Factors affecting the adoption of drone delivery technology in the logistics industry

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Plagiarism Declaration

Declaration

Hereby, I, Mogamad Nieyaaz Adams, declare that investigating the factors that affect the adoption of drone delivery technology in the logistics industry is my own original work, that all sources have been accurately reported and acknowledged, and that this document has not previously, in its entirety or in part, been submitted at any university in order to obtain an academic qualification.

Full name:_Mogamad Nieyaaz Adams Date: 23 Aug 2023

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Abstract

Logistics organisations may struggle to implement commercial drone delivery as part of an innovative drive to improve the efficiency of last-mile logistics in South Africa. The inability of the local logistics industry to fully understand the factors that influence the adoption of the technology could lead to a failed initiative with no financial, social, or economic benefits realised. However, if it is possible to understand the potential customer, the process of deploying drones as a hybrid or complete alternative to traditional last-mile delivery is more likely to be successful. A better understanding of the local environment can allow logistics operators to better package the technology while also allowing the government to improve policies around the commercial use of drones.This research study is aimed at understanding the factors that influence the adoption of drones as a form of parcel delivery in South African organisations. A framework was developed using the TOE, DOI, and TAM models to identify technological, organisational, and environmental factors affecting the adoption of drone technologies. A questionnaire was administered to logistics experts within the local logistics industry. The collected data was analysed quantitatively to understand how the various identified factors affect the adoption of last-mile drone delivery in the South African context.The study identified two significant technological factors that influence the adoption of drone delivery over the last mile in the logistics industry. These factors included complexity and compatibility. With regards to organisational factors, the study identified "senior management support" and "innovative thinking" as significant factors that will play a role in the adoption of drone delivery. In terms of environmental factors, the survey suggested that "drone legislation" and "public infrastructure" are significant factors that need to be understood when adopting delivery drone technology in the last mile. The study contributes to the body of knowledge on factors affecting the adoption of delivery drone technology in the last-mile and logistics industries. The study used the convenience sampling method, which has limitations and weaknesses because the sample is not representative of the logistics population. An opportunity exists for further studies to be undertaken that would consider empirical data using other research methodologies. However, the study was able to achieve its objectives of investigating the factors that affect the adoption of drone delivery in the logistics industry.

Keywords: drones, delivery, last mile, logistics, TOE, technology, innovation, TAM, DOI

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Table of Contents

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http://etd.uwc.ac.za/

UNIVERSITY of the WESTERN CAPE
http://etd.uwc.ac.za/

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Chapter 1. Introduction and Background

The growth of digital commerce and the rise of technologies such as the internet of things and big data are revolutionising the supply chain and logistics industry globally by fundamentally changing how organisations transact, interconnect, obtain, and deliver goods (Ranganathan & Dhaliwal, 2011). According to International Trade Administration (2024), South Africa has seen significant growth in online sales, increasing by 66% over the last few years. South African delivery platforms such as Mr delivery have seen increases of 54% from 2019 (Ecommer, 2024). Accordong to Insaka (2023), Numerous factors, such as expanded internet access, enhanced payment alternatives, and the efficiency and convenience of online buying, have contributed to this trend. The literature suggests that a focus on improving the supplier and customer relationship can lead to competitive advantage (Naude & Badenhorst-Weiss, 2011; Gonzalez-Loureiro, Dabic & Kiessling, 2015), which is inherently hard for market competitors to replicate (Li, Ragu-Nathan, Ragu-Nathan & Subba, 2006). A key element of online retail fulfilment has often been the logistics behind product delivery. According to Brunner, Szebedy, Tanner, and Wattenhofer (2018) and Chen, Lan, Hu, and Xu (2018), package delivery has been an important issue in the logistic industry for decades, mostly relying on shipping, train, and terrestrial vehicles to meet the growing demand for mobile goods and services. Within the field of logistics, the final step of delivery leading to contact with the customer is often referred to as the last-mile delivery. According to Brunner et al. (2018), the last mile comprises a spectrum of systems and connections intended to cover the expected mobility demand of physical goods that include transport systems and a series of organisational elements characterised by complexity. The fast growth of e-commerce has placed a large strain on retailers, specifically last-mile delivery, as it is often the most expensive leg of the logistics operation. Organisations use a multitude of technologies, such as route planning and cost-effective vehicles, to overcome last-mile challenges such as poor transport networks, extreme weather conditions, natural disasters, or traffic congestion in urban areas.

In South Africa, traditional last-mile delivery is also severely affected by soaring fuel costs, which affect all traditional means of delivery. Over the last few years, there has been an exponential rise in interest in drone delivery to overcome traffic congestion in urban areas or reach rural areas over long distances (Kornatowski, Bhaskaran, Heitz, Mintchev, & Floreano, 2018). It is for this reason that many organisations faced with logistical last-mile delivery issues have turned their attention to drone technology as a commercially viable option to deliver

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goods at a lower cost and faster time while delivering a better customer experience (Yoo & Hong, 2018). A study by Khan and Khanzada (2019) noted that the development of commercial drones is still in its infancy and unheard of in developing countries. Yoo et al. (2018) explain that drones can deliver parcels with great efficiency and speed, being able to cover distances of 50km while flying at speeds between 15 and 65 km per hour. For all the seemingly accessible benefits of commercial drone delivery, many positive and negative issues exist relating to privacy, security, and the environment (Khan et al., 2019). These issues are yet to be examined and understood from an organisational perspective. For example, many consumers are worried about the violation of privacy encountered when drones pass over their homes or the ramifications to their safety if a commercial drone were to crash into their properties (Khan et al., 2019). Other researchers consider the impact on the environment to be positive, with delivery drone technology able to harness the power of sustainable energy (source). For drone delivery to be successful in the South African context, the technology needs to be adopted by logistics organisations as a viable option for the delivery of goods and services. For this to happen, the factors that influence the acceptance of the technology by the organisation need to be understood and examined. By examining the associated risks, the technology can be better packaged and integrated into logistical operations for success.

1.2 Aims and Objectives

1.2.1 The aims of the research

A vital link in the logistics value chain is last-mile delivery. Last-mile delivery, as defined by Kornatowski et al. (2018), is the physical delivery of a product to customers through a collaboration of several systems, processes, and individuals. The purpose of this study is to investigate how the logistics industry's adoption of delivery drone technology will ultimately be impacted by technological, organizational, and environmental issues.

1.2.2 Statement of the research problem

The process of delivering products is often complicated, with geographically hard-to-reach areas lacking transport-efficient infrastructure resulting in high delivery costs or highly dense areas where last-mile delivery is impacted by a host of environmental problems such as traffic congestion or criminal activity, leading to inefficient delivery of products.Drone technology is seemingly becoming a viable method of last-mile delivery, with high potential to reduce costs and improve speed of delivery (Yoo et al., 2018). However, the South African logistics industry may struggle to understand the technology's impact, leading to wasted investment on the part

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of the logistics industry and a lack of economic benefits to consumers. To ensure the drones are correctly adopted as a delivery tool, the impact on the south African logistics industry and consumers needs to be understood. This examination can potentially aid the implementation of drone delivery as a method of last-mile delivery in South Africa.

1.2.3 Primary research problem

What factors are affecting the adoption of drones in the last mile within South Africa?

1.2.4 Research Objectives

The objective of the study is to understand the factors that affect the adoption of commercial drone delivery in South Africa.

To answer this objective,

- To identify technological factors that influence the adoption of drone delivery.
- To identify organisational factors that influence the adoption of drone delivery.
- To identify environmental factors that influence the adoption of drone delivery.

The research study will achieve the research objectives outlined above in four separate chapters. Chapter 2 is a literature review to investigate the academic body of knowledge around drone delivery and its potential use case in the logistics industry. Chapter 3 will present the methodology for the research study, including the development of the technological, organisational, and environmental factors that affect the adoption of drone delivery. Chapter 4 will unpack the data collected during the survey. Chapter 5 will discuss the findings of the survey in relation to the observations in the literature survey.

1.2.5 Location of the study

The study will be conducted in Cape Town, South Africa.

1.2.6 Research questions, subquestions, methods, and research objectives.

Table 1.1 Research questions, subquestions, methods, and research objectives.
Research question: What are the factors affecting the adoption of drone delivery by logistics organisations?

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Research Sub-Questions	Research method/s	Research objective
What are the technological factors affecting the adoption of drone delivery.	questionnaire survey	Identify the technological factors affecting the adoption of drone delivery by logistics organisations.
What are the organisational factors affect the adoption of drone delivery.	questionnaire survey	Identify the organisational factors affecting the adoption of drone delivery by logistics organisations.
What are the environmental factors affect the adoption of drone delivery.	questionnaire survey	Identify the environmental factors affecting the adoption of drone delivery by logistics organisations.

1.3 Chapter Layout

Chapter 1 focused on the overview and significance of unmanned drone technology within the logistics industry. This was followed by exploring the background of the study while examining the research objectives, research problem, and location of the study. Chapter 2 entered into a literature review of drone technology and its application in the logistics industry. With the rise of drone technology, a method of last-mile delivery was introduced, after which the potential upside to drone delivery in the last-mile space was considered. The theoretical frameworks Technology acceptance model, Diffusion of innovation, and Technology-Organization-Environment were explored as a means to facilitate the discovery of factors that may influence the adoption of last-mile drone delivery. These TAM and DOI factors included the relative advantage, personal innovativeness, communication, and perceived risks associated with last-mile drone delivery, or drone delivery in general. The TOE framework was also used to examine other technology, organisational, and environmental factors. The chapter concluded with a look at previous delivery drone research, touching on infrastructure readiness, drone-related products, and drone security. Chapter 3 focused on the methodology used to study the delivery of drone technology. The research study used a survey questionnaire to target logistics professionals and examine the eight constructs identified in the TOE, DOI, and TAM frameworks. A minimum of 66 participants were targeted. Chapter 3 also discussed the development of the instrument, which included a quantitative strategy utilising a Likert scale. Opportunity sampling was utilised as the digital channels were used to distribute the survey. The collected data was then analysed in Statistical package for the social sciences, while the

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Cronbach alpha was used to measure internal consistency. The use of digital software was explained to be beneficial as it reduced complexity. Chapter 4 was the presentation of the survey results. Firstly, the research results were introduced, with the demographic data of the sample examined. The chapter then proceeded to illustrate the outcomes of the technology-based questions offered to the participants in the survey. These questions revolved around compatibility, complexity, skills, security, and cost, which were identified as technology factors affecting the adoption of last-mile drone delivery. Organisational questions aimed at understanding adoption factors such as management support, organisational size, and organisational culture were also depicted. Lastly, the survey questions linked to the environmental factors affecting the adoption of last-mile drone delivery were delivered. Statistics were generated to describe the participants understanding of delivery drone energy consumption, infrastructure needs, and the impact of legislation when potentially implementing drone delivery.

1.4 Chapter Summary

Chapter 1 of the study provides an introduction to the research topic. The growth of digital commerce, contributing to an increase in demand for last-mile delivery, was explained. To meet the demand for last-mile delivery, the use of drone delivery is touted as an efficient means to transport goods. The second part of the chapter identifies the research problem as well as the research objectives. The research problem is described as "What factors are affecting the adoption of drones in the last mile within South Africa?". The research objectives were developed to understand the technological, organisational, and environmental factors that affect the adoption of drone delivery in the South African context. The third section of the chapter focuses on the location of the study, which is described as Cape Town, South Africa. The fourth section of the study outlines the research questions, objectives, and method. The research method for the study is specified as a questionnaire survey. The final section of Chapter 1 provides a brief description of the following chapters in the study. Chapter 2 of the study is a literature review of the delivery drone industry. Chapter three will develop the methodology used to study the delivery of drone technology. In Chapter 4, the survey results will be examined and interpreted. The final chapter, which will discuss the survey results in relation to the TOE framework contents, will attempt to answer the research questions highlighted in chapter one.

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Chapter 2: Literature review

2.1 The rise of Drone Delivery

The fourth industrial revolution, also referred to as Industry 4.0, is the digital transformation of the industrial sector (Reagan & Singh, 2020). Over the last decades, various information technologies have been developed with extended functionalities that, together, are able to solve complex business problems (Hernes & Jelonek, 2020). These technologies include the internet of things, cloud computing, big data, artificial intelligence, and blockchain. The logistics industry is able to innovate at an accelerating rate, automating and collecting data to become more efficient in its processes (Ting, Ho, Chung, & Pang, 2014).

The integration of supply chains with innovative production technologies and communication systems has allowed factories to become smarter, safer, and more environmentally sustainable (Hernes et al., 2020). Artificial intelligence, in combination with the internet of things, is becoming very prevalent in quality control processes, security, and management systems. According to Witkowski (2017), innovation and time are the two main competitive advantages that logistics organisations are able to exploit through the use of technology. The use of big data and the internet to improve logistics route planning has been critical in addressing the demand for the delivery of products and services.

Drone technology has been around since the 1900s, according to Giones & Alexander (2017), when the technology or concept was applied in the US military. These unmanned aerial vehicles, or drones, were initially created with the intention of collecting intelligence and completing surveillance without endangering human life. Over the decades, the physical application of drones has taken on many shapes and forms. The advancement of drone technology has evolved with other modern technologies such as artificial intelligence, high-resolution cameras, and sophisticated digital communications infrastructure (Martins & Silkoset, 2021). The ecosystem of technologies associated with drones has helped aid the adoption of drones in many use cases.

According to Kindervater (2016), the use of unmanned drones in warfare may even predate the use of manned aircraft during World Wars I and II. Unmanned air balloons were used to deploy chemical weapons or, in some cases, for surveillance and the targeting of enemies. During World War II, the United States developed an unmanned bomber and later also the technology for long-range missiles, which could all be piloted remotely (Joshi & Stein, 2013). More

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recently, since 1994, unmanned drones have been remotely operated in the US military for a vast number of missions and have also been used as an airborne assassinating tool (Williams, 2010). Today's commercial unmanned drones would not be possible without the long and continuous research and development programme initiated in the 40s. According to Kindervater (2016), it was the cold war that sparked a shift to information and electronic warfare, with an emphasis on collecting and consuming large amounts of data. During the Cold War, unmanned drones were used to intercept and destroy enemy radar while also visiting the other side of the iron curtain. Modern military drones have claimed the lives of countless souls, as explained by Williams (2010), with drones responsible for killing 60 people at a Taliban funeral procession. According to Fojas (2019), drones have also been developed for border surveillance while being integrated into a larger security network. The idea that drones are primarily used for warfare and self-defence has given the technology a dark stigma.

The most recent form sees the technology classified into two groups of drones: fixed wing and rotary wing (Li & Tryfonas, 2017). Modern drones have four basic features, namely: aerial capacity, flight control, position control, and communication (Giones & Alexander, 2017). All these features are a result of rapid advances in fourth industrial technologies such as IoT, big data, and cloud computing, with the world economic forum creating awareness around maximising production capacity in the industry (Park et al., 2018). The improvement of battery technology and low-cost cameras and sensors has allowed drones to become an accessible public technology (Giones & Alexander, 2017; Islam & Yaseen, 2019). Drone flying has become a popular pastime for many hobbyists and enthusiasts, with drone sales increasing rapidly since 2016 (Giones & Alexander, 2017).

The popularity of drones has fuelled the use of applied machine learning and artificial intelligence in developing autonomous drones (Islam & Yaseen, 2019), meaning drones no longer require a pilot. The ability to self-pilot has opened the possibility of applying drones to several problems. In a study by Grofelnik & Sternad (2022), it is explained that drones are used in construction to evaluate the progress of large structures or to survey the volumetric size of large objects. Drones have already been equipped with multitudes of additional sensors and scanning equipment to make use of their aerial visual capabilities.

Drones that do not require an active pilot are perfect for problems where drone scalability may be leveraged. For example, autonomous drones have been used in agriculture, smart city planning, and the logistics industry (Giones & Alexander 2017; Islam & Yaseen 2019).

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Amazon was the first major retailer to explore the use of unmanned drones to deliver goods, with logistics companies such as DHL following suit (Bae, Jung, Park, Kim, Kim,& Kim, 2018). The application of commercial drones in the pilot phase was met with great negativity, as unmanned drones had already developed a reputation for endangering property and lives. According to Giones & Alexander (2017), "a drone reportedly crashed into the White House in the US, causing damage to the property in 2015". Drones have also caused havoc by interfering in airport airspace and endangering the safety of passengers, as well as being a nuisance at major sporting events (Zahy et al., 2017).

The fight against the COVID-19 pandemic has mobilised many national resources, such as human, material, political, and financial (Martins et al., 2021). Drone technology has come to the forefront of technological solutions that can address diverse problems related to the crisis. The idea of social distancing allowed for the use of drones in many different scenarios where humans would be at risk of being infected. Drones were able to deliver supplies, detect possible infections, and provide a form of security during lockdowns (Alsamhi & Lee, 2021).

The drone industry is facing much criticism concerning safety and privacy, which, according to some academics, is due to a lack of effective legislation and policy (Connie et al., 2018). According to Li & Tryfonas (2017), most of the regulations across the world focus on the practice of drone flying rather than regulating their technical abilities. Academics argue that work needs to be done to understand legislation, which can aid the development of drones from "toys" to professional tools (Giones & Alexander 2017). Meaningful legislation must be developed that understands the technology, and it is an opportunity to affect a multitude of industries in a meaningful way. As a solution, Choon et al. (2018) argue that drone technology should be incorporated into existing manned aviation legislation; in a similar way, a self-driving car must follow the same rules as human drivers. There is no doubt that a clear opportunity exists for drone delivery, which, with the correct legislation and application of technology, will be able to create a new market for direct parcel delivery (Giones & Alexander 2017).

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2.2 The potential of Drones in the logistics industry

Over the last decade, there has been rapid growth in digital commerce, with online retailers requiring a means of delivery. According to Chiang, Shang, and Urban (2019), online sales increased by 14.7% in the US during the period of 2016–2017. During the COVID period of lockdowns, there was significant growth reported in the local e-commerce industry in South Africa. A contributing factor to this domestic growth was the use of online platforms to purchase items and avoid making trips to department stores. This sort of growth has been significant enough to warrant an inquiry into alternative delivery methods to support online sales. Drones have become a natural means with which to improve last-mile delivery from both an economic and environmental perspective, as drones generate less carbon emissions and consume fewer fossil fuels than the traditional transport industry (Chiang et al., 2019).

The results of a study by Park et al. (2018) showed that the impact of drone delivery was one sixth of that of a motorcycle covering the same kilometres. Furthermore, drones have proven to have advantages in terms of speed, flexibility, and ease of delivery when used to deliver goods in comparison to traditional methods (Chiang et al., 2019). According to Stolaroff, O'Neill, Lubers, Mitchell, and Ceperley (2018), the adoption of unmanned drone delivery to deliver packages over the last mile will ultimately develop into a new industry. This new model for last-mile delivery will reshape the world and transition the use of energy in the logistics sector. Furthermore, Stolaroff et al. (2018) explain that drone delivery may eventually use less energy to deliver parcels to the front doors of millions of people, but due to the capacity of drones, warehouses and other facilities may be burdened with more energy expenses than when ground vehicles are used. This may be because of increased storage demand, with drones being limited in parcel size and distance.

The ability of drone delivery to reduce costs in the logistics industry is not questionable, but for this innovation to have any large-scale impact as a delivery method, certain barriers and pitfalls need to be circumvented. Some studies have also shown that drones are inefficient compared to traditional transportation when delivering to multiple locations over large distances (Park et al. 2018) and that logistics firms should prefer a mixed method of parcel delivery using trucks for longer hauls. Several researchers, such as Chiang et al. (2019) and Hian et al. (2018), have suggested that the current battery methodology employed in drones is insufficient, as it hinders payload weight and delivery distance. These researchers suggest an investigation into alternative power sources, such as fuel cells, to remedy the problem. In other

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studies, researchers question autonomous drones and argue that their deployment is reckless due to the challenge of ensuring safety in an outdoor environment using only on-board computing (Scott & Gil 2018).

To overcome this issue, other groups of enthusiasts have embraced the idea of infrastructure mapping and route planning to ensure autonomous drones do not pose a danger to their environments. Even in a world where drones have predetermined routes of least resistance, improved design, and functionality, the aerial delivery process may still prove unsettling for some types of cargo. In a study by Mayur et al. (2018), the manoeuvres performed by drones in flight were shown to bring about homogeneous mixing of regents. This may prove to be a large concern for the delivery of food, medicine, and chemical-related products.

2.3 Theoretical frameworks: TAM and DOI

2.3.1 Diffusion of innovation theory and technology acceptance model

The definition of innovation (DOI) or (DIT) theory has been frequently applied in communication and information systems research to aid in the process of explaining why consumers adopt technology. In a study by Alam et al. (2021), the author explains that the five main innovation characteristics explain the rate of adoption with a variance of 49% to 87%. In a similar fashion, the Technology Acceptance Model (TAM) is widely used in information systems research when studying acceptance behaviour (Anon, 2002). Perceived usefulness and perceived ease of use of technology are key to understanding why users accept technology. Perceived risk is often applied with both TAM and DOI due to customers having a lack of trust or uncertainty around technologies in their infancy (Yoo et al., 2018). Research has shown that perceived risk dimensions differ according to products or services; therefore, perceived risk is described as a multidimensional construct (Mauricio & Paul, 2003).

2.3.2 Relative advantage (DOI)

DOI explains the importance of relative advantage in new technology, reasoning that new technology often requires desirability over a substitute product (Jing & Ting, 2019). The link is made so that the customer's perception of an innovation being better than its predecessor will positively affect the adoption of the new technology (Yoo et al., 2018). According to Jing & Ting (2019), a customer sees certain attributes of the new technology to be better than what is currently being offered by substitute goods and services in the marketplace. The Tam model

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further cements this link, suggesting that the perceived usefulness of technological innovation will directly affect a customer's intention to adopt new emerging technologies (Zahy et al., 2017). Furthermore, Valencia-Arias, Rodríguez-Correa, Patiño-Vanegas, Benjumea-Arias, De La Cruz-Vargas, and Moreno-López (2022) explain that users in developing countries adopt technology at a slower rate, often because consumers are not aware of how they may benefit from the technology.

In terms of drones as an innovation and traditional last-mile delivery methods, drones offer perceived attributes of speed, flexibility, and cost (Yoo et al., 2018). (Meng-Hui et al., 2018). According to Valencia-Arias et al. (2022), worldwide e-commerce sales passed 3.5 trillion dollars. The increased demand for the delivery of goods and services has seen service providers strive to improve their logistical operations. Organisations have found a relative advantage in using drone delivery over traditional transport, allowing businesses to meet customer demands for fast and effective delivery (Valencia-Arias et al., 2022). Furthermore, Valencia-Arias et al. (2022) explain that drone delivery is a disruptive technology that has not been recognised and is increasing in competitiveness when compared to other forms of delivery, such as helicopters, which require more resources and costs over time.

According to Chen et al. (2022), organisations employing drone technology have started targeting customers with high-perceived innovation in an effort to create awareness about accepting the technology. Customers with a low sense of innovativeness will thus be slower to adopt and decide on the use of a delivery drone service. Top organisations in developed countries, such as Amazon, UPS, and Domino's, have published their imminent endeavour of using drone delivery for the fulfilment of packages to customers homes. Chen et al. (2022). Drone technology is perceived to be technologically superior to other traditional forms of delivery, with this attribute acting as an advantage when innovative customers are choosing their preferred delivery method.

According to Chen et al. (2022), the concept of word of mouth is important in the adoption of technology, as enthusiasts in the same communities tend to influence each other into using particular technologies. Consumers share information on the products and services that they encounter, acting as promoters or detractors of innovations. According to Yuan et al. (2016), individuals share knowledge in many different forms, ranging from reviews, opinions, scoring discussions, and pieces of advice. The same is true for delivery drone technologies, whereby tech-savvy users will reach out to their respective communities to market the delivery of their

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products, improving the perceived usefulness of delivery drone technology. Furthermore, Chen et al. (2022) explain that many users will identify with the potential benefits of last-mile delivery services using drone technology if they become aware; however, there will be many organisations and individuals who will be reluctant to adopt the technologies due to their highly perceived risks and complexity.

2.3.3 Personal Innovativeness (DOI)

Researchers agree that it is important for consumers to display a willingness to test a new technology (Alkawsi & Baashar, 2021). This individual attribute, according to Yoo et al. (2018), is a key construct of DOI in explaining how personal innovativeness has a positive effect on adoption. Individual innovative characteristics have the ability to influence personal behaviour (Khazaei & Tareq, 2021). According to Alkawsi et al. (2021), it is suggested that personal innovativeness may moderate the variables, which affect the factors, which then influence the adoption of specific technology. In a study by Yu et al. (2017), it is explained that late adopters personal innovativeness affects their perceived ease of use of a particular product or service. This explains why innovative late adopters are generally tech-savvy (Yu et al., 2017) and show confidence in technologies they are not accustomed to.

Personal innovativeness is reflected in how people feel about new technology and their openness to new ideas. According to Yuan et al. (2016), modern consumers are increasingly inquisitive, critical, and open to novelty and innovations. These individuals share knowledge in many different forms, ranging from reviews, opinions, scoring discussions, and pieces of advice. Furthermore, Alkawsi et al. (2021) argue that individuals with high personal innovativeness are more likely to take risks with newer technologies than other less innovative personalities.

For drones to be accepted, consumers may need to exhibit a great deal of innovation. In literature, customers who adopt technology early on are described as early adopters. According to Scott & Gil (2018) and Kathleen et al. (2019), early adopters have been shown to possess high levels of personal innovativeness, characterised by high household income, high education, and a willingness to accept. In other literature, early adopters are determined to have a pivotal influence on the uptake and rate of innovation by other adopter categories (Li & Tryfonas, 2017). Thus, the personal innovativeness of the early adopters in the acceptance of drone delivery will go a long way towards affecting other segments of customers, such as

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Laggards. Furthermore, according to Khazaei and Tareq (2021), personal innovation also means that individuals make decisions to buy or use new technology on their own, not requiring any suggestions from the community. These individuals with a high level of personal innovativeness are also less concerned with the opinions of others when confronted with a new technology. The study by Khazaei & Tareq (2021) goes on to categorise personal innovation into three groups: hedonic, instrumental, and symbolic. Symbolic innovativeness implies that users will seek innovation to enforce their appearance of being innovative. Instrumental motives stress the need for new functionality introduced by new technology. Hedonic motives refer to the emotional qualities attached to enjoying the new technology (Khazaei & Tarek, 2021). When using drone delivery, customers with high personal innovativeness may feel a sense of gratification when having their parcels delivered in a new way. Yu (2017) explains that innovativeness is well documented as a behaviour-altering mechanism; however, market research has shown that it is important to recognise a difference between global innovativeness and specific innovativeness. Delivery drone technology is specific in that the innovation lies in the method of delivery. This form of innovation may not necessarily be of concern to consumers who prefer visiting brick-and-mortar businesses.

2.3.4 Communication (DOI)

According to Jing & Ting (2019), it is important for a new technology to attract a certain amount of attention to increase the likelihood of adoption. Media channels such as social media, newspapers, and television keep potential adopters informed about the developments of new technologies (Yoo et al., 2018). Adopters of new technology often display a sense of information seeking through a process of evaluating products and services by word of mouth and analysing available content (Jing & Ting, 2019). Hence, it may be argued that the attribute of communication positively affects adoption and the acceptance of a new technology. Drone delivery will need to be marketed in a certain way to influence the early adopter and increase the likelihood of first becoming an adopter and later a promoter of the new technology.

According to Chen (2022), social media has evolved into a tactful communication channel through which user perceptions of a service or product can be influenced before it is adopted. In a study by Yuan (2016), it is explained that these social media contact points are continuous flows of knowledge between organisations and consumers. During these interactions with social media channels, users unknowingly share what they have learned and transfer their insight onto others by acting as marketing agents for those interested in similar products and

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services (Silvius, 2016). According to Emmanuel (2019), sharing knowledge about a new technology is a means to introduce new functionality or task capabilities to the market. The effect of information sharing is less prevalent in rural communities, where basic channels for communication may be inadequate (Yu, 2017). Rural communities often have less access to the internet and the social channels that exist on the various media platforms. If organisations are to market drone delivery technology in rural areas, a different methodology needs to be assumed to be less reliant on high levels of communication infrastructure. In densely populated urban areas, communication for the purposes of marketing is improved, as the digitised community is more receptive to media interactions. Information and literacy skills play a big role in moderating adoption behaviour (Yu, 2017), with drone delivery being no different.

Communication is critical in demonstrating the relative advantage, complexity, and compatibility of a new technology such as drone delivery. As explained by Emmanuel (2019), DOI emphasises social structures in the process of technology diffusion, with early adopters being part of the social structures. Quality Communication channels are thus imperative in reaching early adopters within the social structures of last-mile delivery, both from a business and consumer point of view. In a study by Silvius (2016), it is explained that social media can improve organisational communications in the context of project management, as it is a critical success factor. Organisations have become accustomed to working in teams using social media to manage collaboration and stakeholder engagement (Silvius, 2016). With the complexity of delivery drone projects, communication within teams and throughout the logistics organisation becomes imperative.

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2.3.5 Perceived Risks (TAM)

2.3.5.1 Privacy

In a study by Yoo et al. (2018), perceived risks are explained to have six dimensions: financial, time, performance, safety, social, and psychological. These so-called risks will negatively affect the customer's intention to adopt a new technology such as drone delivery. In a study conducted by Eißfeldt and End (2020), German people were surveyed on their approval of drone delivery. 59% of the sample reported their disapproval, while 71% indicated that they would not use the technology themselves. In the case of drones, the first major perceived risk mentioned in the literature is privacy. With new technology, the privacy of consumers is always

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a risk (Chamoso, 2018). According to Clothier (2015), technology such as smart apps tracking customers whereabouts or online retailers using customers cookies to see what they have been searching is justified as organisations claim to be keeping up with their competitors. Modern technologies consume many data points as they automate and facilitate day-to-day tasks previously performed by people.

Many researchers have noted the potential and perceived impact of drones on the privacy of civilians through several studies (Choon et al., 2018; Rabeel et al., 2019; Theo et al., 2017). According to Eißfeldt and End (2020), the lack of acceptance of new technology in one's direct environment is referred to as NIMBY ('Not in my back yard'). Many factors contribute to NIMBY, but the most significant contributor is a potential loss of asset value and effect on quality of life. The presence of NIMBY is reported to be common with new technology, especially in the case of drone delivery.

According to Theo et al. (2017), drones are often deployed in areas where the population has little knowledge of the technology and its ultimate purpose. This then creates a lack of trust between parties, with people on the ground claiming they are being spied on. The concern around physical privacy has been mentioned by Yoo et al. (2018) and Rabeel et al. (2019), who explain that because drones have the capability to invade the privacy of your property aerially, many sensitive customers may feel the technology is threatening and invasive. Just as smart phones provide businesses with many ways to track the actions or physical locations of their customers when interacting with touch points, drone delivery flying over residential areas can provide data to their associated organisations, jeopardising the security of individuals who have not agreed to being monitored.

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According to a study by Chamoso et al. (2018), for most individuals, the idea of drones entering their personal space is the same as for any other flying object. However, with drones, there is no system to identify the drone or its intended purpose when passing over populated urban areas. Privacy risks, according to Alejandro et al. (2022) and Chen et al. (2022), refer to the amount of value people place on their private information, which ultimately affects their adoption of a given technology. When using drone delivery, customers will need to provide their address or more specific information, which will enable the drone to locate the drop-off location. According to Alejandro et al. (2022), many people do not purchase products online as they are afraid to share their credit card details over the internet. Similarly, customers with high privacy concerns may not freely want to share information about their location, home, or

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other amenity attributes. This may negatively affect the adoption of drone delivery (Chen, 2022).

Furthermore, Theo et al. (2017) explain that most customers accept invasion of privacy if the goal is safety; however, the use of commercial drones appears to be the exact opposite, with consumers willingness to go to any lengths advertisers will go to get data. The negativity people feel and the perceived risk of privacy stem from the history of drones for surveillance (Zahy et al., 2017); thus, much needs to be done in terms of regulation and legislation to reduce the tension around drones and privacy if the technology is to be accepted by the average consumer (Zahy et al., 2017). Lastly, according to Chamoso (2018), drone technology requires regulatory changes to be introduced, which will offer guarantees of protection against privacy violations. In some countries, drones cannot fly in certain areas in the same way commercial aircraft cannot. These types of policies ultimately provide the public with a sense of security.

2.3.5.2 Security

Another important dimension of risk with regards to drones is security, which negatively affects a consumer’s intention to adopt new technology (Yoo et al., 2018). The introduction of a new technology is always associated with apprehension, as there is an interest in the resulting knock-on effects further into the future (Khan et al., 2019). With the introduction of microwave technology in a domestic setting, much was said about the potential health risks associated with the technology. This was in part due to the technology being vastly different from the traditional stove, with the microwave technology being misunderstood by the public. Many users did not understand the technology and how it produces the heat required to heat food. With drones, the technology is associated with several anxieties, both threatening the security of people and assets.

According to Khan et al. (2019), the hacking of drones for both their data and the intention to cause malice is of great concern to many individuals. In another study, Theo et al. (2017) explain how drones can be shot down to retrieve the undelivered package. In Germany, any flight over an individual’s home or industrial facility is prohibited by law (Eißfeldt and End, 2020). The laws are designed to protect the interests of society against any potential losses related to the delivery of drone technology. In a study by Ramadan, Farah, and Mrad (2017), it was explained that drones are being tested more and more often, leading to more noticeable impacts on civilian safety. These failed tests often increase consumer anxiety about the use of

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drone delivery. This process is similar to that of self-driving vehicles, which are often involved in accidents that could have been avoided with a human driver. These tech accidents increase the scepticism of the new technology to the point where consumers must accept the risks in exchange for improved products and services.

2.4 Theoretical framework : TOE

The TOE framework was developed by Tornatzky and Fleischer (1990) to examine organisational adoption of various technological products and services. In the TOE framework, the adoption of new technology is explained through three contextual aspects: technology, organisation, and environmental.

2.4.1 Technology Factors

The TOE framework has been used in the study of the factors that affect the adoption of technology within an organisation (Mahkittikun & Bhatiasevi, 2021). The technology context specifically explains to an organisation its technological competence and perceived disadvantages (Qin, Lyu, & Mo, 2020). In research by Malik, Vatanasakdakul, and Chetty (2021), the most notable technological factors considered in the study of adoption are perceived benefits, perceived compatibility, perceived complexity, perceived information transparency, and perceived innovativeness. For this study, the technology factors compatibility and complexity were selected from the TOE framework, as these components were not explained in terms of TAM or DOI models.

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2.4.1.1 Complexity (Ease of use)

In a study by Jing & Ting (2019), complexity is described as the extent to which a customer may struggle to utilise the technology in a meaningful manner. Also explained by Yoo et al. (2018), complexity is the degree to which the technology is perceived as being difficult to use. A danger exists that customers may not understand the functionality provided by a new technology (Somang et al., 2019), leading to negative perceptions around the technology's value and benefits. According to Osakwe, Hudik, Ha, Stros, and Ramayah (2022), the

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capability to comprehend and manage such complexity directly influences the success of any technology implementation in terms of performance. In the case of drones, unwanted complexity will lead consumers to stick to traditional, less complicated methods of delivery rather than accept and promote a technology they are unable to utilise efficiently.

According to a study by Pu et al. (2018) and Shahzad et al. (2021), products and services that are highly complex in nature require a large amount of information sharing. Information complexity may be exasperated due to developing countries having less sophisticated systems and a reliance on traditional management methods. As a result, organisations might feel forced to advance information sharing in light of the fact that drone technology is unfamiliar to general consumers. Furthermore, organisations utilising highly complex technologies such as drone delivery will need to closely coordinate and align business processes within the new infrastructure (Pu et al., 2018). Much of the needed infrastructure to coordinate simple drone delivery is available with most commercial drones using 4G and 5G networks. However, more advanced drones, such as those used in the military, rely on satellite communication networks to reach areas with little to no mobile reception. According to Reuters (2022), in the Russia-Ukraine war, the Ukrainian army has employed civilian drones, using 4G and 5G networks to perform reconnaissance. The Russian military struggled to deploy their reconnaissance drones due to issues with their systems and military connectivity. This example illustrates that technology can be easy or difficult to employ when incorrect infrastructure considerations are made. When organisations decide to use existing, well-serviced 4G and 5G communication channels, the communication aspect of drone delivery will be less complex than using elaborate radio and satellite communication in dense urban areas.

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The use of drones for delivery is well documented in the literature, with many organisations attempting various methods to implement drone delivery in a sustainable way. According to Min et al. (2022), there are patents for flying warehouses filled with products that are able to distribute ordered goods to customers with drone delivery. The idea of using arial stations to house drones, acting as a distribution hub, is a relatively new technology with a high degree of complexity. Arial stations will target highly populated, dense areas where products and services are in high demand (Min et al., 2022). Other delivery drone solutions are less complex and based on existing methods of tracking delivered goods (Osakwe et al., 2022). Customers using drone delivery to have items delivered will find the touch points similar to the delivery of food through traditional methods. In a study by Emmanuel (2019), research in South Africa showed

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that the satisfaction of using one mobile app did not influence the intention to use another mobile app. This may be a hindrance for mobile apps, which look to deliver products with the use of drones.

2.4.1.2 Compatibility

Studies have shown that compatibility can have a positive effect on the acceptance of technology. According to a study by Jing & Ting (2019), compatibility is a key factor in any consumer's adoption of new technology, describing the issue of compatibility as the degree to which the innovation is perceived as consistent. In the study of drones, the perceived consistency speaks to a measure of the simplicity of switching from traditional delivery methods to the new technology (Min & Jeong, 2019). In another study by Shahzad (2021), it is explained that a high level of compatibility means there are fewer changes needed in order for a technology to function effectively within the organisation. In many organisations, innovation is perceived as complex, as there is a need for skills and specialist staff who may not be available in the labour market or in the employment of the organisation. According to Reuters (2022), many large IT-related infrastructure projects fail due to a lack of regulatory frameworks, corruption, transparency, and technological skills. This makes the acquisition or development of skills a critical aspect when deciding to adopt innovative technology such as drone delivery (Shahzad, 2021).

In terms of drones, customers will still need to use an ecosystem of smart mobile apps, in a similar way to the established UBER application available on smartphones. Drone delivery will need to communicate with other drones and with customers. The required communication is often achieved through wireless networks such as 4G and 5G. On the delivery approach to the customer's designated drop-off area, customers will receive information and track delivery, as is the case with most delivery apps (Osakwe, 2022). This means a potential level of compatibility exists within the smartphone ecosystem. Questions over compatibility may be easily overcome and have little to no effect on the acceptance of the technology, as the interactions with the apps are identical to those with Uber, where customers are able to view delivery personnel as they approach the drop-off site.

According to Osakwe (2022), compatibility influences the attitude of consumers when evaluating new technologies in a positive manner. Customers will often evaluate additional service charges when comparing drone delivery with traditional last-mile delivery, indicating

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a perceived level of compatibility with the new technology in an economical and social sense. Organisations considering drones will consider compatibility with their ecosystem of applications and physical infrastructure. Online platforms like Uber already use extensive technology in managing the delivery of products and would be able to seamlessly integrate with delivery drone technology (Thatcher & Zhu, 2006). Less sophisticated businesses that lack capabilities will struggle to integrate drone delivery services with their logistics operations without a track record of innovation and technology mastery.

2.4.2 Organisational factors

A significant benefit of TOE is that the framework is free of any specific industry or organisation size and thus provides a holistic view of the adoption of technology within an organisation (Gangwar, 2015). The organisational context of TOE refers to a firm's makeup in terms of available human resources, organisational size, and how the structure impacts the organisation's ability to make decisions (Mahakittikun et al., 2021). This focus can provide a means to understand the challenges an organisation can experience when implementing a new technology. When considering the adoption of drone delivery in logistics, it is useful to evaluate whether the technology is a notion of market pull or technology push (Maghazei et al., 2022).

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2.4.2.1 Strategic management and support

According to Cho et al. (2021), organisational aspects refer to organisational characteristics such as resources, assets, organisational magnitude, scope, processes, human resources, organisational structure, organisational culture, and communication processes. In a study by Agbejule (2011), it is explained that a well-performing and productive organisation demonstrates a well-integrated and impactful system of beliefs and attitudes that come together to create success. The culmination of the required resources is often referred to as organisational readiness (Clohessy & Acton, 2019; Thatcher et al., 2006).

In terms of applying new technology to improve productivity, senior management support for technology projects is critical (Shavarani, Golabi, & İzbirak, 2019). Top management support has been identified in many studies as a significant factor in the adoption of innovative

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technologies (Clohessy & Acton, 2019; Jacob, Sanchez-Vazquez, & Ivory, 2020). Further, Clohessy & Acton (2019) explain that the impact of management on innovation in large organisations has been undervalued. In this research, we will refer to strategic management support to describe top-level management support. This will allow the research to focus on those decisions that affect the adoption of innovation at the strategic level of the organization. Traditionally, the strategic level of an organisation is the senior level of management. When an organisation suffers from a lack of senior management support, it may struggle to adopt new technologies in a meaningful manner.Typical problems senior management will need to resolve at a strategic level is the infrastructure needed for drone delivery as well as creating an environment that encourages problem solving and innovation (Shavarani et al., 2019; Clohessy & Acton, 2019). These facilities include launch sites and refuelling facilities. Decisions need to be made on which locations will serve which customers as well as the number of drones necessary to meet demand. According to Maroufkhani, Iranmanesh, and Ghobakhloo (2022), emerging technologies enable smaller organisations to become competitive faster and even remain competitive with smaller financial budgets. Due to the potential benefits of embracing new technology, smaller organisations with more to gain are often more likely to embrace new technologies such as drone delivery. According to Maroufkhani et al. (2022), smaller organisations are able to adopt innovative business models with greater ease or less impact on their operations. With the deployment of drone technology in the delivery industry, senior management in these logistics firms will need to be convinced of the potential impacts on productivity and output.

The delivery drone business model is distinctly different from all existing methods, introducing many unknown risks that may threaten the success of delivery drone projects. In a study by Ahern et al. (2014), a distinction is made between complex and complicated technology projects, where complicated projects have their risks identified early on while complicated projects identify these unforeseen risks as the project progresses. It is mentioned by Fichman & Tiwana (2005) that related projects such as delivery drone initiatives are well suited to the use of prototypes, pilot programmes, and a staged approach to deployment. Unknown risks contribute to the complexity of large projects, which are incredibly hard to foresee when projects are initiated (Eriksson, Larsson & Pesämaa, 2017; Bosch-Rekveldt, Mooi, Bakker & Verbraeck, 2011). To overcome these uncertain risks, project managers and top-level management are expected to have more interactions with project teams throughout the life

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cycle of the project (Bosch-Rekveldt et al., 2011). As risks are identified during the life of the project, it is important that there is support for overcoming the challenges.

Furthermore, it is explained by Eriksson et al. (2017) that overspending budgets is a prominent risk related to complex infrastructure developments, which increases the pressure on high-level decision-makers to closely evaluate the milestones of large-scale projects. Another prominent risk inherent to complex projects is the specification problem (Ahern et al., 2014). In large-scale infrastructure projects, it is not always possible to gather total requirements in a traditional sense. The requirements need to be derived as part of the solution in an exercise of knowledge gathering. Again, it becomes important for top management to support the process of knowledge gathering when drone technology is rolled out in contrasting environments subject to unknown risks. According to Ahern & Byrne (2014), when organisations search for solutions to complex problems, they gain knowledge, which further develops the organisation's ability to manage complex projects. In a study by Sauer & Reich (2009), an IT manager explained that she would prefer to work with individuals who exhibit a large hunger for learning than with a team of more experienced individuals when working in a complex project environment. The ability to learn within a complex project results in a high level of flexibility. Further benefits to strategic and complex projects with high uncertainty include the opportunity to magnify the value the projects represent (Fichman et al., 2005). The uncertain nature of complex problems presents the opportunity to take advantage of any opportunities that may arise during the life cycle of the project. Organisations that endeavour to implement large complexes such as drone delivery will need the support of their top-level executives to leverage the opportunity presented by the technology.

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2.4.2.2 Organisational hierarchy

In a study by Luftman & Brier (1999), it is explained that over the past decade, it has become important for organisations to align business strategy and information technology to leverage their capabilities and become more competitive in the business arena. A great deal of research has been conducted into business and its collaborations, which result in a competitive advantage. According to Luftman & Brier (1999), traditional roadmaps for delivering efficient IT business strategies' failed to take complete advantage of technology. The way in which an organisation structures its operations and management is key to business activities or processes delivering a competitive advantage. In a research study by Sauer & Reich (2009), senior executive support was highlighted by IT managers as the single most significant enabler of IT

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alignment. The second most important enabler was the activity of IT in developing business strategy. The organisational structure will often determine not only how well an organisation's senior management is able to influence technology-related projects but also how well the two groups of management can collaborate to develop a successful business strategy. The study by Luftman & Brier (1999) and Webb (2004) highlights the importance of high-level management being able to understand the projects and their influence on the success of the organisation. According to Webb (2004), senior management traditionally has a significant tendency to concentrate their efforts on revenue-generating objectives rather than those goals, which may produce greater returns over the long run. In research by Luft (2004), three ideas were theorised to explain senior-level management. First off, managers don't always have a solid understanding of the revenue generation process. According to Luft (2004), managers believe that there is a high cost of analysis to understand how to improve profit generation. Furthermore, Luft (2004) argues that individual managers inside an organisation often share opposing views or a partial understanding of the processes that generate profits. This may lead to collaborations that seek a neutral outcome rather than one focused on exploiting technology in a manner that will create future revenue streams. For successful delivery drone projects, organisations will require a high level of innovative capacity. In a research study by Petiz & Gomes (2017), it was explained that the innovative success of an organisation depends on its ability to collaborate in partnership with other external organisations. Effective communication of a technology strategy with senior management executives will produce more effective decision-making in complex infrastructure projects, such as delivery drone technology used to deliver items over the last mile, especially in organisations that already have existing forms of last-mile logistics.

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2.4.2.3 Organisational size

Organisational size has been shown to be a viable method for predicting how well an organisation can adopt technology. According to Thatcher et al. (2006), large organisations are often leaders in the market and possess resources, which enable the leverage of complex IT investment projects. Large market share and finances also help big organisations to dissolve risks associated with innovation.

According to Clohessy & Acton (2019), the adoption of complex technologies such as block chains requires a high level of complex problem solving, the acquisition of new resources, the application of new resources, high degrees of communication, and the development of new

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skills and competencies. The required skills and management experience are more abundant in larger organisations. In research by Petiz & Gomes (2017), it is explained that the seniority and experience of human resources increase with the size of an organisation. For this reason, organisations with larger bodies of experience and seniority will most likely fare better in performing all the outputs required in the adoption of complex technology such as drone delivery (Jacob et al., 2020).

Furthermore, it is not only the headcount of an organisation that can indicate its size but also its footprint in a geographical sense. In a study by Zuo & Sun (2021), it was found that farm sizes positively affected the adoption or use of drones in the agricultural sector. Larger commercial farms have more available resources and are able to invest in new technology. Drone delivery in both urban and rural areas will most likely cover great distances, creating large footprints for logistics organisations. These footprints and interactions with the various geographies will require support and management in order to remain sustainable. Logistics organisations with traditionally large footprints, such as DHL, will most likely seek the partnership of local businesses in adopting drone technology, allowing both organisations to benefit financially. Another measure of organisational size is the number of external stakeholders an organisation has. An organisation with a large number of investors will theoretically increase the complexity of large changes within the organisation as the board struggles to formulate agreed-upon methods by which to approach large projects (Eriksson et al., 2017). External partnerships, which aim to create value for all parties, will ultimately present further challenges when deciding on how to overcome issues related to delivery drone technology.

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Within a large organisation, new technology projects will ultimately lead to the generation of great amounts of data. According to Jacob et al. (2020), any hindrances to the analysis of this data by senior management will greatly impact the adoption of the technology. With delivery drone technology, the expected data generated by logistics operations is expected to reach very high levels. These datasets include customer interaction data, route data, and environmental data, which, when analysed, may further enhance the efficiency of the technology deployment. Large organisations with better capabilities to interpret and visualise data will see the leadership in these organisations make better decisions.

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2.4.2.4 Organisational culture

For organisations in the logistics industry, the need for innovative solutions to crippling problems is of critical importance. In a study by Ober (2020) and Faasolo & Sumarliah (2022), it is explained that organisations need to innovate to remain competitive in markets where costs are continuously rising and competition is increasing. Furthermore, Ober (2020) explains that collective trust between employees and management at an organisation brings about an integrated approach to adopting new technologies, which is highlighted by realising distinct ideas related to innovation, namely technology innovation and management innovation. Technology innovation is a much-covered topic in the literature, but less so is the idea of management innovation. Examples of management innovation include allowing employees to challenge existing solutions, ensuring individual independence, freedom to experiment, and regular brainstorming. These are just a few examples of management innovation. According to Kava, Baquero, Curry, Gilbert, Sauder, and Sewell (2018), organisations with certain cultures will most effectively incorporate management innovation ideas into their business processes.

In a study by Kava et al. (2018) and Bhuiyan & Munir (2020), organisational culture is defined as "the values and assumptions shared by members of an organization." Another study by Thatcher et al. (2006) describes culture as collective programming of the mind, which differentiates thinking amongst a group of people. There are various types of organisational cultures, with the most mentioned in literature being clan culture, market culture, hierarchy, and adhocracy. These cultures also form part of the competing values framework (CVT) (Kava et al., 2018). The CVT framework, which is widely used to understand behaviour within organisations in the context of industrial psychology,

Clan culture represents a friendly workplace where the employees are important and values such as loyalty, tradition, and participation are embraced. Market culture is best described as a place where profitability and competitiveness lead the conversation and direction of the organisation. Adhocracy culture can be best described as an entropinerial environment whereby taking risks and innovating lead to rapid growth, often through the introduction of new technology. The opposite of entropinerial is perhaps the hierarchical culture, which is less dynamic and rather more static in its approach to achieving long-term goals. Employees in a hierarchical culture are often strictly managed, with strict processes governing all the organisation's goals and endeavours.

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Culture plays an important role in the decision-making and behaviour of the organisation when new technology is adopted (Bhuiyan et al., 2020). The diversity of cultures that exist in various businesses makes it clear that not all organisations will be in a position to pursue innovations that challenge market norms (Ober, 2020). Previous research suggests that clan and adhocracy cultures are more likely to adopt innovative technologies, as management teams from these culture groups are more likely to innovate and take risks with unproven technologies (Thatcher et al., 2006). Managers from innovative organisations are likely to trial new practices to enhance organisational performance, even if such practices are yet to be tested and hence seem like risky ventures. Delivery drone technology, with all the unknown risks that may reveal themselves, would be considered too much of a gamble for smaller organisations with a rigid structure and fixed thinking. Larger organisations with free-thinking, dynamic cultures may be able to visualise the positive return the drone delivery technology can have on commerce while sharing the belief that many of the obstacles they encounter may be overcome.

2.4.3 Environmental factors

In the TOE framework, the environmental context categorises the factors of adoption that encompass the macro forces acting on the organisation (Mahakittikun et al., 2021). These external forces that affect the adoption of technology include the activities of competitors, the market structure, government policies, and regulations (Qin et al. 2020). In terms of the study of drone delivery, the environmental context of operating drone delivery within a public space while ensuring the obligations of meeting government regulations was deemed essential. Because the delivery drone technology is a relatively new concept, other environmental adoption factors such as market structure and competitors are less impactful in the adoption context.

2.4.3.1 Environmental sustainability

The environmental context is the area in which an organisation drives its core operations, such as industry structure, macrosocial and economic forces, and government policies (Cho et al., 2021) (Oliveira & Espadanal, 2014). The effects technology has on the environment and its influence on the balance of deciding if a technology is positive are important in the context of drone delivery (Khan et al., 2019). The drone's technology is thought to have a positive impact on the environment in terms of sustainable energy consumption and the reduction of carbon emissions (Chiang et al., 2019). According to Yoo et al. (2018), drone delivery is more

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environmentally friendly than traditional carbon-based transport, thus making the technology more attractive to customers who care about issues like global warming.

In terms of negative sentiment around drones and the environment, Khan et al. (2019) explain that the excessive use of drones and the noise these activities generate may prove to be less accepted by customers who are sensitive to noise pollution. Furthermore, Grofelnik et al. (2022) highlight various risks possessed by drone delivery that may play a role in their adoption, such as risks of collisions with other drones, risks of collisions with other objects and structures, invasion of privacy risks, risk of failure of critical components, and danger during takeoff and landing. These risks also pose a threat to the immediate environment where drones are to be implemented. These risks are familiar to the aviation industry, where strict regulations manage all flights. With drone delivery, the airspace is densely populated, which increases the consideration for the aforementioned risks. According to Grofelnik et al. (2022), drone delivery have the capacity to create real concerns around physical safety and privacy.

With the COVID-19 pandemic, the environment in which many delivery organisations operated changed dramatically. Drones were used in certain countries to deliver critical medical supplies in quarantined areas experiencing an epidemic outbreak in Alsamhi (2021). According to Maheswari (2021), drone delivery were used to distribute medical supplies using a parachute over open space without landing to deploy the payload. The distribution of medicines is usually managed through health care centres. With the use of drone delivery, legislation related to pharmaceutical products and medicine will need to be revised, which will permit the use of drone delivery.

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2.4.3.2 Market Regulations and Policies

According to Martins (2021), regulatory frameworks are shaped to address societal needs with a certain flexibility that can be adapted over time. For organisations, these external factors have a big effect on the adoption of technology. Organisations face policies and regulations that are outside of their influence. Government legislation that improves infrastructure, cooperation, and property issues is a very powerful factor in aiding the process of adoption of new technologies in developing countries like South Africa (Faasolo & Sumarliah, 2022). Organisations need support from the government, both in terms of infrastructure development and by means of fair regulations.

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With delivery drone technology, there are many ways in which the government can support or cripple the deployment of the technology. Drones require access to quality digital networks for both communication and navigation. Delivery drone interaction with the public means that new regulations should be established to regulate the socio-economic relationship between drones and people. Existing regulations are insufficient to prevent the rise of drone delivery from becoming a normal reality in South Africa. Most regulations around delivery are based on ground vehicles or large manned aircraft. Regulations do not consider unmanned, small-scale aerial vehicles with small payloads. A study by Hogan, Harris, Brock, and Rodwell (2022) found that many of the Australian health regulations were holding back the development and delivery of drone networks for medical reasons, as these policies dictated how medication and medical material should be transported. In South Africa, if a business were to try to deliver takeout with drones, the new method of delivery may breach health violations regarding food rather than anything related to logistics. Furthermore, a study by Sheftner, Blaauw, Arksey, Hanhn, Nakajima, Mqueen, and Tong (2022) explained that strict aerial regulations will persist to monitor the skylines and work to prevent collisions. Currently, new methods for aerial navigation are still being developed for large aircraft.

The idea that drone delivery may be able to transport a multitude of goods may, in fact, become its legislative weakness. For example, will drones be allowed to transport alcohol or pharmaceutical-regulated medication with strict regulations regarding access to these products? In another study by Esenduran, Kemahlıoğlu-Ziya, and Swaminathan (2017), it is explained that take-back regulation is becoming a trend in government legislation around the world. Take-back regulation means that products need to be collected by their respective agents from whom the product was bought by Esenduran, Kemahlıoğlu-Ziya, and Swaminathan (2017). In this environmental context, organisations will need to upscale reverse logistics to allow the collection of end-of-like items to be collected and disposed of (Esenduran, Kemahlıoğlu-Ziya, and Swaminathan, 2017). Such legislation may have a great effect on the adoption of drones when delivering various products or services, as reverse collection with drones may not be as feasible as traditional staffed ground operations. Organisations will be required to recycle products or remanufacture items. These processes aim to reduce the amount of surplus products and waste, which affects the environment as well. This is another clear example of how macro-legislative forces will influence the adoption of delivery drone technology.

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Not all external macro-legislative factors will benefit technology adoption. Scholars identified that government policies and initiatives, such as training and practical support for workers, clarifying property issues in rural areas, investment in infrastructure development, cooperation encouragement, and helping to manage risks, are considered to be the most powerful factors in aiding the adoption of technology. The COVID-19 pandemic has seen legislation dramatically change to address social needs during domestic restrictions (Martins, 2021). These legislative rules included a change in guidelines with regards to circulation in civilian airspace. According to Miranda et al. (2021), contact between people required a reduction as much as possible; thus, the transportation of goods by drones could prevent physical contact with customers, maintaining the World Health Organisation's recommendations with regards to COVID-19.

The easing of regulations during COVID-19 saw the American universal postal service receive an air carrier certificate to deliver small packages with drones (Rezende, Miranda, Rezeck,Azpúrua, Santos, Gonçalves, Macharet & Freitas, 2021). In the United Kingdom, the United States, and Japan, legislation has been adopted that differentiates airspace based on drone size and payload capacity (Aurambout & Ciuffo, 2019). For example, certain areas may be deemed a no-fly zone, whereas others may become designated drone operations routes for last-mile delivery.

These types of legislative changes developed to integrate commercial delivery drone technology into society will, however, dramatically depreciate delivery drone route options and result in aerial deliveries following a more traditional ground-based approach, whereby routes are not direct. Drone delivery would thus need to avoid private airspace and follow the more traditional ground-based routes, which are airspace over public infrastructure and roads, to complete deliveries. In this way, drone delivery do not completely infringe on privacy but do lose a certain amount of geographical flexibility (Poljak & Šterbenc, 2020).

According to Maghazei & Netland (2022), organisations adopt technology when there is economic potential and strategic relevance. Organisations adopt technology to satisfy consumer demands for seamless and reliable services (Ramadan et al., 2017). The ability of drones to employ line-of-site deliveries results in better optimisation and route planning. In a business, the measurable benefits and costs of adopting a technology are analysed using ROI, or IRR. Global online food delivery services reached 136 billion dollars in 2020, with the increases expected to continue beyond the COVID-19 pandemic (Miranda, 2021). As the

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demand for food delivery is increasing, ROI and IRR projections for drone delivery are becoming more feasible for their benefits over ground-based delivery methods.

According to Miranda et al. (2022), innovations must be developed in transportation to manage increased demand for delivery services. One such innovation is the drone chain, which is a block chain developed for drones to perform complex tasks. According to Alsamhi & Lee (2021), drone chains support accessibility, decentralisation, self-amending, and the use of consensus algorithms. The drone chain innovation means that drone delivery can share information and assist each other in a secure and trustworthy manner.

2.5 Previous studies on drone delivery

Several researchers have investigated the use of drone delivery in commercial applications. Much of the research available online and in journals has been conducted in the US and the UK. Early research has been conducted to examine the effectiveness of drones as a tool for commercial delivery.

Early researchers, such as Ulmer& Thomas (2018) and Grote, Pilko, Scanlan, Cherrett, Dickinson, Smith, Oakey & Marsden (2022), have found that drone delivery needs to be refined to effectively deliver on the promises of speed and efficiency. These researchers have tested several hybrid approaches to drone deployment, combining traditional delivery trucks with autonomous drones, which perform last-mile delivery. These studies show how technology can be used in the logistics ecosystem to best meet the needs of consumers.

In a study by Kornatowski et al. (2018), the idea of hybrid drone beehives is conceived, with early testing showing an improvement in drone efficiency from 7% to 30% in densely populated urban areas. In another study, the two services were compared: ground delivery with UPS vs. aerial delivery with Amazon Prime Air. The UPS service was 8 dollars, while the Prime Air option cost 1 dollar. This study compared the costs of drones against the more traditional ground-based delivery mechanisms. A study by Chang & Lee (2018) also explored the current approaches whereby drones are launched from trucks to service the last mile. Previous studies suggested real-world success in applying a hybrid delivery solution using ground vehicles and aerial drones (Chang & Lee, 2018; Schwehner et al., 2022; and Frachtenberg, 2019). This form of hybrid last-mile delivery allowed parcels to be delivered in parallel, greatly reducing the overall delivery time for all parcels to the longest time for a single

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parcel (Chang & Lee, 2018; Sheftner et al., 2022; and Frachtenberg, 2019). Parcels were able to be delivered aerially while the truck was returning to the warehouse to restock.

A vast amount of research has been conducted in the area of logistic optimisation, whereby drone delivery can transform energy requirements and be more sustainable (Aurambout et al., 2019; Oakey et al., 2022). However, according to research by Grofelnik et al. (2022) and Sheftner et al. (2022), the current technology is not completely suited for the integration of drone delivery in supply chain networks, and thus the immediate application of drone delivery will be slowed significantly. The spatial solutions of the urban settlements need to be refined and technology improved to coexist in harmony.

2.5.1 Infrastructure readiness

It was found that the current last-mile delivery drone technology is not yet fully adequate, and significant technological improvements are needed. It is also necessary to plan integrated urban spatial solutions that will enable safe and efficient delivery in the supply chain. Furthermore, a study by Grofelnik et al. (2022) investigated the notion that environmental elements such as the weather and climate of a particular area could play a significant role in how successful drone delivery may be implemented. The study by Grofelnik et al. (2022) continues to explore contrasting geographies of extreme heat and cold. The study concluded with the notion that although drone delivery present a viable last-mile delivery method, the unknown risks make broad implementations unrealistic at this stage. In a previous study by Tran and Nguyen (2022), it was identified that new air traffic regulations would need to be developed if drone delivery were to be successfully integrated into the skies. The research also investigated the effectiveness of geo-fencing, an augmented approach to creating GPS boundaries within which commercial drones can operate. The topic of drone-related legislation is one that has been greatly researched. In a study by Eleonora (2019), data privacy and legislation are examined. The study analyses consumer responses to the issue of drones impeding their privacy and safety. Candidates in the survey demonstrated high levels of concern about overall security.

2.5.2 Delivery drone applicaitons

Other research done in the drone industry has focused on the products delivered and whether there was any impact on the condition of the products. One such experiment has been conducted with the delivery of insulin to patients. This research conducted by Yee Hii et al. (2019) found

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no meaningful damage or lasting effect on the medication, increasing the likelihood of adopting the technology in the medical logistics industry.

In other research programmes, drones are theorised to be able to effectively transport blood, urine, and stool samples that are low in net weight (Oakey et al., 2022). The use of drone delivery in medical applications has been researched by many groups and academics. In a study by Lin et al. (2018), it is explained that pharma corporations in the United States have successfully tested the concept of medical supply delivery in rural regions, where clinics often struggle to keep supplies of drugs and materials. These pilot tests were very successful in showing how drones can be used effectively in the medical logistics industry.

A delivery drone business in the US has successfully tested the concept of drone deliveryof medical supplies by making such deliveries to a clinic in a rural area of Virginia (Sheftner et al., 2022). Cisco and drone company Monarch Inc. have proposed a drone-powered system for transporting laboratory samples and drugs to support remote clinics operated by Ridgecrest Regional Hospital in rural California. Similar research was conducted by Poljak & Šterbenc (2020), where the impact of drone delivery was examined in supporting remote areas that lack infrastructure; however, this study found that social issues such as culture, community attitudes, and legal issues impede the acceptance of delivery drone usage within the areas studied. The study did, however, highlight the major cost savings that may be realised by healthcare logistics operations by examining the effectiveness of the Malawi and UNICEF partnership in using drones to deliver immunodeficiency antivirus to hard-to-reach areas.According to Poljak & Šterbenc (2020), the tersing not only showed potential cost savings but also a lower time to result. In Papua New Guinea, similar drones were used to transport sputum samples to fight tuberculosis infections. The country of Rwanda has become the most successful African country in using drones to move blood between hospitals and clinics at a national level (Poljak & Šterbenc 2020). According to Poljak & Šterbenc (2020), 18 000 lifesaving flights were made in 2019. Since then, blood has been transported with drone delivery in Ghana as well. Much of the research conducted in the delivery drone arena has shown remarkable cost savings when utilising drones, especially in underdeveloped countries where roads often do not exist.

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2.5.3 Drone privacy and security

More recent studies have focused on understanding the attitudes of consumers and how the best drone delivery can be implemented. In a study by Yoo et al. (2018), it is explained that the relative advantage of drones over traditional delivery methods was the major contributing factor in the attitude towards accepting the technology. The study further found that speed and the level of environmental friendliness had a positive relationship with the acceptance of drone delivery. Other research by Khanet et al. (2019) and Ramadan et al. (2017) indicated that consumers felt a lot of insecurity around privacy issues related to drone delivery, resulting in privacy displaying a negative relationship to acceptance. Research into how the commercial use of drones will affect the security of consumers has become a highly researched topic in academia. Studies by Leon et al. (2021) and Sheftner et al. (2022) highlight how drone delivery will impact privacy regulations and how these regulations need to adapt in light of the technology being adopted commercialy

2.6 Framework development

The study of drones and their potential use in the logistics industry will consider three frameworks, namely, TOE, TAM, and DOI. According to Alam et al. (2021), these frameworks are considered the building blocks for evaluating innovative technology. The amalgamation of TOE and TAM models has been widely accepted in the study of technology adoption in an organisational context, which is supported by many empirical and conceptual studies (Gangwar, 2015) (Cho, Jun, & Lee, 2021). The TAM framework complements TOE, as the constructs of perceived risks broaden the explanatory power of TOE (Cho, 2021). DOI has also been successfully integrated into TOE, as the diffusion of innovation theory can help explain how organisations adopt innovative technology at an organisational level (Lin, 2017; Olliveira, 2014; Pateli & Spyrou, 2020). TOE, on the other hand, allows DOI to have a more comprehensive understanding of IT from a technological, organisational, and environmental standpoint (Oliveira, 2014). Furthermore, Oliveira (2014) and Pateli et al. (2020) also explain that the rapid evolution of technology requires the fusion of theoretical models to accommodate all factors of interest, both internally and externally, ultimately leading to a better understanding of complicated innovation technologies. Because drone technology has become a viable option with the potential to disrupt the logistics industry, the combination of TOE,

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TAM, and DOI will lend itself admirably to explaining how logistics organisations can best adopt technologies in South Africa. The combination of TOE, DOI, and TAM will be used in conjunction with survey instruments to quantitatively understand the factors that influence the adoption of drones in logistics.

2.7 Chapter Summary

In the previous chapter, titled The Literature Review, the study examined literature that discusses the technological, organisational, and environmental aspects of delivery drone adoption. The first sub-section of the literature review investigated the potential of using drones as a means of delivery over the last mile. The literature review found many successful use cases for drones, which included the delivery of products over urban and rural areas. The second phase of the literature focused on the factors affecting the adoption of technology in the context of logistics. The theoretical frameworks DOI and TAM were used to frame the adoption factors: relative advantage, personal innovativeness, communication, and perceived risks. The DOI and TAM frameworks enabled an understanding of which variables affect the adoption of technology from a personal perspective. The TOE framework was used to develop an understanding of technology, organisational, and environmental factors that affect the adoption of drone delivery. The technology factors included compatibility and complexity, while organisational factors included organisational size and culture. In terms of environmental factors, the policies and legislation in the operating environment of the drone were examined. The final subsection of chapter two focused on the unification of the DOI, TAM, and TOE frameworks to forge a hybrid framework for the study.

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Chapter 3: Research Methodology

3.1 Chapter Introduction

Chapter 3 presents the research onion, which acts as a guide to producing a methodology and design to answer the research questions and reach the research objectives. According to Saunders, Lewis, & Thornhill (2019), the research methodology will outline the structure of the research study as a strategy. This strategy will explain the research philosophy and components of the methodology. In Chapter 3, the research philosophy of a research study was explored. According to Eric & Schliesser (2017), the research philosophy is a process of dismantling the questions we ask and the concepts applied in the research study. The research philosophy lends itself to the identification of positivism as the adopted research paradigm of the study. The next section of chapter 3 deals with the research approaches mentioned in the research onion. The two approaches of induction and deduction were assessed, with deduction ultimately being the most applicable process. In the following section of Chapter 3, further layers of the research onion were dissected pertaining to quantitative and qualitative research. A quantitative approach was formulated as this is a deductive process, while the idea of using a survey questionnaire is touted as a quantitative method for collecting data. The next section deals with the survey questionnaire and the details surrounding its design and distribution. It was noted that the survey would use a Likert scale with concise questions pertaining to the TOE constructs of technology, organisation, and environment. The chapter continues to cover the research time horizon, which is mentioned in two forms: longitudinal and cross-sectional. In the research study, the cross-sectional approach was confirmed through a detailed schedule of milestones explaining the various steps of the research process. The study continues to focus on the data collection for this study, with the data analysis in the penultimate section of Chapter 3. Lastly, the chapter concludes with ethical considerations, followed by a summary of the chapter.

3.2 The research onion framework

The research onion, conceptualised by authors Lewis, Saunders, and Thornhill in 2007, is a roadmap for developing a research strategy and methodology when conducting research. When viewed externally, each layer of the research onion describes a more comprehensive phase of the research process (Saunders et al., 2007). The research onion delivers an operational

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progression through which a research methodology can be formulated. The research onion approach is easily adaptable to fit a variety of research types in a variety of contexts (Research Onion: Explanation of the Concept, 2018). The following subsections of Chapter 3 will examine various stages of the research onion while offering a more in-depth explanation of each deeper layer of the research onion. Figure 3.6 below shows the various layers of the research onion that act as a guide to developing a research methodology.

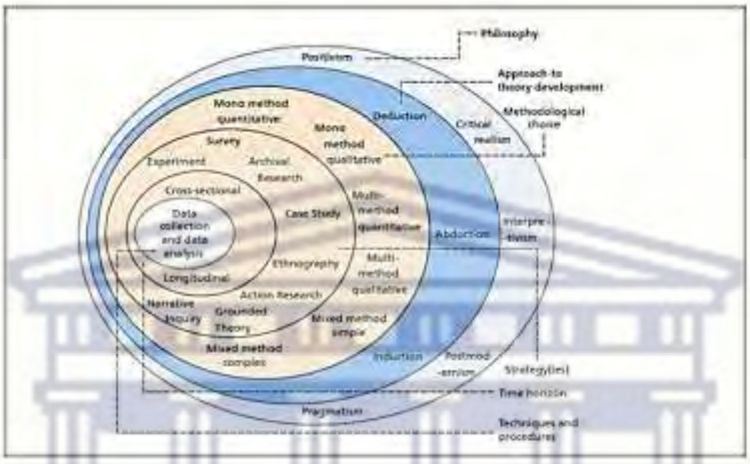

Figure 3.1: Research onion (Source: Saunders, Lewis, & Thornhill, 2019)

The first stage describes the research philosophy, which discusses the set of beliefs regarding the nature of the reality being examined (Alturki, 2021). The second stage covers the research approach, which is deduction, induction, or adduction. The third stage discusses the methodological choices implemented within the research. The fourth stage covers the strategy employed to gather data for the study. The fifth section of the research onion discusses the time horizon of the research strategy. The final step will discuss the mechanics of data collection and the techniques that will be used in analysis.

A number of benefits are derived from using the research onion framework. These include a systematic approach to formulating a research methodology (Thesismind, 2019) with a high level of adaptability to most topics (Saunders, Lewis, & Thornhill, 2019). The practice of documenting the thought processes of research methodology without missing any critical aspects is an additional reason for utilising the research onion framework. The stages within the research onion will be discussed in detail in the following sub-sections of Chapter 3.

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3.3 Research Philosophy: Positivism

According to Eric & Schliesser (2017), philosophy systematically questions the questions we ask, the concepts we use, and the values we hold. These are the basic elements of research paradigms. A research paradigm can be explained as "a basic belief system and theoretical framework with assumptions about ontology, epistemology, methodology, and methods" (Rehman & Alharthi, 2016). In another article, the process of identifying a research paradigm consists of four steps, which include: what we observe and analyse; the type of questions posed; how questions are posed; and how the results are interpreted (Seely, 2010). Research philosophies can be split on the objectives of research and on the best way that might be used to achieve these goals (Goddard & Melville, 2004).

The differences in research philosophies are not a negative sentiment but rather a signal that research philosophies can be articulated based on the research topic and area of study (Alturki, 2021). For a successful study, a researcher should be able to critically analyse the major research paradigms, which comprise their own theoretical assumptions and methods. The research onion suggests positivism, critical realism, interpretivism, postmodernism, and pragmatism. The research paradigm of interpretivism is a social science emphasising the subjective nature of reality, whereby individuals are best positioned to understand various occurrences (Nickerson, 2023). In this particular paradigm, methods of research include interviews, participant observation, document analysis, and phenomenology. The paradigm of postmodernism can be described as "a set of critical, strategic, and rhetorical practices employing concepts such as difference, repetition, the trace, the simulacrum, and hyper reality to destabilise other concepts such as presence, identity, historical progress, and epistemic certainty (Baratova, 2022).

The paradigm of Pragmatis, highlights the importance of practical application and consequences when evaluating truth and value (O'Leary, 2007). Pragmatism, which originates in the United States of America, is an attempt to get philosophers to step into the real world when seeking to understand reality. Critical realism is a paradigm of philosophy that operates independently of awareness, with observable events being the actualization of unobservable mechanisms (Ryan, 2018). This paradigm of critical realism explains that the social world can only be truly understood if the structures that generate the real world can be understood. Finally, the paradigm of positivism explains that true knowledge is scientific and only

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attainable through the scientific process (O'Leary, 2007). For positivists, science is the only way in which our reality and subsequent universe can be understood.

In conclusion, the positivism research paradigm is most closely aligned with the aims and objectives of this study. The favourable characteristics of positivism include the idea that only scientific knowledge is genuine knowledge; hypotheses can be tested by provable scientific laws; knowledge is gained by gathering facts and providing a basis for understanding laws through empirical means (Ryan, 2018).

3.4 Research approach:

The next stage of the research onion speaks to the research approach employed in the study. A research approach is an associative strategy that links research and theory (Alturki, 2021). Inductive and deductive approaches are the significant research methods that are represented within the research approach layer of the onion. According to Svensson (2009), the deductive research approach originates from a specified problem, which is translated into explicit research objectives. Several research questions are then formulated to address the research objectives and, subsequently, the research problem statement (Svensson, 2009). The research component, based on a review of appropriate literature and empirical data collection, is articulated through theoretical frameworks that best fit the area of study.

Alternatively, the inductive research approach starts with an idea but operates in reverse, whereby expected outcomes are examined. According to Svensson (2009), the inductive research approach should be considered a benchmark test or a means to test the suitability of a research process. The inductive research will allow the expected contributions to be evaluated in terms of usefulness and thus develop theory (Svensson, 2009). For this study, the deductive research process was used because it is associated with quantitative research, "where data are collected and analysed to test theory" (Saunders, Lewis, & Thornhill, 2019).

3.5 Methodological choices : Quantitative research design.

The third stage in the research onion presents the methodological choice. This layer provides all the methodological varieties for research design, namely quantitative, qualitative, and mixed methods. According to Saunders, Lewis, & Thornhill (2019), a research design can be described as the direction the researcher must take to answer the research objectives of the

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study. Qualitative research is an evolving inductive process, with themes and definitions emerging through data analysis (Bhattacherjee, 2012). Quantitative studies, on the other hand, is a deductive process whereby fixed research objectives guide the choices in research methods and tools (Bhattacherjee, 2012). Mixed methods are thus a combination of inductive and deductive processes whereby both qualitative and quantitative methods are used.

The research study will use a deductive process whereby a survey questionnaire will be distributed among industry professionals to examine the eight constructs identified in the TOE, DOI, and TAM frameworks. A minimum of 66 participants will be targeted, and the quantitative data will be analysed systematically and reliably to ensure the constructs (independent variable) and effects on acceptance (dependent variable) are understood in the context of South Africa.

The unit of analysis for the proposed research is the organisation. The organisation is an appropriate unit of analysis, as all the constructs that will be studied in the study will be based on responses to the proposed survey instrument. Thus, the unit of analysis will allow for reliable inferences in the study of delivery drone acceptance.

3.6 The research strategy: Survey

The fourth level of the research onion is described as the research strategy of the study. According to Saunders, Lewis, & Thornhill (2019), a research strategy describes the approach to investigating a specific problem. The approach is best derived by evaluating the available tools, types of data, and resources required. The research onion describes various types of research strategies that can be utilised to inquire into research questions during the expansion of a study. These strategies may include experiments, surveys, case studies, etc. For this study, a survey strategy was chosen as a means to collect data to answer the research questions.

In the case of the proposed research design (a survey questionnaire), the instrument will follow specific guidelines and survey good practice techniques. The survey will also incorporate a quantitative strategy by employing a series of questions on a Likert scale.

The survey itself will capture specific demographic data while employing a Likert scale to understand the constructs represented in the research model with specific targeted questions.

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To decrease measurement error, all survey questions will be pre-tested to reflect the topic of interest, as explained by Ponto (2015).

3.7 Research time horizon

The research onion identified two primary time horizons, namely longitudinal and cross-sectional timing. According to Scott (2002), longitudinal research describes patterns of change and establishes the direction and magnitude of causal relationships. The second time horizon is cross-sectional timing. This timing refers to performing a research study of a specific occurrence at a precise period. The researcher requires an allocated amount of time to sufficiently conduct the requirements of the study. This research study used cross-sectional timing to complete the survey strategy in 10 weeks. The schedule for performing the necessary steps is listed below.

In Table 1, the activities are listed in chronological order. This allowed the researcher to manage the time dedicated to each milestone of the research study. In addition, the unit of analysis for the proposed research is the organisation. The organisation is an appropriate unit of analysis, as all the constructs that will be studied in the study will be based on responses to the proposed survey instrument. Thus, the unit of analysis will allow for reliable inferences in the study of delivery drone acceptance.

Table 3.1 : Weekly timeline of survey stratergy

Duration :	Activities :
Week 1	1) Develop a research Sample
Week 2-4	2) Engage with targeted participants to obtain informed consent
Week 5-10	3) Distribution of survey questionnaires to targeted participants.
Week 11	4) Collection of surveys.
Week 12-15	5) Data analysis and interpretation.
Week 16-17	6) Revise and edit the thesis draft.
Week 18	7) Submit draft to supervisor.
Week 19	8) Revision and edit for final submission.
Week 20	9) Submission of the final thesis to relevant committees.

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3.8 Techniques and procedures

3.8.1 The population, Sample and Unit of analysis

The population in the context of research refers to the full set of entities from which a sample is extracted (Saunders, Lewis, & Thornhill, 2019). For this study, the population is the organisations that form part of the logistics industry. The unit of analysis reflects the population and subsequent sample, which are to be sampled during the data collection process of the research study. The unit of analysis for the proposed research is the organisation. The organisation is an appropriate unit of analysis, as all the constructs that will be studied in the study will be based on responses to the proposed survey instrument. Thus, the unit of analysis will allow for reliable inferences in the study of delivery drone adoption.

3.8.2 Data sources and sampling

The logistics industry consists of a large population of organisations spread out over many territories. It would not be possible to survey all parties within the population, and so a representative sample reflecting the makeup of the logistics industry is needed. According to Saunders, Lewis, & Thornhill (2019), Sampling provides a valid substitute for a census when it would be unrealistic for a survey to reach an entire population. This may be due to budget or time constraints on the part of the researcher. In the study, convenience (opportunity) sampling will be utilised to select potential candidates to whom the survey will be offered. Dudovskiy (2012) said, "Convenience sampling (also known as availability sampling) is a specific type of non-probability sampling method that relies on data collection from population members who are conveniently available to participate in the study. Candidates were offered an online survey by means of a digital link via email, social media, and paper. The availability of the various survey channels will allow various individuals with different preferences to participate equally at a time of their convenience.

3.8.3 Data Collection

The sampling process was conducted by targeting senior employees of medium- to large-sized organisations, where logistics was identified as a critical competency. Secondly, these individuals representing their organisations needed to be in a leadership role with an understanding of the logistics landscape. Due to the use of nonprobability sampling techniques, in this case convenience sampling, Over 120 surveys were distributed over social media and

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via email, with 66 replies recorded. The survey achieved a 55% response rate within the required sampling window. Survey results received after the close of the window were discarded.

3.8.4 Survey development

The study required the development of a new survey questionnaire. The instrument was split into three categories, allowing the survey to interrogate three distinct areas of logistics linked to the factors influencing the adoption of delivery drone technology. The three categories included the Technological, Organisational, and Environmental sections from the TOE framework, with additional factors inherited from the DOI and TAM models. Multiple-choice questions were posed as they limit the scope of answers, which produces easy-to-understand data. The multiple-choice questions were presented with a statement by answering on a Likert scale of strongly agree to strongly disagree options. The survey questionnaire had 30 questions tied to the three main constructs as well as research objectives. The different sections of the survey questionnaire are explained below.

3.8.4.1 Section 1: Biographical details

This section of the survey required the participant to complete personal information such as age, race, and gender. The participant was also required to complete work-related information such as company, department, position, and experience.

3.8.4.2 Section 2: Technological factors

This section of the survey was related to technology factors that affect the adoption of drones in the logistics industry. The questions covered technological compatibility, technological complexity, technology skills, technology security, and cost.

3.8.4.3 Section 3: Organizational factors

This section of the survey was related to organisational factors that affect the adoption of drones in the logistics industry. The questions covered organisational management support, organisational size, and organisational culture.

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3.8.4.4 Section 4: Environmental factors

This section of the survey was related to environmental factors that affect the adoption of drones in the logistics industry. The questions covered energy consumption, infrastructure, and legislation.

3.8.5 Survey questionnaire: Validity and Reliability

According to Bhattacherjee (2012), a field survey is a non-experimental exercise where the independent variables are not manipulated but rather measured using statistical models. A sample of a population is used as a snap shot to evaluate beliefs, practices, or situations within the field. Survey questions allow the researcher to obtain relevant information accurately and consistently. Reliability and validity are both needed to assure adequate measurement of the constructs implemented within the survey (Bhattacherjee, 2012). According to Saunders, Lewis, & Thornhill (2019), reliability is found when other researchers realise similar information, meaning the results of the survey are repeatable. Internal validity refers to the level of accuracy the survey questionnaire holds with regard to the constructs it is measuring (Bhattacherjee, 2012). The results of the survey need to reflect the reality of what was measured.

In order to maximise the reliability and validity of a survey questionnaire, Saunders, Lewis, & Thornhill (2019) suggest a number of interventions to improve reliability, which include ensuring questions are designed correctly, the questionnaire has a pleasing layout, and the reason for the questionnaire needs to be well explained with pilot testing if possible. To improve validity, the wording of questions needs to be scrutinised, as this is often the most obvious issue resulting in problems (Saunders, Lewis, & Thornhill, 2019).

3.8.5.1 Construct validity

Construct validity refers to "the extent to which your measurement questions actually measure the presence of those constructs you intended them to measure" (Saunders, Lewis, & Thornhill, 2019). This research study enforced construct validity by ensuring that all participants received a detailed information sheet before consenting to participate in the research study. The information sheet included all the relevant information about the research study. These relevant notices included the research title, the purpose of the study, etc. All participants were briefed

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on the research study before receiving the actual survey questionnaire to complete. The following steps ensured further validity during the data collection process:

3.8.5.2 Steps to data validity:

1. The survey questionnaires were only shared with SMEs based in the logistics industry, concerned with outbound delivery.
2. The time to complete the survey questionnaire was explained to the participant.
3. The questions within the survey questionnaire were pre-tested and pilot-tested before being shared with participants.

3.8.5.3 Pilot-testing

After the draft of the initial survey questionnaire was completed, the researcher completed a pilot testing phase before finalising the survey questionnaire. According to Bhattacherjee (2012), plot testing allows the researcher to detect any significant issues in the research and research instrument. The process of pilot testing also contributes to increased reliability and validity by allowing the Likert questions to be screened. In this study, the researcher conducted a pilot survey questionnaire with a senior specialist in logistics at a well-known last-mile delivery organisation. The feedback provided the researcher with an opportunity to understand how the questionnaire was being interpreted by a participant in the industry of study.

3.8.6 Disposal of data

The primary data is stored electronically and in the position of the supervisor. All physical copies of the survey questionnaires are kept safe in a secure, access-controlled cabinet to which only the researcher and the supervisor have access. All research study data and material are kept for a maximum period of 1 year. When the mini-thesis submission is graded, all electronic and physical material will be disposed of. This includes survey questionnaires, consent forms, and data analysis files.

3.8.7 Data analysis

The collected data will be analysed by scoring responses on a scale of 1–5, with one being negative and five being positive. This will allow the eight constructs to be analysed in a meaningful manner. The Cronbach alpha, which is commonly used to measure internal

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consistency (Bolarinwa 2020), will be utilised in conjunction with other quantitative statistical methods on SPSS version 19, due to the relative simplicity of the software and nature of the calculations. For example, the frequency of individuals who expressed negative concerns about privacy will be counted and grouped by age. This will indicate how privacy risks are perceived by individuals of different age groups or generations.

3.9 Ethical considerations

According to Saunders, Lewis, & Thornhill (2019), a researcher must behave in an appropriate manner in relation to the rights of the subjects within the research group or the persons affected by the study. Another journal by Bhattacherjee (2012) describes ethics as standards to which a researcher must conform when conducting research. In research, there are many various reasons why ethics is considered important. According to Bhattacherjee (2012), science has often been manipulated to advance the agenda of individuals and groups with unethical concerns. Ethics is a moral distinction based on what is right and wrong, whether it is the law or not (Bhattacherjee, 2012). For these reasons, it is imperative that the researcher maintain a level of ethics that satisfies the interests of those participating in or benefiting from the study, thus maintaining scientific credibility. Research ethics groups are also considered important as they concern themselves with several objectives. These objectives include "a proactive role, such as developing an ethical code, and an educational one, such as disseminating advice about conducting research ethically" (Saunders, Lewis, & Thornhill, 2019). For this research study, the researcher agreed to all the research ethics and objectives set by the research ethics committee. All ethics obligations were fulfilled, and the researcher was granted ethics approval from the committee in July 2021. The most significant ethical principle that was adhered to in this research study was to protect the identities of the participants and their subsequent details. No participants were harmed physically or psychologically during this research. Every participant was allowed to exit the study if they were uncomfortable in any way. All information collected during the research study is kept confidential and sealed in a cabinet that is only open to the researcher and the supervisor. Data will be disposed of once the final dissertation is marked and graded. All communications with the participants were clear and concise to alleviate any ambiguity. Lastly, all participants were treated fairly and objectively in this research.

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3.10 Chapter Summary

In Chapter 3, the researcher began by introducing the research onion that was used as a means to develop a research methodology and strategy. A number of research philosophies and paradigms were introduced. The positivism research paradigm was motivated and adopted for use in the research study. The next section of Chapter 3 focused on the research approach, where the author discussed the deductive and inductive strategies to link theory and research. The deduction approach was adopted during this research study. The researcher was motivated by how it complements the study's research design. The following section of the chapter explored the third layer of the research onion, which describes the methodological varieties of quantitative, qualitative, and mixed methods. The quantitative methodology was selected as the method for the research study. The next section investigated the research strategy by introducing the survey strategy as a means to collect data for this study. Chapter 3 then went on to discuss the research time horizon, ultimately suggesting cross-sectional timing as a better fit for the research study. The following section of the chapter focused on the data collection for this study by looking at the sampling techniques and discussing primary data, instrument development, reliability, and validity of survey questionnaires. The disposal of data was also discussed in this subsection of Chapter 3. The next section discussed the data analysis for the study by discussing quantitative data, statistical analysis, and the quantitative data analysis process. The final section discussed the ethical aspects of the research study by investigating all the principles that were followed during data collection. The following chapter covers the research results and analysis obtained from applying the research methods, techniques, and analysis process discussed in this chapter.

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Chapter 4: Research Results

4.1 Introduction

This section presents the results of the data analysis performed during the study. The first sub-section 4.2 presents the frequencies of the demographic data variables: age, gender, race, and experience. The second sub-section 4.3 presents the frequencies of technological factors that affect the adoption of drones. The third sub-section 4.4 presents the frequencies of the variables, which form part of the organisational factors related to the TOE framework discussed in the literature review. Lastly, subsection 4.5 presents frequency analysis and charts for the environmental factors that affect the adoption of drone technology.

4.2 Demographic data

This section presents the demographics of the participants who completed the survey questionnaire on the factors that affect the adoption of delivery drone technology in the logistics industry. Figure 4.1 presents the frequency of the various races of the participants that were analysed in the study. The results indicate that 40.9% of the 66 participants were coloured, while the black participants accounted for 33% of the survey participants. Lastly, the white and Indian participants accounted for 10.6% and 15.2% of the total, respectively.

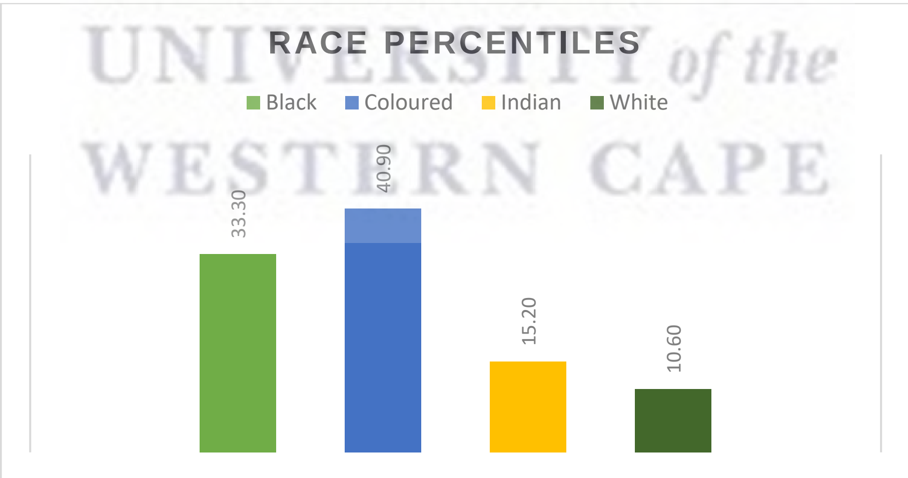

Figure 4.1: Race

Figure 4.2 presents the gender breakdown of all the participants who completed the factors that affect the adoption of delivery drone technology in the logistics industry survey. Of the 66

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persons in the sample, 19 participants were female, while 47 participants were male. Male participants accounted for 71.2% of the sample.

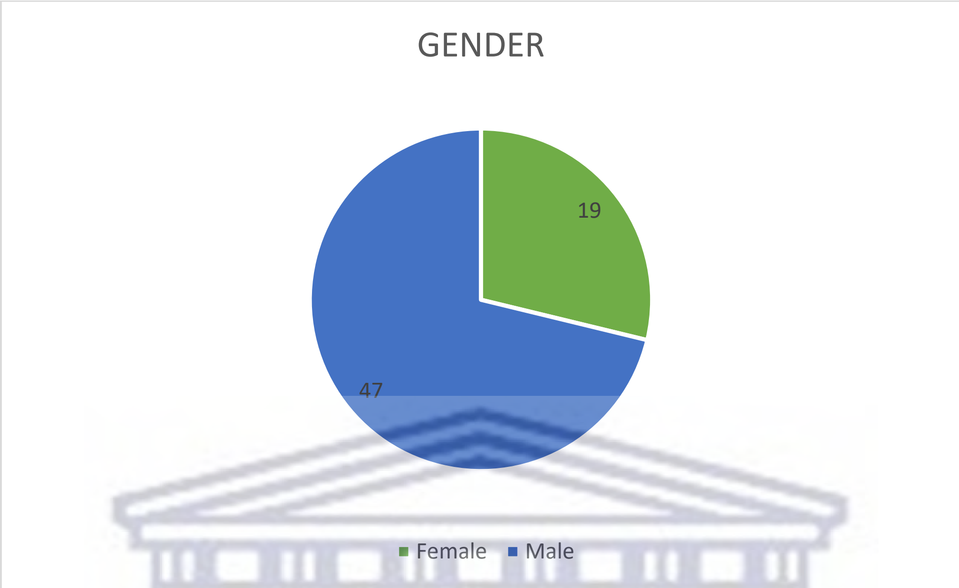

Figure 4.2: Gender

In Figure 4.3, the age ranges of the sampled participants are analysed. The surveyed ages are coded into four groups: 29 years and below, 30-39, 40-49, and 50+ years. The majority of the participants were in the age group 30-39, with the second's highest age group being 40-49. The smallest age group by frequency of 7.6% was the group of participants aged 29 or younger. In the survey, results in Figure 3 also indicate that 78% of the participants were below the age of 50.

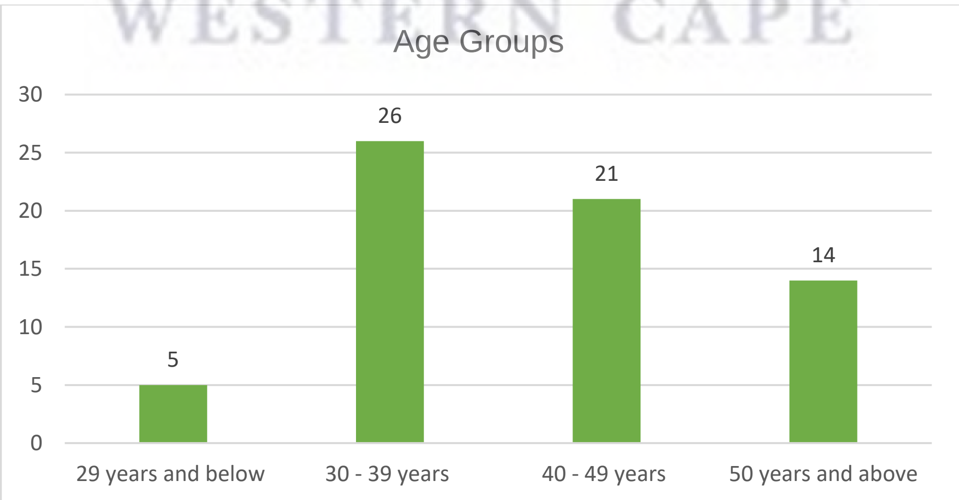

Figure 4.3: Age groups

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Figure 4.4 presents the duration of employment within the logistics industry for the participants of the survey questionnaire. The majority of participants indicated 5–10 years' experience, while 21.2% indicated having less than 5 years' experience.

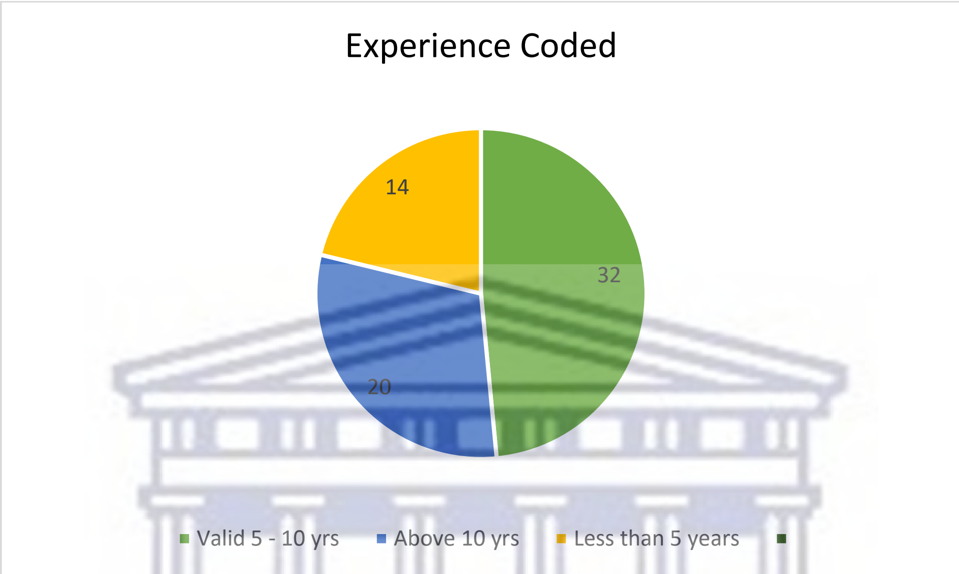

Figure 4.4: Experience Coded

4.3 Technological factors

4.3.1 Technological compatibility

According to Min & Jeong (2019), the compatibility of drone delivery is best understood by understanding how easily the technology can replace the existing delivery methods. Participants were asked to indicate their level of awareness with regards to drone delivery within the logistics industry. In Figure 4.5, participant awareness of drone technologies is 69.7%, while 30.3% have little to no familiarity with drone technology. 18.2% of the participants indicated a strong awareness of drone technologies. According to Jing & Ting (2019), the level of awareness of using an innovative new technology can describe the compatibility of said technology within a given industry. The low level of awareness of delivery drone technologies indicates the low compatibility of drone delivery within the survey organisations.

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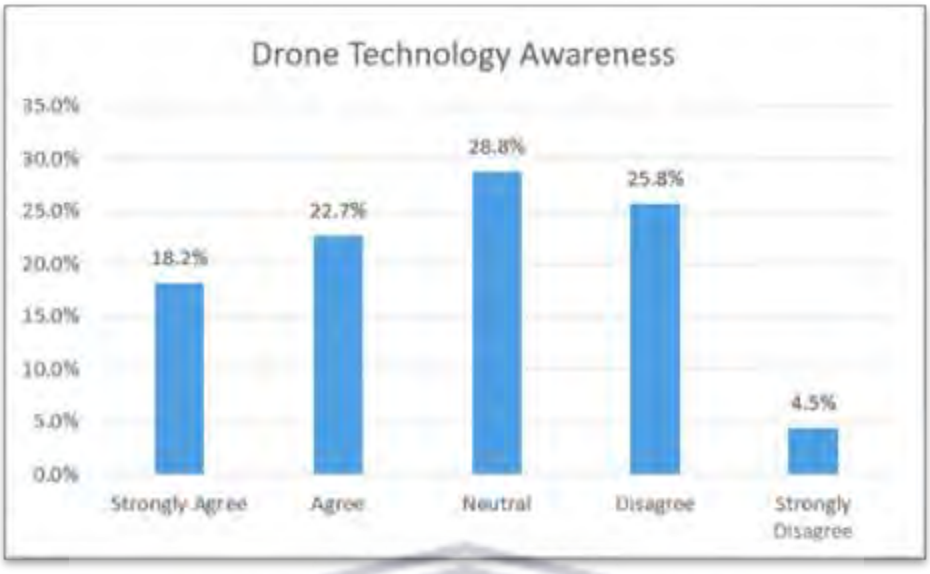

Figure 4.5: Drone technology awareness

In Figure 4.6, participant awareness of how drone delivery can improve efficiency is 72.7%, while 27.3% have little to no familiarity with drone technology improving delivery efficiency. Conversely, 18.2% of the participants indicate a strong awareness of drone technologies adding efficiency to logistics. When the results of Figure 4.5 are considered alongside Figure 4.6, it can be interpreted that there is a low level of awareness about drone delivery in the logistics industry; however, the participants who are aware are aware that drone delivery can potentially improve efficiency within their respective organisations.

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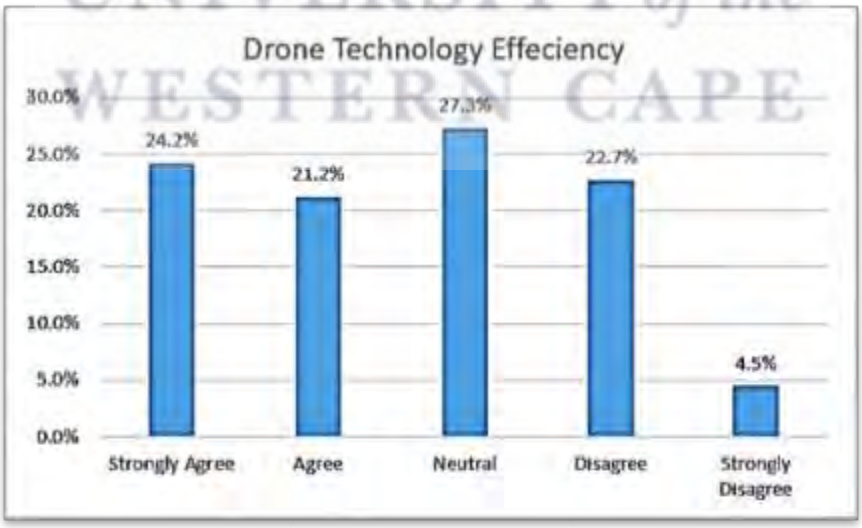

Figure 4.6: Drone technology efficiency

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In Figure 4.7, participants are surveyed about whether their respective organisations have considered delivery drone technology. 25.8% of the participants indicate that drone delivery have been considered, while 74.2% of the participants surveyed reported to their organisations never considering the delivery drone technology. Again, the results in figures 4.5, 4.6, and 4.7 suggest that awareness of drone delivery and their benefits has led to consideration of the technology.

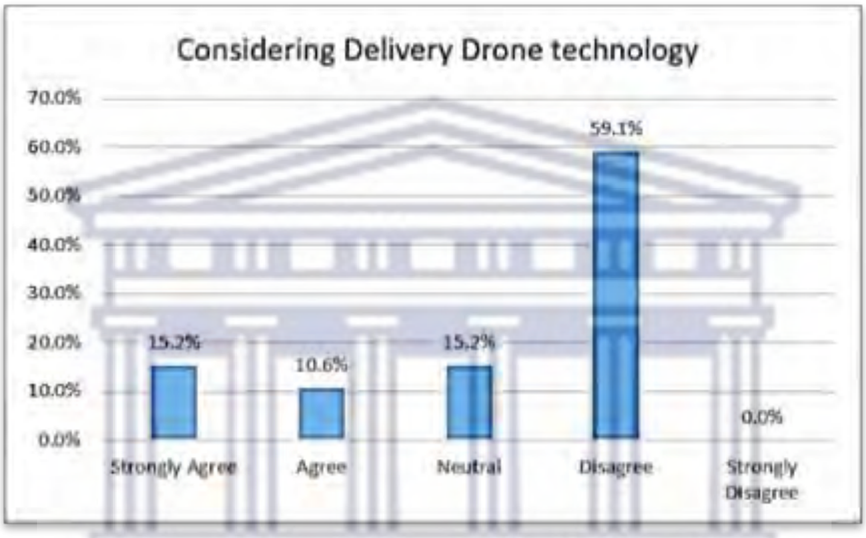

Figure 4.7: Considering delivery drone technology

Figure 4.8 presents the survey responses about physical compatibility. 25.8% of the survey responses indicated that drone delivery would in fact be physically compatible within their organisations. 74.2% of the participants indicated that the delivery drone technology would not be compatible. According to Shahzad (2021), a high level of compatibility requires fewer modifications to achieve the required level of functionality. The low level of physical compatability described by the participants in the survey indicates that physical compatibility will be a significant factor in the adoption of last-mile drone delivery.

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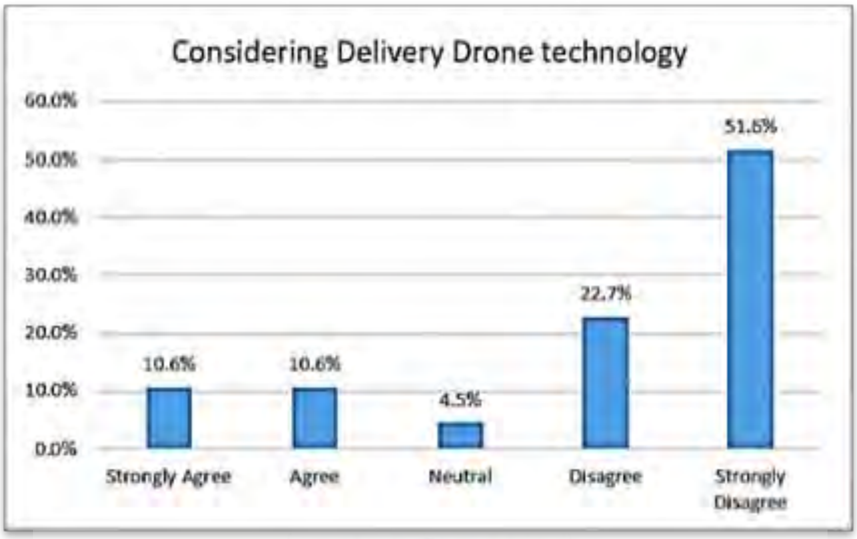

Figure 4.8: Physical compatibility

4.3.2 Technological complexity

According to Maylor & Murray-Webster (2013), technology complexity may indicate the potential to innovate as complex systems have reached a level of maturity that allows for further fusion of products and services. It may be argued that the chaos of complexity reflects the opportunity of technology to solve complex real-world problems such as last-mile delivery. In figure 4.9, the awareness of drone functionality among survey participants is analysed. 89% of the surveyed participants had little to no understanding of delivery drone functionality. 15.2% of the participants had a clearer understanding of the benefits of drone functionality and what they may offer.

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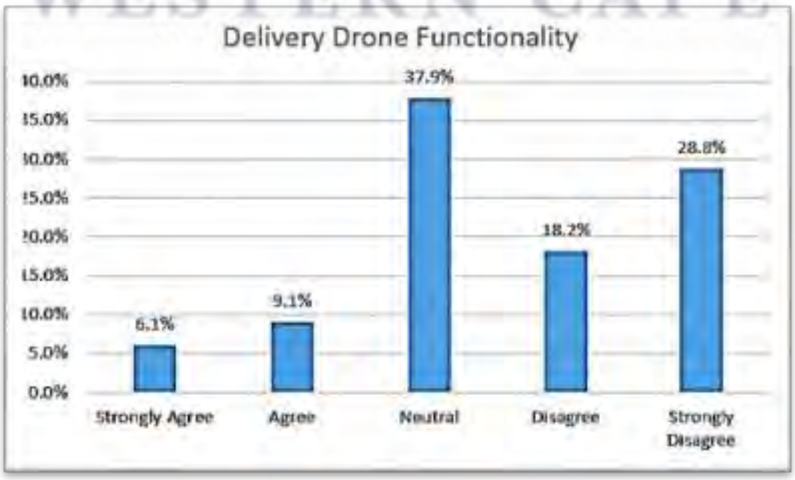

Figure 4.9: Drone Functionality

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Figure 4.10 illustrates the perceived idea of incorporating drone delivery into the participant organisations. 27.3% of the survey participants perceived the incorporation of drones into their logistics operations to be simple. Conversely, 72.7% of the survey participants indicate that the process of assimilation would be more complex. The high level of anticipated complexity is just as important, as technology projects would require much planning and coordination between many disciplines (Maylor, 2013).

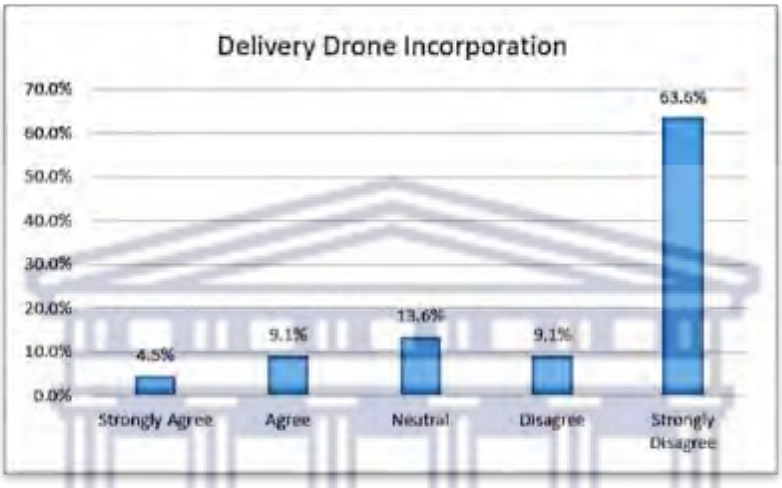

Figure 4.10: Incorporating drone delivery into logistics

4.3.3 Skills

Below in Figure 4.11, the participants are surveyed on their organisation's willingness to outsource critical IT-related skills and services. 47% of the participants indicated their organisation's willingness to outsource its related skills and services, while 22.7% indicated that their organisation does not outsource skills and services at all. In an article by Albertus and Hamman (2021), the dependence on external consultants is theorised to be a result of a shortage of available skills within the market. The willingness of organisations to outsource is indicative of a shortage of internal skills within the participating organisations.

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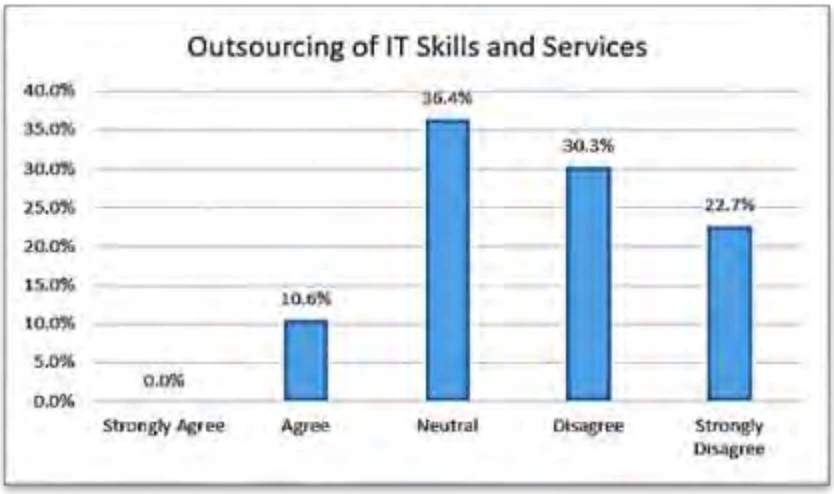

Figure 4.11: Outsourcing IT related skills and services

In Figure 4.12, the participants are surveyed on whether the skills required to implement drones can be acquired through training and development. 28% of the surveyed participants agreed with the notion of acquiring skills, while 27% indicated that the skills could not be acquired through training and development. 15.2% of the participants are indifferent to whether skills can be acquired through training or not.

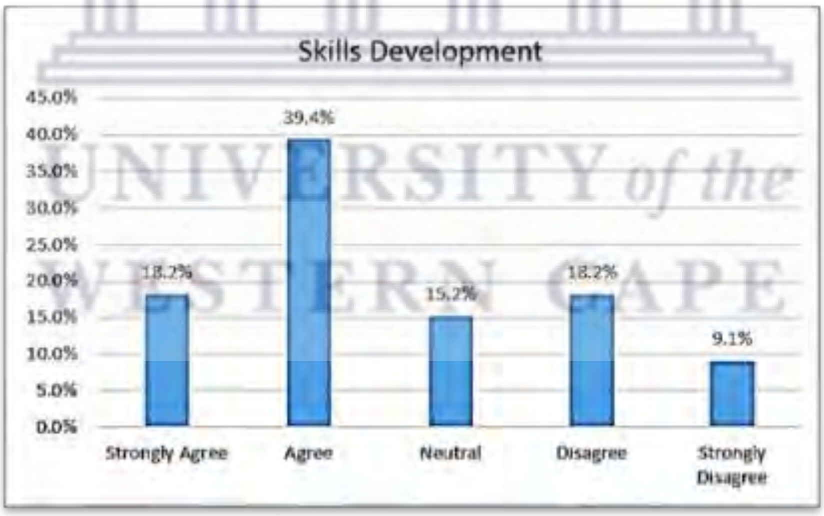

Figure 4.12: Skills development

In Figure 4.13, participants in the survey present their insight into the availability of drone technology-related skills locally. 28% of the survey participants agreed that the skills exist locally, while 31.8% disagreed as to the availability of skills locally. In a research study by Albertus and Hamman (2021), the authors explain that South African organisations struggle to

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develop appropriate upskilling and retention strategies to hold on to valuable and necessary skills. As a result, IT professionals move around a lot, and organisations have a continuous inflow and outflow of skills.

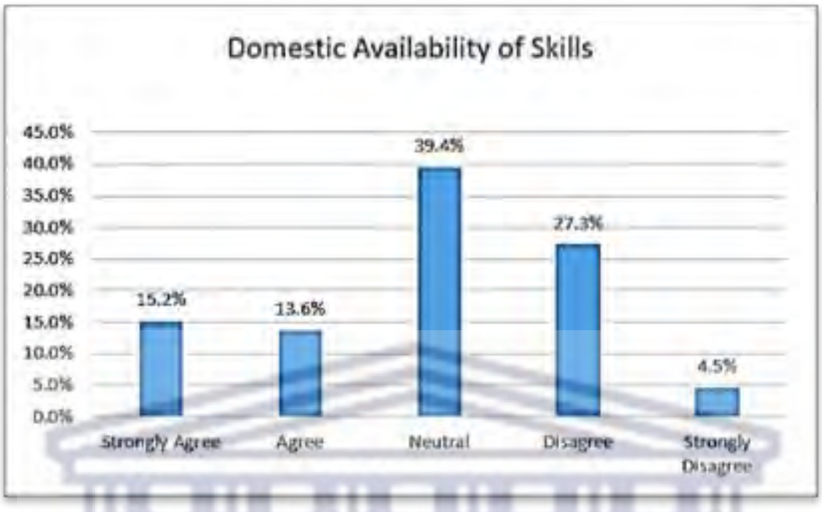

Figure 4.13: Domestic availability of skills

4.3.4 Security

According to Yoo et al. (2018), security is a major factor when adopting new technology. In Figure 4.14, participants expressed their understanding of the importance of security when considering delivery drone technology. 89.4% of the participants agreed that security is a major concern, while only 10.6% felt there was no security threat to be considered. This statistic is consistent with literature emphasising security as a major factor that will affect the adoption of drone delivery.

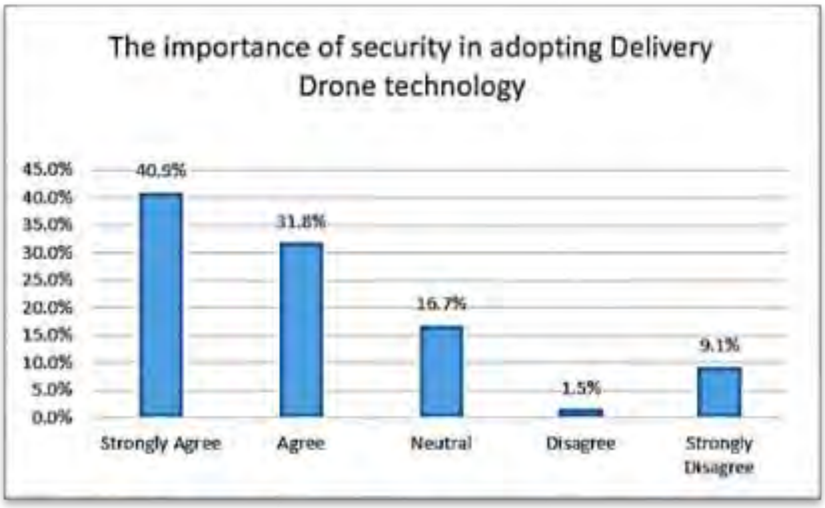

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Figure 4.14: The importance of security in adopting Delivery Drone technology

In Figure 4.15, participants in the survey demonstrated their concern about the possibility of physical security risks. 86.4% of the participants agreed that physical security risks are of real concern, while 13.6% of the participants did not agree to perceive any physical security risks. The high awareness of physical security is in consonance with the literature. According to Raivi et al. (2023), the use of drones to deliver parcels requires physical interactions with the environment and consequently poses a threat to the public safety of all. The degree to which the technology is perceived as a risk will ultimately affect its widespread adoption.

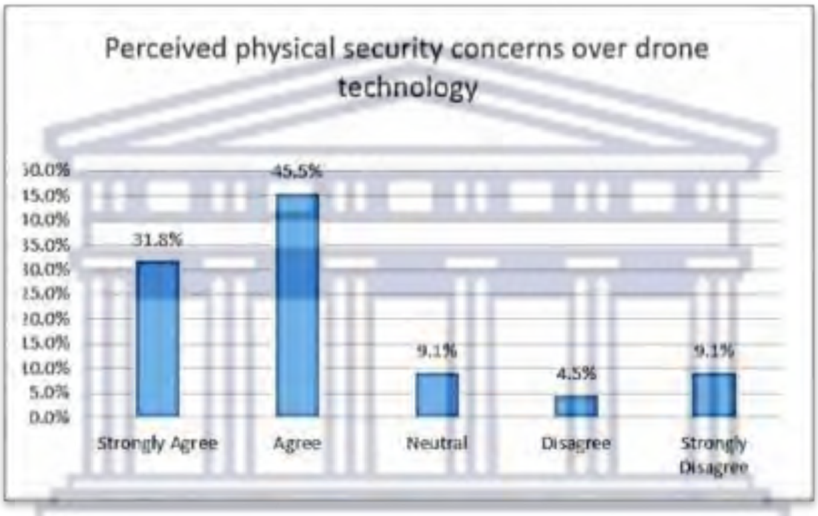

Figure 4.15: Perceived physical security concerns over drone technology

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4.3.5 Cost

Drone delivery are able to improve efficiency and reduce transportation costs (Chiang, W.-C. et al. 2019); however, the introduction of drone delivery will require significant investment. In Figure 4.16, participants in the survey offer insight into whether their organisations invest in improving logistical efficiency. 63.6% of the survey participants felt that their organisations had invested in logistics to improve efficiency. A smaller group of 45% of the participants felt strongly that their organisations do not invest in improving logistics.

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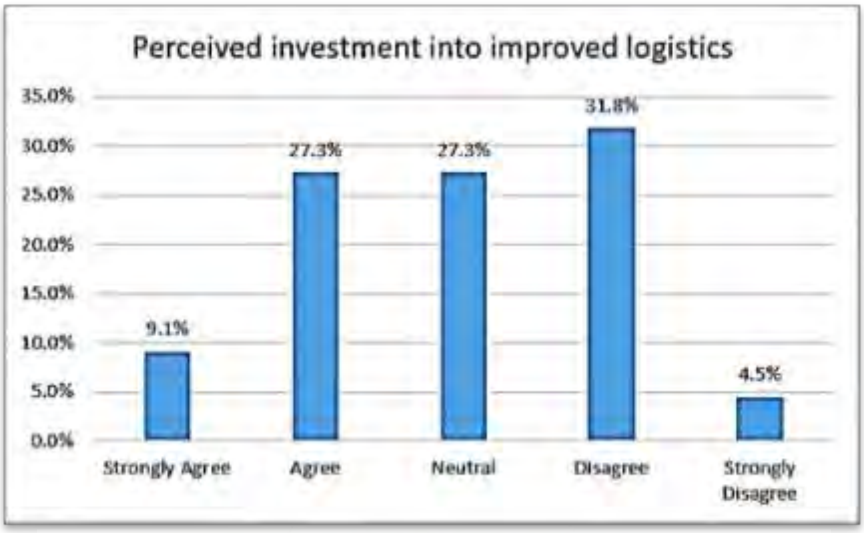

Figure 4.16: Perceived investment into improved logistics

Participants are asked if they agree or disagree with logistics costs being high in their respective organisations. In figure 4.17, 10.6% of the participants strongly agree, while 18.2% strongly disagree. 39.4% of the participants could not decide and were neutral.

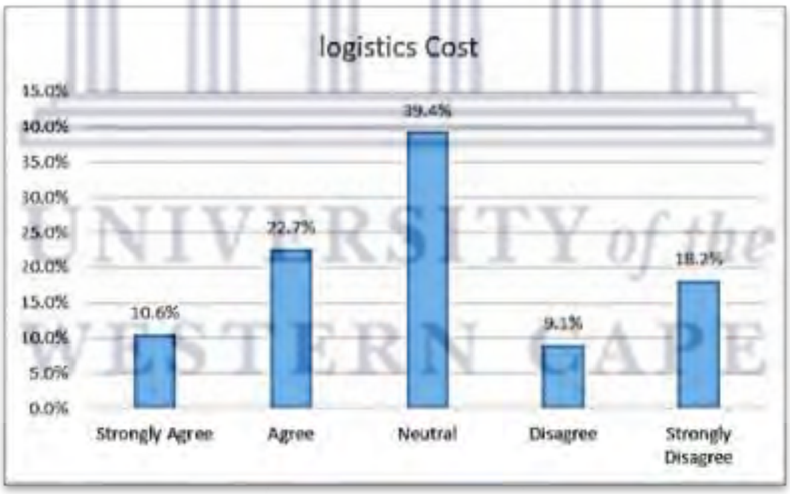

Figure 4.17a: Logistics cost

In the survey, participants are asked if they agree that technology could decrease the logistical costs associated with their operations. 36.9% of the participants strongly agreed that costs would be reduced with the use of delivery drone technology. 18.2% of the participants strongly disagreed that the technology would reduce costs. The consensus that drone delivery will reduce the cost of last-mile delivery is articulated in research; according to Chiang, W.-C. et al. (2019), delivery drone technology will require significant investment, but the returns will

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significantly recover any of the associated costs. Thus, it can be suggested that cost will be an obstacle to the adoption of drone delivery but also a motivating factor.

Figure 4.17b: Drone delivery to reduce costs

4.4 Organisational factors

The organisational factors described in the TOE framework refer to an organisation's composition in terms of available organisational resources, size, and how the hierarchy affects the organisation's ability to make decisions (Mahakittikun et al., 2021). The factor of hierarchy is explained as top management support, whereby management is able to facilitate innovative solutions. The size of an organisation may be an advantage in terms of available resources but also a disadvantage in terms of strategic flexibility. Culture is another critical factor in the adoption of drone delivery, as this describes how ideas are promoted, shared, and consumed.

4.4.1 Top management support

According to Chiang et al. (2019), drone delivery will require significant investment in projects, which will facilitate the adoption of the technology. Investments in technology will require the support of management. In the survey, organisational factors that affect the adoption of delivery drone technology were explored. In figure 18, 66.7% of the participants agreed that senior management support was a key ingredient in employing the technology. 4.5% of the participants strongly agreed that this was not of the utmost importance. 19.7% of the surveyed participants were neutral with regards to senior management support.

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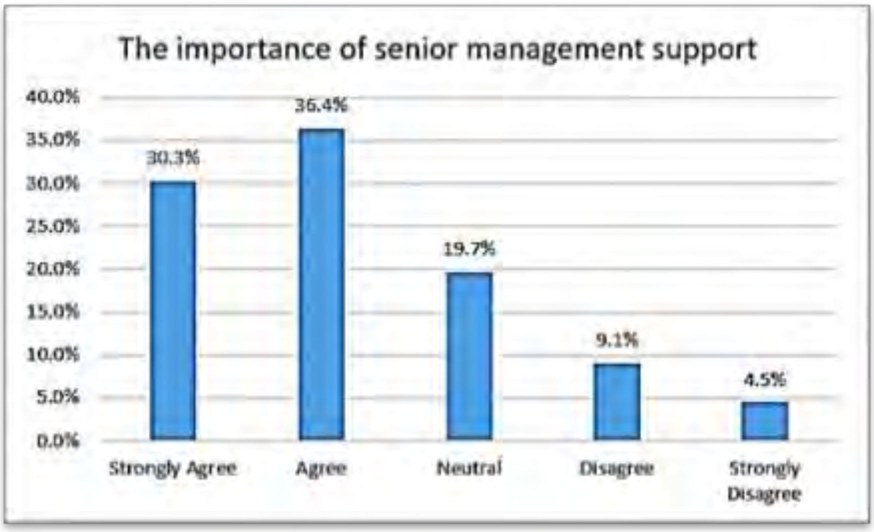

Figure 4.18: The importance of senior management support

In Figure 4.19, participants indicate their organisation's resources and ability to implement delivery drone technology. 28.8% of the participants agreed that their organisations had the resources, while 18.2% felt strongly that they did not have the resources. 43% of the participants were uncertain about resource availability. The allocation of resources is a management function; thus, high levels of management support will boost the availability of resources for projects such as drone adoption. The statistics in Figure 4.19 suggest that management will support delivery drone projects within the South African logistics industry, thus boosting adoption.

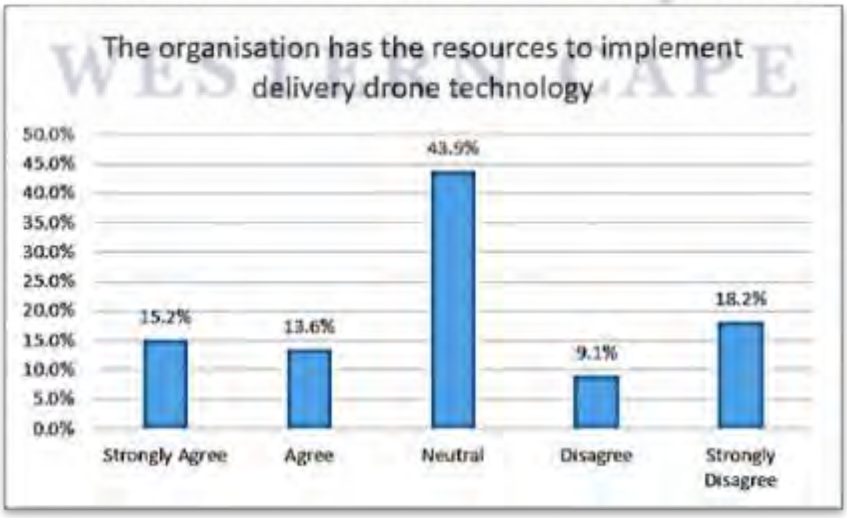

Figure 4.19: The organisation has the resources to implement delivery drone technology.

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4.4.2 Organisational Size

According to Clohessy & Acton (2019), large organisations may be better positioned to adopt new technology. Participants in the survey were asked about the size of their organisations. In figure 20, 43.9% of the participants agreed that their organisations were larger than 200 staff. While 51.3% indicated having a smaller staff complement than 200 employees, 3% of the participants were unsure about the size of their organisation in terms of staff. The data suggests that, more often than not, the participants were part of a large organisation exceeding 200 people. This suggests that, within the local context, organisational size may not be a significant factor.

Figure 4.20: Organisational size

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In figure 4.21, participants indicate whether their respective organisations perform logistics at a national level. 50% of the participants felt that they do perform their operations at a national level, while 12.1% were sure they did not.

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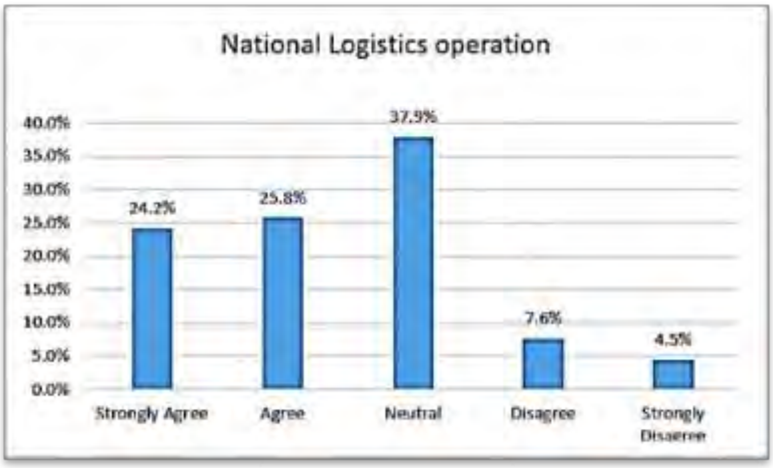

Figure 4.21: National logistics operations

In Figure 4.22, 45.5% of the survey participants were unsure that their organisation's size would affect the adoption of the delivery drone technology. 13.6% of the participants strongly agreed that the drone technology would be more easily adopted by a larger organisation.

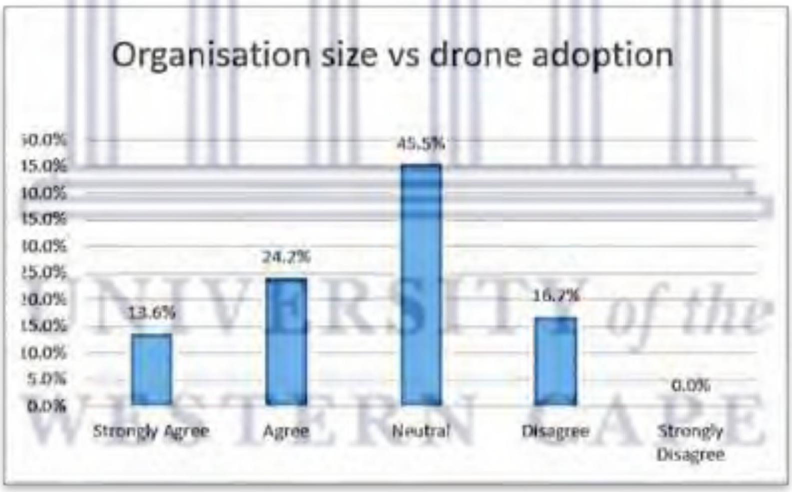

Figure 4.22: Organisation size vs drone adoption

In Figure 4.23, participants are asked about the idea that organisational size will affect the adoption of delivery drone technology. 40.9% of the participants agreed that a larger organisation would benefit more, while 9.1% strongly disagreed that organisational size was relevant.

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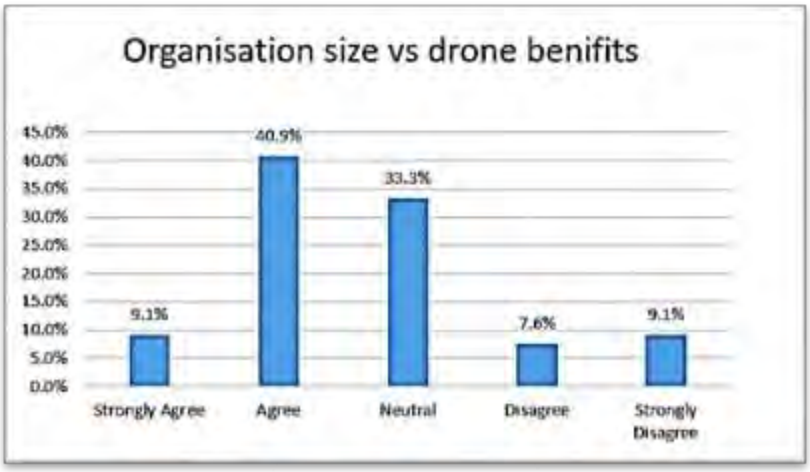

Figure 4.23: Organisation size vs drone benefits

4.4.3 Organisational Culture

According to Ober 2020, the culture of an organisation will greatly influence innovation. As delivery drone technology will require an innovative approach, the culture of an organisation may influence the adoption of the technology. In Figure 4.24, participants provide feedback on the organisation's willingness to innovate and pursue efficiency. 36.4% agreed that their organisations valued innovation, while 22.7% did not agree. 27.3% of the participants were unsure of the value their organisations place on innovation and efficiency.

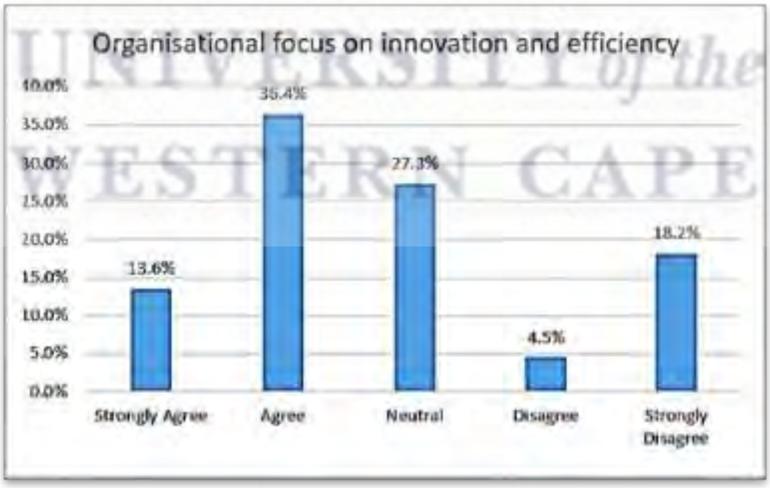

Figure 4.24: Organisational focus on innovation and efficiency

In Figure 4.25, participants are asked if they feel that their organisations reward individual performance. 45.5% of the participants indicated being neutral, while 31.8 agreed that their performance was rewarded. 13.6% of the participants agreed that their organisations did not

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reward individual performance. The results suggest a conservative culture whereby logistics companies do not always reward performance. According to Manso (2017), a culture of rewards can be a valuable management tool to promote efficiency and innovation. The adoption of drone delivery is an innovative idea that brings with it efficiencies that cannot be attained otherwise. For this reason, a culture of innovation and reward will greatly impact how well delivery drone technology is adopted and sustained.

Figure 4.25: Organisations reward performance

4.5 Environmental factors

The environmental factors that influence the adoption of technology can be linked to the external macro forces that affect the thinking of an organisation (Qin et al., 2020). These factors may include government policies and regulations, the activities of competitors, and the structure of the environment both physically and logically. In the literature review, the impact of drone delivery on the environment was considered, as were the impact of aviation and health regulations, as well as the public infrastructure requirements to facilitate drone delivery.

4.5.1 Energy consumption

In Figure 4.26, participants are asked if, in their opinion, the use of delivery drone technology would reduce energy costs within their operations. 50.8% indicated that there would be no reduction in energy costs when using delivery drone technology. 33.3% indicated that there would be a reduction in costs.

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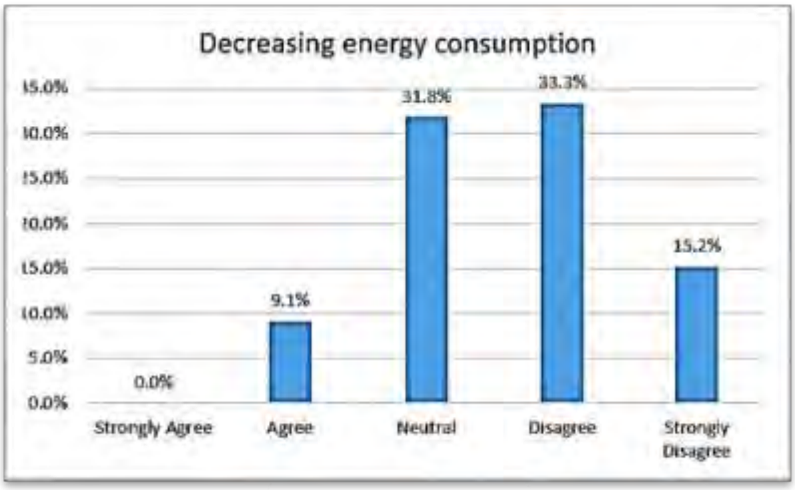

Figure 4.26: Decreasing energy consumption

In the survey, participants were asked if they felt that drones would be more efficient than traditional vehicles. 18.2% agreed that drones could be more efficient, while 51.6% of the survey participants disagreed with the notion that the use of drones would have efficiencies over traditional vehicles.

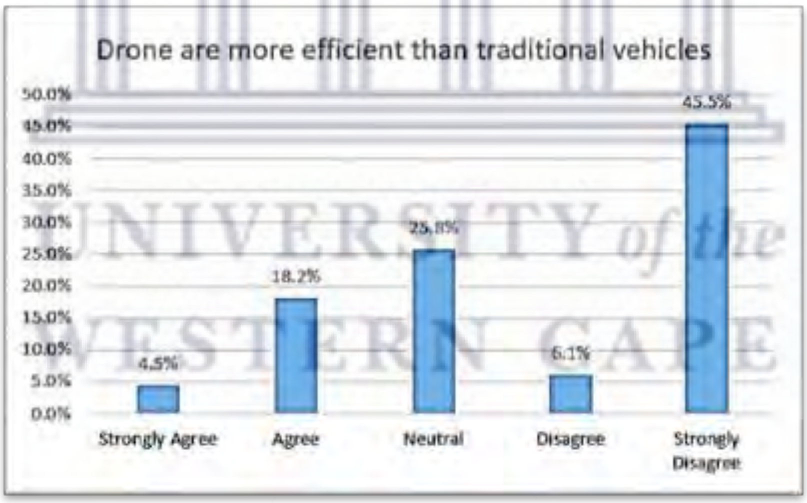

Figure 4.27: Drone are more efficient than traditional vehicles.

In the survey, participants are asked if their organisations solely rely on electricity as a source of energy. 16.7% agreed that their organisations use other forms of energy, while 45% strongly disagreed with using other forms of energy other than electricity.

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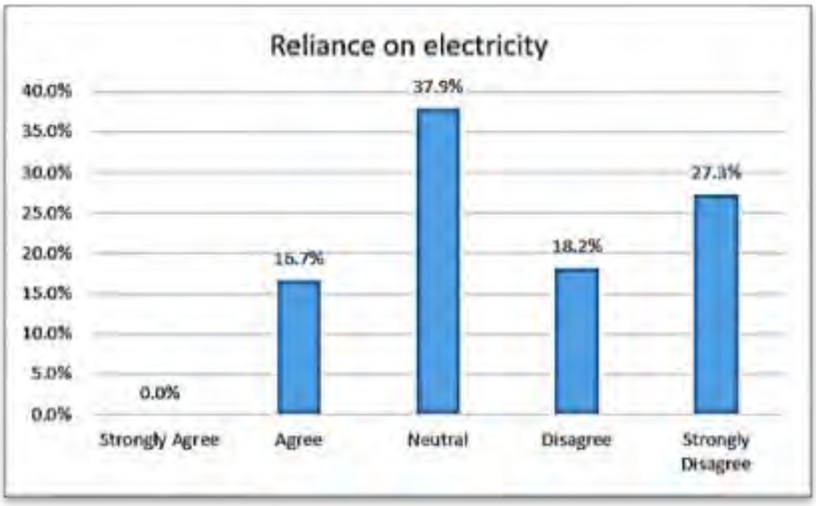

Figure 4.28: Reliance on electricity

4.5.2 Infrastructure

In Figure 4.29, participants are asked about their belief that their organisations have adequate infrastructure to adopt emerging technologies. 45.5% of the survey participants agreed that their organisations do have the means to adopt new technologies, while 54.1% indicated that they were not of the opinion that their organisation had the necessary infrastructure.

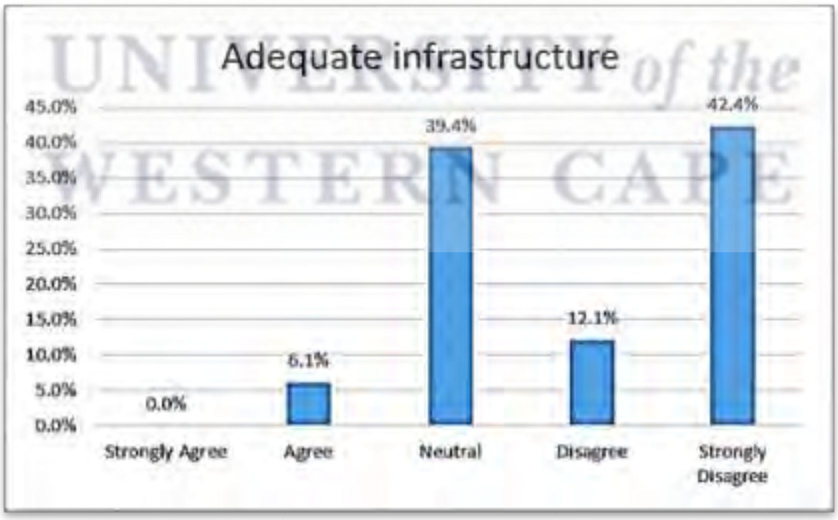

Figure 4.29: Adequate infrastructure

Participants in the survey were asked about their understanding that delivery drone technology could reduce carbon emissions in their organisations. 12.1% agreed, while 30.3% were unsure

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of any significant reduction in carbon emissions. 57.6% of the participants disagree with the idea that their organisation's carbon footprint can be reduced with the use of drone delivery.

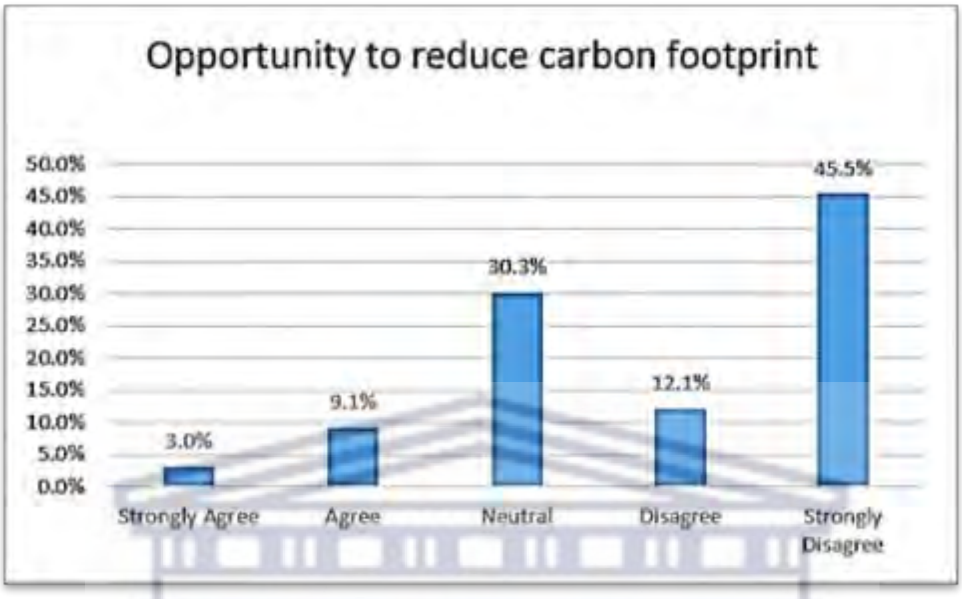

Figure 4.30 : Opportunity to reduce carbon footprint

4.5.3 Legislation

In the survey, participants are asked about their familiarity with drone legislation. 13.6% of the participants were neutral, while 18.2% were familiar with some legislation. 68.2% of the participants had no knowledge of any drone-related legislation.

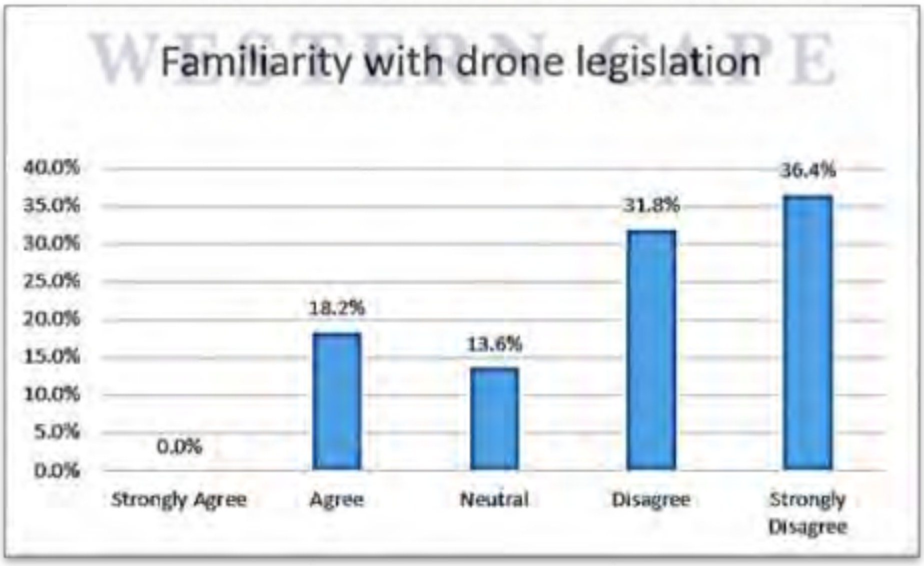

Figure 4.31: Familiarity with drone legislation

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Finally, in the survey, participants are asked about whether they believe that legislation will affect the adoption of delivery drone technology. 40.9% of the participants agreed that that legislation would affect adoption, while 31.8% were unsure. 27.3% of the participants disagreed with the notion that legislation would affect drone adoption.

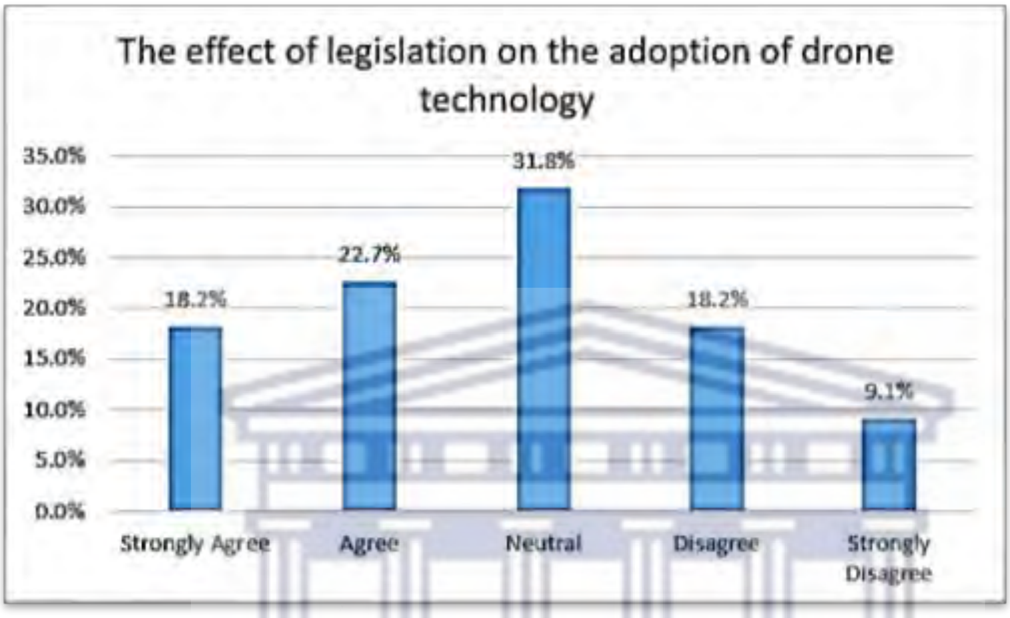

Figure 4.32: the effect of legislation on the adoption of drone technology

4.6 : Reliability

According to Raharjanti, Purwadianto, Soemantri, Indriatmi, Poerwandari, Mahajudin, Nugrahadi, Roekman, Saroso, Ramadianto, & Levania (2022), Cronbach's alpha (α) is a statistical method for calculating the reliability of a survey instrument. The Cronbach's alpha values are interpreted as good reliability above 0.8, acceptable reliability between 0.6 and 0.8, and unacceptable reliability below 0.6. In an article by Jokonya, Kroeze, and Van Der Poll (2014), a Cronbach alpha value between 0.6 and 0.8 indicates an acceptable level of reliability, while a value greater than 0.80 is considered good. A value less than 0.6 is considered unacceptable (Raharjanti et al., 2022).

Table 4.1 : Reliability Analysis

Variable	Cronbach's Alpha	N of Items
Technology	0.63*	16
Organisation	0.77*	10
Enviroment	0.74*	9

*Reliability is acceptable (0.6-0.8)

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In the research study, Cronbach's alpha was calculated for the technological, organisational, and environmental survey questions. The survey questions relating to the organisation and environment were measured at 0.77 and 0.74, respectively, indicating a high level of reliability. With regards to technology, a value of 0.63 was achieved by dropping questions pertaining to "skillset" and "security" from the analysis.

4.7 : T Test results

According to Delacre, Lakens, and Leys (2017), the T test is commonly used to study two independent groups of people. In this study, the t-test was performed to assess significant differences between the mean constructs and variables of technological, organisational, and environmental within the categories of gender.

Table 4.2 : T Test Analysis (Gender Coded)

Variable	F	Sig.
Physical Warehouse Compatibility	8.01	0.006***
Physical Security : Organisational	10.63	0.002***
Physical Security : Consumer	20.51	0.000***
Cost reduction	12.85	0.001***
Senior management support	6.83	0.011**
Strategic Thinking	3.16	0.008***
Organisation size (S,M,L)	18.7	0.000***
The Impact of organisational size	6.24	0.015**
Organisational Size benefits	6.14	0.016**
Culture that rewards	9.6	0.003***
Skill Development	23.29	0.001***
Energy effeciency	11.34	0.001***

Sample (N=66) Note: *P<0.5,**P<0.1,***P<0.01

The t test conducted found no significant differences in the TOE Framework constructs. However, there were significant differences between gender and the following variables: physical warehousing, organisational security, consumer security, strategic thinking, cost reduction, organisational size,culture that rewards, skill development, and energy efficiency. The areas of senior management support and organisational size were calculated to have a

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slightly lesser value of significance. The results suggest that the participants are agreeable in terms of technology and organisational factors.

4.7 Analysis of Variance

Kroeze, Nya, Kroeze, and Van Der Poll (2014) said "The analysis of variance (ANOVA) is used to understand significant differences between demographic variables with more than two categories in terms of non-effects on framework". In Tabrace`, the race demographic variable showed a significant organisational factor. The other constructs—technology and environment—were not significant.

Table 4.3: Anova for Race Demographic

Independent Variable	F	Sig.
Technological	2.2	0.08
Organisational	2.79	0.034**
Enviromental	1.52	0.209

Sample (N=66) Note: *P<0.5,**P<0.1,***P<0.01

In Table 5, the age demographic showed significant organisational factors. Constructs. Other constructs, such as technology and the environment, were not significant.

Table 4.4: Anova for Age Demographic

Independent Variable	F	Sig.
Technological	1.26	0.295
Organisational	4.47	0.007**
Enviromental	1.01	0.395

Sample (N=66) Note: *P<0.5,**P<0.1,***P<0.01

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4.8 Correlation Results

This section illustrates the results of the correlation between the TOE factors—technology, organisational, and environmental. A high degree of correlation was shown across all combinations of technology, organisation, and environment, as depicted below in Table 4.5.

Table 4.5: Correlation Matrix Results

Variable	1) Technological	2) Organisational	3) Enviromental
Technological	1		
Organisational	0.001**	1	
Enviromental	0.00**	0.00**	1

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 (2-tailed)

4.9 : Chapter Summary

This chapter presents the results of the data analysis performed during the research study. The survey questionnaire posed 30 questions to the participants. These questions were split into the areas of demographics, technology, organisation, and environment. The first sub-section 4.2 presents the frequencies of the demographic data variables: age, gender, race, and experience. The next sub-section, 4.3, presents the frequencies of technological factors that affect the adoption of drones. These factors included complexity, compatibility, skills, and cost. The third sub-section 4.4 presents the frequencies of the variables, which form part of the organisational factors related to the TOE framework discussed in the literature review. These organisational factors included culture, size, and structure. Subsection 4.5 presents frequency analysis and charts for environmental factors such as legislation, the physical environment, and energy consumption. In Section 4.6 of the chapter, the reliability of the data was examined, while Section 4.7 dealt with the t-test. In an effort to understand significant variances in demographic variables, an anova analysis was performed within the age and race categories. Lastly, the correlation of the TOE factors was examined.

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Chapter 5: Discussion, Recommendations and Conclusion

5.1 Introduction

In the previous chapter, the research results of the study were presented. Firstly, in this final chapter, the previous chapters will be summarised. Secondly, the chapter will make recommendations in the area of last-mile drone delivery as well as areas for further research. Lastly, the research questions will be discussed in relation to the research results and literature review. The research questions were previously described as follows:

What are the technological factors affecting the adoption of drone delivery?

What are the organisational factors affecting the adoption of drone delivery?

What are the environmental factors affecting the adoption of drone delivery?

5.3 Discussion

5.3.1 Technology adoption factors

5.3.1.1 Compatibility of Drone delivery in South African Logistics industry

The compatibility of an innovation with the technology landscape of an organisation is an important factor. Jing & Ting (2019). Compatibility in the case of new technology may be described as the degree to which the new technology is consistent with what it is replacing. According to Min Jeongg (2019), compatibility for drone delivery is a matter of how simple it is to replace ground vehicles with aerial drones. In the questionnaire, participants were asked about their awareness of drone technology and whether they believed the technology presented an opportunity to improve efficiency over the last mile. The majority of participants demonstrated their awareness of drone technology in the context of the last mile, with 72.7% of the participants believing that drone delivery have the potential to be more efficient than current delivery options. Interestingly, only 25.8% of the participants indicated being part of a logistics firm that had explored the possibility of incorporating delivery technology in some form. The low interest in employing drones may be because of physical incompatibility within their logistics organisations. Of the 66 participants, 74% expressed the notion that the technology could not be integrated into their operations in a simple fashion. According to Shahzad (2021), a high level of compatibility requires fewer changes; thus, the responses of

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the participants largely indicate that drone delivery will require significant changes to the logistics eco-system for compatibility to become less of a factor in the adoption of the technology.

5.3.1.2 Complexity of Drone delivery in South African Logistics industry

Complexity is described as the degree of difficulty a customer or organisation may have when using new technology (Jing & Ting, 2019; Yoo et al., 2018). When people are unable to understand the benefits of a new technology, the risk exists that these people may perceive the technology as complex without any benefit to their lives. Of the 66 participants who had answered the questionnaire, 89% of the respondents indicated that they had no real understanding of the benefits of drone technology in the logistics industry. A very small percentage of the participants described a level of understanding of how drone delivery can benefit the logistics industry. The link between complexity and awareness of benefits was further highlighted when 72% of the participants explained that they perceived the integration of drone technology into their businesses as a complex process. The capability to understand and manage complexity directly influences the success of any technology implementation in terms of output. Osakwe et al. (2022). The strong understanding that drone technology will be difficult to introduce in the South African logistics industry will greatly impact the adoption of drone delivery as a viable option in the last mile. According to Osakwe et al. (2022), the industry will seek to stick to less complex solutions rather than promote or lead with innovation.

5.3.1.3 Skills for Drone usage in the in South African Logistics industry

The introduction of new technologies into an industry will require the development of new skills and competencies for the organisations that seek to innovate. These new skills and competencies will aid in the process of problem solving and the integration of new technologies when they are adopted by organisations (Clohessy & Acton 2019). The use of delivery drone technology will require a unique set of skills, which may not be represented within the logistics industry. To acquire the skills, organisations will need to formulate a human resource strategy. In the questionnaire, 47% of the participants indicated that their organisations would look to outsource skills, which they may require in adopting the delivery drone technology. The outsourcing of necessary skills is often a valuable method for quickly acquiring capabilities, which allow an organisation to rapidly deploy a new technology, thus gaining a competitive

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advantage. Other methods for acquiring skills do exist, with the emphasis being on retaining and building core competencies. A group of 28% of the participants indicated that the competencies required for delivery drone implementation could be trained or developed internally. Training and skill development internally may take long periods of time, and drone delivery may have been brought to market by competitors. Finally, 28% of the participants indicated their belief that the necessary drone skills for deployment in the logistics industry would need to be found internationally. The lack of perceived local skills within the technology industry may be a strong deterrent, which influences the adoption of delivery drone technology in the logistics industry.

5.3.1.4 Security implications of Drone delivery in the South African logistics Industry.

Security is an important factor that influences the adoption of innovative technologies within organisations (Yoo et al., 2018). New technologies are associated with security risks due to high levels of uncertainty about how the technology will interact within a new environment (Khan et al., 2019). In the questionnaire, participants were asked whether security was a significant factor in affecting the adoption of drone delivery over the last mile. An overwhelming group of 89% of the participants indicated that they believed security was a critical concern for the adoption of drone delivery in the South African logistics industry. The successful implementation of drone delivery in the last mile requires drone delivery to be physically active when flying over public areas or when interacting with key points of interest when performing drop-offs.

A study by Ramadan et al. (2017) explained that in testing delivery drone approaches, the dangers to civilian life had become apparent. The risks associated with the physical introduction of new technology, which may pose safety concerns, are a well-documented adoption issue. According to Zhang, So-In, & Thakur (2019), people are generally unwilling to adopt new technology over which they have no control regarding matters of safety. Public safety concerns such as that of self-driving causing unwanted accidents or, more recently, the perception that the use of 5G in consumers' homes is causing health issues have further instilled the fear of incorporating new technology into the consumer environment. Interestingly, 84% of the participants agreed that physical security would represent the greatest risk in deploying the technology in the South African logistics industry. The safety and security concerns around drone delivery may very well be managed by consolidating the benefits that consumers will enjoy. According to Adams (2020), by improving consumers capacity to assess risk through

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understanding the technology, organisations are able to improve the social acceptance of innovations such as drone delivery more rapidly.

5.3.1.5 Cost of technology innovation

The application of innovative ideas to an organisation requires a financial investment, which is often balanced against the return on investment realised by the innovation. In the case of delivery drone technology, the investment in UAVs and other technologies will require a significant outlay; however, these investments will be easily leveraged due to the scalable nature of delivery drone technology used over the last mile (Yoo et al., 2018) and (Meng-Hui et al., 2018). The successful implementation of delivery drone technology will require significant changes to internal and external infrastructure, depending on the delivery model selected. Delivery drone models vary greatly depending on the geographical size and terrain the drones will operate in. The varying models currently utilised and proposed offer contrasting levels of efficiency.

In terms of return on investment, the use of drone delivery is able to improve efficiency and reduce transportation costs (Chiang et al., 2019). In the questionnaire, participants were asked about whether their organisations invested in technologies that would improve logistics operations. The responses indicated that 63.6% of the participants were of the belief that their organisations had invested in improving their operations with technology. Participants were also asked about maintenance costs associated with logistics operations. A large group of 72.7% agreed that typical land-based logistics maintenance costs are significant, which may be reduced significantly by introducing drone delivery, which are said to be less expensive to maintain.

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As explained by Chiang et al. (2019), fuel is a large cost associated with traditional road-operated vehicles. A large group of 81.8% of the participants agreed that drone technology had the benefit of reducing fuel costs compared to traditional road vehicles. Drone technology makes use of lithium-ion batteries, which can be recharged through a number of renewable energy sources such as solar or wind (Hollinger, McAnallen, Brockett, DeLaney, Ma, & Rahn, 2020). Traditional road-based last-mile delivery vehicles require a licenced driver, while the vehicles themselves require a high level of maintenance to remain road-worthy. Unmanned drone delivery have a smaller form factor, making the devices more serviceable than road-going motorbikes or trucks.

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5.3.2 Organisational adoption factors

5.3.2.1 Organisational Culture of South African Logistics organisations

Logistics organisations that operate within the last mile face a number of problems in their operating environment. Issues logistics companies struggle with include increasing energy costs, security concerns, and meeting the needs of the consumer (Badenhorst-Weiss, Hannie, & Weber, 2018). In order to remain competitive, logistics organisations will need to overcome issues by innovating and applying technology to problems (Faasolo & Sumarliah, 2022). Logistics organisations that build a culture of innovation into their operations are likely to overcome obstacles and remain competitive (Ober, 2020). Logistics organisations in South Africa that struggle against the rising costs of fuel and increasing costs of labour will greatly benefit from developing an innovative culture.

In the questionnaire, participants were asked about their organisation's interest in innovation as a tool to improve efficiency. The majority of the participants responses to the questioning were positive, with 36.4% agreeing that their organisations valued innovation. Similarly, participants indicated that 31.8% of the organisations represented by their respective employees received some form of performance incentive. According to Manso (2017), performance incentives allow management to not only push performance objectives but also allow the path to achieving these targets to be better influenced by overarching strategies.

Organisations with innovative management cultures can guide operations to achieve performance from innovative technology-based ideas, which are often more sustainable and efficient. A large group of 63.6% of participants indicated that their organisations did not demonstrate an effective inclination to value innovative thinking. For the adoption of delivery drone technology within the South African logistics industry, a low measure of innovative thinking at an organisational level will handicap the efforts of individuals promoting the use of drones over the last mile. In terms of shifting organisational behaviour to incorporate technology, 68.2% of participants explained that their respective logistics organisations did not receive any form of performance reward, which negatively affects the ability of these organisations to implement strategies that promote innovative ideas such as delivery drone technology over the last mile.

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5.3.2.2 Organisational size of South African Logistics organisations

The size of the logistics organisations in South Africa will affect how technology is adopted. Large logistics organisations have greater resources available to leverage complex investments in delivery drone technology (Clohessy & Acton, 2019). The greater size of the organisation also means skills are more readily available, which positively affects the outcome of successfully adopting delivery drone technology (Jacob et al., 2020). In the questionnaire, 43.9% of the participants indicated that their complement of staff was greater than 200 personnel, while the majority of participants were employed by smaller organisations with 200 or fewer personnel. The survey results suggest that the South African logistics landscape consists of many smaller organisations operating in smaller local areas, whereas the larger organisations with larger staff complements cover a broader area with a more scattered footprint. This sentiment was reciprocated, with 50% of the participants employed at organisations that are active on a national scale. In the case of last-mile delivery, the drone technology is centred on the local geography, as drones are limited by the distance they are able to cover before requiring a recharge. According to research by Clohessy & Acton (2019), Thatcher et al. (2006), and Jacob et al. (2020), larger organisations with greater resources are most likely to be successful at implementing large IT projects. In South Africa, the smaller logistics firms that provide last-mile delivery services are smaller in terms of personnel, indicating that these firms may struggle to adopt drone delivery over more traditional last-mile delivery methods due to a lack of skills and resources. Smaller logistics operators may have to collaborate with larger logistics organisations to successfully adopt last-mile delivery drone technology within the South African context.

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5.3.2.3 Organisational Strategy within South African Logistics

The successful adoption of innovative delivery drone technology will require an organisational strategy that includes targeted improvements in productivity. For any innovative technology strategy to be effective, senior management support is a critical factor in ensuring the adoption of technology (Clohessy & Acton, 2019; Jacob et al., 2020; Shavarani et al., 2019). In the questionnaire, participants were asked if they felt that the adoption of last-mile drone delivery would require buy-in from top-level management. A large group of 66.7% indicated that the support of senior management was important in adopting delivery drone technology. The alignment of beliefs and attitudes within an organisation is often referred to as organisational readiness (Clohessy & Acton, 2019; Thatcher et al., 2006). The large group of participants who

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are of the opinion that they will be supported in an effort to innovate in the delivery of drone space demonstrates a well-integrated organisation where beliefs and attitudes have aligned to improve performance and productivity.

In addition to the alignment of beliefs and attitudes, participants in the survey were questioned about the availability of senior management to provide the necessary resources required to adopt delivery drone technology. In the responses, 28.8% of the participants agreed that their organisations had the resources, while 18.2% felt strongly that they did not have the required resources. A large group of 43% of the participants were unable to evaluate the availability of resources at the disposal of senior management. At a strategic level, the local senior management or executive management teams will need to solve complex organisational problems unique to the social environment and geography of various locations. The implementation of complex solutions will require human resources and a working environment in which said resources may be allowed to innovate freely (Shavarani et al., 2019; Clohessy & Acton, 2019). From the survey results, it is clear that many of the participants expressed satisfaction with the efforts made by their senior management teams to adopt and support innovative technology-based projects. However, it is also clear that a lack of resources at an organisational level may ultimately hinder the adoption of last-mile drone delivery within the South African logistics industry.

5.3.3 Environmental adoption factors

5.3.3.1 Energy Consumption of South African Logistics organisations

According to Khan et al. (2019), the impact technology has on the environment is key to understanding whether or not the potential exists for the technology to be adopted. In the case of delivery drone technology, the technology is thought to have great potential for reducing carbon emissions (Chiang et al., 2019). An article by Yoo & Jung (2018) suggests that drone delivery are more environmentally friendly than traditional carbon-based transport, such as road vehicles. With increasing energy costs affecting the global economy, the use of green energy has become a priority in the logistics industry.

In the survey, participants were asked whether they felt that delivery drone technology would reduce energy costs related to last-mile delivery in South Africa. Interestingly, 33% of the participants felt there was a real benefit to adopting last-mile drone delivery in terms of direct energy savings, with 67% indicating that they do not foresee any energy-saving benefits within

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their own organizations. In terms of last-mile drone delivery being more economical in an energy sense, 18% of the participants indicated that they saw the last-mile delivery technology as being more efficient than traditional road-based vehicles. A small group of 16% of the participants indicated that their organisations used fuel sources other than fossil fuels to perform logistical operations.

As the reduced carbon emissions of drone delivery (Chiang, Shang, & Urban, 2019) are a significant factor in the adoption of drone delivery, the responses to the survey questionnaire indicate that very little is known in the local logistic industry with regards to the energy benefits of last-mile drone delivery. The lack of understanding of the selling points of last-mile drone delivery will negatively affect the adoption of the technology within the local industry. However, the local pressure on South African businesses to navigate the increases in local energy costs may shift the ultimate focus in logistics to harvesting renewable energy-based delivery systems such as drones.

5.3.3.2 Infrastructure capabilities of South African Logistics organisations

The implementation of last-mile delivery drone networks will require access to public and private infrastructure systems. In terms of public infrastructure, the availability of quality 4G and 5G cellular networks lays the foundation for efficiently implementing delivery drone technology within the logistics industry. Delivery drone technology uses cellular networks to navigate routes and locate targets.

In order to satisfy the commercial aspects of last-mile drone delivery, such as warehouse loading stations, organisations will need to coordinate the implementation of complex technology projects when the required environment lacks the necessary infrastructure readiness. In the survey, 45% of the participants indicated that they believed their organisations had the necessary capabilities to successfully implement last-mile drone delivery. The adoption of last-mile drone delivery within the logistics industry will be influenced by the industry's understanding of what the infrastructure demands of drone delivery will be. Organisations with large financial resources may not be put off by the high costs associated with infrastructure projects, while smaller logistics operators may seek less complex delivery drone models that are solely reliant on public infrastructure, such as 4G networks, consumer smart phones, and GPS.

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The South African logistics industry has successfully implemented a number of last-mile delivery solutions, such as Uber Eats and Mr. Delivery, which require minimal large-scale infrastructure. The growth of fast food delivery in populated urban centres demonstrates the willingness of businesses in the South African context to innovate and provide solutions that make full use of basic infrastructure.

5.3.3.3 Legislation within the South African Logistics industry

Government legislation that describes infrastructure use, commercial and public interactions, and property issues is a very powerful factor in influencing the adoption of new technologies in developing countries like South Africa (Faasolo & Sumarliah, 2022). Organisations need support from the government, both in terms of infrastructure readiness and by means of reasonable regulations. Logistics operators adopting drone delivery technology will do well to understand and familiarise their organisations with the many policies and legislation affecting drone technology. Delivery drone technology may be affected by legislation governing products such as medical supplies (Hogan et al., 2022) or aerial regulations, which seek to maintain air safety (Sheftner et al., 2022). Policies and legislation also explain mandatory business processes that should be available to all consumers, such as reverse logistics (Esenduran et al., 2017). Due to the nature of delivery drone technology, the adoption of the technology will be impacted by policies and legislation from many different areas of interest.

In the survey, 68% of logistics professionals surveyed indicated that they had no clear understanding of the current policies and legislation that may affect the last-mile delivery drone ecosystem. This is a significant measure of the local industry's readiness to meet the legislative challenges of adopting last-mile drone delivery. When participants were surveyed about the idea of last-mile delivery using drones, 40.9% agreed that legislation would in fact affect the adoption process negatively, making the deployment of innovative ideas challenging. During the COVID-19 pandemic, many countries eased regulations related to drone delivery, allowing for the distribution of small products (Aurambout et al., 2019). In some countries, specific delivery drone routes were legislated to promote drone delivery, allowing for less person-to-person contact during COVID-19. Past evidence suggests that large macroeconomic disasters such as COVID-19 can reshape legislation, allowing new technology to be more easily adopted. In South Africa, the local energy sector may further loosen the legislative barriers preventing the widespread adoption of drone delivery, as the technology is proven to be more green in terms of energy.

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5.4 Critical evaluation of the research objectives

After completing the survey analysis and discussing the factors that affect the adoption of last-mile drone delivery, this section of the chapter evaluates the success of the study by revisiting the study's objectives.

5.4.1 Identify the Technological factors affecting the adoption of drone delivery by logistics organisations.

To attain the objective of identifying the technological factors affecting the adoption of drone delivery by logistics organisations, a survey questionnaire was provided to senior individuals working in the logistics industry. The survey featured a Likert scale ranging from 1 to 5, with 1 being strong agreeability and 5 being strong unagreement. The results of the survey questions relating to technology were analysed using various statistical methods. The technological variables achieved a Cronbach alpha of 0.63, indicating a high level of reliability. The factors with the highest mean scores were complexity and compatibility of technology. In the survey, 72.7% of the participants indicated that the process of integrating drone delivery into their organisations would be challenging. In terms of compatibility, 74.2% of the participants indicated that the delivery drone technology would not integrate well with their current solutions and processes. Therefore, this study identified two technological factors that impact the adoption of drone delivery within the South African logistics industry.

5.4.2 Identify the Organisational factors affecting the adoption of drone delivery by logistics organisations.

To understand the objective of identifying the organisational factors that affect the adoption of drone delivery in the South African logistics environment The survey asks participants a number of questions related to organisational factors that impact the adoption of technology. The organisational variables achieved a Cronbach alpha of 0.77, indicating a high level of reliability. The two significant organisational factors identified in the survey were "senior management support" and a "stragic focus on innovation". In the study, 66.7% of the participants agreed that the adoption of drone delivery would be impacted by senior management support. Furthermore, 50% of the participants also confirmed that innovative thinking is a critical factor in considering the adoption of drone delivery. The study identified

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two significant organisational factors that affect the adoption of deliver drones in the South African context.

5.4.3 Identify the Environmental factors affecting the adoption of drone delivery by logistics organisations.

To understand the objective of identifying the environmental factors that affect the adoption of drone delivery in the South African logistics industry The survey focused on a number of environmental factors identified in the literature. The environmental variables achieved a Cronbach alpha of 0.74, indicating a high level of reliability. The two significant environmental factors identified in the survey were drone-related "legislation" and "infrastructure". In the study, 68.2% of the participants indicated having no knowledge of delivery drone-related legislation. The lack of knowledge around legislation will negatively influence the adoption of drone delivery, thus making legislation a significant cornerstone of any successful delivery drone project. Furthermore, 54.5% of the participants believed that little public infrastructure exists to support the end-users of delivery drone operators. The study identified two significant environmental factors that affect the adoption of drone delivery in the South African context.

5.5 Recommendations for further study

The focus of this study is on drone delivery used in the last mile within the South African context. I recommend further research be performed on how drone delivery can be used in other areas of commercial logistics, such as fleet management. Further research into the use cases for drone technology in the logistics industry may further allow the identification of challenges that affect drone delivery in the last-mile logistics sector.

5.6 Conclusion

The application of drone delivery in the South African logistics industry can unlock a great deal of efficiency in the last-mile delivery economy. In this study, I noted the factors that may influence the adoption of last-mile drone delivery in the South African context by performing a literature review on the topic of drone delivery. The framework for the study was also researched in the literature review, which examined variables from TOE, TAM, and DOI. A survey was developed to understand how the factors identified in the literature would apply to the South African logistics industry. The study results suggest that technical factors

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(complexity and compatibility), organisational factors (management support and culture), and environmental factors (regulations and public infrastructure) affect the adoption of delivery drone technology in last-mile logistics. The study contributes to the body of knowledge on factors affecting the adoption of delivery drone technology in the last-mile and logistics industries. The study used the convenience sampling method, which is a form of non-probability sampling. The use of convenience sampling to harvest the opinions of participants in various locations electronically means the study has its limitations and weaknesses because it was not based on random sampling. Non proberbility sampling implies biase when selecting candidates for the research study.Thus, the results cannot be representative of the logistics industry as a whole as only a small portion of the logistics industry had the opportunity to demonstraight their insight into the issue of drone delivery in south africa. An opportunity exists for further studies to be undertaken that would consider empirical data using other research methodologies. However, in conclusion, the study was able to achieve its objectives of investigating the factors that affect the adoption of drone delivery in the logistics industry.

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Appendices

Appendix A : Survey Questionnaire

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES

Department of Information Systems

1. Investigating the factors which affect the adoption of drone delivery technology in the South African logistics industry

You are invited to participate in a survey to investigate the Factors Affecting the Adoption of Drone delivery in the South African Logistics Industry, conducted by Nieyaaz Adams with student number: 2203318. It is in partial completion of the researcher's thesis towards a Master's degree at the department of Information systems, at the University of the Western Cape. The survey is to be completed by checking (X) in the appropriate box indicating Strongly Agree, Agree, Neutral, Disagree or Strongly Disagree when reading the statement.

Biographical Details	Details
Age	
Race:	
Gender:	
Length of time at company:	
Department	
Position	
Date:	

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
TECHNOLOGICAL FACTORS THAT AFFECT THE ADOPTION OF DRONES IN THE LOGISTICS INDUSTRY.					
Technological Compatibility					

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1. I know what drone technologies are?					
2. I believe that drone delivery technology can be used to improve efficiency in logistics and last mile delivery?					
3. My organization has considered drone delivery technology?					
4. The current drone delivery technology will be physically compatible within our warehouses and customer premises.					
Techno logical Complexity					
5. My organisation understands all the functionality that drones have.					
6. It will be very simple for my organisation to switch or incorporate drones into logistics business processes.					
Skills					
7. The availability of skills can determine the successful adoption of technology.					
8. The skillset to implement and maintain drone delivery technology exist domestically.					
9. My Organisation outsources many IT related services.					
10. The skillset to implement and maintain drones can easily be acquired through skills development and training.					
Security					
11. Security factor is important in the adoption of drones in the logistic industry.					
12. The security concerns of emerging drone technology may affect its adoption within my organisation.					

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13. Drone technology used in last mile delivery may pose uncertain physical security concerns for consumer or public assets.					
Cost					
14. My organization constantly invests in new technologies to improve logistics processes.					
15. The current technology employed in logistics and last mile delivery does not require high maintenance costs.					
16. The latest drone technology will reduce costs and improve efficiency of logistics over the long run.					

Statement	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
ORGANIZATIONAL FACTORS THAT AFFECT THE ADOPTION OF DRONES IN THE LOGISTICS INDUSTRY.					
Top Management Support					
1. It is important to have the support of senior management when implementing drone technology.					
2. Senior management in my organisation understands their roll in driving drone technology related projects such as the adoption of drone technologies.					
3. Senior management would be able to provide the required resources to implement drone related projects in the logistics operations.					
Organizational Size					
4. My organization has more than 200 employees.					
5. My organization conducts logistics operations across the country.					
6. The size of the organization will impact the willingness to adopt drone technology.					
7. A larger organisation will benefit more from drone delivery technology then a smaller entity.					

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Organizational Culture					
8. My organization has a strong focus on innovation and efficiency.					
9. My organisation has a culture that rewards performance.					
10. My Organisation has a culture whereby management supports skill development and growth.					
Statement	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
ENVIRONMENTAL FACTORS THAT AFFECT THE ADOPTION OF DRONES IN THE LOGISTICS INDUSTRY.					
Energy Consumption					
1. Drone delivery technologies can decrease operational costs in my organisation by reducing energy consumption.					
2. Drones can be more energy efficient than traditional logistics vehicles.					
3. My organisation makes use of other energy sources besides electricity.					
Infrastructure					
4. My organisation has adequate infrastructure to adopt emerging technologies in logistics?					
5. My organisation promotes green energy and recycling.					
6. My organisation can benefit from drone delivery technologies as it can reduce my organisations carbon footprint.					
7. The organisation makes use of suppliers that also promotes green energy and infrastructure awareness.					
Legislation					
8. I am familiar with the legislation which impacts the logistics industry.					
9. The logistics industry legislation has an impact on the adoption of emerging technologies such as drones.					

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10. The current drone related legislation promotes the adoption of drone delivery.					

Thank you for your participation

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Appendix B : Quil Bot Premium Statistics

Figure 1 : Overall paper tones

Figure 2 : Chapter 1 – 2 Statistics

TOTAL ERRORS	0
ERROR PERCENTAGE	0%
READING TIME	56 mins 12 secs
READABILITY	College graduate
SENTIMENT	Positive

Figure 3 : Chapter 3-5 Statistics

TOTAL ERRORS	0
ERROR PERCENTAGE	0%
READING TIME	47 mins 26 secs
READABILITY	College graduate
SENTIMENT	Positive

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Appendix C : Turnitin Results

Turnitin Originality Report
Thesis Final by Nieyaaz Adams
From Social Media (My Research)

- Processed on 05-Sep-2023 21:18 SAST
- ID: 2158435991
- Word Count: 30020

Similarity Index
16%
Similarity by Source
Internet Sources:
14%
Publications:
6%
Student Papers:
4%

sources:

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