1 (Sulaiman et al., 2023). This further supports discriminant validity in the results obtained.

Table 5: Cross Loadings

	C	CP	DTA	GS	KAC	PEUDT	PRA	PUDT
C2	0.815	0.477	0.379	0.396	0.520	0.351	0.449	0.324
C3	0.899	0.408	0.366	0.358	0.540	0.397	0.453	0.347
C4	0.676	0.303	0.320	0.474	0.507	0.313	0.307	0.245
CP1	0.475	0.781	0.365	0.230	0.244	0.299	0.470	0.396
CP2	0.349	0.743	0.348	0.213	0.211	0.294	0.526	0.444
CP3	0.353	0.831	0.389	0.180	0.334	0.410	0.663	0.623
DTA1	0.354	0.192	0.601	0.378	0.445	0.269	0.244	0.236
DTA2	0.344	0.273	0.684	0.343	0.500	0.309	0.301	0.289
DTA3	0.324	0.527	0.929	0.165	0.388	0.422	0.530	0.499
GS1	0.409	0.068	0.237	0.654	0.448	0.183	0.091	0.067
GS2	0.370	0.073	0.268	0.739	0.401	0.235	0.073	0.075
GS3	0.330	0.408	0.289	0.795	0.382	0.283	0.352	0.317
KAC1	0.584	0.318	0.477	0.439	0.891	0.374	0.446	0.371
KAC2	0.573	0.249	0.506	0.460	0.818	0.392	0.363	0.289
KAC4	0.536	0.310	0.512	0.548	0.894	0.362	0.428	0.385
PEUDT1	0.353	0.323	0.383	0.241	0.383	0.821	0.460	0.479
PEUDT2	0.336	0.214	0.370	0.267	0.339	0.676	0.338	0.369
PEUDT3	0.373	0.462	0.340	0.271	0.320	0.884	0.560	0.545
PRA1	0.431	0.558	0.394	0.199	0.372	0.519	0.851	0.584
PRA2	0.412	0.599	0.449	0.197	0.413	0.495	0.922	0.686
PRA3	0.441	0.618	0.469	0.263	0.421	0.491	0.832	0.584
PRA4	0.458	0.644	0.392	0.179	0.421	0.462	0.806	0.576
PUDT1	0.296	0.513	0.349	0.244	0.263	0.437	0.559	0.759
PUDT2	0.343	0.519	0.439	0.175	0.377	0.561	0.634	0.912
PUDT3	0.320	0.531	0.393	0.135	0.360	0.464	0.587	0.820

4.1.3 Structural Model Assessment

The second major step of complete structural equation modelling was assessing the structural model. In this step, the relationship between constructs was assessed to essentially test the hypothesised theoretical model (Hair Jr et al., 2019). The structural model is depicted in Figure 7.

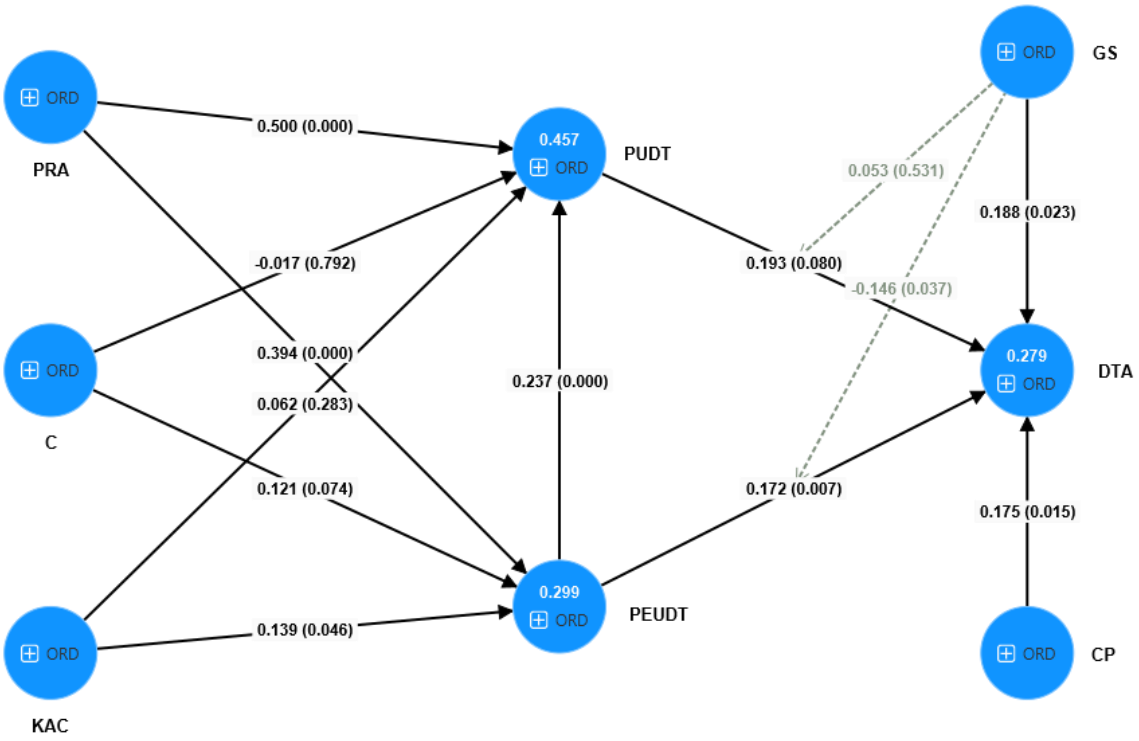

Figure 7: PLS Structural Model for Structural Equation Modelling

a. ***Collinearity Statistics***

When evaluating the severity of collinearity among constructs, a variance inflation factor (VIF) greater than 5 is considered severe (Hair Jr et al., 2019). Based on the results in Table 6, no values greater than 5 were observed. Therefore, there was no concern of high multicollinearity among constructs.

Table 6: Variance Inflation Factor Statistics

	VIF
C2	1.903
C3	2.155
C4	1.959
CP1	2.030
CP2	2.329
CP3	1.686
DTA1	1.749
DTA2	2.002

DTA3	1.512
GS1	3.516
GS2	3.772
GS3	1.230
KAC1	3.560
KAC2	2.746
KAC4	2.648
PEUDT1	2.925
PEUDT2	2.384
PEUDT3	1.683
PRA1	3.080
PRA2	2.183
PRA3	3.761
PRA4	3.457
PUDT1	1.992
PUDT2	2.978
PUDT3	2.431
GS x PUDT	1.000
GS x PEUDT	1.000

b. *Coefficient of Determination (R^2)*

According to Richter (2016), in-sample predictive power is determined by the coefficient of determination. A perfect relationship is represented by 1, whereas no relationship is observed when the coefficient is 0 (Richter et al., 2016). A coefficient of 0.75 is considered strong, with 0.25 considered weak and a value of 0.5 considered moderate (Hair Jr et al., 2019). Hence, based on the guidelines, the coefficient of determination for DTA, PEUDT and PUDT, as observed in Table 7, are considered moderate.

Table 7: Coefficient of Determination

	R^2	R^2 adjusted
DTA	0.390	0.374
PEUDT	0.372	0.364
PUDT	0.558	0.550

c. *Effect Size (f^2)*

The effect size represents the change in R^2 when there is an omitted exogenous construct to observe if there is a substantive impact on the endogenous constructs (Hair Jr et al., 2019). According to literature, a large effect is represented by 0.35, with no effect for values less than 0.02 (Cohen, 1988). Cohen (1988) further detail that a small and medium effect size are represented by 0.02 and 0.15, respectively. Based on the literature, as shown in Table 8, 3 out of 13 relationships had no effect, 6 had a small effect, 3 had a medium effect and 1 had a large effect. Hence, majority of relationships had small effect sizes.

Table 8: Effect Size

	f^2	Effect Size
C -> PEUDT	0.014	No effect
C -> PUDT	0.004	No effect
CP -> DTA	0.028	Small
GS -> DTA	0.086	Small
KAC -> PEUDT	0.017	Small
KAC -> PUDT	0.004	No effect
PEUDT -> DTA	0.023	Small
PEUDT -> PUDT	0.099	Medium
PRA -> PEUDT	0.223	Medium
PRA -> PUDT	0.412	Large
PUDT -> DTA	0.046	Small
GS x PUDT -> DTA	0.026	Small
GS x PEUDT -> DTA	0.069	Medium

d. *Path Coefficients*

In the structural model assessment, the size of the path coefficient, as well as its significance, was considered. Bootstrapping method was performed to obtain the significance of the path coefficients as shown in Table 9. Hair et al. (2019) describe a path coefficient of +1 and – 1 as having a perfect positive relationship

and perfect negative relationship, respectively. Based on the results obtained, 8 out of 13 relationships assessed were considered statistically significant based on p-values less than 0.05. Furthermore, these 8 paths had t-values higher than 1.96 (Sulaiman et al., 2023), with the highest being 7.057 for PRA -> PUDT, which further emphasises significance. In addition, it is observed that β-values for PRA - > PUDT, PRA -> PEUDT and PEUDT –> PUDT were the highest, suggesting comparatively stronger influencing factors.

Table 9: Path Coefficients

	Original sample (O)	T statistics (|O/STDEV|)	P values	Result
C -> PEUDT	0.121	1.785	0.074	Not significant
C -> PUDT	-0.017	0.263	0.792	Not significant
CP -> DTA	0.175	2.429	0.015	Significant
GS -> DTA	0.188	2.270	0.023	Significant
KAC -> PEUDT	0.139	2.001	0.046	Significant
KAC -> PUDT	0.062	1.075	0.283	Not significant
PEUDT -> DTA	0.172	2.688	0.007	Significant
PEUDT -> PUDT	0.237	3.555	0.000	Significant
PRA -> PEUDT	0.394	5.068	0.000	Significant
PRA -> PUDT	0.500	7.057	0.000	Significant
PUDT -> DTA	0.193	1.752	0.080	Not significant
GS x PUDT -> DTA	0.053	0.626	0.531	Not significant
GS x PEUDT -> DTA	-0.146	2.088	0.037	Significant

4.1.4 Mediation effects

Bootstrapping, a nonparametric resampling process, was a recommended technique for analysing mediation (Hayes, 2009). The mediating effect of variables, PEUDT and PUDT, were investigated between the independent variables (PRA, C) and the dependent variable (DTA). Table 10 details the mediation analysis of the four proposed mediation hypotheses. For investigation of the mediation effect of perceived usefulness of digital technologies, none of the two mediating hypotheses were found to be statistically significant. For investigation of the mediation effect of perceived ease of use of digital

technologies, only one out of the two mediating hypotheses were found to be statistically significant, which was the path PRA -> PEUDT -> DTA.

Table 10: Mediation Test of TAM Variables

	Hypothesised Path	Original sample (O)	T statistics (|O/STDEV|)	P values	Result
Mediation effect of perceived usefulness	H3c: PRA -> PUDT -> DTA	0.096	1.631	0.103	Not supported
	H4c: C -> PUDT -> DTA	-0.003	0.243	0.808	Not supported
Mediation effect of perceived ease of use	H3d: PRA -> PEUDT -> DTA	0.068	2.331	0.020	Supported
	H4d: C -> PEUDT -> DTA	0.021	1.458	0.145	Not supported

4.1.5 Moderating effect of government support

Table 11 shows the moderating effect of government support between independent variables, PUDT and PEUDT, and dependent variable, DTA. From the results, government support only had a significant influence on the relationship between perceived ease of use of digital technologies and intention to adopt digital technologies.

Table 11: Moderating effect of Government Support

Moderator Effect	Original sample (O)	T statistics (|O/STDEV|)	P values	Result
GS x PUDT -> DTA	0.053	0.626	0.531	Not Supported
GS x PEUDT -> DTA	-0.146	2.088	0.037	Supported

Furthermore, Figures 8 and 9 depict the slope analysis for the moderating effects of government support on the independent variables, perceived usefulness of digital technologies and perceived ease of use of digital technologies, respectively. Figure 8 depicts a positive slope, indicating a positive relationship,

however, the result was insignificant. Figure 9 depicts a negative slope for the presence of government support between the relationship of perceived ease of use and intention to adopt digital technologies.

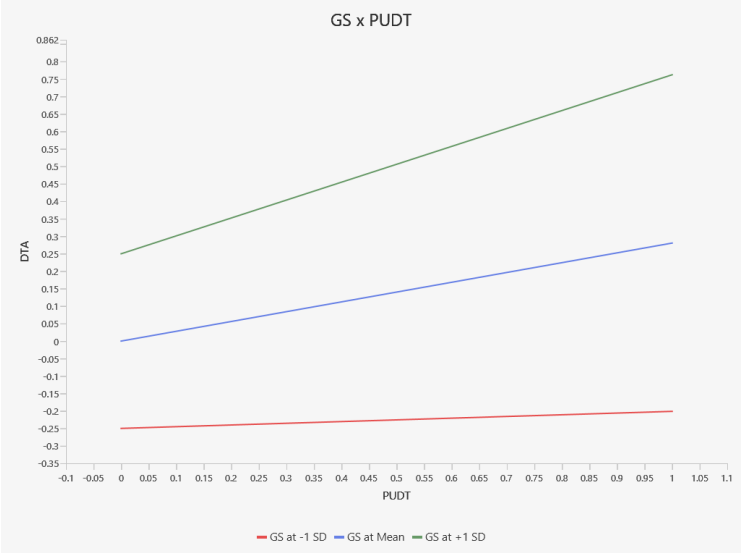

Figure 8: Moderating effect of GS x PUDT

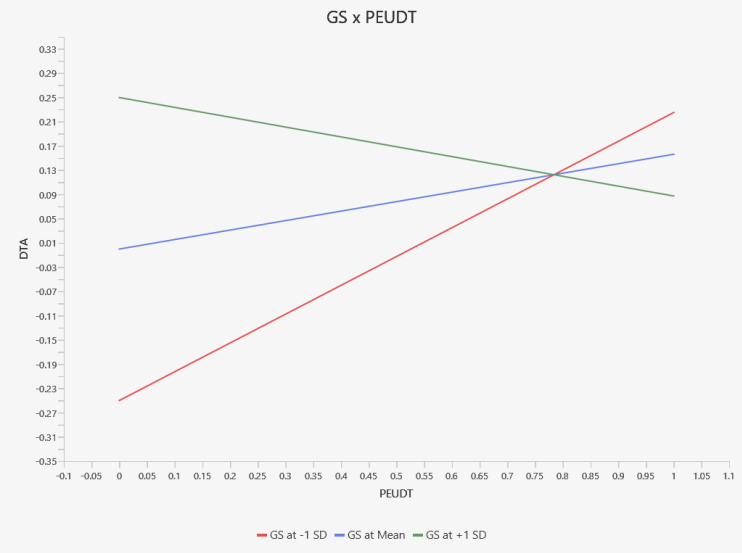

Figure 9: Moderating effect of GS x PEUDT

4.2 Results pertaining to Hypothesis $H1_0$

$H1_0$ evaluated whether perceived usefulness of digital technologies does not have a positive influence on the intention to adopt digital technologies. From the results obtained, it was revealed that the relationship between perceived usefulness of digital technologies on the intention to adopt digital technologies proved to be statistically insignificant. Hence, the null hypothesis $H1_0$ was supported.

4.2.1 Measurement Model

Construct reliability and validity were achieved for PUDT, with a α = 0.868, a C.R = 0.878 and AVE = 0.694 observed. Both α and C.R were above the recommended 0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. Fornell-Larcker criterion assessment showed a square root of the AVE of 0.833, which was greater than the correlations. The HTMT ratio of 0.713 was less than the 0.85 threshold and there were no cross-loadings observed, with all indicators of PUDT above 0.1.

4.2.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 2.978. A moderate R^2 of 0.558 was observed. This suggests that 56% of the variance in dependent variable, PUDT, was predicted by the statistical model, with 44% of the variance not explained by the model. An f^2 of 0.046 was established as having a small effect. The results of the path coefficient analysis showed that the hypothesised path, PUDT -> DTA, was statistically insignificant (β = 0.193, t = 1.752, p = 0.080).

4.3 Results pertaining to Hypotheses $H2_0a$ and $H2_0b$

$H2_0a$ evaluated whether perceived ease of use of digital technologies does not have a positive influence on the intention to adopt digital technologies. Furthermore, $H2_0b$ evaluated whether perceived ease of use of digital technologies does not have a positive influence on the perceived usefulness of digital technologies. It was observed that the relationship between perceived ease of use of digital technologies on the intention to adopt digital technologies proved to be statistically significant, and the relationship between perceived ease of use of digital technologies on perceived usefulness of digital technologies proved to be statistically significant. Hence, the null hypotheses, $H2_0a$ and $H2_0b$ were rejected and the alternate hypotheses accepted.

4.3.1 Measurement Model

Construct reliability and validity were achieved for PEUDT, with a α = 0.841, a C.R = 0.851 and AVE = 0.638 observed. Both α and C.R were above the recommended 0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. Fornell-Larcker criterion assessment showed a square root of the AVE of 0.798, which was greater than the correlations. The HTMT ratio of 0.436 was less than the 0.85 threshold and there were no cross-loadings observed, with all indicators of PEUDT above 0.1.

4.3.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 2.925. A moderate R^2 of 0.372 was observed. This suggests that 37% of the variance in dependent variable, PEUDT, was predicted by the statistical model, with 63% of the variance not explained by the model. An f^2 of 0.023 and 0.099

was observed for PEUDT -> DTA and PEUDT -> PUDT, which were considered small and medium effects, respectively. The results of the path coefficient analysis showed that the hypothesised path PEUDT -> DTA was statistically significant (β = 0.172, t = 2.688, p = 0.007) and the hypothesised path PEUDT -> PUDT was also statistically significant (β = 0.237, t = 3.555, p = 0.000).

4.4 Results pertaining to Hypotheses $H3_0a$ and $H3_0b$

$H3_0a$ evaluated whether perceived relative advantage does not have a positive influence on the perceived usefulness of digital technologies. Furthermore, $H3_0b$ evaluated whether perceived relative advantage does not have a positive influence on the perceived ease of use of digital technologies. It was observed that the relationship between perceived relative advantage and perceived usefulness of digital technologies proved to be statistically significant, and the relationship between perceived relative advantage and perceived ease of use of digital technologies proved to be statistically significant. Hence, the null hypotheses, $H3_0a$ and $H3_0b$ were rejected and the alternate hypotheses accepted.

4.4.1 Measurement Model

Construct reliability and validity were achieved for PRA, with a α = 0.916, a C.R = 0.917 and AVE = 0.729 observed. Both α and C.R were above the recommended 0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. Fornell-Larcker criterion assessment showed a square root of the AVE of 0.854, which was greater than the correlations. The HTMT ratio of 0.566 was less than the 0.85 threshold and there were no cross-loadings observed, with all indicators of PRA above 0.1.

4.4.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 3.761. No R^2 was observed as PRA was an independent variable. An f^2 of 0.223 and 0.412 was observed for PRA -> PEUDT and PRA -> PUDT, respectively. The effect size of PRA -> PEUDT was considered small and the effect size PRA -> PUDT was considered medium. The results of the path coefficient analysis showed that the hypothesised path PRA -> PEUDT was statistically significant (β = 0.394, t = 5.068, p = 0.000), whereas the hypothesised path PRA -> PUDT was statistically significant (β = 0.500, t = 7.057, p = 0.000).

4.5 Results pertaining to Hypotheses $H4_0a$ and $H4_0b$

$H4_0a$ evaluated whether compatibility does not have a positive influence on the perceived usefulness of digital technologies. Furthermore, $H4_0b$ evaluated whether compatibility does not have a positive influence on the perceived ease of use of digital technologies. It was observed that the relationship between compatibility and perceived usefulness of digital technologies, as well as the relationship between compatibility and perceived ease of use of digital technologies were statistically insignificant. Hence, $H4_0a$ and $H4_0b$ were supported.

4.5.1 Measurement Model

Construct reliability and validity were achieved for C, with a α = 0.841, a C.R = 0.856 and AVE = 0.643 observed. Both α and C.R were above the recommended 0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. Fornell-Larcker criterion assessment showed a square root of the AVE of 0.802, which was greater than

the correlations. There were no cross-loadings observed, with all indicators of C above 0.1.

4.5.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 2.155. No R^2 was observed as C was an independent variable. An f^2 of 0.014 was observed for C -> PEUDT and 0.004 was observed for C -> PUDT. Both effect sizes were considered to have no effect as results were below 0.02. The results of the path coefficient analysis showed that the hypothesised path C -> PUDT was statistically insignificant (β = -0.017, t = 0.263, p = 0.792) and the hypothesised path C -> PEUDT was also statistically insignificant (β = 0.121, t = 1.785, p = 0.074).

4.6 Results pertaining to Hypotheses $H5_0a$ and $H5_0b$

$H5_0a$ evaluated whether knowledge absorption capability does not have a positive influence on the perceived usefulness of digital technologies. Furthermore, $H5_0b$ evaluated whether knowledge absorption capability does not have a positive influence on the perceived ease of use of digital technologies. The relationship between knowledge absorption capability and perceived usefulness of digital technologies proved to be statistically insignificant. It was observed that the relationship between knowledge absorption capability and perceived ease of use of digital technologies was statistically significant. Hence, null hypothesis $H5_0a$ was supported, but $H5_0b$ was rejected and the alternate hypothesis accepted.

4.6.1 Measurement Model

Construct reliability and validity were achieved for KAC, with a α = 0.901, a C.R = 0.904 and AVE = 0.754 observed. Both α and C.R were above the recommended 0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. Fornell-Larcker criterion assessment showed a square root of the AVE of 0.868, which was greater than the correlations. The HTMT ratio of 0.556 was less than the 0.85 threshold and there were no cross-loadings observed, with all indicators of KAC above 0.1.

4.6.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 3.560. No R^2 was observed as KAC was an independent variable. An f^2 of 0.017 and 0.004 was observed for KAC -> PEUDT and KAC -> PUDT, respectively. The effect size of KAC -> PEUDT was considered small and the effect size KAC -> PUDT was considered to have no effect. The results of the path coefficient analysis showed that the hypothesised path KAC -> PEUDT was statistically significant (β = 0.139, t = 2.001, p = 0.046), whereas the hypothesised path KAC -> PUDT was statistically insignificant (β = 0.062, t = 1.075, p = 0.283).

4.7 Results pertaining to Hypothesis $H6_0$

$H6_0$ evaluated whether competitive pressure does not have a positive influence on the intention to adopt digital technologies. It was observed that the relationship between competitive pressure and the intention to adopt digital technologies proved to be statistically significant. Hence, $H6_0$ was rejected and the alternate hypothesis accepted.

4.7.1 Measurement Model

Construct reliability and validity were achieved for CP, with a α = 0.830, a C.R = 0.831 and AVE = 0.618 observed. Both α and C.R were above the recommended 0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. Fornell-Larcker criterion assessment showed a square root of the AVE of 0.786, which was greater than the correlations. The HTMT ratio of 0.496 was less than the 0.85 threshold and there were no cross-loadings observed, with all indicators of CP above 0.1.

4.7.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 2.329. No R^2 was observed as CP was an independent variable. An f^2 of 0.028 was observed for CP -> DTA, which was considered a small effect. The results of the path coefficient analysis showed that the hypothesised path CP -> DTA was statistically significant (β = 0.175, t = 2.429, p = 0.015).

4.8 Results pertaining to Hypothesis $H7_0$

$H7_0$ evaluated whether government support does not have a positive influence on the intention to adopt digital technologies. It was observed that the relationship between government support and the intention to adopt digital technologies was statistically significant. Hence, $H7_0$ was rejected and the alternate hypothesis accepted.

4.8.1 Measurement Model

Construct reliability and validity were achieved for GS, with a α = 0.782, a C.R = 0.780 and AVE = 0.535 observed. Both α and C.R were above the recommended

0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. Fornell-Larcker criterion assessment showed a square root of the AVE of 0.731, which was greater than the correlations. The HTMT ratio of 0.392 was less than the 0.85 threshold and there were no cross-loadings observed, with all indicators of GS above 0.1.

4.8.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 2.329. No R^2 was observed as GS was an independent variable. An f^2 of 0.086 was observed for GS -> DTA, which was considered a small effect. The results of the path coefficient analysis showed that the hypothesised path GS -> DTA was statistically significant (β = 0.188, t = 2.270, p = 0.023).

4.9 Results pertaining to Hypotheses $H3_0c$, $H3_0d$, $H4_0c$ and $H4_0d$

$H3_0c$ evaluated whether perceived usefulness of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies. $H3_0d$ evaluated whether perceived ease of use of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies. $H4_0c$ evaluated whether perceived usefulness of digital technologies does not mediate the relationship between compatibility and intention to adopt digital technologies, whereas $H4_0d$ evaluated whether perceived ease of use of digital technologies does not mediate the relationship between compatibility and intention to adopt digital technologies. It was observed that the mediating effect evaluated by $H3_0c$, $H4_0c$ and $H4_0d$ were statistically insignificant, with only $H3_0d$ having a statistically significant mediating effect. The mediating effect of perceived ease of use on the relationship between

perceived relative advantage and intention to adopt digital technologies (β = 0.068, t = 2.331, p = 0.020) was statistically significant. Hence, null hypotheses $H3_0c$, $H4_0c$ and $H4_0d$ were supported but the null hypothesis, $H3_0d$, was rejected and the alternate hypothesis accepted.

4.10 Results pertaining to Hypotheses $H8_0a$ and $H8_0b$

$H8_0a$ evaluated whether government support does not moderate the relationship between perceived usefulness of digital technologies and intention to adopt digital technologies. Furthermore, $H8_0b$ evaluated whether government support does not moderate the relationship between perceived ease of use of digital technologies and intention to adopt digital technologies. It was observed that the moderating effect of government support on the relationship between perceived usefulness of digital technologies and intention to adopt digital technologies was statistically insignificant. However, the moderating effect of government support on the relationship between perceived ease of use of digital technologies and intention to adopt digital technologies was statistically significant, yet negative. Hence, $H8_0a$ was supported, but null hypothesis $H8_0b$ was rejected and the alternate hypothesis accepted.

4.10.1 Measurement Model

Construct reliability and validity were achieved for GS, with a α = 0.782, a C.R = 0.780 and AVE = 0.535 observed. Both α and C.R were above the recommended 0.7 thresholds, whereas AVE was above the recommended 0.5. Discriminant validity was achieved as observed by the results. The HTMT ratio of 0.406 and 0.473 was observed for GS x PUDT and GS x PEUDT, respectively. These results were less than the 0.85 threshold.

4.10.2 Structural Model

The results of the VIF analysis showed that there was no collinearity observed, with all indicator VIF values below the recommended 5.0 and the highest being 1.00. No R^2 was observed as GS was a moderating variable. An f^2 of 0.026 and 0.069 for GS x PUDT -> DTA and GS x PEUDT -> DTA was observed, respectively; the effect sizes were considered small and medium, respectively. The moderating effect of government support on the relationship between hypothesised path GS x PUDT -> DTA (β = 0.053, t = 0.626, p = 0.531) was statistically insignificant and the hypothesised path GS x PEUDT -> DTA (β = -0.146, t = 2.088, p = 0.037) was statistically significant.

4.11 Summary of the results/findings

Table 12 summarises the hypotheses from the measurement model assessment and the structural model assessment. Out of the total 13 null hypotheses depicted in the conceptual framework in Figure 10, 8 were rejected. Furthermore, from the 4 mediating effect null hypotheses evaluated, only 1 was rejected. It was observed that, in order of size of relationship, perceived relative advantage, perceived ease of use and government support were the three highest influencing factors, followed by competitive pressure and lastly, knowledge absorption capability.

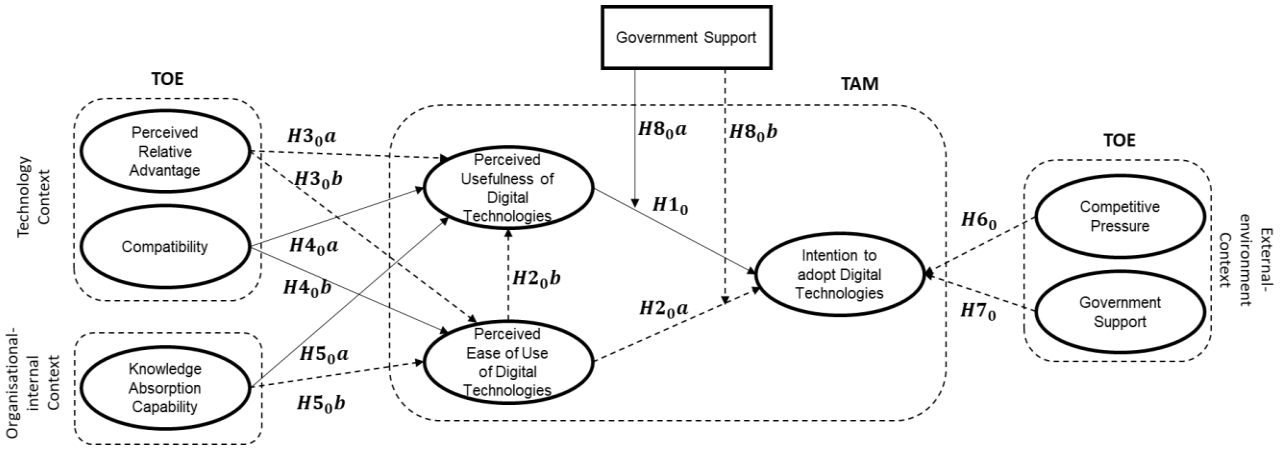

Figure 10: Final conceptual framework

Table 12: Summary of Hypotheses

Hypothesis No.	Hypothesised Path	Outcome
$H1_0$	PUDT -> DTA	Accepted
$H2_0a$	PEUDT -> DTA	Rejected
$H2_0b$	PEUDT -> PUDT	Rejected
$H3_0a$	PRA -> PUDT	Rejected
$H3_0b$	PRA -> PEUDT	Rejected
$H3_0c$	PRA -> PUDT -> DTA	Accepted
$H3_0d$	PRA -> PEUDT -> DTA	Rejected
$H4_0a$	C -> PUDT	Accepted
$H4_0b$	C -> PEUDT	Accepted
$H4_0c$	C -> PUDT -> DTA	Accepted
$H4_0d$	C -> PEUDT -> DTA	Accepted
$H5_0a$	KAC -> PUDT	Accepted
$H5_0b$	KAC -> PEUDT	Rejected
$H6_0$	CP -> DTA	Rejected
$H7_0$	GS -> DTA	Rejected
$H8_0a$	GS x PUDT -> DTA	Accepted
$H8_0b$	GS x PEUDT -> DTA	Rejected

CHAPTER 5. DISCUSSION OF THE RESULTS

5.1 Introduction

The results in this chapter are discussed according to each main hypothesis, as in the latter part of chapter 4. Each main hypothesis section explained the results pertaining to it and its association with existing literature. This included highlighting deviations and presenting similarities between findings.

5.2 Discussion pertaining to Hypothesis $H1_0$

From the results, the statistical insignificance of $H1_0$ confirmed that perceived usefulness of digital technologies does not have a positive influence on the intention to adopt digital technologies. The outcome was inconsistent with majority of studies, including those performed by Venkatesh and David (2000), Ramkumar et al. (2019) and Arumugam et al. (2022). Furthermore, Kamble et al. (2021) had stated that perceived usefulness was important in predicting the intention to adopt blockchain, with Katebi et al. (2022) supporting the significant impact of perceived usefulness on the intention to adopt AI. Differences observed was that this study was performed in the context of the freight transport sector of a developing country, whereas Katebi et al. (2022) had performed their study within the context of a developed country, Japan, specifically in the construction industry. However, the study of Kamble et al. (2021) was also in the context of a developing country, India, but specifically focusing on automobile and chemical industries.

According to Cserdi and Kenesei (2021), the freight transport industry is required to be responsive and maintain its competitiveness, minimising disruptions due to its contribution to economic development. Hence, introducing new technology

into the system, that demands operational excellence associated with speed of delivery and cost effectiveness, could introduce reluctance towards its usefulness and adoption (Cserdi & Kenesei, 2021). Farquharson et al. (2020) suggested that the skills gap in South Africa's freight transport sector could lead to a lack of understanding of the benefits of digital technologies in the sector. In addition, cyberattacks, security and privacy issues associated with digital technology usage could inhibit the perceived usefulness of digital technologies (Farquharson et al., 2021). Furthermore, the statistically insignificant influence of $\mathrm{H1_0}$ could also suggest that a digital technology that is useful is not sufficient for adoption in the freight transport industry in a developing country due to the constraints associated with the industry. As discussed by Ajayi et al. (2021), developing countries have reduced adoption of Intelligent Transport Systems (ITS), unlike developed countries, due to deteriorating infrastructure, poor maintenance and high developmental inequalities. African countries struggle to perceive mobility improvements as useful, especially from the context of Westernised nations, due to political climates, non-compliance factors and regulatory complexities (Cisse & Pambuka, 2020).

5.3 Discussion pertaining to Hypotheses $H2_0a$ and $H2_0b$

From the results, the statistical significance of $\mathrm{H2_0a}$ confirmed that perceived ease of use of digital technologies has a positive influence on the intention to adopt digital technologies. This outcome was consistent with majority of studies examined, including those performed by Smit et al. (2018), Mishra et al. (2023) and Matikiti et al. (2018). In the study performed by Smit et al. (2018) on mobile self-service technologies in the South African airline industry, one of the main findings was that perceived ease of use strongly influenced intention to adopt self-service applications. Smit et al. (2018) further discussed that enhanced adoption rates can be realised when digital technologies, such as airline mobile applications, are easy to use and that user-friendly functionality should be a critical part of the design process. Furthermore, a study performed by Hong et al.

(2021) in China, found that perceived platform value, based on perceived ease of use and relative advantage, had a positive influence on the adoption of supply chain service platforms. Hong et al. (2021) suggested that improvement of user-friendliness influenced perceived platform value, which had a statistically significant direct effect on adoption. In addition, Ullah et al. (2022) emphasised that an easy-to-use digital technology was convenient as it allowed the user to effortlessly transition in current work environments due to minimal disruptions in learning the new technology. Hence, less effort in usage increased the technologies usability, thereby increasing adoption rates.

The results of the study also confirmed the statistical significance of $\mathrm{H2_0b}$, proving that perceived ease of use of digital technologies has a positive influence on the perceived usefulness of digital technologies. Similar findings were observed in a study performed by Berg and Lingen (2019), which supported that perceived ease of use had a positive influence on perceived usefulness, specifically in the adoption of mobile enterprise applications in South African organisations. This relationship has also been observed by Ullah et al. (2022), with Chen and Aklikokou (2020) having observed a statistically significant positive relationship between the two constructs for e-government adoption. However, an insignificant relationship was observed in the study by Hu et al. (1999), as well a study by Mahlamaki et al. (2020) on the adoption of supply chain digital sales force automation tools. In a study on cloud computing adoption in Pakistan, perceived ease of use, related to cloud or distributive computing's ability to manage large data instantaneously and conveniently, significantly influenced perceived usefulness, which was associated with improved accessibility and the enablement of total data management in an organisation (Hassan et al., 2022). Therefore, it was observed that once a digital technology was considered easy to use or effortless, then there was higher certainty of its usefulness or propensity to consider it useful (Ababneh, 2016).

5.4 Discussion pertaining to Hypotheses $H3_0a$ and $H3_0b$

The outcome of the results for $\mathrm{H3_0a}$ confirmed that perceived relative advantage has a positive influence on the perceived usefulness of digital technologies. The positive influence of perceived relative advantage on the perceived usefulness of digital technologies was supported by studies performed by Gangwar et al. (2015) on cloud computing adoption in India, Hussein et al. (2019) on e-commerce adoption and Al-shanableh et al. (2024) on the adoption of big data analytics in Jordan. However, the influence of perceived relative advantage was not found to be statistically significant in studies performed by Agrawal (2023) on generative AI adoption in India and Grover (1993) on the adoption of customer-based inter organisational systems. According to Aligarh et al. (2023), the perceived relative advantage of cloud computing technology was associated with superior benefits, in comparison to alternative technologies, such as increased sales, improved use of shared resources and reduction in operational expenses. Gangwar et al. (2015) further discussed the perceived benefits of cloud computing for organisations as improved mobility when accessing content, increased flexibility and scalability in operations. The advantages of blockchain in maritime supply chains include reduction in administrative tasks, improved transaction times and supply chain transparency (Lin, 2023). Freight transport organisations are strategically important for the growth and development of a country. Hence, digital technologies that are perceived to have a relative advantage could be of strategic importance to freight transport organisations by providing a competitive advantage, such as increased productivity and improved efficiency (Adjei Kwakwa et al., 2022). Therefore, in an increasingly competitive global transport industry, perceived relative advantage or superior benefits of digital technologies are considered useful due to the competitive advantage it could provide (Adewole & Struthers, 2019, p. 84).

The results of the study also confirmed the statistical significance of $\mathrm{H3_0b}$, proving that perceived relative advantage has a positive influence on the perceived ease

of use of digital technologies. The relationship between perceived relative advantage and perceived ease of use of digital technologies has not been extensively investigated in the field of transport and logistics. However, in a study on the adoption of local government digital technologies, David et al. (2023) investigated the effect of technology, technological preparedness and convenience adoption. The investigated factors were linked to ease of use of digital technologies, with attributes related to improved user-friendliness and reduced complexity. The study supported the significance of perceived relative advantage on perceived ease of use of digital technologies, observing that simple to use and easy to understand digital technologies, as well as user friendliness and accessibility, were linked to a lower digital gap (David, et al., 2023). The perceived relative advantages associated with perceived ease of use included improved usability and understanding of digital technologies that led to streamlining of processes in operations. Advantages of digital technologies in logistics, such as integrated platforms using blockchain technology and IoT, enhanced the convenience of tracking shipments and goods being delivered (Gokalp et al., 2022). Furthermore, in supply chain operations, the use of digital twin technology provided an easy-to-use virtual representation of actual operations, which allowed users to better visualise operations (Aba et al., 2021). Therefore, the relative advantages associated with interconnected devices in transport, influenced the ease of use of digital technologies.

5.5 Discussion pertaining to Hypotheses $H4_0a$ and $H4_0b$

From the statistically insignificant results of $\mathrm{H4_0a}$, it was confirmed that compatibility does not have a positive influence on the perceived usefulness of digital technologies. The insignificant influence of compatibility on the perceived usefulness of digital technologies was supported by studies performed by Yoon and Lim (2020) on internet-only banks in Korea, Gangwar et al. (2015) on cloud computing adoption in India and Katebi et al. (2022) on building construction technology adoption in Hong Kong. However, the result was inconsistent with

studies performed by Puiu et al. (2023), Morgan et al. (2013) on cloud computing adoption, as well as Al-shanableh (2024) on big data analytics adoption. A compatible digital technology is not necessarily useful or sufficiently superior, unless it provides superior benefits associated with competitive advantage in the industry (Cisse & Pambuka, 2020). Therefore, implying that strategic alignment is preferred in comparison to ease of integration in an organisation. Furthermore, Mariani (2017) discussed the importance of architectural innovations in providing strategic advantage through the fundamental ways that technologies work together; innovations adopted to reduce maintenance and fuel consumption in Southwest airlines were difficult to copy by competitors as the architecture was not understood. Hence, unless it contributes to architectural innovation, compatibility may not be seen as a superior benefit (Mariani, 2017).

The results for $H4_0b$ were also statistically insignificant, confirming that compatibility does not have a positive influence on the perceived ease of use of digital technologies. The insignificant influence of compatibility on the perceived ease of use of digital technologies was not supported by majority of studies, including those performed by Qin (2020) on building information modelling technology adoption in China, Gangwar (2015) on cloud computing in India and Chebrolu and Ness (2012) on cloud adoption. According to Gangwar (2015), the positive influence of compatibility on perceived ease of use of digital technologies indicates that users do not need to significantly adapt their ways of work and jobs, due to the high compatibility of the digital technology with their work style. However, if an organisation is faced with constraints such as failing infrastructure, low capital investment and lack of skills and knowledge, there may be ease of integration into the architecture but the capability to utilise the digital technology may be lacking (Habiyaremye et al., 2023). Hence, even with compatibility, convenience and ease of use are not primary considerations as the constrained organisations are not capacitated to exploit the ease of integration (Ozturk et al., 2016).

5.6 Discussion pertaining to Hypotheses $H5_0a$ and $H5_0b$

The outcome of the results for $\mathrm{H5_0a}$ confirmed that knowledge absorption capability does not have a positive influence on the perceived usefulness of digital technologies. The insignificant influence of knowledge absorption capability on the perceived usefulness of digital technologies was supported by studies performed by Bamasoud et al. (2014), specifically for the attributes of understanding and assimilating. However, the influence of knowledge absorption capability on the perceived usefulness of digital technologies was inconsistent with studies performed by Lin (2023) and for the knowledge application attribute investigated by Bamasoud et al. (2014). An organisation positioned to transform opportunities into new capabilities through its existing configuration, may not perceive a new digital technology as useful (Dehghani et al., 2022). Therefore, organisations that are configured to adapt to changing environments may consider digital technologies less beneficial or superior as the organisation is able to transform with its current capabilities. Also, if the benefits of a digital technology are not understood, then the digital technology is not perceived as useful (Kamble et al., 2020). As discussed by Kamble et al. (2020), relevant skills, knowledge and training are important in recognising the usefulness of digital technologies. Hence, a lack of skills and knowledge implies that an organisation is not capacitated to identify the usefulness, or business value, of digital technologies in current operating environments for strategic advantage (Wamba & Queiroz, 2022).

The results of the study confirmed the statistical significance of $\mathrm{H5_0b}$, proving that knowledge absorption capability has a positive influence on the perceived ease of use of digital technologies. The significant influence of knowledge absorption capability on the perceived ease of use of digital technologies was supported by studies performed by Mayeh et al. (2016) on Enterprise Resource Planning (ERP) adoption in Iran and Zhang et al. (2006) on information technology adoption in the United States of America. However, the outcome was inconsistent with a

study performed by Bamasoud et al. (2014) on the application attribute of knowledge absorption capability but was consistent for the understanding and assimilation attributes. The significant influence of knowledge absorption capability on the perceived ease of use of digital technologies aligns to the concept of an organisation's ability to acquire external knowledge and usefully convert it to aid innovation adoption (Lin, 2023). According to Liu et al. (2021), strong knowledge absorption capabilities allow organisations to collaborate with their supply chain partners and improve responsiveness to market changes. Furthermore, Xie et al. (2021) indicate that intense knowledge absorption capabilities enable better collaboration between organisations and their customers by incorporating customer suggestions into improving innovations, which enables the ease of use of the digital technology. Knowledge absorption capability allows organisations to sense, seize, and transform external opportunities into a competitive advantage and organisational change (Mahmood & Mubarik, 2020). Therefore, a strong knowledge absorption capacity allows for high knowledge assimilation, thereby improving user comprehension of digital technology functionality (Xie et al., 2021). This suggests that an ease of understanding improves usability of the digital technology, enabling effortless use of digital technologies.

5.7 Discussion pertaining to Hypothesis $H6_0$

The results of the study confirmed the statistical significance of $\mathrm{H}6_0$, proving that competitive pressure has a positive influence on the intention to adopt digital technologies. The significant influence of competitive pressure on the intention to adopt digital technologies was supported by studies performed by Malik et al. (2021) on blockchain adoption in the Australian context, Chittipaka et al. (2022) on blockchain technology for supply chains in emerging markets and Kiu and Chan (2023) on the adoption of data analytics in the Europian Union. However, the influence of competitive pressure on the intention to adopt digital technologies was inconsistent with a study performed by Maroufkhani et al. (2020). The study

was performed in the context of Iran, with reasons cited as low levels of multinational competitors in the country, as well as low big data analytics adoption (Maroufkhani et al., 2020). Competitive pressure can alter an industry's structure as it creates the need for industry players to obtain competitive advantage over its competitors (Chen et al., 2021). Increased industry competition compels organisations to explore different avenues to enhance performance, gain competitive advantage and to retain market share (AlNuaimi et al., 2022). The need to remain relevant in a competitive environment pressurises organisations to investigate advantageous tools and technologies that enhance operational excellence (Basloom et al., 2022). An effective technology used in a similar industry, or by a competitor, may be attractive to the adopting organisation as benefits have already been realised, saving time due to the accelerated learning curve of adopting a tried and tested technology (Anzolin, 2024). Hence, the intention to adopt digital technologies to realise associated benefits in an industry due to competitive pressure.

5.8 Discussion pertaining to Hypothesis $H7_0$

The results of the study confirmed the statistical significance of $\mathrm{H}7_0$, proving that government support has a positive influence on the intention to adopt digital technologies. The significant influence of government support on the intention to adopt digital technologies was supported by studies performed by Chiu and Shih (2023) on RFID adoption in Taiwan and Wen and Kamaruddin (2023) on blockchain technology adoption in Malaysia. The influence of government support on the intention to adopt digital technologies was inconsistent with a study performed by Hussain et al. (2020) on e-commerce adoption. The study focused on adoption by SMEs in Pakistan, with the insignificant results justified as only large organisations prone to being supported by government in terms of incentives, enabling policies and the provision of resources, such as technical infrastructure and skills (Hussain et al., 2020). Furthermore, there was inconsistency with a study performed on SMEs by Maroufkhani et al. (2020), with

reasons cited as rapid regulatory changes in government creating uncertainty and government incentives lacking justification for the substantial investment in big data analytics adoption. Through government support, including legislation and policy frameworks, funding, investments, structural reform and interventions for improved competitiveness, a sector can be transformed in the long term (Chinguwo, 2022). Ngah et al. (2023) state that leadership and government can work towards guiding organisations towards innovation. Hence, the significance of government support to improve and support innovation adoption in the freight transport sector.

5.9 Discussion pertaining to Hypotheses $H3_0c$, $H3_0d$, $H4_0c$ and $H4_0d$

Hypothesis $\mathrm{H}3_0d$ was not supported by a study performed by Hussein et al. (2019), where the mediating effect of perceived usefulness was statistically significant rather than perceived ease of use. Perceived relative advantage could be associated with factors relating to better convenience, more powerful capabilities and increased speed of the new digital technology (Chen et al., 2021). Convenience, increased power and higher speeds of digital technology are perceived as easier to use due to the effortlessness associated with these relative advantages (Hussein et al., 2019). Hence, $\mathrm{H}3_0c$ was insignificant, with $\mathrm{H}3_0d$ statistically significant, as even though perceived relative advantages may enhance ease of use of digital technologies, it may not deliver the required benefits desired by freight transport organisations. Therefore, implying that convenience does not necessarily translate into usefulness in the sector.

A study performed by Katebi et al. (2022) supported the insignificant mediating effect of hypotheses $\mathrm{H}4_0c$ and $\mathrm{H}4_0d$ on compatibility. It is suggested that perceived usefulness and perceived ease of use have insignificant mediation effects due to lack of coordination methods among freight transport organisations, where extensive coordination is required in transport and supply

chain management (Katebi et al., 2022). Hence, the usage simplicity of compatible digital technologies associated with perceived usefulness and perceived ease of use being insignificant due to the complexities associated with integrated transport systems.

5.10 Discussion pertaining to Hypotheses $H8_0a$ and $H8_0b$

Even though the result for $\mathrm{H8_0a}$ was statically insignificant, the slope analysis showed that the positive relationship between perceived usefulness of digital technologies and intention to adopt digital technologies was strengthened by the presence of government support. The result of $\mathrm{H8_0b}$ proved to be statistically significant, yet negative. A decreasing slope was observed when government support was present, which signified a weakening relationship or dampening effect of government support between perceived ease of use of digital technologies and the intention to adopt digital technologies. Furthermore, in contrast, the slope analysis also depicted a steeper, increasing slope in the absence of government support.

The intention of hypotheses $\mathrm{H8_0a}$ and $\mathrm{H8_0b}$ was to investigate the moderating effect of government support on the TAM relationships and observe if it enhanced or dampened the relationships. The outcome of hypotheses $\mathrm{H8_0a}$ and $\mathrm{H8_0b}$ were inconsistent with a study on the adoption of RFID in United Kingdom logistics, where government support was found to be a statistically significant moderator. It was observed that strong levels of government support assisted in improving the usability of RFID and maximisation of its benefits (Ramanathan et al., 2014). However, Ngisau and Ibrahim (2020) found that government support moderating the relationship between compatibility and technological innovation adoption was insignificant, with compatibility being attributed to perceived usefulness in the benefits it provided. Hence, the study performed by Ngisau and Ibrahim (2020) supported the insignificance of $\mathrm{H8_0a}$. Furthermore, in a study by Mensah et al.

(2022), the moderating effect of perceived government support on the relationship between facilitating conditions and the adoption of M-government services was supported. Facilitating conditions referred to widespread interface access, easy access to devices and availability of technology, which can be attributed to perceived ease of use. Hence, the outcome of $H8_0b$ was inconsistent with the study by Mensah et al. (2022).

Government support can be in the form of incentives, regulatory support through the development of policies and enabling legislation, funding and investment, advisory support and decision-making bodies (Cirillo et al., 2023). Dehghani et al. (2022) observed a significant negative relationship in a study on organisational intention to adopt blockchain technology, suggesting that the lack of uncertainty was due to the inability to manage complexities of regulatory uncertainty because of knowledge inadequacy or lack of financial resources to support compliance needs. Furthermore, larger organisations may lack the flexibility to adapt to regulatory requirements and may be reluctant to commit resources on a solution that may jeopardise operations (Dehghani et al., 2022). Lengthy development of government policies and regulations create a barrier to adoption, especially with the uncertainty surrounding digital technologies and innovation (Guan et al., 2023).

Salem et al. (2023) state that policies or initiatives may not be comprehensive, lacking clear direction and guidance in the form of targets, as well as insufficient support in funding and incentives. The statistically significant but negative influence of government support on the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies suggests that policies and initiatives are not effective, beneficial or supportive in enabling convenience of digital technologies (Salem et al., 2023). Furthermore, government may lack strategic foresight in the ambit of erratic external environments, alluding to innovations in technology and market changes (Salem et al., 2023). Chinguwo (2022) recognised that the adoption of digital

technologies has benefits such as job creation for different skill levels. However, it has also led to the decay of employment relationships, with the new ways of work created by digital technology adoption, therefore requiring sensitivity surrounding labour laws (Chinguwo, 2022). Furthermore, in the discussion on government support through public procurement initiatives in South Africa, Simone and Balasundharam (2023) suggest that poorly enforced, ineffective and fragmented legislation cause procurement violations, such as collusion, abuse of information and fraud. Hence, the presence of ineffective aid from government could negatively impact the perception that government support is useful and enables usability.

5.11 Conclusion

Majority of results from the research study proved to be successful, showing statistically significant relationships between the independent variables, mediating variables, moderating variable, and the dependent variable. It must be noted however that there were findings that did not prove to be statistically significant, resulting in the null hypothesis being accepted. The insignificant findings included the relationship between knowledge absorption capability and compatibility on perceived usefulness of digital technologies, compatibility on perceived ease of use of digital technologies, perceived usefulness of digital technologies on intention to adopt digital technologies and government support as a moderator on the relationship between perceived usefulness of digital technologies and intention to adopt digital technologies. Furthermore, the mediating effect of perceived usefulness of digital technologies was statistically insignificant for all investigated relationships, with only perceived ease of use of digital technologies mediating the relationship between perceived relative advantage and intention to adopt digital technologies.

Therefore, from the results of the study, statistically significant internal factors influencing digital technology adoption include perceived relative advantage from

a technological context, knowledge absorption capability from an internal-organisational context, and competitive pressure and government support from an external-environment context. Furthermore, with regards to the moderation analysis that was performed, it can be inferred that the government support moderates the effect that perceived ease of use of digital technologies has on the intention to adopt digital technologies as the findings from the research study proved to be statistically significant.

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1 Introduction

The primary aim of this study was to investigate the internal and external factors at an organisation level that influence the intention of South African freight transport organisations to adopt digital technologies. Furthermore, the study also aimed at investigating how government support moderates the intention of South African freight transport organisations to adopt digital technologies. Hence, this chapter is structured according to the three main objectives of the study and details the findings and insights observed.

6.2 Conclusions regarding research objective 1

Research objective 1 focused on investigating the internal factors that influence the intention of South African freight transport organisations to adopt digital technologies. From the TOE model, internal factors investigated were perceived relative advantage and compatibility from a technological context and knowledge absorption capability from an internal organisational context. Furthermore, from the TAM model, internal factors investigated were perceived usefulness of digital technologies and perceived ease of use of digital technologies. The findings highlighted that statistically significant internal factors included perceived relative advantage on both perceived usefulness and perceived ease of use of digital technologies, and knowledge absorption capability on perceived ease of use of digital technologies only. Also related to the TAM framework, a positive significant relationship was observed between perceived ease of use and perceived usefulness of digital technologies. Perceived ease of use of digital technologies

was found to significantly influence the intention to adopt digital technologies. Furthermore, the study established that perceived ease of use of digital technologies mediated the relationship between perceived relative advantage and the intention to adopt digital technologies.

From a TOE framework perspective, results that were consistent with studies included the statistical significance of perceived relative advantage on both TAM constructs, and knowledge absorption capability on perceived ease of use of digital technologies only. An insignificant result that was consistent with previous literature related to the relationship between knowledge absorption capability and perceived usefulness of digital technologies.

The technological context construct, perceived relative advantage, was observed to have a significant positive influence, and strongest relationship, on both perceived usefulness and perceived ease of use of digital technologies. Perceived relative advantage was related to the superior benefits associated with an alternate digital technology, where superior benefits related to improved usability or competitive advantage. In the increasingly competitive global freight transport industry, the perceived relative advantage or superior benefits of digital technologies are perceived as useful in the context of South Africa's freight transport sector due to the competitive advantage it could provide (Adewole & Struthers, 2019, p. 84). Considering the noticeable decline in South Africa's transport infrastructure quality as well as an unstable LPI, which according to Joynt (2019) impacts global competitiveness, the superior benefits of digital technologies are relevant and are of strategic importance in the sector, such has increased customer demand due to technological innovations (Adenigbo et al., 2023). Furthermore, in South African freight transport organisations, superior benefits linked to improved usability of digital technologies are attractive due to the nature of operations and constraints associated with the sector. Advantages related to reduced complexity, or ease of use, of digital technologies were linked to a lower digital gap and streamlined processes in operations (David et al.,

2023). The declining performance observed in the freight transport sector shifts the focus to operational improvement, which suggests that an easy to use technology is advantageous as it reduces time spent on learning the technology, preventing unnecessary training costs and enabling freight transport resources to focus on operational improvements.

From an internal-organisational context, knowledge absorption capability was found to have a positive influence on perceived ease of use of digital technologies. Freight transport organisations that are configured to effectively seize, sense and transform opportunities, may consider an alternative digital technology as easy to use due to improved user comprehension (Mahmood & Mubarik, 2020). Strong knowledge absorption capabilities could enhance agility, allowing for responsiveness to easily adapt to the requirements of a new digital technology, enabling effortless use of it. This suggests that an ease of understanding improves usability of the digital technology, enabling effortless use of digital technologies in the South African freight transport sector. Furthermore, it was observed that knowledge absorption capability does not have a positive influence on perceived usefulness of digital technologies. The current lack of knowledge and skills in the freight transport sector (Group, 2020) suggests that there is a gap in understanding the usefulness, or business value, of digital technologies in current operating environments in South Africa. Knowledge absorption capability enables an organisation to seize opportunities externally and maximise the potential benefits. Therefore, a lack of knowledge and skills in the freight transport sector could negatively impact the ability to identify opportunities and comprehend potential benefits of digital technologies in the context of the sector.

From a TAM framework perspective, the significant relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies was consistent with literature, as well as the significant relationship between perceived ease of use and perceived usefulness of digital technologies.

It was found that an easy to use and user-friendly functionality was associated with enhanced adoption rates and could influence perceived value of a digital technology (Smit et al., 2018). Furthermore, studies support that there is a higher probability a digital technology is seen as useful if it is considered easy to use. Hence, in the South African freight transport sector, there is a higher intention to adopt digital technologies and perceive it as useful, if a digital technology is easy to use. The decline of freight transport performance (Transport, 2023) suggests that an easy to use and convenient digital technology could minimise excessive training of resources to understand the technology, which also saves time spent on understanding the technology. Functionalities of digital technologies enabling ease of use, such as enhanced speed and improved accessibility, can lead to strategic advantages in South Africa's freight transport sector. The declining performance of freight transport organisations (Transport, 2023) requires maximum availability and reliability of resources, which suggests minimal disruptions related to time and money spent on uptake of digital technologies. The cost and time savings can be directed towards capital investment in infrastructure and improving operational efficiencies, respectively, allowing focus on strategic initiatives that lead to competitive advantage.

The results were inconsistent with majority of studies for compatibility not having a significant influence for either TAM constructs, and for perceived usefulness having an insignificant influence on the intention to adopt digital technologies. These two outcomes were noticeably different from previous studies published. In the context of the South African freight transport sector, compatibility has an insignificant influence on perceived usefulness of digital technologies, as in the highly competitive freight transport environment a digital technology should enable competitive advantage. Increased competitiveness could be a major criterion for considering digital technologies useful, as the criteria for only integrating effectively into work environments may not offer a sustained competitive advantage. If a digital technology offers a sustained competitive advantage, South African freight transport organisations may intend on adopting

it regardless of the constraints of its compatibility, due to the sector's declining performance and lack of competitiveness. It is suggested that the insignificant result of perceived usefulness of digital technologies on the intention to adoption digital technologies in the South African freight transport sector, may be due to the lack of skills and knowledge that assists in understanding and exploiting the benefits of digital technologies in the sector. The South African freight transport sector is constrained by multiple factors and may have difficulty adopting a digital technology based solely on usefulness. Freight transport organisations may be aware of superior benefits of digital technologies, however, difficulty understanding or quantifying benefits realised may be a challenge (Maepa et al., 2023). In addition, a digital technology may appear to be useful but, in the context of South Africa's freight transport sector, usefulness may be insufficient to adopt due to developmental inequalities and distrust in the system (Kafile, 2023).

Furthermore, the relationship between compatibility and perceived ease of use of digital technologies was found to be statistically insignificant. Hence, even with compatibility, convenience and ease of use may not be primary considerations as South African freight transport organisations are not capacitated to exploit the ease of integration, due to lack of skills and infrastructure capability. Compatibility may minimise the cost, time and effort required to align a new digital technology with existing IT infrastructure, work environments and business needs. However, it may not encourage ease of use once integrated as freight transport organisations may require additional resources to further understand and utilise the digital technology. This is undesirable in the already constrained South African freight transport environment. Furthermore, compatibility with existing systems that are not easy to use or are inefficient, results in a new digital technology being added to an already ineffective system, compounding the problem rather than improving it. Low digital technology adoption rates (Adenigbo et al., 2023) have been observed in South Africa's freight transport sector, so the possibility of legacy and redundant systems is high.

Furthermore, the mediation results for perceived relative advantage and compatibility, through mediators perceived usefulness and perceived ease of use of digital technologies, were supported by majority of literature. Only perceived ease of use of digital technologies was found to mediate the relationship between perceived relative advantage and intention to adopt digital technologies as convenience, increased power and higher speeds are associated with effortlessness in freight transport organisations. However, the mediation effect of perceived usefulness of digital technologies and perceived ease of use of digital technologies were insignificant for the remaining tested hypotheses, as perceived relative advantage may not deliver the required benefits desired by freight transport organisations, therefore not translating into usefulness. Furthermore, for compatibility, the mediation effects were insignificant, with literature suggesting lack of coordination methods among freight transport organisations and complexities of integrated transport systems as reasons for insignificance (Katebi et al., 2022).

6.3 Conclusions regarding research objective 2

Research objective 2 focused on investigating the external factors that influence the intention of South African freight transport organisations to adopt digital technologies. External factors investigated were competitive pressure and government support from an external environment context. For external factors at an organisation level, competitive pressure and government support were found to significantly influence the intention to adopt digital technologies in the South African freight transport sector.

The deterioration in freight transport infrastructure has led to inefficient service delivery in the sector, with the negative repercussions cascaded to other industries (Godongwana, 2023). The South African freight transport sector is a highly competitive environment, especially between rail and road within the country (Transport, 2023). Furthermore, the ports environment is under constant

scrutiny when compared with African and international ports on a global scale (Transport, 2023). An increase in competitive advantage, ultimately enables an industry to remain relevant. Therefore, the significant influence of competitive pressure relates to the context of the South African freight transport sector as the declining volumes in freight rail has shown an influx of road freight being transported, with major South African ports losing cargo to competitor ports on the African continent (Transport, 2023). A loss of cargo represents a loss of market share and profit for industry and in the case of competitors benefiting from local inefficiencies, economic growth and development is ultimately hindered in South Africa (Bank, 2023). The increased industry competition compels freight transport organisations to explore different avenues to enhance performance, gain competitive advantage and to retain market share. The need to remain relevant in a competitive environment pressurises freight transport organisations to explore advantageous tools and technologies that enhance operational excellence. An effective technology used in a similar industry, or by a competitor, may be attractive to the adopting organisation as benefits have already been realised, saving time due to the accelerated learning curve of adopting a tried and tested technology. Therefore, the adoption of digital technologies can assist industries gain a competitive advantage by leveraging effective digital technologies within similar operating environments. Hence, from the findings, if competitive pressure is enhanced, it will ultimately drive the adoption of digital technologies in the freight transport sector in South Africa.

The study revealed that government support had a significant influence on the intention to adopt digital technologies in the South African freight transport sector. The finding was consistent with majority of studies performed, highlighting that government support is a significant predictor of behavioural intention. Inconsistencies in literature relate mainly to small to medium enterprises not benefiting directly from government support. However, literature reveals that larger organisations may have the resources and flexibility to adjust to regulatory requirements. Therefore, positively influencing adoption of digital technologies in

larger organisations. Majority of freight transport infrastructure in South Africa is under the ownership of the South African government, with government owned and managed infrastructure subject to regulatory requirements. Hence, in the South African context, regulatory support is crucial in assisting the freight transport sector to exploit the benefits derived from digital technologies. In the South African freight transport context, regulatory support refers to strategic private sector participation (PSP) initiatives, funding, investment vehicles, and empowering the freight transport sector with resources to install and utilise the most effective digital technologies as per business needs (Transport, 2023). Through the creation of an enabling environment, South African freight transport organisations could leverage the supporting resources from an intellectual and financial perspective. By creating a consistent and reliable support structure, government interventions could enable and sustain innovation in the freight transport sector. The outcome of the study revealed that government support directly impacts the intention to adopt digital technologies, possibly due to its majority ownership of freight transport infrastructure in South Africa and its responsibility to invest in the sector.

6.4 Conclusions regarding research objective 3

Research objective 3 focused on investigating how government support moderates the intention of South African freight transport organisations to adopt digital technologies. The findings of the third objective of the study highlighted that government support only moderates the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies and does not moderate the relationship between perceived usefulness of digital technologies and the intention to adopt digital technologies.

The outcome of both moderating effects deviated from majority of literature reviewed. Even though the slope analysis for the relationship between perceived usefulness of digital technologies and intention to adopt digital technologies

showed a positive relationship, that was strengthened by the presence of government support, the outcome was statistically insignificant. The slope analysis for the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies depicted a negative moderating effect of government support. Hence, with the outcome being statistically significant, the presence of government support weakened the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies.

Previous studies have shown that the presence of government support strengthened the relationship to adopt digital technologies due to the enabling support it provided, suggesting that logistics organisations maximised benefits in the presence of government aid. However, in the context of South Africa's transport and logistics sector, the results reveal that government support may be an inhibitor of the intention to adopt digital technologies. The South African freight transport sector has experienced a decline in infrastructure quality and logistics competitiveness, largely due to historical underinvestment and inefficiencies in the system (Bank, 2023; Forum, 2023; Transport, 2023). Majority of transport infrastructure is state owned in South Africa, so the underinvestment and inefficiencies allude to negligence from a state perspective. The outcome of the study revealed that freight transport organisations in South Africa consider the influence of government support as unfavourable. The historical decline in transport competitiveness and performance (Transport, 2023) could refer to a lack of trust in the system and how it has been managed. As observed in literature, support provided by government includes financial aid, enabling legislation and policies, and functioning infrastructure. It is suggested that the dampening relationship of government support is due to uncertainty regarding consistency and standardisation in legislation, and the inability of organisations to align to legislative requirements or inability to maximise benefits (Maroufkhani et al., 2020). Particularly in the South African context, the dampening relationship of government support relates to complexities in implementing digital

technologies through lack of skills and knowledge to practically translate policy requirements, and distrust in systems derived from inefficiencies in legislation. Technologies have benefits such as job creation for different skill levels but, introducing new digital technologies can lead to the decay of employment relationships. With the new ways of work created by digital technology adoption, sensitivity surrounding labour laws are required (Chinguwo, 2022). In South Africa, the impact of labour dissatisfication is detrimental to transport and logistics as observed in trade union strikes in the transport sector. According to South African Association of Freight Forwarders (SAAFF), a week long strike in the transport sector in 2022 prevented movement of goods worth approximately R 65.3 billion. Hence, the importance of engagements with labour in accommodating members on the use of new digital technologies in the South African transport sector and the support from government to manage expectations.

The South African freight transport sector is required to adhere to policies and frameworks as set out by the South African government. The Department of Transport (DoT) oversees legislative and policy documents that guide the logistics system in South Africa (Transport, 2023). According to the World Economic Forum (2018), the rapid advancement of innovation and digital technology development exceeds the ability of legislative processes to align requirements accordingly. The lengthy development and time-consuming nature associated with regulatory processes suggests that by the time a policy or framework supporting innovation adoption is approved in the sector, there is an increased likelihood that the technology would have changed. Thereby, resulting in redundancy of the policy or framework, with the resultant developments rendered inconsequential. Furthermore, poorly enforced, ineffective and fragmented legislation cause procurement violations, which has resulted in governance issues in transport organisations in South Africa (Simone & Balasundharam, 2023; Transport, 2023). Ineffective legislation in South Africa gives rise to inefficient systems, such as the inability to efficiently procure

applicable digital technologies, within the required timeframe and according to desired specifications, due to lack of capacity and capability of officials and contractors (Nkwananchi, 2010). Therefore, the presence of ineffective aid from government could negatively impact the perception that government support is useful and enables usability. Hence, the presence of government support being insignificant and having a dampening effect on the respective relationships investigated, due to the lack of benefits derived and inability to support usability in the South African freight transport sector.

6.5 Recommendations

Based on the outcome of the study, the following recommendations have been provided, with specific relation to different stakeholders in freight transport organisations.

6.5.1 Theoretical contribution

The study contributes to literature in understanding factors on freight transport organisations' intention to adopt digital technology from a local perspective, in a South African context. A larger body of literature focuses on digital technology adoption from an overall supply chain perspective, however minimal literature has been observed in the freight transport sector, specifically in South Africa. Furthermore, the study seeks to bring diversity in the theoretical framework considered by combining TAM-TOE theoretical frameworks and incorporating government support as a moderating variable, which is considered unique to the South African freight transport sector context. In addition, the focus of most studies was on the adoption by small to medium enterprises, rather than larger organisations as well as a focus on a single digital technology, such as blockchain or cloud computing, specifically. There were contradictions with some findings in this study from those previously investigated, with previous studies focusing on either a different industry to transport, smaller firms or different regulatory

environments. Therefore, suggesting that influencing factors investigated may be distinct to the South African freight transport sector.

6.5.2 Policy contribution

The investigation of government support as both a moderator on the perceived usefulness and perceived ease of use of digital technologies, and the influence of it directly on the intention to adopt digital technologies, has highlighted the importance of government support as well as the complexities of it in the South African freight transport sector. The outcome of this study highlights the need for government support in the adoption of digital technologies in the South African freight transport sector; relating to regulatory support, advisory support and dedicated resources, including human and financial. The outcome of the study serves to guide government on the importance of supporting the sector by promoting digital technologies to enable innovation and sustainability in freight transport. Regulatory support that is standardised, has strategic foresight and enables efficient selection and procurement of relevant digital technologies is necessary. Legislation, policies and frameworks should be in accordance with industry needs, allowing for sustainable innovation and ensure clear direction and targets for the freight transport sector. Government support should be intentional in creating an enabling environment, including infrastructure development and a collaborative digital ecosystem, promoting digital technologies through initiatives and strategic planning. Furthermore, government could provide attractive incentives or stimuli that could compel freight transport organisations to adopt digital technologies, providing a catalyst for reformation towards innovation. The establishment of a central body or centre, responsible for overseeing and leading digitalisation in the South African freight transport sector, could enable better digital technology adoption as it would support concentrated efforts, thereby enabling industry transformation and benefit realisation.

6.5.3 Practical implications

Based on the outcome of the study, it is suggested that subject matter experts consider influencing internal factors in the South African freight transport sector as perceived relative advantage, knowledge absorption capability and perceived ease of use, with influencing external factors as competitive pressure and government support. Understanding these driving factors can enable different stakeholders, including top management, executives, middle management, subject matter experts and specialists, across freight transport organisations, to support digital transformation and enablement.

From a technological context, associated with perceived relative advantage, top management and executives should ensure clear strategic direction and initiatives for digital transformation, linked to business requirements and IT capability at an organisational level. Strategic direction should clearly define strategic choices of digital technologies and associated benefits, which enable sustainable competitive advantage. Tactically and operationally, middle management should develop functional strategies linked to cascaded strategic choices that enable digital transformation. Specialists and subject matter experts should practically assess digital technology needs in the business, ensuring that cost-benefit analysis is performed to accommodate constraints in freight logistics organisations, while considering the competitive advantage that digital technologies may enable. Middle management should effectively communicate the benefits and advantages of digital technologies in the organisation and create awareness on effective utilisation and how digital technology enablement supports the organisation’s strategic direction and enhances its performance. Specialists and subject matter experts should ensure that relevant digital technologies are adopted in the organisation, while applying the principle of quality over quantity to ensure unnecessary application and system use. Furthermore, senior and middle management should monitor benefits realisation

and effectiveness of digital technology enablers, noting deviations and encouraging a feedback loop to apply corrective and proactive measures.

In terms of internal-organisational context, knowledge absorption capability is a significant driver of digital technology adoption in freight transport organisations. Top management and executives should create structures in freight transport organisations that support learning and development, and dynamic capability enhancement. Freight transport organisations should be structured to support innovative and lean ways of working. Senior and middle management should promote agility and implement agile methodologies in operations and implementation. Specialists and subject matter experts should collaborate with customers and employees to enhance effectiveness of digital technologies in the organisation, instilling a culture of continuous improvement. Furthermore, specialists and subject matter experts should sense market trends and the external environment to seize and assimilate opportunities within the organisation. Line managers should tactically position and support these opportunities to digitally transform freight transport organisations. Also, there are several stakeholders that influence the operations of freight transport organisations. These include competitors, labour unions, municipalities, customers such as mining companies and shipping lines, and communities in which freight transport organisations operate in (Transport, 2023). Hence, engagement, transparency and effective communication is essential in creating a network of information flow and feedback with each of these stakeholders to leverage support from these networks. Subject matter experts should understand challenges and pain points of digital technology adoption, and incorporate feedback into business processes and systems to enable continuous improvement. Furthermore, perceived ease of use of digital technologies was found to be a significant driver of digital technology adoption. Therefore, specialists and subject matter experts should design applications and systems for user-friendliness and ease of use, ensuring accessibility of applications and technology. Dedicated support should be provided for ease of understanding,

educating and consistently training resources. Training and testing the transfer of knowledge should be done at regular intervals, thereby creating a learning organisation.

From an external-organisation context, competitive pressure and government support were found to significantly influence the intention to adopt digital technologies in the South African freight transport sector. Specialists and subject matter experts should learn from best practices and investigate digital technologies that have been successfully implemented with noticeable benefits in similar industries, which can assist freight transport organisations accelerate adoption of digital technologies. Encouraging a community of learning and engagement with competitors can assist in creating a sustainable, holistic supply chain, where learnings can be shared and gaps closed. Executives and senior management should cascade learnings from engagements, while middle managers should promote the benefits and case studies of digital technologies that support the strategic direction of the organisation. Furthermore, from a government support perspective, middle management should escalate challenges that impact operations to platforms that engage with government entities. These channels should be proactive and equipped with dedicated resources to remove blockages where possible. It is important for management across the organisation to be transparent and effectively communicate the needs and challenges in the organisation related to digital transformation initiatives. This can assist government support to be targeted, with sustainable solutions created in collaboration with freight transport organisations. Considering the constraints associated with digital technology adoption in the freight transport sector related to inadequate infrastructure and lack of financial resources and skills, effective collaboration between government and vendors should be considered (Lutfi, et al., 2023). Sustainable solutions include vendor provided training and technical support that is reasonably priced in the short term, with government supporting longer term initiatives for digital technology adoption.

6.6 Suggestions for further research

The scope for further research is substantial on digital technology adoption in the freight transport sector. Based on the results, further validation can be performed due to the moderate predictive power of the current study. Further research can be performed in the freight transport sector of other developing countries and even developed countries.

Using the combined TAM-TOE framework, various other technological, internal-organisation and external-environment context constructs can be considered. In addition, the relationships of the technological and internal-organisation context constructs can be tested directly with the intention to adopt digital technologies, as in this study it was investigated through perceived usefulness and perceived ease of use of digital technologies.

This study considered different digital technologies in the freight transport sector, whereas further research can be performed on a particular digital technology in the freight transport sector, such as internet of things or cloud computing only. In relation to this, digital technology adoption can be explored in a particular industry, rather than investigating the entire sector, by looking at ports or rail industries only for example. Furthermore, the omission of the air industry in the current study creates opportunity for further investigation in this industry.

The current study has observed the need to understand the benefits of digital technologies. Hence, further studies can extend the proposed research model to include constructs related to potential benefits of digital technology adoption, such as improved efficiency, customer satisfaction or reduced costs. Further studies can also extend research by considering supply chain and logistics, rather than only focusing on the transport component. In addition, from a methodological perspective, future studies can consider a longitudinal study and include more stakeholders and freight transport organisations in the sampling methodology.

Table 13: Consistency Matrix

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
1.	To investigate the internal factors that influence the intention of South African freight transport organisations to adopt digital technologies	Venkatesh and Davis (2000) Ramkumar et al. (2019) Katebi et al. (2022) Kamble et al. (2021) Chowdhury et al. (2023) Balci (2021) Arumugam et al. (2022) Mishra et al. (2023)	$H1_0$ = Perceived usefulness of digital technologies does not have a positive influence on the intention to adopt digital technologies. $H2_0a$ = Perceived ease of use of digital technologies does not have a positive influence on the intention to adopt digital technologies. $H2_0b$ = Perceived ease of use of digital technologies does not	Questionnaire Q1.1 to Q1.7	Ordinal Data (7-point Likert Scale)	PLS-SEM

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
		Smit et al. (2018) Berg and Lingen (2019) Ullah et al. (2022) Rogers (2010) Wong, et al. (2020) Bhattacharya and Wamba (2018) Tasnim et al. (2023) Kamble et al. (2019) Wong et al. (2020)	have a positive influence on the perceived usefulness of digital technologies. $H3_0a$ = Perceived relative advantage does not have a positive influence on perceived usefulness of digital technologies. $H3_0b$ = Perceived relative advantage does not have a positive influence on perceived ease of use of digital technologies.			

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
		Puklavec et al. (2018) Lin (2023) Hussein et al. (2019) David et al. (2023) Rogers (1995) Chittipaka et al. (2022) Shahadat et al. (2023) Rogers (2010) Sharma et al. (2023)	$H3_0c =$ Perceived usefulness of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies. $H3_0d =$ Perceived ease of use of digital technologies does not mediate the relationship between perceived relative advantage and intention to adopt digital technologies. $H4_0a =$ Compatibility does not have a positive influence on the			

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
		Al-shanableh et al. (2024) Qin (2020) Sideri et al. (2021) Dehghani et al. (2022) Khan and Tao (2022) Kamble et al. (2020) Wamba and Queiroz (2022) Papathanasiou et al. (2020)	perceived usefulness of digital technologies. $H4_0b$ = Compatibility does not have a positive influence on the perceived ease of use of digital technologies. $H4_0c$ = Perceived usefulness of digital technologies does not mediate the relationship between compatibility and intention to adopt digital technologies. $H4_0d$ = Perceived ease of use of digital technologies does not			

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
		Mahmood and Mubarik (2020) Mayeh et al. (2016)	mediate the relationship between compatibility and intention to adopt digital technologies. $H5_0a =$ Knowledge absorption capability does not have a positive influence on perceived usefulness of digital technologies. $H5_0b =$ Knowledge absorption capability does not have a positive influence on perceived ease of use of digital technologies.			

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
2.	To investigate the external factors that influence the intention of South African freight transport organisations to adopt digital technologies	Ali et al. (2023) Chittipaka et al. (2022) Shi and Yan (2016) Allen and Iano (2019) Shahadat et al. (2023) Hussain et al. (2020) Malik et al. (2021) Kiu and Chan (2023) Chiu and Shih (2023)	$H6_0$ = Competitive pressure does not have a positive influence on the intention to adopt digital technologies. $H7_0$ = Government support does not have a positive influence on the intention to adopt digital technologies.	Questionnaire Q2.1 to Q2.2	Ordinal Data (7-point Likert Scale)	PLS-SEM

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
		Christiansen et al. (2022) Sharma et al. (2020) Li et al. (2020) Lin (2023) Gokalp et al. (2022)				
3.	To investigate how government support moderates the intention of South African freight transport organisations to	Ramanathan et al. (2014) Ngisau and Ibrahim (2022) Mensah et al. (2022)	$H8_0a =$ Government support does not moderate the relationship between perceived usefulness of digital technologies and the intention to adopt digital technologies.	Questionnaire Q3.1	Ordinal Data (7-point Likert Scale)	PLS-SEM

RO #	Research Objective	Literature Review	Hypotheses	Sources of data	Type of data	Data analysis method
	adopt digital technologies		$H8_0b =$ Government support does not moderate the relationship between perceived ease of use of digital technologies and the intention to adopt digital technologies.			

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APPENDIX A: Analysis Tables and Charts

Table 14: Target population and calculated sample size (Organisation Y, 2023) (Road Freight Agency, 2023)

Organisation	Org A	Org B	Org C	RFA
Industry	Rail	Pipeline	Port	Road
Target Population	9 186	633	3 708	100
Sample Size*	251	19	101	4
Total Target Population	13 627			
Total Sample Size*	374			

*Based on a 5% level of precision and 95% confidence level; calculated using http://www.raosoft.com/samplesize.html.

APPENDIX B: Survey

A	Demographic Question	Response Options
1.	Transport organisation type	i. Road ii. Rail iii. Port iv. Pipeline
2.	Size of organisation	i. <50 ii. 51-100 iii. 101-500 iv. 501-1000 v. >1000
3.	Years of experience in transport sector	i. (1-10) ii. (11-20) iii. (21-30)

		iv. (31-40) v. >40
4.	Level/Job Position	i. Junior ii. Mid-level iii. Senior iv. Executive v. Specialist vi. Consultant vii. Other
5.	Highest level of qualification completed	i. Less than Matric ii. Matric iii. Diploma iv. Bachelor's Degree v. Master's Degree vi. Doctorate

5.	Experience in digital technologies in transport sector	i. Novice - Limited experience; requires close supervision. ii. Advanced Beginner - Basic knowledge of key aspects of digital technologies; requires supervision of overall task. iii. Competent - Good working and background understanding and experience of digital technologies; ability to achieve most tasks using own judgement. iv. Proficient - High depth of understanding and application of digital technologies; full responsibility of task, with oversight of others to some degree. v. Expert - Authoritative knowledge and experience in digital technologies, with deep tacit understanding; full responsibility of task, with ability to go beyond existing standards.

7.	Use of digital technologies in work environment	i. Daily ii. Weekly iii. Monthly iv. Quarterly v. Annually vi. Less often than annually		
#		Research Question	Response Options (7-point Likert Scale)	Cronbach Alpha & Reference
1. Research Objective: Internal Factors				
1.1.	Intention to Adopt Digital Technologies (DTA)	DTA1: I predict my organisation will adopt digital technologies regularly in future DTA2: Using digital technologies are advantageous	1 – Strongly disagree, 2 – Disagree, 3 – Somewhat disagree, 4 – Neutral,	S. S. Kamble et al. (2021) 0.934

		DTA3: My organisation is in favour of using digital technologies	5 – Somewhat agree, 6 – Agree, 7 – Strongly Agree	
1.2.	Perceived ease of use of Digital Technologies (PEUDT)	PEUDT1: Digital technologies are easy to understand PEUDT2: Digital technologies are easy to use PEUDT3: Digital technology features will be easier compared to other alternative technologies		S. S. Kamble et al. (2021) 0.886
1.3.	Perceived usefulness of Digital Technologies (PUDT)	PUDT1: Digital technologies will help improve business efficiency PUDT2: Digital technologies will help improve business productivity PUDT3: Digital technologies develops organisational competitiveness		S. S. Kamble et al. (2021) 0.932

1.4.	Organisational Readiness (OR)	OR1: My organisation has availability of financial resources and funds to implement digital technologies OR2: My organisation has access to technical knowledge and skills to implement digital technologies OR3: My organisation has access to IT infrastructure and internet connectivity to implement digital technologies		S. S. Kamble et al. (2021) 0.897
1.5.	Knowledge Absorption Capability (KAC)	KAC1: My firm has the capability to identify digital technology-related knowledge KAC2: My firm has the capability to acquire digital technology-related knowledge		Hsiu-Fen Lin (2023) 0.879

		KAC3: My firm has the capability to assimilate digital technology-related knowledge KAC4: My firm has the capability to exploit digital technology-related knowledge		
1.6.	Perceived Relative Advantage (PRA)	PRA1: The utilisation of digital technology in the organisation will assist in achieving undertakings all the more rapidly PRA2: The utilisation of digital technology in our organisation will empower us to reduce expenses PRA3: Utilising digital technology administrations can expand profitability in our organisation		Gho-bakhloo et al., 2011; Moore & Ben basat 1991 0.849

		PRA4: Utilising digital technology can expand adaptability in our organisation		
1.7.	Compatibility (C)	CO1: Use of digital technologies are compatible with existing IT infrastructure in my organisation CO2: Use of digital technologies are compatible with my business processes and operations CO3: Use of digital technologies are compatible with my organisation's preferred work practices CO4: Use of digital technologies are compatible with my organisation's customers		Ghobakhloo and Tang (2013), Tripopsakul (2018) and Sutanon-paiboon and Pearson (2008) 0.788
2. Research Objective: External Factors				

2.1.	Competitive Pressure (CP)	CP1: Digital technologies offer competitive advantages CP2: Competitors are in the process of implementing digital technologies CP3: Competitors will become more competitive with digital technology implementation	1 – Strongly disagree, 2 – Disagree, 3 – Somewhat disagree, 4 – Neutral, 5 – Somewhat agree, 6 – Agree, 7 – Strongly Agree	S.S. Kamble et al. (2021) 0.893
2.2.	Government Support (GS)	GS1: Government provides support in digital technology adoption and implementation to business GS2: Government is helping to lower the cost and setting up of digital technology facilities GS3: Government support is important to encourage intensive use of digital technologies		Looi (2005) 0.876

3. Research Objective: Government Support as a Moderator				
3.1.	Government Support (GS)	GS1: Government provides support in digital technology adoption and implementation to business GS2: Government is helping to lower the cost and setting up of digital technology facilities GS3: Government support is important to encourage intensive use of digital technologies	1 – Strongly disagree, 2 – Disagree, 3 – Somewhat disagree, 4 – Neutral, 5 – Somewhat agree, 6 – Agree, 7 – Strongly Agree	Looi (2005) 0.876

APPENDIX C: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

Dear Sir / Madam

My name is Sharday Jaiswar. I am Masters student in the field of Digital Business at the University of the Witwatersrand, Johannesburg. My supervisor is Dr Pius Obas. I am conducting a research study about digital technology adoption in the freight transport sector in order to understand influencing factors that can ultimately assist in benefit realization, such as improved competitiveness. The study title is Factors influencing digital technology adoption in the South African Freight Transport Sector.

I am inviting you to take part in a questionnaire. If you decide to take part, your participation in this research study will last approximately 20 minutes. The questionnaire will be online via a Qualtrics link that can be completed at your convenience.

With your permission, I would like to gather your response as data for my study. Only the researcher will have access to the data.

During the research activity, I will need to ask for some personal information about you, including your job position, number of years in your organisation and your experience level with digital technologies.

The questionnaire will be confidential and anonymous. When I share the results of the research study, I will not include anything that could identify you.

If you decide to take part in the research study, it should be because you want to volunteer. You do not have to take part. You can stop being in the study at any time. You do not have to answer any questions if you do not want to. You will not get any direct benefits if you choose to join the research study. You will not lose any services, benefits or rights you would normally have if you decide not to join. Taking part in the research study will not cost you anything. You will not be paid for being in this research study.

The risks for this research study are no more than what happens in everyday life.

This research study will be written up as a research report. If you would like to receive a summary of this report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,
Sharday Jaiswar

Researcher:
Sharday Jaiswar, 686265@students.wits.ac.za, 061 442 1250

Supervisor:
Dr Pius Oba, pius.oba@wits.ac.za, +27 11 717 3976

APPENDIX D: Participant Agreement Form

PARTICIPANT AGREEMENT FORM

Factors influencing digital technology adoption in the South African Freight Transport Sector

Sharday Jaiswar

I, ……., agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES NO
I understand that I can volunteer to take part in the study	YES NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report)	YES NO
I agree that other researchers may use the information I provide in my questionnaire (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES NO

…… (signature)
…… (name of participant)
…… (date)

APPENDIX E: Ethics Approval Notification

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/DB686265/503
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below)

Project title	Factors influencing digital technology adoption in the South African freight transport sector
Investigator / Researcher	Mrs Sharday Jaiswar
Nature of Project	MM (Digital Business)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed anonymity and confidentiality.
Issue Date of Certificate	2023/10/13
Expiry date	Date of submission of the project / research report
Chairperson	Dr Pius Oba ☎ +27 11 717 3976 +27 82 733 6587 pius.oba@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

16/10/2023
Date:

APPENDIX F: Permission Letters from Organisations

03 August 2023

Ms Sharday Jaiswar
Wits Business School, University of the Witwatersrand,
2 St Davids Place & St Andrew Road
PARKTOWN
2193

Attention: Ayanda Magida, 686265@students.wits.ac.za 011 717 3544 / 3953

Dear Ms Jaiswar,

Request for permission to conduct a quantitative method study through the Association.

Your letter of request for permission to use The Road Freight Association (RFA) to conduct a quantitative study method for your master's research on "Factors influencing adoption of digital technologies in the South African Transport Sector", refers.

Such access approval is only granted under the conditions that the study is strictly for academic purposes, and all research will be handled confidentially with the anonymity of participants completing the survey being fully guaranteed on your part.

Your request to use Association to conduct a quantitative method study in the research, using an online survey, is granted.

We look forward to receiving the final research report from Wits Business School.

Yours Sincerely

Gavin Kelly
Chief Executive Officer
Contact Numbers: 011 974 4399 E-mail: charlene@rfa.co.za

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