NAVIGATING DRONE-BASED ETHICAL DECISION MAKING:

A TECHNOETHICS FRAMEWORK FOR THE RESPONSIBLE USE OF DRONE TECHNOLOGY WITHIN THE COLD SUPPLY CHAIN INDUSTRY OF SOUTH AFRICA

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DECLARATION

I, Amanda Vester, declare that this thesis titled: *Navigating Drone-Based Ethical Decision Making: A Technoethics Framework for the Responsible Use of Drone Technology within the Cold Supply Chain Industry of South Africa* is my own, unaided work. Furthermore, I declare that this thesis has not been submitted before for any degree or examination at any other University.

04 September 2025

Amanda Vester

DEDICATION

In the cherished memory of the two most important women in my life. To the matriarch of our family, my grandmother *Wilhelmina Vester (nee' Steenkamp)*, a resilient soul who navigated the harshest storms in life with strength and grace. May your journey continue to inspire those to come to foster a world where compassion prevails.

In loving memory of my beloved mother, who was a scholar at heart; my forever mentor, and a woman of strength. Mom, you left behind a legacy of wisdom that has manifested. This work is a testament to the torch of knowledge you so passionately ignited and instilled within me. May your indomitable spirit continue to inspire and shape the present and future generation with the legacy of your academic pursuits. Thank You Mommy!

To my children, I pray this thesis will be a whispered conversation across your generation and those to come, and the unwritten future chapters that you will contribute.

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ABSTRACT

Globally, drones have begun to transform commercial industries and enhance operational efficiency through the enablement of a supplementary mode of delivery. Within South Africa, this technological momentum has emerged as a critical solution to challenges experienced within the cold supply chain industry. This is especially so given the persistent logistical challenges such as delivery delays, product spoilage, and resource constraints. In light of these challenges, and the solutions that drone technology offers, this study contends that as drone technology becomes a viable option within South Africa's cold supply chain, that it may introduce ethical challenges that have not been fully considered. To this end, this study contends that ethical decision-making must be central to the adoption, integration and application of drones within the commercial operations of the cold supply chain industry of South Africa.

Therefore, the purpose of this study is to explore how key decision-makers within South Africa's cold supply chain industry can anticipate, evaluate, and navigate the ethical implications of drone adoption. Anchored in a technoethics theoretical framework, the study aims to provide structured guidance for balancing technological innovation with moral responsibility. To achieve this, a two-phase methodology was employed being: (1) a scoping literature review to map key themes and conceptual foundations, and (2), qualitative data collection through semi-structured interviews with senior industry stakeholders involved in strategic and technological decision-making. Furthermore, to enhance the credibility, resonance, and ethical robustness of the analysis, supplementary data was collected through member checking, which allowed selected participants to validate and reflect on the preliminary findings.

The findings revealed that while the adoption, integration and application of drones hold clear promise for improving supply chain efficiency, decision-makers remained underprepared to address the ethical dimensions of their deployment. Issues such as privacy, workforce displacement, fairness in market access, and regulatory ambiguity emerges as recurrent concerns. In response to these concerns, the study proposed a technoethics-based ethical decision-making framework to address the pre-adoption phase, operational readiness, and long-term sustainability of drone use within the cold supply chain. The framework is intended to serve as a practical and adaptable tool for organisations seeking to integrate drone technology ethically and responsibly. Against this backdrop, this research contributes to the discourse on responsible innovation, and offers actionable insights for key decision makers operating within the cold supply chain industry that will navigate the future of unmanned systems in logistics.

Keywords: drone technology, technoethics, cold supply chain, ethical decision-making, heuristics, drone technology in South Africa

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CHAPTER ONE: INTRODUCTION

1.1. Purpose of the study

The current nature of the South African cold supply chain[1] industry faces a growing need for more efficient and reliable operations to meet the increasing demands of the Fourth Industrial Revolution (4IR). This industry handles the transportation and storage of perishable goods and therefore requires stringent temperature control and monitoring to ensure product quality and safety. These logistical imperatives have been further intensified by the rapid expansion of e-commerce, which has increased consumer expectations for faster delivery and broader access to perishable products. In response to this, drone technology has emerged as a disruptive logistics innovation with the potential to transform the first and last-mile delivery logistics[2], reduce transit delays, and enhance supply chain responsiveness. Moreover, drone technology has also emerged as a compelling solution to longstanding distribution and delivery challenges. However, this technological promise is not without ethical cost. To this end, the central claim of this study is that, while drone technology promises significant logistical gains, the relaxation of existing regulatory restrictions will introduce new ethical tensions previously absent from current operational realities. The study argues that prospective emerging technoethical challenges[3] may emerge in the post relaxed regulatory environment. As such, the study contends that any introduction of drone technology within the ambit of the cold supply chain industry necessitates a robust ethical decision-making framework to anticipate and mitigate ethical challenges and normative risks beyond technical planning for drones.

To explore this, the study is grounded in technoethics, a multidisciplinary lens that interrogates the moral and social implications of technological systems within institutional contexts. This was imperative as the study was not focused on hypothetical or speculative ethical dilemmas, instead, this research was centred on how organisational decision-makers in the cold supply chain industry perceive and respond to ethical challenges during the prospective adoption of drone technologies. To support this inquiry, the study employed a two-pronged methodological approach. First, a scoping literature review was conducted to systematically map the conceptual landscape surrounding drone technology, cold supply chain logistics, and technoethical considerations. This approach provided a structured synthesis of existing knowledge and helped identify key themes and gaps relevant to the ethical deployment of drones. Second, primary data were collected through an interpretivist qualitative design, consisting of semi-structured interviews with a purposefully selected sample of 25 industry professionals representing strategic, operational, technical, and compliance domains. Participants were drawn from a diverse range of organisations across the Western Cape, and fieldwork was extended across multiple timelines to maximise contextual richness. This design enabled triangulation across organisational types and decision-making tiers, yielding a multidimensional ethical analysis that was both theoretically informed and empirically grounded. The study culminates in the development of a scalable, context-sensitive ethical decision-making framework, rooted in technoethics, to assist organisations in navigating the normative complexities of drone integration. This contribution enriches ongoing academic discourse in technoethics and provides practical value to industry stakeholders seeking to implement emerging technologies responsibly.

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1 A cold chain is a specific part of the supply chain that deals with the movement and distribution of temperature-sensitive products. These include perishable foods such as fruits and vegetables, meat, dairy products and other foodstuffs that require low temperatures to prevent the growth of harmful micro-organisms. The industry consists of components such as temperature monitoring, packaging considerations, specialised shipping and unique storage (Steyn, 2024)

2 Supply chain logistics have three main components: First mile, middle mile, and last mile. These are the parts that require delivering goods to the final customer. The first mile is the collection of goods from the producers and transport initiation. Middle Mile serves as a connection between the first and last mile. This consists of shipping things from small spokes to the big hubs frequently miles away. The Last Mile is, finally, that final step of getting goods from centers to the end customer (Onro, 2025).

3 These include, but are not limited to, employment displacement in already vulnerable labour markets; the opacity and accountability of algorithmic decision-making; risks of monopolisation by dominant logistics platforms; inequitable access to drone infrastructure; deceptive compliance practices; and the ethical governance of data collected by autonomous systems.

1.2. Background Discussion

Chen, Liao and Yu (2021) asserts that with the improvement of living standards, that the proportion of fresh products in people's daily diet is rapidly increasing. To this end, the authors posit that perishable food items, including vegetables, meat, and vaccinations, necessitate specific handling procedures due to their vulnerability and the risk of food quality deterioration and spoilage. As a result, specialised supply chain systems called cold supply chain, and its logistics ensure the preservation of perishable items during transportation and storage. Bamakan et al. (2021) explicates that a cold chain is a supply chain that keeps products at controlled temperatures. Moreover, that it covers all stages from production to delivery and is a system is used for temperature-sensitive goods to prevent spoilage and maintain quality. Zhang and Mohammad (2024) goes on to assert that the food and cold supply chain is an intricate network of interconnected processes, that play an important role in facilitating food delivery from production to consumption.

However, Chen, Liao and Yu (2021) observed that despite the crucial role of the cold supply chain, that are frequent encounters and obstacles that lead to huge losses of perishable goods. Rodriguez (2018) adds to this, highlighting that the complexity of transporting frozen produce for order fulfilment is a risk to food spoilage and loss of revenue. The findings of Morris (2021) expounds on this, highlighting how any interruption to the cold storage of fresh or frozen food leads to problems such as spoilage and wastage. Moreover, changes in the appearance, taste, or smell of a product can result in the growth of harmful bacteria, making the prevention of any interruption during the cold supply chain delivery process imperative. Other forms of cold supply chain issues were revealed by Ashok (2017) who observed that the current cold supply chain systems are unable to assure the availability of safe and potent vaccines during medical deliveries. This affirms the findings of Chen, Liao and Yu (2021) that fresh products are difficult to keep fresh at room temperature, while Maersk (2022) observed how the shift in consumer purchasing behaviour has prompted suppliers to deliver fresh and frozen produce directly to retail stores. The author goes on to attribute online shopping as the main driver for this shift, thus leading to an increased demand for fresh and frozen consumables.

To this end, Rodriguez (2018) argues for a digital intervention with advanced technologies that can address the demands of the modern-day supply chain and logistics challenges. Bányai *et. al.* (2018) affirms this notion in their observation of the significant impact of emerging technologies on the integration of products, customers, production, and service companies within the supply chain and logistics industries. Thus, through digitisation efforts, drone technology emerges as an efficient, flexible, and customer-focused solution that advances smart logistics and warehousing practices. A drone is a remote or autonomously operated technological platform equipped with sensing, imaging, and delivery capabilities designed for a range of commercial and logistical applications (Wang, Zhou, Xing, Li, & Yang, 2023). Within the cold supply chain, drone technology is increasingly explored as a solution for enhancing the speed, accuracy, and traceability of temperature-sensitive deliveries, helping to reduce spoilage and optimise last-mile logistics (Jahani, 2024). This claim is supported by Chen, Liao and Yu (2021) who holds that low-carbon economy is the new tendency of economy development, which is an emerging pathway toward sustainable development of cold chain logistics.[4] Moreover, the findings of Canon (2023) revealed that the supply chain and logistics industries within South Africa stand to benefit significantly from the commercial application of drone technology.

However, Malinga (2023) observed that within South Africa, the use of drones mainly encompasses the use of UAV[5] drones, being mainly used for non-revenue generating commercial activities such as mapping, inspection, disaster management, and surveying to organisations specialising in a wide range of industries including mining,

4 The study by Chen, Liao and Yu (2021) is based on the proposition for a cold chain logistics routing plan for from the distribution centre to front warehouses.

5 The lingo attached to UAV's are unmanned aircraft systems (UAS), unmanned aerial vehicles (UAV), or remotely piloted aircraft systems (RPAS) (Bányai, Illés, & Bányai, 2018).

critical infrastructure, security and agriculture. This empirical evidence indicates that the full commercial potential of drones have not been harnessed within South Africa[6]. While drone technology has been proven to enhance delivery efficiency, reduce costs and optimise supply chain operations globally, the widespread adoption of this emerging technology for commercial use within South Africa remains constrained. These constraints have been identified at the SA Innovation Sumit (2022) as regulatory barriers, limited government support, economic factors and fragmented stakeholder relationships. Given the need for the commercial benefits of drone technology, the current restrictive legislative environment has prompted calls across several commercial industries for the relaxation of the stated drone constraining factors. Notably, leading industry reports,[7] the global drone market size is forecasted to reach US$54.6 billion by 2030, with the commercial market growing at a 7.7% CAGR[8]. Moreover, several reports including industry reports from Verified Market Research® (2025), published in 2025 forecasts that the Middle East and Africa (MEA) is anticipated to grow fastest. For South Africa, the commercial use of drones remains in a nascent state despite being the first country to pioneer drone regulations in 2015 (Schlub, 2021). Despite this, the only strides made since then have been amendments in 2022, which were the inclusion of technical specifications that had no material bearing on the commercial use of drone technology across the economic sectors of South Africa (Mokoena, Daniyan, Mpofu, & Abisuga, 2022). To frame the concept of the "commercial use" of drone, an internet search yields misaligned definitions to this concept. To this end, amongst the analyses of a plethora of studies and the findings of Quamar *et al.* (2023), the concept of commercial use can be distinguished between Revenue-Generating use of drone and Non-Revenue Generating use of drone.

Notably, the commercial utilisation of drone technology spans a spectrum of commercial uses, with a fundamental distinction arising between its revenue-generating and non-revenue-generating applications. Revenue-generating uses include aerial surveying, mapping for construction, and agricultural monitoring, which directly contribute to operational efficiency and profit growth. In contrast, non-revenue-generating uses, such as hobbyist activities or research, serve purposes beyond financial gain, such as public safety and academic inquiry. Leaning on the findings of Quamar *et al.* (2023), in a profit-centric capacity, drones appear to be strategically positioned as providers of aerial surveying and mapping services to construction enterprises. This strategic offering involves the imposition of fees for the provision of accurate topographical data, a critical component for meticulous project planning within the construction sector. Contrariwise, non-revenue-generating uses of drones include activities driven by non-financial motives, such as recreational drone use for capturing scenic views or university research projects that study wildlife behaviour. Government and public services also deploy drones for tasks like firefighting, wildlife monitoring, and search and rescue operations, prioritizing public safety over profit (Brederode, 2023).

However, study does not focus on the specific regulatory barriers to drone adoption. Instead, the study seeks to explores the central claim that relaxing these constraints may give rise to new ethical challenges. Therefore, the study will aim to examine how ethical decision-making can assist stakeholders in navigating the complexities of drone integration within a more permissive regulatory environment in the cold supply chain industry. To critically appraise the ethical implications of drone-enabled logistics, it is necessary to consider the potential risks that may emerge alongside adoption, and how this impact strategic decision-making. For example, where the use of drones for commercial deliveries solves the call by Rodriguez (2018) for a digital intervention with advanced technologies, the emergence of concerns related to data collection and surveillance will manifest, as drone capabilities may capture environmental, locational, and personal information. This presents ethical challenges related to privacy, consent, and informational autonomy, all of which require careful deliberation by decision-makers. Furthermore, labour displacement emerges as a concern, where automation may threaten to disrupt

6 This includes the cold supply chain of South Africa

7 Reports such as such as Drone industry insights (2023)

8 Compound Annual Growth Rate (CAGR). The compound annual growth rate is the rate of return that would be required for an investment to grow from its beginning balance to its ending balance, assuming the profits were reinvested at the end of each period of the investment's life span (Fernando, 2024).

employment structures and organisational responsibilities. This is evident in the findings of Canon (2023), where it was highlighted how the government of the United Kingdom (U.K.) is actively considering the establishment of drone corridors. The aim of these drone-corridors per the is to optimise supply chain and logistics operations across the various economic sectors of the U.K. The potential benefits of such adoption include cost savings in delivery, reduced carbon emissions, decreased labour costs, and job creation.

Against this background, these emerging dilemmas highlight a broader ethical gap being the lack of structured decision-making that could assist cold supply chain decision makers in navigating the trade-offs between technological innovation, stakeholder rights, and long-term organisational responsibility. In light of this, this study asserts that relaxing the factors that permeates the nascent state of the widespread adoption of drone technology in commercial sectors such as the cold supply chain industry[9], could introduce new ethical challenges related to legal accountability and operational integration. These ethical risks could also emerge through industry pressure, where drone technology has gained widespread adoption within global supply chains and logistics industries (OECD, 2018). In light of the aforementioned discussions and the empirical evidence presented, this study contends that where the current impediments are resolved and restrictions are relaxed, that the potential ethical challenges previously absent in the current environment[10] will emerge in the new environment as a trade-off of issues.[11] As such, it necessitates that this study investigates what potential ethical challenges may emerge in a prospective relaxed regulatory environment, and the critical role of ethical decision-making in navigating such ethical challenges.

1.3. Context of the study and of the Research Problem

Building on the background discussions and the central claim of this study[12], Abubakar *et al.* (2019) argue that decision-making strategies play a crucial role in shaping an organisation's commitment to its values, vision, and mission. These factors ultimately drive its ethical stance within society and the commercial sector. The stance of Abubakar *et al.* (2019) is supported by Varuna (2024), in so far that the author asserts that integrity in logistics entails ethical decision-making, and means making choices guided by moral principles, even under challenging circumstances. Thus, in light of the background discussion, in the context of integrating drone technology, organisations operating within the cold supply chain industry will require a well-defined decision-making strategy that will enable them to navigate ethical challenges effectively. Pereira et al. (2025) expounds on this asserting that within the cold supply chain, key decisions such as inventory planning, delivery configuration, and system responsiveness are made in ways that directly influence ethical outcomes. Therefore, a decision to integrate drone systems, for example will not occur in isolation; but will intersects with broader strategic choices around fulfilment speed, product sensitivity, and service reach. As such, ethical considerations must be embedded within these logistics decisions to ensure that technological advancement aligns with organisational values, stakeholder expectations, and long-term sustainability.

9 Per the factors identified at the SA Innovation Summit (2022) discussed earlier in the background discussion

10 As at 2024, and the assumption that this will permeate through to 2026 based on the current scio-economic conditions and the literature review findings of this study.

11 This claim is based on the slow shift to drone technology within South Africa, where non-revenue commercial exploitation of drones are harnessed by the City of Cape Town's service delivery by drone (Caboz, 2019), and the Western Cape's Health Department's EMS drone rescue project (Tshuma, 2021). Lastly, empirical evidence of a commercial example in this context, is the business case for the planned drone hub to be launched by the Saldanha Bay Industrial Development Zone, facilitated by Wesgro as an administrative partner (Wesgro, 2022). Other examples reported on the w.w.w. is the non-revenue generating use of drone, the findings by Malinga (2023) and Rajput (2022), that reveals that modernisation, urban lifestyle and change in consumption patterns have propelled the growth of the food industry. Furthermore, that this is expected to grow further by 7.9% during 2021-2026. This is set to drive the demand higher for cold chain market in South Africa. Moreover, several studies have observed that major cities such as Gauteng, Cape Town, and Durban are emerging as a hotbed for the cold chain industry, since most of the industrial regions are also located nearby. Thus, as industries across South Africa observe the commercial benefits of Drone use amidst the restrictive conditions impeding the commercial exploitation of drone technology across various economic sectors in South Africa, it can be anticipated that drone technology will become an integral business optimiser, particularly for the operations of the cold supply chain industry within the near future.

12 Relaxing the current regulatory, structural, and economic constraints on drone adoption in South Africa's cold supply chain industry will introduce new, underexplored ethical challenges that must be anticipated and addressed through structured ethical decision-making.

Moving from this premise and in line with the central claim of this study, it will therefore be imperative for organisations to adopt decision-making strategies that addresses both ethical and technical dimensions. In response to this need, the study aimed to develop a conceptual ethical decision-making framework that is anticipated to identify and address potential ethical challenges confronted during ethical decision making, in a more permissive regulatory environment. Given the dual ethical and technological nature of these challenges, technoethics was employed as the central theoretical lens to provide critical insights. Technoethics advocates for greater moral and social responsibility among decision-makers, technologists, and engineers concerning their technological creations (Luppicini, 2009). To this end, technoethics provided this study with a structured approach to addressing the ethical implications revealed through the literature review investigations. Moreover, it also provided a forward-looking framework to assist decision-makers in anticipating and managing the ethical challenges associated with drone technology's integration into the cold supply chain industry. Against this background, to contribute to academic debates on drone ethics and the potential for widespread commercial adoption, this study proposed a conceptual drone-based ethical decision-making framework to guide decision-makers in anticipating, identifying and addressing ethical challenges in a futuristic more permissive regulatory environment.

1.4. Research Problem

Building on the background discussion, notably, while stakeholders across various economic sectors in South Africa advocate for relaxing restrictive regulations to unlock the potential benefits of commercial drone use (SA Innovation Sumit, 2022), it is equally critical to address the ethical concerns that accompany this technological shift. In this regard, balancing the commercial benefits of drones with ethical considerations such as privacy, security, and human rights demands careful, strategic decision-making (Falcon, 2023). It will therefore be incumbent on organisations operating within the cold supply chain industry to pursue innovation but also ensure that their actions align with ethical standards.

Thus, when the economic sectors across South Africa inevitably consider a move toward the commercial use of drones, it will necessitate that ethical principles guide their adoption, deployment, and responsible use. Against this backdrop, the role of ethics in drone technology becomes a matter of choice and is an imperative in circumstantial conditions that would likely give rise to new ethical challenges. These prospective ethical challenges are asserted by this study as a trade-off between the constraints of the old restrictive environment and the opportunities presented by a new, more permissive regulatory landscape. Moreover, these prospective ethical challenges would require decision makers in the cold supply chain industry of South Africa to engage in ethical strategic decision-making to navigate this evolving regulatory environment and harness the commercial benefits of drone technology.

Therefore, the core research problem of this study centres on investigating the prospective ethical challenges that may arise from the adoption of drone technology in the cold supply chain. Moreover, how decision-makers can strategically navigate these challenges through ethical decision-making processes while maximising the commercial benefits of drones. To support this investigation, the study employed a technoethics framework, which provided insight into the moral and social responsibilities associated with drone technology. This framework aimed to offer a structured approach to integrating ethical principles into strategic decision-making, particularly in the context of a more permissive regulatory landscape. Emerging form this research problem, is the following research question, research aim and objectives to structure the investigations of this study as follows:

1.5. Research Question

What ethical decision-making framework can assist decision-makers in the South African cold supply chain industry to navigate prospective ethical challenges, associated with adopting and integrating the commercial benefits of drone technology in a prospective permissive regulatory environment?

1.6. Research Aim

This study aims to identify and analyse the potential ethical challenges that are likely to arise from relaxing restrictive regulations on harnessing the full commercial benefits of drone within South Africa. Specifically, the investigations of this study will focus on how a decision maker within the cold supply chain industry can navigate ethical challenges associated with drone-based decisions in a new and more permissive regulatory environment.

1.7. Research Objectives

RO1: Identify and evaluate the critical ethical considerations that must be addressed by decision makers when confronted with ethical challenges in the new and more permissive regulatory environment.

RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework, to address ethical challenges encountered.

RO3: Determine how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.

1.8. Significance and Contributions of the study

This study addresses a critical gap in understanding the ethical implications of drone adoption and integration within the cold supply chain in South Africa. Evidently, Hause (2024) argues that while drones reduces the risk of collateral damage owing to its own reconnaissance, it is important to note that there are questions of legality, strategy, and ethics that must be answered. Additionally, Kisters (2023) asserts that the ethical concerns surrounding drone technology are complex, considering the socio-economic impact, job displacement, well-being of society as ethical considerations that needs to be balanced against the benefits of innovation by drones and its technology.

The arguments presented by Hause (2024) and Kisters (2023) highlight the need for this study, and its contribution to ethical approaches to decision-making associated with the adoption and use of drone technology, regardless of the industry. Furthermore, this study is crucial as its contribution to the cold supply chain industry, especially considering South Africa's socio-economic, political, and labour landscapes which poses inherent risks as emphasised in the background discussions. Thus, while stakeholders advocate for relaxing restrictive regulations to unlock the potential of drone technology, it is essential to balance innovation with ethical responsibilities such as privacy, security, and job preservation. In light of this, it necessitates proposing a conceptual ethical decision-making framework grounded in technoethics, as a contribution to both the academic discourse and the practical application of drone technology in the context of this study. This is in addition to the following contributions made by this study:

1.8.1. Contribution to Academic Knowledge and Theory

In the realm of academic knowledge, this study makes a significant contribution by expanding the theoretical foundations of technoethics within the context of 4IR technologies, particularly drone technology. The proposed framework provides a structured method for understanding and addressing ethical challenges, offering insights into how decision-makers should approach the adoption of advanced technologies in a responsible manner. This study advances current debates on the ethical use of drones by addressing industry-specific concerns, such as operational efficiency and societal impact, and linking these to broader technoethical principles. Thus, it enriches the literature on ethical decision-making in emerging technologies, filling a notable gap in discussions around drone technology in the context of logistics and supply chain management.

1.8.2. Contribution to Industry Practice

This study contributes to industry practice by providing a scalable ethical decision-making framework tailored to the specific needs of the cold supply chain. This framework was envisaged to assist industry leaders to navigate the complex ethical landscape of integrating drone technology, ensuring that innovation is balanced with ethical considerations such as privacy, security, and societal well-being. In the event that the regulatory environment becomes more permissive, the framework offers practical guidance on how to maintain responsible drone use, mitigating potential risks while harnessing the technology's commercial benefits. This contribution is crucial in promoting sustainable, ethical drone-based practices across various industries.

1.8.3. Contribution to Broader Economic Sectors

The findings of this study had implications that extended beyond the cold supply chain to other economic sectors in South Africa. By proposing a flexible, scalable framework, the study provided a model that can be adapted to different industries where drone technology is expected to play a transformative role. The framework promoted a responsible, ethics-driven approach to integrating advanced technologies in sectors such as agriculture, mining, and security, with the objective pf helping to ensure that technological innovation does not come at the expense of societal values. This cross-sector relevance highlights the broader significance of the study and its utility in fostering responsible adoption of 4IR technologies such as drone technology across South Africa's economic landscape.

1.8.4. Contribution to Government Policy and Regulation

This study also makes a meaningful contribution to government policy and regulation by providing insights that can inform the development of ethical guidelines for drone use. The proposed ethical decision-making framework offers a basis for policymakers to craft regulations that align with both innovation and ethical principles, ensuring that the potential benefits of drone technology are realised without compromising societal values. The findings of this study, highlighting the importance of balancing innovation with privacy, security, and job preservation allows this study to contribute to a robust and ethically grounded policy frameworks. This ensures that decision-makers in both the private and public sectors can make informed, ethically responsible choices as they adopt and integrate drone technology.

1.9. Delimitations of the study

The delimitations of the study was informed by the framework provided of Miles (2017), who argued that delimitations help narrow the focus of a study, shape its design, define the population, and clarify what would not be addressed. These delimitations were essential to ensure that the study was conducted in a feasible and practical manner. Accordingly, the researcher defined the focus of the study as follows:

Temporal Delimitations: This study assumed that, during the timeframe of 2024-2027, the cold supply chain industry would not yet have adopted commercial drone technology in the context of this research. This temporal delimitation provided a basis for evaluating the state of the industry as of 2024 and allowed for an assessment of the prospective impact of drone-based decision-making related to future adoption and integration.

Sectoral focus delimitations: The study primarily focused on the cold supply chain industry of South Africa, a sector facing challenges that could benefit from the integration of drone technology, particularly given the country's ongoing economic crisis. The cold supply chain served as a practical model, offering strategic insights that could be applied to other industries and serve as a blueprint for broader industrial decision-making processes.

Research setting delimitations: The study was conducted within organizations operating in the cold supply chain and logistics industries located in the Western Cape of South Africa. Although the researcher acknowledged potential limitations in representativeness, the selection of the Western Cape was validated by a United States investor report (2022), which indicated that a significant portion of cold supply chain companies were based in KwaZulu Natal and the Western Cape.

Research scope delimitation: To maintain a focused research scope, this study exclusively investigated the prospective ethical challenges that could arise during the adoption of drone technology. This approach allowed for an in-depth exploration of the decision-making processes, challenges, and benefits related to the integration of both basic and advanced drone technologies in the cold supply chain industry.

The study did not explore general perspectives of drone adoption, legal aspects, regulatory policies, or the broader economic impact of adopting drone technology within South Africa's cold supply chain. These areas were excluded to keep the scope manageable and to provide a foundation for future studies. Thus, maintain a focus on ethical challenges allowed for a contribution to a continuous and evolving research agenda in the field of drone technology.

Empirical and Methodological delimitation : The study employed a single-phase qualitative fieldwork design focusing on a representative research sample population of 25 strategically positioned decision-makers across four organisational domains (strategic, operational, technical, and compliance roles). Participants were drawn from multiple organisations and accessed over a six-month period, to ensure both temporal depth and organisational diversity. While the fieldwork was conducted as a single empirical phase, it incorporated role-based, cross-functional, and institutional triangulation consistent with the standards of qualitative doctoral research. This empirical design was not intended to generalise findings statistically, but rather to extract context-specific, ethically informed insights from individuals responsible for shaping drone adoption decisions. In addition to this, the methodology supporting the study, to the inclusion of the sample size and fieldwork strategy, was rigorously reviewed and approved during the formal doctoral proposal defence process. This key academic quality gate approved a sample size of 25 participants and was also accepted by the doctoral review committee and ethical clearance board. This delimitation therefore reflects a strategic, theory-aligned, and epistemologically appropriate design boundary in line with international norms in qualitative doctoral work.

1.10. Orientation of the study

Chapter 1: <u>Introduction</u>
This chapter provided the introductory section of the study, offering a contextual understanding of the research. It began by situating the study within its broader context and delving into the background that set the stage for outlining the research problem, aims, and objectives. Furthermore, this chapter served as a roadmap for the reader, offering an overview of the study's purpose and previewing the subsequent chapters.

Chapter 2: <u>Literature Review</u>
The literature review was structured into three parts, guided by the research objectives. Part one explored the concept of drone technology, including its architectural components, followed by an examination of the ethical challenges posed by drones. Part two interrogated the ethical considerations involved in drone use, with a focus on how the principles of technoethics can guide ethical decision-making. Finally, the chapter concluded by outlining the theoretical framework that informed the research methodology and subsequent primary data collection and analysis.

Chapter 3: Research Methodology

This chapter outlined the research approach, design, and rationale for selecting the chosen methodology. It defined the research population and sample, clarifying the unit of analysis derived from the theoretical framework. Additionally, this chapter detailed the data collection methods, instruments, and procedures, offering a comprehensive overview of how the study was conducted.

Chapter 4: Presentation of Results

This chapter presented the research findings in a structured manner. The results were reported in line with the execution of the study, and the findings were summarized to provide a clear understanding of the empirical outcomes. The chapter concluded with a synthesis of the results, setting the stage for the discussion in the following chapter.

Chapter 5: Discussion of Results

This chapter critically analysed the results in the context of the study and the literature explored in earlier chapters. It linked the findings to the research objectives and provided answers to the research questions. Furthermore, the chapter interpreted the practical implications of the study, offering insights for the cold supply chain industry and future academic research.

Chapter 6: Conclusion and Recommendations

In this final chapter, the study concluded by summarising key findings and providing answers to the research questions. Recommendations were made based on the findings, and avenues for future research were suggested, encouraging further exploration of the ethical dimensions of commercial drone use in a changing regulatory landscape.

1.11. Conclusion

This chapter introduced the central research question, aims, and objectives of the study. From the background discussions, emerged the central claim of the study that relaxing restrictions on the commercial use of drones will likely lead to new ethical challenges. Therefore, this study aimed to identify these challenges and to develop a conceptual framework for ethical decision-making to help navigate ethical challenges during decision making. Furthermore, chapter one also highlighted gaps in current research, particularly regarding ethical concerns in the cold supply chain. To this end chapter two will review existing literature on the ethical implications of drone technology and technoethics, to provide a foundation for developing the proposed ethical decision-making framework. Moreover, chapter two will also offer a theoretical framework to inform the methodology of the study, and to guide the data collection process for insight into the perspective of strategic decision makers operating with the cold supply chain of South Africa.

CHAPTER TWO: LITERATURE REVIEW

2.1. Chapter Overview and Introduction

Snyder (2019) posits that a well-conducted review of literature within a research study forms a solid foundation for knowledge advancement and theory development. Samuel (2023) further supports this by noting that literature reviews map the research landscape, identify gaps, and frame future research. The insights from Snyder (2019) and Samuel (2023) were essential to the research objectives of this study. However, Snyder (2019) also cautions against flawed assumptions and selective use of evidence in literature reviews. The author posits that this can lead to unreliable findings if sources lack valid methodologies. Given the novelty of drone research that is ongoing within academia and debates and at many forums such as the World Economic Forum,[13] it necessitated that this study employ a rigorous literature review methodology. Thus, a scoping literature review methodology was employed to synthesise evidence supported by a range of guidance on concept definitions, conduct, reporting and that could support the review of varied evidence sources (Alexander, et al., 2024). Moreover, the scoping review was employed in response to the risk raised by Snyder (2019).

Moving from this premise, Munn *et al.* (2018) explicates that scoping reviews[14] serve as a valuable tool for delineating the extent and content of existing literature related to a specific subject. Moreover, scoping reviews are valuable for examining emerging evidence and offering a comprehensive overview of existing literature when targeted questions for systematic reviews are not yet defined. This approach was particularly suitable for this study, given that drone technology is both emerging and nascent within South Africa. In light of this, where the researcher reviewed alternative literature review methodologies such as narrative reviews, traditional literature reviews, and rapid reviews were found to lack depth, rigor, and a systematic approach necessary for the research objectives of this study.

Thus, a scoping literature review methodology was therefore particularly beneficial for addressing the research objectives, which involved identifying and evaluating critical ethical considerations (RO1), examining best practices (RO2), and developing a scalable monitoring and evaluation tool (RO3). In addition to the frame that the research objectives provided for the literature review investigations, the researcher further demarcated the literature review into two parts, each with its specific scope of investigations. The demonstratable benefits of the scoping review methodology employed by this study, was supported by Xue *et al.* (2024), that a scoping review methodology has the ability to synthesise emerging evidence, provide a comprehensive overview of the context of the phenomena under investigation and identify and analyse gaps in relevant literature on a specific topic. Moreover, scoping reviews has the ability to answer board research questions that are current.

To assist with the execution of the search strategy for valid and reputable literature, Kelly *et al.* (2024) assisted the researcher in the selection of an appropriate methodological approach. Premised on the postulation of Paré and Kitsiou (2017), the authors posited that the consultation of the main literature sources and types of evidence available, as well as the extent, range and nature of research activity can act as a knowledge translation component to the review. From here, the scoping literature review methodology created a higher order for evidence collected during the literature review of the study. This ensured that the literature review transcended

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13 Conference delegates argued the several benefits to using drones over bikes or vans. The first was their ability to reach inaccessible geographical locations. The second was that they could be used as a means of communication and data collection for tracking vulnerable populations and they offered the potential of reverse logistics. However, it was also argued that the advantages and risks of drones, as well as the legal and ethical norms that needs to be established. It was concluded that the implementation of 4IR technologies such as drones requires a collective effort from multiple stakeholders, including governments, the private sector, civil society organisations and communities (Santhanam, Gupta, & HP, 2023)

14 That a scoping review is generally conducted to examine the extent, range and nature of research activities in a particular area, and to identify research gaps in the extant literature.

beyond simply summarising the findings of consulted literature review sources but also formed an implicit alignment with the exploratory nature of the research question.

To search and review appropriate literature, it necessitated that a search strategy be employed. For this study, the researcher formulated Appendix A as the search strategy protocols to ensure the credibility, validity and trustworthiness of the literature sources. Guided by the objectives of the study, the literature review adhered to strict inclusion and exclusion criteria that considered literature in both English and Afrikaans. The strategic approach to the literature review and search strategy was thus logically structured using the core criteria being Quality of the study, the Usability of the findings, the Extent of the literature and the Scope of the literature in alignment to the context of this study. This protocol was therefore as follows:

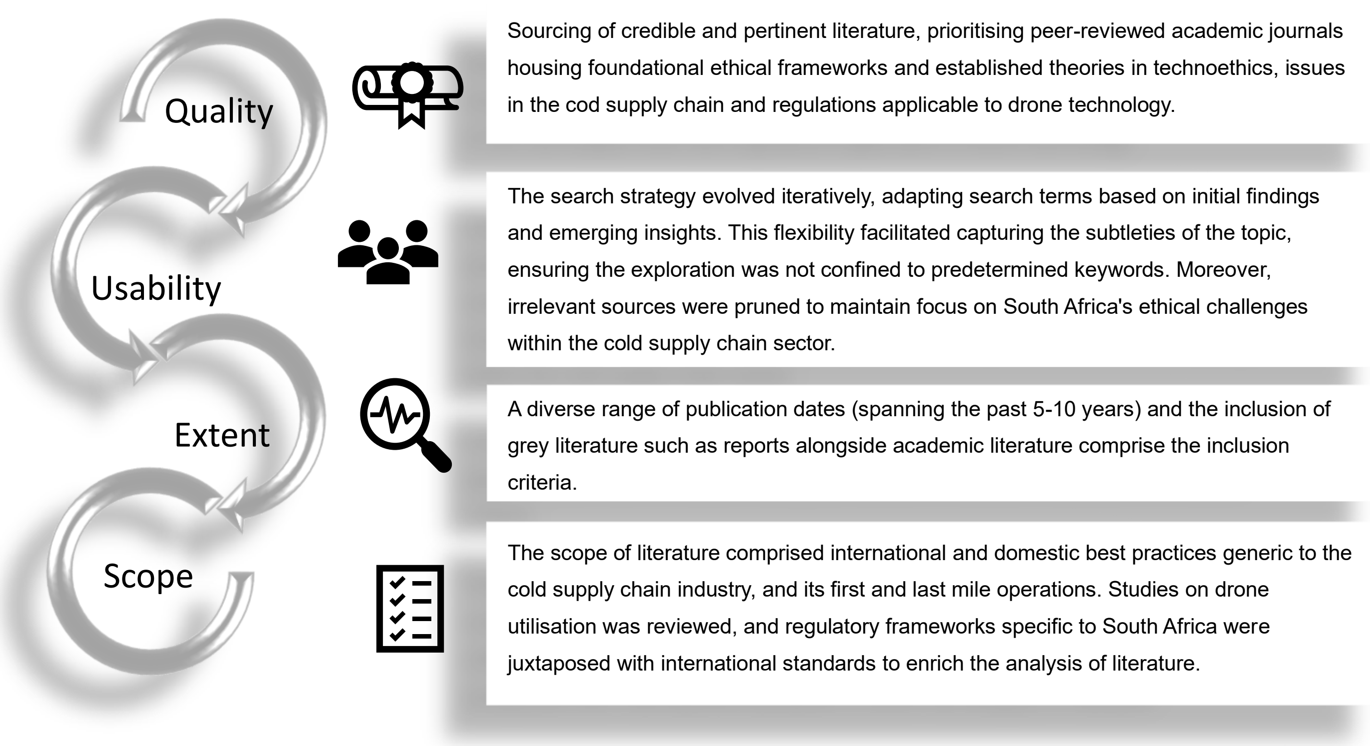

Figure 1 Literature review search strategy logic of the study

In addition to this logical search strategy protocol and, the literature review investigations were demarcated into two distinct parts, each contributing to o provide a clear structure for investigating the ethical considerations surrounding drone technology in the cold supply chain industry as follows:

Part One

Objective: The objective of Part One was to establish a foundational understanding of drone technology by examining its architectural and technological nature. This directly aligns with Research Objective 1 (RO1), which seeks to identify critical ethical considerations. Additionally, this part of the literature review investigated the potential applications of drones within the cold supply chain industry, along with the challenges that may emerge from their integration, thereby addressing Research Objective 2 (RO2) by identifying best practices and challenges for drone adoption. The investigation emphasised the prospective nature of the study, focusing on emerging trends in drone use.

Approach: The investigations in this part of the literature review leveraged the theoretical lenses of cognitive constructivism or alternatively structuralism[15], to examine the potential ethical challenges associated with the commercial use of drones within a more permissive regulatory environment. This approach provided a theoretical foundation for analysing drone technology, helping to fulfil Research Objective 1 (RO1), which is concerned with identifying ethical challenges. To organize the investigations, the researcher segmented the study into three parts:

Segment A: An overarching examination of drones, focusing on their architecture, technological nature, dependencies, and associated technologies. This addressed the need for a comprehensive understanding of drone technology, as required for RO1.

Segment B: Examination of the prospective application of drones within the cold supply chain industry of South Africa, aligned with RO2's focus on practical applications and best practices.

Segment C: Investigation of the potential challenges associated with drone adoption in the cold supply chain, with a specific focus on how these challenges might introduce ethical concerns, contributing to RO1's exploration of ethical challenges.

Part Two

Objective: The objective of Part Two was to explore the strategic implications of adopting drone technology in the cold supply chain industry. This objective was aligned with Research Objective 3 (RO3), which aimed to develop a scalable monitoring and evaluation tool for decision-makers. By understanding these strategic implications, the study intended to guide industry leaders in navigating the ethical complexities of drone adoption.

Approach: The investigations in Part Two built upon the challenges identified in Part One, focusing on the ethical implications arising from these challenges. This was directly aligned with RO1's goal of identifying ethical considerations and RO3's goal of developing an ethical decision-making framework. To achieve this, the following process was used:

- Firstly, the researcher established an ethical evaluation framework using Normative, Applied, and Meta-ethics to support the technoethics theoretical lens. This process helped identify the ethical implications and considerations emerging from the challenges found in Part One, aligning with RO1.
- Subsequently, the researcher then explored these ethical considerations within the context of drone-based ethical decision-making, addressing the core aim of RO3, which is to create a structured framework for ethical decision-making in this evolving technological landscape.

To ensure the rigor of the literature review and substantiate the central claim of this study, the Toulmin and Rogerian models of argumentation were leveraged to serve as rhetorical tools. These tools were employed to structure and analyse the ethical disagreements and stakeholder conflicts that the literature review may identify

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15 Cognitive Constructivism or alternatively Structuralism, is an intellectual tendency that seeks to understand and explain social reality in terms of social structures. Structures are defined as the patterns and forms of social relations and combinations among a set of constituent social elements or component parts such as positions, units, levels, regions and locations, and social formations. Structuralism tends to proceed on two different analytic levels, as a method of analysis or procedure of knowing (epistemology), and as an ontology or metaphysical design of social reality. It also tends to approach its subject matter under the auspices of two different meta-theoretical perspectives on social reality: social structure as an empirical and historical reality, and social structure as a model or representation of reality (Heydebrand, 2002).

during the decision-making process when adopting drone technologies. To this end, the researcher employed a combination of Toulmin's argumentation model and the Rogerian argument model, alongside the scoping literature review methodology. Kurtz (2017) defines the Toulmin's argumentative model as a systematic process aimed at justifying specific statements, concentrating solely on the substantiation thereof. However, the complexities of human cognition emerge when faced with the necessity to acknowledge the validity of opposing viewpoints. Humans, due to their inherent complexity, often vehemently oppose a particular stance only to undergo a transformation in perspective when presented with compelling evidence. Therefore, while emotions may initiate arguments, the introduction of logical evidence capable of challenging the position of the argument can evoke a significant internal quandary, compelling a meticulous re-evaluation of convictions.

In terms of the Rogerian model, this method adopts an approach that scrutinises counterarguments that is not an outright opposition, but as potential augments or concessions. Unlike conventional argumentative structures such as the "Classical Argument Model"[16], the Rogerian method abjures sequential stages. This approach encourages constructive engagement with opposing viewpoints, facilitating a balanced understanding of the issue at hand. When employed in argumentation, the Rogerian method facilitates a constructive dialogue on an issue by examining counterarguments that emerge (Kurtz, 2017).

Within the context of this study, the Toulmin and Rogerian argumentation models were employed to provide a robust methodological framework for evaluating the ethical considerations associated with drone technology in the cold supply chain industry. The justification for employing Toulmin's model was located in its ability to structure complex arguments systematically, ensuring that claims were substantiated by strong evidence and logical reasoning. Given the emergent and controversial nature of drone technology, Toulmin's model was particularly valuable for organising and presenting the ethical justifications identified in the literature. This model enabled the researcher to break down the arguments for and against the commercial use of drones into clear components, claims, grounds, warrants, and backing thereby providing a logical foundation for the study's ethical decision-making framework. Furthermore, Toulmin's model was crucial in addressing the research objectives, particularly in identifying and evaluating the critical ethical challenges (RO1).

In relation to the use of the Rogerian argumentation model, this model was integrated to ensure that the study examined the dominant ethical positions and also actively considered counterarguments and alternative viewpoints. This model was particularly well-suited to the literature review since its focus was on building consensus and resolving conflicts between opposing perspectives. In the context of the cold supply chain industry, where stakeholders may have conflicting views on the ethical implications of drone technology, the Rogerian model facilitated a constructive dialogue. This approach ensured that the study did not merely present one-sided arguments, but instead incorporated a range of perspectives on the best practices and potential risks of drone adoption. Thus, the use of the Rogerian model was instrumental in addressing Research Objective 2 (RO2), which involved examining best practices for the ethical use of drones.

Employing both Toulmin's and Rogerian models assisted the literature review to achieve greater depth and coherence. Toulmin's model provided the logical structure for justifying the ethical considerations identified, while the Rogerian model ensured that differing perspectives were fully integrated into the analysis. Together, these models supported a thorough and balanced evaluation of the ethical considerations and best practices associated with the commercial use of drones in South Africa's cold supply chain industry.

16 This model foster a goal, that as a writer (or orator), the goal is to persuade your audience to adopt your side of the issue (Kurtz, 2017).

2.2. PART ONE: A CONCEPTUAL INTRODUCTION TO DRONE TECHNOLOGY

2.2.1. Introduction

To initiate this part of the literature review investigations, it necessitated that an understanding of the nature of drone technology was delved into. This involved an overview of the classification of drone types, a high-level understanding of its architectural[17] composition, and the potential benefits and drawbacks within the cold supply chain industry. To achieve this, the investigations will be underpinned by the principles of structuralism to operationalise the investigation into the practical and structural dimensions inherent in drone.

Against this backdrop, this part of the literature review discussions will be structured in three parts. Segment A will delve into a high-level architectural understanding of drone and its associated technologies. Segment B will examine the prospective application of drone within the cold supply chain industry of South Africa. This examination will pave the way for Segment C, where the literature review will investigate the potential challenges associated with drone, that may potentially be introduced into an organisation operating within the cold supply chain industry of South Africa.

2.2.2. Segment A: Establishing a Foundational Framework for Understanding Drone Technology

The origins of drones can be traced back to the pioneering work of Nikola Tesla[18], the inventor of the first known drone-like device as early as 1898. Since this groundbreaking invention, drones have undergone a remarkable evolution, manifesting as invaluable infrastructures and aid across various economic and industrial domains. In present times, a drone[19] and its enabling technologies was initially only available for military applications. This has evolved into versatile platforms, suitable for a wide range of sensing, payload and transportation purposes (Strawbridge, 2022). Furthermore, drones have diversified into distinct categories, namely: Unmanned Aerial Vehicles (UAV) designed for both local and aeronautical skies; Unmanned Ground Vehicles (UGV) designed for terrestrial operations; and, Unmanned Underwater Vehicles (UUV), commonly referred to as an underwater drone. However, drones are more than just unmanned vehicles as expounded by Strawbridge (2022). This is imperative to note since the visual dimension of drone perception has very much dominated the perceptions of drones and how it is reconfigured the human sensorium (Agostinho & Maurer, 2020). To contextualise the distinction between different types of drones and their dual uses, this literature review summarises the following classification of drones based on an extensive body of literature:

2.2.2.1. Drone Classifications

To provide an overview of the realm of drones and their evolution into diverse platforms, the researcher categorized the literature into two main groups: Unmanned Vehicles and Autonomous Robotic Systems and Sensory-Driven Drones. These categories encompass key classifications, including unmanned vehicles that operate autonomously or remotely, and other drones such as ground-level robots that are primarily sensory driven. Understanding these classifications is essential for grasping the full range of drone applications across various industries, from aerial surveying to underwater exploration and beyond.

i. Category One: Unmanned Vehicles

17 As stated in the delimitations of the study, the study will not delve into the detailed technical discussions surrounding the technology and structural composition of drones, but rather aim to provide a summary overview of the architectural overview.

18 Tesla's noteworthy innovation laid the foundational principles for a myriad of subsequent devices, inter alia: garage door openers, fax machines, remote controls for televisions, stereos, and toy cars. Additionally, Tesla's pioneering work has been instrumental in the development of unmanned military Drones, which have found its application in battlefield reconnaissance missions and even in satellites operating within the expanse of outer space (Palmer, 2009).

19 Drones is an acronym for "Dynamically Remotely Operated Vehicles" (Kant et.al., 2019) In the subsequent part two of this scoping literature review, it will be demonstrated how crucial it is for professionals and researchers in this field to grasp the naming conventions and terms that are associated with Drones, as they play a fundamental role in shaping the discourse and understanding within the domain of Drone technology.

a) Unmanned Aerial Vehicles (UAV)

Unmanned Aerial Vehicles (UAV's) are aerial robots that function in conjunction with a Global Positioning System (GPS). These drones can be operated using a remote control or console termed a Remotely Piloted System (RPS). Alternatively, these drones are able to function autonomously via software-driven flight plans, algorithms and control systems that are embedded within their systems. UAV's have emerged as a pivotal and popular technology in remote sensing, finding its application across a diverse spectrum of domains and industries (Nexa, et al., 2022). An example of this is drones for recreational purposes. A recreational drone are interchangeably referred to as small remotely operated drone or a drone with autonomous capability. Generally, these drones are used for enjoyment and not for commercial purposes, or for compensation (Antunes, 2020) as expounded in the background discussions. This drone category serves various purposes, such as capturing breathtaking aerial photography, wildlife observation, engaging in racing or acrobatics, or simply enjoying the experience of flying a drone. Their ease of use, affordability, and lightweight design make them accessible to beginners and hobbyists[20]. However, they are highly susceptible to damage as a result of their lightweight build and lack specialised features[21]. Therefore, these drones are not suitable for commercial use, owing to its limited flight ranges and a range of limited advanced features (GrindDrone, 2023) not found in commercial drones.

b) Unmanned Ground Vehicles (UGV)

Unmanned Ground Vehicles (UGV) are robotic entities deployed to augment human capabilities in both civil and military industrial domains. These drone types find utility in open terrains, serving as substitutes for human involvement in a range of perilous activities *inter alia*, handling explosives, bomb defusal, and front-line reconnaissance missions (Sathiyanarayanan, 2011)[22]. Equipped with an array of sensors, UGV's monitor their environment, facilitating autonomous decision-making or relaying sensory information to remote human operators via its RPS. Thus, these transactions involve intricate and resource-intensive techniques, thereby necessitating high-bandwidth communication channels and complex hardware (Biswas et.al., 2018). An example of this is a space drone. Space drones as expounded by Fathima (2017) is a drone that can operate within the vacuum of outer space, representing a departure from terrestrial drone that rely on propellers. This distinction arises from the impracticability of employing conventional propulsion systems, as used in common-use UAV's and Commercial drone applications. Due to the absence of an atmosphere, the operational duties executed by space drones exhibit notable similarities with Unmanned Ground Vehicles (UGVs), akin to NASA's rovers. These drones enable the acquisition of samples through the utilisation of diverse tools that are underpinned by advanced 4IR technologies, rendering them adaptable to address the evolving research requirements of scientists in the unique and challenging environment of outer space.

c) Unmanned Underwater Vehicles (UUV)

Allard (2014) delineates Unmanned Underwater Vehicles (UUV) as a category of drones designed for underwater operations, comprising two distinctive subtypes. The first is Remotely Operated Vehicles (ROV's)[23], which are under direct human control, while the second category encompasses Autonomous Underwater Vehicles (AUV's), which function independently without continuous human intervention. The author goes on to clarify that AUV's represent the more intricate category as they necessitate autonomous functionality due to the inherent limitations of radio-frequency transmission underwater. This autonomy is essential for navigating in environments where acoustic communication is constrained by bandwidth limitations and although more costly, offer unparalleled capabilities and applications.

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20 Recreational drones offer several advantages, including ease of maintenance due to their simple construction, user-friendliness with uncomplicated controls, portability facilitated by their lightweight design, and the capacity to capture high-quality images through optional powerful cameras. Additionally, they are easily deployable, precise, suitable for indoor use, cost-effective, versatile, and enjoyable for users of all levels.

21 These features have limited applications, and are constructed from fragile materials, and typically have restricted flight durations.

22 This literature review has observed that minimal studies are available on drones used within the military.

23 This literature review has observed that minimal studies are available on ROV drones

d) Conceptual Understanding of the Unmanned Vehicle classification

To conceptually understand the context of Unmanned drones, Sihag *et al.* (2023) provides an illustrative example of a UAV drone system and its primary components. These are shared features across the unmanned vehicle drone classifications as shown in figure below.

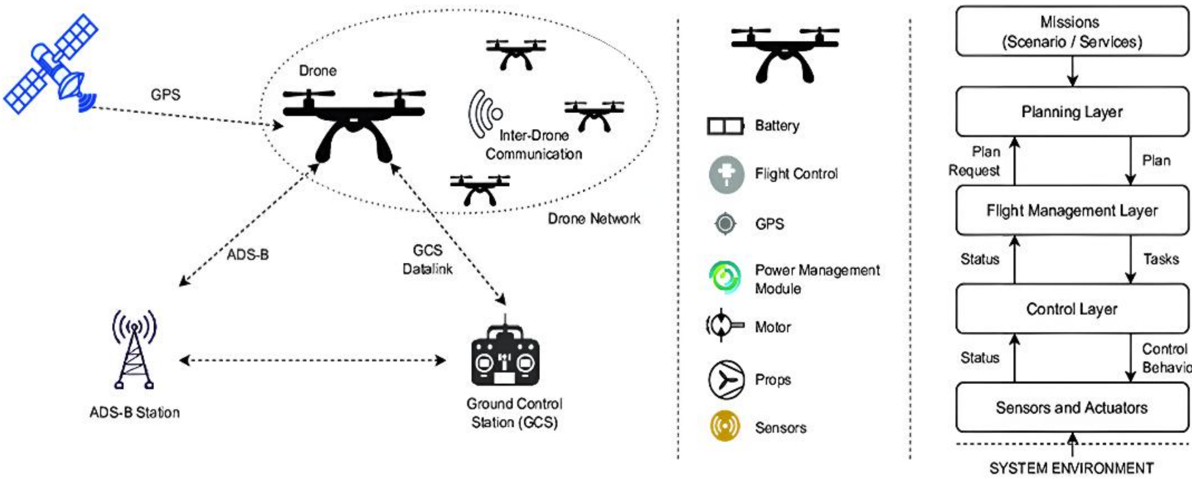

Figure 2 Unmanned Drone system and components

Source: Sihag *et al.* (2023)

In the context of unmanned vehicles, Sihag *et al*. (2023) outlines the essential components that make up the system architecture of a typical unmanned aerial vehicle (UAV) as demonstrated in Figure *2*. The illustration highlights three key elements: the UAV (drone), the Ground Control Station (GCS), and the communication link that connects them. The UAV itself includes crucial subsystems such as a power source, flight control, GPS, and sensors that allow it to autonomously or remotely perform tasks. The GCS provides oversight, sending commands and receiving real-time data through a communication link (ADS-B, GPS, etc.), ensuring seamless coordination between the vehicle and ground operators. This layered system allows UAVs to function effectively and autonomously in various operational environments.

ii. Category Two: Sensory-Driven Drones

Agostinho and Maurer (2020) explains that sensory driven drones, which include Artificial Intelligence (AI) capability, are a medium with a multisensorial interface that connects the different sensorial modes of agents, technologies, environments, infrastructures, machinic systems, data signals, and algorithms. In other words, the drone is representative of “synesthetic media technologies” that combine a plethora of sensing modes to produce multisensory knowledge in human and nonhuman terms. Hartwell (2023) dealinates these drone types into three categories: Automated Guided Vehicles (AGVs); Autonomous Mobile Robot (AMR) and Simultaneous Localisation and Mapping (SLAM) technology. Hartwell (2023) goes on to explain the concept of each as follows:

a) Automated Guided Vehicles (AGVs)

AGVs follow predetermined routes, following magnetic tape, wires, or markers on the floor, similar to railway tracks. But unlike trains, they can adapt to their environment. They use sensors, such as cameras, laser imaging, detection, and ranging (lidar), and ultrasonic time-of-flight (ToF) sensors, to detect objects and avoid collisions.

b) Autonomous Mobile Robot (AMR)

Here, Hartwell (2023) explicates that the concept of a AMRs is an advancement of a AGV. This robot that serves as a sensory dorne has the ability to navigate more complex environments. Unlike AGVs, AMRs are able to adapt to changes in their surroundings, flexibly navigating through the warehouse without colliding with other objects or causing damage.

c) Simultaneous Localisation and Mapping (SLAM) technology

Hartwell (2023) explains that Simultaneous Localisation and Mapping (SLAM) technology is a form of drone technology that enables a ground level robot to navigate and understand their surroundings in real-time without relying solely on GPS. Just as humans use their senses to perceive their environment and avoid obstacles, SLAM allows drones (the robot) to autonomously explore and map their surroundings by combining data from sensors, cameras, and mapping algorithms. This makes the robotic drone capable of navigating through complex environments, where traditional GPS navigation might fail. This diversification highlights the enduring significance of Tesla's early innovations, which laid the foundation for the modern landscape of drone technology and their wide range of applications.

d) Conceptual Understanding of the Unmanned Vehicle classification

Here, Hartwell (2023) explicates that some companies are experimenting with using sensory-driven drones equipped with mapping software to create 3D maps of a warehouse to help optimise its layout, detect out-of-place objects, and improve efficiency. Sensory-driven drones can also collect data such as temperature, humidity, and light levels in a warehouse to maintain ideal conditions for stored products. The author provides a conceptual illustration of the use of sensory driven in harmony with unmanned drones in warehouse logistics as follows:

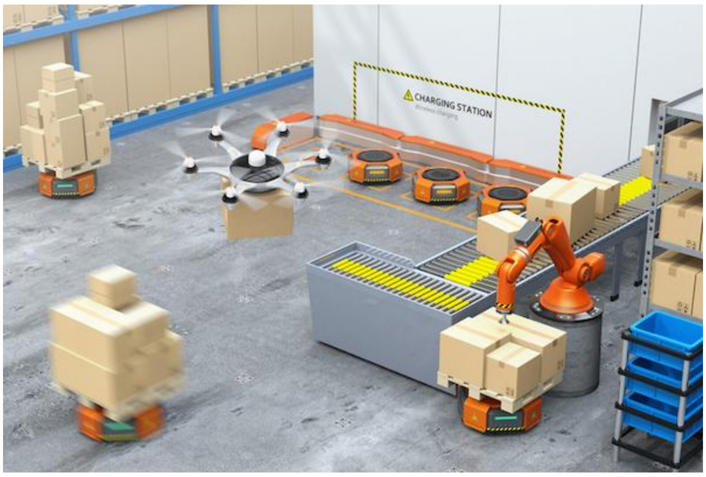

Figure 3 Advanced Robots and Sensory-Driven Drones in a warehouse

Source: Hartwell (2023)

2.2.3. High-level architectural understanding of Drone technology

Building on the classifications and categories of drones, it is important to understand the architectural composition of drone technology. This understanding is crucial to the nature of this study. Drones consist of a complex system of integrated technologies, including propulsion systems[24], flight controllers, and drone-specific firmware and software. These elements work in harmony to ensure the efficient and effective operation of drones, which rely

24 In the case of a remotely operated drones, the controller technology is programmed at a base station to undertake scenario-based decisions which are underpinned to the desired computational logic and rules. In an autonomous drone, the computational rules become the logic off the drone undertakes its autonomous decision-making tasks.

on a range of technological pillars[25] and advanced infrastructure (Dirican, 2015). The seamless collection and transmission of data between these systems is a pivotal aspect of drone functionality, as illustrated by Sihag *et al*. (2023).Key to understanding the architecture of drones is recognising the role of integrated sensory units, which are capable of collecting various types of data such as motion, humidity, sound, temperature, and other sensory inputs (Zemrane, Baddi, & AbderrahimHasbi, 2020). This data is initially captured in analogue format, then converted into digital signals for transmission. The processed data is sent to a Remotely Piloted System (RPS) or directly to the source system in the case of autonomous drones (Corrigan, 2020). The entire process of data transmission, from collection to local or cloud-based processing, highlights the complex architecture that enables effective drone operation.

Against this backdrop, for decision-makers, understanding the architectural intricacies of drones is essential for navigating the complex choices required in the deployment of this technology. A distinction must be made between remotely operated drones and autonomous drones, as each type presents unique challenges and opportunities. To this end, Zemrane et al. (2020) provide an explication of the intricate communication structure that is involved in the architectural underpinning of drones, highlighting their intrinsic interoperability requirements. The architecture[26], although not exhaustively explained within this study, manifests as integral components of a broader technological framework Remotely operated drones rely on technologies such as sensors, cameras, and GPS, while autonomous drones leverage advanced 4IR technologies, requiring more sophisticated programmable languages[27] (Murali, Sriram, Samad, & Saha, 2019). Although both types of drones collect and transmit data, they differ in how they communicate[28] and process information. As such, remotely operated drones rely on control through a ground system, whereas autonomous drones process instructions and transmit data directly.

Therefore, understanding the complexity of drone architecture and its technological composition is critical for appreciating the full potential of drone technology. The adaptability of drones highlights their versatility across various industries, but this versatility is only fully realised when the systems they rely on can interact seamlessly with other technological environments. It is important to highlight, that this functionality is highly dependent on interoperability. Jauregui, (2019) explains that at a high level, interoperability is the ability of two or more components or systems to exchange information and to use the information that has been exchanged. Thus, to achieve interoperability among systems and processes[29], it necessitates that an organisation upgrade or enhance their existing technological estates and business process landscape. This would also require the purchasing of new infrastructure, and that a level of technological development is effected as the interoperability would span across systems and process and therefore can be considered as cross-domain[30] interoperability. This means that for drone technology to be adopted within an organisation operating within the cold supply chain industry of South Africa, that at all levels of interoperability, there would need to be a “connect” of all technologies via each layer that could possibly be interoperable. To this end, the layer of interoperability ensures that drones can communicate efficiently with destination systems and third-party technologies. Achieving such interoperability requires sophisticated layers of integration, where systems are designed to exchange and process information

25 These technological pillars are *inter alia*: internet connectivity, IoT (Internet of Things) technologies, data warehousing, mobile technologies, electronics, nanotechnology, mechatronics, cloud computing

26 The UAV architectural explanation by Zemrane et. al. (2020) has been used to distilled only the common architectural features between remotely operated drones and autonomous drones. The differences from there have been highlighted within the passage.

27 These applications include oceanographic surveys, operations in hazardous environments, underwater structure inspection, military, and civilian applications

28 These advanced technologies include the internet, IOT Technologies, Data Warehousing, Mobile Technologies, Electronics, Nano Technology, Mechatronics, Cloud Computing, AI, advanced Robotics, Algorithm technology and so forth, to the inclusion of any other advanced technologies and advanced technological infrastructure.

29 Drone technology and destination system

30 Cross-domain interoperability is the ability of systems from different domains that requires interaction and information exchange with business process interoperability (BPI), to integrate and communicate with each other via standard well-defined business languages (Larsen, 2022).

across various technological domains without friction. Conceptually, the complexity of the required interoperable layers to enable the communication and signal relay of drones can be conceived using the following illustrative example as follows

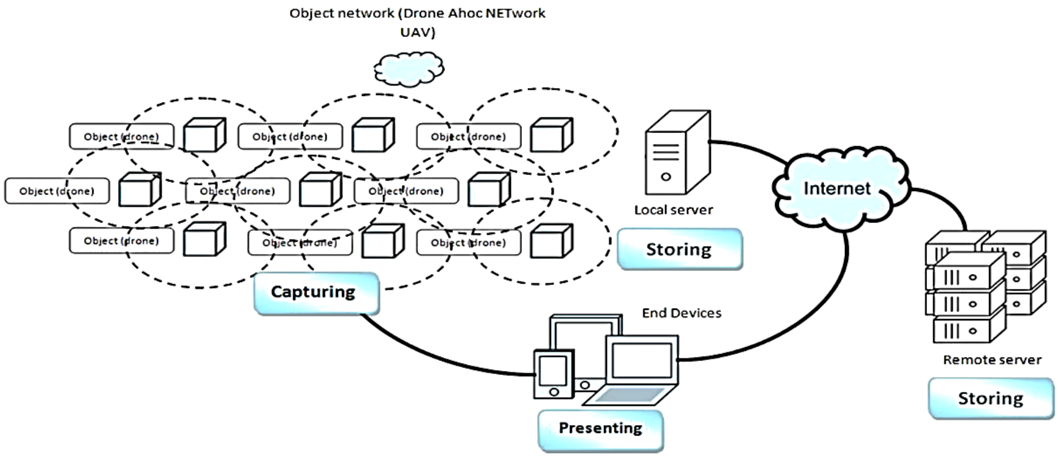

Figure 4 Conceptual Overview of Drone Interoperability

Source: Zemrane *et al.* (2020)

The preceding discussions on the architectural taxonomy of drones and their technological composition highlight the critical importance of understanding and appreciating the complexity of drone technology. Moreover, the adaptability of drones has highlighted their versatility, technological intricacies, and various applications. The complexity of drone communication processes was also emphasised, as well as the need for interoperability, which ensures that drones are compatible with the systems they must interact with. This necessitates sophisticated interoperability between a drone, its destination systems, and any third-party technologies to ensure smooth operation in a technological ecosystem. Against this backdrop, Hosseini, (2016) contends that industry[31] stakeholders must develop and implement technical standards that facilitate seamless exchange of data and information messaging standards. Moving against this premise, and from the conceptual explanations of interoperability, this literature review observes that a demand for automation to meet the complexity of drone technology emerges, as well as a demand in the variation of technologies to meet the demand of interoperability.

Additionally, the literature asserts the importance of decision makers in the cold supply chain industry understanding the distinctions between various types of drones and their architectural makeup. This knowledge is crucial for optimising drone selection based on specific operational needs. For example, understanding automation levels, payload capacities, and operational ranges allows decision makers to choose technologies that meet the unique demands of maintaining temperature-sensitive products while ensuring efficient operations. Furthermore, understanding that seamless interoperability between drones and existing systems is essential for integration and enhanced automation. This understanding of system integration also leads to cost-effectiveness, allowing decision makers to select the most suitable and economically viable drone solutions that align with operational goals without over-investing in unnecessary capabilities.

From this analysis, the importance of regulatory compliance also becomes evident. In this context, decision makers must be aware of varying regulations to avoid legal issues. Additionally, scalability and futureproofing through the integration of advanced technologies also emerge as key considerations. Furthermore, another finding from this analysis is the pressing need for automation to meet the increasing complexity of drone technology, along with the need for varied technologies to meet the requirements of interoperability. This reinforces the responsibility of decision makers to understand the differences in drone architectures, which is

31 Supply and Logistics value chains

crucial for optimising operational efficiency, ensuring cost-effectiveness, complying with regulations, and future-proofing investments, as suggested by Rodriguez (2018) in the background discussions.

2.2.4. Segment B: Exploring the prospective strategic application of Drone technology within the Cold Supply Chain Industry

Building on the background discussions, it is evident that the integration of drone technology[32] presents a transformative opportunity for the cold supply chain and logistics industry, particularly in South Africa. Canon (2023) observed that drones offer a cost-saving model integration of drone technology presents a transformative opportunity for the cold supply chain and logistics industry, particularly in South Africa. Furthermore, the findings of Canon (2023) revealed empirical evidence that suggests that drone-based delivery services can significantly reduce operational costs[33] by eliminating expenses tied to traditional delivery methods, such as labour and transportation overheads. For example, the planned development of drone corridors in the UK offers a glimpse of how drones could streamline logistics, potentially providing similar benefits in South Africa.

From this, it can be inferred that the cold supply chain industry could derive substantial benefits from integrating advanced drone technologies. As Matsiyana (2023) posits, drones equipped with geographic information systems (GIS) and IoT sensors can optimise operations, helping meet customer expectations[34] and address the unique challenges of the cold supply chain. Specifically, these technologies[35] enable the real-time tracking and monitoring of temperature-sensitive goods, ensuring the safe delivery of perishable products such as fresh and frozen foods.

In support of these potential benefits, Sonthalia *et al.* (2022) highlighted several key challenges *inter alia*, temperature related issues, technical difficulties related to the storage of perishable products during delivery, and the time to deliver perishable products. The author goes on to posit that these challenges often result in product spoilage, which leads to revenue loss and the return of defective goods. Similarly, Karasu *et al.* (2023) identified product spoilage during the transport of perishables, particularly over long distances, as a significant issue. From here, a link emerges with the findings of Larsen (2022) and Morris (2021) in the background discussions, who observed that the increase in demand for the rapid delivery of fresh and frozen products impacts the delivery of perishable produce and goods. Furthermore, the authors also cited complexities involved in the transporting of frozen goods as a contributor of disruptions within the delivery process. To this end, Rodriguez (2018) contends that organisations dealing with the transportation of fresh produce, and the delivery of cold or frozen deliveries or supplies experience the most complexity during the logistics and delivery process of the cold supply chain system. The author goes on to call for modern food supply systems that can be integrated to become a digitised supply chain. Moreover, that these supply chain systems should include advanced technologies[36] and innovative warehousing solutions to optimise space utilisation, accelerate order fulfilment, and reduce operational costs. Thus, Rodriguez (2018) emphasised the need for an integrated and digitised supply chain and logistics operations.

Within this context, Thuermer (2022) identified additional challenges in South Africa's cold supply chain, such as limited warehouse space at ports and traffic congestion, both of which drive up operational costs. Additionally,

32 Whether unmanned or sensory drones. Moreover, whether remotely operated or autonomous drones

33 The author refers to a common scenario involving Drone based services enables streamlined business operations that in turn contribute to cost savings such as transport overheads and other common courier-based overheads.

34 This literature review infers from here that advanced technologies embedded in drone technology can potentially ensure that the quality and safety of frozen produce, goods and supplies does not result in wastage or spoilage. This will solve for challenges highlighted by Rodriguez (2021)

35 These advanced technologies that can be embedded into the digital systems of a drone, coupled with communication systems, will allow stakeholders to remain connected during the delivery process. Additionally, advanced 4IR technologies allow for the enabling of an optimised digital route mapping system that allows delivery and other supply chain and logistics operations to be coordinated more efficiently.

36 The author refers to robotics, automation, and smart warehousing systems as potential warehousing technological solutions

Ashok (2017) noted that current systems are often unable to ensure the timely delivery of temperature-sensitive goods, such as vaccines[37], especially during periods of energy crises[38], which plague South Africa with power cuts that disrupt the cold chain. Thus, the potential for drone technology to alleviate these issues is evident. Bui *et al.* (2022) demonstrated the sophisticated[39] capabilities of drones in determining precise positioning and communicating with central command systems during flight missions. This ability is particularly relevant in the context of South Africa's cold supply chain, where innovative warehousing solutions, such as robotic automation and smart warehousing systems as expounded by Hartwell (2023) could greatly benefit from the introduction of drones. Moreover, Ayamga *et al.* (2021) found that drones expedited the delivery of critical supplies, reduced operational costs, and provided real-time data that offered valuable insights for operational decision-making.

Moreover, an example of drones' potential beyond logistics is the Google kite, which generates Airborne Wind Energy using drone technology (Airborne Wind Europe, 2022). Here, the application of drone technology is presented as beneficial to solve critical socio-economic needs. While it was piloted in Hawaii, its application could offer solutions for South Africa's energy crisis, proving that drones can address both technological and socio-economic needs. These insights lead to a key question: what are the strategic benefits of adopting drone technology in South Africa's cold supply chain?

To explore this question, the utilisation of the Business Model Theory[40] was leveraged to evaluate the potential strategic benefits of drones. To this end, Ovans (2015) postulates that at a fundamental level, all strategies boil down to two very broad options: Do what everyone else is doing (but spend less money doing it), or do something no one else can do. This perspective is crucial to identifying specific business drivers and serves as a framework that helps identify specific business drivers associated with drone technology. From a strategic perspective, an inference made using the theoretical lens of the business model theory reveals the following strategic business drivers, guided by the analytical framework of business model theory as follows:

Business Value Drivers

- Tacit and Implicit Knowledge and Skills
- Creative abilities that add to the health of an orginisations culture

Business Inovation Drivers

- Innovation of product creation
- Innovation of service delivery
- Innovation of Business and Systems Process
- Innovation of Evoloutionary Management
- Collaborating innivatively globally
- Value in innovatively reducing the cost to compete

Strategic Business Drivers

- Drive channge in organisational stratergy: Change; People; Mission and Ethics
- Drive Profits: Product Customer needs (demand and supply)
- Contribute to Green/Environmental footprint
- Influence an organisations contribution to Macro-economic Stretagies: Competitive Forces; Market Forces; Regulations and Taxes
- Drive Technology and Inovation within an organisation

Figure 5 Strategic Framework Application of Drones

37 The medical industry also has a reliance on the logistical capability of the cold supply chain industry

38 A BusinessTech news report highlighted how the energy crisis adversely impacts delivery delays. Moreover, that logistical interruptions and interruptions to the cold storage owing to a cut in the power supply has led to subtle levies that are guised in price increases of products and services within the cold supply chain industry (BusinessTech, 2022).

39 This means that Drones can be equipped with light detection technology, including inter alia, ranging; sensor technology; stereo vision and complex algorithms such as simultaneous localisation and mapping technologies.

40 Business Model Theory is a generic framework that serves as a structured representation of an organisation's value creation strategies and how an organisation delivers and captures value from its customers. To be specific within an operational context, this theory incorporates compositional elements, including considerations related to customers, value propositions, organisational architecture at both firm and network levels, and economic dimensions. In essence, it provides a comprehensive framework for understanding and analysing how businesses generate and sustain their competitive advantage through effective value management and economic viability (Fielt, 2014).

From Figure *5*, the strategic benefits of drone technology evaluated through the theoretical lens of Business Model Theory provides a clear framework. An understanding emerges on how drone adoption can drive innovation, reduce costs, and enhance competitive advantage within the cold supply chain industry. This theoretical approach enabled the following focused analysis of how drone adoption can transform business models and operational efficiency in this sector as follows:

2.2.4.1. Evaluation of Strategic Drives of Drones

i. Evaluation of the Business Value Driver Dimension

Within this dimension, the adoption of drones can act as a pivotal catalyst in reshaping organisational dynamics by aligning with essential business value drivers. Drones offer the potential to introduce new skills and competencies within cold supply chain organisations, particularly in areas such as autonomous operations and data analytics. This transition would likely contribute to intellectual capital and foster a culture of creativity and innovation. As drones enhance product and service offerings, they could drive an environment of inventive problem-solving, signalling a shift towards an innovative and knowledge-driven organisational culture in South Africa's cold supply chain industry.

ii. Evaluation of Business Innovation Drivers

Within this dimension, the adoption of drones signals an opportunity for significant innovation within business processes. Drones can revolutionise logistics by enabling faster, more efficient operations, while also promoting adaptability in leadership practices in the context of the Fourth Industrial Revolution (4IR). The strategic integration of drones into global supply chains could provide South African cold chain companies with a competitive advantage through streamlined operations and improved global reach.

iii. Evaluation of Strategic Business Drivers

Within this dimension, the review highlighted how drones, far from being isolated tools, can function as integral components capable of positively impacting the entire supply chain ecosystem. This implies that the application of drones could enable organisations in the cold supply chain to operate more efficiently, remain competitive, and sustain themselves amidst rapid technological advancements, evolving market dynamics, and global trends. From this, two key strategic benefits emerge: a) a positive impact on the top and bottom lines of an organisation, and b) a positive influence on strategic intent and competitive advantage. The evaluation revealed the following:

a) Drone Technology as positive to the top and bottom line of an organisation

From a traditional technological perspective, Mancha and Iyer (2007) argued that digital technologies have facilitated transformative changes across various business domains, leading to comprehensive enterprise metamorphoses. This perspective remains relevant today, with Schwab and Davis (2018) forecasting that the Fourth Industrial Revolution (4IR) will continue to disrupt industries, underscoring the strategic importance of leveraging drone technology within South Africa's cold supply chain. The assertion of Mancha and Iyer (2007) gains even more relevance when considering the advanced digital nature of drone technology.

Given the rapid pace of technological advancements and disruptions within 4IR, this literature review infers that drone technology will improve the top and bottom lines of organisations. This conclusion is supported by Canon (2023) empirical evidence, which demonstrates how the substitution of traditional operations with drones reduces costs and streamlines processes, positively influencing organisational performance. A drone-based cost-saving model will have a favourable impact on both the top and bottom lines of organisations by minimising operational expenses. Consequently, organisations that embrace drone technology stand to benefit from this integrated cost-saving model, underscoring the transformative potential of drone technology on financial performance.

b) Drone technology as a strategic intent and competitive advantage

Strategic intent encompasses the aspirational plans that are essential for an organisation to realise its vision (APM, 2022). At the same time, competitive advantage is the ability of a company to outperform its rivals by producing goods or delivering services more effectively, thereby generating superior margins and added value for stakeholders (Peterdy, 2022). When viewed from this lens, drones can serve as a driver for both strategic intent and competitive advantage, as their integration into supply chain operations can propel an organisation toward achieving its vision and staying ahead of its competitors.

The strategic utilisation of drone technology offers numerous benefits and serves as a catalyst for organisational innovation. This technology has the potential to foster product offerings and services that align with consumer preferences. Additionally, drone-based operations—due to their cost-effectiveness and efficiency—can help companies provide more affordable and readily available products, which improves their competitive edge. By driving strategic intent and enhancing competitive advantage, the integration of drone technology not only fosters innovation but also solidifies an organisation's position in the competitive landscape.

From the evaluation of the strategic benefits through the lens of Business Model Theory, the insights gained demonstrate how drone adoption can positively impact the entire supply chain ecosystem. The insights gained from this evaluation reveal the transformative potential of drone technology, offering a comprehensive solution for the cold supply chain industry. Canon (2023) and Matsiyana (2023) emphasised how advanced drone systems improve financial performance through cost savings, operational efficiencies, and optimised operations that meet customer expectations.

Thus, while the literature primarily emphasised the benefits of drones, it is equally important to consider the potential challenges that may arise from their adoption. Understanding and addressing these challenges is crucial for ensuring the seamless and effective implementation of drone technology within South Africa's cold supply chain. Thus, the next section will focus on identifying the prospective ethical challenges associated with drone technology adoption, which is essential for informed decision-making and sustainable integration within the industry.

2.2.5. Segment C: Examining the prospective challenges presented by the commercial exploitation of Drone within the cold supply chain industry

From the preceding evaluation, several advantages have been highlighted in relation to the commercial application of drones within the cold supply chain industry of South Africa. These benefits were presented as operational efficiency, costs benefits and strategic benefits to an organisation. However, given the complexity of drone architecture explored in Part One and the disruptive nature of this emerging technology,[41] it became essential to examine the potential challenges drones may pose within the cold supply chain industry. This section explores these challenges through a thematic analysis, with key challenges identified as follows:

i. Challenges linked to the discernment of Drone technology capability

41 Fourth Industrial Revolution (4IR) - In 4IR, technology is poised to run everything, from genomic code cracking, drug discoveries, and health and shopping prediction, to drone deliveries, autonomous-driving vehicles (AVs), and smart devices (called IoT (Internet of Things)) to remotely control cameras, lock doors and turn on lights (Datta, 2021). Moreover, According to Schwab (2018) the Fourth Industrial Revolution is fundamentally different. It is characterised by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human. The resulting shifts and disruptions mean that we live in a time of great promise and great peril. The world has the potential to connect billions more people to digital networks, dramatically improve the efficiency of organizations and even manage assets in ways that can help regenerate the natural environment, potentially undoing the damage of previous industrial revolutions. However, Schwab also has grave concerns: that organizations might be unable to adapt; governments could fail to employ and regulate new technologies to capture their benefits; shifting power will create important new security concerns; inequality may grow; and societies fragment.

A critical challenge emerging from the architectural discourse on drones is the need to distinguish between the capabilities and functionalities of remotely operated versus autonomous drones. As Elmokadem and Savkin (2021) argue, autonomous drones bring with them specific challenges related to their dynamic nature. Delving deeper, Bui and Shirakawa (2022) point out that the complex algorithms used to determine a drone's relative position also enable real-time monitoring of its surroundings.[42] This capability introduces risks such as privacy and security breaches, [43] as well as legal implications when an autonomous drone makes decisions[44] in crisis situations. To this end, these risks may potentially introduce far reaching legal implications linked to legal concepts such as Actio Injuria[45] and other legal delicts in the realm of South African law.

Mekdad *et al.* (2023) further highlight risks related to privacy breaches due to systematic monitoring of individuals' behaviours in public spaces. The author observed that privacy and security breaches resulting from systematic monitoring of individuals' behaviours and interests in public spaces and near their homes. Embedded drone technology encompasses four levels: sensor-level, hardware-level, software-level, and communication-level. In terms of sensor-level safety issues, drone heavily rely on sensors to gather environmental data, exposing them to malicious attacks that may deceive operators by simulating GPS signals. Such attacks can compromise a drone's flight mission by exploiting real-time data from onboard sensors, leading to system malfunctions. Furthermore, at the hardware level, vulnerabilities include hardware trojans, physical drone collisions, hardware failures, and issues related to operating skills. Software-level threats involve malicious software enabling system attacks to access sensitive data, potentially allowing tampering with captured videos, system ID spoofing, or reverse engineering drone software systems to reveal architecture and functionalities. Additionally, Mekdad *et al.* (2023) goes on to identify unknown software vulnerabilities that could pose critical threats to drone operators. Finally, at the communication level, the study highlights a safety threat in the drone system for flight control and data transmission. Disruption of the communication link could jeopardize the flight mission, posing risks to both the operator and society at large.

Given these risks, the literature suggests that decision-makers in the cold supply chain industry must make informed choices regarding drone technology. Understanding the distinct functionalities and capabilities of remotely operated versus autonomous drones is crucial for avoiding operational inefficiencies and managing risks. Failing to do so could have far-reaching consequences for privacy, security, and compliance with South African law as expounded by Mekdad *et al.* (2023).[46] Thus, failing to discern these differences between drone classes and its associated technology and functions can lead to operational inefficiencies and exacerbate existing industry challenges. This was validated by Sonthalia *et al.* (2022) who noted that the failure to clearly differentiate these technologies could hinder progress and innovation. Decision-makers need to grasp the critical differences between drone types to ensure efficient implementation and avoid unnecessary risks. Thus, discerning drone capabilities extends beyond operational concerns it also encompasses ethical and societal considerations. These themes form the basis for further exploration in the following sections.

42 This observation is based on the use of laser rangefinders (light detection and ranging (LiDAR)), RGB-D sensors, stereo vision, and complex algorithms, such as simultaneous localisation and mapping (SLAM) can determine the relative position of a drone in a ELOS flight mission, at any instance.

43 Lee et. al. (2021) noted that in recent times, methods for autonomous navigation systems have been advanced for use as on onboard sensors, that are embedded within autonomous drones. This furthers the rise in Deep Learning approaches, and in computer vision applications to advance automation.

44 This decision may be linked to a perceived risk by an autonomous drone, per its programmed logic or its algorithmic learnings, - for example, infringement of people's privacy where a drone may capture an image of a private home revealing the security systems and vulnerability areas.

45 Liability in the legal realm of *actio injuriarum* is a delict and the breach of a duty imposed by law on a person independent of his will. The interests protected by *actio injuriarum* are the interests related to a privacy, dignity and the reputation of a person (Wijesinghe, 2018).

46 Regarding systematic monitoring by drones that constitute privacy and security breaches which is further linked to the legal concept of *Actio Injuria*,

ii. Challenges linked to interoperability requirements of Drone technology

Building on the preceding discussion, a critical challenge that emerged was the complexity of interoperability[47] requirements of drone technology. Notably, the degree of interoperability that appear to be required for the interoperability of drones into the technological estate[48] of an organisation is known as cross-domain interoperability[49]. In the context of enterprise interoperability and interoperability with third-party technologies, systems, and processes, here the integration of drone technology introduces another semantic interoperable layer called cross-chain interoperability[50]. This introduces cross-domain and cross-chain interoperability challenges, which require drones to seamlessly connect with both internal systems and third-party technologies.

From here, this literature review posits that drone technology with its inherent predisposition toward interoperability will present challenges when integrating with an organisation's existing technological estate. This is supported by the observation of Cooper (2021), that the heightened demand for rapid delivery services, is driven by the imperatives of innovation and automation. Subsequently, this introduces intricate challenges related to interoperability and the integration of drone technology with interlinking processes, systems, and their respective technological prerequisites. This assertion is supported by Pillet *et al.* (2017) suggesting that modern Information Technologies (IT) have gradually transformed into complex digital artefacts. Moreover, that this modernisation has blurred and changed functional boundaries. In light of this, literature review calls into question the manner in which complex interoperability requirements would be cause for an organisation to adjust their operations. This deliberation is necessary, for example, organisations must enhance their enterprise interoperability (EI) to interact effectively with other enterprises and third-party systems. This creates a heightened need for technological adaptation, especially as automation demands increase. This challenge emerges against the backdrop of the predisposition of drone and its inherent interoperability that would in turn demand of an organisation to have high levels of interoperability[51]. Since drone demand seamless integration with existing systems and third-party technologies, it can therefore be deduced that this would intensify the complexity of interactions within technological eco-systems and between business processes. Additionally, the imperative for Enterprise Interoperability (EI) emphasises the need for organisations to flexibly and cost-effectively interact with other enterprises. Therefore, these demands necessitate adjusting operations and technology standards to accommodate the new technology.

A second challenge to note is the variation of technology to meet stringent requirements for interoperability in the realm of drone technology. Driven by *inter alia*, consumer demands, the need to be innovative, the need to remain sustainable and to survive amidst the rapid advancement of 4IR technologies, these demands will drive high-levels of automation[52]. Furthermore, this challenge will necessitate a corresponding need for substantial technological development. This is necessitated to tackle the intricate interoperability demands of drone

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47 Ducq *et al.* (2008) defines interoperability as the ability for a system or a product/service to work with other systems or products/services without special effort from the user. Added to the distinction of interoperability between organisational systems and enterprise interoperability (EI), which encompasses the ability of an enterprise(organisation) to interact with other enterprises (organisations). This necessitates a degree of flexibility and should be achieved at the most economical cost.

48 The existing technological estate in the context of this study refers to the collection of technological estate, infrastructure, and assets already in place within an organization. It encompasses hardware, software, networks, databases, and any other technology-related resources that an organization currently utilises to support its operations. Moreover, how these technologies are interconnected and work together to facilitate various business processes and functions and includes how This could include assessing compatibility with existing systems, identifying potential integration challenges, and determining the impact on overall operations and workflows.

49 Cross-domain interoperability level is the ability of systems from different domains that requires interaction and information exchange with third-party technological eco-systems and processes, to integrate communicate and exchange information (Honkola, Laine, Brown, & Oliver, 2009)

50 Cross-chain interoperability refers to the ability of different blockchains to communicate and exchange value with one another. It involves building bridges between other blockchains to allow for the seamless movement of assets and data between them. These bridges act as rules-based protocols, fundamental for scaling solutions, and use messaging infrastructures to ensure secure communication between different blockchains (Honkola, Laine, Brown, & Oliver, 2009)

51 This would encompass cross-domain and cross-chain interoperability as an imperative and prerequisite for Enterprise Interoperability (EI).

52 This demand for automation would need to be embedded within processes and systems of an organisations to serve its technological estate.

technology; however, the implication of this challenge is Software Development Waste[53] (SDW). This potential waste would potentially arise from the need to create variations in technology to accommodate the interoperability requirements. A further implication of this challenge is the management of technological variations. This will require a balancing of innovation with considerations of Software Development Waste since the implications of automation within the context of the Fourth Industrial Revolution (4IR) will result in the demand for innovation. This ripple effect stemming from the variation of technology highlights how decision-makers must strike a balance in alignment with the consequences associated with the introduction of drone technology. Moreover, this creates tension between the demand for innovation and the potential waste generated by the development of varied technologies.

A third challenge that emerges is the impact of interoperability complexities on data collection and data transformation lifecycles. This challenge is linked to the interoperability requirements that would need to provision by an organisation in order to accommodate drone technology. Failing to have any technology present to enable an interoperable chain of technology or a cross-chain interoperability functionality, will render a technological integration activity fruitless. Therefore, it necessitates that the destination has compatible technology, processes and systems to receive the data, imagery or information from the said drone. To this end, drone-based data becomes a critical aspect that will call into question the Data Lifecycle Management (DLM)[54] processes of an organisation.

In light of the prospective nature of this study and the potential risks that emerged, the evaluation of this challenge reveals three key findings namely: 1) interoperability complexity and organisational transformation; 2) balancing innovation and waste in the interoperability conundrum; 3) the ethical crossroads of interoperability and drone integration and data management as a critical interoperability boundary. Addressing these challenges will require a fundamental shift in the approach to an organisations technological landscape and approach to drone integration. This complexity extends beyond technical hurdles, compelling organisations to rethink their digital ecosystems, potentially triggering transformative processes of adaptation and innovation.

Moreover, the pursuit of high interoperability in drone technology comes with a double-edged sword: while automation promises increased efficiency and competitive advantage, the need for diverse technologies to meet stringent interoperability demands can lead to a proliferation of redundant or incompatible applications. As expounded in the evaluation, the implication her is software development waste (SDW). This raises a critical question: How can organisations balance the need for innovation with the potential waste generated by technological variation? Finding this balance is essential for ensuring the long-term sustainability of enterprise-wide technological investments. To this end, the intricate web of interoperability requirements presents a complex ethical landscape for organisations. Without robust frameworks for ethical decision-making, integrating drone technology raises serious questions about data privacy, security, and the potential misuse of drones under the guise of commercial operations.

The evaluation of this challenge therefore suggests that the absence of standardised guidelines could leave organisations teetering on the brink of ethical dilemmas, and uncertain about how to navigate the complexities of interoperability while ensuring responsible and ethical technology implementation. Furthermore, the seamless

53 Sallin *et al*. (2023) defines SDW as any activity that uses resources, but creates no value for customers. In the context of this study, this literature review observes that SDW will be driven by the need for integration, interoperability requirements and the demand for the variation of technologies, applications, and software

54 Data Lifecycle Management (DLM) combines the best practices from the various stages of the data life cycle: production, data cleansing, data management, data protection, and data governance. It defines how the data is captured, prepared, transported, managed, analysed, and governed at each phase of the data life cycle Additionally, these processes encompasses how the data is captured, prepared, transported, managed, analysed, and governed at each phase of the data life cycle. Moreover, these processes must align to industry best practices such as ISO/IEC 27050:201654, that requires organisations to comply with regulations regarding data privacy and safety. (Eryurek, Gilad, Lakshmanan, Kibunguchy-Grant, & Ashdown, 2021)

flow of drone-generated data into an organisation's existing data lifecycle management (DLM) systems emerges a crucial concern. Ensuring compatibility at every stage of this process demands more than just technical solutions; rather, it requires a thorough re-evaluation of internal data management processes. This challenge therefore presents an opportunity to reimagine DLM process as a strategic enabler for drone technology integration. However, in the specific context of this study, Part B of the literature review must investigate the ethical implications arising from these interoperability challenges, such as the seamless data exchange across diverse domains, enterprises, and blockchain technologies within an organisation’s existing technological estate. While the potential for innovation and operational efficiency is undeniable, ethical considerations particularly regarding data privacy, algorithmic bias, worker displacement, and environmental impact must not be overlooked.

iii. Challenges associated with Unfair Business Practice

A key ethical concern that emerged from the strategic evaluation of drone adoption is the potential exposure of organizations to unfair business practices, including anti-competitive behaviour. While the presence of risk does not automatically equate to unethical conduct, the market dynamics introduced by drone logistics technologies merit closer scrutiny. As highlighted earlier in this review, dominant actors such as Amazon and Zipline exemplify how platform-based economies can consolidate market power in ways that marginalize smaller competitors. Thus, without adequate ethical oversight, such dynamics may lead to de facto monopolies and barriers to entry, particularly in emerging markets.

This aligns with Shih (2020), who argues that modern technological development increasingly depends on access to complex systems, specialised skills and conditions that inherently favour large incumbents. In the context of drone-supported cold chain logistics, these conditions may not only introduce regulatory complexities but also enable vertical and horizontal trade practices that risk undermining fair competition. Latici (2019) supports this concern by contending that drones prompt a fundamental rethinking of traditional business models. Such transformation, while potentially beneficial, carries ethical implications when existing market participants lack equal opportunity to adapt or compete. While market displacement is a known and often inevitable outcome of technological change (i.e., alignment to the Schumpeterian disruption theory), it must be distinguished from unfairness. Ethical inquiry does not assume that disruption is inherently unjust, but it seeks to highlight when technological shifts intersect with asymmetries in access, governance, and power, necessitating proactive ethical assessment rather than retrospective correction.

These arguments highlighted the legal implications related to fair business and labour practices. This assertion aligns with the legal implications related to fair business[55,56] and labour practices[57]. Moreover, the potential for anti-competitive behaviour, as observed in the findings of Ovans (2015), could have inadvertently led to anti-competitive[58] practices. This was compounded by Menachof *et al.* (2018) observed that organisations and individuals still prioritise profit over ethics. The observations of Menachof *et al.* (2018), who observed that profit-driven motives often took precedence over ethical considerations. Their findings challenged the earlier assumptions regarding drone technology’s cost-saving benefits. This suggests that while drones offered financial advantages, these could come at the cost of equitable business practices and fair competition, particularly affecting employees and small and medium-sized enterprises (SMEs).

55 Section 23(1) of the Constitution of the Republic of South Africa 1996 guarantees a fundamental right in respect of labour relations by providing that “everyone has the right to fair labour practices”.

56 The Harmful Business Practices Amendment Act, Act 23 of 1999 makes provision for the prohibition or control of unfair business practices.

57 Section 185 of the Labour Relations Act addresses unfair labour practices in South Africa and defines it as deceitful or discriminating acts or omissions that occur between an employee and employer

58 Wigmore (2019) goes on to explicate that that anti-competitive practices involved deliberate actions by one or more business entities that distorted market conditions, making it difficult or impossible for new entrants, particularly SMEs, to succeed. This results in higher prices, reduced innovation, and poor service quality.

Furthermore, these practices are deliberate, thereby making it difficult or impossible for other entities and entrants such as SMEs to enter or succeed in the same market. This will result in market distortion, stemming from anti-competitive practices that result in higher prices, poor service, and the stifling of innovation among other effects. Moreover, unfair business practices can disproportionately affect SMEs and will in effect exacerbate the existing digital divide[59] within South Africa. This issue is intertwined with the abuse of market dominance, vertical and horizontal restrictive business practices, and unequal resource distribution as posited by the assertion of Xu *et al.* (2018). The authors go to contend that the most valuable resource in a technology-driven era will be those who innovate and generate new ideas, a notion consistent with the adaptability of drone as versatile sensing and payload transportation platforms (Novitzky, Kokkeler, & Verbeek, 2018). However, without proper regulation, this adaptability favoured larger, well-resourced entities, leaving smaller competitors at a disadvantage.

Moving from this premise, that while drones improved an organisation's financial performance, their application also presented regulatory challenges tied to restrictive business practices. Vertical practices[60] where companies controlled supply chains in a way that limited competition, and horizontal practices, where companies collaborated to limit competition, resulted in market[61] distortion (CCSA, 2023). From the evaluation, such outcomes could have increased prices, reduced service quality, and stifled innovation. Moreover, this may introduce the risk of regulatory concerns, particularly under South African law, which governed unfair trade practices through the Competition Act and the Consumer Affairs Act [62] of South Africa. The consequences of this challenge may be a regulatory implication, in so far that any form of unfair business practices within South African law is governed by the Competition Act[63] of South Africa. This act regulates these exclusionary acts and in the context of this challenge, would mean the creation of monopolistic markets and the exacerbation of the digital divide existent within South Africa. This could also include market distortion, higher prices, poor service, and a stifling of innovation. Regulatory bodies, such as the Competition Act[64] as the custodian of these practices require organisations to ensure fair competition.

In light of the aforementioned challenges established, this literature review highlights the potential for drone technology to exacerbate existing inequalities, particularly for SMEs, further widening the digital divide within South Africa and raising concerns about ethical business conduct. One key concern lies in the potential for drone technology to facilitate anti-competitive behaviour. The review cites Shih (2020) and Latici (2019), who argue that the integration of drone can lead to vertical and horizontal restrictive practices that stifle competition. This aligns with legal frameworks such as the South African Competition Act, which prohibits agreements that substantially lessen competition (CCSA, 2023). Furthermore, the potential for cost savings associated with drone technology, as highlighted by Menachof *et al.* (2018) could be exploited by organisations prioritising profit over ethical considerations. This raises the spectre of unfair trade practices that disproportionately affect SMEs, further marginalising them in an increasingly digitalised economy within South Africa.

59 Drone technology, depending on its deployment and regulation, has the potential to exacerbate the digital divide by favouring more resource-endowed entities, potentially leading to adverse consequences. This has been acknowledged by the Minister of Communications and Digital Economies, who pronounced how the South African economy is moving into a predominate digital economy; however, a digital divide remains prevalent.

60 Section 5 of the Competition Act, it an offence for any person who is a director of a firm or has management authority to cause a firm to enter into agreements or practices that are competitively restrictive or perpetrate abuse of dominance

61 Section 4 of the Competition Act prohibits any agreement, concerted practice, or decision that involves restrictive horizontal practices. These are agreements that would have the effect of substantially preventing or lessening competition in the market. The Act provides that parties who conclude such an agreement must prove that there is a technological efficiency or any other gain that favours competition that results from the agreement

62 Section 10(1) of the Consumer Affairs Act, 71 of 1988 of South Africa defines an unfair business practice as any business practice which directly or indirectly, has or is likely to have the effect of harming the relations between businesses and consumers, unreasonably prejudicing any consumer, deceiving any consumer, or unfairly affecting any consumer or natural person.

63 Section 8 and 9 of The Competition Act 89 of 1998, regulates exclusionary acts that prohibiting organisations charging prices below cost, to exclude rivals from the market and buying up a scarce input required by a competitor (Act No. 89 , 1998).

64 Section 8 and 9 of The Competition Act 89 of 1998, regulates exclusionary acts that prohibiting organisations charging prices below cost, to exclude rivals from the market and buying up a scarce input required by a competitor.

Furthermore, the review draws attention to the potential for exacerbating the digital divide. In this context, Xu *et al.* (2018) argue that the innovation and resource demands of drone technology could favour larger, well-resourced entities, leaving smaller players behind. This aligns with the concerns expressed by the South African Minister of Communications and Digital Economies (2021) regarding the persisting digital divide within the country. Furthermore, the review also suggests that drone technology, if not carefully managed, could exacerbate this divide, limiting access and opportunities for marginalised communities. In light of these concerns, the review calls for further investigation into several key areas. Firstly, the ethical implications of drone technology in its engagement in anti-competitive practices is necessary. Secondly, the potential impact of drone technology on labour practices and worker rights needs thorough examination. Thirdly, the development of ethical guidelines for the responsible use of drone technology, considering its broader social and economic implications.

By investigating these areas further, this literature review can contribute to an understanding of the ethical implications surrounding drone technology. Moreover, this understanding can inform the development of responsible and sustainable practices for its deployment, ensuring that its benefits are shared equitably and potential harms are mitigated. Thus, the literature review must investigate the ethical considerations in Part B of to understand where drone technology serves as a force for positive change, and not a tool for exacerbating existing inequalities.

iv. Challenges associated with unfair labour and employment practices

Stroud and Weinel (2020) asserts that the integration of drone technology into the workplace introduces complex and evolving implications for labour. Moreover, that this integration raises critical questions about the nature of work, job security, and the restructuring of employment models. Shrivastava (2025) responds to this positing that while routine and repetitive tasks are susceptible to automation, that the implementation of automation often leads to the redefinition of job roles. This is supported by Manyika *et al.* (2018), who argued that drones could either complement human work or perform tasks beyond human capabilities. Moreover, that automation capabilities of drones may result in certain jobs becoming obsolete or relegated to lower-skilled labour, potentially leading to job displacement, lower wages, and labour disputes. Thus, as drones take on more automated tasks, they will fundamentally transform the nature of job roles. However, drawing on Orlikowski’s socio-technical lens and the six dimensions of technology 'effects' proposed by Edwards and Ramirez, Stroud and Weinel (2020) goes on to argue that rather than viewing automation solely as a driver of displacement, cognizance should be taken of how drone technology both challenges and redefines traditional employment. This notion is substantiated by the findings of Kavese *et al.* (2022), emphasising the increasing prominence of the gig economy[65], which is projected to drive transformative changes in business models. This finding supports the earlier postulation of Kim *et al.* (2018) suggesting that the emergence of digital business models could reshape the nature of work and employment relationships in ways that may further disrupt traditional employment. These findings are further supported by Manyika *et al.* (2018), who warned of the potential shifts in employment relationships, driven by the gig economy's expansion.

In light of the tension between the potential for job displacement and job creation, it was incumbent on this literature review to explore the ethical ramifications of drone technology on the workforce. This included assessing whether the benefits of automation align with principles of fairness, workers' rights, and social justice. Premised on the findings of this investigation, it would then be important to propose ethical guidelines and regulatory measures to mitigate potential negative impacts. This need was also called for in the ITF (2021) report regarding the impact of drone technology on employment practices revealed that the increasing need for automation, has implications of job displacement. This was also observed by Sahim (2025), that the acceleration of automation

65 The term "gig economy" is defined by a market which is based on a fixed-term contract or that is paid per project by a company, third party, or online marketplace (Roy & Shrivastava, 2020)

has exacerbated economic inequality by deepening wage and skills disparities between workers who can adapt to technological change and those who cannot. As digital and emerging technologies increasingly displace traditional roles, the labour market now prioritises expertise in artificial intelligence, robotics, and data analytics. The author goes on to argue that this shift has intensified competition among low-skilled workers for a shrinking pool of stable jobs, while disproportionately rewarding high-skilled technical professionals with rising incomes. The result is a widening economic gap, especially in acute developing economies where wage stagnation and job insecurity disproportionately affect the digitally marginalised. The author further proposes that to address this, that a coordinated policy response is needed, one that prioritizes STEM education, vocational retraining, and universal access to digital literacy programs, with active participation from governments, educational institutions, and employers. This validates the earlier challenge for the demand for automation, where the resulting impact is on workforce retention, and the engagement with alternative employment with workers operating within the gig economy.

In light of this evaluation, it can be deduced that organisations may be faced with challenging drone-based decisions. The potential for automation by drones while promising efficiency and productivity, casts a long shadow of potential job displacement and how routine workers will have to keep up with technology. In furtherance of this, the gig economy emerges as another challenge, within its offerings of flexible work opportunities, that empowers individuals but also complicates the already convoluted employment landscape in a constrained economy such as South Africa. While offering freedom and income generation, the gig economy may reshape work and employment relationships in ways detrimental to worker rights and social safety nets.

Thus, the ethical implications of drone technology cannot be ignored. It therefore necessitates that Part B investigate the ethical implications of the automotive impact by drone, and its alignment with principles of fairness, worker rights, and social justice. This investigation becomes essential to this study, since this challenge carries the risk of drone-based automation that may necessitate job displacement, that may either require training and reskilling of the workforce or, dispel redundant jobs which in turn furthers the high unemployment rate within South Africa. At the same time, legal frameworks and labour courts may demand the recognition of fresh employment opportunities, particularly within the gig economy. As the ITF (2021) report points out, significant modifications in job roles and compensation structures are inevitable, thus, it is inevitable that drones will be cause for disruption within employment practices.

v. Challenges associated with the application of Drone technology

A news report authored by Caboz (2022), emphasised the addition of new charge codes listed within the database of the South African Police Service (SAPS). These codes specify the procedures that police officers should follow when prosecuting drone pilots or hold organisations accountable in accordance with drone regulations. According to Thompson (2019), these regulations were introduced in response to the growing concerns regarding the irresponsible use of drones within South Africa. Additionally, the author also reported findings that highlighted a staggering 1,200 informal drone collisions in South Africa during 2019. Alarmingly, 75% of these collisions were attributed to pilot errors and the lack of meticulous pre-flight inspections. Moreover, both reports of Thompson (2019) and Caboz (2022) further revealed that drones were being flown for commercial purposes despite no regulatory provision for commercial application of drone within South Africa. Furthermore, these activities were undertaken under the guise of hobbyist activities and as a result, lawmakers have raised the threshold for compliance and monitoring within South Africa.

In light of the updated prospect of legal prosecution by the legal fraternities of South Africa, ensuring the safe use of drones and its associated technologies emerges as a significant challenge, in so far that the risk of drones being exploited for illicit activities can be potentially masked under the guise of organisational operations. This concern was supported by empirical evidence found in reports from the DeDrone (2023) database, and other related research. These reports consistently highlight instances of drug trafficking within correctional facilities, where numerous recorded incidents of illegal contraband smuggling across national borders were recorded. Examples of these reports are those of Crumley (2021), who reported that seven prison wardens in the city of Valledupar were implicated in the transport of contraband items, such as cell phones, SIM cards, tobacco, and cannabis, into the correctional facility.

Additionally, Hollister (2022) detailed a covert operation by law enforcement authorities that successfully intercepted a drone delivering a package containing 0.57 pounds (259g) of methamphetamine. These accounts collectively underscore the significant risks that organisations operating within the cold supply chain industry of South African may potentially face. These are especially significant in a country plagued by pervasive corruption and criminal activity. This assertion is validated by Mokoena (2022) who reported on the CPI index rating[66] of South Africa. The report situated South Africa as the 70th most corrupt country, from a list of 180 countries. The report further highlighted that the most significant areas of corruption as being maladministration at 18%, procurement corruption scored 16%, and abuse of authority was rated 6% within the corruption index. Furthermore, the report goes on to accentuate the prominent areas of corruption, including maladministration, procurement corruption, and abuse of authority (BusinessTech, The most common types of corruption in South Africa, 2022).

Another challenge that is consistently highlighted by the reports listed within the DeDrone (2023) database, is the surge in incidents where drone have caused physical harm to individuals, property and to the environment. An example of such a report was delivered by Mogg (2023). The author narrates a grievous incident involving a high-profile Taiwanese actor who suffered severe injuries during a Netflix shoot due to a drone collision. Amongst several other reports contained in this repository, that is updated on a daily basis, is such empirical discourse that culminates in the realisation that drone possess the capacity to cause harm and injury. This accentuates the significance of ensuring that drone operators are certified and well-versed in safe and ethical drone operation. Additionally, another contention that emerges in addition to this, is that the liability of drone operators for any malicious or harmful actions that could potentially conflict with the principles of the South African agency law. Within the legal framework of South Africa, this scenario positions organisations as the principle and primary party liable[67] for damages and criminal offenses.

Consequently, organisations may either shoulder full accountability or share the responsibility for wrongful actions with the drone operators rendering services on their behalf. The shadow of tort liability under the law of agency also looms large, especially when skilled operators deviate from ethical guidelines and the prescribed drone regulations. Thus, this extensive review underscores the vital importance of organisations remaining cognisant of the prevailing common law principles in South Africa, which safeguard the rights of citizens under the overarching principles of actio *injuriarum*[68]. Moreover, these rights are held in combination with the rights and principles of the constitution[69] of South Africa. Thus, any transgressions in this regard may culminate in organisations, including their directors, being held culpable for gross negligence or deliberate wrongdoing, leading to legal repercussions. From here, the challenge and risks of accountability and liability for organisations emerged, which is affirmed by the argument advanced by Nanda, (2021). The author contends that organisations

66 Report of Transparency International's 2021 Corruption Perceptions Index (CPI)

67 The organisation will become the principle and the operator the agent who furthers the contractual obligations set out by the organisation as the principle

68 *Actio injuria rum* may be defined as "an intentional and wrongful interference with another's right to seclusion in his [or her/their] private life" (Web Wentzel Attorneys, 2022)

69 Section 14 of the Constitution of the Republic of South Africa, 1996 provides for an express, justiciable right to privacy. It grants everyone the right to privacy, which includes a right not to have their person, home or property searched, their possessions seized, and their communication infringed. In combination with the Constitutional principles, the common law right to privacy also gives effect to the practical application of these constitutional rights. Therefore, the South African courts recognises this as a common law action under the broad principles of the *actio injuriarum* (Web Wentzel Attorneys, 2022).

should prioritise responsible decision-making over profit maximisation stemming from drone technology. This discourse highlights how the malicious use of drone can subtlety introduce the legal concept of tort[70] liability under the South African law of agency.

2.2.6. Conclusion to investigations of Part One

Given the serious repercussions that emerged during this evaluation, it becomes imperative for the literature review to explore the ethical challenges and risks associated with the prospective burgeoning use of drone by organisations within the cold supply chain industry of South Africa. Moreover, the emerging legal landscape and regulatory Gaps through the introduction of new charge codes by the South African Police Service (SAPS) signifies growing awareness of drone-related offenses. However, the lack of specific regulations for commercial drone applications creates a grey area, prompting stricter compliance and monitoring. This regulatory gap, alongside South Africa's concerning ranking of 70th most corrupt on the Transparency International Corruption Perceptions Index, fosters an environment ripe for illicit drone activity. This was evidenced by the reports from DeDrone and other sources that offered empirical evidence of numerous instances of drug trafficking and contraband smuggling via drone, raising concerns for national security and public safety.

In light of these findings, organisations within the cold supply chain industry of South Africa seeking to utilise drones should prioritise ethical decision-making over profit maximisation. This is paramount and therefore becomes the foundation for the investigations in Part B of this literature review. Part One of this literature review explored the potential application of drones within the South African cold supply chain, highlighting several strategic benefits such as cost savings, improved financial performance, enhanced operational efficiency, reduced spoilage, and a competitive edge. The literature review findings revealed that drones can reduce labour and transport costs, automate inventory management, enable real-time tracking, and optimise route planning, leading to overall operational improvements. However, despite these advantages, the review also highlighted key challenges and ethical considerations that must be addressed. These include distinguishing between remotely operated and autonomous drones, ensuring interoperability with existing systems, mitigating the risks of anti-competitive practices, addressing the impact on labour, and managing safety and security concerns. Therefore, it is crucial to address these challenges for responsible and sustainable drone adoption. In line with research objective one, Part Two will focus on the ethical considerations necessary for decision-makers to navigate the complexities of drone technology adoption within the cold supply chain industry. Furthermore, Part Two will also address research objective two in ascertaining best practices that can leveraged and improved on.

2.3. PART TWO: EXPLORING THE POTENTIAL ETHICAL CONSIDERATIONS LINKED TO DRONE TECHNOLOGY WITHIN THE CONTEXT OF THE COLD SUPPLY CHAIN INDUSTRY OF SOUTH AFRICA

2.3.1. Introduction

Part One of this literature review examined the strategic advantages of adopting drone technology in the cold supply chain industry. However, alongside these benefits, significant challenges[71] emerged. These challenges now form the foundation for exploring the ethical implications of drone adoption in Part Two. This section seeks to identify and analyse the ethical concerns linked to integrating drone technology within the industry, focusing on the ethical considerations that organisations must address in their decision-making processes. To guide this exploration, the review will be demarcated into two segments. Segment A will first establish a framework for

70 The law of agency in South Africa regulates the performance of a juristic act on behalf or in the name of one person ("the principal") by another ("the agent"), who is authorised by the principal to act, with the result that a legal tie (vinculum juris) arises between the principal and a third party, which creates, alters or discharges legal relations between the principal and a third party (Hoffman C. , 2019).

71 These challenges can be referred to as the potential risks and implications that decision-makers, stakeholders, and organisations may face as they tread the path of drone technology integration.

ethical evaluation. This will provide a structured approach to identifying the ethical implications stemming from the challenges discussed in Part One. From there, Segment B will outline key ethical considerations for decision-makers when implementing drone technology.

2.3.2. Segment A: Framework Development for the Evaluation of Drone-Based Ethical Considerations

The concept definition of “ethics”, as defined by the Oxford Dictionary (2023), encompasses moral principles influencing behaviour across diverse contexts. Menapace (2019) expands on this by describing ethics as a technique of abstract reasoning about norms and values, of balancing different values, and of building moral arguments that try to justify for better or worse. In the context of technology, Lane (2019) links ethics with technology as the creative application of knowledge to tasks involving humans and machines, oriented towards sustainable objectives. Supporting this is Burgess and Worthington (2021) who further emphasise that the ethical utilisation of technology hinges on the intentions of individuals when engaging with specific technological applications.

However, where Danaher (2022) takes a normative[72] ethical view on ethics in technology, Saetra and Danaher (2022) advocate for the inclusion of broader ethical domains[73] to avoid redundancy and grounding of fundamental ethical principles. Birhane (2021) supports this perspective by contending that neglecting the typology of ethics risks perpetuating unresolved ethical debates that fall short of providing a comprehensive framework for the ethical use of emerging technology. To this end, Gyekye (2011) argues that understanding the key tenets of ethics assumes paramount importance in addressing the challenges posed by globalisation, technology, and cultural diversity. The author goes on to assert that the tenants of ethics is paramount to ensure that ethical systems remain effective and relevant in an ever-changing world. In light of this, and in the context of this study, the exploration of ethical considerations associated with drone technology necessitates employing a lens that will enhance the depth of the ethical evaluation of the challenges that were identified in the preceding part one of the literature review. This rationale is supported by Gibson and Leather (2018) who posit that ethical research requires a much broader approach. Donia and Shaw (2021) furthers this perspective, by contending that technology, in an ethical context, demands a viewpoint that extends beyond technology itself, thereby encompassing a socio-technical[74] system. To this end, it necessitated that the literature review established a reasoning approach to examine the ethical implications of the challenges that emerged in part one. Against this backdrop, the tenets of the ethical typology of normative, applied and meta-ethics emerges as an ethical framework that will structure the investigations of this study, and intersect this typology of ethics as argued for by Saetra and Danaher (2022), Birhane (2021) and Gyekye (2011).

To give effect to the tenants of applied ethics, Dimmock and Fischer (2017) explicates that applied ethics has its focus on addressing moral challenges in practical aspects of life. Moreover, the ethical domain involves the examination of ethical conduct and prompts compelling arguments that prompt reconsideration and the potential revision of moral perspectives in specific aspects of our lives. However, to examine the ethical conduct, Khalid *et al.* (2017) goes on to posit that ethical reasoning is predominantly contingent on an individual's thought processes, specifically, the approach taken to make ethical choices and arrive at a conclusive decision. This postulation aligns with the tenants of metaethics[75] theory, given the emphasis on individual thought processes and inquiry into the foundational aspects of ethical reasoning. However, albeit applied ethics together with meta-ethics provides a reasoning approach structure for the investigations, it still necessitates an evaluation lens to discern

72 The author asserts that ethics plays a crucial role in determining the morally acceptable standards and evaluating the impacts of technology.

73 Here the author refers to the foundational ethical theories of normative, applied and meta-ethics

74 In this context, a sociotechnical system refers to the broader collection of interpersonal relationships, organisational policies, corporate contracts, and government regulations that shape the ways in which technologies are adopted and used (Donia & Shaw, 2021).

75 The domain of metaethics transcends the pragmatic resolutions of everyday ethical quandaries, concentrating on furnishing philosophical explications for foundational inquiries within moral discourse (Morán-Reyes, 2022).

of what is ethical and what is not ethical. Thus, within the scope of this study, the ethical considerations in a technological context and ethical reasoning is called under scrutiny.

To address this, the literature review draws on the ethical reasoning framework proposed by Paul and Elder (2005) for guidance. The authors postulate that ethical decisions are tied to the same basic structures that underlie logic, thought and reasoning. Moreover, ethical inquiries are constructed through various formulations. Conceptually, the authors contend that decisions start with elements of thought that influence the logic of reasoning and influences a perspective that essentially guides the ethical or unethical decision made.

To establish a theoretical understanding of the ethical decision-making model offered by Paul and Elder (2005) for this study, the researcher leveraged Cumulative Technological Culture Theory (CTC) to offer insights. CTC posits that technologies can be optimised without a comprehensive human understanding of their inner workings. Moreover, that optimisation is achieved through the application of technical-reasoning skills (TRS) (Osiurak, et al., Technical reasoning is important for cumulative technological culture, 2021). Against this backdrop, the principle of CTC appears to advocate for a departure from individual-centric decision-making, challenging the traditional approach of ethical decision making in favour of a more socially conscious reasoning approach. To this end, since this study is situated within South Africa, a pertinent question emerges in relation to a reasoning approach that can be applied in a country grappling with a digital divide[76]. The tenants of CTC did not appear to address this. The contention here lies in examining the adaptability and responsiveness of ethics within this specific context. In response to this, Grigoropoulosi (2019) attributes challenges to ethical behaviour in a South African context, to influences by contemporary parameters such as globalisation, technology, intangible assets, and talent management rather than socially conscious reasoning approach as posited by CTC theory. Moreover, inhibiting factors such as increasing competition, profit pressure, political corruption, generational values, and the expectation of quick gains challenge ethical intentions and behaviour. This is especially important to consider given the prospective drone-based decisions that will demand an ethical approach in light of the challenges that emerged in part one of this literature review.

Thus, the ethical reasoning approach that must accompany the applied and meta-ethics reasoning must be scalable enough to consider the contemporary influences, cultural nuances, and cross-cultural variations posited by Grigoropoulosi (2019). From here, the role of normative ethics theory emerged. Normative ethics plays a pivotal role in shaping the ethical landscape, by articulating foundational principles that guide how society should lead their lives and determine morally right courses of action (Driver, 2005). Burgess-Jackson (2021) adds to this, explaining that a normative ethical theory explicates the underlying principles that determine the moral properties of concrete actions, including rightness, fairness, goodness, justice, and praiseworthiness. However, this calls for an approach to ethical decision-making in the face of the digital divide and ongoing technological developments such as the need for drone technology to address current supply chain issues. Against this backdrop, a tension is created within the realm of normative ethics, that involves three areas namely Virtue ethics (what would a person of good character do?); Deontological ethics (rules, principles and duties) and Consequentialist ethics (what will the outcomes of the action be?) (Gunnell, 2023). Within these three areas, technoethics prompts an examination of how technological advancements and their consequences challenge established moral and regulatory principles as a framework that evaluates the ethical dimensions of technological choices (Pfordten, 2011). In light of this, the researcher took into account the ethical tensions of normative ethics, the perspectives

76 The South African Government has acknowledged that the economy is moving into a predominate digital economy; however, that a digital divide that is prevalent in South Africa needs to be bridged on an elementary level. The digital divide refers to the gap in usage, access to digital infrastructure, services between individuals, communities, corporations and geographical areas. Causes of the digital divide can be attributed to illiteracy, unemployment, geographical, age, racial segregation, language, disability, policies and gender. Additionally, unemployment is rife in people or job seekers who are not digitally skilled. The challenges of the digital divide within South Africa will impact the operational effectiveness of Drone applications. This will therefore call for effective 4IR leadership, in order to steer, manage and monitor the technological adoption of Drone technology and optimise the correct internal processes that will give rise to product, process and service innovation. (DEM for SA, 2020)

offered in the preceding discussion that is linked to business ethics in the realm of applied ethics and the theoretical foundations of meta-ethics being morality itself to create a methodology to identify the ethical considerations linked to the ethical challenges that emerged in part one.
Conceptually, Figure 8 below illustrates this framework as follows:

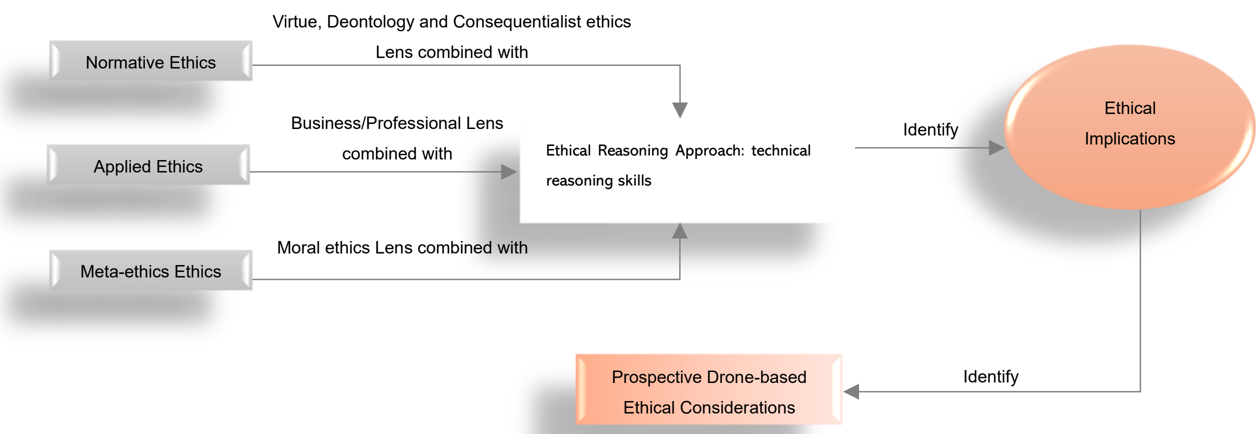

Figure 6 Ethical Framework for ethical Considerations Identification

From Figure 6, the methodological approach for the said investigation will assist this literature review to identify the ethical considerations in a technological context. Moreover, the ethical evaluation framework comprising the lenses of Normative ethics, Applied Ethics and Meta-ethics was as a departure methodology from individual-centric decision-making in favour of a socially conscious framework.

2.3.3. Segment B: Examining Ethical Implications and Establishing Ethical Considerations in Drone Technology

a) Ethical Considerations linked to the Discernment of Drone Technology

Emerging from the discussions in part one were the potential risks[77] it was established that an absence of discerning the difference between a remotely operated drone and an autonomous drone can present far-reaching organisational and societal impacts. Moreover, it also emerged that a decision maker at a strategic level must endeavour to understand a high-level architectural understanding of drones and its technology. Against this backdrop, the lens of deontology ethics highlights a fundamental ethical principle as *Respect for Autonomy* linked to informed consent and moral thinking and behaviour. Stonehouse and Bifarin (2021) defines this ethical principle in a technological context as self-rule without undue control or interference. The author goes on to delineate the concept of autonomy in an ethical context, into three components namely:

1) autonomy of thought[78] ; 2) autonomy of will[79;] and 3) autonomy of actions[80].

77 These risks emerged as privacy and security breaches, legal ramifications, and operational shortcomings
78 Here the author links this concept to assessing information for decision-making
79 Here the author links this concept to the intention to follow through on decisions
80 Here the author links this concept to the implementation of the two preceding decisions

From this definition, and in the context of this study, discerning the difference between a remotely operated drone and an autonomous drone aligns with the potential infringement on individual autonomy when data is collected and processed by drone[81]. Given that one of the primary functions of a drone involves the collection, storage, and processing of drone-based data, the imperative of obtaining informed consent becomes a foundational requirement. Thus, in the absence of discerning between drone technology as expounded in part one, ethically, a decision maker may indirectly infringe on an individuals' rights regarding how their data will be processed and used is compromised. This ethical implication is further situated in the risks identified in part one, *inter alia*, privacy and security breaches[82] in relation to decisions[83] that an autonomous drone may take in a time of crisis or emergency. Furthermore, these risks were also observed in the findings of Mekdad *et al.* (2023)[84] and the findings of Bui and Shirakawa (2022)[85]. In light of this ethical implication linked to the ethical principle of autonomy, this literature review asserts that the absence of informed consent policies or process poses risks to an organisation. These risks comprising privacy and security breaches as highlighted by Mekdad *et al*. (2023) is especially amplified in the case of the decisions that an autonomous drone might make in times of crisis or emergencies. As such, ensuring informed consent becomes a critical ethical safeguard, when addressing potential ethical pitfalls associated with drone technology is especially significant in the context of respecting the autonomy of individuals in the present digital age.

From an ethical typological perspective[86], normative ethics becomes a central tenant in ethical implication of the potential infringement on autonomy. This is especially significant to the manner in which drones collect and process data, and how decision-makers embed ethical safeguards[87] such as informed consent. Moreover, how a decision maker avoids the unintentional consequence of infringing on rights of data subjects[88] in the context of data processing can be attributed to a lack of understanding the functionality and discerning which drone would pose a higher risk in this context. For example, the deployment of an autonomous drone may pass over people's homes thereby easily accessing their ground view and abele to eavesdrop on conversations. This was revealed in the findings of Mekdad *et al.* (2023)[89] where these actions are tantamount to that of spying activities.

A shift from normative ethics to applied ethics, highlights the practical implications in drone technology. Empirical evidence of such practical implications was observed in a Dedrone (2023) report authored by Eminian, (2021), where it was reported that an umpire brought a baseball game to a halt, and ordered players off the field stating that: *"These days, there is no way to know what the Drone operator's intentions are. Not to mention the distraction is a safety risk for the players, no matter how harmless the drone operator's intentions."*

From here, it becomes imperative how a decision maker approaches the fit-for-use[90] principle to ensure the safe use and application of a drone without infringing on people's privacy rights, and additionally, to ensure that the

81 This could be remotely operated Drones or Autonomous Drones

82 Lee *et. al*. (2021), noted that in recent times, methods for autonomous navigation systems have been advanced for use as on onboard sensors, that are embedded within autonomous Drones. This furthers the rise in Deep Learning approaches, and in computer vision applications to advance automation.

83 This decision may be linked to a perceived risk by an autonomous Drone, per its programmed logic or its algorithmic learnings, for example, infringement of people's privacy where a Drone may capture an image of a private home revealing the security systems and vulnerability areas.

84 The author observed that privacy and security breaches resulting from systematic monitoring of individuals' behaviours and interests in public spaces and near their homes. Embedded drone technology encompasses four levels: sensor-level, hardware-level, software-level, and communication-level.

85 It was noted in part one that the author observed that complex algorithms used to determine a Drone's relative position.

86 The amalgamation of normative, applied, and metaethics as an ethical typology

87 Here, the literature review refers to the discernment between remotely operated and autonomous Drones

88 Individuals, places of interest, wildlife and all aspects that Dornes captures or executes task on, in a legal context is considered as data subjects

89 Mekdad et.al. (2023) observed that privacy and security breaches resulting from systematic monitoring of individuals' behaviours and interests in public spaces and near their homes. Embedded Drone technology encompasses four levels: sensor-level, hardware-level, software-level, and communication-level.

90 The FFP approach has three fundamental characteristics. Firstly, there is a focus on the purpose and then how to design the means for achieving it as well as possible; secondly, it requires flexibility in designing the means to meet the current constraints; and, thirdly, it emphasizes the perspective of incremental improvement to provide continuity (Enemark, McLaren, Lemmen, Antonio, & Kahiu, 2016).

costs to use the technology is not outweighed by features that are fit for use within the organisation. This is a critical ethical consideration. Moreover, this is also an important ethical challenge that emerges, necessitating that the balance of safety with privacy, and that of a data subject and individual rights is addressed. However, a question that emerges from here is how informed consent is expected to be obtained, particularly in a time of crisis in the context of an autonomous drone?

To answer this question, it necessitates an inquiry into the proactive measures and pre-established protocols that would be required. This includes developing advanced communication strategies[91] to inform the public about potential drone use during emergencies, and the transformative shifts in business paradigms. To this, Smith (2023) observes that managing digital strategies and policies becomes intricate, particularly with the rapid deployment of modern technologies within the framework of 4IR.[92] Additionally, organisations resistant to embracing the advanced iterations of 4IR expose themselves to digital threats and other challenges associated with this technological paradigm. Furthermore, Stefanini (2021) contends that organisations relying on antiquated technologies, strategies, and policies tailored to previous industrial revolutions run the risk of employing outdated constructs in a market that is progressively engaging with newer 4IR technologies. Thus, organisations clinging to obsolete practices face the peril of leveraging enhanced technologies and strategies.

In light of the arguments, the ethical considerations by decision maker within an organisation operating within the cold supply chain of South Africa should invest in transparent policies. These policies must detail the purposes, types of data collected, and intended use of drone. During emergencies and activities that appear to be part of illicit activities, the programmable language of an autonomous drone should encompass real-time notifications and clear channels for individuals to express concerns. Moreover, opt-out models[93] should be in place. This should be embedded in the programmable logic of an autonomous drone. Furthermore, post-crisis, debriefing sessions and transparent communication about the extent of drone usage and data collected are essential for building and maintaining trust. Thus, in the realm of applied ethics, decision-makers within the cold supply chain of South African should prioritise transparent policies, incorporating real-time notifications and clear communication channels to address ethical concerns that fosters respect for autonomy.

In the realm of meta-ethics, the relationship with ethical considerations was linked with the nature of moral knowledge in the context of moral epistemology. Therefore, the lens of meta-ethics views the conceptualisation of autonomy as an autonomy of thought, will, and actions. An empirical example of this is located in a Dedrone (2023) report authored by Boey (2021), where a farmer was arrested for shooting a law enforcement drone resultant of the perception that the drone was harassing him. This constitutes an example of a scenario that is reflective of how respect for autonomy is substantiated in a meta-ethical realm. The risk that emerges from here for the cold supply chain industry of South Africa, is based the perceived and suspected privacy[94] challenges that individuals may have towards drones. Furthermore, the broader society may perceive the sector as a threat if they feel that their privacy is being invaded. This perception could lead to incidents of malicious damage that is caused to a drone as the property of organisations within this industry.

91 This means that the company assumes consent unless individuals actively voice their objection. This approach is sometimes referred to as an "opt-out" model, where consent is presumed unless individuals take specific action to decline or object. However, if objections are raised later, especially in punitive circumstances, it suggests a potential issue with the adequacy of the company's initial communication or the clarity of the information provided. Informed consent should ideally be obtained through transparent and easily understandable communication, ensuring individuals are fully aware of the implications of their consent. If individuals raise objections later, it may indicate a failure in the company's communication strategy or a misunderstanding on the part of the individuals regarding the scope or consequences of the data collection or other activities (South AFrican Law Reform Commision, 2005)

92 The Fourth Industrial Revolution

93 An opt-out model is the act of indicating that a data subject no longer wishes for their data to be processed anymore. The opt-out encompasses restriction of processing, withdrawal of previously given consent, deletion of personal data, prevention of sales of personal data, or any other action that prevents the data controller, i.e., the business, from doing anything with the personal data they have collected or processed previously. (South AFrican Law Reform Commision, 2005)

94 Which can be considered a right in the context of autonomy

In light of this, decision-makers will be entrusted with recognising autonomy as an ethical consideration and infusing moral thinking into their decision-making processes, and ultimately moulds the moral behaviour of decision-makers within the cold supply chain industry. Considering this, the legal implications that emerge her is associated with *Actio Injuria*[95] and other legal delicts in the realm of South African law. It therefore becomes evident that adhering to a moral perspective during decision-making[96] is crucial. Hopkins (2017) offers a perspective on this, postulating that the use of drones can be viewed as an unbiased practice that favours certain interests, while negatively impacting others. The resolution to this issue is not straightforward since the moral and legal implications from the ethical lenses in this evaluation is linked to the legal implications of *Actio Injuria.* Moreover, it demands an intricate balance between the consequences of a technological choice in the context of a drone, and the adherence to fundamental moral principles that becomes central to the ethical considerations in this regard.

b) Ethical considerations linked to interoperability requirements of Drone technology

The investigation into the challenges arising from the interoperability requirements inherent in drone technology, highlighted significant complexities that a decision maker would need to navigate when integrating drone technology into the existing technological estate of an organisation. Additionally, the discussions in part one also highlighted the inherent predisposition toward interoperability of drone technology, that will necessitate careful consideration and strategic planning to mitigate challenges related to its assimilation[97]. Furthermore, it was observed that organisations seeking to integrate drone technology will be compelled to provision resources for new[98] infrastructure, that would need to be tailored to meet the specific interoperability prerequisites of drone technology. This necessary step introduces a divergence in technological components within the organisational framework, impacting both the technology landscape and the intricate lifecycles of data collection and transformation.

Thus, the evaluation in part one revealed that while interoperability may be treated as a systems integration or operational issue, this literature review has premise to contend that it also holds substantial ethical implications. This is based on the inability to achieve interoperability between drone systems and existing infrastructures that can result in exclusionary outcomes, such as vendor lock-in, increased barriers to entry, and unequal access to drone-based technologies. From an ethical standpoint, these outcomes raise concerns related to equity, justice, and the duty of care. If only resource-rich actors can afford the interoperability infrastructure, smaller firms or public institutions may be excluded from the benefits of drone logistics. Furthermore, interoperability failures can lead to fragmented data lifecycles, increasing the risk of errors, accountability gaps, and reduced stakeholder trust. Therefore, ethical evaluation must accompany technical planning to ensure fair and inclusive system design. In light of these implications, deontological ethics views transparency and interoperability as duties linked to fairness and accountability, requiring decision-makers to proactively address system design risks that could affect stakeholder rights and responsibilities. Furthermore, virtue ethics connects the challenges to moral character by promoting honesty and integrity, while the utilitarian ethics lens supports it as a means to achieve the greater good through informed decision-making. To this end, this normative ethics view creates an explicit alignment with the ethical principle of transparency[99]. This alignment prompts an exploration of the ethical

95 Liability in the legal realm of *actio injuriarum* is a delict and the breach of a duty imposed by law on a person independent of his will. The interests protected by *actio injuriarum* are the interests related to a privacy, dignity and the reputation of a person (Wijesinghe, 2018).

96 This decision making is asserted as the discernment of drone technologies and that of any decision made in the context of drones.

97 These challenges emerged from the analysis in part one of this literature review.

98 And require upgrades to the existing technological estate of an organisation

99 In the disciplines of information management studies, business ethics and information ethics, ‘‘transparency’’ tends to be used to refer to forms of information visibility, which is increased by reducing or eliminating obstacles. In particular, transparency refers to the possibility of accessing information, intentions or behaviours that have been intentionally revealed through a process of disclosure. In the disciplines of computer science

implications and considerations, that articulates constructs associated with the ethical implications and considerations arising from the integration of drone technology.

Against this backdrop, Felzmann *et al.* (2019) posit that the ascendancy of automated decision-making systems in conjunction with advanced Fourth Industrial Revolution (4IR) technologies has led to a fusion of these technologies with decision-making processes. Essentially, this involves delegating decisions to machines or systems[100]. Within this context, Felzmann *et al.* (2019) identifies transparency as a pivotal challenge. Belli *et al.* (2020) supports the argument of Felzmann *et al.* (2019), contending that transparency is a crucial mechanism in ensuring that decisions from organisations are legitimate and trustworthy. Furthermore, the authors developed the concept of "interoperable transparency" to address the issues of transparency during interoperability of technological eco-systems and software. However, Hosseini (2016) cautions that the ethical implications of transparency have been observed to be associated with the risk of deceptive actions. These deceptive practices were observed to be linked to wasteful practices associated with not being transparent with stakeholders, regarding any inefficiencies during the software or systems development lifecycle (SDLC)[101]. The author further posits that the lack or absence of transparency during the technological development led to challenges such as software development waste (SDW). [102]

In light of this, notably, this literature review asserts that the traditional opacity associated with algorithms, especially for those lacking expertise in the field, is further compounded by the capabilities of artificial intelligence (AI) and other sophisticated 4IR technological eco-systems. This was premised on the central arguments of Felzmann et al. (2019) and Belli *et al.* (2020) and the arguments and findings in part one where the ethical implication of transparency was emphasised to play a pivotal role in software and systems development lifecycles (SDLC). To this end, the postulation of Hayes *et al.* (2022) emphasises the importance of disclosing knowledge as part of transparent decision-making. Additionally, that such decision making encompasses value-laden objects and systems in a transparent manner that can be conceptualised as follows:

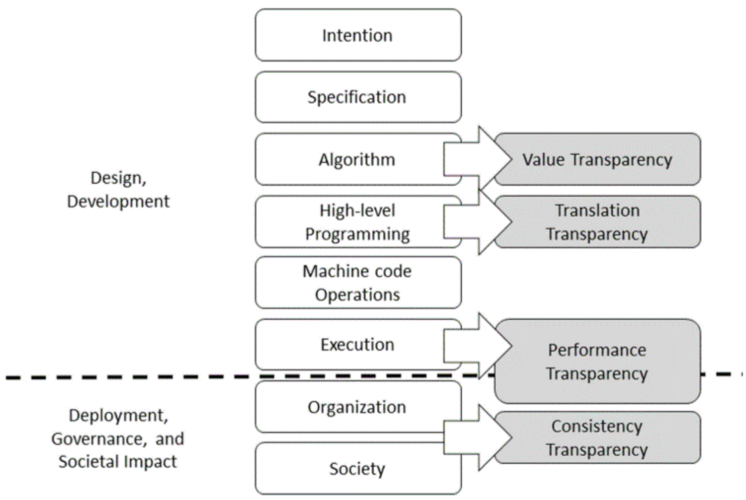

Figure 7 Design, Development and Technical Implementation of Ethics
Source: Hayes *et al.* (2022)

and IT studies, however, ‘‘transparency’’ is more likely to refer to a condition of information invisibility, such as when an application or computational process is said to be trans-parent to the user (Turilli & Floridi, 2009).

100 Here the author refers to technologies that rely on deep learning, and all other processes that allow processes to run largely independently of human control has.

101 The software or systems development life cycle (SDLC) is used to design, develop, and produce high-quality, dependable, cost-effective, and on-time software products or systems improvements. This is also known as a model of the software or systems development process.

102 Sedano et al. (2017) defines SDW as any activity that consumes resources but adds no value for an organisation and its customers.

Ofem *et al.* (2022) support the assertion of Hayes *et al.* (2022), contending that transparency within the SDLC process also refers to fully disclosing all functions of the software to its users. Furthermore, given the complex nature of how transparency ought to be achieved, Ofem *et al.* (2022) identified two dimensions namely: process and information dimensions.

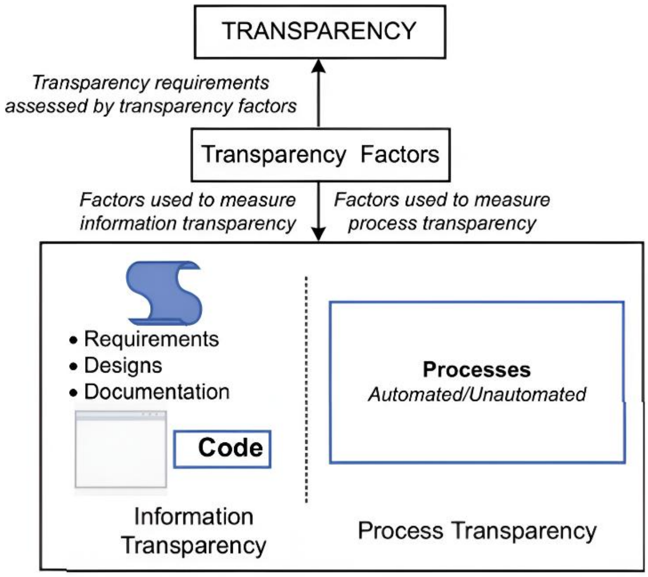

Figure 8 Overview of transparency conceptualisations and operationalisations
Source: Ofem *et al.* (2022)

From figure 8, in dimension 1: process transparency (PT) encompasses the conceptualisation and operationalisation of transparency, and focuses on automated (i.e., software) and unautomated (i.e., other organisational or business processes) processes. This supports the literature review findings in part one, regarding enterprise interoperability requirements that would need to be provisioned. Moreover, that this is a semantic layer that would need to be accounted for in decision making processes related to drone integration during the SDLC process. In light of the conceptual models offered by Hayes *et al.* (2022) and Ofem *et al.* (2022), this literature review concludes that transparency, with its ethical implications and two identified dimensions (process and information), are crucial factors in drone based integration decision-making. Moreover, that these factors are crucial during the practical implementation of system and software during the SDLC Lifecycle. Furthermore, the consideration of both dimensions and the semantic layer of EI requirements expounded in part one, becomes pivotal when organisations are required to adjust their operations for the successful integration of drone technology.

It can therefore be inferred that transparency is crucial in decision-making during the software development lifecycle (SDLC), especially when integrating drone technology. The complexity of interoperability requirements for drones may exacerbate software development waste (SDW), manifesting as inefficiencies such as building the wrong product, mismanaging backlogs, and creating overly complex solutions as expounded by Sedano *et. al.* (2017). Furthermore, poor communication, psychological distress, and loss of knowledge can further compound these issues, highlighting the ethical risks associated with a lack of transparency as expounded by Hayes *et al.* (2022). Moving from this premise, this literature review recognises that these manifestation areas of SDW have implications for the data-lifecycle management (DLM) process of drone-based data. This substantiates that there is a need for transparency in the Drone based Data Lifecycle Management (DLM)[103] processes. Thus, transparency becomes even more critical in managing drone-based data. Without clear protocols for handling, storing, and transmitting data, ethical concerns about privacy and security may arise, particularly in the context of data-lifecycle management (DLM) processes. Ensuring transparency in DLM processes, especially in the gathering and use of drone data, is essential to building trust and mitigating ethical risks.

From a normative ethics perspective, transparency relates to the moral obligation to disclose information during the SDLC for legitimate decision-making This normative perspective is supported by Felzmann *et al.* (2019), Belli *et al.* (2020). This forms a premise and critical backdrop for evaluating the integration of automated decision-making systems, particularly within the ambit of 4IRtechnologies and drone technology. Furthermore, the ascendancy of such technologies underscores a fusion with decision-making processes. In the realm of applied ethics, the assertions of Hosseini (2016) are acknowledged as a caution regarding deceptive actions that has the potential to arise from a lack of transparency. This emphasises how deceptive practices can lead to challenges such as SDW. The complexity of interoperability requirements for drone technology is further highlighted as a potential exacerbator of SDW, leading to counterproductive tasks and team dynamics issues. Thus, the key applied ethical consideration is the practical impact of transparency, on software development waste (SDW), inefficiencies, and potential risks in data handling. To this end, it becomes incumbent on decision makers to consider how this impact will exacerbate SDW, owing to the complexity of interoperability requirements in the context of drone technology.

From a meta-ethical perspective, the conceptual models presented by Hayes *et al.* (2022) and Ofem *et al.* (2022) contribute to understanding the nature of transparency and its justification. This is justified by the two dimensions of process and information, and its significance during the SDLC Lifecycle as well as the integration of drone technology. The ethical principle of transparency, when linked to SDW, is further delineated through nine types of waste, as expounded by Sedano *et al.* (2017). The emphasis on the broader implications for the data-lifecycle management (DLM) process in drone-based data is the key meta-ethical consideration of the ethical implication of transparency linked to software development waste (SDW) through nine types of waste outlined by Sedano *et al.* (2017).

Thus, the ethical implication of transparency is central to the integration of drone technology and must be regarded by a decision maker. The lack of incorporating this ethical principle into decision-making could lead to the potential exacerbation of software development waste (SDW) due to the complexity of interoperability requirements.

c) Ethical considerations linked to Fair Business Practice

From part one, the risk of anti-competitive behaviour emerged[104]. From the evaluation of the discussions, the lens of deontological ethics prominently highlighted the ethical principle of fairness[105], as the central ethical implication. In light of the prevalence of algorithmic decision-making that would be required and the growing reliance on machine learning algorithms as expounded by Hartwell (2023), deontological ethics emphasised the adherence to the principles of “fair equality of opportunity” and a “difference principle”, coupled with an equal “right to justification”, was imperative constructs of fairness. While the first two principles emphasised the

103 Data Lifecycle Management (DLM) combines the best practices from the various stages of the data life cycle: production, data cleansing, data management, data protection, and data governance. It defines how the data is captured, prepared, transported, managed, analysed, and governed at each phase of the data life cycle (Kamaly, 2022)

104 From the analysis in part one

105 This ethical principle emerges in light of fair competition issues, preventing market distortion, promoting innovation, and addressing the potential negative impacts on SMEs and the digital divide.

distributive aspect of the ethical principle of fairness[106], the third aspect shed light on its socio-relational nature through the lens of utilitarianism. These normative ethical principles were deeply rooted in the acknowledgment of the equal moral worth of each individual, demanding equal respect as the appropriate ethical response. Consequently, fairness emerged as an intrinsic ethical value of significant moral consequence, necessitating a commitment to ensuring equal respect for individuals in their capacity as persons.

Thus, the ethical implications associated with the challenges of unfair business practices in the adoption of drone technology were intricately tied to the ethical principle of fairness. In the context of anti-competitive behaviour and market distortion, the principle of fairness highlighted that decision makers should take decisions that contribute to the creation of a fair market environment, where entities, regardless of size, have an equal opportunity to participate and thrive in the market. However, the assertions of Tiribelli *et al.* (2022) creates a tension for the principle of fairness. The author argues that striking a balance between leveraging the strategic benefits of drones and upholding ethical considerations are paramount. Schroeder *et al.* (2019) further highlight the intricate personal values, ethical principles, and decision-making responsibilities for individuals within organisations. In this context, decision-makers must prioritise fair competition, regulatory adherence, and equitable treatment of stakeholders, including competitors and SMEs. The commitment to responsible innovation and ethical business practices therefore becomes integral in mitigating the risks associated with anti-competitive behaviour, while capitalising on the strategic benefits of drone technology.

Against this backdrop, in the realm of anti-competitive behaviour, the ethical principle of fairness demands that organisations using drone technology must ensure a level playing field for competitors, especially SMEs. The observations of Wigmore (2019) regarding any deliberate actions that hinder competition therefore run counter to the ethical imperative of fairness. Seymour *et al.* (2022) supports this assertion, arguing that even if a technological system is in some sense fair, just, or ‘safe’, it can nonetheless be exploitative, coercive, inconvenient, or otherwise conflict with cultural, individual, or social values. From here, the literature review asserts that the ethical evaluation of drone adoption hinges on the alignment with the principle of fairness, necessitating decision makers on behalf of their organisations to balance innovation and cost savings with a commitment to equitable competition, societal impact, and ethical labour practices.

Against this backdrop, Shih (2020) contributes to the norma-ethical perspective, emphasising the regulatory implications of vertical and horizontal practices associated with drone applications highlights the need for ethical standards and adherence to laws. In a South African context, this would refer to the Consumer Affairs Act and the Competition Act in South Africa, to ensure fair business practices and the prevention of anti-competitive behaviour. From here, the central ethical consideration emerges as the need for adherence to ethical standards and regulatory frameworks, such as the Consumer Affairs Act and the Competition Act in South Africa. This insight emphasises the crucial role of regulatory compliance and ethical standards to maintain integrity and equity in business operations involving Drone applications.

Latici (2019) adds depth to this, contributing an applied ethics perspective. The author asserts that drone technology prompts a fundamental rethinking of traditional business models, introducing potential legal implications related to fair business and labour practices. This applied ethics perspective highlights the practical implications of adopting drone technology, urging organisations to align their strategies with ethical guidelines to mitigate challenges, such as market distortion and negative impacts on SMEs. From here, the ethical imperative revolves around ensuring that the integration of drone into business operations is done in a manner that prioritises fairness, ethical labour practices, and considers the broader impact on the market and smaller enterprises. This emphasises the responsibility of organisations to navigate the ethical dimensions of technological innovation and its implications for business and labour practices.

106 Tiribelli *et.al*. (2022) contends that the ethical principle of fairness transcends a socio-relational dimension.

However, the conflicting views presented by Menachof *et al.* (2018) and Wigmore (2019) highlight the diversity of ethical perspectives in a technology-driven era. Against this backdrop, the meta-ethical perspective is expanded to the underlying assumptions and values shaping ethical reasoning regarding the adoption of drone technology. The tension here emerges between prioritising profit and adhering to ethical principles, prompting a deeper exploration by a decision maker of the foundations guiding strategic decisions in business. From here, the central ethical consideration revolves around the diversity of ethical perspectives in a technology-driven era. This central ethical consideration points to the necessity for decision-makers to critically examine and align their fundamental ethical beliefs and values, with the rapidly evolving landscape of technological innovation driven by 4IR technologies. Moreover, an emphasis on the importance of ethical consistency and coherence in strategic decision-making processes emerges. Another area under this ethical evaluation not addressed, was the implications of the demand for automation and the gig economy. The ethical implications in this regard are expounded as follows:

a) Ethical implication linked to automation

In part one, Manyika *et al.* (2018) highlighted a key finding regarding labour and employment practices tied to automation. From their findings, it can therefore be inferred that the displacement of workers by automated machines may widen the gap between returns to capital and returns to labour. The authors observed that while sufficient work opportunities may exist to maintain full employment until 2030, that it is anticipated that transitions pose significant challenges, reminiscent of historical shifts. Furthermore, that technical feasibility alone will be insufficient as other critical factors influencing the pace of automation adoption include the cost of development and deployment. Additionally, labour market dynamics (quality, quantity, and wages), broader benefits beyond labour substitution, and regulatory and societal acceptance can also be considered critical influencing factors. This comprehensive understanding is vital for navigating the complexities of integrating automation into the workforce, while considering its broader social and economic implications.

However, Nunes (2021) argues that the discourse surrounding the labour market impact of technology frequently centres on the polarising perspectives of job creation versus job destruction. Economists routinely categorise technology as either displacing or reinstating labour, prompting a critical examination of whether technology, on balance, generates more jobs than it eliminates. To this end, Nunes (2021) consulted the World Economic Forum's projection regarding drone technology. The report projected that drone technology was set to yield at least 12 million additional jobs by 2025, adding wight to the argument of Nunes (2021) that, over the long term, automation will prove to be a net positive for society. Nunes (2021) further strengthened this offering empirical evidence regarding a Google-backed startup pioneering driverless taxis. The proliferation of their sensor-equipped minivans[107] in American suburbs serves as a tangible illustration of technology's potential to transform industries and contribute significantly to job creation. Thus, the assertions of Nunes (2021) challenges the McKinsey Report (2018) report regarding technology as a purely labour-displacing force.

To add to this and the explanation of Hartwell (2023) in part one, an empirical example of Nunes (2021)'s argument in action is Amazon's experimentation with a humanoid robot. Here, the deployment of the Sequoia robotic system in its United States based warehouse can be considered a strategic move aimed at enhancing efficiency and expediting deliveries (Dresser, 2023). Shakir (2023) observed that the introduction of Sequoia is designed to identify and store inventory significantly faster. Moreover, the system promises a 75% improvement in inventory handling but also a potential 25% reduction in order processing times. This demonstrates the technology company's commitment to leveraging robotics to streamline operations and improve overall customer service. However, while Amazon acknowledged that the implementation of such robotic systems may render

107 Another example of sensory driven drones as explained by Hartwell (2023) in part one

certain tasks redundant, Dresser (2023) argues that its automation choices will also give rise to new job opportunities.

When considering the argument of Dresser (2023) versus the perspectives of Manyika *et al.* (2018), Nunes (2021) and Jones (2023), it can be inferred that technology's impact on the labour market must involve considerations of displacement, challenges, and divergent perspectives. Thus, emerging from the discussion is ethical implications of distributive and social justice that is underpinned by utilitarianism tenants[108]. Another observation emerging from this norma-ethical lens is the application of technological innovations and how these innovations should be guided by ethical principles that prioritise equitable distribution. Moreover, that the potential impact on marginalised or disadvantaged groups was highlighted. As postulated by Hanna (2021), this is a phenomenon tantamount to the application of a set of moral, social-institutional, and/or political principles, processes, and structures that determine the distribution of benefits and burdens in society. From here, the emphasises on the importance of using technology ethically is highlighted, as well as the fair manner of the distribution of benefits as well as the well-being of all members of society is highlighted. Hanna (2021) describes this as a set of principles that guide how society shares the benefits and burdens of technological advancements.

Thus, when examining the ethical implications of automation through a normative ethics lens, then a complex landscape emerges. This landscape encompassing the rapid implementation of automation technologies may, as highlighted in the evaluation, result in job displacement and as an exacerbation of inequality, particularly for workers in routine or low-skilled roles. In light of this, a utilitarianism lens prompts an evaluation of whether the overall benefits, such as increased efficiency and economic growth outweigh the negative consequences. From a deontological perspective, fair treatment and opportunities for those affected by displacement is emphasised. Moreover, the central ethical consideration linked to the impact of automation by drones emerges as the safeguards and measures that address the potential adverse impacts on job displacement. This ethical stance highlights the imperative for the deployment of automated systems that follows ethically sound and understandable decision-making processes.

From an applied ethics perspective, the analysis on automation and its impact on the labour market is highlighted by Manyika et al. (2018) as challenges tied to the anticipated transitions in employment practices due to automation. This perspective emphasises the importance of considering various factors, including labour market dynamics, broader benefits, and societal acceptance, to navigate the complexities of integrating automation into the workforce responsibly. The applied ethics lens therefore highlights the need for organisations to balance the potential benefits of automation with ethical considerations, societal impact, and the well-being of the workforce.

From a meta-ethics perspective, the technological impact on the labour market reflects divergent perspectives and challenges conventional narratives. Here the perspective of Nunes (2021) introduces a meta-ethical inquiry by questioning the polarising views on job creation versus job destruction in the context of technology. The conflicting views presented by Manyika *et al.* (2018) and the empirical evidence offered by Nunes (2021) regarding Amazon's robotic systems highlight the complexity of ethical reasoning in the face of technological advancements. These underlying meta-ethical assumptions, values, and ethical principles shape a perspective that emphasises the need for an understanding of the impact of technology on the workforce.

Thus, a discernible observation crystallises that irrespective of the decision to adopt drone technology, organisations are confronted with an imperative to strategically invest in the upskilling of their workforce to meet 4IR technological disruption. This observation aligns with the findings of Li (2022), where the author concludes that the current workforce is experiencing an unprecedented acceleration in the introduction of new skills and

108 From a deontological perspective, the focus is on moral duties, rights, and justice, while the utilitarian perspective emphasizes overall happiness and the well-being of all stakeholders. Ethical considerations related to fair labour and employment practices should therefore aim for a balanced approach that respects workers' rights, ensures a fair distribution of benefits, and maximises overall societal well-being.

technologies, necessitating a shift towards lifelong learning. This is particularly crucial as organisations embark on the responsible implementation of drone technology. The dual challenges posed by the economic aftermath of the COVID-19 pandemic, and the escalating impact of automation demand that employees undergo reskilling. This imperative emphasises the dynamic nature of the modern employment landscape, requiring adaptability and continuous learning for professional resilience.

Therefore, it will be incumbent upon technology developers, organisations and policymakers[109] to extend their ethical responsibility beyond mere technological advancements. Moreover, an organisation must actively engage in mitigating negative consequences, in pursuit of fostering a human-centric approach that prioritises dignity, fairness, and societal well-being amidst the transformative currents of technological change.

b) Ethical implications linked to Gig economy engagement

Building on the preceding discussion, the implication of automation of the workforce linked to the engagement with the gig[110] economy resonates with the findings of Kavese *et al.* (2022). The author observed that the rise of the gig economy in relation to the advancements of digital technologies will play a major role in facilitating changes to business models. Kavese *et al.* (2022) goes on to posit that digital business models in the context of the gig economy have already begun to affect the nature of work, workers, and employment relationships globally. Furthermore, with the demand for automation[111], it was observed that advanced technologies may require human workers to settle for lesser paid employment. [112] From this argument, it can be deduced that this employment trade-off will in turn will lead to litigation and labour court applications and/or add to the digital divide. Moreover, this aligns with the postulation of Jumah (2022) that as automation is substituted for labour, that the net displacement of workers by machines might exacerbate the gap between returns to capital and returns to the labour market. To this end, the findings of Tan *et al.* (2021) concludes that there is also a risk of exploitation of gig workers due to the flexible and precarious nature of their employment. The significance of these findings to this study is the manner in which the impact of staff and skills retention strategies are impacted, since it is the nature of gig economy workers to engage in alternative employment opportunities. This will inevitably accelerate the engagement of operators/workers within the gig economy by organisations.

In light of the findings of Kavese *et al.* (2022), the author posits that drone technology is expected to create entirely new business activities, and that this in turn will give rise to fresh employment opportunities. This is suggestive of an overall impact on employment practices that will be complex as argued by ITF (2021). The ethical implications outlined in the context of automation and gig economy engagement align with consequentialist ethics[113] in assessing overall outcomes. The ethical implication also aligns with distributive justice ethics in addressing concerns about fair resource distribution and the potential exploitation of workers. The nature of these normative ethical considerations requires a thoughtful and balanced approach to navigate the complex landscape of evolving employment practices.

When examining these ethical implications through the theoretical lens of consequentialist[114] ethics, then the central ethical considerations revolve around the potential exacerbation of inequalities that emerges between

109 This would be internal organizational policy makers

110 The term "gig economy" is defined by a market which is based on a fixed-term contract or that is paid per project by a company, third party, or online marketplace, and may hold more than one contract at a time (Roy & Shrivastava, 2020)

111 This encompasses software enhancements, machine learning, artificial intelligence, and Drone technology

112 This refers to tasks that automation will render as not feasible to employ a human for

113 The concept of consequentialism, is premised on a rule that that the best action to take in any situation is the one that will produce the best outcomes. According to act consequentialism, the best action to take is the one that will lead to the consequences with the greatest value. In the context of decision making, consequentialism evaluates how the decision will unfold base on the action that is taken at a particular moment in time

114 Distributive justice is concerned with the fair distribution of the burdens and benefits of social cooperation among diverse persons with competing needs and claims (Kaufman, 2012).

returns to capital and returns to the labour market due to the automation of the workforce and the rise of the gig economy. Here, consequentialist ethics play asserts that the central ethical consideration in this context is whether the trends of automation and the gig economy contribute to a just or unjust distribution of societal resources. In light of this, this literature review posits that the central ethical consideration from a norma-ethical perspective is ensuring that the outcomes of these technological developments align with principles of distributive justice, in pursuit of promoting fairness and equitable access to the benefits generated by automation and gig economy engagement.

However, the literature review was cognizant of the fact that this ethical consideration may take time to manifest, whilst unethical outcomes may be quicker to emerge. This suggests that timing will be a critical ethical consideration. This is emphasised through an applied ethics lens. In this regard, the ethical implication of automation and the gig economy engagement appeared to introduce practical challenges such as the risk of exploitation faced by gig workers due to the flexible and precarious nature of their employment. Against this backdrop, the applied ethical concerns extended to the impact on staff and skills retention. Here, applied ethics asserted that workers in the gig economy may have too many alternative employment opportunities, that could impede on the knowledge structures of an organisation. This dynamic was identified by ITF (2021) including the creation of new business activities by technologies such as drone technology, could further complicate the employment landscape. Thus, applied ethics in this context emphasises the ethical considerations for navigating the evolving employment practices influenced by automation and gig economy trends. From a meta-ethical standpoint, the nature of the normative ethical considerations reflects the underlying principles guiding consequentialist and distributive justice ethics. Moving from this premise, it can be deduced that technology shapes the future of work and from here, a metaethics lens prompts a deeper exploration of the philosophical foundations that inform the ethical judgments. To this end, in the context of automation and the gig economy engagement, the ethical evaluation has highlighted the implications on workers and society. Moreover, the complexity of navigating the evolving landscape of employment practices becomes an ethical consideration that underscores the complexity inherent in navigating the ethical dimensions of technological advancements. This emphasises the importance of a thoughtful and well-informed meta-ethical approach to guide ethical decision-making in the face of evolving employment practices.

The ethical framework, underpinned by normative, applied, and meta-ethical perspectives therefore requires that a decision maker has regard for the evolving nature of employment practices. On this basis, this literature review posit that a decision maker must consider the precarious employment conditions and its impact on income and job security. This must be a focal point for equitable treatment among different segments of the workforce. Hence, the central ethical consideration is to take into account the reshaping of business models through advanced technological disruptions, such as drone, and the multifaceted nature of these changes.

c) Ethical considerations linked to the application of drone technology

Stemming from the discussions in part one, the literature review deduces that the ethical implications of drone technology in South Africa encompasses *inter alia*: challenges related to liability and accountability. This emerged from the challenges that were expounded in part one, where it emerged that drone can be used for illicit activities under the guise of commercial drone based tasks as reported by Thompson (2019) and Caboz (2022). Other empirical evidence highlighted the physical harm that drones can pose to society and infrastructure. In response to these adverse complexities, legislation within South Africa has strengthened to a level of accountability that will see company directors accountable for drone-based decisions. This includes autonomous drone. Attorneys Weber Wentzel (2022) explicate that drone regulations within South Africa are explicit regarding drone operators that must have a drone pilot licence[115]. This also includes a licence to operate in broader aviation air spaces of South Africa. However, given the ambiguous drone regulations and the rise of the Gig economy, it calls into question the distinction between the drone operator and the drone pilot. A Drone operator could be a likened to a company and also fulfil the role as a pilot; however, distinct licence categories are required as an operator and drone pilot as well as other various licences[116]. This was affirmed by the South African Civil Aviation Authority (SACAA) (Emma-Iwuoha, 2018).

Considering this legal obligation against the report of Caboz (2022) in terms of SAPS[117] charge codes, then the law of agency within South Africa will be the legal implications that will position an organisation as the liable party for damages and criminal offences. This may manifest where an organisation may either be held accountable in full or share the responsibility of wrongdoing with the drone operator as a pilot rending a service to an organisation. This will render an organisation vulnerable to the risk of tort liability under the law of agency[118]. Furthermore, this would extend to an autonomous drone and the automated decisions taken based on its programmable logic. Thus, in the event that an autonomous drone makes a rogue decision, given the rapid pace of machine and deep learning, an organisation as the registered owner may potentially be held liable as the principle as opposed to the drone operator. Additionally, technical teams that effected the computational logic that enabled the autonomous decision of the automated drone may also be incorporated into the liability for harm and injury resulting from drone operations which raises significant ethical questions. In this context, adherence to common law principles will become crucial to avoid as the legal repercussions required to uphold the principles of responsible and ethical drone use within the South African legal framework.

This complex legal and societal factor resonates with the ethical principles of accountability and responsibility. To define this ethical principle, Lechterman (2021) observed that scholars hold diverse perspectives on the meaning of accountability and responsibility in the realm of advancing technologies. The author goes on to highlight how some scholars view accountability as a master virtue, equating it with moral justifiability. On the contrary, others take a more limited view, regarding accountability as a tool to ensure algorithmic compliance with existing legal standards or to trace aspects of system performance. This scope of accountability is further debated, with some scholars considering it a mechanism for regulating professional roles and organisational relationships, while others see it as a fundamental aspect of moral responsibility that exists independently of institutional practices. Disagreements extend to whether accountability and responsibility should be attributed to those who design and deploy advanced technological systems, or if it should be seen as an inherent quality of the systems themselves.

To this end, Lechterman (2021) goes on to assert that one notable challenge in these debates is the lack of explicit clarification regarding these conceptual differences. As a result, participants in discussions about accountability and responsibility often find themselves talking past each other, reflecting the complexity and evolving nature of the ethical considerations surrounding emerging and advanced technologies. In the context of this study, the central ethical implication of this ethical principle revolves around the question of who bears responsibility for the actions and decisions made during drone operations. This principle encompasses various aspects, including the distinction between a drone operator and a pilot, as well as the adherence to legal obligations (especially the law of agency), and considerations related to autonomous drone decision-making.

115 Regulation 101.05.13 and 101.05.14 of the Civil Aviation Regulations Part 101, no RPAS shall be operated within a lateral distance of 50 metres of any people, structure or building unless the operator holds a remote operator certificate (ROC).

116 Within South Africa, licences in the realm of Drone regulations encompasses inter alia: Pilot Licensing; Training ATO Sale and resale of RPAS Private Operations; Registration of RPA Operations; Certificate Airworthiness RPAS operators (ROC/RTO); RPAS Maintenance Letter of approval for the RPA Forms Fees; General Information Legislation Pilot Licensing; Training ATO; Sale and resale of RPAS; Private Operations Registration of RPA; Operations Certificate

117 The South African Police Services

118 The law of agency in South Africa regulates the performance of a juristic act on behalf or in the name of one person ("the principal") by another ("the agent"), who is authorised by the principal to act, with the result that a legal tie (vinculum juris) arises between the principal and a third party, which creates, alters or discharges legal relations between the principal and a third party

Moreover, the need for organisations to be accountable for the actions of both human drone operators and autonomous drone, thereby highlighting the potential legal and ethical consequences of their activities.

Moving against this background, the central ethical implication that will confront a decision maker may potentially revolve around the complex legal and societal factors. This will be particularly in the context of accountability and responsibility for drone operations. To this end, within the realm of applied ethics, the ascendancy of the gig economy introduces complexities in delineating the roles of drone operators and pilots. Ethical considerations in this regard extend beyond regulatory compliance to address the fair treatment and just working conditions of gig workers within the drone industry. Therefore, the ethical dimension of autonomous drone-based decision making requires a meticulous evaluation of the implications of rapid machine learning[119]. Furthermore, a commitment to the adherence of ethical guidelines becomes pivotal, especially concerning skilled operators and the autonomous drones that are deployed. Against this backdrop, a meta-ethic ethical consideration revolves around achieving conceptual clarity regarding accountability and responsibility in the context of drone operations. This ethical consideration supports the findings in part one regarding the discernment by a decision maker between a remotely operated drone and an autonomous drone.

2.3.4. Conclusion to investigations of part two

The exploration in this part of the literature review investigations revealed a complex and dynamic set of ethical considerations. The technological advancements, societal values, and ethical reasoning was evident throughout the analyses of the ethical challenges that emerged in Part One. The incorporation of diverse ethical theoretical frameworks such as normative ethics, applied ethics, and meta-ethics, provided a robust foundation for understanding the ethical considerations prospectively associated with drone technology in a permissible regulatory environment.

2.4. Theoretical Framework

2.4.1. Introduction

The literature review revealed several ethical challenges that may emerge within a more permissive regulatory environment. Stemming from the literature review findings, an early indication emerged that this study would require the input of strategic decision makers operating within the cold supply chain industry of South Africa, to understand the approaches that would be taken toward the ethical challenges that emerged. However, the researcher was cognisant of the postulation of Hiebert *et al.* (2022) regarding the purpose of a theoretical framework. The author posits that a theoretical framework provides evidence of the research contribution to knowledge, in so far that it sets parameters, or alternatively provides the ambit of the research scope for the contribution of the study.

This demonstrates how the study will take advantage of what is known and what is new about what the phenomenon under study. Furthermore, this approach guards against the overgeneralisation of claims that go beyond the evidence unwarranted. Moreover, the researcher was cognizant of the assertion of Garvey and Jones (2021). The authors posits that the theoretical framework of a study should aim to provide a frame that allows for the collection and analysis of evidence of data collected by the study. This argument, supported by Gough *et al.* (2020) asserts that research evidence in the form of participant data collected plays a pivotal role in the findings of a study.

119 In this context, a decision maker would need to contemplate the potential ramifications of decisions that may result in harm or injury

Building upon this premise and drawing upon the findings that emerged within the literature review, early insights into the implications for data collection and analysis emerged. To this end, the researcher observed several recurring themes stemming from the literature review investigations together with the implication on the data collection and analysis process. These themes established the parameters and scope for data collection, ensuring that the study remained focused on addressing key issues identified in the literature review investigations. Moreover, these themes also served as the foundation appraised for the theoretical framework of this study as follows:

2.4.2. Thematic Foundation for the primary data collection and analysis

i. Theme One: The critical importance of discerning capabilities and functionalities between remotely operated and automated drone

The central concern of this theme is the ethical implications tied to autonomy and informed consent, particularly how decision-makers address challenges associated with autonomous drones. As expounded in the literature review discussions, these drones, unlike remotely operated ones, pose significant ethical and legal risks. Moreover, this may potentially emerge in cases where they may act independently or take rogue actions. The literature indicates that such actions, without informed consent, could amount to spying, as highlighted by Mekdad *et al.* (2023)[120] and Eminian, (2021). In South African law, this can have serious legal ramifications, including *Actio Injuria*[121] and other legal delicts.

This theme aligned with the assertion of Bannister *et al.* (2020), in so far that the authors posits that organisations and their leaders seldom develop an overall approach to the ethical impacts of technology use. Moreover, that simply understanding the ethical issues involving technology requires a decision maker to apply a methodological approach for identifying ethical courses of action. However, Joshi and Afanasyev (2020) opposed the assertion of Bannister et al. (2020), asserting that overconfidence in IT governance structures may obscure deeper ethical concerns. Therefore, it is crucial to discern between remotely operated and autonomous drones due to their distinct ethical, legal, and operational challenges.

Against this backdrop, the implications for the data collection and analysis process were substantial, as the ethical, legal, and operational distinctions between remotely operated and autonomous drones required careful consideration. In light of this, the researcher extracted key constructs representing the ethical challenges that decision-makers may face, specifically in relation to the central argument of this study. These constructs were organized into sub-themes, derived from the literature review's investigations and findings. This approach highlighted critical areas where these distinctions influence ethical decision-making, thereby providing a framework for both data collection and analysis, aligned with the research objectives of the study as expounded in table 1 below:

120 Mekdad et.al. (2023) observed that privacy and security breaches resulting from systematic monitoring of individuals' behaviours and interests in public spaces and near their homes. Embedded Drone technology encompasses four levels: sensor-level, hardware-level, software-level, and communication-level.

121 Liability in the legal realm of *actio injuriarum* is a delict and the breach of a duty imposed by law on a person independent of his will. The interests protected by *actio injuriarum* are the interests related to a privacy, dignity and the reputation of a person (Wijesinghe, 2018).

Table 1 Sub-Themes for exploration of Theme One

Constructs (sub-themes)	Description	Alignment to research Objective
Differentiation of Drone Types within decision making	Highlighting the distinct operational, ethical, and decision-making challenges specific to remotely operated and autonomous drones.	This differentiation aligned with RO1 by identifying critical ethical distinctions and informs RO2 by proposing best practices specific to each drone type's operational context.
Ethical Constructs underpinning drone based decisions	Exploring the implications of autonomy, informed consent, and unintended data capture when deploying drones.	The alignment to the research objective was the focus on respect for autonomy and informed consent. This was aligned to RO1 by evaluating autonomy and informed consent issues. This informed RO2 by contributing to the ethical decision-making framework through analysis of moral behaviour in organizational contexts.
Legal Implications associated with drone based decisions	Exploring the legal consequences of drone operations, including spying activities and *Actio Injuria* under South African law.	Addressing ethical challenges, especially with autonomous drones, aligns with RO1 by addressing legal challenges. This informed RO2 through the identification of legal considerations for best practices and RO3 by emphasizing the need for monitoring tools to evaluate compliance with legal standards.

Stemming from table 1, the unit if analysis was derived from the constructs and sub-themes. Given the complexity of these challenges, it became evident that senior decision-makers were the appropriate focus of the analysis. These individuals were deemed uniquely positioned to navigate the strategic, compliance, and technical aspects of drone adoption and use within their organisations. Their responsibility for the ethical and legal consequences of drone-related decisions, particularly in distinguishing between remotely operated and autonomous drones, made them central to this study. Thus, these decision-makers' ability to apply informed and knowledgeable judgment in these areas was identified as a critical factor for the analysis.

ii. Theme Two: Ethical considerations linked to the technological integration of drone technology within an organisation's existing technological estate

The literature review revealed several ethical challenges that emerge when integrating drone technology into an organisation's existing technological estate.[122] . Moreover, these challenges stem from the technical and operational complexities involved in ensuring that drone systems function seamlessly within existing infrastructures. Another critical finding from the literature was the importance of transparency in decision-making and data management, especially in the context of handling drone-generated data. The ethical principle of transparency suggested that the complex integration requirements of drone technology may lead to Software Development Waste (SDW), manifesting in issues such as the development of unnecessary features, devious actions, or the misuse of investor resources.

As such, transparency within Data-Lifecycle Management (DLM) was highlighted as crucial, especially when processing drone-based[123] data during the DLM lifecycle. Therefore, the constructs under this theme was focused on addressing interoperability requirements. The emphasis was on transparency in decision-making and data management, and managing ethical concerns related to privacy and data security within the DLM framework. Against this backdrop, the researcher identified the following key constructs, which served as sub-themes guiding data collection. These constructs are aligned with the research objectives, as follows:

122 The existing technological estate in the context of this study refers to the collection of technological systems, infrastructure, and assets already in place within an organization. It encompasses hardware, software, networks, databases, and any other technology-related resources that an organization currently utilises to support its operations. Moreover, how these technologies are interconnected and work together to facilitate various business processes and functions and includes how This could include assessing compatibility with existing systems, identifying potential integration challenges, and determining the impact on overall operations and workflows.

123 The literature review emphasised the ethical implications concerning privacy and data security

Table 2: Sub-Themes for exploration of Theme Two

Constructs (sub-themes)	Description	Alignment to research Objective
Interoperability Challenges	Ethical issues arising from the technical and operational integration of drones into existing systems.	This theme aligns with RO1 by identifying and evaluating the critical ethical considerations involved in integrating drone technology, ensuring that ethical standards are maintained in a regulatory environment. It supported RO2 by establishing best practices for ethical decision-making frameworks that address these integration challenges. Additionally, it informs RO3 by aiding in the development of scalable monitoring tools to continuously assess and manage the ethical aspects of drone integration and operation.
Transparency in Decision-Making and Data Management	The imperative for transparency to mitigate risks such as Software Development Waste (SDW), devious actions, and resource wastage.	This theme aligns with RO1 by emphasizing the importance of transparency to identify and evaluate ethical considerations, thereby preventing issues such as SDW and ensuring accountability. It supports RO2 by promoting best practices for ethical decision-making and data management, which can be incorporated into decision-making frameworks. Furthermore, it informs RO3 by providing a foundation for developing scalable monitoring tools that ensure ongoing ethical compliance and transparency in decision-making processes.
Data-Lifecycle Management (DLM)	Ethical implications concerning privacy and data security during the processing of drone-based data throughout its lifecycle.	This theme aligns with RO1 by highlighting the critical ethical considerations related to privacy and data security that need to be evaluated within a regulatory framework. It supports RO2 by examining these implications and establishing best practices for managing drone-based data ethically throughout its lifecycle. Additionally, it informs RO3 by contributing to the development of monitoring and evaluation tools that ensure continuous ethical assessment and compliance in drone operations, focusing on data privacy and security.

From table 2, it could be deduced that drone technology was anticipated to be shaped by the specific social dynamics and power structures within the cold supply chain industry. To this end, unit of analysis stems from the constructs and sub-themes outlined in Table 6. The integration of drone technology is anticipated to be shaped by the social dynamics and power structures within industries, such as the cold supply chain. Therefore, the unit of analysis focused on decision-makers responsible for navigating compliance, technological, and operational aspects of drone technology integration within the Software Development Lifecycle (SDLC) and the Data-Lifecycle Management (DLM) processes. These decision-makers are expected to provide key insights into how ethical decisions are approached when integrating drone technology into an organisation's existing systems. Their perspectives are crucial for understanding how organisations balance ethical concerns with operational requirements in the context of drone technology.

iii. Theme Three: Ethical considerations linked to fair business practices and the broader implications for labour and employment practices

The literature review highlighted the broader implications of drone adoption on fair business and labour practices. Specifically, fairness in business practices emerged as an ethical imperative, shaping how decision-makers ensure a level playing field for market creation. Moreover, the review also emphasised that fair competition could become a significant ethical challenge, particularly between large organisations and Small, Medium, and Micro Enterprises (SMMEs). This was affirmed in the findings of Myres *et al.* (2022) where the importance of SMMEs as drivers of economic growth, innovation, and job creation. However, Makwara (2022) cautioned that larger firms could threaten the survival of small businesses in South Africa. Furthermore, the literature identified potential unethical business practices, including anti-competitive behaviour, as a looming risk with the adoption of drone technology.

A critical question emerging from this is how organisations can create a fair marketplace as the drone industry becomes more established. Additionally, organisations with the resources to drive the drone economy must tangibly support SMMEs within this economy, ensuring fair competition.

The importance of evaluating how decision-makers foster fair competition and consider societal and worker impacts of drone adoption also became a key concern. This extends to ensuring fairness in labour and employment practices amidst technological advancement, automation, and the rise of the gig economy. This was validated in the findings of Canon (2023), where the shortage of drone pilot skills was highlighted, and the risk of this that will result in a demand of such skills, thereby propelling the engagement with gig economy workers.

Further ethical concerns included how decision-makers, particularly in the cold supply chain industry, will maintain ethical labour practices while navigating the innovative landscape of drone technology. The literature review by SAFA (2023) indicated that automation, as a feature of drone technology, could lead to job displacement, particularly in roles involving routine or manual tasks. Thus, there is an ethical imperative to adopt drone technology cautiously, ensuring that the strategic benefits identified in the literature are shared equitably and address workforce transformation. Against this backdrop, the researcher identified the following key constructs, aligned with the research objectives, to assess theme three:

Table 3 Sub-Themes for exploration of Theme Three

Constructs (sub-themes)	**Description**	**Alignment to research Objective**
Ethical Imperative of Fair Business Practices	This theme highlights the importance of fairness in business practices as an ethical requirement, focusing on establishing a level playing field in market creation, especially for Small, Medium, and Micro Enterprises (SMMEs).	This aspect aligns with RO1, in so far that it identifies fairness in business practices as a critical ethical consideration, emphasising the need for a level playing field in a new regulatory environment. Moreover, this aspect aligns with RO 1 and RO2 through the suggestion of best practices for ensuring fair competition, crucial for developing an ethical decision-making framework.
Ethical Challenges and Anti-Competitive Behaviour	This theme addresses the potential for unethical business practices and anti-competitive behaviour associated with drone technology adoption, emphasising the need to support SMMEs and prevent larger firms from dominating the market.	This aspect aligns with RO1, in so far that it identifies anti-competitive behaviour as a crucial ethical issue needing attention in the new regulatory landscape. Moreover, it provides insight into best practices for preventing anti-competitive behaviour, informing the ethical decision-making framework (RO 2 &3).
Impact on Labour and Employment Practices	This theme explores the broader implications of drone adoption on labour practices, including the risk of job displacement due to automation and the rise of gig economy workers, highlighting the need for ethical labour standards.	This construct highlights the broader ethical considerations related to labour practices and job displacement due to drone technology (RO1) and focuses on best practices for maintaining ethical labour standards, which should be integrated into the decision-making framework (RO2&3).
Fairness in the Cold Supply Chain Industry	This theme focuses on the ethical challenges of maintaining fair labour practices within the cold supply chain industry amidst the adoption of drone technology, ensuring that the benefits of automation are shared equitably and ethically.	This construct points out the specific ethical challenge of maintaining fair labour practices in the cold supply chain industry with drone adoption (RO1). Moreover, it suggests best practices for upholding ethical labour standards in this industry, contributing to the decision-making framework(RO2&3).

From table 3, it necessitated a unit of analysis to probe for the value-laiden weighting that a decision maker places on their decisions. Moreover, this unit of analysis sought to gather insights from decision-makers who balance the strategic advantages of drone technology with ethical responsibilities related to fair competition, societal impact, and labour practices. These perspectives are essential to understanding how decision-makers manage the potential consequences of drone technology adoption, such as job displacement, the risk of exploiting gig economy workers, and broader societal implications.

Given these considerations, the unit of analysis was expanded to evaluate how decision-makers incorporate the principle of fairness into their business, labour, and employment practices. The focus was therefore directed to senior decision-makers within organisations adopting drone technology. Moreover, this included such senior decision-makers who have the capacity to make decisions involving compliance, technological integration, and operational strategies. Thus, the unit of analysis required individuals who would fulfil a critical role, in ensuring that ethical considerations remain central to the adoption and prospective use of drone technology.

iv. **Theme Four: Knowledge structures Informing best practices, guidelines and responsible use of drone technology.**

A key aspect of this theme was the reliance on third-party knowledge, which can introduce risks within an organisation. The literature review revealed that fostering responsible, ethical, and sustainable drone-based decision-making practices emerged as closely tied to knowledge structures informed by best practices and regulatory compliance. The review emphasised the importance of establishing a centralised drone knowledge center to enhance collaboration, mitigate the risks of misinformation, and facilitate informed decision-making among stakeholders. This was seen as especially crucial for organisations operating within the cold supply chain industry in South Africa.

Furthermore, this overarching theme emphasised the importance of continuous improvement, and adherence to established guidelines to achieve proactive and ethical decision-making. In light of in light of these findings, the investigations under this theme aimed to produce a best practice framework, which could serve as a risk mitigation tool for decision-makers. This framework was envisaged to help them navigate the complexities of adopting, integrating, and operating drone technology within the cold supply chain industry. Against this backdrop, the researcher identified the following key constructs, which served as sub-themes guiding data collection. These constructs are aligned with the research objectives as follows:

Table 4 Sub-Themes for exploration of Theme Four

Constructs (sub-themes)	Description	Alignment to research Objective
Knowledge Structures and Centralised Drone Knowledge Center	The importance of establishing a centralized drone knowledge centre to facilitate collaboration, reduce misinformation risks, and provide stakeholders with reliable data for ethical decision-making.	This sub-theme aligns with RO1 by addressing ethical risks related to misinformation, RO2 by establishing best practices for managing knowledge, and RO3 by providing a platform for monitoring and evaluating the quality of information used in decisions.
Knowledge Structures and Centralised Drone Knowledge Center	The importance of establishing a centralized drone knowledge canter to facilitate collaboration, reduce misinformation risks, and provide stakeholders with reliable data for ethical decision-making.	This sub-theme aligns with RO1 by addressing ethical risks related to misinformation, RO2 by establishing best practices for managing knowledge, and RO3 by providing a platform for monitoring and evaluating the quality of information used in decisions.
Risk Mitigation through Compliance and Best Practices	Addressing how compliance with industry regulations and the adoption of best practices can mitigate operational and ethical risks in drone-based decision-making within the cold supply chain industry.	This sub-theme aligns with RO1 by addressing the ethical necessity of regulatory compliance, RO2 by establishing best practices for risk mitigation, and RO3 by laying the foundation for a tool that monitors compliance with ethical standards.
Continuous Improvement and Ethical Decision-making	Emphasizes the importance of continuous improvement in decision-making processes to ensure ethical and responsible use of drones. This sub-theme focuses on how decision-makers can create adaptive frameworks that evolve with the technology and regulatory environment.	This sub-theme aligns with RO1 by addressing the need for ongoing ethical reflection, RO2 by identifying best practices for continuous adaptation, and RO3 by ensuring that monitoring tools evolve to meet new ethical challenges.
Sustainability and Responsible Growth in Drone Technology	Examines how sustainable practices and responsible growth can be embedded into the adoption and operation of drones, ensuring that ethical considerations guide long-term strategy in the cold supply chain industry.	This sub-theme aligns with RO1 by addressing long-term ethical considerations, RO2 by establishing sustainable best practices, and RO3 by ensuring that sustainability is integrated into scalable monitoring tools for long-term ethical assessment.

In light of the inquiries made under Theme Four, the unit of analysis necessitated senior managers and operational managers that would serve as key decision-makers involved in or influencing the prospective drone adoption and use of drone technology within the cold supply chain industry in South Africa. Additionally, the unit of analysis centred on those responsible for strategic decisions regarding the adoption, integration, and operation of drone technology. These decision makers were deemed to prospectively fulfil a pivotal role in ensuring compliance, knowledge sharing, and ensure the ethical implementation of best practices as expounded in the literature review.

i. Synthesis of Key Sub-themes Emerging from the Literature Review

Each theme that emerged and its associated sub-themes contributed to an understanding of how decision-makers must navigate the complex landscape of drone adoption. To this end, a synthesis of these sub-themes informed the collection of data by guiding the focus areas and ensuring alignment with the identified sub-themes. Each sub-theme informed the design of the data collection process and methods to explore key ethical and operational challenges. Against this backdrop, the sub-themes created a data collection framework as follows:

Table 5 Data Collection Guiding Framework

Constructs (sub-themes)	Description	Data Collection Focus
Theme One: The critical importance of discerning capabilities and functionalities between remotely operated and automated drone		
Differentiation of Drone Types within decision making	Highlighting the distinct operational and functional differences between remotely operated and autonomous drones.	This theme informed the data collection process by guiding the creation of questions that explored how decision-makers navigate the differences between these two types of drone categories, focusing on their operational and ethical implications.
Ethical Constructs underpinning drone-based decisions	Exploring how respect for autonomy and informed consent are impacted by the type of drone technology used. Examining moral thinking and behaviour in organisational contexts when deploying drones for data collection, including unintended data capture.	This theme informed the data collection process by shaping the focus of questions on how a decision maker would address ethical challenges such as ensuring informed consent and preventing unintended data capture.
Legal Implications associated with drone based decisions	Analysing the legal ramifications of drone operations, particularly regarding issues such as spying activities and *Actio Injuria* in South African law.	This theme informed the data collection process by focusing the data collection on how a decision maker would mitigate legal risks, such as spying activities, and ensure compliance with relevant laws such as Actio *Injuria*.
Theme Two: Ethical considerations linked to the technological integration of drone technology within an organisation's existing technological estate		
Interoperability Challenges	Ethical issues arising from the technical and operational integration of drones into existing systems.	This theme informed the data collection process by focusing the inquiry on the ethical and technical challenges related to drone interoperability with other organizational systems.
Transparency in Decision-Making and Data Management	The imperative for transparency to mitigate risks such as Software Development Waste (SDW), devious actions, and resource wastage.	This theme informed the data collection process by shaping the questions to explore how a decision maker would maintain transparency in data management and decision-making, especially concerning the prevention of software development waste (SDW).
Data-Lifecycle Management (DLM)	Ethical implications concerning privacy and data security during the processing of drone-based data throughout its lifecycle.	This theme informed the data collection process by guiding the focus on privacy and data security concerns throughout the data lifecycle, from collection to storage and dissemination.
Theme Three: Ethical considerations linked to fair business practices and the broader implications for labour and employment practices		
Ethical Imperative of Fair Business Practices	This theme highlights the importance of fairness in business practices as an ethical requirement, focusing on establishing a level playing field in market creation, especially for Small, Medium, and Micro Enterprises (SMMEs).	This theme informed the data collection process by focusing on how a decision maker on behalf of an organisations would ensure fair competition and market creation, and how they would incorporate fairness into their business strategies.
Ethical Challenges and Anti-Competitive Behaviour	This theme addresses the potential for unethical business practices and anti-competitive behaviour associated with drone technology adoption, emphasising the need to support SMMEs and prevent larger firms from dominating the market.	This theme informed the data collection process by focusing on exploring decision makers in how larger firms would prevent anti-competitive behaviour, and how they support smaller businesses in the context of drone adoption.
Impact on Labour and Employment Practices	This theme explores the broader implications of drone adoption on labour practices, including the risk of job displacement due to automation and the rise of gig economy workers, highlighting the need for ethical labour standards.	This theme informed the data collection process by guiding the focus on understanding the ethical implications of drone adoption for labour, particularly job displacement and the rise of gig economy workers.
Fairness in the Cold Supply Chain Industry	This theme focuses on the ethical challenges of maintaining fair labour practices within the cold supply chain industry amidst the adoption of drone technology, ensuring that the benefits of automation are shared equitably and ethically.	This theme informed the data collection process by focusing the inquiry on how a decision maker on behalf of an organisation would ensure that the benefits of drone technology are equitably shared and that labour practices remained ethical.
Theme Four: Knowledge structures Informing best practices, guidelines and responsible use of drone technology		

Knowledge Structures and Centralised Drone Knowledge Center	The importance of establishing a centralised drone knowledge center to facilitate collaboration, reduce misinformation risks, and provide stakeholders with reliable data for ethical decision-making.	This theme informed the data collection process by focusing on how knowledge centres that a reliance on reputable and tested information has, can reduce misinformation risks and support ethical decision-making through reliable data.
Risk Mitigation through Compliance and Best Practices	Addressing how compliance with industry regulations and the adoption of best practices can mitigate operational and ethical risks in drone-based decision-making within the cold supply chain industry.	This theme informed the data collection process by focusing on how organisations mitigate operational and ethical risks by adhering to compliance standards and best practices.
Continuous Improvement and Ethical Decision-making	Emphasizes the importance of continuous improvement in decision-making processes to ensure ethical and responsible use of drones. This sub-theme focuses on how decision-makers can create adaptive frameworks that evolve with the technology and regulatory environment.	This theme informed the data collection process by focusing the inquiry how a decision maker on behalf of an organisation can incorporate continuous improvement into their ethical decision-making processes to adapt to evolving technology and regulatory environments.
Sustainability and Responsible Growth in Drone Technology	Examines how sustainable practices and responsible growth can be embedded into the adoption and operation of drones, ensuring that ethical considerations guide long-term strategy in the cold supply chain industry.	This theme informed the data collection process by focusing on how organisations integrate sustainability into their drone technology adoption strategies and ensure that growth is ethically responsible.

2.4.3. Appraising the Theoretical Framework of the study

The data collection framework, guided by the sub-themes stemming from the literature review, provided the foundation for the thematic analysis in Chapter Four. While the analysis provided a structured presentation of findings, a composite theoretical framework[124] was necessary to interpret those findings in Chapter Five. This necessity emerged from the recognition that the interpretation of the thematic analysis findings required an integrated approach. Moreover, an approach that transcended beyond ethics to encompass the broader societal, cultural, and governance implications of drone technology.

From a continuity perspective, the literature review established an ethical evaluation framework anchored in the definitions of ethics by Menapace (2019) and Lane (2019). Menapace (2019) defined ethics as a method of abstract reasoning about norms and values, where conflicting values are balanced, and moral arguments are constructed to justify actions. Lane (2019) expanded this view by linking ethics with technology, describing it as the creative application of knowledge to tasks involving humans and machines, directed toward sustainable goals. From the findings of the literature review, the researcher observed a strong connection that exists between the arguments put forth by Lane (2019) and Valkenburg (2013). This connection lies in the idea that technological culture can be influenced by moral discursive order, and vice versa. This suggested that the development and use of technology can shape societal values and ethical considerations, just as moral norms and ethical discussions can impact the development and utilisation of technology. These two domains thus appeared to mutually influence and shape each other, aligning with the tenants of technoethics as a core theoretical framework.

Technoethics therefore emerged as the appropriate framework, allowing for the evaluation of practical consequences of adopting and using drones commercially within South Africa's cold supply chain industry. To give effect to this theoretical lens, "Technoethics" was officially coined by Mario Bunge in 1970, as he advocated for heightened moral and social responsibility among technologists and engineers regarding their technological creations (Luppicini, 2018). Since the inception of this ethical framework, numerous scholarly discourse and ongoing ethical debates have contributed to the development of the field of Technoethics. Fan *et al.* (2018) defines technoethics as an interdisciplinary research field dedicated to exploring the ethical dimensions of technology and its pervasive impact on everyday transactions. Conversely, Dhirani *et al.* (2023) characterises technoethics as a research domain that integrates theories and methodologies from diverse fields, including communication systems, sociology, innovation studies, ethical theories, and principles. Additionally, the findings of Valkenburg

124 Garvey and Jones (2021) defines a theoretical framework as tool that describes concepts and relationships of a given phenomenon under study, and is useful in situations where there is copious data to be explored. The authors go on to assert that a theoretical framework provides a signpost (theoretical orientation, concepts and constructs) in pursuit of answering the research question and address the research objectives of the study through the analysis and interpretation of data that are congruent to the phenomenon under study.

(2013), asserts that technoethics highlights the inseparable interconnection between technological infrastructure and culture. This delineation accentuated how technoethics as a discipline contemplates the practical considerations into the trajectory of technology development such as drones.

However, while technoethics presented an overarching strength to interpret the findings of the data analysis in a socio-technological context, it was necessary address the limitations of technoethics. Moreover, its ability to fully address broader social, and moral dimensions that arise in complex, real-world contexts. To address these shortcomings and to broaden the interpretation of the findings, the supporting theoretical lenses of social constructivism and prospect theory were leveraged. The lens of social constructivism was deeply concerned with how decision-makers would navigate ethical, legal, and operational challenges within socially complex environments. Wolfers (2024) explains that the *social* in social constructivism highlights that this construction of reality is not an individual process but occurs collaboratively through communication between members of a society. Moreover, together, members of a society make sense of their social world and construct an "intersubjective common-sense world" including shared meanings and perceptions of their surroundings. This collaborative construction has passed on over generations through socialisation and is historically conditioned, meaning it depends on the historical context. In the context of this study, this theoretical lens explained how ethical decision-making is influenced by social and cultural contexts, adding depth to the understanding of stakeholder perspectives and societal norms.

In light of the central claim[125] of this study, it therefore necessitated a lens that would explains the risk-averse strategies employed by decision-makers facing uncertainty in adopting new technologies. To this end, the lens of prospective theory was leveraged. Ansari (2024) expounds that prospect theory as a theoretical lens explains the behaviour of individuals in making decisions based on perceived gains and losses. Moreover, that this theory asserts that individuals value gains and losses differently and make decisions by comparing perceived gains and losses relative to a reference point. Thus, prospective theory assisted to highlight how decision-makers should manage risk and uncertainty. Moreover, this lens assisted to explain their preference for risk-averse strategies.

However, given the ethical nature of decision-making involved in the objectives of this study, it necessitated a reasoning framework, to understand the ethical nature of the decision making and the approach to ethics by a decision maker. To this end, the researcher elected to leverage the ethical reasoning framework used in the literature review comprising the typology of ethics namely: *Normative ethics, Applied Ethics and Meta-Ethics*. Further to the definition of these ethical theories in the literature review, these lenses assisted to interpret the findings as follows:

Normative ethics
From a deontological perspective, this lens assisted to understand how decision-makers have a moral duty during decision making. Moreover, this theoretical lens offered practical guidelines for how decision-makers ought to act when faced with ethical dilemmas, emphasising duties related to fairness and responsibility.

Applied Ethics
The lens of applied ethics was leveraged to focuses on creating ethical guidelines for decision making, thereby asserting there must be a long-term ethical sustainability approach in the decision making. To this end, applied ethics addressed the ethical challenges that could potentially arise during the implementation of drone technology, and how a decision maker should endeavour to ensure that ethical principles are applied in practice.

Meta-ethics
This lens was employed to understand the moral obligation of a decision maker through the lens of justice and fairness. Moreover, how ethical principles should guide a decision maker. Therefore, meta-ethics as a theoretical lens explored the nature of ethical principles, questioning whether ethical concepts are universal or context-specific.

Figure 9 Ethical Reasoning Approach of the Theoretical Framework

125 The central claim of this study is that in light of restrictive conditions impeding the commercial exploitation of drone technology in South Africa, this study contends that where these conditions are relaxed, that new ethical challenges previously absent in the current environment will emerge.

However, the researcher observed a limitation of this ethical reasoning framework. Notably, the ethical reasoning framework duplicated from the literature review was limited in detecting whether decision-makers would resort to cognitive shortcuts. Moreover, the ethical framework did not expound on how such shortcuts may lead to ethical risks, particularly those highlighted by prospect theory. This assertion aligns to the postulation of Wu and Ding (2021), that a decision-maker in the real-world context cannot consider all alternatives because of limited attention. In light of this, the authors proposed a satisficing choice model to describe the choice procedure based on the incomplete preferences under the limited attention of the decision-maker. Thus, for this study, the theoretical lenses of satisficing heuristic revealed the possibility of decision-makers opting for "good enough" ethical solutions rather than optimal ones, especially when under time or resource constraints. However, the researcher was cognisant of how decision-makers might rely on readily available or recent information, potentially skewing ethical judgments by focusing on prominent risks while overlooking less visible yet significant ethical challenges.

To this end, the researcher employed the lens of availability heuristic. Hoffman (2024) describes this theoretical lens as an *availability bias* lens that refers to the tendency to give more credence to information that we are already aware. This Hoffman (2024) posit is especially true if that information is dramatic or emotionally charged. Thus, the lens of availability heuristic highlights where a skewed perception of reality exits, and how this may influencer decisions based on the information most readily available, rather than a balanced overview of all relevant data. Therefore, to uncover the risks associated with perceived ethical choices made under pressure, availability heuristic assisted to better understand how cognitive biases may influence decision-making. These complementary lenses enriched the technoethical approach to theoretically interpreting the findings on the ethical challenges emerging from the findings. Thus, in light of the technoethics interpretive framework that was supported by a multi-disciplinary theoretical lens, it necessitated a composite theoretical framework. Among the various academic definitions of a composite theoretical framework, the definition by Skeith and Gallagher (2019) was found to align with the context of this study. They define a composite theoretical framework as a multidimensional construct that combines two or more data sources into a single measure. Furthermore, they suggest that such frameworks summarise complex, multi-dimensional realities, supporting decision-makers in navigating these complexities. In the context of this study, the perspectives of a diverse unit of analysis can be considered the "data sources" that needed to be integrated into a unified framework.

However, Skeith and Gallagher (2019) also identified important limitations to composite frameworks. These include: (1) the risk that aggregation may disguise important variations across cases, leading to simplistic or inappropriate policy conclusions, and (2) the potential for complexity to mask poor measurement, a weak conceptual framework, or biased intentions. To overcome the limitations, the core theoretical framework lens of technoethics was supported by the lenses of social constructivism, prospect theory, heuristics theory, meta-ethics, normative ethics, and applied ethics with its theoretical role expounded earlier. Against this backdrop, this multi-lens framework capitalised on the strengths of each theory, working in harmony to avoid the pitfalls of aggregation by maintaining contextual specificity. It also mitigated bias by ensuring that multiple, balanced perspectives were applied to the ethical evaluation, leading to a more thorough and ethically robust interpretation of the findings. Against this backdrop, to enrich the findings of the study, the technoethics framework was used to assess whether the findings from the study support, expand upon, or challenge the themes stemming from the literature review findings. This was to ensure that the findings align with existing theoretical frameworks or introduce new insights. Moreover, this approach would also asset to make the findings more relevant and impactful as well as to provide an integrative understanding of the ethical challenges and the ethical considerations that a decision maker would need to navigate the prospective challenges that emerge from the findings of this study. To this end, the interpretative framework sought to assess whether the findings support, expand upon, or challenge the following themes established within this composite theoretical framework:

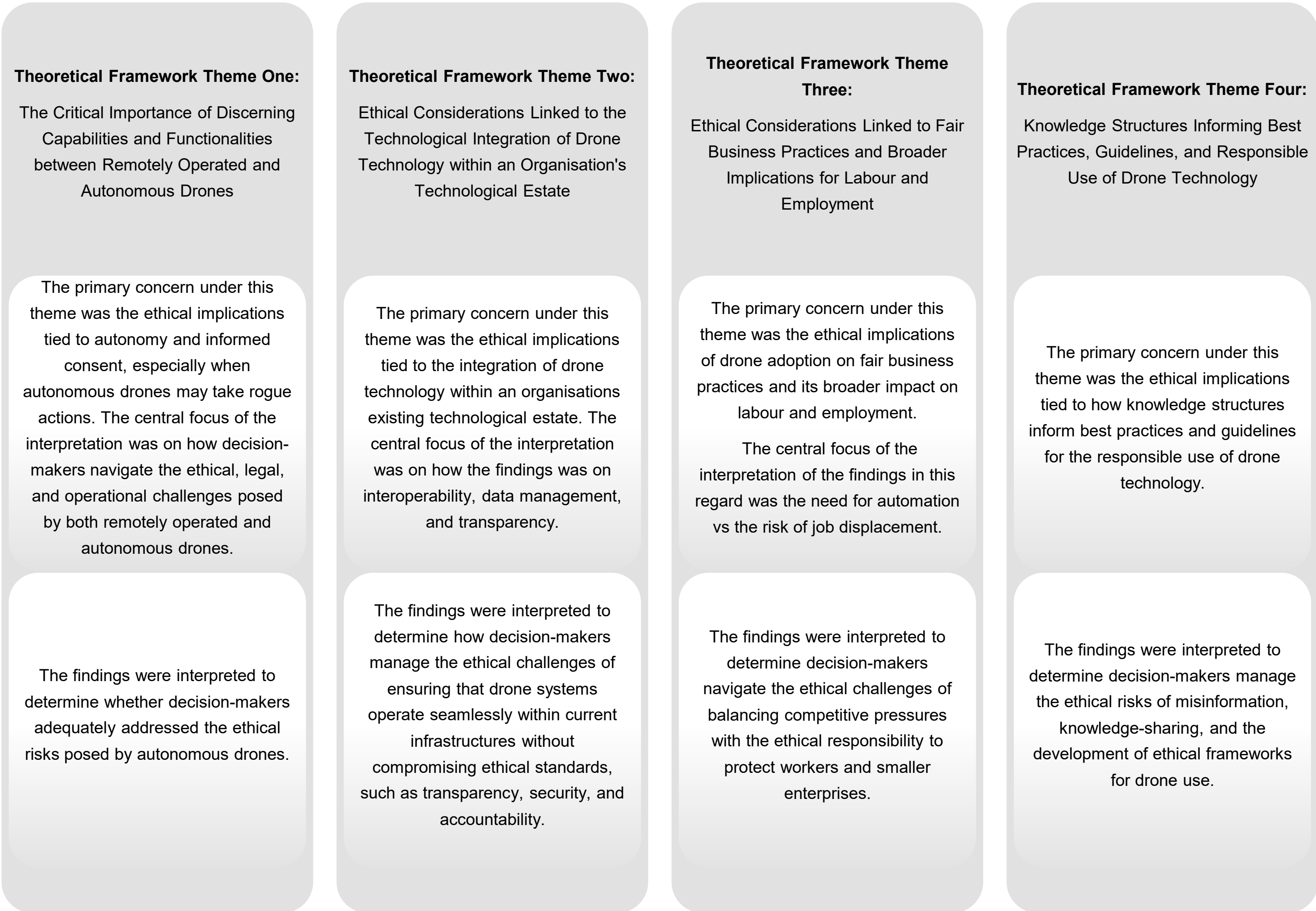

Figure 10 Theoretical Framework Themes of the study

The composite theoretical framework positioned technoethics as the primary lens for interpreting the ethical challenges associated with drone technology adoption. Technoethics also served as the foundational perspective, while supplementary lenses such as social constructivism, prospect theory, heuristics, normative ethics, applied ethics, and meta-ethics were integrated to provide a more well-rounded approach to analysing and interpreting of the findings study. Each of these theoretical lenses contributed to a richer interpretation of the diverse perspectives on the ethical issues, ensuring a robust and rigorous evaluation of how the findings challenge, expand or support the themes of this composite theoretical framework. Moreover, this theoretical framework formed the analytical basis for understanding the complexities of decision-making processes and the ethical dilemmas posed by drone technology.

2.4.4. Conceptual Framework

The transition from a theoretical framework to a conceptual framework can be understood as a shift from interpretation to action. Mensah (2024) validates this explaining that a conceptual framework outlines how a research problem will be investigated, offering a structured approach to understanding the subject under study. A conceptual framework not only clarifies the relationships between key concepts but also organizes them logically, providing a visual or mental map of how these ideas connect within the study. Given the complexity and multidimensional nature of the ethical challenges identified in the findings, a conceptual framework became essential for guiding decision-makers in applying ethical principles to practice. This framework was designed to bridge theoretical interpretations and operationalize the key ethical considerations emerging from the research.

A critical component in shaping this framework was the role of the unit of analysis, which includes decision-makers and key stakeholders responsible for the adoption, integration, and governance of drones within their organizations. These decision-makers, the primary unit of analysis, face the challenge of navigating ethical dilemmas while balancing operational efficiency and societal expectations. Their perspectives provide valuable real-world insights into ethical decision-making processes, particularly in areas such as autonomous drone capabilities, labour impacts, and data management. Thus, the conceptual framework was designed to be both practical and actionable, serving as an operational model that demonstrates how the findings, research objectives, and theoretical interpretations converge in practice. It acted as a roadmap, allowing the study to explore the complexities of drone-related decisions. The subsequent visualisation of the conceptual framework further operationalised the study's theoretical framework, aligning it with the research objectives in a clear and structured manner.

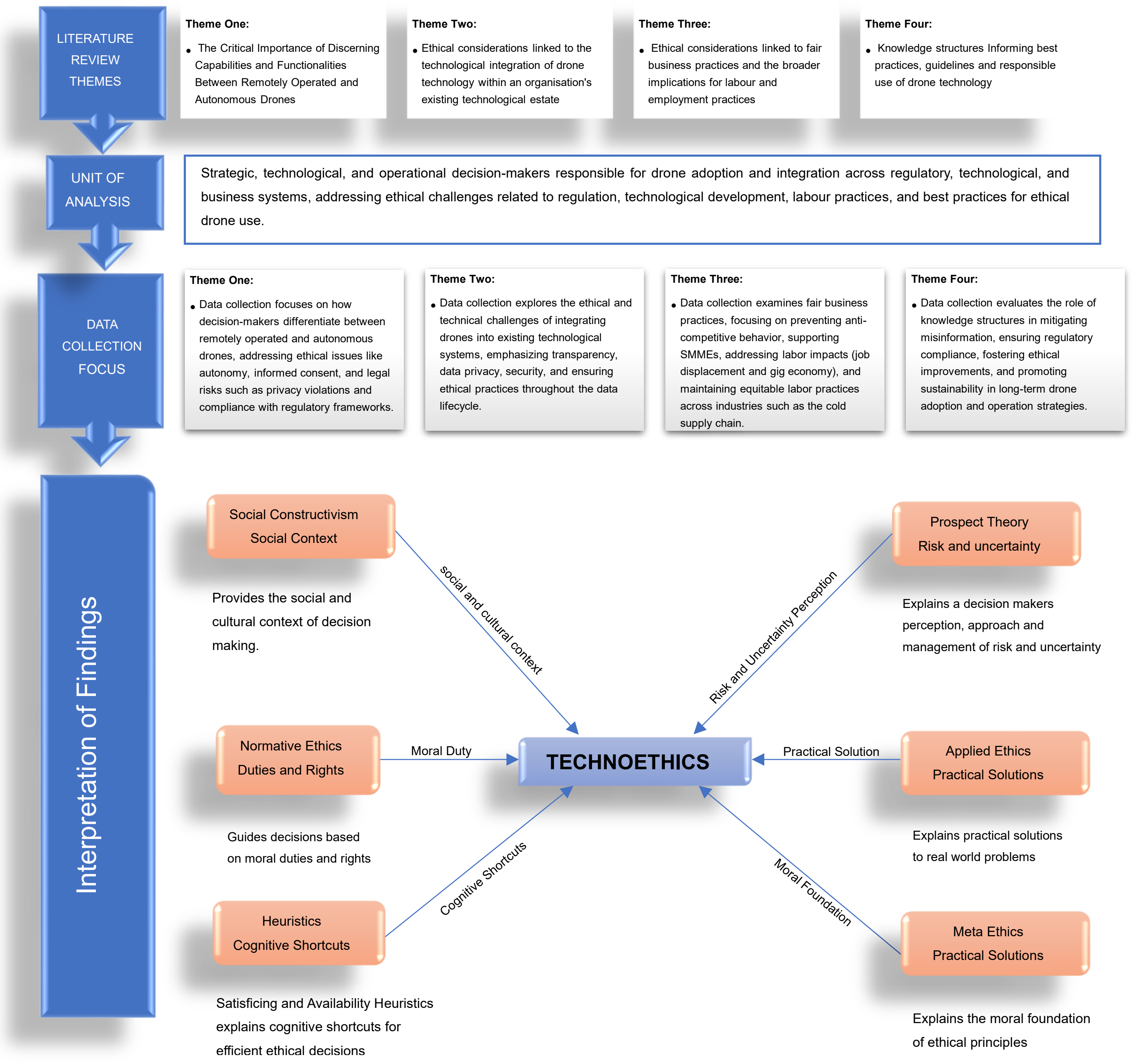

Figure 11 Conceptual Framework of the Study

CHAPTER THREE: RESEARCH ORIENTATION AND METHODOLOGY

1. Introduction

Chapter Three serves as a pivotal juncture in the research journey of this study. Transitioning from the theoretical framework, this chapter will delve into the methods used for the practical execution of this research. To organise how the production of knowledge was generated from this research study, it was essential to establish the methodological path that this research followed. Figure 12 below illustrates the logic of the methodology used to support this study:

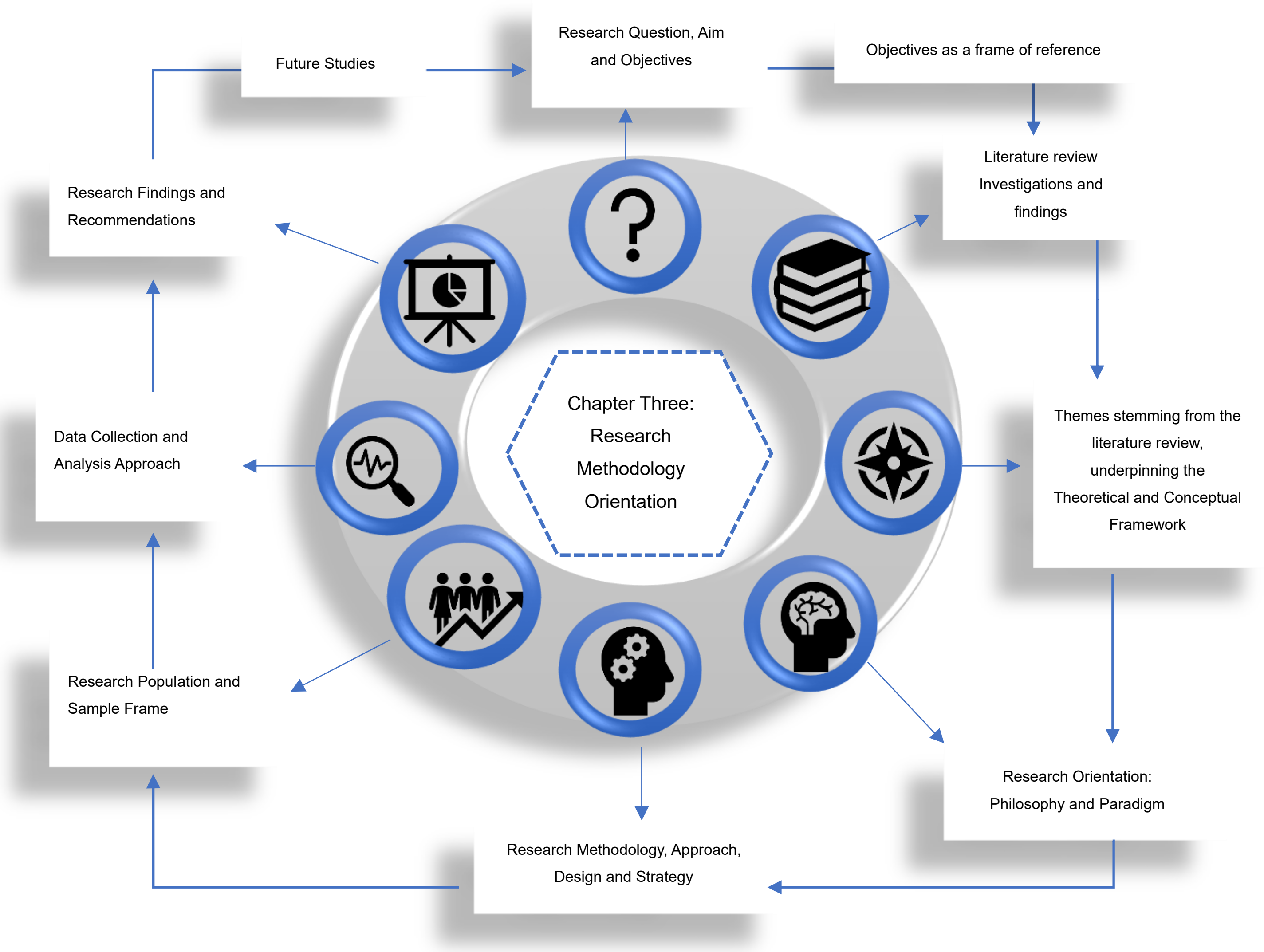

Figure 12 Explanation of research phases of this study

2. Research Philosophy and Paradigm

Cariaga (2023) expounds that the word "Philosophy" finds its etymological root in the compound Greek term "Philosophia,"[126] which means "love of knowledge." In the context of research, this etymological origin of philosophy represents an intrinsic quest for knowledge, shaping the intellectual foundation that guides the research process, as illustrated in Figure 9. This foundation is crucial for exploring the central claim of this study: to understand and address the ethical challenges decision-makers in South Africa's cold supply chain industry may face when adopting, integrating, and using drone technology for commercial operations within a permissive regulatory environment. In exploring a philosophical perspective on drone technology, Chamayou (2015) noted

126 composed of the affix "Philo," which signifies "wisdom" or "friendship," and "sophia,"

that drones fundamentally transform various dimensions, including psychic, moral, and physical spaces. The author also highlighted that their emergence necessitates new ethical norms. Given the futuristic setting of the study, these assumptions regarding ethical norms had to be probed. As such, the theoretical framework outlined in Chapter Two played a pivotal role in shaping the philosophical underpinnings of this research. The composite theoretical framework, informed by mainly by technoethics and social constructivism, served as a lens for exploring the subjective experiences and interpretations of decision-makers in the cold supply chain industry of South Africa. This was especially imperative given the prospective ethical challenges highlighted in the literature review posed by drone technology.

To articulate the considerations taken into account, the researcher first considered phenomenology as a research methodology. Kaufmann and Alhazmi describe phenomenology as a philosophy focused on how human beings extract meaning from the world through personal experience. While phenomenology could have provided insights into individual experiences with technology, it was deemed unsuitable because it lacked the broader social constructivist perspective necessary for understanding the broader social and ethical context. Subsequent to this, the researcher considered critical realism as an alternative. Stutchbury (2021), notes that critical realism focuses on explaining social structures and agency, which was promising but ultimately did not delve deeply enough into the subjective ethical concerns emphasized by technoethics. Critical realism's focus on causal mechanisms would not have captured the subjective, interpretative processes essential to understanding ethical perceptions in the cold supply chain industry. The researcher eventually selected interpretivism as the most suitable research philosophy. Interpretivism focuses on understanding social interactions through individual beliefs, motivations, and reasoning (Nickerson C. , 2023) Moreover, this philosophy perspective emphasises the importance of individual meanings and socially constructed realities, thereby aligning with the theoretical framework's focus on the subjective interpretations of decision-makers. Interpretivism, therefore, complemented the theoretical framework by acknowledging the inherent subjectivity involved in addressing ethical challenges in drone technology.

As the research philosophy was situated within a social constructivist paradigm, it became crucial to recognise the importance of understanding individual perspectives within a socially constructed reality. This recognition demanded a research paradigm capable of articulating these perspectives effectively. Alele and Malau-Aduli (2023) define a research paradigm as a set of philosophical assumptions that orient a researcher's worldview and approach to engaging with research. These assumptions become the lens through which a researcher views the world, shaping decisions about methods for data collection and analysis. Moon and Blackman (2017) goes on to explicate that the philosophical assumptions that orientate a researcher's worldview and approach to engaging with the research is demarcated into four branches namely the ontology, epistemology, axiology and the methodological assumptions. To this end, the philosophical assumptions of this study which was expressed and grounded in a social constructivist research paradigm was expounded as follows:

2.1. Ontology

Sugathadasa (2017) conceptually explains that the etymological logic of the concept of ontology as follows:

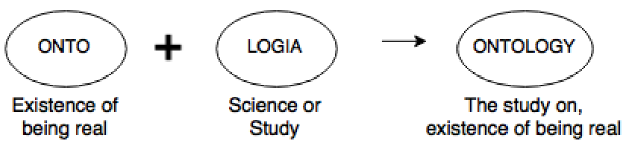

Figure 13 Concept of Ontology
Source: (Sugathadasa, 2017)

Sugathadasa (2017) explicates conceptually defines ontology as the study of what exists within a specific domain, aiming to describe and understand the underlying structures that shape individual and group perspectives. Building on this, Ugwuet *et al.* (2021) assert that ontology pertains to the foundational ideas that inform the examination of key themes and patterns for data analysis and interpretation. In this study, an interpretivist philosophy underpinned by a social constructivist paradigm informed an ontological stance that recognises the socially constructed nature of reality. This stance assumes that ethical considerations for drone-based decision-making are not inherent, but are actively constructed through social interactions, interpretations, and shared meanings within the South African cold supply chain industry. Thus, for this study, its ontology acknowledges that the reality of decision-makers in this industry is shaped by the ethical challenges they encounter, alongside the social processes and interpretations that occur within their operational environment.

In alignment with the research objectives of the study, the ontological position asserts that ethical frameworks and best practices are socially constructed through interactions in a dynamic industry. For example, research objective one explores how socially constructed ethical frameworks influence decision-making processes in adopting drone technology. Similarly, research objectives two and three examine the evolution of best practices and the continuous improvement of ethical decision-making, shaped by social dynamics and the changing technological landscape. Therefore, the ontological stance emphasises that the ethical considerations, frameworks, and decision-making tools are socially constructed within the specific regulatory and operational context of South Africa's cold supply chain industry.

Epistemology

Epistemology, as defined by the Britanica encyclopaedia (2023) refers to the philosophical study of the nature, origin, and limits of human knowledge. The concept of epistemology is derived from the Greek word epistēmē (“knowledge”) and logos (“reason”) and therefore referred to as the theory of knowledge (Martinich & Stroll, 2023). Moon and Blackman (2017) explain that epistemology addresses the validity, scope, and methods for acquiring knowledge, posing questions such as: What constitutes a knowledge claim? How is knowledge acquired? And how can its transferability be assessed? For this study, the epistemological foundation is shaped by the relationship between the researcher and the participants, as described by Moon and Blackman (2017). This recognition of the diversity of perspectives is crucial to understanding decision-making processes in the context of drone technology. The significance of this recognition was supported by Carneiro (2021), who emphasised that epistemology is not static but evolves alongside new branches of knowledge, particularly in emerging fields like drone technology. Against this backdrop, the epistemological stance of this study was grounded in an exploratory and anticipatory approach, acknowledging the importance of co-constructing knowledge with research participants. This approach ensures that diverse perspectives are considered when understanding the ethical challenges and decision-making processes surrounding drone technology in South Africa.

2.2. Axiology

Deane (2018) explicates that “*Axiology*”, derived from the Greek words "axios" (value) and "logos" (study) serves as the philosophical inquiry into the nature of value. In simpler terms, axiology delves into what is considered good or bad in life and what holds worth or significance to individuals and societies. The author goes on to explain that the axiological assumption in research encompasses the examination of ethics, which deals with moral principles and theories. Against this backdrop, the axiology of this study was premised on value-driven decision-making[127], and adopted a axiological framework encompassing five ethical considerations namely: 1) an ethical commitment toward the inquiry of the study; 2) a value-driven inquiry that aimed to support the ethical commitment to the study; 3) a promotion of ethical frameworks that served to contribute to the body of drone knowledge; 4) humanistic values that dealt with the ethical approach during data collection and, 5) striving for ethical excellence which reinforced the commitment to the ethically inclined commitment to the study. In light of this, the framework employed by this study recognised the importance of ethical considerations in shaping organisational practices and societal well-being. To expound on the axiological framework employed for this study, table 06 provides context as follows:

Ethical Commitment
• In terms of the "*Ethical Commitment*" to the study, the axiological stance was underpinned by an ethical commitment to the identification and analysis of the potential ethical challenges arising from the relaxation of restrictive conditions on drone technology usage. This commitment reflected a broader recognition of the moral imperative to anticipate and address ethical challenges that may emerge in the pursuit of commercial benefits, that implicates ethical considerations that a decision maker would need to navigate during their decision making process.
Value-driven Inquiry
• In terms of the "*Value-driven Inquiry*" ethical consideration, the axiological stance of the study acknowledged the intrinsic value of ethical decision-making frameworks in the context of emerging technology and other business science ethically driven decision making frameworks, that served to guide organisational behaviour toward ensuring the responsible use of drone technology. This ethical consideration recognised that ethical considerations are not merely abstract concepts, but embody real-world values that shapes organisational culture, stakeholder relationships, and impacts on societal values.
Promotion of Ethical Frameworks
• In terms of the "*Promotion of Ethical Frameworks*", for this ethical consideration, the study underpinned its aim and objectives to underscore a commitment to promoting ethical frameworks tailored to the unique challenges of drone-based decision-making within the cold supply chain industry. Through rigorous evaluation and examination of established ethical considerations and best practices, the study sought to identify pathways for ethical decision-making that prioritised the well-being of stakeholders and society.
Humanistic Values
• In terms of addressing "*Humanistic Values*" as an ethical consideration, it was implicit within the axiology of this study that a humanistic orientation that values the dignity, autonomy, and rights of individuals affected by drone technology adoption, was underscored by a human-centric approach. Underscoring the importance of considering the broader societal implications of a decision maker at an organisational level, and the ethical responsibilities of industry stakeholders.
Striving for Ethical Excellence
• In terms of "*Striving for Ethical Excellence*" as an ethical consideration, the axiological stance of the study was characterised by a commitment to excellence in the context of ethical decision-making which underscored the nature of the study. By developing a technoethics ethical decision making framework as a scalable monitoring and evaluation tool for ongoing drone based ethical decision making assessments, the study aimed to foster a culture of continuous improvement and ethical reflexivity as a demonstration to an organisation operating in the cold supply chain industry.

Table 6 Axiology Framework of the study

In light of this value-driven axoglial framework, the researcher embraced value-driven judgements to underpin the expert decision-making required by the researcher for this study, as well as a commitment to humanistic principles.

127 Hall and Davis (2007) describes value-driven decision-making as a view of the decision environment from multiple perspectives enhances the decision-maker's ability to make better-informed choices. This can be driven by a new or novel set of circumstances; where an individual may be forced to make decisions with limited information or time available for analysis. In such contexts, the set of alternative solutions developed may be greatly affected by the personal values and the perspective those values precipitate.

2.3. Methodology of the Research

Building on the articulation by Alele and Malau Aduli (2023) regarding the role of a research methodology**,** Heath (2023) asserts that the research methodology of a study encompasses the underlying strategic approach guiding the research endeavour. The author goes on to distinguish the research “method” of a study as the tools and techniques employed to gather and analyse data for the benefit of the study. This distinction facilitated a pathway for the researcher to embed a foundation for future researchers to understand the overall approach used in this study, allowing for potential replication in different contexts and ensuring the transferability of its findings. Against this backdrop, the selection of a methodological framework for this study was contingent upon several considerations *inter alia*: the nature of the research, the research questions posed, and the type of data to be collected (Sileyew, 2019). These considerations influenced the choice of appropriate research methods, strategies, and tools, ensuring that the research process was coherent and effective. Given the interpretivist philosophical orientation of this study, coupled with the parameters outlined in the theoretical framework, a qualitative research methodology was adopted.

This qualitative methodology was well-suited to support the exploration of the subjective decision-making processes of decision-makers within the cold supply chain industry. Moreover, it enabled the researcher to examine the subjective realities of participants, particularly those navigating prospective ethical challenges arising from the potential relaxation of regulations governing commercial drone use. Employing a qualitative methodology, the study could gather rich data and explore emerging ethical concerns in detail. Having established a qualitative research methodology as the guiding methodology of the study, the following sections will outline the specific research methods that will be employed by this study to operationalise the objectives of the study effectively.

3. Research Methods of the study

3.1. Research Approach

In light of the reasoning approach articulated in the theoretical framework, this study necessitated a research approach capable of addressing the inherent complexity associated with decision-making about drone technology. To achieve this, an inductive research approach was employed. Okoli (2021) explains that three main research approaches exist namely: deductive, inductive, and abductive. The author goes on to expound that deductive reasoning commences with a general premise and derives specific conclusions from it. Conversely, inductive reasoning starts with specific observations and extrapolates general conclusions from them. Abductive reasoning operates by commencing with incomplete observations and employing the most plausible explanation to develop hypotheses or explanations that best account for the observed phenomena.

The decision to adopt an inductive approach stems from the necessity to explore the emerging ethical challenges directly from the qualitative data, ensuring that the voices and experiences of participants guide the development of ethical insights. Unlike a deductive approach, which tests pre-existing hypotheses, the elected inductive approach facilitates the discovery of new patterns and ethical considerations that may not have been previously identified in the existing literature, especially given the novel context of drone technology adoption. Furthermore, this research approach acknowledges that while the theoretical framework provided ethical lenses such as normative ethics, applied ethics, and meta-ethics, that the real-world decision-making processes could be influenced by cognitive constraints.

The need to understand how decision-makers handle complex ethical choices, often under pressure, informed the study's commitment to integrating decision-making theories such as satisficing and the availability heuristic. These perspectives allow the research to go beyond abstract ethical reasoning and delve into the practical cognitive biases and constraints that shape ethical decision-making in real-world contexts. Thus, employing an inductive research approach was designed to extrapolate ethical challenges, cognitive biases, and practical constraints directly from the qualitative data. This approach was essential for capturing the intricate realities faced by decision-makers and for offering a view of how ethics and practicality link in their decision-making processes. Furthermore, aligned with the central claim of this study and its research objectives, the inductive approach adopted by this study served as a methodological cornerstone of the validity and reliability of this study.

3.2. Research Design

Premise on the research philosophy, the research approach and the qualitative nature of this study, it necessitated that the researcher considers between an appropriate research design for this study. The researcher considered a case study and an exploratory research design as a suitable qualitative design for this study. Starting with the consideration of a case study research design, Asenahabi (2019) explicates that this research design involves an in-depth analysis of a particular case, such as an individual, organisation, or event. Case studies are useful in exploring complex issues within a real-life context, with the aim of providing a rich and detailed understanding of the topic. In relation to an exploratory research design, this design is often used when little is known about the research topic, and the aim is to gain a better understanding of the research problem or address to address the research objectives of the study.

When contrasted with an exploratory research design, Dudovskiy (2024) explicates that this type of research design is usually employed to explore research problem that has not been clearly defined yet. Moreover, this research design is used to determine the nature of the problem, however, an exploratory research design is not intended to provide conclusive evidence but assist toto have a better understanding of the problem. Against this backdrop, for this study, an exploratory research design was selected to answer the research question of the study and likewise, to address the aim and objectives of the study. This research design, based on its exploratory nature, was deemed suitable to dissect the constructs underpinning the themes articulated within the theoretical framework. When considering the latter research designs, a case study research design, albeit was not deemed a best fit for the aim of the study and its prospective nature. The researcher deemed a case study research design to be more focused on understanding specific instances rather than examining overarching themes thereby coming into conflict with the theoretical framework of the study.

In light of these considerations, employing an exploratory research design was flexible in its design given the prospective nature of the research and the need to navigate prospective ethical challenges in a relatively unexplored domain within South Africa. Furthermore, this study necessitated a research design that allowed for the exploration of novel ethical dimensions that underpinned the perspectives of research participants as a scrutiny of ethical decision making and best practices in an open-ended inquiry. This rationale fostered an understanding that informed the subsequent development of an effective ethical decision-making framework.

3.3. Research Strategy

3.3.1. Strategic Approach

Based on the research philosophy, research approach and design of this study, cognisance was taken of the careful planning that is traditionally involved in qualitative research. In light of this, the central claim[128] of this study established the primary focus of the research, and the aim of the study outlined the overarching goal of the study. To this end, the researcher required an evidence-based strategy that would support the gathering of detailed, descriptive data with the aim of interpreting the data to gain insights. Thus, building upon the data

128 In light of restrictive conditions impeding the commercial exploitation of drone technology in South Africa, this study contends that where these conditions are relaxed, that new ethical challenges previously absent in the current environment will emerge.

collection framework articulated within the theoretical framework of this study; in order to collect the primary data[129][130] required for this study, a research strategy was required to structure the method of the data collection. To achieve this, the researcher incorporated the research strategy of Tobi and Kampen (2018). Conceptually, the research strategy of Tobi and Kampen (2018) encompasses process steps that starts with the conceptual design phase of the study, followed by the technical design phase.

In the conceptual design phase, the 'why' and 'what' of the research is structured and addressed. This creates a path for the technical design phase that expounds on the 'how' of the research and is underpinned by 'why' and 'what' questions that sets out to shape the methods and protocols for data collection and analysis, and the execution phase that synthesises the findings of the investigations, culminating into the outcomes of the research findings. To this end, the researcher leveraged the research strategy of Tobi and Kampen (2018) as a strategic approach to execute this study within the structure of the key phases namely, the conceptual design phase and the technical design phase as follows:

a) Conceptual Design Phase

The research question, aim and objectives of this study directly addressed the "why" and "what" of the conceptual design phase within the research strategy of Tobi and Kampen (2018). The context of the research question pinpointed the need for an ethical framework and the context in which it will be used (ethical challenges in a relaxed regulatory environment for South African cold supply chains). Moreover, it principally asked: "What kind of framework can organisations use to navigate these ethical challenges?"

In relation to the research aim, the "why" and "what" of the conceptual design phase translated the broad aim of the study into focused and measurable steps directly relevant to the South African cold supply chain. In relation to the research objectives, the "why" and "what" of the conceptual design phase served as a roadmap guiding the research strategy and the literature review investigations as well as the formulation of the theoretical framework of the study.

b) Technical Design Phase

Building upon the foundation of the conceptual design phase, and the evidence[131] based structure expounded by McCloud et al. (2023), the technical design phase of this study focused on the data collection of this study. In this regard, the Tobi and Kampen (2018) research strategy guided the data collection and analysis in pursuit of answering the central research question of the study, as the premise of the "Why" and "What" aspect of Tobi and Kampen (2018) process step. Thus, the central research question was used probe the perspectives of the research participants on the prospective ethical challenges that may emerge when drone technology is prospectively adopted widespread within the cold supply chain of South Africa. Furthermore, the data collection plan also aimed to establish how a decision maker would undertake drone-based decision making, when confronted with ethical challenges.

129 According to McCloud *et al*. (2023), data can be defined as the raw numbers, values, and text gathered from research, surveys, interviews, observations, and/or experiments. Information is considered data in context or data that have been analysed and/or presented in a way that is meaningful. Finally, evidence is information that has been synthesised in a way that may demonstrate support (or lack thereof) for an argument or set of assumptions and leads one to accept or not accept that argument.

130 The data collected by this study was guided by the themes and propositions that underpinned the theoretical framework of the study, and as a guide for what data you should collect and how you should analyse it.

131 According to McCloud *et al.* (2023), data can be defined as the raw numbers, values, and text gathered from research, surveys, interviews, observations, and/or experiments. Information is considered data in context or data that have been analysed and/or presented in a way that is meaningful. Finally, evidence is information that has been synthesised in a way that may demonstrate support (or lack thereof) for an argument or set of assumptions and leads one to accept or not accept that argument.

3.3.2. Data Collection

3.3.2.1. Data Collection Approach

To identify potential ethical challenges derived from the perspectives of research participants representing the cold supply chain industry, a data collection strategy was the first step employed within the technical design phase of this study. This involved considering the type of evidence that would be collected during the data collection process, the ambit of the scope of evidence, and its relevance to the objectives of the study. Against this backdrop, the researcher was guided by the theoretical framework to develop a formal protocol that would determine what level of empirical evidence was to be collected for this study. Duden (2021) supported this approach, asserting that a qualitative research study requiring evidence requires a mechanism to establish credibility, and a greater understanding of the rich interpretations required to deepen the understanding of the interpretations made during the data analysis process.

From here, to assist the researcher leveraged the principles of a "qualitative evidence synthesis" (QES) method; however, the researcher was cognizant that the principles of QUES are traditionally associated with studies that employs systematic reviews within its study, or alternatively, a study that is inherently quantitative in nature. However, a shift in this traditional use of QUES method was observed by Flemming *et al.* (2021). The author observed that QES methods were being leveraged as a response to an increasing demand for evidence that goes beyond “what works” in a specific context such as traditional systematic reviews. To this end, the author observed that the principles of QES guides evidence that is synthesised from both literature reviews and primary data collection within qualitative studies with the aim of developing new cumulative knowledge. Moreover, it was also the observation of Flemming *et al.* (2021) that the QES methodology encompasses various methods that are applied either independently or to amalgamate qualitative research findings commonly explored in primary qualitative research. Furthermore, that QES facilitates the generation of interpretations concerned with the impact of a condition, intervention, or policy on the lived experiences and emotions of individuals involved.

For this reason, to ensure rigorous and meaningful synthesis of findings from evidence stemming from both the literature review and primary data collection, it become feasible for this study to adapt the QUES principles observed by Flemming et al. (2021) and other studies for the benefit of this study. This allowed for the provision of a framework for gathering and interpreting data from research participants and connecting the findings to the themes within the theoretical framework, in pursuit of gaining a broader understanding of prospective ethical challenges that may emerge based on the perspectives of research participants as industry experts. Moreover, the adapted QUES framework was developed as a tool to assist the researcher with the analysing and synthesising of the data collected for this study. From the consultation of several studies using traditional QUES methods, the researcher adapted the principals of QUES for the benefit of this study as follows:

Quality:	Utility:	Extent:	Scope:
The evidence (participant responses) collected was required to ensure the credibility and trustworthiness of evidence sources. This involved employing a recruitment startergy that adheard to ethical protocols during primary data collection (interviews).	Prioritise evidence during the data collection (probing follow up questions) that is relevant to the research question, and that informs an understanding of the ethical challenges faced by organisations within the cold supply chain industry.	Consider the breadth and depth of evidence required (line of questions poased). in this context, the primary data collected was required to target a sample population that offered diverse and rich insights and that was representitive o fthe research population.	To maintain the focus of the study, the scope of questions posed should explore participants' experiences, public perception, and potential societal impacts of relaxed regulations.

Table 7 Data collection approach underpinned by QUES framework

From these adapted QUES principles expounded in table 7, the researcher ensured that the harmony in the application of these principals permeated during the data collection design. Against this backdrop, the researcher set out to ensure that the data collected was relevant to the research question and could be analysed under the themes articulated in the theoretical framework. Kabir (2016) posits that primary data collection of a research study stands as the cornerstone of research, offering firsthand information gathered directly from the source (research participant). The author goes on to argue that unlike pre-existing data that is reviewed within the literature review, primary data represents a raw and unmediated encounter with the research subject matter (research participant). This direct access allows a researcher to delve deeper into the lived experiences and perceptions of participants, potentially uncovering unknown aspects of the research topic (QUES - Utility). This focus on participant experiences aligns with the social constructivist paradigm employed within this qualitative research study, where knowledge is accepted as socially constructed. Against this background, the researcher first determined the research population of the study to guide the selection of the primary data sources for this study.

To determine the primary data sources of the study, it meant first establishing the research population of interest, and thereafter, the target population of the study. This was imperative as the research population[132] and target population of a research study provides the backbone of any research study, and the foundation to the selection of the research sample as the representative entity of the research population (Willie, 2022).

3.3.2.2. Research Population of Interest

Willie (2024) defines the research population of interest within a study as a population with similar features within a specific context. This group provides a researcher with a basic grasp of the demographic or institutional environment they want to study. Against this backdrop, the background discussions and the literature review discussions revealed that the inquiry of this study is inherently situated within the downstream supply chain industry activities, hence, the population of interest needed to encompass stakeholders directly involved in or affected by these aspects. To this end, the researcher took into account the scope of the study, the stakeholder roles and impact, the theoretical framework and practical considerations. Each of these considerations was integral in shaping the research population of interest, ensuring that the study would be well-positioned to explore the dynamics of drone technology in a permissible regulatory environment.

Based on the delimitations of the study, as expounded in chapter one, the geographic and sectoral scope of the study focused on the supply chain sector of South Africa. This meant that the research population had to comprise stakeholders operating within this specific context. This included entities that are part of the production, storage, transportation, and distribution processes that could potentially or currently utilise drone technology. In relation to the stakeholder roles and impact, a crucial consideration was identifying the roles within the cold supply chain that significantly influence or are influenced by drone technology. This included decision-makers who have the authority to adopt new technologies, as well as those impacted by these decisions, such as logistics personnel and regulatory bodies. In relation to the theoretical framework of the study, the researcher took into account the lenses of technoethics and social constructivism, that guided the unit of analysis.

To this end, the inclusion of stakeholders who could provide insights into how ethical considerations and social interactions shape the adoption and integration of drone technology was critical. Another critical consideration was the practical consideration of the study. Under this consideration, the researcher considered the practical

132 Casteel and Bridier (2021) clarifies that the first concept being the “Research Population of Interest” can be considered as individuals, dyads, groups, organisations, or other entities that the study seeks to gather data from. From the data collected, recommendations can be made based on the findings that emerge. The authors goes on to expound that the research population of the study create boundaries for the scope of a study. Such boundaries place natural delimitations upon the research and affords the principal researcher the opportunity to clearly identify subpopulations, such as the target population and the sample population of the study. This ensures an alignment between these groups are ensued, and also that the sample population of the study is representative of the research population of the study.

aspects such as accessibility of participants, the potential for rich data collection, and the representativeness of different stakeholder groups. This influenced the selection of the research population. Moving from these considerations as well as the determination of decision makers operating with the supply chain sector of South Africa, the researcher used this premise to determine the target population for this study as well as the aim of this study. In this regard, the target population inherently emerged as decision makers operating within the cold supply hain industry of South Africa. However, the researcher was confronted with a limitation in the determination of the target population of interest. This limitation consisted of an ideal that involved a count of all the cold supply chain companies and indirect cold supply chain operators[133] operating within the cold supply chain industry of South Africa. This would serve as a determination of the target population of the study. Against this backdrop, this rationale presented a significant challenge due to several inherent complexities. Firstly, the researcher via the background discussions and the literature review investigations observed that the cold supply chain industry encompasses a diverse array of players, ranging from large multinational corporations to small, informal street vendors. This was also observed in a United States investor report (2022), where it was reported that South Africa currently houses the majority of the African continent’s cold storage capacity with many positive (fresh fruit and vegetables) and negative (fish and meat) cold storage options.

The report goes on to record that the majority of the cold supply chain companies were found to be located within KwaZulu Natal and the Western Cape (2022), thereby comprising of large corporations dealing with fresh, frozen or even biomedical supplies or specimens that needs to be kept in cold storage. This included formalised supermarket chains as well as street vendors (Bell, 2022). Moreover, that the market often saw the liquidation of companies for reasons along the PESTLE analysis conducted within the report, or new entrants such as SME that fails to run sustainable businesses. This dynamism was premised on new companies emerging post the covid pandemic as a result of job displacement, and others exiting the market regularly per the observations of Rajput (2022). The author observed that major cities such as Gauteng, Cape Town, and Durban emerged as a hotbed for the cold chain supply chain markets, since most of the industrial regions are also located nearby.

From here, the dynamism in the shifts of markets and business operations within the cold supply chain industry made it impossible to do a count (census) of how many companies operate within this the cold supply chain industry. In light of this, this study acknowledged that while the entire cold supply chain industry encompassed a diverse range of actors. These diverse actors are strategically focused on decision-makers and occupy senior positions within the industry. This approach presented a compelling approach to determine the target population for this research study. This focus was shaped by the range and extent of literature reviewed, as well as the unit of analysis expressed in the theoretical framework and real-time searches on the cold supply chain industry of South Africa on several internet search engines such as Google and Bing etc. Moving from this premise, the researcher observed that the following key roles comprised decision makers as follows:

Table 8 Key Decision Maing Roles in the Cold Supply Chain Industry

Roes	Responsibilities
Strategic Decision Makers	
Long-term Planning	Develop and implement long-term strategies to enhance efficiency, sustainability, and profitability within the cold supply chain.
Policy Development	Formulate policies that align with the overall goals of the organisation and industry trends, particularly focusing on innovation and technological integration.
Investment Decisions	Make decisions on major investments, including the adoption of new technologies such as drone, to improve logistics and supply chain operations.
Risk Management	Identify and mitigate potential risks associated with strategic initiatives, ensuring that the organisation is prepared for future challenges.
Stakeholder Engagement	Engage with key stakeholders, including suppliers, customers, and regulatory bodies, to ensure alignment with strategic goals and compliance with industry standards.
Technological Decision Makers	

133 SME’s and companies with product lines comprising fast consumable goods and goods requiring cold storage.

Technology Integration	Lead the integration of new technologies into the cold supply chain, such as drone, IoT sensors, and blockchain for tracking and transparency.
Innovation and Development	Stay abreast of technological advancements and drive innovation to enhance the cold supply chain's efficiency and effectiveness.
System Management	Oversee the implementation, maintenance, and improvement of technological systems and infrastructure within the supply chain.
Data Management	Ensure the proper handling, analysis, and security of data generated from technological applications, supporting decision-making and compliance.
Vendor Management	Collaborate with technology vendors and service providers to procure, implement, and manage technological solutions.
Operational Decision Making	
Day-to-Day Management	Oversee the daily operations of the cold supply chain, ensuring efficiency and effectiveness in logistics and inventory management.
Process Optimisation	Implement and refine processes to optimise the operational performance of the supply chain, including the use of technology to streamline operations.
Resource Allocation	Manage the allocation of resources, such as manpower, equipment, and technology, to ensure smooth operations and timely delivery.
Quality Control	Ensure that products within the cold supply chain are stored and transported under optimal conditions to maintain quality and safety.
Performance Monitoring	Continuously monitor performance metrics and operational KPI's to identify areas for improvement and ensure compliance with standards.
Compliance Decision Makers	
Regulatory Adherence	Ensure the cold supply chain operations comply with all relevant local, national, and international regulations, including those related to food safety, transportation, and technology use.
Policy Implementation	Develop and enforce compliance policies and procedures that align with regulatory requirements and industry standards.
Auditing and Reporting	Conduct regular audits and prepare reports to demonstrate compliance with regulatory bodies and internal standards.
Training and Education:	Provide training and resources to staff on compliance-related issues, ensuring that everyone is aware of and adheres to regulations.
Incident Management	Manage and respond to compliance-related incidents, including investigations and implementing corrective actions.

Since the aim of this study has an implication on decision making, in so far that the study seeks to understand how organisations within the cold supply chain industry will navigate ethical challenges specific to drone-based decisions in the new and more permissive regulatory environment, it appeared that the roles observed by the researcher could be justified as the research target population of this study. This justification was based on the following reasons which also served as the justification for the target population specified for this study as follows:

Direct Involvement in Ethical Decision-Making

- Each of the decision-makers listed in table 8, would have a critical role to play in the ethical decision-making process regarding the adoption and use of drone technology. Moreover, their involvement would mean that these key decision makers would possess the insights and experiences necessary to understand and navigate the ethical challenges posed by new or advanced technological integrations. Furthermore, the relevance of their insight was observed to be linked to research objective one in so far that these decision-makers were directly involved in identifying and evaluating ethical considerations, making them essential for gathering insights into the critical ethical challenges that must be addressed.

Wide-ranging Perspective and relevance to the research objectives

- From table 8, based on the role of the decision-makers within the decision making process, this would provide the study with an opportunity to capture a holistic view of the ethical considerations aligned to the research objectives of this study. Moreover, their insights would prove significant to research objective two in so far that these individuals engage with various stakeholders, and would therefore be in the position to provide this study with insights into best practices that could be incorporated into the technoethics ethical decision making framework. Thus, the level of relevance to the research objectives of this study was determined as follows:

Figure 14 Justification framework of the target population the research

Strategic Decision Makers:

- These decision makers would be able to provide insights into long-term planning, investment decisions, and policy development which are aspects that are crucial for understanding the broader implications of drone adoption. The data collected from these decision makers emerged relevant to RO1 and RO2 since their insights were deemed crucial for understanding the broader ethical implications and best practices. Moreover, their strategic insights would assist in understanding how other decision makers operating within the cold supply chain industry can balance ethical considerations with commercial benefits.

Operational Decision Makers:

- It was determined that these decision makers would offer a practical perspective on a day-to-day implementation and operational challenges. This was considered essential for evaluating the real-world prospective impact of drones within the cold supply chain, and therefore had relevance to research objective one and two. Moreover, the relevance was linked to the practical insights and the best practices that could prospectively be applied to the day-to-day cold supply chain challenges, and practical insights into how ethical challenges manifest in daily operations.

Compliance Decision Makers:

- It was determined that these decision makers would offer insight into a perspective on the regulatory and legal aspects of drone usage, thereby highlighting the importance of adhering to ethical standards and regulations. Moreover, the relevance of the insights of these decision makers had a direct link to research objective one and three in so far that these decision makers would assist with insight into the regulatory and ethical compliance, which was considered essential for developing and implementing a scalable monitoring and evaluation tool. Moreover, their regulatory focus provided the study with insight into the necessary compliance and ethical standards.

Technological Decision Makers:

- These decision makers would bring a focused technical viewpoint, that addresses the feasibility, innovation, integration and data management issues related to drone integration. The relevance of the insights of these decision makers was linked to research objective one and three in so far that these decision makers offer insights into the technical expertise needed for integrating drone and developing scalable frameworks for ongoing assessment. Moreover, their technical expertise was deemed crucial for understanding the implications of drone technology and ensuring it is used ethically

Figure 15 Dimension of Decision-Making Tiers

Moving from this premise, the decision makers expounded in table 8 were deemed key decision makers who influence and shape the ethical landscape on behalf of an organisation operating within the cold supply chain industry. Moreover, their decisions would have an impact on the prospective adoption of drone technology, and also how prospective ethical challenges would be addressed and managed. Furthermore, the relevance of their insight was linked to research objective one, two and three in so far that their influence on the strategic direction and ethical standards under investigation by this study. This was deemed critical in ensuring that the researcher did not include irrelevant perspectives that would compromise the credibility and the validity of the findings of the study. In light of this, the decision makers listed in table 8 formed the framework for the unit of observation expounded in Appendix B. To this end, to assist the researcher to filter out participants who did not meet the objectives of the study, the exclusion criteria expounded in Appendix C was premised on the following rationale:

Thus, for this study, engaging with the decision-makers articulated in table 8, were aligned to the unit of analysis articulated in the theoretical framework, and were deemed feasible and an appropriate target population due to their direct involvement and influence over the ethical considerations and strategic decisions related to the adoption of drone technology.

3.3.2.3. Sample Population of the study

a) Sample Strategy

Ponto (2015) explicates that the primary objective of sampling strategies is to facilitate the selection of a sample from the population of interest, thereby achieving a representative sample size. Gill (2020) reinforces this notion. The author emphasised how an appropriate sampling strategy bolsters the rigor of qualitative research studies, and that the selection of participants (sample population) holds paramount importance in ensuring the validity and reliability of research findings. McCombes (2023) builds on this by delineating the existence the sampling strategy associated with various sampling techniques tailored to qualitative studies. The author goes onto explicate that non-probability as a qualitative sampling strategy involves non-random selection of research samples, subject to the qualitative sampling technique employed.[134] In light of the classification and nature of this study, the researcher employed a non-probability sampling strategy. Vehovar *et al.* (2016) characterised non-probability sampling as a sampling strategy that involves a selection process that aligns the characteristics of the target population. Furthermore, the characteristics is underpinned by the unit of analysis and the unit of observation, to identify units that closely resemble the desired sample that is representative of the population of interest. Against this backdrop, and in light of the background discussions[135], the exploratory nature of this research lent itself to a non-probability sampling strategy.

Rather than seeking to make precise population estimates, the objective of employing a non-probability sampling strategy for this study was to gain insights and perspectives regarding the decision-making processes when confronted with the potential ethical challenges emergent from the literature review findings, as ethical considerations that the cold supply chain industry must consider. This allowed for the selection of participants who could provide rich and diverse perspectives insight into the topic of this study. The con-probability sampling strategy of this study therefore facilitated the identification and inclusion of individuals aligned to the target population of the study outlined in table 8 above.

b) Sampling Method

Post the selection of a sampling strategy, the researcher required a method to execute the sampling strategy with the aim of arriving at a research sample representative of the research population of interest. To achieve this, the researcher considered the respective sampling methods as expounded by Alele and Malau-Aduli (2023). The author explicated that in qualitative research, four key sampling methods exist namely: Convenience sampling; Purposeful sampling; Theoretical sampling and Snowball sampling. From the detailed explanations of these methods by Alele and Malau-Aduli (2023), the researcher considered the applicability of each sample method. After considerations of the explications, the researcher employed a convenience and snowball sampling methods in combination.

These sampling methods were deemed suitable, practical and feasible as a combined sampling technique to gather data from enrolled research participants. Convenience sampling, was employed to swiftly identify readily available participants, thereby ensuring efficiency and cost-effectiveness in assembling a diverse participant pool. However, recognising its susceptibility to selection bias as cautioned by Alele and Malau-Aduli (2023), careful consideration was given to counteracting this shortcoming. As such, the researcher employed the snowball sampling method to access individuals with known decision-making power at a professional level rather than organisational representation. Moreover, the use of snowball sampling was best placed to obtain referrals and to allow the researcher to obtain direct contact details which otherwise would not have been as rapidly possible by latter or alternative means. In this way, the researcher had just cause for compliance with privacy laws which would otherwise have introduced additional ethical considerations and implications for this study. This was important especially since the researcher was not inherently in direct contact with such key decision makers required by this study. Therefore, the use of the combination of convenience and snowball sampling techniques allowed the researcher to reach the required representative sample.

In addition to the solve of accessibility through the employ of convenience and snowball sampling techniques, another key factor in the employ of the sampling technique for this study was the sampling of participants that shared individual perspectives consistent across organisational and industry-wide boundaries. Here, the relevance of accessing decision-makers regardless of their organisational affiliations was important. To this end,

134 Here the author went on to clarify the other research sampling techniques as voluntary response sampling, purposive sampling, snowball sampling, quota sampling, theoretical sampling and convenience sampling.

135 Where it emerged that the research population of this study spanned a dynamic and diverse landscape, characterised by stakeholders ranging from diverse backgrounds, as well as the constraints of time and resources required for this study – underscored the need for a cost-effective sampling strategy.

the researcher used convenience sampling to access the sample population participating in relevant forums and conferences through social media interactions such as LinkedIn. This allowed the researcher to effectively tap into networks to recruit participants who shared a common interest in drone technology use within the commercial business sector of South Africa. Simultaneously, the researcher used snowball sampling to leverage referrals and recommendations from these industry contacts. Thus, the combination of convenience and snowball sampling as the research sampling methods(s) allowed for swift data collection, while ensuring that recruitment efforts were legally compliant and targeted towards the appropriate representative research population.

c) Sample Size and Adequacy Considerations

Post the selection of the sampling strategy, the researcher deliberated on the sample size determination and the adequacy of the sample size for the ambit of the scope of investigations. Daniela (2020) posit that the adequacy of the sample size within a qualitative study, is a key indicator of research quality. However, the author goes on to expound that there is no consensus on the exact number needed for a proper sample size within a qualitative research study. Moreover, Daniela (2020) observed that some authors consider the number of units investigated to be irrelevant, emphasising instead that the richness of data provided by the sample is of more importance. The author goes on to share other observations, where some researchers argue that sample size is crucial for achieving reliable results and ensuring the credibility of qualitative research. This was evident in the arguments of Vasileiou et al. (2018), where the authors asserted that sample adequacy in a qualitative research inquiry pertains to the appropriateness of the research sample composition and size. The author goes on to emphasise the importance in evaluating the quality and trustworthiness of a qualitative research study. However, the authors argue that where samples in qualitative research tend to be small, that it may fail to support the depth and analysis of the study.

To this end, Daniela (2020) argues that there are no clear methods or rules for determining the appropriate sample size in qualitative studies, and that researchers often follow various guidelines to evaluate whether their sample size is adequate. In response to the postulation of Daniela (2020), Sarfo et al. (2021) posit that for a qualitative researcher to address how many participants are enough in pursuit of reaching data adequacy and possible theoretical saturation, is the alternative of engaging data saturation[136]. However, the author cautions that failure to reach data saturation could influence the quality and trustworthiness of a research study. Frome here, Sarfo et al. (2021) asserts that in practice, data saturation can be problematic given that for some studies, data saturation may be enough, and for others this technique may not be adequate. Moreover, the author also observed several other arguments against the employ of data saturation, in so far that data saturation is broadly considered to be ‘theoretical’ and as an idea that ‘true saturation’ of information may only be assumed.

This was evident in the argument by Vasileiou et al. (2018) and Daniela (2020), where the authors argue that the traditional justifications of a qualitative research study sample size has traditionally been contingent on the number of interviews conducted to achieve the objective of data saturation. From here, the authors concluded that sample size insufficiency was seen as a threat to the validity and generalisability of a qualitative study, and its results. The authors go on to argue that research should critically consider how saturation parameters are applied within their research to encourage data adequacy. Additionally, the authors called on researchers to consider alternative approaches to data saturation, as a means to be more transparent about evaluations of their sample size sufficiency.

In light of the arguments of Vasileiou et al. (2018) and Daniela (2020), the researcher explored conceptual depth instead of focusing solely on reaching data saturation. This meant ensuring that the perspectives of decision-makers across different segments of the cold supply chain industry were adequately represented and deeply

136 Data saturation defined by Sarfo *et al*. (2021) is a data adequacy point where no new information could be obtained from participants in qualitative research.

explored. In so doing, the study was guided by the individual unit of analysis stemming from the theoretical framework[137], to ensure the reliability of the sample size and the adequacy thereof, the researcher leveraged the principals of the QUES framework adopted for this study. This rationale was used to explore the type of evidence that would be required and as the premise used to motivate for an alternative approach by this study. To appraise the justification of sample adequacy, size and features that were intrinsic to the study, the final selection of the research sample and sample size and adequacy was premised on the following factors namely: *The Nature of the study; The Quality of Data; Emphasis on Conceptual Depth Over Quantity and Avoiding the Pitfalls of Data Saturation.* To explain these consideration dimensions, the study leveraged the explanations of Shaheen et al. (2019) in terms of these factors, to adapt these concepts for the benefit of the study as follows:

Consideration One: Nature of the study:	• The complexity the themes articulated in the theoretical framework influenced the sample size determination, and mitigated against the risk of overlooking critical insights. Moreover, this consideration enhanced the validity and reliability of the findings of the study. Thus, the exploration of the ethical considerations of drone technology necessitated a sample that could provide in-depth insights rather than a larger sample that might offer more breadth and assisted the principal researcher with capturing the required depth of information thereby ensuring adequacy.
Consideration Two: Quality of Data:	• The consideration of the quality of data was influenced by factors such as participant expertise and operational capacity. This approach underpinned by the principles of the QUES evidence matrix emphasised that participant expertise and operational capacity over demographic factors and assisted with the inclusion of the most relevant and insightful perspectives. This strategy was validated by Wang et al. (2024) in the theoretical framework, and thereby underscored the importance of gathering and evaluating evidence from various sources to enhance credibility and truthfulness. Thus, the quality of data and its ability to reflect on the nature of the study were pivotal factors influencing the determination of the sample and sample size. Furthermore, the assertion of Vasileiou et al. (2018) regarding sample adequacy and quality, as well as the factors outlined by Shaheen et al. (2019) emphasised the conceptual depth and data quality over sheer quantity. Taking these assertions into consideration ensured that the sample size selected was adequate to capture a wide range of perspectives essential for the objectives of the study. Moreover, the prioritisation of including participants based on their expertise and the relevance of their roles in the cold supply chain industry highlighted the necessity of engaging with participants who could provide the most relevant and insightful perspectives. Therefore, focusing on participant expertise and operational capacity assisted to mitigate potential selection biases and assisted to ensure the inclusion of high-quality data.
Consideration Three: Emphasis on Conceptual Depth Over Quantity:	• The primary objective of this study was to delve deeply into the ethical considerations associated with drone technology rather than merely aiming for a point where no new information emerges. To this end, focusing on conceptual depth allowed the study to gather insights and rich detailed data from participants who either have a level of exposure to advanced technology, or are involved in strategic decisions. This also included participants with significant expertise and experience in the realm of technological implications on a business. This approach aligned with the arguments of Vasileiou et al.(2018) and Daniela (2020), who emphasised the importance of data quality and the depth of information over the sheer number of participants and data saturation.
Consideration Four: Avoiding the Pitfalls of Data Saturation:	• As expounded on earlier in arguments of Daniela (2020) and Sarfo et al. (2021), that while data saturation is the widely accepted tool to ensure sample adequacy in qualitative research, the authors provided this study with insight into why it may not always be practical or sufficient for studies with complex and evolving themes. As explicated by these authors and further validated by Vasileiou et al.(2018), the principal researcher observed that the pursuit of saturation can sometimes lead to an overemphasis on quantity at the expense of quality. Thus, for this study, prioritising conceptual depth and the richness of data, assisted this study to avoid the limitations of data saturation and to ensure that the findings were both credible and relevant. This being a principle of data saturation

Figure 16 Sample Size Adequacy Considerations

Building on this premise, the decision by the researcher to prioritise conceptual depth and data quality over data saturation was driven by the need to gather rich and meaningful insights from a representative sample of decision-makers within the South African cold supply chain industry. To this end, the researcher mapped the evidence required from key decision makers using the QUES principles. This mapping as expounded in Appendix C assisted the study to capture a wide range of perspectives essential for understanding the complex ethical considerations related to the prospective adoption, integration and use of drone technology within the cold supply chain industry.

d) Sample Population of the study

In light of the aforementioned considerations involving the selection of an appropriate and adequate sample, a middling sample size was determined to be suitable. A middling sample size allowed the researcher to focus on understanding the depth and the complexity of the perspectives research participants, rather than making

137 As eexpounded in Appendix B

generalisations about the general population. Moreover, this type of understanding and focus would not have been easy to achieve when collecting data from a large number of participants as is the case in quantitative studies (Laja, 2024). This meant that the researcher could ensure the validity, reliability and confidence regarding the research findings, which would have a high margin of relevance regarding the nature of this research study despite the middling sample size. To this end, the research sample size of this study was determined as *n* = 25 pax, comprised as follows:

Table 9 Sample Size of the study

Sample Required	Decision Making Capacity	Alignment to Unit of Analysis	Contribution of the sample	Sample Size
Strategic Manager on a C-suite level	Executive Management	These individuals represented decision makers that are responsible for high-level decision-making, long-term strategy, and investment decisions within the supply chain.	C-Suite Managers were included to provide insights into strategic planning, risk management, and the ethical implications of new technologies such as drones in the cold supply chain. Their input was deemed essential to understand how decision makers on behalf of organisations would navigate strategic challenges such as technological integration of drones, and other ethical challenges.	5x
SME Owner	Executive Management	This sample represented smaller businesses within the cold supply chain, with a focusing on operational sustainability and strategic growth.	As established in the literature review, SMEs are key drivers of innovation and economic growth, and their perspective were crucial in understanding the challenges of smaller firms in adapting to technological advancements and competing with larger organisations.	2x
Representative of the skills development sector Authority (Strategic Manager Equivalent)	Executive Management	This sample represented the authority on skills development, and what alignment to industry standards and best practices should be considered within the cold supply chain industry	This sample contributed insights into the policy-making frameworks that an organisation should consider, and what skills development should be invested in by decision makers to align industry standards to organisational goals	1x
Compliance Manager	Middle Senior Management	This sample represented decision makers that ensure regulatory adherence, implementation of policies, audit compliance, manage incidents and such compliance activities on behalf of an organisation.	This sample contributed insights into the maintaining of regulatory compliance in a highly regulated industry such as the cold supply chain logistics, especially concerning technology integration and risk management.	5x
Operational Manager	Middle Senior Management	This sample represented decision makers that manage day-to-day operations, optimise processes, allocate resources, ensure quality and performance.	This sample contributed insights into the operational aspects of supply chain management, and to assist the study with insight into the practical challenges and efficiencies when integrating advanced technologies such as drones.	5x
Fleet Manager operating within Logistics (operational Manager Equivalent)	Middle Senior Management	This sample represented decision makers that manage fleet logistics, ensure efficiency, optimise fleet operations, maintain compliance with regulatory standards.	This sample contributed insights into the practical insights into the logistical challenges of implementing drone technology and how it affects transportation within the cold supply chain.	2x
Technology Manager	Middle Senior Management	This sample represented decision makers that lead tech integration, manage innovation, handle data and systems and work with vendors	This sample contributed an understanding of how new technologies such as drones would be adopted, managed, and optimised within supply chain operations.	5x
			Total Size of Sample Population of the Study:	**25**

From table 9, the researcher strategically chose to balance the depth and breadth of participant insights required form the sample population of this study. The carefully selected sample size of *n*=25 therefore ensured that the study captured a wide range of perspectives essential for understanding the complex ethical considerations of drone technology within the cold supply chain industry. This approach ensured high-quality data over sheer quantity, thereby ensuring that the findings of this study would be both credible and highly relevant to the key ethical, operational, and technological challenges being investigated.

e) *Recruitment Strategy*

Manohar et al. (2018) defines the construct of recruitment in the context of research as the process involves identifying, targeting, and enlisting potential participants, followed by the provision of information regarding the research study to the potential participants, to establish their interest in the stated study. The author goes on to assert that in order to ensure appropriate recruitment within qualitative research, that it is important to identify participants that closely represent the target population.

Building on the previously explained sampling strategy, the recruitment of participants for this study was conducted using a combination of convenience sampling and snowball sampling methods. These techniques assisted to efficiently access the specific pool of decision-makers and professionals involved in the cold supply chain industry, where expertise in the ethical, operational, and technological challenges of drone technology is critical. Convenience sampling was the starting point to engaging participants who were easily accessible and willing to participate in the study. The primary recruitment channels included professional networks such as LinkedIn, where business forums related to supply chain logistics, technology integration, and compliance were actively monitored. LinkedIn, with its wide-reaching professional base, provided immediate access to industry leaders and decision-makers in relevant fields such as technology management, compliance, and operations within the cold supply chain. This allowed the researcher to quickly gather participants who fit the study's criteria.

From here, the snowball sampling technique was employed to expand the participant pool. This involved requesting enrolled participants to recommend other professionals within their network who met the criteria of the study. Snowball sampling proved especially useful in reaching highly specialised individuals, such as C-suite executives, SME owners, and compliance managers, whose perspectives were crucial for the study. By relying on peer referrals, the study tapped into trusted industry connections, enhancing the credibility of the sample. In addition to LinkedIn, business forums and industry-specific networks were explored to recruit participants. These forums provided access to niche discussions on supply chain technologies and operational challenges, which aligned well with the study's focus. Legal recruitment channels were also utilized to ensure that all recruitment methods adhered to ethical guidelines and data protection regulations, maintaining the integrity of the research process.

However, the researcher was cognizant of the protection of personal information act 4 of 2013 (POPIa) of South Africa, that places strict limitations in terms of the manner in which information is collected. To this end, the researcher queried whether participant data related to age, demographics, and gender were relevant to the study. This was an important construct of the recruitment strategy and as the foundation for the design of the data collection instrument of this study. Moreover, this study carried a data collection strategy that set out protocols for the study as expounded in Appendix C. To this end, the researcher deemed the collection of demographical data such as age and gender as irrelevant due to the specific focus of the study. However, Hayes (2024) differed with the rationale of the researcher. Hayes (2024) argues that demographical data such as age and gender need to be collected, since these variables provide important information about the research participants and their influence on the results and interpretation of the study. The author goes on to explain that age can impact research outcomes as it is associated with different levels of experience, knowledge, and cognitive abilities, whereas gender is another important demographic variable to consider as it can influence perceptions, behaviours, and experiences. Hayes (2024) further asserts that by including age and gender in the demographics, that researchers can better understand the effects of these variables on their research outcomes and identify potential biases or disparities that may exist.

However, Duden (2021) observed that where perspectives across a plethora of qualitative studies did not include demographical data, that the researcher was still able to obtain comprehensive insights and were also able to gain a deeper understanding of the concurrent and contrasting human experiences. Based on the arguments of the Hayes (2024) and Duden (2021), the researcher adopted a strategic approach to participant enrolment to maintain the integrity and validity of the study, as well as to mitigate the potential for selection bias. Emphasis was therefore placed on recruiting industry individuals with significant information power and operational expertise within the cold supply chain industry. This approach was essential to ensure that the study captured the most relevant and insightful perspectives as required by the scope and configuration of the study. It is however important to note that this approach did not entail any preference of any specific gender or demographic group. Rather, the focus was on identifying participants who operated in key capacities within the cold supply chain industry. This strategic emphasis on participant expertise and operational capacity ensured that the study benefitted from diverse perspectives and insights relevant to the research topic rather than the focus on demographic and gender representation.

To explain the concept of “Information Power”, Malterud *et al.* (2015) explicate that “Information power” posits that the more information the research participant holds as relevant for the study, the lower the amount of participants is needed to be enrolled in the study. Moreover, that this rationale is based on the consideration of the aim of the study, sample specificity, use of established theory, quality of dialogue, and the analysis strategy. This study met these considerations by mapping[138] the type of evidence required to the information power of the sample determined in table 15. This mapping guided the researcher during the recruitment process, in pursuit of generating significant findings that contributed to valuable knowledge to the field of emerging technology and ethical debates within academia.

At this juncture, the concept of data saturation resurfaced in the reflection as a query. To this end, Malterud *et al.* (2015) argues that “data saturation” is closely tied to a specific methodology[139], and the term is often inconsistently applied. Malterud *et al.* (2015) therefore validated the earlier arguments of Daniela (2020) and Sarfo et al. (2021), that while data saturation is the widely accepted tool, it may not always be practical or sufficient for studies with complex and evolving themes. This was further validated by Vasileiou et al. (2018), where the researcher observed that the pursuit of saturation can sometimes lead to an overemphasis on quantity at the expense of quality. To this end, Negrin (2022) argued that the recruitment and enrolment of research participants within a qualitative study is an important factor in the research outcome, as it has an influence on the trustworthiness of the qualitative research study. Shaheen et al. (2019) supported this assertion, positing that the reliability of the findings of qualitative research rely heavily on the information provided by the participants of the sample. Moving from this premise, the study adopted the concept “information power” as the premise for the recruiting participants based on their contribution rather than demographics, age and qualifications. However, the researcher observed the following limitations of information power as follows:

EMPHASIS ON DEPTH OF UNDERSTANDING:	**SUBJECTIVITY**:	**INHERENT BIASES:**	**OVEREMPHASIS ON EXPERTISE:**	**COMPLEXITY OF ANALYSIS:**
▪ Information power emphasises the depth of understanding rather than the breadth of representation. Therefore, findings derived from a sample with high information power may not always produce findings that are scalable to the research population. In this case, the entire supply chain as opposed to just the cold supply chain.	• Determining the level of information power appeared to have a wide margin of subjectivity, however, this varied depending on researchers' interpretations and judgments. The principle researcher viewed this as a risk that subjectivity could introduce bias into the data analysis.	• Information power relies on the assumption that individuals with specific characteristics or experiences can provide richer data. However, the principle researcher had a query on whether this assumption may potentially overlook valuable insights from individuals with different perspectives or backgrounds, leading to potential biases in the data collected.	• The principle researcher observed that prioritising participants with high information power may inadvertently lead to a lack of diversity within the sample, and that this may limit the richness and inclusivity of the data collected.	• While high information power can lead to rich and detailed data, the principle researcher queried how the complex analysis techniques employed within this study would explore and interpret the diverse perspectives and insights collected.

Table 10 Limitations of Information Power

138 Appendix C

139 The author argues that data saturation is closely tied to grounded theory.

To mitigate the limitations of information power, the researcher leveraged the QUES matrix adopted by the study, as a tool to enhance the rigor and transparency of the recruitment and the data collection process. Moving from this premise, the researcher used the principles of the QUES matrix to structure the specific evidence that would be required from the participant with information power. This was important in the effort to balance the strengths of the concept of "information power", and as a resolve of the inherent limitations of participant perspectives. To this end, the recruitment of appropriate research participants for this qualitative research study involved an initial identification of participants through professional networking platforms, technology associations, and industry-specific forums. Moreover, the potential participants for this research study were identified in alignment with the unit of analysis as highlighted in Appendix C. To this end, the recruitment of appropriate research participants as explicated earlier, involved an initial identification of participants through professional networking platforms, technology associations, and industry-specific forums.

Electronic invitations and targeted messaging were planned, with wording that outlined of the purpose of the study, anonymisation protocols, and the benefits of participation within the electronic invitations sent to the identified participants. This initial contact was aimed at establishing rapport and interest among individuals possessing the requisite, information, knowledge and experiences pertinent to the research question of the study. Additionally, leveraging referrals from existing participants facilitated the expansion of the participant pool through the snowball sampling technique employed for this study, thereby ensuring a diverse representation.

3.3.2.4. Data Collection Instrument and Protocol of the study

1. Selection of data collection instrument

For this study, the theoretical framework served as the frame that set the thematic direction of the data collected. Thus, to select the data collection instrument of this study, Busetto *et al*. (2020) explains that the most common methods of qualitative data collection are observations, document studies, semi-structured interviews, structured interviews, and focus groups. Considering these qualitative data collection methods, a semi-structured interview was selected as the data collection instrument for this study. The selection of a semi-structured interview emerged as a robust and versatile tool for this qualitative research study, as it allowed for a rich exploration of the perspectives of participants while preserving methodological rigor (Ruslin, Mashuri, Rasak, Alhabsy, & Syam, 2022). While the remaining qualitative research methods mentioned by Busetto *et. al.* (2020) may have provided valuable insights, the limitations of these instruments emerged as less suitable for clarifying what the prospective ethical landscape would be when compared to the efficacy of a semi-structured interview. Moreover, the study agreed with the postulation of Wingate and Bourdage (2024), that a key challenge for interviewers may be deciding what needs to be accomplished with the interviews, and how to design the interviews to accomplish the stated research objectives. However, the researcher was cognisant of the argument by George (2023), that asserts that the type of questions that are developed can in turn become the limitations that can be imposed on a study when using a semi-structured data collection method. It therefore necessitated that the design of the semi-structured interview as the data collection instrument for this study was designed to provide depth, flexibility, and detailed insights into the prospective ethical considerations of drone technology within the South African cold supply chain industry.

2. Design of the Data Collection Instrument

Wingate and Bourdage (2024) posit that a semi-structured interview serves three goals namely: targeted assessments, making a positive impression regarding the significance of the study and informing the applicant about the processual factors being beliefs about social judgment, structural characteristics, and concerns about fairness. The authors go on to posits that these interview goals must frame the interview design. Bearman (2019) furthers this positing that an interview must be premised on the basic building blocks of the interview being: (1)

considering which core event or series of events illustrate phenomena of interest, (2) ordering questions to optimise an intuitive and conversational flow and (3) the interview protocols. Moving from this premise, the researcher was guided by a theoretical model offered by Wingate and Bourdage (2024) regarding the design of the semi-structured interview and its underpinning goals as follows:

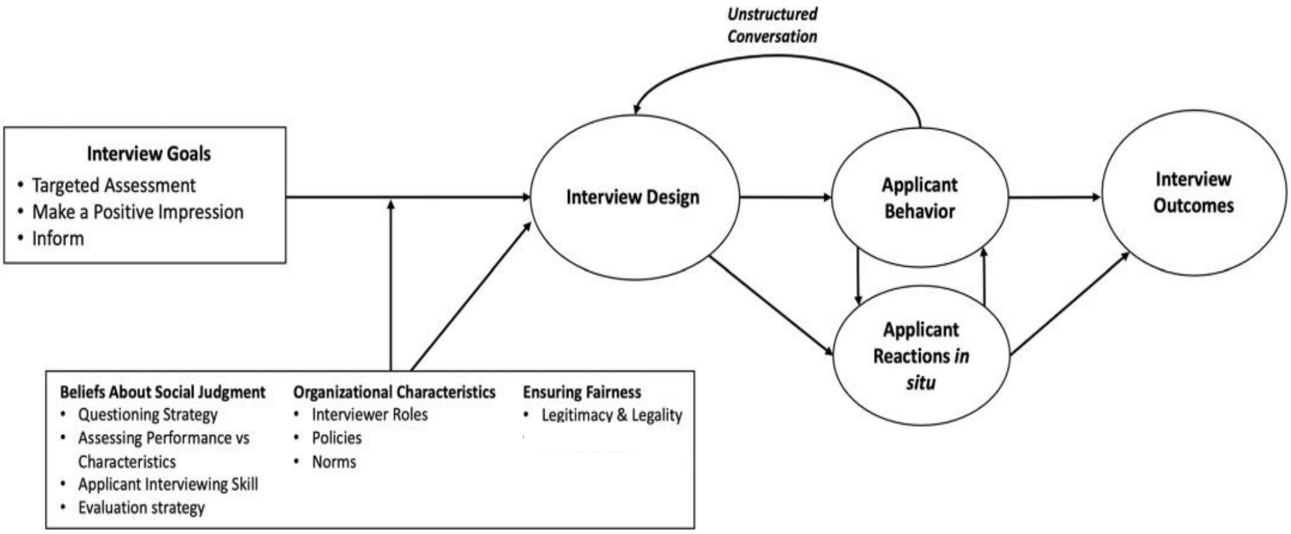

Figure 17 Design of the semi-structured interview
Wingate and Bourdage (2024)

Considering the interview design framework of Wingate and Bourdage (2024), it necessitated an exploratory approach to gain insight into the ethical considerations surrounding the adoption, integration and ethical use of drone and its associated and dependant technologies. This meant that the interviews had to uncover a range of ethical concerns, including privacy, data security, safety regulations, and potential environmental impacts as per the literature review findings. Moreover, the perspectives gathered from research participants had to highlight how these concerns may vary based on the participant's responsibilities and decision-making approach. Against this backdrop, the researcher reflected on the interview outcomes as per the design framework of Wingate and Bourdage (2024), and how the perspectives of research participants would be explored using the semi-structured interview as the data collection tool (instrument) of this study. This necessitated consideration on how the questions would be formulated to achieve the research objectives of this study.

In this regard, the researcher considered a few question formulation frameworks such as PICO, SPIDER and ECLIPSE. Booth (2019) investigated these frameworks and a total of 38 alternative qualitative question frameworks. The author concluded that none of the frameworks investigated (save for the SPICE framework) was entirely suited to capture a complexity perspective when addressing questions potentially answerable by qualitative evidence syntheses. From the consideration of these frameworks guided by the investigations of Booth (2019), as well as the objectives of this study and the evidence required as expounded in Appendix C, it emerged that the SPICE qualitative question framework was suitable to assist with the qualitative question formulation mnemonic.[140] To design the semi-structured interview for this study, a need for question mnemonic arose as the critical starting point in the design process. This need arose from the aim of evidence and the insight that this

140 As explicated by Tylane University (2024), a mnemonic tool refers to any method employed to enhance the retention or retrieval of information in human memory, thereby promoting better comprehension.

study wished to capture. Against this backdrop, the researcher leveraged the constructs of the SPICE framework by Booth (2006) as follows:

- Setting – where?
- Perspective – for whom?
- Intervention – what?
- Comparison – compared with what?
- Evaluation – with what result?

In light of this, the researcher adapted the SPICE framework for the benefit of this study, and as the question mnemonic to formulate exploratory questions to collect the primary data of the study as follows:

S = Situation or Scenario:

In this dimension, the guiding principles adopted was questions based on the literature review findings where situations such as drone privacy as observed by Mekdad *et al.* (2023) sought to explore how the immediate conditions and circumstances within the cold supply chain industry could be used to establish the prospective ethical challenges that a decision maker would have to navigate in a permissible regulatory environment that was in favour of harnessing drone commercially. Thus, this dimension assisted the researcher to formulate questions that were contextually relevant, forward-thinking, and scenario-based, and aimed at ensuring the depth in the exploration of the research participant perspectives. This was important in pursuit of obtaining the insights and perspectives that contributed meaningfully to the interview and its discussions.

P = Problems or Perceptions:

In this dimension, the aim was to transcend surface-level inquiries and to explore underlying beliefs and values influencing decision-making processes. Moving from this premise, the questions under this dimension were formulated to delve into challenges that currently confronts decision makers, to capture the complexity of decision-making processes within the cold supply chain, and to gain a deeper understanding of the ethical implications that may emerge in the relaxed regulatory commercial environment.

I = Impact or Implication:

In this dimension, questions were formulated to understand potential consequences and implications of decisions, while considering the practical considerations and broader implications thereof. Here a strategic alignment emerged with the concept of information power. This allowed for the interrogation of how decisions would be made regarding the adoption, integration and commercial use of drones and its associated technology within supply chain operations. Moreover, this approach allowed for the exploration of practical considerations and what impact would be made regarding the broader ethical implications of stakeholders and the industry as a whole.

C = Choices or Choices that will be or should be made:

For this dimension, the focus of questions was on decision-making and ethical choices, thereby probing how the proposed drone based ethical decision-making framework would benefit the industry. To this end, the question design had to capture insight into the perspectives toward the use of drones and its associated technology and labour practices. This approach assisted with the design of questions and allowed for the identification of potential gaps and discrepancies between current practices and future needs. Moreover, the questions formulated under this dimension allowed for the provision of valuable insights into the potential choices and decisions that stakeholders may face. Furthermore, this approach assisted the researcher to elicit the reactions of participants regarding the dynamic regulatory landscape and ethical considerations that must accompany technological advancements.

E = Evaluation or Experiences:

In this dimension, the evaluation of a decision makers perception was probed, to understand how the decision-making process was shaping. This approach allowed for an examination of factors to emerge that was deemed influencing aspects on decision-making processes, and as motivation of a drone based ethical decision-making framework. This evaluative principle also guided the formulation of all questions in pursuit of evaluating the propositions articulated within the theoretical framework. Furthermore, the questions formulated under this dimension allowed for themes that emerged within participant narrative responses, that were offered in response to questions posed.

To commence with the formulation of the exploratory interview questions, the researcher took cognisance of the assertion of Bearman (2019), that effective interview questions should elicit rich, detailed responses. Moreover, that well-crafted interview questions should include prompts that provoke deep thoughts and descriptions of the research topic. Bearman (2019) goes on to posit that the researcher should include prompts that must be relevant and meaningful to the participants, thereby ensuring that interview questions are clear and enjoyable, reducing any feelings of threat or defensiveness. However, Bearman (2019) argues that despite having well-prepared interview questions, that participants may have different perceptions of what is meaningful, sometimes requiring adjustments of questions. Thus, conducting a semi-structured interview often involves improvisation. Interviewers therefore need to make real-time judgments about which responses to delve into further and which paths to pursue.

From here, Bearman (2019) advises that the most effective questions are those that allow for flexibility and impromptu decision-making, rather than being perfectly phrased. To achieve this and to ensure comprehensiveness, the interview questions for purposes of the collection of the primary data was guided by the themes in the theoretical framework. From here, the researcher mapped the questions in Appendix D and E, to the SPICE framework and aligned them with the research objectives and the themes within the theoretical framework. This mapping ensured the data collection process delved into the content of ethical considerations (e.g., specific concerns) and the consequences of these considerations (e.g., how they impact decision-making processes) whist sharing the findings of the literature review to interrogate the perspectives of the research participants.

To ensure the validity of the data collected, the researcher embedded the concept of member checking by including findings of the literature review within the interview questions. According to Broussard (2023), member-checking is a valuable technique that can enhance the trustworthiness of research findings. By returning to participants to validate or confirm research findings, researchers can increase the credibility, dependability, confirmability, and transferability of their results. Researchers can conduct it in a variety of ways, including reviewing transcripts, discussing findings, and sharing draft reports with participants. The author goes onto to assert that researchers should plan ahead, be transparent, ensure confidentiality, and be open to feedback from participants. From several definitions of this concept, it was presented as the technique is used post interview process. However, based on the prospective nature of this study, the researcher employed this technique as part of the structure of the interview questions to probe the research participant during the interview as opposed to losing the essence and momentum by returning at a later date for clarification. The rigorous approach to mitigating further enhanced the reliability and validity of the research outcomes, thereby ensuring that the findings of the study were credible, relevant, and comprehensive.

For the design of the interview questions of this study, the researcher ensured a thorough exploration of the ethical considerations in adopting, integrating and harnessing drone technology within the cold supply chain industry. This design approach also aligned with the objectives and themes articulated in the theoretical framework. However, a question that emerged was how the researcher would deal with potential biases as potential limitations during the interview process?

In response to this question, the researcher was prompted to adopt a robust approach to mitigate potential biases during the interview process, including addressing selection bias. From here, to mitigate selection[141] bias as well as the researcher own biases, the researcher used the type of evidence required in the context of the information power held by the research participant as evident in Appendix C to develop evidence-based exploratory questions[142] to guide the interview process as expounded in Appendix D and E. This reduced the likelihood of response[143] bias, and therefore also tailored the structure of the questions to each participant group. In addition to these measures, to address confirmation[144] bias, the QUES evidence matrix was during the formulation of questions, as a means to prevent the collection of premature evidence gathering.

3. Execution of data collection instrument

Following the design of the data collection instrument for this study, it necessitated that the researcher creates protocols for the application of the data collection instrument. These protocols were required for pre-interview activities and post interview activities.

Protocol One: Pre-interview Protocol

Following on from the design of the interview, the researcher drafted Appendix F[145] as the information that would inform eligible research participants of the nature of the study. The researcher also considered the manner in which informed consent would be preserved by this study. To this end, given the technological focus of the study, the researcher formulated an online consent form that was aligned to the ethical requirements of the University of Witwatersrand, as well as the principles of research principles incumbent on the researcher, Appendix G was created using Google forms. The consent form outlined the nature of the participants consent, the legalities involved, and the commitments and responsibilities of each party to the interview. Moreover, the consent form was securely encrypted to protect the data it collected and was only accessible to the researcher. To ensure that the legality and validity of the consent form, affirmations at the end of the form was provided, where the research participant was able to make a declaration and participants were provided with a copy of their submission.

This ensured transparency and allowed the participant to retain a record of their consent in the event that they wished to exercise their right to withdraw from the study. This was facilitated through the online system, which automatically sent a copy of the completed consent form to the participants' email addresses upon submission. This method of obtaining and securing informed consent was particularly suited to the technological nature of the study, aligning with modern data management practices and legal requirements. Moreover, it provided a robust and efficient means of ensuring informed consent while maintaining the highest standards of data security and participant trust. This approach not only complied with data protection regulations of South Africa but also safeguarded the participants' information from unauthorised access or breaches which is a required of the Protection of Personal Information Act 4 of 2013 of South Africa. This also assisted the researcher to obtain signatures by the research participant in a manner that conformed to data privacy laws of Southern Africa. This

141 According to Clayton *et al*. (2023), selection bias can occur when the sample of a study differs from the target population and therefore affects the validity of the study.

142 Albeit Annexure D and E have tailored questions per decision making group, the underlying questions remained the same however just phrased differently to align to terminology used by the decision-making category. No material changes or new questions were added.

143 According to Williams (2024), response bias refers to conditions or factors that occur during a research response processes, affecting the accuracy and reliability of responses provided. The author goes on to expound how response bias can manifest in different ways, including desirability bias, demand bias, acquiescence bias, dissent bias, non-response bias, extreme and neutral response bias, question and answer order bias, voluntary response bias, and courtesy bias. These biases can distort research findings and impact the reliability of data collected and is therefore imperative that mitigating strategies are employed.

144 According to Hoffman (2023) confirmation bias refers to the tendency to interpret information in a way that confirms what is already believed to be true. This bias promotes wishful thinking, that leads to the halting of evidence gathering when the evidence already gathered confirms the views or prejudices that the principal researcher wishes to be true.

145 Appendix F was the letter of information sent to eligible participants.

was important since the researcher elected to use an electronic signature that constituted an advanced electronic signature (AES). [146]

To ensure member checking, the researcher considered the manner in which the interview questions would be delivered. To this end, the researcher made use of the Microsoft PowerPoint presentation software to focus the interview process and to keep the research participants engaged given the complex nature of the study. This was also important given the prospective nature of the study and the fact that drone is in a nascent commercial state within South Africa. The PowerPoint presentation was constructed with an introduction which outlined the central claim of the study, the objectives of the study, and the central research question that the study sought to answer. The rationale here was to reinforce the ethical principles of informed consent and transparency by ensuring that participants were fully informed about the purpose and scope of the research before deciding to participate. Additionally, the use of the presentation facilitated participant engagement, respecting their time and expertise by providing a clear and concise overview of the study's objectives and expectations. Furthermore, the inclusion of the literature findings was a member checking embedment that allowed for the validity and accuracy of findings to be produced. This approach also upheld ethical standards by promoting transparency, respect for participants, and ensuring their understanding and consent throughout the research process.

Protocol Two: Interview Protocol

The recruitment strategy was activated and from the engagements with potential participants, it emerged that the preferred methods for conducting interviews were either face-to-face or via secure, advanced technological platforms such as Microsoft Teams or the paid version of Google Meet. These online meeting platforms are current and known for their security and encryption. Other platforms, such as Zoom, were not deemed suitable due to concerns such as ease of use, recording capabilities, and voice quality, which were considered risks for the critical interviews needed to collect primary data for this study. Thus, for this study, the interview protocol for this study involved the following:

- A day prior to the interview session, participants were provided with Appendix F, being the same letter of information that was initially sent during the solicitation of their participation. This was accompanied by a link to complete an online consent form. The purpose of these steps was to reinforce the ethical principles underpinning the study, reminding participants of their rights and involvement.
- On the day of the interview, the researcher administered the interview questions using the PowerPoint presentation prepared prior to the interview process. This approach provided a structured framework while allowing flexibility to ask probing questions based on participants' responses.
- Based on the manual control required to navigate the PowerPoint presentation, and to ensure a coherent flow of the interview, it necessitated the assistance with recording and transcribing the interview.
- For the transcription of interviews, the researcher elected to make use of the paid for version of Otter software. This was the preferred method of the researcher which was previously trialled in preparation for this study. Baruch *et al.* (2023) explicate that the process of transcription involves the extraction of insights directly from raw data collected from research participants, representing a pivotal intermediary stage between the inherent richness of raw data and the meaningful insights derived from it. Despite the personal costs incurred, the paid version of Otter software was utilised to ensure the privacy and secure storage of the interview data. Notably, this leading transcription software was used to either transcribe or improve the linguistic format or improve the readability of the transcribed data, thereby reducing the burden on the researcher. However, it is imperative to acknowledge that while software aided in the efficiency, rigorous quality checks and verification

146 This being a type of digital signature was provided for in section 37 of the Electronic Communications and Transactions Act 25 of 2002 (ECTA) (Beretta, Odenda, & Wilter, 2023). Rens (2020) goes on to confirm that the ECT Act recognises data as the functional equivalent of writing, or evidence in writing, by guaranteeing data messages the same legal validity as messages written on paper. It states that a requirement under law that a document or information be in writing is met if the document or information is in the form of a data message and accessible in a manner usable for subsequent reference to a person who either wants to rely on the existence of a particular agreement or for record purposes.

by the researcher remained indispensable to ensure the accuracy and integrity of the transcribed data. This approach was in line with the commitments made by the researcher in the letter of information (Appendix F) and the online consent form (Appendix G). Moreover, adherence to this protocol assisted the researcher with a conducive environment that shaped an open and honest dialogue, that aimed to ensure that participants felt comfortable and understood their role within the study. The use of advanced transcription software facilitated accurate record-keeping and also upheld the highest standards of data security and participant confidentiality.

Protocol Three: Post Interview Process

Following the completion of each interview session, the recorded audio files were automatically transcribed using Otter Software and available to the researcher. Given that the paid for version of Otter software was used, for privacy and ethical reasons, for this protocol, the researcher was required to download the transcription files, and store the raw data files in a pseudonymised folders that was password protected, and only accessible by the researcher. This was essential given the nature of the study being grounded in ethics and the sensitivity of the data which could expose the research participants. Furthermore, this was in line with the commitment by the researcher that participant data would only be used by the researcher for purposes of academic as expounded in Appendix G, and that no sharing of the data with any third party to the inclusion of university staff given the relationships between the community with the cold supply chain industry that existed. Additionally, this was especially true given the industry contacts that was to be obtained by this study through referrals between decision makers to participate within this study. On this basis, the researcher ensured compliance with laws governing data collection, operation and destruction and records management within the Republic of South Africa.

In addition, for the regard of the laws of the land, the researcher also embraced self-management as an ethical principle to safeguarding the research participant data. Brandenburg and McDonough (2019) define this principle as the conscientious and responsible conduct of researchers who take ownership of ensuring that their work adheres to ethical principles and standards. This involves a commitment to upholding moral values such as justice, respect, beneficence, and reciprocity throughout all stages of the research process. Ethical self-management also entails obtaining informed consent from participants, minimising harm, and complying with relevant regulations and guidelines set forth by oversight bodies such as institutional ethical review both on an institutional and external level. Moving from this premise, to ensure that the Otter transcription application did not retain any participant data, albeit a paid for version, for this protocol, the researcher was required to download the transcription files individually, and encrypt each data file with a password to protect the data file. Thereafter, the researcher was required to store each data file in a secure cloud folder that was further password protected for use by the researcher during the data analysis phases. Post this protocol stage, the data analysis phase of the study began. The following sections expound on the data analysis plan comprising the methods tools and techniques used within the data analysis for this study.

3.3.3. Data Analysis Plan and Interpretation Methods of Primary Data Collected

In response to the overarching claim of this study, and in alignment with the theoretical framework of the study, a data analysis plan was crafted to deal with the analysis of primary data. Building on the preceding sections for this study, Kim and Liu (2017) defines the analysis of primary data as the process of making sense of data collected to answer the research question of a study and address the objectives of the study. Moreover, the Busetto *et al.* (2020) explicates that for data collected through semi-structured interviews, a plan to process the raw data into organised data is required in order to interpret the organised data and to make meaningful findings. Therefore, in the context of this study and the research objectives, it was important to establish a data analysis framework, comprising of a coding and analysis framework to assist with the extrapolation of meaningful insights and findings that were embedded in the narrative answers of the research participants. Conceptually for this study, the following data analysis plan was pronounced and expounded on in the subsequent explanatory sections:

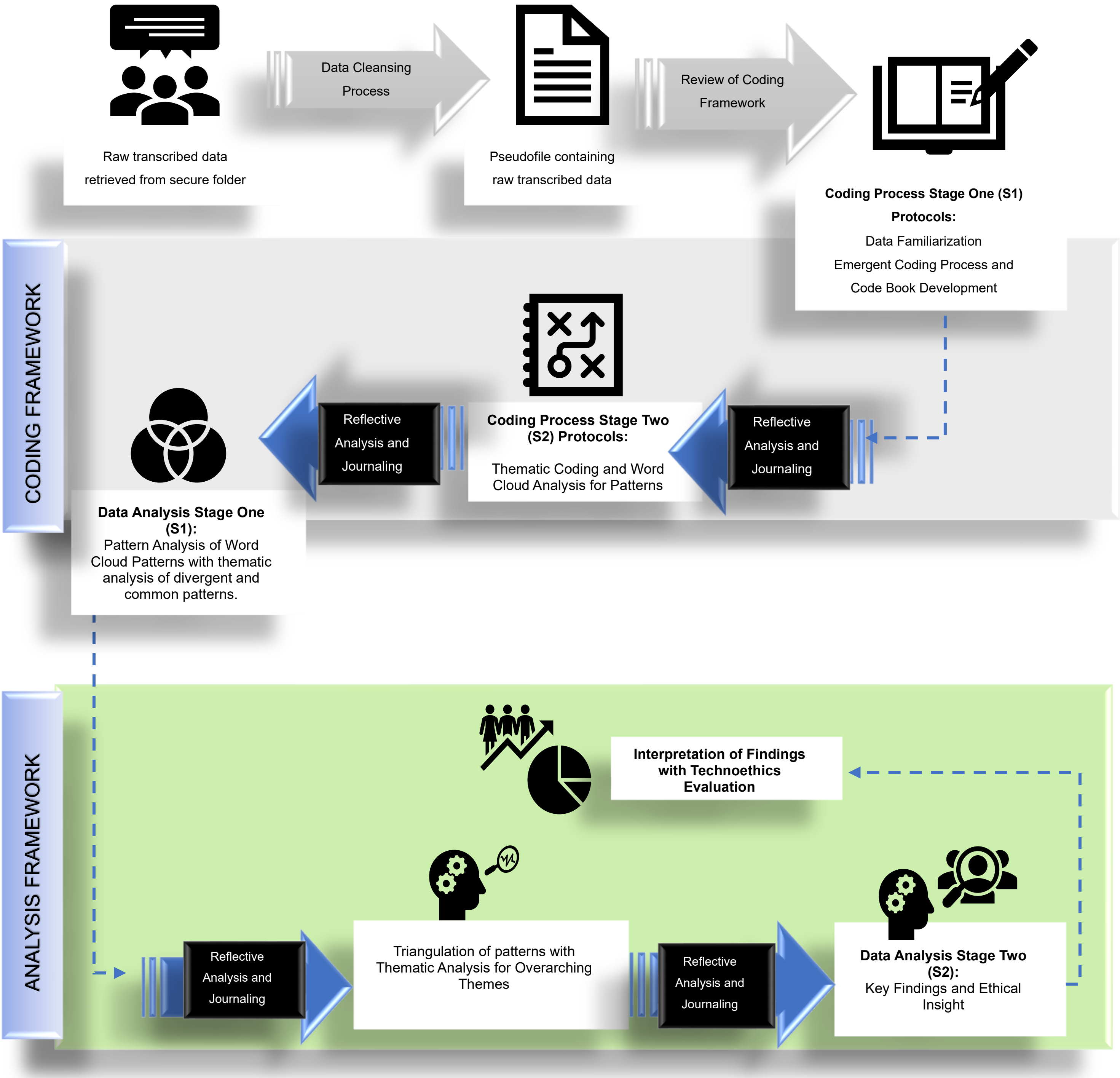

Figure 18 Data Analysis Plan of the study

3.3.3.1. Protocols preceding the Coding and Data analysis Stages

- **Protocol One: Retrieval of Transcribed Data**

Following on from the post interview process explicated earlier, protocols were put in place for the retrieval and preparation of the Otter.ai transcribed software files. Building on the preceding discussions, each file was required to be stored in a secure Google Drive cloud folder. Following this, the researcher engaged in a pseudonymisation process[147] for each transcription data file. However, the researcher was cognizant of the assertion of Martine (2024), that although the pseudonymisation process assists with the personalisation of personal data, a risk still exists that the data could still be indirectly linked to the research participant. Given the nature of the study, such a risk had implications against the commitment to research participants regarding the protection of their anonymity. To this end, the transcription files were further subjected to an anonymisation process which involved generalisation and data masking[148]. The process served as a reasonable likelihood test that was to ensure that the dataset(s) were anonymised, so that re-identification of individuals were not reasonably likely. Moreover, this process was especially important since it was the condition on which participants agreed to participate in the study. On this basis, it was essential that the researcher remove all personal identifiers such as names, company names and any third party mentions from data in order to protect the privacy of individuals, and to ensure that the researcher. This also included any contextual clues that could potentially lead to the identification of the participants. Thus, the pseudonymisation, anonymisation and redaction process was carried out to preserve the integrity and meaning of the interview content. This allowed for the highest standards of privacy to be adhered to, with a strict alignment with ethical research practice. Following this, the dataset(s) were to be organised into folders and given a pseudonymised label in preparation for the subsequent phase of data analysis process.

- **Protocol Two: Data Cleansing**

Data cleansing as explicated by Ridzuan *et al.* (2019) is an operation that is performed on existing data to remove anomalies, in pursuit of performing analysis on a dataset that is accurate and is a unique representation of the research environment. Furthermore, this process involves eliminating errors by transforming the data into a uniform format. Thus, the data cleansing process is complex and consists of several stages *inter alia*: specifying the quality rules that must be adhered to during the data cleansing process.

For this study, data cleansing rules were adopted to guide the data cleansing process. This served as essential guidelines to ensure the accuracy, consistency, and completeness of the data collected, and also to help maintain data integrity and reliability (Microsoft, 2024). In line with this postulation, the researcher was cognizant of the assertion by Ridzuan *et al.* (2019). The author asserts that data must be handled correctly as unreliable information could lead to misguided findings, and that incomplete information would generate uncertainties during data analysis stages. Moreover, errors or missing values in the dataset may produce results that affect the accuracy, validity and dependability of the research findings.

In the context of answering the research question of this study, and to achieve the objectives of this study, the following data quality rules were essential to ensure the integrity and reliability of the data collected for use within this study. Therefore, in order to develop a framework for ethical drone-based decisions within the cold supply chain industry of South Africa, the following data cleansing rules were adopted in alignment with the research objectives as follows:

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147 Pseudonymisation enables the personal data to go through a process that makes the personal data unidentifiable to a specific person without any extra information (Martine, 2024).

148 The DPO (Center, 2023)Centre defines these two processes as:

1. Generalisation: Personal data is aggregated to a level that groups individuals within a demographic to reduce the risk of re-identification of an individual data subject.
2. Data Masking: Personal data is replaced with random strings of numbers and letters to mask the existing data.

Accuracy

- **Relevance to RO1**: Ensure data accurately represented real-world ethical considerations was critical. Ethical considerations and decision-making details needed to be accurately captured to reflect the actual operational environments and ethical challenges faced by organizations in the cold supply chain.
- **Data Cleansing Rule**: Data points were to be cross-referenced with Otter software and MS Teams transcription audio files to ensure the accuracy of recorded narrative answers. This included verifying that transcriptions correctly matched the spoken words to maintain the integrity of the information.

Completeness

- **Relevance to RO1 and RO2**: Cleansed data was then deemed complete data. However, another critical checkpoint was to fully identify and evaluate all critical ethical considerations and best practices. This was neccesary as missing data could have led to gaps in understanding and addressing ethical challenges.
- **Data Cleansing Rule**: Inconsistencies in the transcriptions, such as missing words, spelling errors, and grammatical mistakes not properly recorded by the transcription software, were identified and addressed. Thus,ensuring completeness was essential to avoid missing key insights related to ethical challenges and decision-making processes.

Conformity

- **Relevance to RO2 and RO3**: Ensuring data followed standard formats allowed for consistent analysis and incorporation into the ethical decision-making framework. Conformity in data formats facilitated a better understanding and comparison of best practices.
- **Data Cleansing Rule**: Data was catergorised per question answered, to enable a consistent format for ease of comparison and analysis.

Consistency

- **Relevance to RO1 and RO2**: Consistent grammar, spelling, and technical jargon across the transcription files ensured that the identified ethical considerations and best practices were uniformly represented, thereby avoiding contradictions that could have undermined the framework's reliability.
- **Data Cleansing Rule**: Consistency checks were performed to ensure uniform representation of information across all records, such as maintaining consistent terminology for ethical issues and stakeholder roles. This included correcting discrepancies in the use of technical terms and ensuring the same spelling and grammatical standards throughout the dataset.

Figure 19 Data Cleansing Rules

3.3.3.2. Coding Framework Protocols

- **Coding Process Stage One (S1): Data Familiarisation, Emergent Coding Process and Code Book Development**

Post the data cleansing stage, it necessitated that the researcher starts with a process of coding the data. To achieve this, the researcher becomes familiar with the data sets. This was important since the researcher did not manually transcribe the interviews but rather relied on Otter.ai Software for the transcription of each interview conducted. Naeem *et al.* (2023) describes the familiarisation with data as an important step in the analysis process. The author contends that this phase allows a researcher to dive deep into the content while discerning important segments. Moreover, when a researcher immerses themselves in the data during the familiarisation phase, it mitigates the duplication of codes, and that such codes[149] are applied to quotes in the interview narrative. This risk mitigation strategy aptly ensures that the representation of the diverse viewpoints and patterns are pertinent to the research objectives of the study.

For this study, the researcher became familiar with the data through repetitive re- reading of the same interview data files to understand the data and gain insights. From here, prior to engaging in the coding of data within each data file, the researcher was cognizant of the assertions of Jones (2024). The author explicates that to ensure consistency within the coding process; it necessitates that coding procedures and guidelines are established from the outset of the analysis phase. Hahn (2007) supported this argument, in so far that the author asserts that the nebulous nature of interview data necessitates the use of coherent and well-elucidated strategies, to produce defensible results. These assertions were important since the researcher was cognizant of the inductive approach followed by the study, and its exploratory research design employed. Against this backdrop, it necessitated a coding technique to apply codes to the narrative data that would accurately reflect participant voices.

149 A code in the context of qualitative data analysis is a summary of a larger segment of text (Hecker & Kalpokas, 2024).

However, the researcher was also cognizant of the argument of Bingham (2023), who argues that there should be a link that is established between the initial familiarisation of the data which can be likened to the open coding phase in traditional qualitative studies, and the subsequent coding phase that would emerge themes to be analysed. In light of this, the researcher considered several open coding techniques. In furtherance of this, and to establish a rationale for this approach, the researcher reflected on the postulation of Tanabe *et al.* (2020). The author explicates that an understanding of narrative text requires the ability to read between the lines and determine changes in the characters' emotional states concerning the ongoing situation described in the text. The authors goes on to explain that the mental state of a character in a narrative can be more accurately classified by using the preceding context of a target sentence. Moreover, due to the innate complexity of human emotions, that a sentence can express multiple emotions that an annotator[150] may be unable to disassociate. Tanabe *et al.* (2020) goes on to argue that this is an issue that is linked to multi-label classification, which must be approached in a structed manner to ensure that there is mutual dependencies that is handled among emotion categories.

Rashkin *et al.* (2018) supports the arguments of Tanabe *et al.* (2020), arguing that understanding a story requires reasoning about the causal links between the events in the story and the mental states of the characters, even when those relationships that are not explicitly stated. To facilitate their research in addressing this challenge, Rashkin *et al.* (2018) formulated an annotation framework to explain naive psychology of story characters as fully specified chains of mental states with respect to motivations and emotional reactions. Upon review of the annotation framework of Rashkin *et al.* (2018), the researcher had regard for the assertions of Yu et al. (2018), regarding emotion detection within a data set that is narrative. Yu *et al.* (2018) posit that emotion detection is typically modelled as a multi-label classification, since each sentence may contain one or more emotions from a standard emotion set containing anger, anticipation, disgust, fear, joy, love, optimism, pessimism, sadness, surprise and trust. Against this reflection, and to establish the link between the initial familiarisation of the data which can be likened to the open coding phase in traditional qualitative studies, the researcher employed an emergent coding[151] technique. This technique was particularly valuable given the inductive approach and the exploratory research design of the study, where the exploratory interview questions probed the prospective novel nature of ethical implications of drone technology adoption within a permissible regulatory environment within South Africa. Moreover, this method allowed for a more natural reflection of the complexity within the data.

Since the data files were saved in a Microsoft (MS) Word format, the researcher initiated the emergent coding process using the comments feature in the MS Word application, to inductively apply codes and a definition to the data.

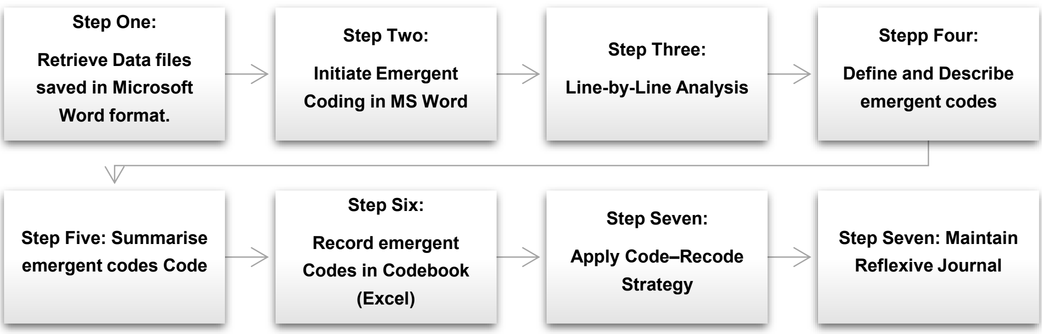

Figure 20 Emergent Coding Process

150 In the context of this study, this would be the principal researcher

151 Emergent codes are codes that are derived from the data can help researchers to explore the data in depth, and to capture the richness, diversity, and complexity of the data. They can also allow researchers to discover new or surprising findings, or to challenge existing theories or assumptions (LinkedIn, 2024).

As illustrated in figure 20, the emergent coding process involved a line-by- line analysis of each MS Word transcript file per decision maker category[152], where a descriptive code was assigned together with a description or definition of the assigned code. Following on from this process, the definition of the code was based on the participant responses to questions and to capture the key ideas, phrases, and/or sentences. Moreover, the description of the emergent code served as a summary refection of the narrative that was coded, to ensure validity and reliability during the iterative rereading of the data file. At this juncture, these codes were recorded in a codebook, using a Microsoft Excel workbook to systematically record these emergent codes within a spreadsheet of the MS Excell workbook. To validate the emergent codes, the researcher used a code–recode strategy[153]. The application of this strategy involved reflecting on the initial coding decisions made and thereby identify and potential biases. During this process, the researcher maintained a reflexive journal[154] during the coding process, to assist with the tracking of the researchers thought process, and any changes in their understanding of the data. Moreover, this iterative process of reflecting on these codes was to establish whether there were any duplication amongst the emergent codes. From here, the codes were revised and the new codes merged with the exiting codes, to reflect the evolving insights and perspectives that enriched the analysis. Furthermore, the new codes were updated to reflect emerging concepts that were not initially anticipated, and to accommodate additional unforeseen perspectives that contributed to an understanding of the ethical challenges and decision-making processes related to drone technology in the cold supply chain industry.

- **Coding Process Stage Two (S2) Protocols: Thematic Coding and Word Cloud Analysis for Patterns**

Traditionally, following on from the initial coding phase[155], is axial coding. Simmons (2017) explicates that axial coding is a qualitative research technique that involves relating data together in order to reveal codes, categories, and subcategories to construct linkages between data. Scott and Medaugh (2017) describe axial coding as a stage that results in a coding framework from which to synthesise and organise data into more coherent, hierarchically structured categories and subcategories. However, for this study, the framework developed during the S1 coding stage was a hierarchical frame that comprised emergent codes that were further adjusted and refined through thematic codes.

This was important to note given that Simmons (2017) explicates that axial coding has a historical relationship with grounded theory, which is a qualitative methodological framework that involves constantly comparing emergent themes within the research data set in order to make theoretical claims. Given that this study does not follow a grounded theory methodology and approaches, and given the baseline narrative code hierarchical framework created, it necessitated that the researcher consider what further steps were required in order to derive meaningful insights from the data. To address this, and in furtherance of ensuring the reliability and validity of the data analysis findings, the researcher employed thematic coding as a technique to organise the emergent codes that were refined and adjusted. From here, the researcher used a thematic coding technique[156] to scientifically map each emergent code to a thematic code. [157] This process was in line with the earlier argument of Bingham (2023) regarding the link that must be established between the initial familiarisation of the data, and the subsequent axial coding phase that would emerge themes.

152 These categories as expounded in table 13 earlier, were general senior manager (GM), compliance manager (CM), operational manager (OM), technology manager (TM) and the skills development sector manager (SDM)

153 The code–recode strategy refers to the principal researcher coding the data and then leaves the analysis for a period of time and then comes back and recodes the data and compares the two sets of coded materials (unisatu, 2024).

154 The principal researcher centralised the reflective journal within the code book, as a sheet within the journal.

155 In this study, the traditional initial alternatively open coding phase was structured as the S1 emergent and thematic coding phase. This means that this phase was specifically tailored for the study as opposed to using a traditional approach.

156 A thematic coding technique is a type of qualitative data analysis that finds themes in text by analysing the meaning of words and sentence structure. When you use thematic coding to analyse, the principal researcher will use themes that are most frequent across the data set (Medelyan, 2024)

157 Coding data in a thematic analysis process involves systematically identifying and labelling relevant parts of the data. This process is not just about tagging data with codes but also about engaging deeply with the content to discern underlying patterns and meanings (Hecker & Kalpokas, 2024).

Furthermore, the purposes of undertaking a thematic coding process was in line with the earlier argument of Rashkin et al. (2018), that understanding a story (narrative data) requires reasoning about the causal links between the events in the story and the mental states of the characters, even when those relationships that are not explicitly stated. This aligned with the assertions of Simmons (2017) that the subsequent phase of initial coding of qualitative data, a process of inductively locating linkages between data may occur in myriad of ways inter alia: identification of behaviours, events, activities, strategies, states, meanings, participation, relationships, conditions, consequences, and settings to name a few. Against this backdrop, the thematic coding process began by examining the refined thematic codes to identify codes that appeared share common themes. This involved clustering codes that addressed similar aspects of the research objectives or those that represented recurring ideas across the emergent codes. Once the related codes were grouped, the next step was to merge themes that were similar, to avoid redundancy and to organise and synthesise the initial codes into broader themes. However, where themes that were too broad to apply a code, the researcher split broad themes, by dividing the themes into more specific sub-themes and applied a thematic code for greater clarity and precision.

To validate the accuracy and applicability of the thematic mapping, the researcher performed a cross-reference with the original data. This step involved revisiting the raw data to confirm that the narrative extracts were correctly mapped to the appropriate thematic codes. This validation process was crucial for maintaining the integrity and relevance of the emergent codes. Furthermore, the researcher aimed to ensure the validity and reliability of the data analysis findings, by ensuring that the thematic codes accurately encapsulated the essence of the emergent code definitions and its underlying representation of the narratives within data file. Following this process, the researcher commenced with the process of identifying patterns within the data. Elahi (2024) refers to the identification of patterns within qualitative research as pattern checking, and defines this concept as an analytical process of identifying specific sequences within a given data set, which may repeat across a large data set within the same domain.

Cortis (2022), goes on to posits that that the role of pattern checking as a data analysis protocol within a qualitative study, can increase the internal validity and transferability of a qualitative research. For this study, the researcher used a contextual analysis to understand the context underpinning the thematic codes. The need to understand context was supported by Masito and Dovey (2021) who argues that the issue of context is rarely addressed in research emphasises the contextually contingent aspects of data analysis as imperative. Saazar (2020) goes on to posits that contextual insight as a contextual inquiry assist to uncover hidden insights about a research participant that may not be available through other research methods. Moving from this premise, the researcher premised the contextual inquiry based on the following four principles namely:

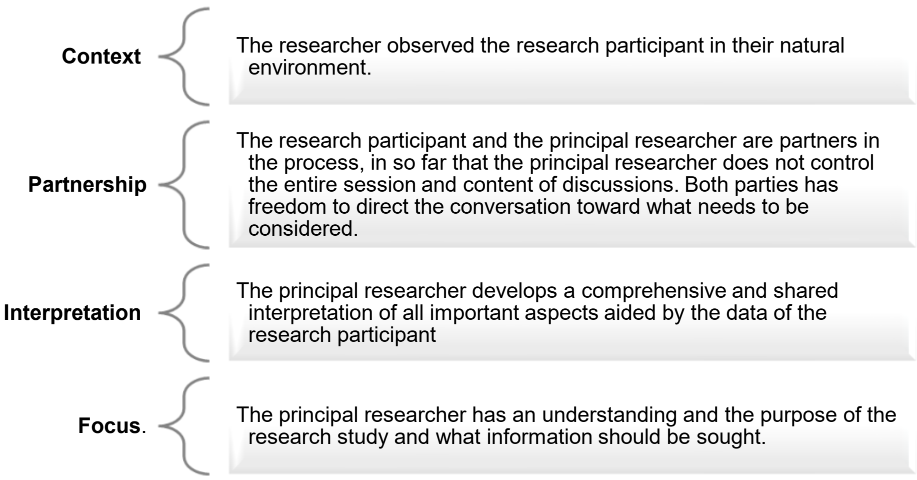

Figure 21 Principles of the contextual analysis inquiry

Premised on the principles expounded in figure 21, the researcher proceeded to use these principles to conduct a contextual analysis to move beyond the mere frequency of words stemming from the specific sequences of words, phrases, and ideas underpinning the thematic codes. Added to this, the researcher supplemented the contextual analysis with a thematic analysis, to serve as a pattern analysis approach used to analyse the recurrence and interconnections of the contextual analysis and to identify the patterns that emerged. However, the researcher observed that the contextual and thematic analysis was not without its challenges. One potential limitation that emerged was the risk of confirmation bias. Hecker and Kalpokas (2024) assert that confirmation bias is a risk that emanates when researchers selectively focus on data that confirm the predefined themes while disregarding evidence that contradicts them, leading to confirmation bias in the analysis and interpretation of results. To address this, the contextual analysis process as expounded in figure 18 was designed to ensure rigor and to contextually analyse the data during each review interval. This served as the cross referencing of the data to ensure reliability.

To ensure validity, the researcher used a word cloud analysis technique, to identify the prominent patterns through the visualising of the frequency of words across the thematic code themes. Kalmukov (2021) explicates that creating word (tag) clouds is an effective data visualisation method that enables users to quickly familiarise themselves with the content of a large collection of textual documents, and discern their key patterns instantly. Rather than frustrating the reader by going through numerous files, the content can be automatically extracted via specialised software and processed to generate the most important terms being highlighted and displayed in the form of a word cloud. However, for this study, the researcher acknowledged that while the use of a word cloud analysis provided an effective starting point for the pattern checking (identification) analysis, that it is was important to recognise the limitation of overreliance on word frequency. This approach and sentiment was based on the researcher's reflection that words that and concepts underpinning the thematic codes that appeared frequently would not always be the most contextually significant. To counter this, the word cloud was used solely as an initial exploratory tool that would identify High-frequency terms, Prominent terms and terms that were frequently repeated as words and phrases. To conduct the word cloud analysis for patterns, the researcher used the following logic:

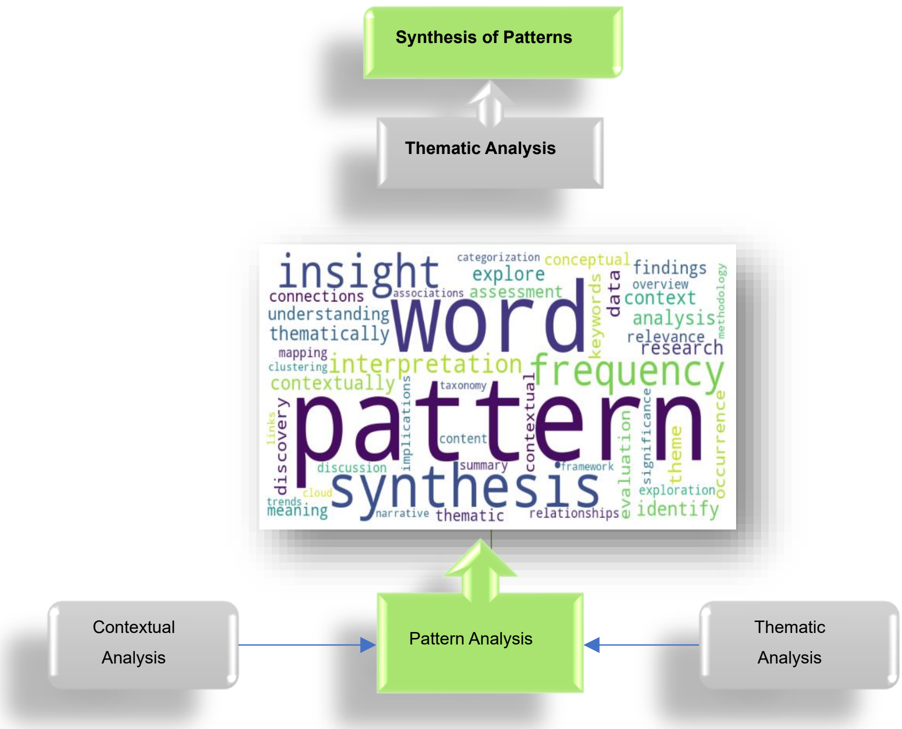

Figure 22 Word Cloud Analysis

From figure 22, the researcher used the Mnetimer software to generate the word clouds, given the funding limitations of this study. To conduct the analysis of the word cloud patterns, the researcher conducted the word cloud analysis by using the protocols outlined in figure 19 to analyse the outcome of the generated word cloud. This processes simultaneously served as a cross-reference of the data to ensure validity and reliability. In this context, the principal set the following definitions as analyses protocols for each category that the word cloud would reveal.

High-Frequency Terms:

- In this catergory, the principal resarcher will analyse for the most freqeuntly occurring words or phrases.

Prominent Terms:

- In this catergory, the principal resarcher identifed and analysed prominent terms, to reveal which specific words or phrases were emphasised. This will assisted the principal researcher to understand the key concepts or issues that emerged as patterns.

Repeated Phrases:

- In this catergory, words were assesed on their repetitions, to assit with the subseqeunt pinpointing of trends, sentiments, or topics that constitute a pattern.

Figure 23 Word Cloud Analysis Protocols

Following the word cloud analysis, the researcher synthesised each key pattern that emerged as expounded in Appendix I.

3.3.3.3. Data Analysis Protocols

- **Data Analysis Stage One (S1): Pattern Analysis with Thematic analysis for Overarching Themes**

Following the exploration of the word cloud analysis, the researcher proceeded to conduct a thematic analysis of the synthesised patterns to identify the underlying themes. This process provided a foundation for the identification of overarching themes, that captured the underlying meanings and concepts identified within the patterns. As a result, it necessitated that the researcher develop an approach to arrive at the overarching themes to understand the shared experiences, opinions, or behaviours among participants, as well as the exceptions and contrasting experiences across the themes. To achieve this, the researcher had to triangulate the patterns identified during the pattern analysis in Appendix I. Carter *et al.* (2014) explicates that triangulation is the use of multiple methods or data sources in qualitative research, to develop a comprehensive understanding of phenomena. Moreover, that triangulation is also a qualitative research strategy to test validity through the convergence of information from different sources. The authors go on to discuss four types of triangulations namely: (a) method triangulation; (b) investigator triangulation; (c) theory triangulation; and (d) data source triangulation, that can be conceptually explained as follows:

Method Triangulation:

- This approach involves data collection techniques to investigate the same phenomenon. This method may invole the triangulation of data from interviews, observations, and field notes to gather comprehensive insights

Investigator Triangulation:

- This method entails the involvement of two or more researchers in the same study. This, investigator triangulation can validate findings and introduce diverse perspectives, thereby broadening the understanding of the phenomenon under study.

Theory Triangulation:

- In this type of triangulation, different theoretical frameworks are applied to the analysis and interpretation of data. By utilising various theories or hypotheses, this approach helps researchers either support or challenge their findings.

Data Source Triangulation:

- This method involves collecting data from a variety of sources, to provide multiple viewpoints and aids in the validation of data through cross-verification from different perspectives.

Figure 24 Methods of Triangulation
Carter *et al.* (2014)

Alele and Malau-Aduli (2023) builds on the definition of Carter *et al.* (2014), explicating that the method of triangulation refers to the process of using multiple methods, data sources, or perspectives to gain a more comprehensive understanding of a research problem. The author goes on to differentiate the triangulation used within quantitative, qualitative and within a mixed method study. This was important to understand in order to apply the correct level and method of triangulation within the study. Alele and Malau-Aduli (2023) therefore expounds that triangulation could occur at the design, methods, interpretation and reporting levels. At the design level, triangulation involves using basic and advanced methods during the conceptualisation phase of the research. Basic designs, such as convergent, exploratory sequential, and explanatory sequential designs, facilitate integration. At the methods level, integration is often related to the type of design employed in the study. At an integration level, the linking of data collection and analysis can be triangulated through several approaches namely: (1) merging, (2) connecting, (3) building, and (4) embedding as follows:

Merging	Connecting	Building
• This occurs when researchers combine quantitative and qualitative databases for analysis and comparison, typically after conducting statistical and textual analyses. The results are then reported together in the discussion section.	• This approach involves linking one type of data to another via the sampling framework, which can happen in both sequential and convergent designs through sampling.	• Here, results from one data collection process inform the design of subsequent data collection strategies. For example, qualitative findings might guide the development of survey items by identifying relevant constructs or language used by participants.

Figure 25 Triangulation methods at an Integration Level

Source: Alele and Malau-Aduli (2023)

Integration at the interpretation and reporting level may use three methods to integrate qualitative and quantitative data during interpretation and reporting: (1) narrative integration, (2) data transformation integration, and (3) joint display integration namely:

Narrative Integration:	Data Transformation Integration	Joint Display Integration
• Researchers use narrative techniques to describe both quantitative and/or qualitative findings, providing a holistic view of the research question. In the contiguous approach, results are presented in a single report, with qualitative and quantitative findings displayed in different sections.	• This involves transforming data into a different format to facilitate comparison or analysis.	• This method involves presenting quantitative and/or qualitative findings together through visual displays, offering new insights beyond what could be obtained from analyzing each type of data separately.

Figure 26 Triangulation at an Interpretation and Reporting Level

Alele and Malau-Aduli (2023)

From the explanations of Carter *et al.* (2014) and Alele and Malau-Aduli (2023), the researcher used a method triangulation approach to triangulate the themes stemming from the pattern analysis. To achieve this, the researcher used a thematic analysis to identify the common and divergent patterns across the underlying themes. To arrive at the overarching themes that would be further explored in the subsequent data analysis, the analysis process followed the following logic:

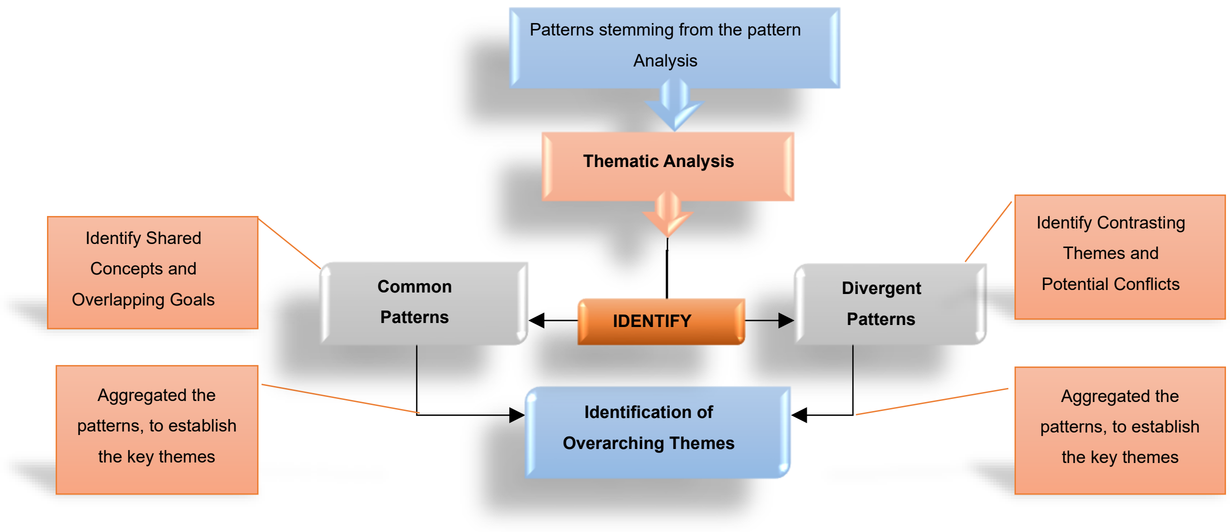

Figure 27 Triangulation of Common and Divergent Patterns

From figure 27, the triangulation process started with the employ of a thematic analysis to identify the common and divergent patterns as expounded in Appendix J. To achieve this, the researcher used the following protocols:

Identification of Common Patterns	Idetification of Divergent Patterns
• This step is focused on identifying common patterns among the themes that share similar concepts or goals across the data. This identification process assisted in understanding the broader trends and overarching themes.	• In this step involves looking for divergent patterns among the themes. It focuses on identifying contrasting themes or conflicts that arise from the underlying themes. This helped to acknowledge the differences and complexities within the dataset.

Figure 28 Protocols for Pattern Common and Divergent Pattern Identification

To identify the common patterns, the commonalities were identified through the shared concepts and any prescience of overlapping goals. This assisted the researcher to understand the broader narrative as well as the main messages that the underpinning data conveyed. To identify for the divergent patterns among themes, the researcher analysed for contrasting themes or potential conflicts within the underpinning data. Recognising these divergences was crucial as it provided an understanding of the subtle messages that were conveyed within the underpinning data. Thus, the thematic analysis was the core process involved in the identification of underlying themes and determining their unique attributes and relationships between the underlying themes. To identify the underlying themes, the researcher conducted a thorough exploration of each, focusing on their characteristics, relationships, and broader implications by analysing for the following:

Theme Characteristics	Interconnectedness of Themes	Contextual Significance	Implications
• Protocoll: Analyse to understand defining elements including its scope, the patterns it encapsulates, and its variations within the dataset.	• Protocol: Analyse the relationships between the umder;ing themes, to identify any overlap, contrast, or complementarity. This analysis was crucial for understanding the complex interdependencies between the themes.	• Protocoll: Analyse for the relevance of each theme in relation to the broader research questions and objectives. This involved exploring how each underlying theme aligns with or challenges existing literature, frameworks, or theories.	• Protocoll: Analyse for the implications of each theme in relation to the objectives of the study, to gain insight into how each underying themes informs or reshapes the understanding of the subject under investigation.

Figure 29 Protocols for Theme Identification

The outcome of this analysis process was expounded in Appendix J. Moving from this premise, a deep engagement with the underlying themes were required to identify the overarching themes that emerged. The researcher conducted a thorough exploration of the common and divergent patterns, focusing on their characteristics, relationships, and broader implications. From here, 30 sub-themes emerged, that were further analysed to arrive at the six overarching themes as expounded in Appendix J. The cyclical nature of the thematic analysis process, particularly the iterative synthesis steps involved reflexive journaling of the researcher observations. This meant recording such observations during the continual revisiting and refinement of the analysis. This was imperative as the synthesis of the patterns created a framework for the sub-themes and the overarching themes to be explored in the subsequent data analysis S2 stage.

- **Data Analysis Stage Two (S2): Key Findings and Ethical Insight**

Post the triangulation of the patterns, the researcher thematically identified the overarching themes and its sub-themes, as expounded in Appendix J. To achieve this, the researcher performed a pattern analysis of the common and divergent patterns stemming from the patterns in Appendix I, to identify the common themes emergent from the pattern analysis and to rigorously examine qualitative data, leading to the identification of overarching themes and sub-themes. To this end, four overarching themes and eleven sub-themes were identified as follows:

Overarching Theme One: Strategic and Balanced Drone Adoption	Sub-Theme 1: Pilot Testing and Iterative Adoption	2x Common Patterns and 1x Divergent Pattern
	Sub-Theme 2: Integration into Existing Operational Systems	1x Common Patterns and 1x Divergent Pattern
	Sub-Theme 3: Worker Displacement and Job Transformation	2x Common Patterns and 1x Divergent Pattern
Overarching Theme Two: Risk Taxonomy Decision Making	Sub-Theme 1: Legal Compliance and Regulatory Adherence	2x Common Patterns and 1x Divergent Pattern
	Sub-Theme 2: Privacy and Security	2x Common Patterns and 1x Divergent Pattern
	Sub-Theme 3: Ethical Decision-Making in Risk Scenarios	2x Common Patterns and 1x Divergent Pattern
	Sub-Theme 4: Data Management and Governance	2x Common Patterns and 1x Divergent Pattern
Overarching Theme Three: Knowledge Structures for Sustainable Drone Adoption	Sub-Theme 1: Knowledge Management and Dissemination	2x Common Patterns and 1x Divergent Pattern
	Sub-Theme 2: Ethical Implications of Misinformation	2x Common Patterns and 1x Divergent Pattern
Overarching Theme Four: Ethical Considerations in Business Practices	Sub-Theme 1: Competitive Advantage and Market Leadership	2x Common Patterns and 1x Divergent Pattern
	Sub-Theme 2: Fair Business and Competition Practices	2x Common Patterns and 1x Divergent Pattern

Figure 30 Thematic Insight and Findings

Following the identification of the overarching themes, the researcher thematically analysed the sub-themes of each overarching theme. The analysis involved a critical and rigorous investigation into the four overarching themes and their associated sub-themes. This in-depth exploration ensured that each theme was scrutinised, with particular attention given to the details captured within the sub-themes. Moreover, the researcher incorporated direct quotations from participants to ground the actual responses as representative of the research participant voices. Ethical considerations were integral throughout this stage, guiding the interpretation of sensitive data and ensuring that participant perspectives were handled with fairness and impartiality. This ethical framing also influenced the triangulation of findings, ensuring the research remained methodologically sound and respectful of participant input. Following the analysis of each sub-theme, key findings were synthesised to allow for a thematic understanding for discussion in the subsequent discussion of the findings. In light of this, this approach provided a framework for the discussion in the subsequent discussion of the findings, that addressed the research objectives of the study theoretically. This deepened the thematic analysis and ensured that the findings were ethically grounded and practically relevant.

4. Evaluation Criteria for Trustworthiness of the Study

Morse *et al.* (2002) posits that implementing verification strategies as an evaluation criterion is integral and self-correcting during the conduct of inquiry itself. The authors goes on to expound that verification strategies in qualitative research ensure the reliability and validity of data through a process that includes methodological coherence, appropriate sampling, concurrent data collection and analysis, theoretical thinking, and theory development. Methodological coherence aligns the research question, methods, and data analysis, while appropriate sampling ensures participants are well-suited to the research topic. Concurrent data collection and analysis create a continuous feedback loop that refines the research process. Theoretical thinking involves constantly re-evaluating emerging ideas, and theory development builds from data analysis, producing valid, logical, and comprehensive theories. Together, these strategies guarantee rigor and contribute to reliable and valid research outcomes.

For this study, the researcher considered the Guba and Lincoln's framework criteria for trustworthiness as the evaluation criteria for trustworthiness. This framework articulates stringent criteria in qualitative research, known as credibility, dependability, confirmability and transferability. Alternatively, this framework is often referred to as "the Four-Dimensions Criteria" (FDC) of a study (Forero, et al., 2018). Nowell *et al*. (2017) explicates that in this framework, several techniques are offered *inter alia*: member checking to test the findings and interpretations with the participants. In relation to dependability, the authors explain that this dimension requires an audit trail to provides readers with evidence of the decisions and choices made by the researcher regarding theoretical and methodological issues throughout the study. Moreover, that method of the dependability criterion is keeping records of the raw data, field notes, transcripts within a reflexive journal to assist a researcher to synthesise, relate, and cross reference data, as well as ease the reporting of the research process as a means of creating a clear audit trail. Confirmability is concerned with establishing that the researcher's interpretations and findings are clearly derived from the data, requiring the researcher to demonstrate how conclusions and interpretations have been reached. Transferability refers to the generalizability of inquiry where the researcher is responsible for providing detailed descriptions to enable others to assess whether the findings can be applied to different contexts.

However, Morse *et al.* (2002) *expressed* concern that, in the time since Guba and Lincoln developed their criteria for trustworthiness, there has been a tendency for qualitative researchers to focus on the tangible outcomes of the research (which can be cited at the end of a study) rather than demonstrating how verification strategies were used to shape and direct the research during its development. While strategies of trustworthiness may be useful in attempting to evaluate rigor, they do not in themselves ensure rigor. While standards are useful for evaluating relevance and utility, they do not in themselves ensure that the research will be relevant and useful. The authors therefore calls on researchers to consider the importance of verification strategies used by the researcher in the process of inquiry so that reliability and validity are actively attained. Given the nature of the study and its contribution to the prospective adoption of drone technology for commercial purposes that is being considered within South Africa, and the advocacy for ethics by this study, the researcher employed the Guba and Lincoln's framework for trustworthiness, but was cognizant of the arguments of Morse *et al.* (2002) regarding its limitations.

Therefore, to ensure the trustworthiness of this study, the researcher used the Guba and Lincoln's framework for trustworthiness within this study as follows:

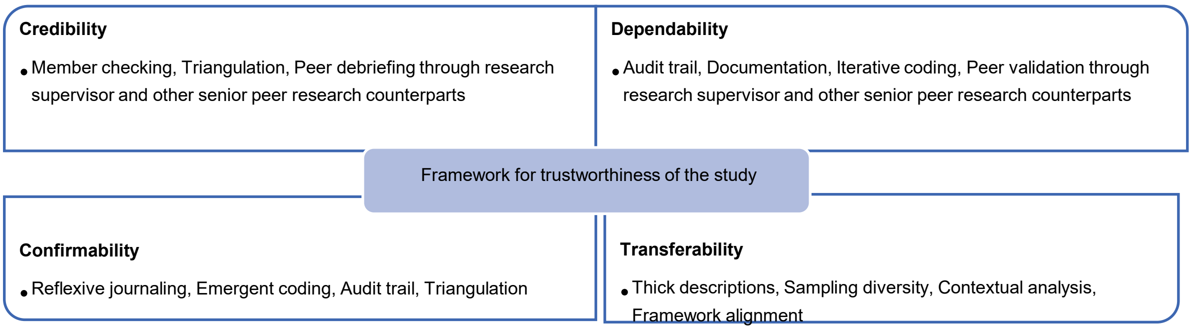

Figure 31 Framework for trustworthiness of the study

As expounded in figure 31, this study employed a robust and transparent methodology that underpinned the trustworthiness criteria for the study, comprising the dimensions of credibility, transferability, dependability, and confirmability. Thes dimensions ensured the that the study was subjected to a rigorous process. The integration of a strong theoretical framework, clear research design, systematic sampling, detailed data collection, and thorough analysis allowed for the findings to be relevant in addressing the ethical challenges of drone technology in the cold supply chain industry within a permissible regulatory commercial environment. To this end, the principles of Guba and Lincoln's framework for trustworthiness were and ensured through a coherent approach that integrated the theoretical framework, research design, methodology, and data analysis. Moreover, each of these aspects were ensured as follows:

1. Credibility

To ensure credibility, the study adhered to several rigorous practices embedded in both the theoretical framework and research methodology. The theoretical framework for the study was aligned with the research objectives and grounded in reliable theoretical foundations that explored the prospective ethical implications of drone technology in the cold supply chain industry. To this end, the researcher employed the framework of technoethics and social constructivism to inform the research questions and ensured that the literature reviewed was directly relevant to the inquiry. Furthermore, the research paradigm, following an interpretivist approach that embraced qualitative methods, where subjective experiences were integral to the study.

In terms of data collection, semi-structured interviews with decision-makers allowed for deep exploration of ethical challenges related to drone technology, ensuring the collection of rich, detailed data. Member checking during interviews gave participants the opportunity to confirm that their responses were accurately reflected in real-time, further reinforcing the credibility of the study by minimising potential biases in the interpretation of findings. During the analysis stages, specific methods of triangulation was employed to cross-verify findings through multiple data sources that comprised the literature, participant responses, and observational insights. This improved the credibility of the results. Added to this, throughout the research process, peer debriefing with the research supervisor and senior research peers added an extra layer of validation, ensuring that interpretations remained grounded in the data and theoretical foundations.

2. Transferability

Transferability within this study was ensured by providing detailed contextual descriptions, thereby allowing the findings to be assessed for applicability to other settings such as the broader supply chain and logistics or alternatively, other economic sectors. The research design and methodology supported the descriptions of the South African cold supply chain industry, and the sampling methods were strategically designed to cover a diverse range of decision-makers on a strategic, operational, compliance, and technological level to gather a broad spectrum of perspectives. Furthermore, the recruitment strategy combined convenience and snowball sampling, ensuring that participants were relevant and knowledgeable about the topic, contributing to rich, transferable data. The alignment of the findings with technoethical principles and social constructivist views also ensured that the results were grounded in universal ethical frameworks, allowing future studies to build on the findings of this study in other sectors or geographic contexts to adapt the methodology and insights where appropriate.

3. Dependability

Dependability in this study was ensured by maintaining a detailed audit trail thorough documenting the research process and the researchers' reflections. This trail included decisions made regarding the theoretical framework, research design, data collection, and data analysis methodologies, ensuring transparency and the potential for replication in future studies. Throughout the research, the use of an iterative coding process allowed for constant refinement and validation of the data. The audit trail captured every stage of the thematic analysis, from coding through to pattern identification and theory development, ensuring that any changes or decisions were well-documented and traceable. Peer validation with the research supervisor and senior peers further solidified dependability, as feedback was continuously incorporated into the evolving analysis. The use of Otter transcription software for accurate and consistent data collection further ensured that the findings could be replicated. Additionally, the QUES framework for synthesising qualitative evidence provided a structured guide for systematically analysing and interpreting the data.

4. Confirmability

Confirmability was ensured through a transparent, reflexive approach, minimising the influence of the researcher's biases on the data interpretation process. The researcher employed reflexive journaling throughout the study to document personal reflections, decisions, and potential biases, ensuring that interpretations were critically examined. The use of an emergent coding technique allowed for the findings to naturally arise from the data rather than being pre-determined by the researcher. Triangulation across different methods such as thematic coding, pattern identification, and word cloud analysis assisted to cross-verify the findings and added layers of validation. The audit trail mentioned earlier provided transparency regarding decisions made during the research, from theoretical conceptualisation to data analysis, allowing other researchers to follow the logic behind the study's conclusions. Furthermore, participant quotes were used in the analysis to provide direct evidence for interpretations, ensuring that findings were based on actual participant narratives rather than the researcher's perspectives. Peer debriefing with the research supervisor and peers and also ensured that the conclusions were cross-checked and grounded in the data.

5. Ethical Considerations of the study

The ethical considerations for this study were closely aligned with established research ethics principles and protocols outlined with Chapter Three of this study. Through the processes of informed consent, confidentiality, data protection, ethical approval, and respectful handling of sensitive information, the study ensured that it adhered to the highest ethical standards while collecting and analysing data on the ethical implications of drone technology prospectively within the cold supply chain industry. According to Mirza *et al.* (2023), ethics in research deals with moral problems related to the practice of research that needs to be considered such as ethic of respect; relationship with participants and conflict of interest; confidentiality and anonymity; informed consent; incentives; confidentiality and anonymity; trustworthiness of research and issues of translation. The authors posit that in conducting ethical research, it is essential to treat all participants with respect, regardless of their background, and to ensure transparent relationships, especially in cases of potential conflicts of interest. Researchers must maintain professional boundaries, seeking informed consent from participants while safeguarding their confidentiality and anonymity. Material incentives should be avoided, and participants should be motivated by the potential societal benefits of the research. To ensure trustworthiness, researchers must address reliability and minimise bias, especially in translation, by acknowledging their subjectivity and taking steps to preserve the integrity of the data. This study adhered to rigorous ethical standards to ensure that the research process was conducted responsibly and with full respect for the participants involved. The ethical considerations were guided by established principles of research ethics and were crucial to maintaining the integrity of the study, which explored sensitive issues related to the adoption of drone technology in the cold supply chain industry. These considerations covered ethical approval by the research committee of the University of Witwatersrand, informed consent, confidentiality, data protection, and the respectful handling of sensitive information.

i. Ethical Approval

Before commencing data collection, the researcher obtained ethical approval from the university of Witwatersrand's institutional ethics review board. The approval process involved a thorough review of the research design, data collection methods, and ethical considerations to ensure that the study met established ethical standards. A certificate was issued numbered H23/10/32. Obtaining this ethics clearance certificate was essential in demonstrating the commitment of the researcher and that of the study to ethical research practices and safeguarding the rights and welfare of participants.

ii. Informed Consent

The process of obtaining informed consent was fundamental to this study. As expounded earlier in this chapter, the researcher informed all enrolled participants of the nature of their participation, the potential risks and the objectives of the study, by virtue of Appendix F. The consent process that was designed as an online consent form explained earlier and expounded in Appendix G, was designed to be transparent and ensure that participation was entirely voluntary and that clear explanations were articulated on their right to withdraw at any time without consequences. This approach aligned with the ethical principle of respect for persons as expounded by Mirza *et al.* (2023), ensuring that participants could make informed decisions about their involvement within this study.

iii. Confidentiality and Anonymity

Protecting the confidentiality and anonymity of the enrolled participants was another critical ethical consideration of this study. Given the sensitive nature of the questions, especially regarding ethical concerns in a specific industry, it therefore necessitated the safeguarding the identities of participants was essential to maintaining trust and encouraging openness during the interviews. To achieve this, the study adopted data cleansing rules and a framework that guided on the removal of all personal identifiers and any contextual information that could potentially reveal a participant's identity. These were carefully redacted and thereafter, followed by a pseudonymisation to ensure that the data collected could not be traced back to individuals, thereby respecting their privacy. This was also in line with the commitments made in Appendix F.

iv. Data Protection

In keeping with the data collection protocols and plan of this study, these were implemented to ensure the security of the information collected. Underpinning this plan was the current data protection regulations namely, Protection of Personal Information Act 4 of 2013 of Southern Africa. To comply with the provisions of this act, data collected was securely stored in an encrypted google drive folder, and access to the data was limited to the researcher only. Furthermore, all digital files were password-protected to further ensure that the data was protected from unauthorised access, thus maintaining the confidentiality and integrity of the research process.

v. Respectful Handling of Sensitive Information

In this study, the ethical challenges associated with drone technology in the cold supply chain industry were potentially sensitive, as they involved criticisms and concerns regarding industry practices, regulations and personal experiences. As such, the respectful handling of sensitive information was a priority. On this basis, participant insights and experiences were treated with care, ensuring that the research did not expose them to any risks of professional or personal harm. Participants were also made aware of the measures taken to protect their identities and the confidentiality of their responses.

vi. Addressing Power Dynamics and Participant Relationships

The study acknowledged the potential power dynamics between the researcher and the participants, especially since many participants were decision-makers and industry leaders within the industry, a capacity that has also been held many times over by the researcher er. This meant that the researcher had to be cognizant of a situation where both the researcher and the participants were operating from positions of relative power, which could potentially influence the way information was shared, interpreted, and received. To address these dynamics, the study ensured transparency, mutual respect, and equal standing between the researcher and participants. This approach aimed to mitigate any undue influence that might arise from these power dynamics and foster open, candid responses from participants, ensuring the authenticity of the data collected. This was further ensured through the power point presentation used as an open communication channel to present the preliminary findings of the study.

vii. Avoiding Conflicts of Interest

Conflicts of interest were also carefully considered. As Mirza *et al.* (2023) highlighted, ethical research requires that all relationships with participants be transparent, particularly where there may be potential conflicts. In this study, the researcher ensured that any professional relationships with participants owing to a referral did not influence the research process. Clear boundaries were established to avoid biases, and participants were reassured that their responses would not impact their professional standing or relationships with the researcher.

viii. Trustworthiness and Minimising Bias

Ensuring the trustworthiness of the research was a core ethical commitment by this study and the researcher er. This was achieved by following established strategies to enhance credibility, transferability, dependability, and confirmability. Reflexive practices were rigorously followed by maintaining a reflexive journal. This was used to monitor and mitigate researcher bias throughout the research process. Moreover, the study acknowledged the subjective nature of qualitative research, but careful steps were taken to maintain objectivity and integrity, particularly during the data analysis phase, by adhering to rigorous triangulation and verification methods.

ix. Cultural and Contextual Sensitivity

Based on the diversity among the research participants, it was important for the researcher to recognise the importance of cultural and contextual sensitivity, particularly as the research explored a specific industry within the South African context. Care was taken to ensure that all communication and interactions with participants were culturally appropriate and respectful. Thus, the researcher ensured that the design of the study accounted for potential cultural differences that may influence participants' views on technology adoption and ethical decision-making. This was in pursuit of ensuring that the research was conducted with cultural sensitivity.

6. Conclusion to Chapter Three

Chapter Three outlined the research methodology adopted for this study, detailing the research design informed by the theoretical framework. The chapter demonstrated how the interpretivist paradigm guided the qualitative, exploratory approach, employing semi-structured interviews to gather in-depth insights from key decision-makers in South Africa’s cold supply chain industry. It also emphasised the alignment between the research philosophy and data collection methods, ensuring that the chosen methodology was appropriate for addressing the objectives of study. Additionally, the chapter addressed the measures taken to ensure the credibility, transferability, dependability, and confirmability the study, with the use of the Guba and Lincoln's framework for trustworthiness. It also acknowledged the ethical considerations and potential limitations, such as sample size and industry focus, while emphasising efforts to enhance the rigor of study. With this solid methodological foundation in place, the study was well-positioned to proceed with the analysis and presentation of findings in the next chapter.

CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION OF FINDINGS

1. Introduction

Pursuant to the detailed description of the research methodology in Chapter Three, this chapter presents the findings from the data collected during the research process. The findings reflect the rigorous data collection and analysis methods outlined in the previous chapter and are organised in a manner that ensures clarity and logical progression. To maintain a structured and transparent presentation, this chapter is divided into four main sections. These sections mirror the key stages of the research process, from participant recruitment to the synthesis of thematic insights, providing a systematic and comprehensive overview of the results.

Section One: Participant Recruitment Process

This section outlines the recruitment strategies and approaches used in alignment with the methodology articulated in Chapter Three, to identify and engage suitable research participants. Moreover, this section details the criteria applied to select individuals with relevant expertise, based on their "Information Power" and relevance to the research focus.

Section Two: Participant Profiles

In this section, the professional background of each participant is presented, emphasising their role in the cold supply chain industry. This section highlights the diversity and relevance of the participant experiences in addressing the research objective of the study.

Section Three: Data Coding Process

This section follows the data analysis process set out in Chapter Three, including how the data was coded using an inductive approach. The coding process, the familiarisation and thematic coding ensured that participant voices were prioritised throughout the analysis.

Section Four: Thematic Insights and Synthesis of Findings

The final section presents the key themes and patterns that emerged from the analysis of section three. Following the methodology and protocols set out for this section, the presentation of the overarching themes that were identified through a triangulation and thematic analysis is put forth. This section also presents a synthesises of the findings within each overarching theme and its sub-themes, and sets the foundation for the discussion in the subsequent Chapter Five.

This structured approach ensures that the findings of the study are presented systematically, to enhance the rigor and trustworthiness of the study.

2. Part One: Data Collection and Analysis Preparation Overview

2.1. Recruitment of research participants

Data was collected using the recruitment strategy outlined in Chapter Three. From here, the researcher made use of the professional business social platforms LinkedIn, to remit invitations[158] to prospective research participant candidates, based on their listed LinkedIn profiles in relation to the objective of the study. The researcher incurred an expense by purchasing a premium option[159], which allowed access to features such as sending messages, viewing profiles and backgrounds, and their connections. No privacy was breached during this process, as all data used for recruitment was publicly available on LinkedIn profiles, and potential participants were contacted within the platform's user agreement and privacy policy. Of the invitations sent, the research noted that there were some unsuitable candidates for two reasons. Firstly, despite the initial LinkedIn profile presentation on prima facie[160] basis, some participants appeared to be a decision maker within an organisation; further engagement revealed that these individuals were not a suitable fit and neither did they meet the criteria[161] of a decision maker in the context of this study. It was also revealed during the initial engagements with these eager participants, that they only handled day-to-day administrative decisions and therefore had no real information or exposure to the strategic side of the business. Moreover, based on the context of this study and its objectives, these participants would also have not been able to engage in the complexity that underpinned the interview questions as opposed to a senior manager with broad decision-making power.

Following the exclusion of the unsuitable invitees, suitable candidates were affirmed on the basis of the nature of their enquiry of the study, and their response to the letter of information[162] that was sent as part of the ethical process followed by this study. Interviews conducted with these 15 participants, yielded an additional 10 referrals of industry contacts required to fulfil the desired sample of n=25. To make contact with these industry contacts, telephone calls were made as well as email correspondence directed to the stated. From here, the 10 refereed participants agreed to an in-person interview; however, upon approach, the researcher observed responses[163] such as:

"….*we do not use drone for business in South Africa*";

"*Drone cannot be used in a business….";*

"….but drone are only used for photography" ;

"…*a PhD study on drone?......what a waste on a toy that my children uses…What is so complicated*?".

A notable observation that emerged from these responses was the prevalent scepticism and limited awareness regarding the strategic and commercial benefits that can be derived from harnessing drone technology within the cold supply chain industry of South Africa. Furthermore, the responses of these decision makers reflected a significant perception gap about the potential business value of drone. Thus, an early validation of the literature review emerged that there would be legal implications for a decision maker that did not understand their selection choice between a remotely operated and an autonomous drone, and the ethical implications of their decisions

158 Appendix F, the letter of information accompanied the invitation for purposes of transparency and to inform the potential candidate about the nature of the study. This allowed the eligible research participants to exercise informed consent to participate in the study.

159 The free version of LinkedIn does not allow for the messaging of contacts using premium. No option for a student researcher or institutional researcher existed to limit research costs to a student.

160 The concept of prima facie is defined by LexisNexis (2024) as evidence or a judgment that at first sight, or on the face of it, or as it appears without investigation.

161 This criterion was based on the unit of analysis and the inclusion and exclusion criteria in Appendix B

162 Appendix G

163 This observation was made as part of the researcher's reflectivity practice thought the research process

and choices. A finding that emerges from here is the necessity for future studies to contribute to the promotion of the responsible and informed use of drone technology in business practices.[164]

2.2. Data Collection and Analysis Preparation Process

2.2.1. Coordination of Interviews

Once participants agreed to an interview, such interviews were scheduled in line with the preference and availability of the enrolled research participant. An option of either an in-person meeting or an online session using Microsoft Teams or Google Meet was offered. Based on the interest expressed to participate in the interview, confirmation of particulars such as the physical address were confirmed in cases of physical meetings, and email address particulars in cases of online meetings. For physical meetings, the researcher ensured that no clashes with online meetings would happen by accommodating travel time, and other logistics such as interview aid set up, and post interview processes. Confirmation of the meeting was done one day prior to the interview to ensure that no impact to time to produce the research was lost. To ensure that this study was ethically conducted, the researcher ensured that consent to participate was obtained by first discussing the purpose and need for the participants consent to participate in the interview, and the contents of the consent form in Appendix H. Thereafter, the researcher electronically emailed the link to the enrolled research participant for completion.

For online meetings, eligible research participants were sent a Microsoft Teams meeting invite link that was embedded with a meeting reminder. As part of the meeting invite, the researcher included the letter of information[165] and the online consent form to complete prior to the study[166] within the online meeting invite. This was to reinforce the ethical principles that underscored this study, where the participant was reminded of their rights and involvement in this study. These preparatory actions served as a means for the eligible research participant to make an informed consent decision regarding their consent to the interview that would be held with them and their participation the same.

2.2.2. Interview Process

2.2.2.1. <u>Interview preparations</u>

Following on from the confirmation of interviews, the researcher was guided by the protocols in Chapter Three regarding the administering of the data collection instrument, to administer the interview questions in Appendix D and Appendix E were administered via a customised Microsoft Power Point presentation that included the literature review findings.

2.2.2.2. <u>Execution of Interviews</u>

Of the conducted interviews, 10 interviews were held in-person and the remaining 15 were conducted using Microsoft Teams (MS Teams). Physical interviews were conducted with the assistance of the Otter.ai transcription software to transcribe the in-person interviews. It should be noted that that the same transcription software was used to transcribe the online meetings the Otter.ai transcription software was found to provide superior accuracy and word capture quality compared to the transcription option available in MS Teams. Before commencing with the interview, the researcher confirmed that the consent form was completed by the enrolled participant and also iterated the contents of the consent form to ensure that participants were aware of their rights. Following this, the researcher conducted the interview and upon completion, thanked the participant for their time, participation and sharing their perspective. During this process, the researcher observed that by presenting the questions in a

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164 This observation is made in direct correlation to the central claim of this study that when the current drone laws within South Africa are relaxed, that ethical challenges may emerge that were not part of the restrictive regulatory environment.

165 Appendix F that was sent in the initial solicitation of the research participants participation within the study.

166 Appendix G. Sending the consent form out early ensured that the participants had ample time to understand their consent and rights that underpinned their participation

structured manner with the use of a PowerPoint presentation, a facilitation of clear communication ensued, and that each question was articulated and presented effectively to the participants. Notably, responses such as those of participant GM01 in reaction to the PowerPoint were:

"…..the presentation is a good way to summarise, so that I know exactly and can follow for information, instead of sitting in answering your question, and you wouldn't know where it's coming from."

In another interesting reaction, research participant CM05 used the presentation content to query the scope of the study, citing that was good insight for future studies to build on.

"…..*from what I've seen here on these slides, is that it's, it's limited to the quantity that it can carry. So that would obviously be quite an issue. With us, we load full container loads of products were like, 24 tons at a time for containers. So how would you? How would this drones move a container? Okay. I mean, I can imagine they'll get quite big but naturally a drone that's going to carry a load to Europe, how they're going to do this?*"

From here, an early finding emerged, revealing that using visual aids such as Microsoft PowerPoint presentations, during interviews is an effective method to enhance the rigor of the interview process. These visual aids assisted the researcher to structure the conversation, making it easier for both the researcher as the interviewer, and the participants to stay focused on key topics.

2.2.2.3. Post interview process

Following the completion of each interview session, the recorded audio files were downloaded, and the transcription files stored in individual pseudonymised folders, that was password protected and only accessible by the researcher. This was essential given the nature of the study which was grounded in ethics. This was important since the sensitivity of the data could expose the research participants in the absence of any password protection. Furthermore, this was also important given the specific condition of the consent form assured participants that their data would only be used by the researcher for purposes of the academic research, and that no sharing of the data with any third party to the inclusion of university staff. On this basis, the researcher ensured compliance with laws governing data collection, operation and destruction and records management within the Republic of South Africa, as well as its ethical commitments. Moving from this premise, to ensure that the Otter transcription application did not retain any participant data, albeit a paid for version, the researcher downloaded the transcription files individually, and renamed each file to align with the sample population and the category of decision maker as expounded in the target population table 15. To this end, the files were renamed as follows:

Decision Maker	**Category of Decision Making**	**File and code Name**
Strategic Manager on a C-suite level	Executive Management	SM
SME Owner	Executive Management	SME
Representative of the skills development sector Authority (Strategic Manager Equivalent)	Executive Management	SDS
Compliance Manager	Middle Senior Management	CM
Operational Manager	Middle Senior Management	OM
Fleet Manager operating within Logistics (operational Manager Equivalent)	Middle Senior Management	
Technology Manager	Middle Senior Management	TM

Table 11 Pseudonymised Folder Names

From table 11, each Otter.ai files were renamed to its decision-making category, and were further encrypted each with a password to protect the data file. Thereafter, the data file were stored in a secured cloud folder that was further password protected for access and use only by the researcher during the data analysis phases.

2.2.3. Dataset Preparation

In alignment with the protocols of Chapter Three, to prepare the data files for analysis, the researcher retrieved the data files individual from the secure cloud folder, and engaged in various data cleansing and organisation tasks. This involved eliminating errors and transforming the data into a uniform format. Following this process, the researcher used the data cleansing rules adopted to guide the data cleansing process and to ensure the integrity and reliability of the data collected. Furthermore, the researcher simultaneously effected the pseudonymisation[167] process for each transcription data file as outlined in Chapter Three. Post the effecting of the pseudonymisation process, the data files were further subjected to an anonymisation process which involved data masking[168]. The process served as a reasonable likelihood test that was to indicate and ensure that the dataset(s) were anonymised, so that re-identification of individuals were not reasonably likely. This was especially important since it was the condition on which participants agreed to participate in the study.

On this basis, it was essential to remove personal identifiers such as names, company names and any third party mentions from data in order to protect the privacy of individuals. This also included any contextual clues that could potentially lead to the identification of the participants. This pseudonymisation, anonymisation and redaction process was carried out to preserve the integrity and meaning of the interview content, thereby adhering to the highest standards of privacy, with a strict alignment with ethical research practice. Following this, the dataset(s) were organised into folders and given a pseudonymised label in preparation for the subsequent data analysis.

167 Pseudonymisation enables the personal data to go through a process that makes the personal data unidentifiable to a specific person without any extra information (Martine, 2024).

168 The DPO (Center, 2023)Centre defines these two processes as: Generalisation: Personal data is aggregated to a level that groups individuals within a demographic to reduce the risk of re-identification of an individual data subject. Data Masking: Personal data is replaced with random strings of numbers and letters to mask the existing data.

3. Part Two: Professional Background Profile of Enrolled Research Participants

As expounded in Chapter Three, research participants were enrolled on the study based on their "Information Power", which meant that the researcher had limited control over the specific demographics of participants. To this end, the professional profile breakdown of participants were as follows:

Job Designation	Decision making capacity	Years of experience
Strategic Manager on a C-suite level	Executive Management	+>15 years professional, Management and Supply Chain experience
SME Owner	Executive Management	+>10 years professional, Management and Supply Chain experience
Representative of the skills development sector Authority (Strategic Manager Equivalent)	Executive Management	+>5-15 years professional, Management and government administration experience
Compliance Manager	Middle Senior Management	+>10-15 years professional, Management and Supply Chain experience
Operational Manager	Middle Senior Management	+>10-15 years professional, Management and Supply Chain experience
Fleet Manager operating within Logistics (operational Manager Equivalent)	Middle Senior Management	+>10-15 years Management and Supply Chain experience
Technology Manager	Middle Senior Management	+>10-15 years professional and Management Supply Chain experience

Table 12 Professional Background overview of research participants

From the participants interviewed, the researcher observed that most organisations had outsourced their IT operations and technical capabilities to SME technology companies. This was affirmed by several of the participants who shared common responses with participant TM05 that:

"……95% of clients in the cold supply chain outsource their IT operations, and seems to be a generally better idea these days for bigger customers like mine……. I know this as I've pretty much been in the game for 26 years."

From this observation, an early finding of this study was that the outsourcing of IT operations in the cold supply chain sector is driven by a desire for operational efficiency, cost-effectiveness, and scalability. Furthermore, the researcher also observed that this trend was widely accepted within the cold supply chain industry.

4. Part Three: Data Coding Process and Theme Development

4.1. Coding Process Stage One (S1): Data Familiarisation, Emergent Coding Process and Code Book Development

To commence the first stage of the data analysis, the researcher was guided by the coding framework, articulated in the preceding Chapter Three. Given that the transcription files had been subjected to a data cleansing process[169], it became easier for the researcher to become familiarised with each data file. From here, the researcher initiated the coding process by using an emergent coding technique to inductively code the data. This involved reviewing each transcript file per decision maker category, to ensure a line-by-line coding process where a code was assigned together with a description of the assigned code. These codes were recorded in a codebook, using a Microsoft Excel spreadsheet to systematically record these emergent codes. To validate the emergent codes, the researcher used a code–recode strategy[170]. This code–recode strategy was underpinned by participant responses to questions that encompassed the capturing of key ideas, phrases, and/or sentences. The application of this strategy involved reflecting[171] on the initial coding decisions made. Thus, the description of the emergent code served as a summary refection of the narrative response that was coded. During this process, the researcher maintained a reflexive journal[172] during the coding process, to assist with the tracking of the researchers thought process, and any changes in their understanding of the data. To this end, to ensure validity and reliability during the iterative re-reading of the data file, the researcher recorded their observations during this process in the researcher's reflective journal within a section of the codebook developed for the data analysis of this study.

Against this backdrop, the 1590 initial codes emerged, and were reviewed for duplicates[173] and adjusted based on the duplicates found. These duplicates consisted of differences in spelling, wordiness and the manner in which the repeat of the codes were just worded differently. Therefore, to standardise the coded labels, codes were renamed; however, the definitions attached remained untouched. This created a reduction of the code count from 1590 initial codes to 465 emergent codes as outlined in Appendix H. This review was also done to ensure that the adjusted codes reflected the voices of the research participants.

4.2. Coding Process Stage Two (S2): Thematic Coding Process and Word Cloud Analysis for Patterns

As expounded in Chapter three, the researcher engaged in thematic coding to categorise the emergent codes based on their alignment with key themes across the S1 emergent codes. Thematic coding allowed for the identification of recurring topics, ideas, and patterns across the data, which could then be further analysed. A total of 43 thematic codes emerged from the thematic coding process as follows:

169 This process involved adhering to the rules and protocols expounded in Chapter Three

170 The code–recode strategy refers to the principal researcher coding the data and then leaves the analysis for a period of time, and then comes back and recodes the data and compares the two sets of coded materials (unisatu, 2024).

171 This reflection was necessary identify and make correction to any potential biases

172 The principal researcher centralised the reflective journal within the code book, as a sheet within the journal.

173 The approach to removing duplicates was validated by Bihu (2024), who expounds that the researcher continuously revises and refines the category system. This iterative process can lead to the development of overarching themes, which reflect a higher level of abstraction and capture the interpreted latent meaning of the text segments. Codes are grouped into categories that answer the research questions. By comparing and appraising codes, the researcher determines which codes belong together, thereby forming a coherent category. Consequently, codes addressing the same issue are categorised together.

Row Labels	Count of S2 Thematic Codes
AI concerns associated drone	1
Application and Limitations of Drone technology	1
Balancing benefits of drone vs risks associated with drone	1
Best practices in drone-based decisions	1
Collaborative approach between private sector and government	1
Compliance with transport and food compliance laws	1
Contribution of drone adoption to the digital divide	1
Direct experience with Drone	1
Drone Adoption Cost Challenges and considerations	1
Drone adoption ethical challenges, considerations and decision making	1
Drone based privacy challenges	1
Drone based Risk and Compliance Management practices	1
Drone based security challenges	1
Drone implementation Strategy Ethical Strategies	1
Drone integration ethical challenges and risks	1
Efficiency vs Ethical Considerations	1
Environmental Impact of Drone adoption	1
Ethical Reasoning differences between key decision makers	1
Fair business practices	1
Fair labour and employment practices	1
Government support for harnessing of commercial drone and activation of drone economy	1
Importance of skills development programs	1
Interoperability risks of Drone adoption	1
Interview rection	1
Legal and Compliant data collection and handling	1
Legal Implications of Drone Adoption Decisions	1
Need for a centralised drone-based knowledge structure	1
Need for a drone based ethical framework	1
Need for advanced technology in the CSC industry	1
Need for automation vs the risk of job displacement	1
Need for Job Creation strategies	1
Need for more studies and discussions of Drone in CSC Industry	1
Participant Query on readiness of South Africa to adopt drone	1
Perceived anticipation of Drone adoption	1
Precedent set by CSC for drone adoption	1
Responsibility of balancing societal rights in decision making	1
Risk of job displacement owing to drones	1
Risks associated with autonomous drone-based decisions	1
Strategic benefits of drone	1
Understanding Remote vs Autonomous Drone	1
Understanding the concepts and technology of drone	1
Use of findings as member checking	1
Use of findings through a PowerPoint Presentation	1
Grand Total	**43**

Table 13 S2 Thematic Codes

Following on from the thematic coding process, as expounded in Chapter Three, the researcher engaged in a contextual analysis and thematic analysis of the thematic codes expounded in Appendix H to identify the patterns expounded in Appendix I. To ensure validity and reliability, and to visualise the relationships between the patterns, the researcher utilised a word cloud analysis method to provide insight into the prominence and frequency of the words and concepts as expounded din Chapter Three. The word cloud analysis revealed the following:

Figure 32 Word Cloud Analysis

To summarise the findings stemming from the synthesis of patterns in Appendix I, one prominent finding was the close association between "adoption" and "implementation," highlighting the importance of structured, strategic steps in introducing drones. Additionally, "training" and "infrastructure" emerged as critical components, highlighting the need for robust preparation before deploying drones. Another key pattern was the emphasis on "pilot" projects and "objections," reflecting a cautious approach to adoption, where testing and managing resistance are vital steps. Furthermore, concerns about the impact on "jobs" contrasted with the desire to achieve "efficiency," showing the balancing act between technological advancements and workforce implications related to job displacement and workforce transformations. Moreover, leadership and decision-making also featured strongly, with terms such as "management," "roles," and "responsibilities" emphasising the importance of guiding the ethical and strategic integration of drones. The frequent mention of "legal," "risk management," and "compliance" pointed to the need for strong regulatory frameworks to address safety, legal, and operational risks, particularly with "autonomous" drones and the ethical implications of its use, particularly in sensitive areas such as surveillance and privacy. Ethical considerations, such as "informed consent," were repeatedly mentioned, thereby reflecting concerns about transparency and stakeholder engagement. This reflects a shared understanding among stakeholders that legal oversight is necessary to mitigate risks and ensure responsible use.

Against this backdrop, the findings from the word cloud analysis indicated that while drone technology offers significant opportunities, its adoption must be carefully managed with attention to ethical, legal, and operational challenges.

5. Part Four: Thematic Insights and Synthesis of Findings

5.1. Data Analysis Stage One (S1): Pattern Analysis with Thematic analysis of Overarching Themes

As expounded in Chapter Three, the researcher used the protocols adopted for the triangulation[174] of the patterns synthesised in Appendix I, to conduct a thematic analysis that identified common and divergent patterns. From here, the common patterns and divergent patterns were further analysed thematically, revealing four overarching themes and eleven sub-themes as follows:

Figure 33 Overarching Themes Underpinning the Findings of the study

5.2. Data Analysis Stage Two (S2): Key Findings and Ethical Insight

Stemming from the analysis as illustrated in figure 33, the researcher conducted a thorough exploration of each overarching themes, by analysing the sub-themes supported by direct quotes from participants as follows:

5.2.1. Theme One: Strategic and Balanced Drone Adoption

This overarching theme stemming from the pattern analysis, emphasised a careful, structured approach to drone technology adoption. The central focus of this theme emerged as the need to balance rapid technological innovation with operational readiness, risk management, and socio-economic concerns. Against this backdrop, three sub-themes underpinning this overarching theme emerged, and were further analysed to draw findings as follows:

5.2.1.1. Sub-Theme 1: Pilot Testing and Iterative Adoption

The thematic analysis indicated that pilot testing and risk management consistently emerged as salient concerns among participants. Notably, several participants advocated for pilot testing to serve as a prerequisite to full-scale drone adoption, positioning this finding as a key risk mitigation strategy rather than a discretionary step. Furthermore, across participant responses, a consistent pattern of emphasis emerged that decision-makers should manage technical and logistical risks through testing, and also engage in anticipatory ethical reasoning to avoid unintended harms. This recommendation is especially evident in the rich narrative of participant GM02, who had international experience with drone operations:

"….., I worked within a multinational, that has got extremely extensive experience in moving cold chain products with drones, not just in Africa…..actually also rolled out into Europe... So, when they do roll this out... my suggestion would be to put a[n] analysis together on a specific rural area... and then you do a drop down to see what the result is when you switch on when you go live... In other words, a full scale roll out."

This reflection signalled the value of controlled, context-sensitive implementation, especially where unique logistical challenges may be posed for drones by South Africa's mixed infrastructure. Moreover, this

[174] The triangulation model used has been expounded in Chapter Three

recommendation illustrates ethical foresight in action. To this end, GM02's concern is not simply operational but concerns the fairness and viability of deployment across socio-economic divides. In a country with infrastructural disparities such as South Africa, deploying a high-tech solution without proper piloting may entrench inequalities, compromise public trust, or result in technology failure. Moving from this premise, participant SDS added that decision-makers must have sufficient technical understanding to ethically manage risk:

"So, if the organisation decides to adopt the drone technology, having an understanding of the technology will assist management to have even more deeper understanding of the technical part of it……, we [management] need to have like high level of understanding of drones so that we were able to even mitigate any challenges….. because be it legal risk or challenges or ethical risk or challenges, we should be able to react on that."

Several participants echoed similar views as those of participant GM02 and participant SDS. These contributions indicated a strong, convergent pattern that participant advocated for a staged implementation strategy grounded in risk analysis, operational testing, and iterative adjustment. Additionally, these insights suggested that pilot testing is not merely a technical necessity, but an ethical decision-making tool and a space for deliberation, feedback, and responsible learning. Thus, from the thematic analysis, the researcher inferred that this controlled, low-risk incremental approach serves as a form of ethical risk governance. It provides the organisational space to evaluate implications (e.g., compliance, safety, public perception) before irreversible commitments are made with prospective drone adoptions and integration. This ethical framing is further supported by discussions around operational readiness where Participant OM01 described contextual constraints:

"…, in terms of the logistics and the cold chain, it's a very different animal in South Africa compared to the rest of Africa …….., there's a culture difference as opposed to other global culture that has got a South African office…….".

Participants OM02 and OM03 expanded this critique, pointing out the limitations of drone capacity in cold logistics where weight and scale render drone solutions potentially ineffective or inappropriate: "…we load full container loads of products were like, 24 tons at a time for containers. So how would drones move a container? Okay. I mean, I can imagine they'll get quite big but naturally, but is that drone going to carry product to Europe, how they're going to do this? So naturally drones then tends would be impractical because it wouldn't handle the carrying capacity that we require. As a cold store, can we deal in bulk. So, when we load carts, we loading pallets at a time, so an appellate averages 800 kilos to a ton. So our customers won't come and pick up a box. Other than that, it's big, big quantities, truck truckloads, half truckloads."

Building on the postulation of participant OM02, participant OM03 expressed that:

"….., in our business, we dealing with a ton of pallet. So I don't, I don't see we're going to get to a point where a drone is gonna fly with a frozen product on it…"

These perspectives suggested that it would be imperative for a decision maker to evaluate the use of a drone that is selected, in order to ensure that such a drone deployed would be fit for the operational purposes. Rather than merely logistical observations, these perspectives reflect implicit ethical considerations about appropriateness, efficiency, and harm avoidance. This means that deploying technology that cannot fulfil its intended function may waste resources, mislead stakeholders, or introduce environmental burdens without value. Moreover, the risks associated with the selection be evaluated before that specific drone is deployed operationally. This was further evident from Participant OM05 raised further ethical concerns around environmental responsibility, asserting that:

"… I'd expect a drone to be efficient. I'd expect what we call turnaround times, which is what we mostly get judged on by customers is how long it takes to load off load trucks. That's the mean time is the expect turnaround times would be a lot better. So yeah, definitely those two will come to mind first, so efficiency, loading time should be reduced, offloading time should be reduced. And definitely cost reduction.."

This concern aligns with technoethical responsibility, where sustainability and lifecycle accountability are central to ethical evaluation of innovation. In addition to this, participants also raised social implications of drone deployment. GM03's concern about retrenchment reflects justice-based reasoning, and was expressed as anticipating the distributive effects of automation: This was supported by participant OM05 who asserted that:

"I suppose from environmental impact, if it's the wrong drone or the batteries don't last long enough, because you haven't done your homework and you've got lead acid instead of lithium. Can you imagine what do you do with batches afterwards, if you need to replace them? So yeah, the environmental impact, right? …..the batches would be more like disposal, I suppose."

This concern aligns with technoethical responsibility, where sustainability and lifecycle accountability are central to ethical evaluation of innovation. This is based on participants who raised social implications of drone deployment. GM03's concern about retrenchment reflects justice-based reasoning, anticipating the distributive effects of automation:

"….., in in our business, we would find sort of a linear or flat approach in moving people into other positions. I'm not sure that that's the industry, that industry will adopt the similar approach and that probably a normal retrenchment process will kick in, and some people will become casualties. Unfortunately…"

From the analysis, the researcher observed from participant perspectives that the adoption of drone technology in commercial logistics requires a strategic approach, where geographical, infrastructural, and socio-economic disparities can complicate deployment, particularly in regions such as South Africa. Moreover, that decisions about pilot testing also have downstream ethical consequences for employment, fairness, and organisational responsibility. Thus, a decision-maker's role extends beyond operational planning into ethical stewardship. To this end, the thematic analysis revealed that there is an ethical implication if a decision is made to not engaging a pilot testing approach to drone adoption and integration. It is evident that participants overwhelmingly supported a stepwise pilot testing approach. While operational in nature, this preference provides a buffer against premature implementation and unanticipated harms. In a South African context, it therefore necessitates tailored strategies, particularly in addressing concerns such as power outages or the lack of reliable infrastructure, as highlighted by participant OM01.

This was amplified by participants OM01 and OM02 who drew attention to contextual and technical limitations. From here, the researcher interprets these concerns as reflecting an ethics of appropriateness where the responsible deployment of technology must account for situational fit, environmental burden, and the risk of misaligned investment. This affirms that participants raised concerns aligned with technoethical responsibility.
Another inference that can be made is that this iterative learning process will enable a decision maker in an operational or compliance capacity to refine their operational plans and improve their readiness to manage these challenges. This was evident in participant OM05's concern regarding drone battery disposal which is suggestive that sustainability considerations must inform procurement and adoption decisions. Additionally, participant GM03's reflection on retrenchment risks reflects justice-based reasoning, highlighting the potential labour displacement effects of automation.

To this end, the researcher concluded that ethical risks are a crucial area for consideration, especially taking into account the importance of preparing for legal and ethical challenges associated with drone uses posited by participant SDS. Furthermore, these insights support a holistic view of pilot testing as a technical rehearsal and as a forum for ethical deliberation. This allows organisations to evaluate compliance, social responsibility, and long-term sustainability. Therefore, drone adoption in commercial logistics should be approached as a phased, reflective process, that integrates technical, environmental, and social concerns into ethical decision-making frameworks.

5.2.1.2. Sub-Theme 2: Integration into Existing Operational Systems

Building on the findings of sub-theme one, this sub-theme emerged in response to how a decision maker on behalf of an organisations should effect their decisions to integrate drone technology into their existing operational systems. Thus, the centra focus of this theme emphasised the practical aspect of drone integration, where drones are used to enhance efficiency and speed while ensuring compliance with stringent delivery and legal requirements. Albeit these constructs emerged in sub-theme one, an aspect that was not addressed was the handling of data especially where automation has underpinned automated data sharing and real-time tracking of goods. These requirements effected via drones would be critical ethical considerations given that supply chain operations require temperature-sensitive products to be monitored and handled. This was attested to by participant OM05 earlier in sub-theme one regarding efficiency; however, participant CM03 furthers this, positing that:

"So my train of thought is always what we call asset critical control points. So we constantly think of assets and how to mitigate the hazards. So in terms of the drone the risk is exposure of data, Well, I suppose you can download the software, if it's autonomous. I would expect that the programming will be controlled. So even if it's autonomous… So wait, where does it get controlled as be controlled in us or does the manufacturer have to have embedded a massive?...you need to have a team. And that must be a multi skilled team, from different parts of the organization. And when you do the hazard analysis, they must give input when they see, there's hazards because you added physical, biological, and chemical. And the new one is obviously. So yeah. You will have to have someone that knows about microbiology, to say, we need to control temperature in this way you need to control your time in this way. Someone from mechanical background operating the drone to say that it is not possible to take this conveyor to a pasture this way, some common sense as well."

Against this backdrop, the researcher inferred that decisions made during drone integration must go beyond merely incorporating drone technology. As confirmed in the literature review findings, drones have the potential to enhance operational efficiency and speed, but the success of their integration depends on ensuring compliance with stringent legal, delivery, and safety requirements. However, during the researcher reflection, a major concern that emerged was the risk of data exposure, especially in automated systems where data would be shared in real-time for tracking and monitoring purposes. This issue emerged as particularly critical in supply chain operations involving temperature-sensitive products, where compliance with ethical standards and safety protocols, such as temperature and time control would have to be rigorously maintained. This was evident in the perspective of participant CM03regarding asset critical control points. This perspective which was shared by several other participants suggested a need for a multidisciplinary approach to hazard analysis, where teams with diverse expertise (e.g., microbiology, mechanical engineering, and logistics) collaborate to ensure safe and compliant drone operations. This would also need to include thorough risk assessments that includes hazard control, data security, and real-time monitoring to ensure operational success.

Moreover, the reliance on cross-disciplinary collaboration emphasises that resistance to change in terms of the introduction of drones especially in industries with entrenched practices, highlighted the need for effective change management and communication are key to overcoming these challenges. This is imperative given perspectives such as GM01 that:

"….I agree with all of this, but I don't know if it's the best idea for us. As a country, I agree with it, but I'm not gonna give you an okay, ….."

From the analysis, the researcher concluded that the integration of drones into existing operational systems necessitates technical alignment of drone capabilities with organisational needs, that is underpinned by the careful consideration of data security, compliance, and ethical responsibilities. Based on the findings that emerged under this sub-theme, it is evident that a strategic-ethics approach could ensure that drone technology enhances efficiency without compromising safety or legal standards.

5.2.1.3. Sub-Theme 3: Worker Displacement and Job Transformation

From the pattern analysis, this sub-theme highlighted the potential impact of drone technology on the workforce of an organisation. The central focus of this sub-theme was the ambit of the risks of worker displacement and the need for reskilling as well as mitigating strategies. Against this backdrop, it emerged that drone technology would bring about substantial efficiency as highlighted in sub-theme one and two. However, the researcher contrasted this with the findings of sub-theme one and two, and inferred that where drones can complete tasks faster and more precisely than human workers, this efficiency comes with the risk of worker displacement, as drones are likely to replace manual tasks that may potentially lead to a reduction in labour demand. This was also contention of participant GM01, arguing that:

"…..,the thing that concerns me and to be honest with you, technological advancement is important, efficiencies are important, right. But it also depends on your geographical location in the world. And my concern is with the unemployment rate that we have. I don't really look at if we look at it from the fact that yes, it will improve efficiencies in the country and reduce costs. Okay. But how does that then get returned to creating jobs

down the line? Because in that, if we don't do that, we've creating a serious issue for ourselves down the line. So yes, the drones will come in fine, they do the job fine. But they are going to replace labour. That's the only way you're going to get cost savings as if they replace labour. Efficiencies is one thing, but you've got people currently doing the job. So if you bring a drone in, well, then why have you got the people? Now you remove the people? Well, unemployment rate is amongst the highest in the world. Now we're removing the people. And the drones are taking over. So it's wonderful in countries where they've got 3% unemployment rates, or four or five or 6%, but coming to us where we bordering on almost 40%. I'm struggling to see how drones will be of value, unless the value that's added is somehow put back into creating jobs. We're kind of shooting ourselves in the foot, I think."

Participant CM02 asserted that:

"….what is the question to ask yourself? What? What is profits based on? At the end of the day? Profits is quantified in money? Yes. But the source of that money is coming from where it's coming out from people. So if you look after the people, you'll make your profits. But if you look solely on the profits, you only get them looking on, how much can I get? How much can I get but the source of those profits, you know, giving a damn about people to me, it doesn't make sense. It just doesn't make sense to me to everybody is different. Each company has a different culture, everyone looks at things differently."

However, participant OM02 opposed the perspective of participant GM01, asserting that:

"…So job creation is massive on our agenda. But you've got to find a balance, you've got to find a balance with implementing technology and saving and in terms of saving jobs. So we tend to upskill people as best we can, and make provision we do massive changes in our budgets. So we've proven it, that we've implemented technology, we've even shut down the entire depots and not retrenched anybody. So it can be done……, so balance is the answer".

From here, the researcher queried whether reskilling programs would be a key strategy for addressing job displacement, and also to enable workers to transition to roles focused on drone management and technology oversight. In response to this query, automation through drones emerged as a common pattern that indicated that automation by drones was the central factor that would lead to the disruption of traditional job roles, and that organisations would increasingly need to focus on reskilling their workforce to align with new job requirements, such as drone management, maintenance, and monitoring. This was the sentiment was expressed by the skills authority representative for technology (SDS) within South Africa that contributed to this study, explicating that:

"If, an organisation decides to strategically to adopt drone technology as one of the technology used……., then they then need to make sure that the employees have their relevant skills and ….., those who have already the basic knowledge they need to be upskilled, and those who doesn't even have, they also need to then be skilled have relevant skill exposure regarding this technology…."

However, among participants responses, there were some opposing views to that of participant SDS. This also emerged as a divergent pattern efficiency gain versus workforce impact highlighted a tension between the drive for operational efficiency through automation and the concern for job losses or role changes within the workforce. From the researcher reflection on this, a conclusion was drawn that while drones were viewed as a tool to enhance efficiency, the pattern analysis indicated that this could come at the cost of significant shifts in the labour market, creating social and ethical challenges. Participant GM04 validated this, explicating that that:

"So for me, the socio economic needs must come first, ….first, get the sewer systems working, make the township safe, make sure people in the townships have access to some basic form of respectful medical care. ….. I'm saying just get them to a place to come down with somebody treats them properly, like human beings. Education, stop and move away from this old degree, degree, degrees. Get people to at least learn how to read and write to a degree of comprehension first, because there's no point chucking people into universities pumping the degrees, when most of our population can't read to comprehension. It doesn't make sense to me. …... Look, we've got so many guys coming out of varsity today. But yeah, but you got 20 times more people there that can't do basic arithmetic. I'd like to read something because of my experience …, for instance, this [identity concealed] guy came and started and what he was doing was started throwing boxes into containers. He was a labourer, he was loading containers. That's what he was doing. Okay, but here's the difference, what I've picked up, out of 200 people coming to do that job. The sad part is, you get one of them coming out of it. And that's, that is a problem in this country. That is the sadness of what's going on here. That is the problem. Because then the issue that comes out here, then is the degree of jealousy that's going to be felt towards him, because he's managed to move himself and move forward. That's another aspect that they have to deal with. …. I think consultation from the beginning is what's important for me, you got to sit down, and you got to talk to people. And you've got to include them and take the contributions right from the beginning, especially in this country South Africa. And I think the main reason for that is because a lot of the issues that are my main issue that I've experienced in my years is very simple. It's comes down to a respect issue. If somebody doesn't feel like they've got that they have that they've been respected. They …. feel like they are invisible, which large portions of our population do, you going to end up with people who are not going to appreciate education, will not going to

appreciate sacrifice, because their entire life feels like a sacrifice, you need to consult you need to include these people. So they feel like hey, I'm actually making a contribution. Somebody's asking me a question because I care what I think. And then the little thing makes a massive difference."

In another opposing perspective, participant OM04 expressed that:

"…in response to the literature review findings about the digital divide, I know that 40% of people that have no internet in our organisation. So, what's their chances of becoming a drone operator? ……Socially depending on your... upbringing, that will have a big role as to whether you can do that….it's not limited to that, but because you would get external training,…. I see the guys saying no, no. ….Some of the guys can't even read. …..,we've got we've got a literacy issue in South Africa….we've got semi-literate people in our facility …so the societal impact is quite big, massive. And this is South Africa. This is not the UK. We've also got cultural barriers to consider …"

TM03 asserting that:

"…I cannot study anymore. I cannot do another certificate. I am done with studying, …. The certification of IT and training is a manipulation of the IT people. I mean some of the it guys have studied more than people with degrees. I mean the amount of certificates you have to do every year, you have to renew this one every two years, every time renew this one. It's like it's some stage I had seven different certificates. I did a new certificate constantly… it's madness. When you get older, you know you're in sadness. Gotta stop at some point….But yeah, that's what you wanna be in the technology game."

However, GM05 contributed a mediating perspective premised on their strong direct experience, postulating that:

"….you've got to have a major mind shift within your top echelons to actually make that mind shift and say, Okay, this is the value. And this is the amount of time it's going to take for us to see the payback…. we do not have many qualified drone pilots within South Africa. So we need education and we need skill sets so we can source skill sets, the Germans will send you skills overnight. So if we don't get smarter about what are we doing, we are going to end up not being able to service certain areas of the country. Because if you just look at the amount of vehicles on the road, for example, at the same time, you have to bring in the balance, because it's people's jobs. It's families that depend on those jobs. But then that's the one aspect of it, … go and ask yourself how sustainable is our road services right now, for the next 10 years. And I can tell you now, if you've got a train of vehicles running between the main centers, every night, and every day, somewhere along the line, something needs to give …., So everything logistics, in this country is driven by a vehicle and a driver. ….,currently, many of the private corporations and multinationals et cetera, et cetera, will consolidate the freight. And they will hand it over to a freighter to a list logistics company. So in my opinion, the development of the drone services is going to come out of that sector. Now you don't have to look at the logistics companies. …what they then do in the background is they cannot execute all the work in the country, they then call on the SME from a logistics perspective, and then they roll out and they pass on. So some of that logistics work although you might think that, that it's like an integrated support system, ….., when these logistics companies actually execute your distribution for you will add eliminate an SME, ….., you'll often have owner drivers that participate within a logistics company to service in areas, so why not make them part of that partnership to actually roll this[drone technology] out? And still involve them and still retain the positions and the work for the staff? But then you must ask yourself the question, will it driver have the reach and the sophistication? Then to become a pilot? Because the world is going to change? Is it going to take longer in in in South Africa? I can tell you will drones take over eventually and do all these deliveries? I can also tell you the one that I was quite fascinated with was the autonomous drone that can take up to I think it's 350 kilograms at the moment. And it's to me that was quite a surprise because if I look at that drone, it's exactly the same drone the Americans used to fly all over the Middle East which they now deploying on a logistics space it so just to give you a straightforward answer. I do believe they will be how do you say it in a nice way that some people will actually end up losing the positions, there will be some collateral damage, if I can call it that, and I don't want to call people collateral damage, because you'll see, I'll always try and refer to people and understand that I'm not talking about just an object, it's, it's a human being that you're going to impact. But I do believe if this comes off the ground for us in South Africa, it will be very much driven in the logistics and in the transport side of things. And the money they invest investment will come from that, and it will come from partnerships that they have, with the customer base, which could be one of the big pharmaceutical companies. That's how I believe it will happen. So if you go and do the analysis, if you need to upscale a driver to become an IT expert or a piloting one of these most definitely, will lead to collateral damage down the road, because our infrastructure will not be able to maintain the excessive amount of vehicles that we carry on the roads at the moment,…. So I do believe and it's not something I say lightly, because you always have to consider the impact of that specifically in South Africa was our employment, our unemployment, right? So you, you also have to understand that this is something that you can't just switch on and say, Sorry, there goes 500 or 2000 people….., this needs to be a phased approach that needs to be really thought through. And again, I would think that government would step in, and they would actually put a cap on how this is this is rolled out, I would honestly think that's what they would do to ensure employment of the people on the lower down employment labels platform, if I can call it that."

Participant OM01 added to the postulation of GM05, positing that:

"I think drone technology should be harnessed with skills and the technology. …..within this industry that would then become highly technologically advanced, would require highly skilled labour, so that we don't contribute to further job losses. And if the labour market turns and employment is created and released, we've still got the skills and technology to spread it out…."

From the excerpts of these contrasting perspectives, a key inference was that the adoption of drone technology presents both risks and opportunities for the workforce. The potential for worker displacement alongside emerged strongly as a risk, however, the possibility of job transformation through reskilling programs emerged as an opportunity that could mitigate this risk. This tension between efficiency gains and workforce impact revealed that where the integration of drones can improve operational speed and precision, that it may also lead to the reduction of labour demand by automating manual tasks traditionally performed by human workers. This was evident in the assertions of participants GM01 who raised concerns about the socioeconomic implications of worker displacement, particularly in regions with high unemployment rates, such as South Africa. Additionally, participant GM01's argument highlighted the risk that drone technology, while offering efficiency and cost savings, could exacerbate already high unemployment levels unless the value added by drone efficiency is reinvested into job creation. This reflected a broader issue where technology may benefit economically in developed regions with low unemployment, but pose significant challenges in countries facing labour market vulnerabilities.

However, contrasting perspectives, such as that of participant OM02 suggested that drone technology can coexist with job retention strategies, particularly through reskilling and upskilling programs. The example offered by participant OM02 demonstrates how organisations have successfully implemented technology without mass retrenchment by reskilling workers to take on roles in drone management, maintenance, and oversight. This indicates that reskilling programs will play a crucial role in mitigating the negative impacts of automation, offering displaced workers opportunities to transition into new, more technologically focused roles. Despite these optimistic views, the researcher observed a skills gap that would become a recurrent concern. This was based on the perspective expressed by participant OM04, regarding the digital divide and literacy barriers that exists within their organisation at present. This means that in a country such as South Africa, that could be a limitation of the effectiveness of reskilling efforts, as many workers may lack the foundational skills required to transition into technologically advanced roles. Additionally, concerns raised by participant TM03 regarding the constant need for recertification and ongoing training in the technology field emphasised the challenges that workers may face in staying current with evolving technologies, especially as they age. However, the mediating perspective provided by participant GM05 validated sub-theme one in so far that the transition to drone technology will need to be a phased and carefully planned to minimise the "collateral damage" of job losses. However, this phased approach would require a combination of government intervention, public-private partnerships, and significant investment in education and skills development.

To this end, a key finding that emerged from this sub-theme, was that while drone technology holds promise for efficiency gains, its widespread adoption must be carefully managed to balance technological advancement with socio-economic realities. Mitigating the risks of worker displacement through reskilling, phased implementation, and strong government oversight will be essential. However, significant challenges would need to be addressed in terms of ensuring that automation does not exacerbate unemployment and inequality, particularly in regions with high rates of job insecurity. In conclusion, a strategic, inclusive, and risk-aware approach is critical for drone adoption to be both successful and sustainable.

5.2.2. Synthesis of Findings emerging From Overarching Theme One: Strategic and Balanced Drone Adoption

The theme "Strategic and Balanced Drone Adoption" emphasised the need for a structured and cautious approach to the adoption and full-scale implementation of drone technology. The findings emerging from the analysis suggests that while drone technology hold promise in terms of efficiency, that there are risks that can also bring forth technical, operational, socio-economic, and ethical challenges that a decision maker must carefully navigate. From the analysis, findings that emerged from the three critical sub-themes were as follows.

5.2.2.1. Findings emerging from sub-theme one: Pilot Testing and Iterative Adoption

A key finding from this sub-theme is that a phased, pilot-driven approach is crucial for mitigating the risks associated with large-scale drone implementation. Participant GM02 highlighted the importance of addressing South Africa's diverse geographical and infrastructural realities through step-by-step deployment. Pilot testing[175] emerged as key risk mitigation strategy, that would assist a decision-maker to adapt and base drone-based strategies on real-world data.

The concerns of participants OM01 and OM02 raised concerns about the capacity of a drones to handle heavy loads, emphasising the importance of assessing technical specifications (carrying capacity, battery life, environmental impact) to ensure operational readiness. In this regard, the findings reveal that a phased approach to drone adoption will supports de-risked, adaptive integration, particularly for industries with specific needs such as the cold chain logistics. To this end, the researcher inferred that an iterative learning process inherent in pilot testing can facilitate informed decision-making by enabling organizations to refine operational plans before full-scale implementation.

Thus, the principal finding that emerged from this theme is that pilot testing is an essential risk mitigation strategy, enabling organisations to align drone systems with industry-specific needs while addressing technical, operational, legal, and ethical challenges through iterative adjustments. Moreover, pilot testing, underpinned by best practices, can ensure that disruptions are minimized, and ethical standards are maintained throughout the adoption process.

5.2.2.2. Findings emerging from sub-theme two: Integration into Existing Operational Systems

The second sub-theme focused on the practical integration of drone technology into existing operational systems. Participant CM03's emphasis on the ethical risks associated with data exposure, particularly in automated systems and real-time tracking, highlighted the need for robust data security and hazard analysis. In addition to this, cross-functional collaboration emerged as a critical factor, particularly in an industry such as the cold supply chain that has with stringent operational requirements. OM05 reinforced the importance of ensuring that drones enhance efficiency while adhering to operational controls and legal standards. Thus, a key insight is that a decision maker should have regard for the fact that drones do not operate as standalone technologies. This means that decisions made should effect seamless integration into broader logistics frameworks, that complies with delivery, safety, and regulatory standards.

Another key finding related to the risk of data exposure, which emerged as a significant concern, especially with automated data sharing and real-time tracking of goods. In this regard, participant CM03 provided critical insight the fact that a decision maker must be mindful of the legal and ethical challenges that may arise in relation to the handling of temperature-sensitive products. The thematic analysis suggested that an ethics strategy will be essential to ensure that drone integration enhances operational efficiency without compromising safety or legal standards.

The key finding that emerges from this sub-theme is that successful integration of drone technology into existing operational systems requires careful consideration of legal, ethical, and compliance factors, particularly regarding data security and real-time monitoring. Cross-functional collaboration is essential, especially in industries like the cold supply chain, where operational and regulatory standards are stringent. Furthermore, drones must not be treated as standalone technologies, but rather integrated into broader logistics frameworks, ensuring seamless compliance with safety, delivery, and legal requirements. The risk of data exposure and the handling of

175 Lomanova (2018) defines a pilot test as a structured, small-scale test conducted before the full-scale launch of a product or innovation. It provides an evaluation of potential outcomes, advantages, challenges, and stakeholder feedback, functioning as a feasibility study to determine whether the concept can be integrated into an operational framework. The primary objective of a pilot project is to inform a decision that either approves the product for full implementation or outlines necessary improvements. It is particularly valuable for testing concepts that carry risks or uncertainties, following a roadmap with defined evaluation criteria and an output summary addressing factors such as stability, scalability, and configuration ease.

temperature-sensitive products highlight the need for an ethics strategy to balance efficiency with regulatory and safety concerns.

5.2.2.3. Findings emerging from sub-theme three: Worker Displacement and Job Transformation

The key finding from this sub-theme is that while drone adoption can improve operational efficiency, it carries significant socio-economic risks, particularly related to worker displacement in regions with high unemployment, within South Africa. From the findings, participant perspectives indicated that the success of drone adoption depends on implementing reskilling and upskilling programs to help workers transition into new roles in drone management, maintenance, and oversight. However, these programs must address foundational issues such as literacy and the digital divide, which pose barriers to effective reskilling efforts in certain regions.

Additionally, the findings expanded on the findings of sub-theme one, positing that the phased approach to drone adoption must be planned to balance operational efficiency with social responsibility. From the analysis, it was inferred that an approach to this finding is that decision makers should include government intervention, public-private partnerships, and significant investment in education to prevent exacerbating unemployment and inequality. Moreover, that this approach would ensure that the workforce is equipped to adapt to technological changes which the findings reveal is essential for sustainable drone adoption.

To this end, the key findings from this sub-theme highlight that effective reskilling and upskilling programs are essential to help workers transition into new roles created by drone technology. However, these programs must be tailored to socio-economic contexts, addressing issues such as literacy and the digital divide to ensure equitable access to new opportunities. Moreover, decision-makers must balance operational efficiency with social responsibility, ensuring that displaced workers are supported through training and job placement initiatives.

Furthermore, drone adoption must be phased and carefully planned to minimise the negative impact of job losses, or "collateral damage." This requires government intervention, public-private partnerships, and substantial investment in education to prevent drone technology from exacerbating unemployment and inequality, particularly in regions with vulnerable labour markets.

5.2.3. Overarching Theme Two: Risk Taxonomy[176] Decision Making

The central focus of this overarching theme involved the ambit of risks inherent in adopting drone technology, that must underpin a decision maker risks management. From the pattern analysis, four sub-themes emerged as the taxonomy areas of risk that participants emphasised a decision maker must consider as the ambit of an organisations drone-based risk taxonomy. The findings were as follows:

5.2.3.1. Sub-Theme 1: Ethical Decision-Making in Risk Scenarios

Participant discussions revealed several contemplations, scenarios and perspectives on ethical risks, such as privacy violations or invasive surveillance as well as potential criminal activity. The researcher also observed conflicting perspectives on obtaining stakeholder input that included community members, employees, and regulators to ensure that drone adoption is transparent and aligns with societal values. Conceptually, safety, security and privacy were concepts that were deliberated on from a technological, business and societal perspective, and were intertwined within deliberations as follows:

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176 Risk taxonomy is the starting point for an organisations risk strategy and risk appetite, risk limits and thresholds, risk policies and procedures. As such, the risk taxonomy of an organisation is a catalyst which can prompt change in other areas of risk management. Furthermore, if a certain risk type is explicitly included in the taxonomy, it tends to receive more management attention, dedicated budget and skilled employees. In short, if it is in the risk taxonomy, it gets managed (Kruizinga, The taxonomy's role in transforming risk management, 2021).

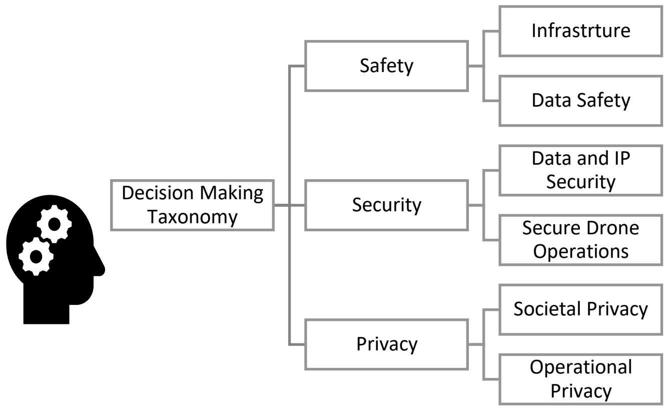

Figure 34 Ethical Decision-Making Taxonomy

From the deliberations, key insights that were notable spanned across the constructs highlighted in figure 34, with excerpts of perspectives as follows:

5.2.3.1.1. Construct One: Safety

Under this construct, infrastructure and data safety emerged prominently during discussions. Participants emphasised risks related to both infrastructure and data safety.

i. Infrastructure Safety

There was a fear of sabotage if automated systems replace human drivers, as displaced workers may react negatively. In light of this, participants posited that successful drone operations will require community support. The perspective of participant GM04 added that:

> *"…., when you do roll out something so sophisticated as the drone logistics service, you need to have stability within your community. Yeah, if you need the stability in your community, the buy in from your community to protect the asset, and to ensure that that asset will continue to operate you need more, you need a sophisticated drone operator pilot to manage that environment to ensure the servicing of the drone to ensure the drone is not moving illegal substances, which is an ethical problem, because that could happen.*

From here, the researcher inferred that is that infrastructure stability and data safety are critical concerns in the implementation of drone technology, particularly in regions where community engagement and support would be essential. Participants emphasised that the successful operation of drones' hinges not only on the technical capabilities of the systems, but also on social stability and trust within the community. In addition to this, another significant concern was the risk of sabotage from displaced workers, who may react negatively to job losses due to automation by drones. This was evident in the perspective of participant CM03, who remarked that:

> *"….so everything in logistics, in this country is driven by a vehicle and a driver. …, make no mistake.…. that war, will be coming, if they eliminate drivers, because you've taken the business away, they could eliminate your setup, and they could sabotage your setup with drones going up."*

This pointed to the need for community buy-in to protect drone infrastructure and ensure that it is not targeted or undermined. The inference from here is that community support emerges as a critical component of ethical governance, and will also be key to the successful deployment of drone technology. In the absence of the consideration of community buy-in as a key stakeholder, the risks to infrastructure, data security, and ethical compliance could undermine the potential commercial benefits of drone logistics.

Another issue that emerged under this construct was the risk of malicious use of drones for the illegal transport of goods. Participant GM03 posited that:

> "….. *in logistics, you've got wonderful people …, I've had massive teams reporting into me, but you have that one, that's going to take the opportunity and load something onto that truck that's illegal in our domain. And you wake up one morning and the sniffer dogs are on your floor."*

The key inference from this issue is the risk of autonomy given to a drone operator that may increase the opportunity for illicit activities without immediate oversight. Participant TM01 contemplated the following scenario in this regard:

> *"….if you just take the criminal perspective…., if you have to literally set the drone to prevent people trafficking or to prevent terrorism, …., it's just there's so many sub areas to consider and areas in the criminal activity."*

This concern points to the need for robust monitoring, security protocols, and strict oversight mechanisms in drone operations to prevent the transportation of illegal substances or goods. It also suggests that the integration of drones into logistics must be accompanied by ethical and legal safeguards, including real-time tracking, stringent data controls, and cooperation with law enforcement to mitigate the risk of drones being misused. From here, a finding that emerges is that the risk of drones being exploited for illegal purposes highlights a critical need for enhanced security and compliance measures in drone logistics, including regular monitoring and the implementation of preventative systems to ensure that drones are not co-opted for illicit activities. This also calls for strong ethical governance and accountability in drone management, particularly where the transportation of goods is highly regulated.

ii. Data Safety

In terms of data safety, the risk of insider threats emerged as a key concern, especially in the context of widespread corruption within South Africa at the time of investigations of this study. Participants raised several scenarios including the fact that sensitive business information could be sold or misused by individuals with access, making it essential to have strong controls over data. This was explicitly expressed by participant OM04 who deliberated on a scenario where a vendor might sell data or IP of an organisation if not controlled:

> *"…data of this business crucial information ….. and with all the corruption going on already in South Africa, you don't know if that guy's gonna go sell it….. there's gonna be so many hands and this technology and the level of data that's gonna flow through this, it's just way more insane…"*

From the perspectives of participants, it can be inferred that as the cold supply chain industry becomes increasingly data-driven, safeguarding both physical and digital infrastructure becomes paramount to ensuring long-term security and trust. This inference that was underpinned by the risk of insider threats emerged as a significant concern, particularly corruption that has a proven track record within South Africa. Participants raised the issue that sensitive business information, including intellectual property (IP), could be compromised by individuals with access to the data. This concern is compounded by the increased complexity and volume of data involved in drone operations and logistics systems, which could make it easier for insiders to misuse or sell valuable information. This was emphasised by participant OM04's scenario that highlighted the fear that vendors or insiders with access to critical data might be tempted to sell or misuse it, especially given the existing climate of corruption known within South Africa. From here, the researcher concluded that this emphasises the importance of implementing stringent data control measures to protect against insider threats. Moreover, strong data governance policies, access controls, and security protocols must be put in place, and that organisations should regularly audit and monitor access to data.

To this end, a finding that emerges is that data security and insider threats presents significant risks in the adoption of drone technology, particularly in contexts where corruption is a concern. Furthermore, ensuring robust data protection strategies, including limiting access to sensitive information and implementing stringent security protocols is essential to safeguard business-critical data from misuse or sale.

5.2.3.1.2. Construct Two: Security

As illustrated in Figure 34 Ethical Decision-Making Taxonomy two concepts that emerged to comprise this construct was data and IP security and secure drone operations.

i. Data and IP security

During the analysis, the researcher observed that participants expressed concerns about potential data breaches, the quality of software, and the control over data access. Participant TM02 shared insight in this regard as follows:

" Maintenance is gonna be a massive thing….., it's gonna have to be very, very good because that's the other thing from a system perspective, you gotta look at your security risk and security is always your primary thing on your infrastructure. Because like I said, for instance, if your security is not in place, you can have breaches and breaches can cause problems, but from an implementation perspective, I don't really see that there's a massive issue at all depends on the development of the software from the drone company or the company the designs, the software that implements it. And yeah, and then obviously have the knowledge of the person who is does the implementation with them and it's to understand the software and exactly how it works and everything….So it's got to have proper control and then the other question from the system perspective that you gotta look at is as well, is that who's gonna have access to that remotely? I think with anything like anything else we've done so far, some IT guys keep all of the control within the business and only allow outside to monitor it. The only problem with that is it opens up some other gaps again, which is pretty much gonna be whether it be software or hardware or whatever. It's all gonna depend on the quality of the of the software, the developers, the hardware attached to it, and obviously the control of whoever controls it."

Participant TM03 posited that:

"…the knowledge of the person who does the implementation….. with them understanding the software and exactly how it works and everything. So it's got to have proper control and then the other question from the system perspective that you gotta look at is as well, is that who's gonna have access to that remotely?"

Participant TM04 postulated that:

"So the other thing that you need to take into consideration…. Everybody's moving away from physical service to office and everything going to the cloud every day. moving people to the cloud, whether it be Office 365 or Google or…. the servers are either hosted at ousted company or it hosted either from Microsoft or Google or whoever….. So you already have that in any it spice or infrastructure business infrastructure….. There's always multiple people that will access that server, right? That person will come into the company and will also need access to the server to do their part of the business….It's very possible you need a database specialist that works in the SQL database or what the Java database or whatever it is, or Oracle or whatever that person might need access ….so the amount of fingers in the pie is always a few right? And then I think that off site is another security thing, …..so I'm actually worried about that security from a specific provider then other providers, so some providers. Once again, you got security risk again because we've seen ransom viruses get into certain of those people……..,.If there's actual people controlling and making decisions and the drone flying outside …. from this perspective …...,we've got some good security software, we've got some really good, developed clouds spaces, so my only worry from a software perspective is when AI becomes involved."

Participant TM05 asserted that:

"….this is a new type of data handling….the problem is I don't think we have a proper solution for the handling of drone data to date… this is this is way more out there than your basic data handling"

From the deliberations among participants, it emerged that the complexity of maintaining security in cloud-based systems, where multiple individuals might need access to servers for business purpose, raises concerns about unauthorised access and ransomware attacks. Participant TM02 contextualised this by asserting that:

"…..I'll throw in a just a curveball of hacking…,"

From the analysis, participants emphasised the importance of skilled individuals managing the software and infrastructure of an organisation, while also acknowledging that current business models in which these individuals manage data and the handling thereof may not be adequate for the complexity of drone-related data. The preceding analysis has identified several key concerns and challenges related to data and IP security in drone systems. These findings, based on the discussions among participants, offer valuable insights into the complexities of safeguarding sensitive information in this emerging technological domain. It emerged from participant discussions, that the implications were associated with the vulnerability of cloud-based systems, the risk of ransomware attacks and the unique challenges of drone data.

From the deliberations of participant TM04 and TM02, it emerged that participants held that the distributed nature of access by multiple individuals for various business purposes will lead to the inherent vulnerability of cloud-based systems, which can make it difficult to implement effective security measures and control access.

Moreover, the threat of ransomware attacks on cloud-based systems emerged as a significant concern among participants. Participants perceived these attacks as potential causes that can lead to data breaches, financial losses, and operational disruptions, highlighting the urgent need for robust security measures to mitigate such risks. In light of this, participants recognised that drone data presents unique challenges due to its volume, variety, and sensitivity. Furthermore, that the handling of such data requires specialised security protocols and considerations to protect against unauthorized access, misuse, and breaches. Against this backdrop, an emphasis for the need for proactive security measures to address the evolving threats and vulnerabilities associated with drone systems emerged. This included implementing strong access controls, regularly updating security software, and conducting thorough risk assessments.

From the critical discussion, the researcher observed an ethical implications of data security in so far that the protection of data and privacy is not only a technical concern, but requires handling thereof responsibly and in accordance with relevant laws and regulations. Since the field of drone technology is evolving rapidly, and with new innovations and applications emerging continuously this would make it challenging to keep pace with the latest security threats and develop effective counter measures. To this end, the findings presented in this analysis highlight the critical importance of addressing data and IP security in drone systems. Moreover, the analysis also emphasises that understanding the challenges and vulnerabilities associated with any physical or cloud based system in a 4IR context, must include proactive steps to protect sensitive information and mitigate risks. Albeit the researcher including participants acknowledge that data handling policies of many organisations in the current day may be prioritised, it becomes incumbent however for a decision maker to transcend a traditional approach to the handling of drone based data. Moreover, that a shift to a 4IR context policy will be required to keep up with the pace with the evolving landscape of drone technology, and to ensure the effective protection of data and privacy.

ii. Secure Drone Operations

In relation to secure drone operations, participants raised safety concerns in terms of the importance of robust security measures and physical drone operations to ensure the safety and efficiency of logistics systems. This was evident in the scenario postulated by participant CM01 regarding drone flights, particularly around the logistics of flight paths, landing pads, and air traffic control. Participant CM01 contemplated the safety in terms of drone flights, asserting that:

> *"I think it raises all big issues around flight landing pads. You're applying traffic control, all those kinds of things, because then you're talking about a drone that is pretty much a helicopter…"*

Participant OM03 furthered these concerns, positing that drones introduce new challenges in terms of accuracy, efficiency, and 24-hour operation, offering potential advantages over human-operated systems.:

> *"… there is an accuracy that comes into play. And I think there's an efficiency. So …..a drone fetching from a shop, you know, you could bypass in different touchpoints on getting the container to where it needs to go. ….,so I think there's an efficiency issue. There's an accuracy issue. There's an operating 24 hours a day we operate 24 hours a day. Sometimes people can't do that, well after hours. Whereas drones could continue operating with lots of light and carry on during the day but I need to use our technical drivers in that space but we need to add accuracy and efficiency as well was…"*

Against this backdrop, the researcher inferred that current security measures and management of drone-related data are deemed insufficient, requiring the development of more advanced solutions and highly skilled personnel to address these emerging challenges. Moreover, that the integration of drone technology as an advanced technology requires better data protection mechanisms and enhanced operational safety measures to mitigate the risks associated with both digital and physical aspects of the systems.

5.2.3.1.3. Construct Three: Privacy

As illustrated in figure 34, two constructs' societal privacy and operational privacy emerged during discussions.

i. Societal Privacy

Participant discussions on privacy highlighted significant concerns regarding ethical dilemmas associated with the use of drones in both societal and operational contexts. For example, participant GM05 remarked that:

> *"…..if drones are good enough to pick up what you're saying in your house. I'm not sure you're gonna pass any authority with that sort of technology? But I mean, also privacy is a massive conversation. And how do you Yeah, it's, I mean, I can only imagine …… you'll struggle getting around the privacy conversation because if I've got a drone with cameras that can fly over people's back gardens and swimming pools?"*

However, participant GM02 had an opposing view on the topic of society privacy that stood out as a notable ethical dilemma that a decision maker may be confront ed with and conflicted about:

> *"….how many times have they been captured on a CCTV camera currently…. from the time they leave home. Before they get to work, they probably captured 1000s of times on CCTV footage. They probably don't even know that. So I'm not sure that how great the impact is going to be on the commercial use drones. …. we're gonna see, it's not either or…..,. I'm not a person that wants to invade people's privacy. But society I'm sure will all object for a couple of months to something like this. But it's like social media platforms, you in one year, you screen privacy, but you display entire life on social media. So I'm sure that we will overcome. ….it will be an initial issue for society, but I can't see it lasting really well."*

From several participant perspectives including those of participant GM05 and participant GM02, the principal observed that the potential for drones to invade private spaces raises serious ethical and legal issues. The researcher also noted the perspectives of participants that society might gradually adapt to this intrusion, much like it has with widespread surveillance through CCTV and social media platforms, where privacy concerns initially sparked debate but were eventually normalised. This raised ethical questions regarding the balance between technological advancement and individual privacy. Against this backdrop, the researcher inferred that it is essential to establish clear guidelines and regulations to govern the use of drones, and to ensure that their benefits are realised while minimising risks to privacy. Furthermore, that while drones offer significant potential benefits, their use must be carefully considered to protect individual privacy, maintain security, and ensure ethical and responsible deployment. Addressing these concerns requires an ethical approach that involves ongoing dialogue among stakeholders.

ii. Operational Privacy

Building on the previous construct, participant discussions indicated that drones raise concerns about unintentional surveillance and potential misuse of captured data. The risk of drones being used for criminal activity, corporate espionage, or unintentionally capturing sensitive information introduces significant operational privacy challenges emerged strongly. This was evident in the scenario highlighted by participant OM02 who deliberated on potential spying operations by a competitor:

> *"How does it [autonomous drone] not accidentally turn around and it sees something that it shouldn't see and there's directors or managers, operation managers that sees the video content that it shouldn't see that gives them a business advantage or something like that…so I would say drone operations should be inside the building. …*b*ut outside the building that's when it gets a little bit tricky…."*

Participant CM02 echoed the contemplation of participant OM02, who postulated that:

> *"….you [operational drone] come into the privacy and you know commercial IP,….. that should be something privacy that's broken from outside perspective…. unfortunately these things are fantastic cameras with very long range….. So the outside perimeter is a massive issue, unless there's some software that's written or something that gives that drown…. Only that parameter to see and when it go see like a green digital wall or something."*

Participant perspectives such as participant OM02 and participant CM02 emphasised the necessity of developing controls and safeguards to ensure that drone technology does not breach privacy boundaries in sensitive environments. Moreover, that there is a need for internal compliance frameworks to steer technological development and innovation, and also to manage these privacy risks effectively. From here the researcher observed from participant discussions that the protection of operational privacy is a critical concern in the context of drone technology. Moreover, that the operational success of drones depends on robust security measures and skilled personnel, but that current systems are viewed as insufficient to address emerging challenges. Additionally, the ethical dilemma of privacy emerged strongly, where drones could invade personal or commercial spaces. To this end, while there is the potential for privacy normalisation, as seen with CCTV and social media, there remains an urgent need for internal compliance frameworks and technological safeguards to manage these risks. To this end, the deliberations suggested that drone adoption must be approached with careful consideration of these ethical issues, requiring a balance between technological advancement and societal protection.

5.2.3.2. Sub-Theme 2: Data Management and Governance

The central focus of this sub-theme emerged as the ethical management of data generated by drones. From the participant perspectives the researcher observed that participants queried the type of data that would be collected, as well as the management thereof that were not addressed in the preceding sub-themes. This was also evident form the in the manner in which participant OM01 queried the data collected by drones:

"What sort of data? Are these drones collecting? Really? I mean, environmental data or spatial data?..., it's mostly spatial I would think…. it's just sensing the signals, it's not downloading information and collecting data, it's just surely it's mostly spatial…."

From perspectives of participant OM01, it was inferred that as drone technology would advance within this industry; and as drone technology becomes more integrated into logistical and operational environments, that the handling of vast amounts of data would transcend spatial data as assumed by participant OM01. Moreover, that sensitive data would become a significant challenge that will require careful governance to mitigate potential drone based data collection and handling risks. This was validated by participant OM03, who asserted that:

"….I'm really, I'm all for the gathering of the data. …. we base our lives around making good decisions on good data. And if this is going to help us, I'm all for it. But there is a second nature to this in terms of society and the impact on the brand. Yeah, that's a different conversation…."

However, the analysis revealed that when querying participants regarding their approach to the ethical handing of data in a compliant manner that respects the privacy of the broader society and likewise, that participants appeared to lack in direct responses. For example, participant GM05 iterated that:

"with our business, suddenly we take an ethical approach with all our major decisions like this. It's a fine balancing, …... we got to we got to do the right thing by society. But also what's best for our organisation…… there will be probably regulation regulatory frameworks to sort of guide and, and monitor…"

Participant TM05 elaborated on this, asserting that:

"*…, well, firstly, you've got data which previously you wouldn't have. In other words, I have a driver and a truck and they're driving and maybe I've got a camera attached to the truck. But the point is, I don't know what's going on in the drivers head. I don't know how you make these decisions. So there's a whole bunch of decision making that we have zero visibility on. Now we putting a drone that on a drone that has information from sensors and is making a decision and if that decision is correct or not, is part of the debate and …... So there is a storage of data in the context of something happened and incident or a decision or whatever it is. I've got to be able to go back and understand why and what was the context and to do that I need to have data I need to be able to see what the drone saw and for what it's was able to do that. So there is a level of storing the data and in this context, let's say a drone, I don't know drives over somebody on the road that leads to a legal case. So now I'm going to have a legal case where I must prove evidence of the data of why that decision happened. And then I'm probably going to have to go all the way back into why did the developer write the code in such a way that made it make the decision that way that led to somebody's death as an example. ….. that it relies on data. So I could see the legality of storing data, being a little bit of I can't, I can keep data in the truck for a short period and deleted but in the context of some of the legal things I could think of it might be more important to store the data longer, even in business if I don't know the fruit, vegetables rotten, you know, I've got to be able to go back. What was the temperature with a truck open? We could do that with a human with a drone. I've got to there's a few other things that*

From the participants perspectives analysed, it can be inferred that there is an evolving understanding of the range of data that drones will collect. Moreover, that as drone technology advances, that the scope of data will likely surpass simple spatial information, thereby introducing sensitive data that requires careful management. Participant OM03's viewpoint further supported this observation emphasising that while data can be used to make better business decisions, it can also bring societal and ethical challenges, particularly regarding brand reputation and public trust. Against this backdrop, the analysis revealed a gap in participants' concrete strategies for ensuring the ethical handling of drone based data. Despite recognising the importance of balancing societal responsibility with organisational priorities, as noted by participant GM05, participants did not provide specific policies or frameworks to govern the data in a compliant and ethical manner. Participant TM05 highlighted the legal implications of storing drone data, particularly in scenarios that might involve incidents requiring historical data for legal defence or accountability, such as accidents or product quality issues. This suggests that as drone technology would progresses, that the need for long-term data storage and traceability would be crucial, not only for operational efficiency but also for legal compliance.

To this end, the overall inference that is made from this sub-theme, is that the increasing complexity of drone-generated data would likely introduce significant governance challenges, particularly in managing sensitive information. This will therefore require that internal polices serve more than an alignment with compliance of legal frameworks, but ensures inclusion of maintaining ethical standards. Thus, decision-makers will need to develop data management strategies that address both operational needs and societal expectations.

5.2.3.3. Sub-Theme 3: Internal Legal Compliance and Regulatory Adherence Frameworks

This sub-theme builds on the findings of sub-theme two, where the focus was on the handling of drone-based data in an ethical and compliant manner. Data governance frameworks in this context emerged as a need and an imperative to ensure that drones operate within the bounds of data protection laws, such as the Protection of Personal Information Act, 2013 (Act 4 of 2013) in South Africa. This data protection frameworks will be one of the frameworks that will need to be complied with, and therefore a decision maker must ensure that data collected by drones is managed, stored, and shared in a secure manner. From here, the researcher made a finding that internal legal and regulatory frameworks would need to be adjusted to comply legal requirements for drone operations. However, from participant responses such as participant GM01, it appeared from the analysis that participants were unsure as to how internal frameworks would be constructed to deal with compliance. This was evident in the postulations of participant OM01, who asserted that:

"….is the technology going to be driven by policies? Or is the policy going to be driven by what the technology is doing? I mean, which ones first? I mean, I think at the end of the day, my view is if you can build into the technology, if your policies can be built into the technology, embedded in the in the technology, then I would go that route. …. I can only speak from what we would do.."

From the perspectives such as participant OM01, the analysis revealed that internal legal frameworks will need to evolve alongside the innovations of drone technology. From here, an inference that can be drawn is that organisations must adjust their internal legal and regulatory frameworks to align with evolving compliance requirements for drone operations, operational staff, vendors and technological handlers of data and developers. Since participants emphasised that policies should either drive technological implementation or be embedded within the technology itself to ensure proper governance, it therefore highlights the importance of establishing robust compliance frameworks that regulate the use of drones operationally and also serves to mitigate risks such as business sabotage or operational failures due to non-compliance with legal standards. To this end, proactive legal and regulatory adherence will be essential for the sustainable integration of drones into existing operational systems, balancing technological advancement with social and business stability. This was premised on the divergent pattern that emerged between compliance and innovation and was validated by perspectives such as TM01, who provided insight into handling of drone-based data:

"…listen, we need to code we don't have time to just tell you each and every little thing that we do, right. So in this context, there going to be a difference in the manner in which drone data is going to be handled as opposed to the current manner of handling data….You know, versus by a driver or by the organization…"

Perspectives such as those of TM01, highlighted that while regulatory adherence is essential for safety and security, it can slow down the adoption the process, particularly in fast-paced industries such as logistics, which would benefit from drone integration to remain competitive. However, the researcher observed from discussions that many participants lacked clarity on how to practically implement drone technology frameworks, indicating a gap in knowledge or strategic planning around regulatory adherence in drone operations. This was evident in the remarks of participant GM02 that:

"Look, ….. my viewpoint is that the organization has a responsibility to make sure that the operator is qualified, and the operators have a clear understanding of what the standard operating procedures are. If the organization adheres to, as much as possible, ensuring that the drone operator works within a responsible works within, we'll call it within responsible parameters."

From the perspective of participant GM02, there appeared to be ambiguity around how to align these responsibilities with broader regulatory requirements. To this end, the analysis suggested that while organisations recognise the need for compliance, many lack clarity on how to integrate these legal and regulatory obligations effectively into their operational practices, pointing to a gap in practical implementation strategies.

This tension highlighted the challenge that a decision maker would need to wrestle with, when balancing regulatory requirements with the drive for technological progress. Against this backdrop, the researcher inferred that while comprehensive regulatory frameworks are necessary, there would potentially be a clear trade-off between strict compliance and the speed of innovation in a prospective commercial drone environment. This would necessitate that a decision maker navigate this tension carefully to achieve a balance between fostering technological advancement and adhering to legal standards. This will allow for a continual improvement of policy and framework development, to embed compliance mechanisms directly into technology policies to ensure that policies are not only theoretical but also operationally effective.

5.2.3.4. Synthesis of Findings emerging From Overarching Theme Two: Risk Taxonomy Decision Making

The overarching theme of "Risk Taxonomy in Decision Making" analysed through four sub-themes focused on the ethical and operational risks that must be considered by decision-makers when adopting drone technology in a more permissive regulatory environment. From the analysis, several risks emerged as critical taxonomies that are critical to ensuring that drone technology can be integrated into business operations without infringing on ethical standards or societal values. From the findings that emerged from the sub-themes, these risks appeared to span across safety, privacy, data governance, and legal compliance as follows:

5.2.3.4.1. Findings Emerging from Sub-Theme One: Ethical Decision-Making in Risk Scenarios

From the analysis under this sub-theme, participants revealed a range of ethical risks, from privacy violations and potential misuse of drones for criminal activity, to challenges in obtaining stakeholder input. The deliberations revealed three constructs safety, security, and privacy concerns that from both technological and societal perspectives, highlighted the complex ethical landscape of harnessing drones. The key findings were as follows:

Construct One: Safety
The analysis under this theme expanded on sub-theme two in theme one. From the analysis, infrastructure and data safety were central concerns. Participants expressed the need for community support to prevent sabotage from displaced workers and ensure the smooth operation of drones. For example, Participant GM04 emphasised that social stability is critical to protect drones and their operational environment. Additionally, GM03 raised concerns about drones that could be exploited for illegal activities, thereby highlighting the need for robust security and oversight mechanisms. From here emerged the key finding that the successful implementation of drones requires technological robustness; however, community engagement is critical to this. Moreover, community engagement is critical to safeguard infrastructure and prevent sabotage. Thus, ethical governance will be required during any decision to adopt drones and must incorporate community buy-in and preventive security measures to avoid misuse.

Construct Two: Security
Participants expressed concerns related to data and IP security. Concerns in this regard emerged as participants discussed the risks of data breaches, the quality of software, and control over data access. Participant TM02

stressed the importance of skilled personnel managing drone software, while TM04 highlighted the vulnerabilities of cloud-based systems, which can expose organisations to ransomware attacks or unauthorised access. These findings provided the study with insight into how ethical decisions would be approached in terms of drone data, especially when stored in cloud-based systems. This was especially significant given that significant security risks can be introduced. Thus, robust security protocols, access controls, and skilled personnel are necessary to safeguard data and prevent breaches.

Construct Three: Privacy

Privacy emerged as a major ethical concern, with participants expressing fears about drones invading personal spaces or capturing sensitive business information. Participant GM05 emphasised that drones could unintentionally violate privacy, leading to legal and societal backlash. To this end, drone operations must navigate privacy challenges, requiring clear guidelines and regulations to prevent invasions of personal and organisational privacy. Ethical frameworks are necessary to balance technological advancement with privacy protection.

5.2.3.4.2. Findings Emerging from Sub-Theme Two: Data Management and Governance

From the findings that emerged under this sub-theme, a key finding that emerged was the complexity of handling drone-generated data. This emerged from queries such as those of participant OM01 raising the question, *"What sort of data are these drones collecting? Is it mostly spatial?"* This reflects a gap in understanding the diverse types of data, beyond spatial, that drones collect, underlining the need for clearer data governance frameworks to address these emerging ethical concerns. Here, the importance of developing robust data management frameworks was stressed, especially concerning insider threats and the misuse of sensitive data.

Key insight that emerged from this theme is that effective data governance is critical to handle the diverse and sensitive data collected by drones. In light of this, decision-makers must establish comprehensive frameworks to prevent insider threats and ensure compliance with legal regulations such as South Africa's Protection of Personal Information Act (POPIA). Moreover, policies must evolve to address the unique challenges posed by drone-generated data, ensuring ethical management and security.

5.2.3.4.3. Findings Emerging from Sub-Theme Three: Internal Legal Compliance and Regulatory Adherence Frameworks

The findings that emerged under this sub-theme highlighted the critical need for drone technology-based decisions to align with both legal and ethical standards, especially in a rapidly evolving regulatory environment. Participants identified several challenges that in turn highlighted the delicate balance required between ensuring compliance and fostering innovation. These insights emphasised that while technological advancements of drones offer immense potential, they must be deployed in a manner that adheres to regulatory frameworks, safeguards ethical integrity, and addresses the complexities introduced by emerging legal requirements.

To this end, the findings under this sub-theme revealed that decision-makers must navigate the balance between compliance and innovation when adopting drone technology in the cold supply chain industry. Against this backdrop, these findings highlight the need for a decisionmaker to identify and evaluate critical ethical considerations, particularly the need for compliance frameworks to evolve alongside emerging technologies.

5.2.4. Overarching Theme Three: Knowledge Structures for Sustainable Drone Adoption

This sub-theme builds on the findings of sub-theme one, two and three, where this sub-theme focused on how drone technology would become more integrated into various industries, that building robust knowledge structures would be essential to ensure that decision makers make informed decisions, manages ethical risks, and prepare their workforce for the changes ahead.

5.2.4.1. Sub-Theme 1: Knowledge Management and Dissemination

This sub-theme emerged from the pattern analysis conducted in Appendix I. The analysis revealed the following common and divergent patterns that underpin this sub-theme:

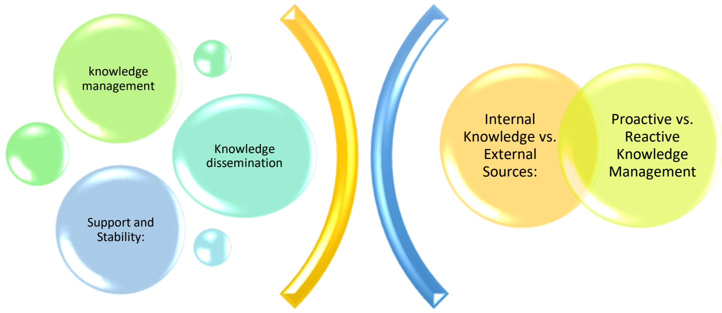

Figure 35 Common and Divergent Patterns of Overarching Three, Sub-theme One

From figure 36, the common and divergent patterns that emerged from the analysis in Appendix I, were grouped around two primary areas: the core processes of knowledge management and dissemination on one side, and the differentiation between internal and external knowledge sources, as well as the strategic approaches to managing knowledge (proactive versus reactive) on the other.

The first pattern that emerged related to knowledge management and dissemination, the pattern analysis revealed that participants recognised that strong knowledge management systems would be crucial for sustainable drone adoption. One of the key findings that emerged across the participant perspectives was that where decision makers lacked knowledge and an understanding of drone technology, that this emerged as a risk that would lead to operational failures and inadequacies. For example, participant CM01 held that:

"You need to have a team. And that must be a multi skilled team, from different parts of the organisation. ….. when you do the hazard analysis, they must get input when they see, there's hazards ….. You will have someone that knows about microbiology, to say, we need to control temperature in this way you need to control your time in this way. Someone from mechanical background say that it is not possible to take this conveyor to a pasture this way, some common sense as well."

The rationale in relation to the pattern *knowledge management and dissemination*, highlights the crucial role that a well-structured knowledge management system can play in ensuring the successful and sustainable adoption of drone technology. A finding that emerges in this regard is that a lack of knowledge and understanding of drone technology among decision-makers presents a significant operational risk. This gap in knowledge can lead to inadequate decision-making, resulting in potential operational failures, inefficiencies, and the inability to fully capitalise on the benefits that drones offer. For example, participant CM01's remark emphasises the importance of a multi-skilled team that contributes specialised knowledge across different domains. The ability to leverage expertise, and common sense when performing hazard analyses exemplifies the need for effective knowledge dissemination throughout an organisation. Thus, as inferred from participant perspectives, the technical capabilities of the drones and an organisation's ability to harness diverse knowledge, share insights, and create cross-functional teams can assist to identify and mitigate potential risks before they impact operations. However, where participant GM02 demonstrated a perspective on drawing insights collaboratively, from a dissemination point, there appeared to be a shift in the responsibility in terms of understanding drone technology. This was evident in the perspective of participant GM02 who asserted that:

"I would say knowledge structures are necessary. … what drives the knowledge structures is management….. management itself can put the basic information pack together and then also investigate? ….., you can get a service provider and you could get your get your IT department or your IT service providers. I mean, they are more exposed to these technologies than anybody else is.. it's up to management. So

management can draw up basic information …. and then you'd get your IT guys in to draw up……,that will be done in line with management, so management and part and parcel of it. But what I would like to carry staff through from the beginning to the end. So you would take certain of your staff members on board with you while you go from the beginning to the end, so that when they get to the point where we do where this gets, basically rolled out, that you've got key staff members who have participated from day one and contribute, as opposed to just get in a document….also,…look at the legislation? I mean, what does the law say? What are the guidelines and the rules, you get those opinions? You educate yourself on that? Then from that you take a look and say, Okay, what are others doing? ….We assuming that they comply with the law, because everybody has to comply with the law. Okay. Are any of them going beyond the law in terms of applying stricter standards on themselves and so forth? Yes, or No…. they're not. Okay, how do we, how do we then compete with them? Do we start selling? Do we start looking purely at the cost of the services living? Or do we …. comply by doing ABC, we've implemented this will. So educating our client base as well on drones and what is currently available, and we are doing this and the reason we're doing this is because of and give them an idea of what your roadmap is? What kind of new client base? That is what I would start from… ..”

OM05 added that in terms of knowledge dissemination, that:

“….., this is a public relations and marketing they will need to deal with it.”

From participant perspectives, the researcher made a finding that relying solely on IT teams or external service providers to understand and manage emerging technologies such as drones can leads to operational failures and strategic misalignment. The traditional model of delegating technological expertise no longer suffices, as technology now drives core business functions rather than simply supporting them. Therefore, decision-makers at all levels must invest in deeper knowledge of these innovations to make informed, agile decisions that are align technology with organisational goals. Without this investment, leadership risks fragmented communication, poor strategic foresight, and missed opportunities for innovation. This is imperative as 4IR demands that decision-makers take a more hands-on approach to technology, ensuring they are not just overseeing but also understanding and guiding its implementation. This finding largely addresses the divergent patterns that emerged as illustrated in figure 30.

To this end, the finding addresses the divergent patterns in knowledge management, specifically internal knowledge development versus external dependence, and proactive versus reactive approaches by emphasising the need for decision-makers to invest in deeper knowledge themselves. This means that decision makers that rely heavily on external sources, such drone advocates as articulated in the literature review, risk misalignment between strategic goals and technological realities. Moreover, this external reliance can lead to outdated or incomplete information, resulting in operational failures and risks. Contrariwise, decision makers that develop internal knowledge systems tailored to their specific needs, and adopt a proactive approach, are more likely to make informed, timely decisions that align with both technological advancements and regulatory demands. The critical argument that emerges here, is the promotion of proactive, internal knowledge development by decision-makers for sustainable drone technology adoption, reducing risks, fostering innovation, and ensuring ethical compliance, as opposed to the reactive or externally reliant models that often hinder long-term success.

5.2.4.2. Sub-Theme 2: Ethical Implications of Misinformation

The central focus of this sub-theme emerged as the ethical risks associated with misinformation about drone technology, emphasising the need for transparency and accuracy in knowledge dissemination to prevent ethical violations. Based on the findings of the literature review that were included in the PowerPoint presentation, participant responses to the reliance on information purported to be reliable by drone advocates, as a foundation of their knowledge structures, were met with both scepticism and cautious acceptance. Some participants expressed concerns over the potential bias and lack of research efforts by these drone advocates, while others felt that the information was credible enough to inform their understanding, though they acknowledged the need for further validation from independent sources. Participant GM01 expressed that:

“Maybe not fully dependent them, …it will depend on the kind of information, but besides them I'll obviously get the different opinions also on this.”

Participant CM01 posited that :

"I think you'd have to go for the, for the sake of your own business, you'd have to go beyond"

Participant TM01 held a strong view against the use of external information:

"Ethically, they must do a study to see if they should employ them (drone advocates)."

From the participant responses such as those of participant GM01;CM01;TM01, an inference that can be drawn from the participant responses in this context, is that there is a general sense of caution among participants when it comes to relying on information provided by drone advocates. While some participants believe that this information could be useful, they are also aware of its potential biases and limitations, leading them to seek additional sources of information to corroborate what is provided by drone advocates. Premised on this, the researcher observed the divergent pattern that emerged as external reliance versus internal integrity. This was premised on the perspective of participant GM02 who asserted that:

"…for us to operate a site, …., I could reach out to this team in [concealed to protect participant]. And within a half a day, I had all the regulatory documents to operate a site in …. you know, if you're not specializing in this kind of thing fully not partially [only UAV's] ….. from my perspective, that kind of knowledge will have to sit in house and they will go out and they will source that knowledge if they have to. In other words, if you've become a drone expert, they'll go out and they'll headhunt you and they'll bring you in to actually have that kind of information…"

The perspective of participant GM02 suggested that companies that rely on external knowledge providers may face a higher risk of misinformation since external sources might have biased or outdated information. This can lead to ethical issues, particularly if decisions are based on inaccurate data. In contrast, companies that invest in internal knowledge management systems can maintain greater integrity and accuracy in their decision-making. This, a tension was observed by the researcher between maintaining ethical transparency and decisions that are made based on reliance on external parties. From this tension, the researcher inferred that that stakeholders that are well-informed is essential for maintaining ethical integrity, and that this information should be developed in-house by expertise that engage in rigorous research efforts that has a methodological approach. Moreover, that the reliance on subjective opinions of external parties, albeit input can be drawn, however, reliance can lead to misinformation, that in turn can lead to ethical violations if decisions are made based on inaccurate or incomplete information. Ensuring that stakeholders are well-informed is essential for maintaining ethical integrity. Against this finding, the researcher observed the postulation of participant SDS, who posited that:

"Look, all of them in my opinion these advocacy groups will have to be approached …. they should be regulated as a chapter nine institution[177] within South Africa, and this should be a requirement of the Aviation Authority, because if that is done then we have one central, you know institution that governs the drone industry. It will really assist you know in a sense where information is to be disseminated, where they needs to be…..also, some code of conduct, though, you know some standards that you know apply across these different and advocacy groups. So yeah, there should be that one central, you know, area or institution that really will look after that or govern the drone and sector."

5.2.4.3. Synthesis of Findings emerging From Overarching Theme Three: Knowledge Structures for Sustainable Drone Adoption

The finding that emerged from this overarching theme revealed two key sub-themes that contributed to building knowledge structures. The analysis highlighted the critical role of robust knowledge systems in ensuring that decision-makers make informed decisions, manage ethical risks, and prepare their workforce for the challenges associated with drone technology adoption.

177 Chapter nine institutions are premised on the separation of powers doctrine, a central tenet of South African constitutional law that entails the provision of checks and balances between the three branches of government. These checks and balances were a constitutional measure aimed at strengthening our democracy. Alongside these measures, various institutions were set out in chapter nine of the Constitution as additional checks on government power.2 These institutions were created to be independent, impartial bodies with the purpose of keeping the government accountable. They are essential in the democracy of South Africa which emerged from a history of discrimination, oppression and lack of accountability. They assist organs of state in adhering to the new constitutional dispensation (Stander, 2024).

5.2.4.3.1. Findings Emerging From Sub-Theme One: Knowledge Management and Dissemination

This sub-theme emphasised the critical importance of internal knowledge systems in ensuring the sustainable adoption of drone technology. The analysis revealed that knowledge gaps among decision-makers can lead to operational inefficiencies, misalignment with strategic goals and heightened risks during the integration of drones into organisational processes. Participants, such as CM01, emphasised that cross-functional teams with diverse expertise are crucial for effective decision-making and hazard assessment. This assertion reinforces the need for comprehensive knowledge across departments.

A key finding that emerged was the importance of tailoring internal knowledge systems to meet the unique needs of the organisation. Thus, decision-makers must proactively invest in creating and disseminating knowledge to ensure that all levels of the organisation understand the implications of adopting drone technology. Without well-structured knowledge systems, organisations risk falling behind on technological advancements, and decision-makers may struggle to fully leverage the benefits of drones or manage associated risks. From here, the key insight that can be inferred is that organisations should develop tailored knowledge repositories such as internal best practices, regulatory updates that align technological advancements with organisational goals. This proactive knowledge development emerges as a strategic risk mitigation that aligns operational objectives, and ensures that drone integration happens in an informed, controlled, and ethically sound manner.

Further to this, a new finding that emerged was that proactive knowledge development is essential for staying ahead of technological and regulatory changes. The thematic analysis revealed that this involves fostering a culture of continuous learning and establishing systems for knowledge-sharing across departments. Moreover, decision-makers should institutionalise these knowledge structures, through the use of internal resources rather than over-relying on external sources. This may turn out to be biased or incomplete. This approach is envisaged to empower internal teams to drive innovation and ensures ethical and well-informed drone technology adoption.

5.2.4.3.2. Findings Emerging From Sub-Theme Two: Ethical Implications of Misinformation

Building on the importance of internal knowledge, this sub-theme explored the ethical risks associated with misinformation and an over-reliance on external sources. The analysis highlighted that depending too heavily on external drone advocates or stakeholders may expose organisations to biased, incomplete, or even inaccurate data. Participants, GM01 and CM01 voiced concerns over the credibility of external sources, warning that these parties might prioritise their own interests such as commercial gains over presenting a full scope of risks.

A key insight that emerged from the analysis and this finding is that a decision maker on behalf of an organisation must recognise the potential biases in external information and invest in building internal knowledge integrity. This must involves creating a framework where decisions are based on well-researched, unbiased, and verified data. Internal research capacity should be strengthened to validate the claims made by external sources, ensuring that the organization's strategic goals and ethical standards are not compromised. Against this backdrop, using this approach will ensure transparency, accuracy, and alignment with ethical standards, thereby reducing the risk of misinformation influencing critical decisions.

5.2.5. Overarching Theme Four: Ethical Considerations in Business Practices

This overarching theme emerged from participant reflections on the strategic implications of drone technology adoption. Through probing interview questions (Appendices D and E), a pattern of tension emerged where participants recognised that drones may confer a competitive advantage yet expressed ambivalence or concern regarding the ethical implications of their use. This was especially in relation to fairness, transparency, and market equity. Accordingly, this theme explored how decision-makers may grapple with the ethical responsibilities that accompany technologically enabled market leadership.

5.2.5.1. Sub-Theme 1: Competitive Advantage and Market Leadership

Common patterns that emerged under this sub-theme indicated that participants were conflicted about the strategic benefits that drone technology provides an organisation. Participants expressed both optimism and apprehension about the strategic benefits of drone technology. Some highlighted drones’ ability to improve efficiency and agility, while others raised ethical questions about their socio-economic impact. For example, GM05 questioned whether drone adoption, absent deliberate job creation strategies, could exacerbate unemployment and deepen poverty:

“….is it morally beneficial? Is it morally the right thing to do for the country that we are living in, based on where we currently sitting and is that competitive advantage, a competitive advantage at the end of the day must be converted into job creation…. otherwise, to me, we're just setting ourselves up for a mountain of more poverty and more unemployment and more disenfranchised youth that's what I see if we start [with drone technology]….just Yeah, it's you got the country that Switzerland where it’s wonderful, no problem but for us its hopeless for drones.”

By contrast, participant GM03 framed drones as enablers of business responsiveness, particularly in time-sensitive sectors such as FMCG, asserting that:

“So … there's certainly benefits of having a drone, ….. If we can use quicker more agile means of getting into the points or the customer or the points of consumption, that's going to revolutionize and change our industry. Certainly, we have a FMCG that is fast paced, and we miss business opportunities, when we, we sometimes have to use a forklift, to load a truck to navigate traffic to get it to an outlet. If we can do that with a drone, being our lead, our lead time will go from possibly three hours to 20 minutes. …., if you think about FMCG, three hours and 20 minutes, three hours, Your opportunity is gone. That crowd of people or that gathering of people with 300 people have just arrived and, you know, unsuspected after two hours is gone. But I couldn't get the product within 20 minutes…”

These contrasting views illustrate a dilemma facing decision-makers in terms of how to reconcile the pursuit of efficiency and responsiveness with broader ethical obligations. While GM03’s view is practical, it may underemphasise the broader societal consequences flagged by GM05 being:

“ ….but all facilities are designed for road ….. so naturally drones then tends to be impractical because it wouldn't handle the carrying capacity that we require. As a cold store, can we deal in bulk. So when we load carts, we loading pallets at a time, so a palate averages 800 kilos to a ton. So our customers won't come and pick up a box. That very seldom happens anytime ….if it does, it is for sampling for micro sampling. Other than that, it's big, big quantities, truck truckloads, half truckloads. “

From the analysis, discussions around the strategic benefits of drone technology revealed a critical inference that drone systems are frequently misunderstood by decision-makers as limited to basic operational tools or simple unmanned aerial vehicles (UAVs). This narrow perception constrains their perceived value to tactical efficiencies such as faster deliveries or cost reductions, while obscuring their broader strategic and ethical implications. This limited framing was challenged by participant TM04, who articulated a more expansive view:

“……first thing to clarify, as drones is not just flying, ….., I think, there's definitely a misunderstanding in the market, I guess around drone. For me, a drone is, I don't wanna say robotics but probable vehicle that can do various things. So you got underwater …..so it's quite a broad spectrum. There's almost two things I see, one is there is a lot of interest in the context of flying drones. And the perception I think, is that when somebody says drones, …… they attempt to get into that context. So they think of drones as flying only around the warehouse and doing stock tags and things like that. But the context of drones in general, I can definitely see drones in the warehouse in terms of robotics, whether that be forklifts, whether that be scanning shelves and doing stock takes those kinds of things. And that take exists as this I think in the context of supply chain in the warehouse. I think there's quite a bit of application in the context of delivery drone trucks. I think that's quite an option….., I guess, most think in the context around flying drones ….in a really large context of containers, I think that is something that is, you know, you could bypass all bunch of road top issues…….”

From the analysis, a critical inference emerged that was underpinned by discussions around the strategic benefits of drone technology revealed that it is frequently misunderstood by participants as merely a functional tool or a basic unmanned aerial vehicle (UAV). In reality, the analysis revealed that its capabilities extend far beyond such limited operational roles. This misunderstanding was addressed by participant TM04, who suggested that many in the market reduce drones to simple flying machines, failing to appreciate their broader applicability in logistics, robotics, and automation. This limited perspective was echoed in the views of participants GM05; GM03 and GM05 who questioned the broader socio-economic value of drones, while GM03 focused largely on their immediate operational utility, particularly in enhancing speed and agility within the fast-moving consumer goods (FMCG) sector. Both perspectives, though grounded in practical concerns, reflect a constrained awareness of the full potential of drone technology.

Notably, GM05's assertion that drones might exacerbate poverty and unemployment implies a perception of drones as direct substitutes for labour, overlooking their capacity to generate new roles and value-added functions. This narrow framing underestimate drone's strategic potential to facilitate digital transformation through enhanced data collection, improved supply chain visibility, and integration with advanced analytics capabilities that can revolutionise decision-making and enable sector-wide innovation. Thus, shifting the organisational mindset beyond labour substitution will enable decision makers to position drone adoption as a platform for enhancing capabilities, not merely reducing costs. Furthermore, GM03's emphasis on delivery speed illustrates an appreciation of functional efficiency but does not fully account for the long-term innovation possibilities highlighted in the literature. Drones, when integrated strategically, also support real-time data analysis, predictive logistics, environmental monitoring, and customer engagement features that can reshape entire industries. This was similar to OM01's concerns about drones' carrying capacity, though valid in the context of bulk logistics, reflect a utilitarian view that limits drones to physical transportation. However, with greater awareness, decision makers might recognise drones as complementary assets within multi-modal logistics networks optimising coordination, monitoring infrastructure, and even supporting sustainability goals through targeted deployment.

In light of this analysis, it can be inferred that decision makers who view drones solely as UAVs risk overlooking their broader strategic utility. Those who instead understand and leverage their integrative potential across analytics, logistics optimisation, and organisational intelligence are more likely to realise sustained competitive advantage. These decision makers can differentiate themselves by moving beyond the narrow operational paradigm and toward a more transformative, systems-level approach to drone technology adoption, which not only enhances efficiency but also fosters long-term innovation and societal value.

5.2.5.2. Sub-Theme 2: Fair Business and Competition Practices

This sub-theme emerged from the common patterns that indicated that the ethical dimensions of using drone technology in business practices, must be underpinned by fair competition, and ethical business operations. However, the discussions around drone technology revealed that many participants expressed concerns about whether businesses could truly maintain ethical practices in an environment where cutting-edge technologies such as drones could offer substantial, and potentially overwhelming, competitive advantages. This was evident in the assertions of GM02:

"…..,look you can't take the responsibility upon your shoulders. …., my thing would be that …. if you operate within an area, I'm talking about geographical area, and not talking about the industry, and you do have a responsibility to ensure that your practices in somehow are benefiting the people that are existing in that area. And on that basis, I guess you could say that, yes, it is your responsibility to ensure that your operations aren't able to participate in the potential for being a monopoly? Yes, I would say so. It is your responsibility. But whether the decision maker is going to take on their shoulders such a responsibility, if it's not such a legal responsibility. So no…"

Participant TM02 remarked about the fierce competition practices that organisations may engage in, and that may impact SME's from entering the drone market, asserting that:

"I don't think anyone's realistically being strategic that everyone is going to win the same, and that everyone's going to be successful. So it doesn't work as our life works.…..."

Participant OM05 remarked that:

"One must always go forward and improve on yesterday….and maybe it opens up a new possibility for someone that can help the small SMEs to also go forward."

From several participant responses, including the excerpts that were highlighted, there was a notable silence regarding the explicit responsibility of businesses to uphold fair practices. For example, participant GM02 raised the issue of monopoly and acknowledged the ethical duty businesses have to ensure their operations benefit the local area and do not lead to monopolistic practices. However, they also question whether decision-makers would voluntarily take on this responsibility in the absence of legal requirements. This statement reflected an ambivalence about the role of ethical responsibility in business decision-making, particularly if that responsibility is not mandated by law. Furthermore, there was a lack of direct engagement with the question of whether businesses themselves should be held accountable for ensuring that their adoption of such technologies promotes fairness in the marketplace. Participant TM02 further highlights the competitive realities that a decision maker may face, suggesting that not everyone can succeed equally. This was affirmed by CM01, who asserted that:

"….I think in a competitive sense business to business, yes, there is going to be an offset of those who get there quicker and have the finances to get there and those who can't, and particularly will struggle to get advantage of that benefit….,competitive as opposed to unfair? I don't say unfair, if you're a new entry to the market, and you don't have deep pockets, how are you going to catch up? If the gap is that big? And so that that is a question? So unfair not, but I would say there needs to be some thought on how to give the small guys the opportunity to get to this. And how does that happen?"

This was supported by participant OM05 who posited that:

"…..I suppose whoever gets there first, and whoever can afford drone technology, I can't imagine this will be cheap, cheap option, and will initially be complex and expensive."

While these perspectives acknowledges the harshness of market competition, it also skirts the question of how a decision maker might actively promote fair practices even in the face of technological advancements that provide overwhelming competitive advantages. However, participant OM05 takes a more positive view, expressing hope that drone technology might create opportunities for SMEs to innovate. Yet, even in this optimistic stance, there is no direct commentary on how businesses could or should take responsibility for ensuring fair competition. To this end, while participants recognised the competitive pressures and potential challenges for SMEs, their discussions largely avoided directly addressing the responsibility that an organisation might have to foster fairness and transparency in their operations. This silence suggests a gap in understanding or prioritisation of ethical considerations, with participants focusing more on the practical realities of competition than on how businesses should contribute to a fair and balanced market. Moving from this premise, the researcher observed that participants voiced concerns about the competitive implications of drone technology but were largely silent on the ethical responsibility that decision makers on behalf of an organisation should hold in promoting fair competition. This gap highlights a how a decision maker, particularly those that adopting new technologies, should ensure that their competitive advantages do not undermine the integrity of a newly formed drone market or create insurmountable barriers for smaller players such as SME's within South Africa.

5.2.6. Synthesis of Findings emerging From Overarching Theme Four: Ethical Considerations in Business Practices

This overarching theme examined how organisations can leverage drone technology for competitive advantage while balancing the societal and ethical implications of its adoption. The analysis revealed two key sub-themes that highlighted the tensions between market leadership, ethical business operations, and the potential for unethical practices in pursuit of a competitive edge.

5.2.6.1. Competitive Advantage and Market Leadership

The analysis of this sub-theme revealed a conflict between the strategic benefits of drone technology and its broader socio-economic impact. While drones offer undeniable operational efficiencies, such as reducing lead times and improving delivery speed, they may also come at the expense of job creation. This builds on the preceding themes where similar findings emerged. However, in this theme this issue was strongly asserted as expounded by participant GM05 voiced concerns about drones exacerbating poverty and unemployment, while others, such as GM03, emphasised the technology's efficiency gains, particularly in fast-moving industries like FMCG (Fast Moving Consumer Goods). From here, a critical finding that emerged was that decision-makers often misunderstand or underestimate the broader strategic potential of drones, seeing them merely as functional tools or UAVs (Unmanned Aerial Vehicles) for specific tasks rather than transformative technologies capable of driving long-term innovation and competitive advantage. Participant TM04 for example, highlighted how drones can transcend their traditional roles and support broader applications in logistics, such as infrastructure monitoring and data collection. By recognising drones' capacity for enhancing decision-making, supply chain visibility, and analytics, organisations can leverage them to unlock new roles and opportunities, rather than focusing only on labour replacement.

The key insight that can be drawn from here, is that decision-makers who recognise the full potential of drone technology beyond its basic functionalities, are more likely to emerge as market leaders. These leaders will leverage drones for operational efficiency and also for strategic innovation. In turn, these strategic leaders will contribute to societal benefits while maintaining a competitive edge. Thus, a decision maker that invest in a comprehensive understanding of drone capabilities, will propel an organisation to move beyond the narrow view of drones as simple tools, to a position where such an organisation can embrace the broader applications of drones in transforming the cold supply chain industry, and driving sustainable growth.

5.2.6.2. Fair Business and Competition Practices

The conceptual framework outlined in Chapter 2 anticipated that ethical dilemmas might arise for decision-makers when adopting emerging technologies such as drones. This was based on how to maintain fair competition and uphold ethical business conduct. The analysis found that while participants acknowledged the competitive advantages that drone technologies could offer, there was a notable absence of explicit discourse on the ethical responsibility of organisations to promote fairness or avoid market exclusion. Participant GM02 raised concerns about monopolistic outcomes and indicated that, while businesses may have a moral responsibility to avoid exclusionary practices, this responsibility might not be acted upon unless required by law:

"*If you operate within an area… you do have a responsibility to ensure that your practices are benefiting the people… But whether the decision maker is going to take on their shoulders such a responsibility, if it's not a legal responsibility…..so no*."

Participants TM02 and CM01 also reflected on the competitive realities that could disadvantage small and medium enterprises (SMEs), particularly when facing resource-rich competitors with early access to drone technology. TM02 observed:

"*I don't think anyone's realistically being strategic that everyone is going to win the same, and that everyone's going to be successful…"*

This was supported by CM01 who noted:

"*If you're a new entry to the market… and you don't have deep pockets, how are you going to catch up? If the gap is that big?... There needs to be some thought on how to give the small guys the opportunity to get to this.*"

These concerns, however, were largely framed in pragmatic or market-oriented terms, rather than explicitly ethical imperatives. While participant OM05 expressed cautious optimism that drone adoption might eventually create opportunities for SMEs, there was no sustained discussion among participants regarding how businesses might actively uphold fairness or contribute to inclusive market development. Thus, from this analysis, it can be cautiously inferred that ethical considerations around fair business practices were under-emphasised by participants. While the potential for competitive imbalance was acknowledged, participants did not attempt to frame this as a matter of ethical responsibility or corporate accountability. Instead, discussions centred on market dynamics, strategic positioning, and the challenges of competing in a resource-intensive environment.

These are not certainties but potential risks, which emphasise the importance of further inquiry and possibly broader stakeholder engagement. As such, while the theoretical framework proposed that fairness and ethical governance are integral dimensions of responsible technology adoption, this view was not strongly corroborated by the empirical data from participants in this study. This suggests a possible gap between theoretical expectations and practice, thereby highlighting the value of continued dialogue around ethical stewardship in emerging drone markets.

6. Conclusion

Chapter Four presented the analysis of data collected by this study, offering insights into the ethical challenges associated with drone technology adoption. The chapter was systematically structured into four parts, beginning with an overview of the participant recruitment process and their professional backgrounds. This provided essential context for understanding their perspectives. The data analysis process was rigorously conducted using a two-stage coding process that included data familiarisation and thematic coding. This method facilitated the identification of overarching themes and sub-themes, which offered deep insights into the ethical, operational, and strategic challenges faced by decision-makers in the context of drone technology. Through thematic and pattern analysis, the chapter uncovered significant concerns around privacy, data management, socio-economic impact, and fair competition. Furthermore, triangulation methods were employed to ensure the validity and reliability of the findings, with participant perspectives serving as the foundation for the analysis. This meticulous coding process reinforced the trustworthiness of the study and provided a nuanced understanding of the key ethical dilemma's decision-makers may encounter.

Thus, Chapter Four has laid the groundwork for a critical discussion of these findings in the next Chapter Five, where the implications of these findings will be explored in relation to existing theoretical frameworks.

CHAPTER FIVE: DISCUSSION

1. Introduction

This chapter provides an interpretation of the findings from Chapter Four. The interpretation will also be guided by the research objectives of the study, which include:

RO1: To identify and evaluate the critical ethical considerations that decision-makers must address in a more permissive regulatory environment.

RO2: To examine the best practices that should be incorporated into an ethical decision-making framework to address the identified ethical challenges.

RO3: To propose how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.

The discussion within this chapter has been organised into two parts as follows:

In part one, the interpretation of the findings will focus on the patterns and relationships across the sub-themes to address Research Objectives 1 and 2. This section will also assess how the theoretical framework themes have been supported, expanded, or challenged by the findings. This discussion was intended to provide insights into how theoretical concepts related to ethical governance, regulatory principles, and innovation management can be applied or adjusted in light of the findings.

Part two will focus on the theoretical and practical implications of the findings. Here, the discussion will highlight the real-world impact of drone adoption in the cold supply chain industry, emphasising the consequences for decision-making, policy, and organizational practices. This section will also consider the broader implications for industry regulation and ethical compliance, guiding decision-makers on how to implement the findings practically within their organizations. This part will address Research Objective 3 by proposing a conceptual framework for decision-makers. This framework is intended to help decision makers to navigate the complexities of drone adoption, integration, and commercial use while ensuring both efficiency and ethical standards. Moreover, it is intended to serve as a scalable tool for monitoring and evaluating ongoing drone-based decisions, promoting sustainable technological advancement.

By the end of this chapter, a structured interpretation of the findings will be provided, that offers practical guidance for decision-makers as they navigate the prospective evolving ethical and regulatory landscape of drone technology.

2. Part One: Interpretation and Synthesis of findings through the lens of Technoethics

2.1. Interpretation of Shared Patterns Across the Thematic Analysis

The thematic analysis uncovered several critical patterns that emerged across the sub-themes. These patterns were analysed to interpret the shared patters between the sub-themes as follows:

Table 14 Key relationships across thematic analysis themes

Overarching Theme (Number)	Sub-Theme (Number)	Related Sub-Themes Across Other Themes	Shared Patterns
Theme One: Strategic and Balanced Drone Adoption	Sub-theme 1.1: Pilot Testing and Iterative	Sub-theme 3.1: Knowledge Management and Dissemination under Theme 3 Sub-theme 2.1: Ethical Decision-Making in Risk Scenarios under Theme 2	Phased, iterative adoption, risk
Theme One: Strategic and Balanced Drone Adoption	Sub-theme 1.2: Integration into Existing Operational Systems	Sub-theme 2.5: Data Management and Governance under Theme 2 Sub-theme 3.1: Knowledge Management and Dissemination under Theme 3	Integration, data security, cross-functional collaboration
Theme One: Strategic and Balanced Drone Adoption	Sub-theme 1.3: Worker Displacement and Job Transformation	Sub-theme 4.1: Competitive Advantage and Market Leadership under Theme 4	Worker reskilling, social responsibility, operational efficiency
Theme Two: Risk Taxonomy in Decision-Making	Sub-theme 2.1: Ethical Decision-Making in Risk Scenarios	Sub-theme 1.1: Pilot Testing and Iterative Adoption under Theme 1 Sub-theme 2.4: Privacy under Theme 2	Ethical governance, security, community engagement
Theme Two: Risk Taxonomy in Decision-Making	Sub-theme 2.2: Safety (under Ethical Decision-Making in Risk Scenarios)	Sub-theme 1.3: Worker Displacement and Job Transformation under Theme 1	Community support, social stability, infrastructure protection
Theme Two: Risk Taxonomy in Decision-Making	Sub-theme 2.3: Security (under Ethical Decision-Making in Risk Scenarios)	Sub-theme 1.2: Integration into Existing Operational Systems under Theme 1	Data and IP security, skilled personnel, cloud system vulnerabilities
Theme Two: Risk Taxonomy in Decision-Making	Sub-theme 2.4: Privacy (under Ethical Decision-Making in Risk Scenarios)	Sub-theme 2.5: Data Management and Governance under Theme 2 Sub-theme 3.2: Ethical Implications of Misinformation under Theme 3	Privacy violation risks, legal/societal backlash, data sharing management
Theme Two: Risk Taxonomy in Decision-Making	Sub-theme 2.5: Data Management and Governance	Sub-theme 1.2: Integration into Existing Operational Systems under Theme 1	Data governance, privacy,
Theme Two: Risk Taxonomy in Decision-Making	Sub-theme 2.6: Internal Legal Compliance and Regulatory Adherence	Sub-theme 4.2: Fair Business and Competition Practices under Theme 4	Compliance, legal adherence, innovation management
Theme Three: Knowledge Structures for Sustainable Drone Adoption	Sub-theme 3.1: Knowledge Management and Dissemination	Sub-theme 1.2: Integration into Existing Operational Systems under Theme 1	Knowledge sharing, cross-department collaboration
Theme Four: Knowledge Structures for Sustainable Drone Adoption	Sub-theme 3.2: Ethical Implications of Misinformation	Sub-theme 2.4: Privacy - Theme 2 Sub-theme 2.5 Data Management and Governance under Theme 2	Misinformation prevention, internal research
Theme Four: Ethical Considerations in Business Practices	Sub-theme 4.1: Competitive Advantage and Market Leadership	Sub-theme 1.3: Worker Displacement and Job Transformation under Theme 1	Operational efficiency, long-term innovation, ethical business
Theme Four: Ethical Considerations in Business Practices	Sub-theme 4.2: Fair Business and Competition Practices	Sub-theme 2.6: Internal Legal Compliance and Regulatory Adherence under Theme 2	Fair competition, ethical compliance, market fairness

2.2. Exploration and Discussion of Key Findings with Theoretical Insight

From table 15, the researcher was interested in how the shared patters were to be interpreted in the context of decision making across drone adoption, drone integration and the long-term use of drones as they evolve alongside the 4IR's futuristic technological landscape. To this end, researcher reflected on how the specific sub-themes in table 15 formed a cohesive framework that would be interpreted to establish the prospective ethical challenges and considerations across the following decision-making dimensions:

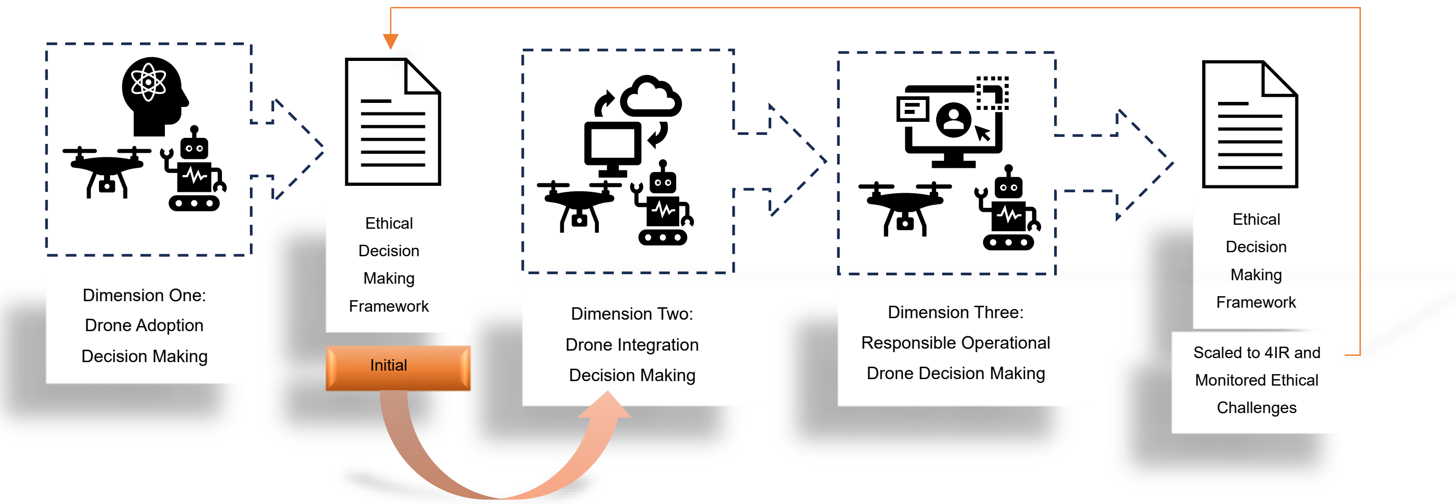

Figure 36 Drone Based Decision Making Dimensions

In light of the dimensions in figure 36, the researcher interpreted the shared patterns across the following decision-making dimensions as follows:

➢ **Dimension One: Drone Adoption Decision Making**

In this dimension, Theme Three plays a pivotal role alongside Themes One and Theme Two, supporting the foundation of ethically grounded knowledge-sharing mechanisms crucial for robust risk assessment. This was premised on the shared patterns: *Phased, Iterative Adoption and Risk, formed by Sub-theme 1.1: Pilot Testing and Iterative in Theme One; Sub-theme 2.1: Ethical Decision-Making in Risk Scenarios in Theme Two and Sub-theme 3.1: Knowledge Management and Dissemination in Theme Three*. Together, these sub-themes emphasised the ethical necessity for drone adoption decisions that must be informed by a risk management framework. From here, the researcher reflected on this, concluding that ethical risk management in drone adoption hinges on continual updated knowledge, testing insights, and collaborative dissemination, which Theme Three provided. When inductively approached, theme three asserts that dynamic risk decision-making frameworks would be required, especially since an organisation would need to keep up with the rapid pace of 4IR as expounded in the literature review by Schwab and Davis (2018).

To this end, three shared patterns highlighted the ethical need for transparent data management to mitigate legal backlash from internal and external stakeholders, coupled with privacy concerns. These shared patterns were: *Sub-theme 2.4: Privacy and Sub-theme 2.5: Data Management and Governance in Theme Two, in conjunction with Sub-theme 3.2: Ethical Implications of Misinformation from Theme Three.*

Against this backdrop, a key finding that emerged was *Risk Taxonomy for Drone Adoption Decision Making*, framed by these shared patterns and its underpinning sub-themes. The central focus of the exploration of this finding was that decision making in dimension one should be a process that establishes a risk taxonomy prior to the actual adoption of drones. This ensures that risk assessment frameworks can anticipate risks and respond to identified risks in a manner that will ensure that decision-making comprises ethical principles of transparency, accountability, and respect for privacy, safety, and regulatory compliance in adopting drone technology. Moreover, that the initial ethical decision-making framework highlighted in figure 38, has a risk taxonomy that will ensure that the operational readiness is aligned with legal and societal standards, in pursuit of building a sustainable and an ethically resilient risk taxonomy.

- **Dimension Two: Drone Integration Decision Making**

In this dimension, the ethical demands of achieving operational readiness emerged from the collaboration of Theme Three with Themes One and Two. From here, a foundation was created that accounts for knowledge accuracy, data security, and ethical compliance in readiness assessments. This was premised on the shared pattern's *Sub-theme 1.2: Integration into Existing Operational Systems in Theme One, Sub-theme 2.5: Data Management and Governance in Theme Two, and Sub-theme 3.1: Knowledge Management and Dissemination in Theme Three.* These sub-themes emphasised how cross-functional collaboration will ensure that drone integration respects data security and privacy. Furthermore, *Sub-theme 2.2: Safety in Theme Two and Sub-theme 1.3: Worker Displacement and Job Transformation in Theme One, grounded further by Theme Three's Sub-theme 3.1 and 3.2.* emphasised that operational readiness must align with community and social responsibilities, such as worker transformation and infrastructure stability. To this end, *Operational Readiness Ethical Challenges and Considerations* emerged as a key finding framed by these shared patterns and its underpinning sub-themes.

The central focus of the exploration of the findings under this dimension, was that ethical readiness for drone operations must encompasses privacy protection, safety protocols, and cross-functional collaboration that align operations with ethical standards. Against this backdrop, the exploration of the findings was to interpret the operational readiness constructs that must underpin ethical decision making in dimension two, that respects privacy, supports cross-functional integration, and maintains social and workforce stability.

- **Dimension Three: Long-Term Sustainability Strategies**

In this dimension, long-term sustainability with a focus on ethical business practices, knowledge integrity, and competitive fairness emerged from the shared patterns. Moreover, the shared patterns also revealed how knowledge structures are essential to fostering sustainable and ethically sound innovation. These shared patters comprising *Sub-theme 3.1: Knowledge Management and Dissemination in Theme Three with Sub-theme 1.2: Integration into Existing Operational Systems in Theme One and Sub-theme 4.1: Competitive Advantage and Market Leadership in Theme Four* underlined that sustainable drone adoption must involve cross-departmental collaboration and ethical knowledge sharing. Moreover, that establishing ethically sound knowledge management practices will ensure that the long-term integration of drones in competitive landscapes remains both innovative and responsible. Furthermore, *Sub-theme 4.2: Fair Business and Competition Practices from Theme Four with Sub-theme 2.6: Internal Legal Compliance and Regulatory Adherence from Theme Two and are supported by Sub-theme 3.2: Ethical Implications of Misinformation from Theme Three* encourages fairness by stressing ethical compliance and misinformation prevention, both critical in maintaining trust in competitive practices and sustainable strategies.

Against this backdrop, the central focus of this finding was that understanding how decision making in this dimension would ensure that drone adoption contributes to sustainable industry growth and how decision makers will ensure that an ethical focus is placed on fair competition, information integrity, and support for affected workers.

2.2.1. Dimension One: Risk Taxonomy for Drone Adoption Decision Making

For dimension one, it necessitated that the researcher's interpretation centred on identifying critical factors that decision-makers must consider when initially assessing the adoption of drones. This interpretation highlighted the ethical considerations essential to the responsible deployment of drones for commercial purposes, with adaptability for future advancements. Through this interpretive process, the researcher uncovered several significant risk areas, underscoring the need for a risk taxonomy decision-making framework to guide informed adoption.

To give effect to the concept of a risk taxonomy, Kruizinga (2021) explicates that taxonomies have their origins in science, and type of classification tool of risks that helps an organisation to prioritise and manage risks. Moreover, a risk taxonomy is the starting point for the organisations risk strategy; risk appetite; risk limits and thresholds; risk policies and procedures. McCowan and Duggan (2022) adds depth to this explanation, explicating that a risk taxonomy serves as an organised inventory that maps the risks that matter. The author goes on to expound that effective taxonomies become a "snowflake", starting with core risks that build upon each other, creating complex interdependencies that are often unrecognisable by traditional risk analysis. These dependencies extend into third parties, fourth parties and beyond. Moreover, that connecting risks enables a more rapid identification and assessment.

Moving from this premise, a drone-based risk taxonomy for drone adoption decision making was interpreted through the lens of technoethics as follows:

i. Risk Taxonomy One: *Balancing Efficiency with Ethical Integrity*

Participants expressed concerns regarding the suitability of drones for large-scale operations, especially in logistics involving heavy loads such as pallets and other warehouse items in cold stores. To this, Jazairy *et al.* (2024) observed that companies such as Amazon and UPS have tested the capability of the carrying loads of drones, which were found to be up to 5 pounds (2.27 kg) and flying at speeds of up to 50 mph (80.47 kph). In one example, the authors noted that drones transported blood samples weighing 6.4 kg at a speed of 10 m/s, marking one of the highest payloads noted in research. Thus, one of the conclusions drawn was that drone capacities differ depending on the model and type, which leads to trade-offs. For example, considering the drone classification explanation in the literature review, multirotor drones offer great manoeuvrability but can only carry limited payloads, while hybrid drones, combining wings and propellers, have greater range but reduced agility.

To address drone capacity constraints, Jazairy *et al.* (2024) posit that several strategies can be used, such as optimising the number of launch points in relation to receiver density and drone speed, scheduling deliveries based on battery life, using multiple drones to transport a single load, and equipping drones with multiple propellers or mini-jet engines. From the findings of Schmidt *et al.* (2023), the authors postulate that a truck and its drone can either move together or separately. To operate alone, a truck can release its drone at the depot or at a customer location and likewise pick it up at a later location visited by the same truck. In this way, both trucks and drones deliver goods to customers working together as synchronised working units. However, the authors caution that a feasible route has to satisfy the capacity constraints of both the truck and the drone.

From here, where participants queried the capacity of drones, Jazairy *et al.* (2024) and Schmidt *et al.* (2023) provided some solutions until the future of drone developments solves for the larger capacities. Technoethics encourages this integrated approach but emphasises that a decision maker must balance efficiency with ethical integrity as drone logistics is expanded. Thus, for those drones that can be used such as the lighter versions and the sensor-driven drones that can perform ground level task it would therefore necessitates that a decision maker transcends their focus of the physical capabilities of a drone's, to how integrated systems such as AI and sensors that will contribute to the overall operational fit.

From a technoethical standpoint, technoethics asserts that the principle of “fitness for purpose” must be regarded by decision-makers, assessing whether the entire technological ecosystem of drones (including AI, sensors, and UAVs) aligns with ethical business practices. Hosier (2022) defines the principle of “fitness for purpose” as a product or service that must possess the necessary qualities to fulfil its intended use, regardless of any claims, descriptions, or test results associated with it. This means that a decision maker with this approach would be able to detect whether the drone deployed will function as expected, and for its specified purpose, beyond just meeting standards in testing or certification. Hosier (2022) goes on to posit that In legal terms, *fitness for purpose*, unlike a professional duty of "reasonable skill and care," focuses on meeting the standards of a competent professional. Thus, “fitness for purpose” requires that the product or service actually achieves a specified result.

From a technoethical perspective, balancing efficiency[178] with ethical integrity emerges as the ethical implication. The ethical challenge that may potentially confront a decision maker in the context of this study is that the obligation of a companies to ensure that drone technology meet the principle of “fitness for purpose” includes assessing whether drones fulfil their logistical functions, but also align with broader ethical, environmental, and data security considerations. This aligns with the assertion of Xu et al. (2018) that the most valuable resource in a technology-driven era will be those who innovate and generate new ideas, a notion consistent with the adaptability of Drones as versatile sensing and payload transportation platforms (Novitzky, Kokkeler, & Verbeek, 2018). In this context, technoethics asserts that decision-makers should critically assess the technological ecosystem of drones, to ensure the selected drone genuinely is fit for purpose. This assertion is supported by Bcukley et al. (2016), who asserts that early ethics assessment of technological innovations promises to produce greater sensitivity to the potential for unfair impacts and problems of consent and distrust. Moreover, even if specific outcomes from a technology cannot be predicted with accuracy, early ethics assessment promises to create greater awareness of the potential for unfair impacts, especially among vulnerable populations. When technical elites become aware of this potential, they may become more sensitive to such impacts in their design activity. In the context of this study, this means that a decision maker must transcend beyond technical compliance, to a mandate that includes evaluating the operational and ethical ramifications of drone deployment. Moreover, that decisions involving drone adoption, including the type and class of drones that will be used in the organisation, must align with sustainable and ethical business practices.

To understand how this ethical implication could become a challenge within the decision makers intended drone deployment radius, the lens of social constructivism was engaged. This lens highlighted that the decisions about drone adoption are not merely technical, but are also influenced by the perceptions, norms, and values held by stakeholders involved in or affected by the technology. Jia (2017) echoes this, asserting that viewing emerging technology such as drones as a neutral instrument that discounts the social impacts or organisation-wide impacts may result in ethical oversights, decreased accountability, reduced adaptability, erosion of public trust, and missed opportunities for ethical leadership. These factors highlight the importance of a technoethical perspective in evaluating technology, encouraging a decision maker to integrate social and ethical considerations at every stage of technological adoption. For example, community members may view drones differently if they see them as intrusive or disruptive. Thus, social constructivism argues the principle of “fitness for purpose” itself is a socially constructed concept in so far that over time, society’s expectations of what is considered an “ethical” and “fit” application of drone technology may shift as people become more accustomed to or critical of drones. Against this backdrop, social constructivism highlights the importance of decision-makers remaining adaptable to changing perceptions of both internal and external stakeholders, and to continuously assess whether drone technology aligns with current societal standards and expectations.

To understand how a decision maker should effect decisions within the realm of this risk taxonomy, the lens of prospect theory highlighted that decision-makers may be likely to perceive the ethical and operational risks

178 Efficiency in the context of this risk taxonomy can be the suitability in the context of participant perspectives.

associated with drones as having a higher potential for loss than gain. This aligns with the findings of Fox (2020), that prioritising profit over governance can introduce vulnerabilities and exposure to various risks that weaken an organisation's resilience, operational integrity, and trustworthiness. Thus, from a prospect theory perspective, the implication of balancing efficiency with ethical integrity is that decision-makers are likely to approach drone adoption with a risk-averse mindset. From this perspective, the researcher reflected on perspectives of the research participants in this regard, which necessitates those decisions taken in the context of this risk taxonomy, carefully balance efficiency and profit motives with strong governance practices to mitigate potential risks. To this end, Jia (2017) posit that a paradigm shift is required by decision makers in the context of viewing emerging technologies such as drones as neutral instruments, to a paradigm of ensuring that ethical integrity, regulatory compliance, and stakeholder trust remain central to drone technology adoption decisions and operational strategies. For this study to expound on a potential paradigm shift, the researcher engaged the ethical typological framework of normative, applied, meta-ethics to critically examine the ethical considerations that a decision-making process should follow:

From a normative ethics perspective, specifically duty-based (deontological) ethics, decision-makers are responsible for ensuring that drones meet logistical objectives that align with ethical principles such as transparency, social responsibility, and environmental stewardship. This aligns with the decision-making model for tailored decision making designed by Chamberlain *et al.* (2023). The authors emphasise that a systematic approach that is essential when develop a technological decision-making framework. The authors designed a process that begins with clearly defining the goals of the engagement, setting boundaries, and justifying the need for it. However, the lens of satisficing heuristics argues that a decision maker may have a tendency to settle for basic operational compliance as ethically sufficient. From here, prospective theory asserts that this cognitive shortcut may introduce risks such as privacy concerns that detract the adoption of drone plans due and environmental consequences, which could compromise community trust and public perception.

To counteract the satisficing heuristics cognitive shortcut in lieu of ensuring that the duty-based ethics approach to the technoethics principle of "fitness for purpose" is translated into a practical action, the lens of applied ethics was engaged. Applied ethics interpreted fitness for purpose as the need to go beyond basic functionality and ensure that drones operate with minimal negative impact on society and the environment. For instance, assessing a drone's energy efficiency, noise levels, and data handling aligns its use with ethical goals of sustainability and privacy protection. However, satisficing heuristics in this context asserts that a decision maker might rely on minimal regulatory compliance without conducting thorough impact assessments, potentially disregarding cumulative risks. Prospect theory frames these cumulative impacts as potential losses such as environmental harm from frequent battery replacements or privacy violations that could erode public trust. Applied ethics, therefore, encourages decision-makers to see the cost of ethical shortcuts as greater than the benefits of compliance-only approaches.

However, a reflective meta-ethics perspective on these challenges the assumption that drones are purely neutral, efficiency-driven tools. The lens of meta-ethics therefore encourages decision-makers to question how drones interact with, and shape societal values. This meta-ethical perspective is supported by Zhao and Fariñas (2022), who asserts that decision makers who adopt advanced technologies must develop standards to detect prejudices and eradicate them as a positive action to counteract existing decision making biases. Meta-ethics therefore encourages a decision maker to, in addition to questioning the interaction of drones, to also thoughtfully analyse how the operational goals of drones might clash with broader social values. However, the lens of availability heuristics posit that a decision maker might adopt familiar, high-profile examples (e.g., Amazon's or UPS's drone programs) without fully considering unique ethical implications in their specific context. To this end, prospect theory pointed out the risks of ethical oversights where decisions are based on generalised models that could ignore local privacy norms or environmental standards, leading to *ethical myopia*[179], and community resistance. This assertion is supported by the findings of Kandlhofer *et al.* (2023) in the literature review regarding the awareness that must be created around Artificial Intelligence (AI) technological development. The authors contended that the increasing digitisation and automation processes in daily life through the use of Artificial Intelligence (AI) pose great challenges for society.

Against this backdrop, technoethics asserts that during drone adoption decision making, that decision-makers should consider the broader implications of drones and have regard for the principle of *fitness for purpose*. Moreover, decision makers should be cognizant to avoid cognitive biases as highlighted by the theoretical lens satisficing heuristics and availability heuristics. Furthermore, a decision maker must navigate social expectations as highlighted by the lens of social constructivism and adopt a reflective approach as posited by the normative, applied, and meta-ethical reasoning approach. This reasoning approach encourages ethical foresight and proactive measures to mitigate potential social, environmental, and ethical concerns associated with drone technology. Thus, the overarching technoethics perspective on this challenge calls for a paradigm shift, where decision-makers transcend compliance-focused mindsets, embracing a comprehensive approach that aligns drone operations with ethical business practices and societal expectations.

ii. Risk Taxonomy Two*: Balancing Innovation and Compliance*

From the findings, participant perspectives indicated that decision-makers may struggle to balance regulatory compliance with the rapid pace of technological innovation, especially as they seek to maximise efficiency while upholding ethical integrity. A technoethics perspective on this is that decision-makers may be confronted with the dual challenge of ensuring that innovation does not compromise ethical standards. Furthermore, that decisions do not fall short of regulatory expectations, while addressing the ethical implications that drone technology and its autonomous features brings.

Participant OM01 contributed to this finding, raising critical questions regarding whether technology should drive policy or vice versa. From here, technoethics highlighted a broader ethical dilemma about how a decision maker would ensure that internal compliance policies on the use of drones and its advanced technology is compliant with legal frameworks without stifling its potential for innovation. This was validated by Fenwick *et al.* (2017), who posited that technological transition[180] is going to be a permanent state in the age of disruptive innovation. The authors go on to assert that the inability of rule makers[181] to address regulatory issues associated with disruptive innovation will likely generate high levels of legal uncertainty and inconsistency that inhibit innovation during technological transition periods. This validated the argument of Stefanini (2021) in the literature review, that organisations relying on antiquated technologies, strategies, and policies tailored to previous industrial revolutions run the risk of employing outdated constructs in a market that is progressively engaging with newer advanced 4IR technologies. Thus, organisations clinging to obsolete practices face the peril of leveraging enhanced technologies and strategies.

From a technoethical perspective, the ethical implication that emerges from here centres on the tension between advancing technology and maintaining ethical and legal standards. Moreover, the ethical responsibility to develop adaptable compliance frameworks that can evolve alongside technological advancements. Against this backdrop, technoethics proposes two compliance frameworks to append internal compliance policies on. These emerged as: dynamic compliance frameworks and compliance by design.

179 Ethical Myopia, alternatively Moral myopia refers to the inability to see ethical issues clearly. The term, coined by Minette Drumwright and Patrick Murphy, describes what happens when we do not recognise the moral implications of a problem or we have a distorted moral vision. An extreme version of moral myopia is called moral blindness (Ethics Unwrapped, 2024).

180 In this context, the transition of previous digital transformations to advanced digital technology use.

181 In this context, a compliance manager

a) Technoethical perspective on a dynamic compliance drone-risk decision framework

The dynamic model underpinning decision making within the dynamic compliance framework, is explained by Chen *et al*. (2024) as a complex decision-making process. This process involves addressing both the fuzzy uncertainty of target information and the time factor of this information as it evolves. The key challenge in this context lies in determining and integrating attribute weights (which reflect the importance of different target attributes) and time weights (which reflect the significance of information at different points in time). Achieving effective decision outcomes requires an approach that accounts for the uncertainty and variability of the target, as well as incorporating the evolving relevance of information over time. Moving from this premise, from a technoethical perspective, a dynamic compliance framework in the context of drone compliance policies must align with evolving legal standards and societal values. Moreover, technoethics asserts that an adoption of a dynamic compliance model as a framework requires a responsive approach that integrates real-time risk assessments with regulatory requirements.

b) Technoethical perspective on a compliance by design drone-risk decision framework

According to Kelly *et al.* (2024), "Compliance by Design" as a concept entails moving from a reactive approach to one that demonstrates a proactive and preventative strategy to risk mitigation. This involves first defining the outcomes that aligns a value proposition. In turn, these outcomes are tied to performance expectation metrics, compliance requirements and where possible, automated assurance tests. In the context of the study, the concept of "Compliance by Design" signifies a shift from traditional and reactive compliance methods to a proactive, risk-preventative approach. Here, technoethics asserts that compliance by design requires decision-makers to first define desired outcomes and ethical accountability in pursuit of ensuring that any decision-making process has outcomes that are central to an organisation's value proposition. This means that a decision maker should not treat this as compliance regulatory checkbox, but rather as a built-in, continuous process that anticipates and mitigates risks associated with drone technology.

From this critical assessment, technoethics identified that the need to align rapid technological advances with ethical and regulatory standards will be an ethical challenge that decision makers will have to grapple with. This validates the contention of Hosseini (2016) regarding stakeholders that must develop and implement technical standards to deal with the ethical challenges. Moreover, this also validates the literature review findings that the demand for automation to meet the complexity of drone technology will lead to a demand in the variation of technologies to in turn meet the demand of interoperability. Moving from this premise, technoethics proposes that a decision maker should uphold ethical standards through proactive approaches underpinned by compliance by design and dynamic compliance frameworks. This aligns with the findings of Stöber *et al.* (2019) that the elements of compliance programs are *inter alia*: codes of conduct, compliance training, and whistleblowing. Considering this perspective, technoethics asserts that the integration of ethical and regulatory considerations into decision making should be done from the outset, rather than as an afterthought.

Against this backdrop, technoethics emphasises the need to integrate ethical and regulatory considerations proactively, ensuring that innovation does not compromise ethical standards or lag behind regulatory expectations. This aligns with the findings of the literature review, where Caboz (2022) reported that new charge codes that have been added to the databases of the South African Police Service's (SAPS). Moreover, these codes regulate how the SAPS should deal with perceived and direct Drone regulation contraventions. Furthermore, McNeal (2014) contends that the commercial use of Drones has raised concerns for lawmakers, and that errors will be used to drive the legal definitions and combinations with other laws will drive the legalities of actions involving Drones by organisations. It is these aspects that will become the legislators' considerations as terms of reference when adjudicating cases. Thus, what a layperson comprehends in relation to Drones, may be what a legislator means when adjudicating matters involving Drones (McNeal, 2014).

To understand how a decision maker within the cold supply chain industry would make decisions on balancing innovation and compliance from a compliance and ethical perspective, it necessitated that the researcher engage the lens of prospect theory. These theoretical perspectives were engaged to under and how a decision maker would decision-makers to manage risks effectively and ethically while remaining adaptable to societal needs and evolving regulatory standards.

Table 15 Comparative view of Prospect Theory and Social Constructivism

Prospect Theory Perspective	Social Constructivism Perspective
Dynamic Compliance: Propect theory emphasises continuous adaptation to reduce regulatory risks and avoid reputational damage. Moreover, this perspective highlights the importance of adjusting in real time to regulatory changes, driven by a desire to avoid the potential losses (legal, financial, and reputational) associated with non-compliance.	**Dynamic Compliance**: Social consturctivism asserts that this framework aligns drone operations with changing public attitudes, ensuring technology respects current societal values. This view emphasizes that technology must remain sensitive to evolving societal standards and cultural perceptions. Moreover, social constuctivism calls for flexible adjustments as dynamic compliance that is based on feedback and social expectations.
Compliance by Design: Propect theory emphasises the integration of ethical standards to prevent future compliance issues and ensure ethical consistency. In this proactive model, prospect theory encourages compliance that is embedded directly into the operational design of drone technology to mitigate risks from the start. This perspective therefore values foresight, aiming to avoid future losses by establishing ethical and regulatory safeguards as integral parts of the technology rather than reactive measures.	**Compliance by Design**: Social constructivism encourages building public values into drone technology from the outset, treating compliance not as an add-on but as foundational. Furthermore, social consturctivism asserts that embedding socially responsible practices early through compliance design, will helps to cultivate trust and support, showing that drone use considers ethical and societal impacts as essential components of its operational framework.

From here, technoethics asserts that balancing innovation with compliance is an ethical challenge that a decision maker must address to ensure the drone technology selected meets both ethical and operational standards, maintaining public trust without stifling innovation. Thus, technoethics proposes an ethical strategy to address the challenges identified within the risk taxonomy of balancing innovation with compliance. This strategy includes a Dynamic Compliance Framework and Compliance by Design, both of which aim to align drone operations with evolving legal and ethical expectations:

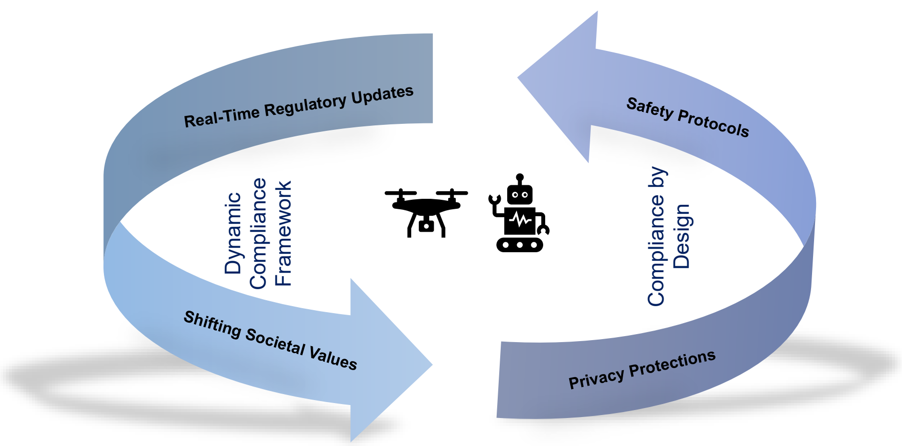

Figure 37 Pre-emptive Compliance Integration Decision-making Framework

To understand how *"Dynamic Compliance Framework"* operates within a technoethics decision making framework, from here, technoethics asserts that decision making must operate in real-time, incorporating regulatory changes and societal values as they develop. For this framework, the central integration of updated standards allows drones to remain compliant with both emerging ethical considerations and regulatory shifts. This real-time adaptability is essential for a decision maker to navigate the technological landscape evolves rapidly, Thus, technoethics implies that this framework will assist a decision maker to maintain ethical integrity without impeding innovation.

In terms of the "*Compliance by Design*" framework, here, technoethics asserts that decision makers can embed essential compliance measures such as privacy protections and safety protocols directly within the drone technology decisions from the outset. This proactive integration ensures that drones meet ethical and regulatory standards consistently throughout their operational lifecycle, rather than as an afterthought. This strategy encourages an embedded approach to compliance that anticipates ethical challenges and integrates solutions, supporting a sustained balance between innovation and accountability. Thus, these frameworks combined as a strategy within a technoethics decision making framework will assist decision-makers to proactively address both legal and ethical standards, thereby fostering responsible innovation while meeting public expectations for safety, privacy, and transparency.

However, to understand how a decision maker approach decision under this risk taxonomy, prospect theory implies that the risk of loss aversion may influence how decision maker views regulatory compliance versus innovation. For example, if a decision maker views compliance as potentially stifling innovation, they may perceive this as a loss of competitive edge. This assertion aligns with the findings from Fenwick *et al.* (2017) and Stefanini (2021), which indicate that static regulatory frameworks can impede organisations from capitalising on disruptive innovations. From here, prospect theory asserts that decision-makers might attempt to innovate "under the radar" of full compliance, relying on riskier compliance strategies until regulations evolve to catch up with the technology. When translated in practice, a social constructivist approach asserts that the risks highlighted by prospect theory can be mitigated by engaging diverse stakeholders such as regulators, technology developers, ethicists, and the public. This should be an ongoing dialogue to co-create adaptable compliance frameworks. Moreover, social constructivism holds that this would mitigate the risk of legal uncertainty and inconsistency noted by Fenwick *et al.* (2017), where the author asserts that compliance policies must evolve alongside technological advancements in pursuit of reducing barriers to innovation. Against this backdrop, the ethical reasoning framework comprising the ethical typology of normative, applied and meta ethics was consulted underpinned by satisficing and availability heuristics.

From a normative ethics perspective, duty-based (deontological) ethics requires decision-makers to ensure that drone technology aligns with regulatory and ethical standards. This aligns with the literature review findings that without consensus on drone applications and functionality, that the cold supply chain risks adopting suboptimal or non-compliant drone solutions, further complicating ethical decision-making (Edet, 2022). In this regard, satisficing heuristics asserts that a norma-ethical approach may lead decision-makers to accept minimal compliance standards as adequate, focusing on basic regulatory adherence rather than broader ethical obligations. This aligns with the transparency ethics framework by Ofem *et al.* (2022) expounded in the literature review, where the author likened transparency in a decision making process as a semantic layer that would need to be accounted for in decision making related to drones. This was amplified through availability heuristics that highlights how decision makers may model their approach on well-known industry cases, assuming that compliance practices used by major players such as Amazon or UPS set sufficient ethical standards. From here, availability heuristics highlights how this reliance on prominent examples may prevent decision-makers from tailoring compliance to specific ethical contexts, leading to "ethical myopia" and potential oversights in privacy or public accountability.

To this end, applied ethics asserts that implementing technoethical principles requires proactively addressing risks beyond basic regulatory compliance. Yet, satisficing heuristics argues that this can lead to decision-makers settling for minimal adherence, assuming that regulatory compliance covers all ethical bases. Availability heuristics further suggests that familiar compliance standards may be applied without questioning their relevance in the dynamic context of autonomous drones, potentially leading to ethical oversights. Against this backdrop, a meta-ethics perspective challenges the assumption that drones are neutral tools, prompting decision-makers to consider the broader ethical implications of drone use. Here, satisficing heuristics holds that this perspective may lead decision makers to overlook these implications, focusing narrowly on operational goals. The lens of availability heuristics reinforces this by showing that reliance on prominent compliance models may cause ethical myopia, where local ethical values and privacy standards are ignored, potentially leading to ethical conflicts in their specific operational environments.

Moving from this backdrop, technoethics inferred from this reasoning framework, that ethical decision making in the context of drone adoption requires decision-makers to:

- Tailor compliance and ethical standards to their specific operational and societal contexts,
- Recognise the limitations of simply following regulatory or industry standards,
- Incorporate transparency and public trust as central components, and
- Continuously evaluate the broader societal impacts of drone technology to prevent ethical myopia and oversights.

iii. Risk Taxonomy Three: *Balancing Innovation and Job Displacement*

From the preceding ethical challenges and the findings that emerged, it is evident that the integration of drone technology presents a complex array of ethical challenges. This is a testament to the assertion of Schwab and Davis (2018), that the fourth industrial revolution (4IR) and its associated technologies such as drone technology has the potential for shifts and disruptions that could bring both promise and peril, such as unequal resource distribution and job displacement. From a technoethical perspective, the findings revealed that the adoption of drone technology has the potential to displace workforce and have a negative impact on the socio-economic conditions of such displaced workforce. Huff *et al.* (2016) and Rawlins (2016) expands this finding, positing that drone-powered solutions will likely replace over $127 billion worth of human labour globally, within the near future. This raises the ethical responsibility incumbent on a decision maker, to mitigate the negative impacts of automation by drones. To this end, technoethics suggests that decision makers must adopt a balanced approach to prevent any deepening socio-economic inequalities, and also to ensure that technological advancements are inclusive and socially sustainable.

From the findings, it emerged that reskilling and upskilling initiatives are potential options to mitigate the displacement of workers. However, the findings revealed that the digital divide[182] and digital literacy skills poses a constraint to this option. Participants frequently highlighted by that many workers, particularly those in disadvantaged or rural areas, may lack the foundational skills needed to transition into more technologically advanced roles. To amplify this, as at Y2023, Hassim (2023) observed that in terms of digital education barriers at a nationally level were that only 22% of households possessed a computer, while only 10% were reported to have an internet connection. From here, the risk of not addressing these literacy barriers during the decision making for drone adoption, risks leaving behind large segments of the workforce, exacerbating existing inequalities. Moreover, addressing the digital divide is essential to ensuring equitable access to the benefits of drone technology. Against this backdrop, technoethics asserts that a decision maker should actively seek opportunities to collaborate with government and academic institutions to provide accessible[183] reskilling

182 In addition to the literature review discussions, Mlaba (2021) goes on to clarify that South Africa's digital divide can be broken down into three factors: 1) access to hardware, 2) understanding digital means of communication, and 3) internet affordability. These Mlaba (2021) asserts are factors that have a negative impact on two of the country's best chances at development and equality, those being access to education and access to employment opportunities.

183 This must include hardware, software and other essential needs

programs that empower all workers. This must be regardless of an affected workers socio-economic background, to participate in the digital economy. This approach aligns with the ethical imperative to promote inclusivity and fairness in technological adoption.

In addition to the digital divide and literacy as well as the socio-economic challenges, drone misuse was also highlighted by technoethics. As expounded in the literature review discussions, drones can be exploited for criminal activities, such as transporting contraband or conducting unauthorised surveillance. This risk emerged from participants concerns, however, the findings expanded the literature review discussions. From the thematic analysis, participants identified the risk that displaced workers who may be in a position of fearing job losses, may collude with internal staff to make a living by transporting illicit goods for example. This aligns with the findings of Kim *et al.* (2018) and Manyika *et. al.* (2018) that as machines substitute for human labour, the disparity between those who own the technology and those who operate it may become a chasm, raising critical questions of fairness and social justice (Manyika & Sneader, 2018). This presents an ethical dilemma for decision-makers, who must implement stringent oversight mechanisms to prevent such misuse while ensuring that drone operations are transparent and accountable. This aligns with the literature review argument by Seymour *et al.* (2022) that even if a technological system is in some sense fair, just, or 'safe', it can nonetheless be exploitative, coercive, inconvenient, or otherwise conflict with cultural, individual, or social values. From here, it will necessitate that decision makers deliberate on robust security protocols, real-time monitoring, and public accountability which will therefore become the ethical imperatives that must be addressed to maintain trust in drone technology.

Premise on this evaluation, technoethics asserts that decision-makers can mitigate the socio-economic impacts of a decision to adopt drones, by addressing the digital divide, fostering inclusivity in workforce transitions, collaborating with governments, educational institutions, and community organisations to provide reskilling and upskilling initiatives. However, technoethics also highlights the ethical imperative for decision-makers to ensure the security and accountability of drone operations, especially in light of potential misuse by displaced or disenfranchised workers. This aligns with the argument regarding the engagement with the gig economy in the literature review by of Kim *et al.* (2018), suggesting that the emergence of digital business models could reshape the nature of work and employment relationships in ways that may further disrupt traditional employment. These findings were further supported by Manyika *et al.* (2018), who warned of the potential shifts in employment relationships, driven by the gig economy's expansion.

From here, prospect theory suggests that decision-makers may have to weigh the perceived economic gains of drone adoption against the socio-economic losses of job displacement. This may lead to risk-averse behaviour (slowing innovation to protect jobs) or risk-seeking behaviour (prioritising economic gains despite potential job loss), based on how immediate and impactful these outcomes appear. To this end, the lens of social constructivism highlights the need for inclusive, co-created solutions that involve diverse stakeholders in addressing job displacement. Moreover, social constructivism emphasises digital equity and transparency in technology deployment, supporting the idea that technological advancements should align with societal values of fairness and inclusivity. This aligns to the assertion of Kim *et al.* (2018), who observed that while there are many benefits of 4IR technologies, the rapid advancement of 4IR technologies driven by high-speed automation could yield greater inequality, particularly in its potential to disrupt labour markets.

In light of this, from a technoethics perspective, the central ethical implication is that decision-makers must adopt a balanced approach to drone integration, that balances the pursuit of innovation with the ethical obligation to protect the rights, livelihoods, and security of all stakeholders. Moreover, technoethics emphasises that these challenges must be addressed simultaneously by a decision-maker, as an approach that integrates ethical considerations into every stage of drone deployment. However, prospect theory suggests that decision-makers may overestimate the economic benefits of automation while underestimating the long-term social costs of job displacement. This validated the findings in the ITF (2021) report regarding the impact of drone technology on employment practices. The research findings revealed that the increasing need for automation, has implications of job displacement. For a decision maker in the cold supply chain, this creates an ethical risk where the potential negative impacts of automation are downplayed in favour of immediate economic gains. This theoretical perspective is strengthened by social constructivism, that holds that job displacement must be viewed within the broader social context, where societal norms around employment and technology adoption are evolving. This was supported by the observations of Kisters (2023), positing that while stakeholders advocate for relaxing restrictive regulations to unlock the potential of drone technology, that it is essential to balance innovation with ethical responsibilities such as job preservation. Here, an engagement with normative, applied, and meta-ethical frameworks were necessitated to account for these complexities in decision-making.

Through a normative ethical lens, decision-makers have a duty to balance economic gains with the well-being of workers whose livelihoods may be affected by automation as per the arguments of Kim *et al.* (2018) and Manyika *et. al.* (2018). Thus, normative ethics challenges the idea that job displacement is an acceptable trade-off for increased efficiency, instead positing that decision-makers have a responsibility to consider the implications for vulnerable workers. However, a satisficing heuristic perspective highlights how decision-makers may settle for minimal interventions such as basic reskilling programs that superficially address workforce impacts without fully grappling with the social risks highlighted by prospect theory and the ITF (2021) report findings. Several media reports have reported on the impact of automation to date. Corrall and Stringer (2024) reported that following significant workforce reductions in 2022 and 2023 within the ICT industry, that 2024 had seen more than 130,000 job cuts across 457 big brand companies, according to independent layoffs tracker Layoffs.fyi (2024). The authors goes on to report that major companies such as Dropbox; Tesla, Amazon, Google, TikTok, Snap and Microsoft have conducted sizable layoffs in the first months of 2024, that has been a continuance since 2022. Smaller-sized startups have also seen a fair number of cuts, and in some cases, have shut down operations altogether.

To this end, applied ethics advocates for collaborative efforts involving government, educational institutions, and industry stakeholders to create accessible reskilling and upskilling programs. This aligns with the call for 4IR leadership by Alade and Windapo (2020), where the authors assert that drone technology operates within the disruptive technology realm of 4IR. Therefore, it becomes essential for an organisation to have effective 4IR leadership due to new demands on organisations to develop and select leaders to effectively lead the organisations during the disruptive 4IR era. However, the availability heuristic cognitive shortcut in this regard may lead decision-makers to disproportionately emphasise short-term success stories of drone technology. This may include cost reductions or productivity improvements, at the expense of acknowledging the broader social implications of workforce displacement. This is evident in the reports by Corrall and Stringer (2024) . Against this backdrop, a meta-ethical perspective encourages decision-makers to critically examine the foundational assumptions underlying their approach to automation. This means that a decision maker must question the presumption that economic progress is inherently beneficial. Here, meta-ethics invites decision-makers to consider whether their decisions align with values of inclusivity, social justice, and community resilience. This emerged as a query from several participants, where it was held that the South African commercial sector is not ready for drone adoption due to its high-unemployment rate. From here, social constructivism complements the meta-ethical reflection, positing that job displacement is not merely a technical issue but one shaped by existing social inequalities and evolving norms around technology adoption. This reflection aligns with the findings of Li (2022), where the author concludes that the current workforce is experiencing an unprecedented acceleration in the introduction of new skills and technologies, necessitating a shift towards lifelong learning. This perspective challenges the availability heuristic, which may lead decision-makers to assume that visible economic successes justify technological expansion, by encouraging a more nuanced understanding of social impacts.

From here, technoethics identified balancing innovation and job displacement in drone technology adoption as the ethical challenge that requires decision-makers to address workforce displacement, digital inequality, and security risks in a socially responsible way. The primary ethical obligation in the context of this risk taxonomy, will be for a decision maker to make a decision that encompasses a mitigation strategy to avoid job losses. This, as technoethics has identified can be done through options such as accessible reskilling and upskilling programs, especially in areas with limited digital infrastructure. Additionally, this means that decision makers must make efforts to collaborate with governments and educational institutions to bridge digital literacy gaps. Furthermore, transparent security protocols are essential to prevent misuse and maintain public trust in drone operations. Technoethics therefore calls for a balanced approach, where technological advances do not exacerbate socio-economic disparities, but instead align with societal values of fairness, inclusivity, and long-term resilience.

iv. Risk Taxonomy Four: *Community Buy-In and Societal Trust*

From the findings, a critical ethical challenge that emerged was the need for community engagement and societal trust in drone operations. Participants such as GM04 emphasised that the success of drone adoption, particularly in logistics, depends on gaining the support of local communities to prevent resistance or sabotage. Moreover, that without community buy-in, that there would be a risk that drones could face opposition from local stakeholders or even be targeted for destruction. Kandlhofer *et al.* (2023) contextualises this, asserting that the increasing digitisation, automation, and use of Artificial Intelligence (AI) in everyday life brings about significant societal and educational challenges. These challenges are not just technical, but also social as they involve building awareness and public acceptance of emerging technologies such as drones. Therefore, the risk of societal resistance or rejection of drone integration arises if trust is not fostered, potentially hindering adoption in sectors such as logistics and public services.

From the sentiment of Kandlhofer *et al.* (2023), it can be deduced that the lack of understanding how drones operate, as well as their benefits to an organisation, can fuel fear or opposition. This reasoning was supported by Neirotti (2021) who contends that in general, people and societies know *"What"* they do and some are aware of *"How"* things are done, but many ignore "*Why*" they do "*What"* they do; that, in the end, has an impact on the outcomes. Thus, a crucial symbiotic relationship between fostering drone literacy, raising public awareness, and increasing general knowledge emerges. To this end, technoethics highlighted that it becomes essential for a decision maker to consider how building societal trust is accommodated within their decision making, as a foundation for informed and cooperative participation with the broader society.

Moreover, for society to trust that an organisation using the application for drone operations in a responsible manner, is imperative since several publications have projected the imminent use of drone commercially. This aligns to the postulation of Bourne (2023), that that effective stakeholder management enhances decision-making and aligns with a company's ethical responsibilities towards its stakeholders. This reciprocal relationship would therefore require stakeholders to openly communicate their preferences and expectations, whether through purchasing decisions or ongoing reliance on the company. Additionally, such transparent communication serves as a catalyst for businesses to increase their commitment to improvement. Against this backdrop, from a technoethics perspective, it can be concluded that when drone technology becomes commercially embedded in everyday life within the near future, that it would be incumbent for a decision maker to have regard for the need for communities to be educated and engaged.

From here, the ethical implication revolves around the necessity of fostering societal trust through increased awareness, transparency, and stakeholder engagement during the deployment of drone technology. From a technoethical perspective, this trust should not be deemed a secondary concern by a decision maker but should be regarded as a fundamental ethical requirement for the responsible and successful integration of drones into society. Without building this trust, even the most advanced technological systems may face resistance, regulatory barriers, or sabotage that could emerge as a risk of undermining the potential benefits of drones for commercial operation use by an organisation. This ethical implication therefore emphasises the responsibility of decision-makers to engage impacted stakeholders, particularly communities, during the drone adoption process to ensure alignment with societal values and expectations. This ethical implication was validated by Ocain (2020), where the author posit that by giving communities care and consideration, they will be more supportive. Thus, decision-makers must prioritise community engagement, establish governance structures, and address concerns related to socio-economic impacts. This could potentially ensure the building of trust and fostering cooperation while ensuring that drone technology deployment is transparent, ethical, and socially responsible.

However, the strength of technoethics in this context is its focus on transparency and trust-building. In light of this, prospect theory highlights that decision-makers may overestimate the ease of gaining societal trust, assuming that education and public relations efforts alone will suffice to alleviate concerns. The lens of satisficing heuristics further compound this risk, asserting that decision-makers may adopt public engagement strategies that meet minimal transparency standards, that fail to establish meaningful dialogue with affected communities. This minimalist approach can result in a top-down strategy that does not resonate with local stakeholders. This was exacerbated by the lens of availability heuristic, where it was highlighted how decision-makers may rely on visible, high-profile examples of successful drone integration. Moreover, that this may lead to them to assuming similar success will follow without deeper community involvement. These heuristics perspectives underline the importance of a more robust, inclusive approach to trust-building, one that goes beyond superficial efforts to genuinely engage and address local concerns.

Against this backdrop, a social constructivist perspective asserts that the ethical challenge of community buy-in and societal trust in drone operations is deeply influenced by how people collectively understand and give meaning to this technology within their social and cultural contexts. Hanna (2021) describes this as a set of principles that guide how society shares the benefits and burdens of technological advancements. This viewpoint emphasised that successfully integrating drone technology depends on educating the public about its functionalities but also on engaging with communities about why these operations matter to society. This is premised on the assertions of Kandlhofer *et al.* (2023) and Ocain (2020) who highlighted the importance of fostering community trust and understanding; however, a social constructivist approach transcends this. It suggests that trust is cultivated by co-constructing knowledge with the community, addressing both concerns and aspirations in a way that validates their perspectives. This aligns with the postulation of Neirotti (2021) ,in regard to understanding the "why" behind technology use can be just as important as the "what" and "how," as it addresses the underlying reasons that matter most to society.

From this perspective, the ethical responsibility of decision-makers is to actively involve communities in the conversation about an organisation intended use of drones. By doing so, an acknowledgement of community values that foster a sense of ownership over the technology can be facilitated. This includes recognising concerns about potential issues such as environmental impact, privacy, and job displacement. Here, the lens of social constructivism asserts that this type of transparent engagement will allow a decision maker incorporating these into the design and operation of drone initiatives. Social constructivism stresses that trust is not built through one-time engagement, but through ongoing, transparent, and participatory governance. This aligns with the heuristics perspective earlier and is reinforced through the lens of meta-ethics that demands that the principle of autonomy and justice allow that communities have a meaningful say in the technologies that affect their lives. This aligns with the literature review argument of Santhanam *et al.* (2023) regarding the implementation of 4IR technologies such as drones, that requires a collective effort from multiple stakeholders, including governments, the private sector, civil society organisations and communities

To this end, normative ethics, particularly from a utilitarian perspective, furthers the meta-ethical perspective, arguing that decision-makers must seek to maximise societal benefits. Moreover, that this must be done by ensuring that drone technologies are deployed in ways that align with community values and interests. Additionally, that building societal trust requires genuine engagement and cooperation, rather than superficial outreach. Applied ethics furthers this standpoint, asserting that decision-makers must develop inclusive forums for dialogue where communities can express their concerns and have a direct impact on decision-making. This involves creating long-term governance structures that include community representatives and ensure that drone technologies are aligned with local needs and expectations.

From here, a technoethical perspective asserts that decision-makers have a responsibility to go beyond superficial outreach by creating inclusive governance structures. This means that a decision maker should have regard for the fact that the success of drone integration relies heavily on fostering societal trust, which can only be achieved through genuine and sustained community engagement. Without this foundation of trust, there is a significant risk of societal resistance that could undermine the adoption of drones across various sectors, including logistics, public safety, and healthcare. Notably, a purely technoethical approach emphasises transparency and accountability, which are vital but insufficient if applied as superficial measures. For trust to be deeply rooted, it was established through the supporting theoretical lenses that decision-makers must go beyond outreach and public relations campaigns and instead develop inclusive governance structures that allow community input and participation in decision-making.

To this end, the risk taxonomy must include decisions that premised on mitigating strategies that address societal trust in drone deployment. Moreover, a decision maker should have a risk adverse approach that does not have any misalignment with societal values, as such failure to address these values can result in persistent resistance, diminishing the potential societal benefits drones offer. Against this backdrop, achieving community buy-in and societal trust requires a commitment to transparency, shared governance, and active engagement with communities to ensure that drone technology aligns with ethical standards and public expectations.

2.2.1.1. Theoretical Insights and Implication

The theoretical implication of the findings under this dimension one, was that a paradigm shift in technoethics is required. This is as a result of the fact that technology adoption decisions involving drones are not solely operational, but embedded within a framework of continuous ethical alignment, adaptability, and socio-economic responsibility. Moreover, the findings revealed that the prospective adoption of drone technology within South Africa's cold supply chain industry is poised to present a range of ethical risks that must be carefully navigated within a technoethics-driven decision-making framework.

Theoretical Implication of Risk Taxonomy One: Balancing Efficiency with Ethical Integrity

Risk taxonomy one identifies the ethical implications of balancing drone efficiency with societal expectations, contributing to RO1, which seeks to identify and evaluate critical ethical considerations in a permissive regulatory environment. Jazairy *et al.* (2024) highlighted practical strategies for optimising drone efficiency (e.g., adjusting launch points, battery management); however, technoethics asserts that these efficiency gains must align with the technoethical principle of "fitness for purpose" as expounded by Hosier (2022). However, where technoethics proposes the principle of "fitness for purpose", social constructivism expands this taxonomy by proposing that societal expectations redefine what is deemed ethically "fit," suggesting that ethical standards must adapt based on evolving community attitudes (Jia, 2017). This directly ties into RO1, as it highlights the need for decision-makers to incorporate public perceptions into their ethical evaluations, particularly when drone technology could be seen as intrusive. This means that decision-makers must remain sensitive to evolving community perceptions of the use of drones with high manoeuvrability or load-bearing capabilities that may face public resistance is seen as intrusive. Thus, a social constructivist view suggests that technoethics incorporate ethical benchmarks for drone adoption that requires continual reassessment based on public feedback, to ensure long-term societal acceptance. The technoethical implication expands, supports, and challenges theoretical framework theme one in so far that it brings a broader ethical dimension to the evaluation of drone capabilities. The emphasis that those operational capabilities, such as payload or speed, must undergo ethical assessment alongside technical evaluation, supports Theme One's focus on the ethical implications tied to autonomy and informed consent. This therefore reinforces that decision-makers must address ethical considerations even in assessing a drone's basic functionality, thereby advocating for an ethical decision-making framework that includes the technical proficiencies of technology used in drones itself.

However, this implication also challenges Theme One by introducing a social constructivist perspective, that suggests that societal expectations should play a critical role in defining what is ethically "fit" for drone deployment, beyond the technoethical principle of "fitness for purpose." This viewpoint pushes theoretical framework Theme One to consider that ethical benchmarks cannot be static but must adapt based on evolving societal norms and public perceptions surrounding drones. Furthermore, the theoretical implication expands Theme One by emphasising the importance of continuous ethical reassessment, especially as drones gain more advanced functionalities. This supports the theme's call for informed consent and responsible autonomy, suggesting that decision-makers must engage in ongoing ethical evaluations that respond to both technical advancements and societal feedback. Thus, the challenge to the technoethical risk taxonomy framework is that it must go beyond intrinsic ethical standards and incorporate community-based assessments that is underpinned by ethical standards that are technologically informed and socially responsive.

Theoretical Implication of Risk Taxonomy Two: Balancing Innovation and Compliance

The second risk taxonomy centres on dynamic compliance as an ethical governance mandate, addressing RO2, which examines best practices associated with ethical decision-making frameworks. In the regulatory landscape[184] that would be both evolving, compliance must adapt in real time to ensure legal and ethical alignment. This need for flexibility directly supports RO2 by emphasising Compliance by Design, where ethical standards are embedded in the design phase of drone technology. Form here, technoethics was in alignment with the normative ethics perspective that compliance should be proactive rather than reactive. This was supported by Chen *et al.* (2023) that contended that compliance frameworks must adapt in real time to shifting regulatory landscapes. This "dynamic" approach ensures that compliance evolves with innovation, reducing the risk of legal ambiguities that stifle technological advancement (Fenwick, Kaal, & Vermeulen, 2017).

Against this backdrop, the theoretical implication of dynamic compliance as a technoethical mandate critically supports, expands, and challenges theoretical framework Theme Four, in so far that the mandate reshapes the understanding of compliance in the context of drone technology. This implication emphasises that ethical governance cannot remain static; instead, it requires flexibility to meet new societal and regulatory demands in a fast-evolving technological landscape, as argued by Chen *et al.* (2023).This supports theoretical framework Theme Four's commitment to continuous improvement within ethical decision-making frameworks, reinforcing the need for adaptable governance structures that can keep pace with regulatory shifts. However, the concept of dynamic compliance also expands the theme by introducing the concept of Compliance by Design as an embedded approach. This theoretical implication suggests that ethical and operational standards should be integrated within the drone technology's design rather than applied solely as external policy. Against this backdrop, this approach expands Theme Four's focus on external governance by asserting that ethical accountability should be built into the design phase of drone technology, thereby promoting a proactive stance on compliance. However, the normative ethical dimension of this implication challenges theoretical framework Theme Four by reorienting ethical accountability to be preventative rather than reactive. The implication of this is that a decision to embed compliance directly into drone technology positions compliance as a regulatory necessity and a moral duty.

The theoretical implication on a decision maker as well as on existing literature pushes the risk taxonomy within the technoethics framework to move beyond traditional governance structures and adopt a more intrinsic approach to ethical standards. This urges a shift towards proactive and embedded ethical accountability.

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Theoretical Implication of Risk Taxonomy Three: Balancing Innovation and Job Displacement

Risk taxonomy three introduces technoethical responsibility for workforce impacts, directly addressing RO3, which aims to develop an ethical framework for monitoring and evaluating the ongoing impact of drone-based decisions. Rawlins (2016) and Huff *et al.* (2016) supported this finding asserting that automation via drones could replace significant labour value, underscoring the technoethical responsibility to address workforce impacts. This expansion of technoethics emphasises the ethical obligation to address socio-economic effects, with decision-makers considering reskilling initiatives to mitigate negative impacts on workers, particularly in underserved or rural areas where digital literacy may be low (Hassan, 2024). However, given the cognitive shortcuts highlighted by the lens of heuristics, meta ethics addressed ethical myopia within decision making. The expansion of the meta ethical framework in this regard challenged the presumption that the technological advancement of drones within the cold supply chain industry will be inherently beneficial. Furthermore, the meta-ethical perspective cautioned against an overemphasis on economic efficiency without accounting for broader social costs. To this end prospect theory suggested decision-makers may overestimate immediate economic benefits while underestimating job displacement risks (ITF, 2021). In light of this, meta-ethics urged decision-makers to adopt a more reflective approach, considering the long-term socio-economic impacts of their choices, beyond short-term profit gains.

From this theoretical insight and implication, theoretical framework Theme Three was supported by the findings, emphasising that automation's impact on the workforce demands ethical accountability. Additionally, the insight expanded the theoretical theme by introducing reskilling initiatives as a proactive response, rather than just a risk response as expounded in the literature review. The expansion was brought on by suggesting that reskilling initiatives should be inclusive given the digital divide and therefore should include workers in underserved areas where digital literacy may be limited. This proactive approach highlights that ethical responsibility goes beyond harm prevention, suggesting an obligation to empower and adapt the workforce in response to technological shifts. However, the theoretical insight also challenged theoretical Theme Three through a meta-ethical perspective that warns against "ethical myopia". The metal ethical perspective in this respect warned that there may be a tendency for decision makers to overemphasise immediate economic benefits while overlooking long-term socio-economic impacts. This was also informed by the risks of cognitive biases, where decision makers may focus narrowly on profit This perspective therefore urged decision-makers to take a more reflective, balanced approach that considers the broader social and ethical implications of automation, beyond short-term economic gains. Thus, the theoretical insight enriched theoretical framework Theme Three, by supporting a balanced approach to labour impacts, expanding the theme with reskilling solutions, and challenging it to address ethical myopia for a more socially responsible adoption of drone technology.

Theoretical Implication of Risk Taxonomy Four: Community Buy-In and Societal Trust

From the technoethical evaluation of under this theme, the theoretical implication that emerged was the need for societal trust and community engagement in drone technology adoption decision making. This addressed theoretical framework Theme One directly, by emphasising autonomy, consent, and the proactive regulatory measures needed for responsible drone use. The findings of each risk taxonomy responses to theoretical framework theme one as follows:

Risk Taxonomy One: Balancing Efficiency with Ethical Integrity

This taxonomy supported Theme One since it aligns with the importance of assessing the operational and ethical suitability of drones, meeting the "fitness for purpose" standard beyond mere functionality. Moreover, it addressed the need to discern capabilities between remotely operated and autonomous drones. From here, the findings revealed gap that emphasised how organisations may lack structured ethical guidelines to address autonomy and informed consent issues with autonomous drones during decision making. where technoethics proposes the principle of “fitness for purpose”, social constructivism expands this taxonomy by proposing that societal expectations redefine what is deemed ethically “fit,” suggesting that ethical standards must adapt based on evolving community attitudes (Jia, 2017). This directly ties into RO1, as it highlights the need for decision-makers to incorporate public perceptions into their ethical evaluations, particularly when drone technology could be seen as intrusive. This means that decision-makers must remain sensitive to evolving community perceptions of the use of drones with high manoeuvrability or load-bearing capabilities that may face public resistance is seen as intrusive.

Thus, a social constructivist view suggests that technoethics incorporate ethical benchmarks for drone adoption that requires continual reassessment based on public feedback, to ensure long-term societal acceptance. To this end, the emphasis on "fitness for purpose" bridged this gap by positing that ethical standards for autonomy and consent are to be built into decision-making, thereby bridging the need for specific guidelines that account for the complexities of autonomous drones. Moreover, the ethical implication of balancing drone efficiency with societal expectations, contributed to RO1, which seeks to identify and evaluate critical ethical considerations in a permissive regulatory environment.

Risk Taxonomy Two: Balancing Innovation and Compliance

This risk taxonomy expanded Theme One in so far that it contributed Dynamic Compliance and Compliance by Design as proactive solutions to manage regulatory requirements as drones evolve. The gap between the findings and existing literature emerged as the adaptability of compliance protocols for emerging drone technologies. This, technoethics bridged this gap by asserting that decision makers dealing with compliance and internal policies and processes, should embed compliance frameworks into drone designs. This should ensure that ethical and legal standards remain adaptable. This contribution therefore addressed the challenge of static regulatory frameworks in a rapidly evolving technological landscape. Moreover, the contribution was warranted by Stefanini (2021) who contended that organisations relying on antiquated technologies, strategies, and policies tailored to previous industrial revolutions run the risk of employing outdated constructs in a market that is progressively engaging with newer 4IR technologies. Thus, organisations clinging to obsolete practices face the peril of leveraging enhanced technologies and strategies. This need for flexibility directly addressed RO2 by emphasising Compliance by Design, where ethical standards are embedded in the design phase of drone technology. Form here, technoethics was in alignment with the normative ethics perspective that compliance should be proactive rather than reactive.

Risk Taxonomy Four: Community Buy-In and Societal Trust

The findings emerging under this risk taxonomy supported Theme One through its emphasis on public awareness and informed consent, especially around autonomous drones. However, a social constructivist perspective revealed a gap in the findings and Theme One in so far, the findings showed a lack of structured community engagement to ensure informed consent and societal trust. To this end technoethics promoted transparency and public involvement, where the theoretical perspective promoted the fostering of community trust as a principle during decision making. This aligns drone deployment with societal expectations, bridging the gap in public awareness and ensuring ethical accountability.

2.2.1.2. Proposed Technoethics Risk Taxonomy Framework for Ethical Drone Adoption Decision Making

Stemming from the theoretical implications, was the following decision-making framework proposed for drone adoption decision making as follows:

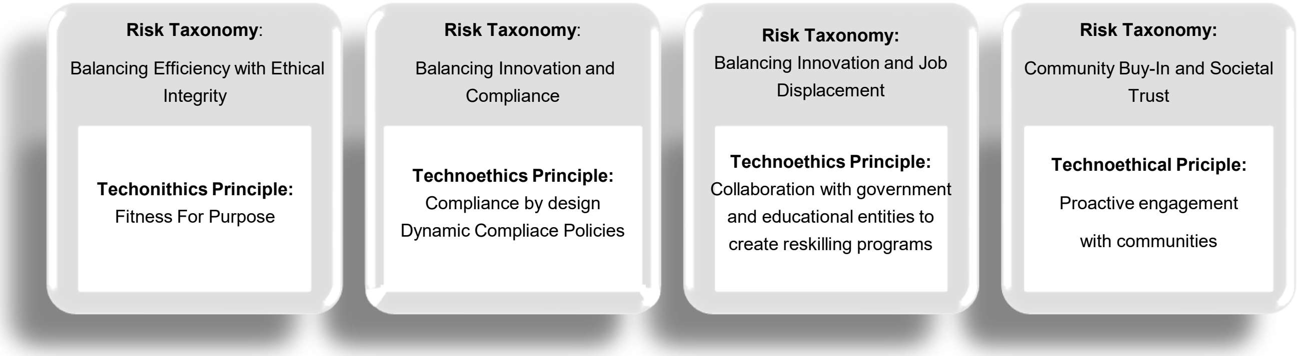

Figure 38 Technoethics Risk Taxonomy Decision Making Framework

2.2.2. Dimension Two: Operational Readiness Ethical Challenges and Considerations

For this dimension, the researcher had to interpret the findings to understand what participants viewed as operational readiness considerations ethically. This meant that the researcher had to interpret how decision-makers must achieve a delicate balance between leveraging advanced surveillance capabilities of drones with safeguarding individual and societal rights. The findings revealed a significant need for ethical foresight, especially as drones has the potential to introduce unique challenges that amplify existing privacy risks that can create new vulnerabilities for data security. From a technoethical perspective, an interpretation of the ethical readiness considerations were as follows:

i. Privacy Violations and Surveillance Risks

The findings revealed significant concerns regarding privacy violations associated with drone systems, a concern similarly noted in the literature review by Mekdad *et al.* (2023). The thematic analysis revealed that participants downplayed the capability of drones in relation to surveillance. This was evident from the perspective of participant GM02 on how society has seemingly adapted to various forms of surveillance. Participant GM02 referred to CCTV cameras as an example, suggesting that people are becoming more comfortable with being monitored. This perceived acceptance of surveillance created an ethical tension when it comes to drone use, particularly since drones can observe individuals without their explicit consent. Unlike static surveillance systems such as CCTV, the literature review investigations established that drones are mobile, often discreet, and can cover broader areas. This raises deeper concerns about privacy intrusions. In light of this, technoethics emphasised that decision-makers must consider the ethical implications of drone usage, especially where invasive surveillance is concerned. This is especially important given the caution of Savkin (2021) who contended that autonomous drones bring with them specific privacy challenges owing to their dynamic nature.

Against this backdrop, it should be noted that in the event that a decision maker chooses to downplay this ethical challenge, that such a decision maker may be confronted with the repercussions of several South African laws that safeguards society against privacy and safety breeches in general. Christodoulou (2019), articulates these act(s)/regulatory frameworks which can extend to drone use. This extension was evident in the literature review findings, where Bui and Shirakawa (2022) posited that complex algorithms are used to determine a drone's relative position. Moreover, that drones can therefore enable real-time monitoring of the Drone's detected surroundings. Furthermore, the findings of Mekdad *et al.* (2023) as expounded in the literature review highlighted that privacy and security breaches by drones were as a result of systematic monitoring of individuals' behaviours and interests in public spaces near their homes.

From a technoethics perspective, the ethical implication that emerges from here, is the balance between technological advancement and the protection of individual privacy. This was evident in the findings of Mekdad *et al.* (2023), where it was concluded that while drones may offer significant benefits in areas such as security and logistics, they may also raise serious concerns about privacy violations when used without explicit consent. This potential for intrusive surveillance, especially when drones capture footage from private spaces, highlights the critical ethical responsibility of informed consent and respect for privacy within ethical decision making. Thus, decision-makers must ensure that the deployment of drones does not infringe upon individual privacy rights. This is important given the liability implications in the legal realm of *actio injuriarum* is a delict and the breach of a duty imposed by law on a person independent of his will. The interests protected by *actio injuriarum* are the interests related to a privacy, dignity and the reputation of a person (Wijesinghe, 2018). Additionally, technological safeguards, such as geofencing or privacy filters, should be incorporated to mitigate privacy risks. In light of this, decision-makers must balance advancing drone technology with protecting privacy rights through ethical governance frameworks and technological safeguards.

To this end, prospect theory highlights the risk of a decision-makers' tendency to weigh perceived benefits over potential ethical drawbacks, particularly where operational advantages are clear and immediate. Moreover, prospect theory asserts that decision-makers may prioritise the efficiency and security advantages of drones, by downplaying privacy risks in favour of these immediate gains. This risk calculus can lead to decisions that overlook long-term social implications, with decision-makers potentially undervaluing the risks of privacy violations in the interest of short-term gains. Against this backdrop, technoethics emphasises the ethical challenge of decision-makers that must weigh the benefits of drone deployment against these privacy risks, upholding privacy rights through careful regulation and robust safeguards. This was attested to by Tiribelli *et al.* (2022), that striking a balance between leveraging the strategic benefits of drones and upholding ethical considerations are paramount. From here, the lens of social constructivism suggests that the normalisation of drone surveillance may shift societal expectations around privacy, leading individuals to become desensitised to continuous monitoring. This aligns to the postulation of Matsiyana (2023), that advanced 4IR technologies[185] such as geographic information systems, and IoT[186] sensors can facilitate the tracking and monitoring of temperature during the delivery process of fresh and frozen perishable goods.

From the assertion of Matsiyana (2023) in the context of this finding, the desensitisation risks framing surveillance as a public good, subtly shifting norms and possibly encouraging self-censorship. This means that over time, the erosion of privacy expectations can compromise individual autonomy and reshape public norms around freedom, as surveillance becomes a standard societal feature. To counter risks, social constructivism emphasises the need for transparency and trust-building in technology deployment, urging decision-makers to implement clear policies and engage public dialogue to ensure informed societal acceptance. Moving from this premise, it necessitates an exploration on how the desensitisation to surveillance might shape decision-making and ethical standards in drone deployment.

From a normative ethical perspective, specifically rights-based ethics lens, privacy emerges as a core human right linked to autonomy, requiring decision-makers to implement robust privacy protections. This theory suggests that privacy is not just a regulatory checkbox but a moral obligation to uphold individual freedom. However, the lens of satisficing heuristic cautions that in the context of this moral obligation, that a cognitive shortcut of decision-makers may be the settling for minimal standards that meet basic regulatory requirements without fully addressing privacy risks unique to drones. Thus, by relying on this heuristic, decision makers might prioritise efficiency over thorough privacy considerations, weakening the normative commitment to protect individuals from unnecessary surveillance. This may also contribute to an environment where surveillance becomes normalised. Furthermore,

185 These advanced technologies that can be embedded into the digital systems of a Drone, coupled with communication systems, will allow stakeholders to remain connected during the delivery process. Additionally, advanced 4IR technologies allow for the enabling of an optimised digital route mapping system that allows delivery and other supply chain and logistics operations to be coordinated more efficiently.

186 The Internet of Things (IoT) authorises devices and sensors to be remotely detected, connected, and controlled over the Internet, whereas traditional internet communication infrastructure connects end-users with different communication systems (Rahmani, Bayramov, & Kalejahi, 2021).

this gradual erosion of privacy protections, as Matsiyana (2023) points out, could lead to self-censorship and diminished autonomy.

Moving from this premise, applied ethics stresses the need for specific, proactive privacy protections embedded within drone systems, such as anonymisation and geofencing, which can anticipate and mitigate privacy risks. However, availability heuristic as a cognitive shortcut may cause decision-makers to rely on familiar frameworks, such as those used in CCTV surveillance, assuming that society will adapt to drone monitoring similarly. This was evident in the perspectives of several participants. Thus, this cognitive shortcut can lead decision-makers to overlook the distinctive privacy implications of drones, which are more mobile and invasive than static surveillance systems. By treating drones as an extension of existing surveillance norms, decision-makers might assume societal acceptance without considering that drones pose heightened risks.

From a metaethical perspective, privacy safeguards emerge as intrinsic moral duties as expounded in the literature review. This aligns with the argument of Eryurek *et al.* (2021) regarding the imperative of processes that must align to industry best practices such as ISO/IEC 27050:2016[187]. This ISO best practice requires organisations to comply with regulations regarding data privacy and safety. However, the lens of satisficing heuristic in this regard may lead decision-makers to treat privacy protections as optional or minimally sufficient, thereby downplaying the intrinsic value of privacy in favour of compliance. Against this backdrop, the primary technoethical challenge here is balancing the technological benefits of drones with the ethical responsibility to protect individual privacy. This means that decision-makers must weigh these operational benefits against the ethical need for privacy protections that prevent intrusive surveillance. This challenge emphasises that privacy should be seen as a moral and societal imperative, not merely a regulatory checkbox. To this end, technoethics recommends the following strategies to address privacy and surveillance risks:

Technological Safeguards	Transparent Governance	Ethical Governance Frameworks
Integrate geofencing, anonymization, and privacy filters to limit drones' surveillance reach and protect individual privacy.	Engage in public dialogue and establish clear policies to build trust and support for drone use.	Embed privacy as a foundational principle, with regular audits and compliance checks to uphold privacy standards as technology evolves.

Figure 39 Strategies to address Privacy and Surveillance Risks

ii. Data Security and Privacy in Automated Drone Systems and Insider Threats

The literature review findings highlighted how the introduction of automated drone systems into organisations will create complex technoethical challenges, particularly concerning data security and privacy. In this regard, technoethics highlighted how technological advancements affect societal values such as privacy, accountability, and transparency. In the case of drones, which collect and process vast amounts of real-time data, technoethics revealed ethical challenges that may arise from the deployment of drone systems as the security of the data that drones generate, and the risks posed by insider threats and external cybersecurity vulnerabilities.

The risk of data breaches was the first ethical challenge noted from the findings, where it emerged that the integration of drones into organisational operations raises the risk of data breaches, both from external actors (such as hackers) and internal sources (such as employees with access to sensitive data). This established a gap in the literature review findings, where this gap builds upon the gap identified by Airlangga and Liu (2023), where the authors emphasised that drone architecture robustness is very important, and that one of the most common architectures developed is based on a centralised pattern in which all drones are controlled from a

187 ISO/IEC 27050:2016 that sets out the best practices in relation to the handling of Electronically Stored Information (ESI)

central location. This Airlangga and Liu (2023) argues is a risk and posits that developers must expend more effort to adapt and improve security as attack patterns are utilised by attackers to exploit system vulnerabilities. Therefore, more effort must be directed to defence patterns to prevent or minimise the impacts of these attacks. Sihag *et al.* (2023) supports this, asserting that unreliable communication mediums and frequency-based vulnerabilities increase attack risks. Moreover, drones, which have their camera, and GPS signal associated with it, are also vulnerable to attacks. Considering that drones generate large amounts of information as established in the literature review findings, which includes personal, proprietary, or confidential business data, it therefore will necessitate robust cybersecurity measures, including encryption, secure storage, and regular audits, to ensure that the data is adequately protected.

Building on the argument of Airlangga and Liu (2023), the second ethical challenge emerged as insider threats. This threat emerged from the findings, where it was suggests that this challenge may potentially be posed by individuals within the organisation such as employees or contractors with legitimate access to sensitive drone-generated data. In this context, technoethics emphasises the importance of designing systems that secures data externally but also has an internal protection layer. This is especially relevant in a country such as South Africa, where corruption is a known issue. This was also evident in the perspectives of research participants, where concerns were expressed about insiders potentially misusing data for personal gain.

Moving from this premise, the main ethical implication that emerged from this finding was compliance with data privacy and security standards. This builds on the ethical challenge investigated in the literature review, that integrating drones into operational systems is not just a technical process, but also one fraught with ethical complexities. Against this backdrop, data governance and privacy emerge as key concerns, particularly with automation and real-time data sharing. However, the findings push this further by highlighting how a fragmented understanding of data types introduces risks, reinforcing the importance of clear ethical frameworks for data handling. Porter (2024) posit that the lack of clarity around the diverse types of data being collected can lead to mishandling or misuse, further emphasising the need for training and cross-functional collaboration to ensure that all stakeholders understand their ethical obligations and responsibilities in data governance. In light of this, it can be asserted that the rapid advancement of drone technology will present significant technoethical challenges in a prospective permissible regulatory environment, particularly as organisations must navigate complex regulatory frameworks, such as ISO/IEC standards, while adapting to both national and international laws. This assertion is consistent with the argument made by Eryurek *et al.* (2021), who stresses the imperative of compliance with ISO/IEC standards for data privacy.

Therefore, in the context of this study, it is important to note that as drones operate autonomously or semi-autonomously, the lines of accountability between human operators and machine functions will become blur, making it difficult to attribute responsibility in cases of data breaches or operational failures. This finding is supported by the argument of Porter (2024), regarding the complexity of these data ecosystems that necessitates adaptive governance structures, capable of evolving alongside technological advancements to mitigate future ethical risks. This creates a dynamic tension between maintaining internal compliance policies and staying aligned with continuously evolving regulations. In light of this, technoethics asserts that organisations will be obligated to ensure strong data security measures, including encryption, secure storage, and that restricted access controls go beyond simple legal compliance. This is important so as to safeguard the privacy of individuals and protect sensitive business information.

Another factor highlighted by technoethics, is the ethical implication of transparency in data collection, storage, and use. This ethical implication is equally essential to maintain public trust, particularly in cases where drones collect personal or sensitive data. This validates the argument of Ofem *et al.* (2022) who contend that the ethical principle of transparency within the SDLC process also requires the full disclosure of all functions related to software development. Yet, it can be deduced from several studies, that compliance with international standards, such as ISO/IEC, while critical, is insufficient on its own. Thus, organisations must ensure that their drone usage aligns with broader ethical principles, such as fairness and respect for individual autonomy.

Furthermore, the risk of insider threats such as employees misusing access to sensitive drone-generated data highlights the need for robust ethical governance. Chipangura *et al.* (2024) expands on this, emphasising that organisational privacy vulnerabilities are influenced by both internal organisational cultures and external socio-cultural factors. For example, the risks associated with corruption and the gig economy in South Africa, as noted in the preceding findings, highlight how organisational decisions are shaped by broader societal pressures and norms. This suggests that ethical decision-making must account for socially constructed risks related to local cultural and regulatory environments. To mitigate this risk, organisations should implement clear ethical guidelines, restrict data access, and promote a culture of ethical responsibility. Additionally, as expounded on in the literature review discussions, decision makers could invest in privacy-by-design frameworks as drone technology evolves, ensuring that privacy and ethical considerations are central to technological innovation rather than being added as an afterthought.

A stronger consideration is the concept of ethical hacking, which is defined by Munjal (2014) as the way to detect the weaknesses and vulnerabilities in a system or computer network. The author goes on to describe the procedure as hacking in an ethical way for any network. In this context, the ethical hacker has a good purpose to do it. However, Munjal (2014) cautions that the limitations of this approach is that where ethical hacking has become a very upcoming technological subject from the last few years, that the true intentions of the hacker is still called into question. To this end, technoethics advocates for a structured ethical decision-making when integrating drones into organisational operations, that underpins the following factors:

Data Privacy and Security: Organizations must protect drone-generated data through encryption, access controls, and secure storage to prevent unauthorized access and misuse.

Compliance with Legal Frameworks: Organizations should follow laws and standards such as ISO/IEC to ensure they meet global data protection requirements.

Transparency in Data Use: Clear policies must explain how drone data is collected, stored, and used, ensuring stakeholders understand the risks and benefits.

Insider Threat Prevention: Decison makers should limit access to sensitive data, conduct audits, and encourage ethical behavior to prevent insider threats.

Cross-Functional Ethical Collaboration: Legal, technical, and ethical teams must work together as decision makers to ensure responsible drone use and operations across the organisation.

Accountability: Desicion makers should endevour to define responsibility when drone systems fail or cause security breaches, as both human errors and technology can be to blame.

Securing Data: Decision Makers should accept the ethical duty to protect drone data beyond legal requirements, and ensure individual privacy and safeguarding business information.

Privacy and Transparency: Transparency is vital, ensuring that people know how drone data is collected and used to maintain public trust.

Adherence to International Standards: Following international privacy standards, like ISO/IEC, is crucial, but organizations must also consider fairness and respect for individual rights.

Managing Insider Threats: Ethical guidelines should be in place to prevent employees from misusing drone data. This includes limiting access and conducting audits.

Balancing Innovation and Privacy: While drones can bring great innovation, organizations must respect privacy by integrating privacy protections into their systems from the start.

Figure 40 Technoethical decision making factors for data privacy and security

From figure 40, it becomes apparent that a complex relationship between technological innovation and ethical responsibility emerges. It therefore necessitates that decision makers prioritise the security of drone-generated data, to ensure compliance with evolving regulatory standards while protecting against insider threats and external breaches. The ethical implications of drone integration therefore go beyond legal compliance, and involves a broader commitment to transparency, privacy, and accountability. However, a limitation of technoethics that must be noted, is the long-term governance challenges posed by autonomous or semi-autonomous drone systems. Technoethics appears to underestimate the complexity of managing insider threats within culturally complex organisations, particularly in regions with high levels of corruption or weak regulatory enforcement. This limitation when evaluated through the lens of prospect theory suggests that decision-makers may underestimate the likelihood of insider threats, as their focus may be primarily on external cybersecurity risks.

This creates an ethical blind spot where internal vulnerabilities are not fully accounted for, leaving organisations susceptible to data breaches from within. The lens of heuristics further complicates this issue, as decision-makers may use cognitive shortcuts that prioritise external threats, assuming that robust firewalls or encryption are sufficient to mitigate insider risks. Through the lens of satisficing heuristics, decision-makers may prioritise basic cybersecurity measures, addressing only minimal compliance requirements without implementing safeguards against insider threats. The lens of availability heuristic further complicates this, as decision-makers often focus on familiar external threats, such as cyber-attacks, while underestimating the unique, and often more complex, risks posed by internal vulnerabilities. From a social constructivist perspective, the normalisation of drone surveillance without robust oversight risks conditioning society to accept continuous monitoring, potentially eroding privacy standards and fostering a culture of self-censorship

The heuristics cognitive approaches were constrained by normative ethics, particularly from a deontological perspective that assert that organisations have a duty of care to protect personal and sensitive data. In this way, insider threats must be addressed through stringent access controls, regular audits, and the establishment of whistleblower protections to safeguard against data misuse. This is furthered by a meta-ethical standpoint, where trust and transparency in data handling emerges as critical moral obligations. A meta ethics perspective therefore requires that ethical decision-makers must ensure that clear accountability structures are in place to protect sensitive data from misuse. This includes both externally and internally to an organisation. This is reinforced through the lens of social constructivism and applied ethics. Social constructivism posits that data governance should reflect the societal context in accounting for local cultural and regulatory environments that shape privacy expectations. Applied ethics further this by placing emphasis on creating a multi-layered data security protocol, that addresses both technical and human vulnerabilities. This involves implementing encryption and secure storage, while also investing in employee training, regular security audits, and the establishment of a strong data governance framework. Thus, applied ethics expects of a decision-makers to prioritise transparency, ensuring that organisations remain accountable to stakeholders in the event of data breaches or security incidents.

Against this backdrop, technoethics asserts that data governance and insider risk mitigation. This ethical consideration is premised on the need for data protection and the need for a decision maker to address the internal vulnerabilities posed by insider threats. This necessitates that decision-makers implement a data governance framework that addresses both external and internal risks, ensuring that sensitive data is protected through technical safeguards, organisational measures, and robust accountability structures in a 4IR context. Continuous monitoring and adaptive security strategies are also to be regarded as essential to maintaining ethical data governance in evolving drone systems.

iii. Phased Drone Adoption and Risk Mitigation

A technoethics evaluation revealed that pilot testing was a key operational readiness factor. However, while there was consensus on pilot testing before full-scale drone adoption as a risk mitigation strategy in this regard, technoethics raises several ethical questions. These questions spanned across safety and risk management factors, particularly as unforeseen factors such as infrastructure challenges (e.g., power outages, battery failures etc.) and geographical disparities could create additional risks. These challenges were compounded when considering the integration of autonomous drones, that are premised on AI-driven decision-making and sensor-based automation. Moreover, the challenges were also pounded by how remotely operated drones or AI and sensor-driven drones could introduce complexities in monitoring, control, and accountability.

Against this backdrop, the technoethical evaluation recognises the need for decision-makers in the context of this study, to responsibly pilot drones and navigate its associated technologies in diverse environments while considering the broader implications of sensor-based data collection and AI-driven automation. The ethical imperative that emerges in this context, is that before moving toward full-scale deployment, that decision-makers must responsibly pilot drones in diverse real-world environments. To this end, Jacoff (2023) posit that pilot testing is essential to evaluate the physical capabilities of drones and to ensure that the integrated systems such as AI and sensors can safely and effectively carry out missions in complex and hazardous environments. The author goes on to expound that this approach demands a thorough evaluation of how these systems interact and respond in real-world scenarios, creating ethical imperatives to ensure public and environmental safety. Moreover, that these missions demand various capabilities, which can be objectively measured through standardised test methods as illustrated by the authors as follows:

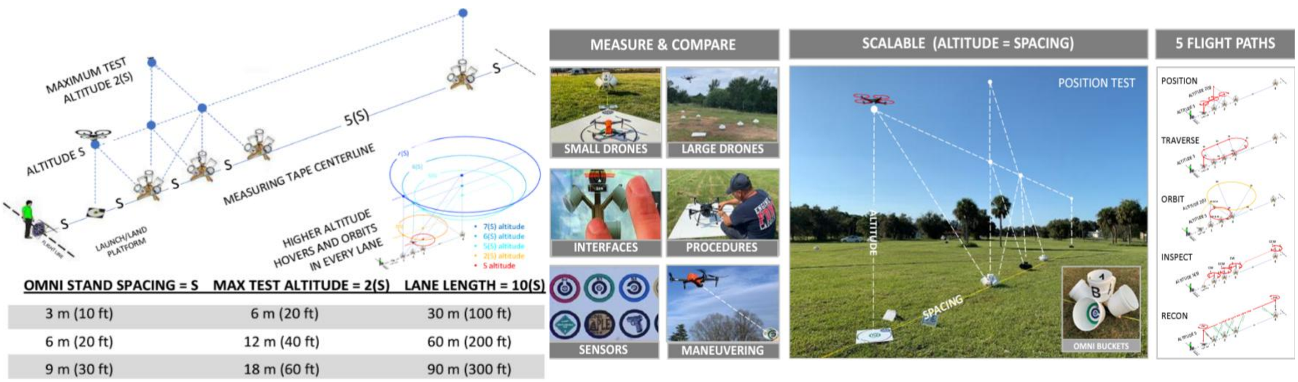

Figure 41 Illustration of Test Methods

Jacoff (2023)

A limitation of pilot testing as per the argument of Gray (2021), is that testing environments commonly referred to as “sandboxes”, are insufficient for effectively test business models and commercialising drone technologies, particularly due to their inability to operate at scale. The author goes on to posit that the highly controlled nature of sandboxes restricts innovation and learning, as one stakeholder noted, “You can’t build a business in a sandbox; you must be able to scale.” Thus, Gray (2021) argues against the postulation of Jacoff (2023), asserting that the sandbox approach alternatively pilot testing falls short of fostering scalable, market-relevant testing, thereby inhibiting the commercialisation of drone technologies.

However, Jacoff (2023) counters the argument of Gray (2021), positing that test trials (pilot testing) will result in objective measures of drone capabilities and remote pilot proficiency that can be compared and tracked over time. Moreover, that an organisation using these test methods set their own level of acceptable performance to align with their air space, environment, and mission complexities. Furthermore, that an organisation can also adopt pass/fail performance thresholds set by others within their user community as demonstrated as follows:

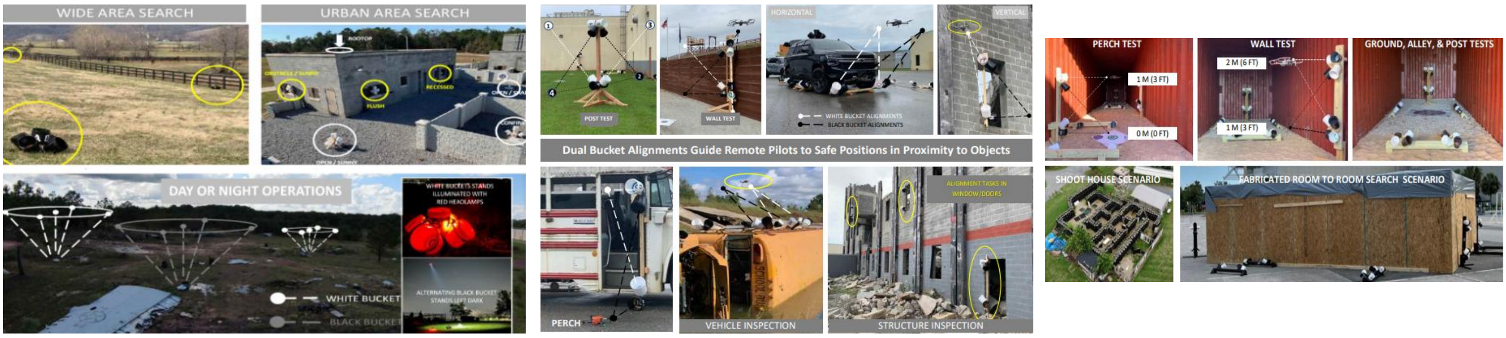

Figure 42 Pass/Fail Performance thresholds
Jacoff (2023)

To validate the proposed test measures of Jacoff (2023), several bloggers and news reports such as Drones.R.Africa (2024) have reported that the government in Spain is in pilot tests for drones in accident assessment and smart mobility. These pilot tests have incorporated the proposed test measures of Jacoff (2023) and also the test measures such as those proposed by Szőke *et al.* (2022) for the proper training of their remote pilots. In light of this, technoethics advocates for the precautionary principle[188] in decision-making in the context of pilot testing. According to technoethics, this principle imposes an ethical responsibility on decision-makers to prioritise the safety, well-being, and rights of all stakeholders while adopting new technologies like drones. From here, this ethical implication may manifest in three key areas[189]: ensuring operational readiness for safe drone application in diverse environments, mitigating risks through phased learning and data-driven experimentation, and balancing innovation with the moral obligation to safeguard communities, workers, and data privacy.

However, where technoethics emphasised a precautionary approach, it is important to note that the strength of this approach lies in its focus on minimising immediate risks through careful testing and iteration. Moreover, technoethics does not appear to fully account for the unpredictability of autonomous systems, where AI learning and emergent behaviours can evolve beyond what is foreseeable in controlled environments. This creates a gap in long-term safety management, especially when AI-driven decision-making becomes increasingly complex and potentially opaque. To understand this gap, Estlin *et al.* (2020) expound that one crucial element of AI driven or stand-alone autonomous drone capabilities is the creation of command sequences. These sequences outline a structured set of commands that aim to accomplish specific science objectives while ensuring no operational or resource constraints are breached. Often, these sequences must be adjusted or improved during execution to accommodate evolving science goals or unexpected environmental changes. If an unforeseen event occurs during execution, such as an abnormal sensor reading or an unexpectedly lengthy traversal, the drone must enter a "safe" mode until further instructions from ground control provide new commands. This process frequently leads to significant delays, resulting in lost science time and limiting the ability to seize unexpected scientific opportunities.

Against this backdrop, prospect theory posits that decision-makers may place undue confidence in the results of pilot testing, but may underestimate the low-probability, high-impact risks that may arise from these emergent behaviours. This theory warns that incremental approaches could foster a sense of security that downplays the possibility of catastrophic failures, especially as AI systems adapt and learn from real-world data. This may be as a result of overconfidence that is partly shaped by cognitive bias, which simplify complex risk landscapes and

188 The precautionary principle enables decision-makers to adopt precautionary measures when scientific evidence about an environmental or human health or hazard is uncertain and the stakes are high. Furthermore, the precautionary principle is closely linked to governance and has three aspects: risk governance (risk assessment, management and communication), science-policy interfaces and the link between precaution and innovation.

189 These are expounded on within this risk taxonomy

provide decision-makers with mental shortcuts that obscure the true depth of potential risks. This was evident in the perspective of This was evident in the findings where participant GM02 asserted that:

> *"….how many times have they been captured on a CCTV camera currently…. from the time they leave home. Before they get to work, they probably captured 1000s of times on CCTV footage. They probably don't even know that. So I'm not sure that how great the impact is going to be on the commercial use drones. …. we're gonna see, it's not either or…..,. I'm not a person that wants to invade people's privacy. But society I'm sure will all object for a couple of months to something like this. But it's like social media platforms, you in one year, you screen privacy, but you display entire life on social media. So I'm sure that we will overcome. ….it will be an initial issue for society, but I can't see it lasting really well."*

The view of participant GM02 contradicted empirical evidence offered by Mekdad *et al.* (2023) in the literature review, where it was established through the observation of the author that that privacy and security breaches by drones were resultant of systematic monitoring of individuals' behaviours and interests in public spaces and near their homes. This expanded the theoretical framework theme that focused on the integration of drone technology into the exiting technological estate of an organisation. Thus, if a decision maker has an approach of participant GM02 that fails to take into account the societal view during the decision-making process, then the lens of prospect theory suggests that decision-makers may disproportionately weigh potential losses over gains. In other words, decision makers may emphasise the risks (e.g., data breaches or system failures) over the benefits, potentially stifling innovation. Technoethics, with its inherent risk-averse stance, may exacerbate this by overly focusing on immediate risks, potentially discouraging long-term innovation and adaptation necessary for ethical advances in drone technology. This theoretical view supports the argument of Sonthalia *et al.* (2022) in the literature review, where the author noted that the failure to clearly differentiate these technologies could hinder progress and innovation. The literature review therefore inferred that decision-makers need to discern drone capabilities that extends beyond operational concerns, to encompasses ethical and societal considerations.

Against this backdrop, the lenses of satisficing and availability heuristics highlight the limitations of decision-making that could occur under this type of uncertainty. Satisficing suggests that decision-makers might settle for "good enough" solutions instead of optimal ones, while availability heuristics cites bias judgments based on readily available information. This is evident in the view of participant GM02. In this regard, the ethical considerations put forth by technoethics could inadvertently lead to satisficing behaviour, where the focus on precautionary measures encourages minimal compliance with ethical standards rather than robust adherence. Moreover, decision makers might rely on the most available risk data, leading to ethical myopia[190] where long-term consequences are not thoroughly explored. To bridge the gap between limitations within a technoethics risk-averse framework and its emphasis on the precautionary approach for the scalable adoption of drones, it necessitates an evaluation through the lenses of normative, applied, and metaethics.

To this end, normative ethics, especially from a deontological standpoint goes on to assert that decision-makers are duty-bound to protect the public, and this obligation does not end after pilot testing. Therefore, continuous risk evaluation is a moral imperative, as the unpredictability of AI systems must be actively managed to prevent unnecessary harm. When viewing this from an applied ethics perspective, the emphasis on embedding fail-safe mechanisms and real-time risk management protocols becomes crucial. It will therefore be incumbent on a decision maker to ensure that these safeguards are designed to adjust dynamically as the AI-drive systems evolves. Furthermore, an applied ethics perspective demands further that ethical decision-making must be underpinned by transparency in communicating potential risks and the mitigation strategies to the public. In this way, a decision maker can ensure that all stakeholders are informed and protected.

190 Ethical Myopia, alternatively Moral myopia refers to the inability to see ethical issues clearly. The term, coined by Minette Drumwright and Patrick Murphy, describes what happens when we do not recognise the moral implications of a problem or we have a distorted moral vision. An extreme version of moral myopia is called moral blindness.

To achieve this, the lens of social constructivism suggests that public trust and risk perceptions are co-created through social engagement and transparency. Therefore, a decision maker must have regard for the fact that public concerns about drone technology and its risks must be considered, and decision-makers should engage in open dialogue with communities to foster trust and understanding. This perspective is reinforced by a meta-ethics perspective, where the theoretical lens introduces a deeper moral reflection on the principles of non-maleficence (avoiding harm), suggesting that safety in this context must evolve with the advancements of drone technology. This perspective challenges technoethics to extend beyond initial risk management and aim for scalable ethical responsibility thereby ensuring that the use of drone technology remains safe and effective as it progresses. From this critical assessment and in the context of this study, it can be concluded that a decision-maker may face complex risks associated with advanced technologies[191]

This challenge, premised on the findings of the thematic analysis, will potentially be compounded by the unpredictability of AI, potential infrastructure limitations, and the need to protect privacy and environmental safety. The ethical considerations that should therefore underpin decision-making include the precautionary principle from technoethics, emphasising a proactive, risk-averse approach through phased adoption, involving careful pilot testing and continuous evaluation to assess operational readiness. Social constructivism highlights the importance of transparency and community engagement at each phase, fostering trust and involving public perspectives on privacy and ethical concerns. By combining responsible risk management with open dialogue, decision-makers can ensure that drone adoption is ethical, safe, and aligned with societal values.

2.2.2.1. Theoretical Insights and Implication

The insights interpreted from the findings collectively emphasised the need for a rigorous, ethically integrated approach in evaluating operational readiness for drone adoption. This approach appeared to posit that privacy, data security, phased deployment, and public trust remain central to decision-making processes. This promotes an operational readiness model that aligns with societal expectations and ethical obligations. To this end, this theoretical insight impact the theoretical framework themes as follows:

i. Operational Consideration Factor One: Balancing Technological Surveillance Capabilities with Privacy Rights

From the findings, the theoretical insight that the mobility and discretion of drones amplify traditional surveillance capabilities, creating ethical dilemmas in privacy protection. Unlike static CCTV systems, drones offer real-time, mobile surveillance that can extend into private spaces, raising ethical concerns around consent and individual autonomy. The findings of Mekdad *et al.* (2023) validated this, emphasising that this mobility presents unique privacy challenges that requires ethical foresight to prevent overreach. To this end, technoethics provided a framework where decision-makers were urged to prioritise privacy and minimise invasive surveillance. Moreover, technoethics advocated for ethical governance structures that align drone capabilities with respect for individual rights.

The ethical implication on decision making emerges from here as an ethical obligation to safeguard privacy. To this end, the findings supported theoretical framework Theme Two by reinforcing the need for transparency in data management and also emphasised privacy protections. Against this backdrop, the findings revealed inadequate privacy safeguards, particularly around data collection and management within complex technological environments as a gap in the findings of the existing literature. Thus, the focus on Privacy-by-Design in the finding addresses this gap by embedding privacy protocols into drone operations, ensuring that privacy remains a central consideration within data management processes. Moreover, it addresses RO1 by identifying critical ethical

191 These risks include AI-driven automation, sensors, and data collection systems, while ensuring public trust and safety

considerations in a permissive regulatory environment, RO2 by informing best practices on privacy protections, and RO3 by laying the groundwork for ongoing privacy compliance within the decision-making framework.

ii. Operational Consideration Factor Two: Navigating Data Security and Insider Threats in Drone Operations

From the findings, technoethics highlighted the critical importance of robust data governance and security, addressing both external cyber threats and insider risks. As Airlangga and Liu (2023) expounded, drones collect extensive amounts of data, creating ethical challenges related to safeguarding this data from misuse. This was amplified by the findings that expanded Theme Two: This challenge emphasised the need for robust, layered data protection, addressing insider threats and ensuring ethical data governance. Moving from this premise, the theoretical discussions identified gaps in a decision makers capacity to secure sensitive drone-generated data effectively. Therefore, recommending stringent access controls in addition to encryption and secure storage expands data security practices and addresses vulnerabilities that could otherwise compromise ethical data management. This theoretical implication therefore addressed research objectives RO1 by identifying critical data security and privacy concerns, RO2 by contributing best practices for data governance, and RO3 by aiding in the development of monitoring tools that assess data security and compliance.

iii. Operational Consideration Factor Three: Phased Drone Adoption and Risk Mitigation

The Precautionary Principle as an ethical consideration was highlighted by technoethics as an imperative during decision making. This was in addition to identifying phased drone adoption through pilot testing as a central tenant to drone operational readiness as explicated by Jacoff (2023) explicated that pilot testing and incremental implementation are critical to assess operational readiness in real-world environments. This approach challenged the assumption that operational readiness can be achieved without phased implementation. Moreover, it challenged theoretical framework Theme two, as it emphasised continuous assessment and gradual deployment to address ethical risks. To this end, technoethics highlighted overconfidence in initial deployment results as a gap since this can pose a risk of ethical oversights during rapid integration. Technoethics therefore advocates for phased deployment and continuous assessment, ensuring that ethical concerns are carefully managed at each stage of integration, thereby reducing the risk of oversights. This insight strengthened theoretical Theme One as an operational readiness factor, and an ethical consideration by emphasising preventive measures during the drone integration decision making process. This theoretical implication therefore addressed RO1 by identifying risk mitigation strategies, RO2 by establishing best practices for safe and ethical drone implementation, and RO3 by supporting the development of monitoring tools that track ongoing risk assessments and safety standards.

In addition to the three findings under this dimension, social constructivism asserted that as drones become normalised in public spaces, societal expectations around privacy may shift, leading to an acceptance of constant monitoring. However, prospect theory challenged that normalization contending that it risks eroding public values around privacy and autonomy, making transparency and public engagement vital in maintaining ethical standards (Matsiyana, 2023). Against this backdrop, the theoretical implication on a decision maker is the ethical duty to foster transparency through public engagement and to educate stakeholders on the purpose, limits, and protections around drone surveillance. This approach supported theoretical framework Theme Three by way of its focus on public engagement and transparency to uphold ethical practices in drone surveillance. This addressed RO1 by identifying transparency as a key ethical consideration, RO2 by promoting best practices in public engagement, and RO3 by contributing to the development of tools that assess ongoing societal impacts and public alignment with drone technology use.

2.2.2.2. Operational Readiness Drone Driven Decision Making Model

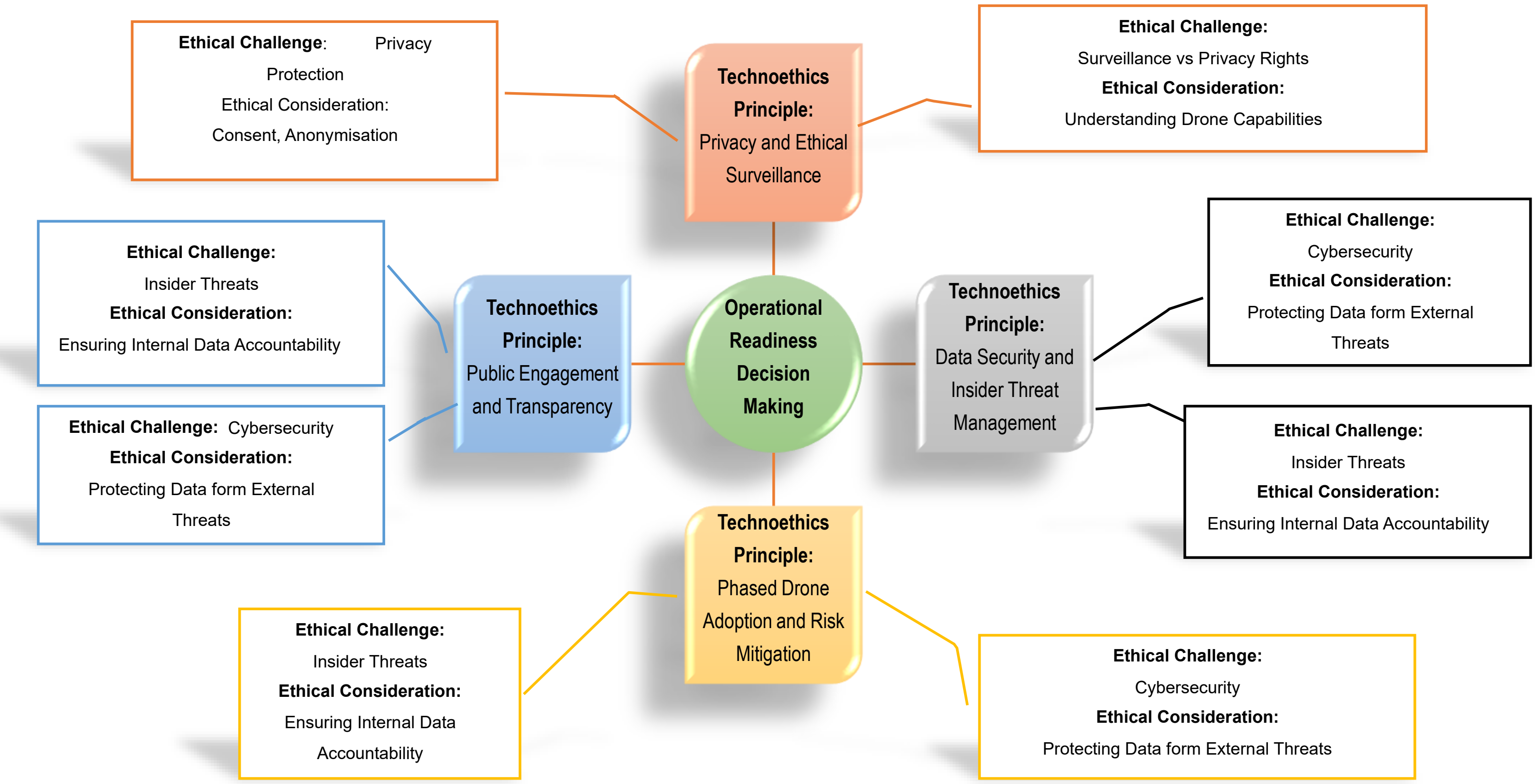

Figure 43 Operational Readiness Drone Driven Decision Making Framework

2.2.3. Dimension Three: Long -Term Sustainability Strategies

In this dimension, the principal decision maker interpreted the findings to establish what long-term ethical considerations were to be taken into account. This was imperative as a decision maker would have to consider how to balance the operational use of drone commercially with ethical expectations that accompany drone use as expounded in the preceding discussions.

i. Ethical Challenge of Competitive Pressure versus Ethical Business Practices

Several participants who also fulfils the role as a business leaders demonstrated a strong view of drones as functional tools rather than transformative technologies. This narrow view appeared to limit the recognition of the ability of drones and its ability to drive long-term innovation through data integration, advanced analytics, and enhanced supply chain visibility. The ethical dilemma here is rooted in short-term thinking, where companies focus on immediate operational benefits without fully embracing the broader, strategic implications of drones.

For decision-makers, this presents a significant ethical consideration: how should businesses balance short-term gains with the long-term potential for sustainable innovation? Haessler (2020) responds to this, asserting that in order to meet the changing societal demands, organisations have to adapt their long-term strategies and incorporate environmental and social aspects into their product offerings and decision-making. However, at the same time organisations must satisfy short-term profitability interests and demands from shareholders. Gurnani (2020) adds that today’s leaders are faced with an incredible opportunity to carve out a new future for their businesses by importing the principles of sustainability into their strategy. The author goes onto to expound that it is amazing to see how far technology and multinational corporations have already transformed business.

All we need now is to translate the traditional vision of "business profitability" to one of "broader social impact". Moreover, that amid this growing focus on people, planet, and profits, the onus lies with the business leader to figure out the right balance between short-term and long-term priorities to create enhanced value for stakeholders.

To this end, should a decision maker within the cold supply chain industry fail to fully leverage drone technology, then this failure will be representative of a missed opportunity for competitive advantage as expounded in the literature review discussions. Considering the literature review findings, a question that emerges regarding a company's ethical responsibility to lead in innovation. By underestimating the potential of drones, decision-makers risk neglecting their duty to contribute to sustainable industry growth and to use technology for the greater good, such as environmental sustainability or improved social services. Furthermore, leaning on the literature review discussions, this short-sighted approach can stifle the broader societal benefits that drones could facilitate, reinforcing the ethical imperative for leaders to adopt a more forward-looking perspective. Against this backdrop, another critical ethical challenge that emerged from the findings was the potential for monopolistic practices.

Participant GM02's acknowledgment of early adopters of drone technology that can secure a competitive edge, emphasises the risk that businesses adopting drones may unintentionally create barriers for smaller players, especially in regions like South Africa where drone markets are still emerging. The technoethical concern here is the power imbalance that could develop if larger corporations dominate the drone space. Premised on this assertion and the literature review findings in this regard, this would effectively stifle innovation and limit opportunities for small and medium-sized enterprises (SMEs). Moreover, the risk of monopolies being created, and competitive pressure being introduced. This can be translated into ethical complexities. This is validated by Tiribelli *et al.* (2022), who asserts that striking a balance between leveraging the strategic benefits of drones and upholding ethical considerations are paramount. Schroeder *et al.* (2019) goes on to expound that among personal values and ethical principles, that decision-makers must prioritise fair competition, regulatory adherence, and equitable treatment of stakeholders, including competitors and SMEs.

The commitment to responsible innovation and ethical business practices becomes integral in mitigating the risks associated with anti-competitive behaviour while capitalising on the strategic benefits of drone technology. Against this backdrop, technoethics emphasised that the fierce competition that drone technology may foster can push businesses to prioritise short-term market gains over long-term ethical considerations. This expands the earlier finding of risk dimension one, where prospect theory highlighted that decision-makers may prioritise perceived gains such as efficiency and speed, while underestimating risks, including environmental harm or legal repercussions.

Another ethical challenge that may emerge from here is unethical practices such as price manipulation, exclusionary tactics, or even compromising on safety and transparency to outmanoeuvre competitors. In such a landscape, technoethics asserts that decision-makers may face the challenge of balancing the need to remain competitive with the imperative to uphold ethical business practices. Moving from this premise, it becomes important to note that the ethical implications in this regard are twofold. First, decision makers that cut ethical corners in pursuit of market advantage may undermine trust and face reputational damage, which in the long run could erode customer loyalty and provoke legal challenges. On the other hand, maintaining ethical integrity in a competitive market can foster long-term success by building a reputation for fairness and transparency. When considering this through the lens of satisficing heuristics, then it emerges that decision-makers may prioritise basic cybersecurity measures, that addresses only minimal compliance requirements without implementing safeguards against insider threats. The availability heuristic further complicates this, as decision-makers may only focus on familiar external threats such as cyber-attacks, while underestimating the unique, and often more complex, risks posed by internal vulnerabilities. To understand this, the lens of social constructivist asserted that the normalisation of drone surveillance without robust oversight risks may condition society to accept continuous monitoring, potentially eroding privacy standards and fostering a culture of self-censorship.

Thus, for decision-makers, the challenge in this regard is located in ensuring that competitive strategies are aligned with ethical standards. This might require the introduction of internal ethical guidelines or a push for industry-wide codes of conduct to ensure that the adoption of drone technology remains fair and responsible. From a technoethics perspective, it therefore necessitates that the ethical challenges presented by drone technology be carefully balanced with innovation, competition, and ethical responsibility. In light of this, it is important to note that a limited understanding of drones' strategic potential, may risk short-term thinking that neglects long-term ethical obligations to innovate sustainably. Furthermore, the potential for monopolistic practices calls for an active role in promoting fair competition, and the strategic attendance of handling the pressure of a competitive market that demands that companies maintain ethical integrity even as they seek to gain an edge. On this basis, decision-makers must recognise that their decision-making approaches to drone technology will shape their organisations success, but that such a drive will have either a positive or negative impacts on broader societal implications.

Moreover, addressing these ethical challenges proactively can help to ensure that drone technology is used to drive industry transformation and also to promote fairness, transparency, and social good during strategic decision making. However, the researcher reflected on this and observed that technoethics did not fully address the pressures faced by businesses to prioritise short-term gains over long-term ethical commitments, particularly in a prospective highly competitive drone market. This was evident when considering the technoethics perspective through the lens of social constructivism. Through this lens, social norms around fairness and competition were emphasised as crucial to how technologies are adopted. Moreover, social constructivism called into question how decision-makers should align their strategies with societal expectations of fairness and transparency.

To this end, from the heuristic's evaluation, it was asserted that decision-makers may adopt a shortcut that equates business success with short-term profitability, leading to unethical behaviours that undermine trust and transparency. From here, a meta-ethical perspective called for a decision maker to consider the ethical principle of justice and fairness, that demands that monopolistic practices be avoided, and that competition remains ethical and equitable. This means that decision-makers must ensure that their competitive strategies do not harm smaller players or create unfair market advantages. Normative ethics, particularly from a deontological perspective goes on to argue that decision-makers have a moral duty to ensure that their pursuit of market dominance does not compromise ethical principles or harm broader societal interests. This is furthered by applied ethics, where the focus on establishing ethical guidelines for competitive behaviour is emphasised, calling on a decision maker to ensure that businesses operate within a framework that promotes fair competition and responsible innovation. This, the ethical responsibility imposed on a decision-maker, is that they must prioritise long-term ethical sustainability over short-term market gains, ensuring that competitive strategies align with broader societal values.

Against this backdrop, the ethical consideration that must be incorporated with the technoethics perspective, is that a decision maker should have regard for ethical competitive sustainability. While technoethics emphasised the need for fair competition, the supporting theoretical lenses necessitates that a decision maker also address the pressures that businesses face in prioritising short-term gains. Therefore, a decision-maker will have the ethical responsibility to balance competitive pressures with ethical business practices. Having regard for such an ethical business practice as a principle, will ensure that market strategies do not undermine fairness, transparency, or long-term sustainability. This will necessitate that a decision maker creates ethical guidelines that prioritise responsible innovation and equitable competition in the prospective evolving drone market.

ii. ***Misinformation and Disinformation Reliance in Decision Making***

From the findings, an ethical challenge of inadequate knowledge management structures and reliance emerged, which was also identified in the literature review as the over reliance on drone advocates. Moreover, it emerged that without cross-functional teams that possess diverse expertise, that decision-makers may lack an understanding of drone capabilities and limitations. Furthermore, that this can lead to misaligned technology choices that can disrupt operations.

From a technoethical standpoint, an ethical obligation emerges for a decision maker to maintain robust accessible knowledge systems that support informed decision-making. This technoethical perspective suggested that a decision maker should prioritise internal knowledge sharing, ongoing training and collaboration, to ensure that drone technology aligns with strategic goals and mitigates risks. However, technoethics also highlights that this mitigation may lead to the risk of misinformation and disinformation[192] that will compound this challenge. Zurich (2024) cites the Global Risks Report 2024, where the findings reveal that misinformation and disinformation have the potential to wear down social cohesion and make people mistrust information and politics. The author goes on to place emphasis on misinformation as risk that positions advanced technologies a risk. To give effect to the risk, the author expounds on an example where chatbots use generative AI which has been proven to hallucinates between 3 and 27% of the time when summarising information. The author links this to the statistical reporting of over 100 million weekly users on ChatGPT alone, who get their facts wrong.

To this end, technoethics asserts that if a decision maker relies on incomplete or biased data, they risk making ethically flawed decisions that could harm stakeholders or lead to operational failures. Moreover, technoethics emphasises that relying on external knowledge sources without proper vetting introduces ethical risks, such as decisions based on misinformation that can compromise safety, privacy, and financial wellbeing. Therefore, an ethical responsibility that will be incumbent on a decision maker, is to validate all information that is relied on thoroughly, to ensure it meets ethical standards.

Another critical ethical challenge that emerged was critical risks posed to the knowledge structure of an organisation. This builds on the preceding risk of misinformation and disinformation, where the over-reliance on external knowledge providers can further exacerbate risks. For example, since AI is a rapid and fast evolving field, it therefore stands to reason that AI skills may not be present in organisations to validate the information, knowledge or literature purported by external stakeholders. In light if this, technoethics argues that it is important to note that such a reliance creates vulnerabilities, as external providers may have commercial biases that do not align with the organisation's values. To maintain decision-making autonomy, it will necessitate that an organisation’s decision makers invest in developing internal expertise to reduce their dependence on third-party knowledge sources. Against this backdrop, the ethical implication emerges as the responsibility of decision-makers to ensure that their choices are based on accurate, unbiased, and well-validated information.

At the core of this ethical implication, is that decision-makers are obligated to establish and maintain robust internal knowledge systems and validation processes to safeguard against the misuse of inaccurate data. Failure to do so can result in ethical breaches, such as privacy violations, financial losses, or harm to employees and the broader society. Thus, where decisions are made on unreliable data, such decisions may fail to protect stakeholders' interests. Additionally, over-reliance on external providers with potential commercial biases can compromise an organisation’s ethical autonomy. This affirms the literature reviews contention about the reliance on drone advocates.

192 Zurich (2024) cites a definition by the Oxford Dictionary, to define misinformation as "the act of giving wrong information about something", whereas disinformation is "a form of propaganda involving the spreading of false information with the deliberate intent to deceive or mislead".

Thus, technoethics highlights that it is imperative that decision-makers invest in developing internal expertise and rigorous information validation mechanisms, to uphold ethical governance and prevent decision-making from being compromised by external misinformation. However, a key limitation of technoethics is that it does not fully address the systemic risks posed by external disinformation, especially when knowledge comes from third-party providers or AI-driven information systems. This means that a decision maker who has a reliance on information structures that comprise misinformation and disinformation, may underestimate the complexity of validating rapidly evolving technological claims, particularly when external knowledge providers may have commercial biases.

To this end, the lens of social constructivism asserts that social trust in technology is shaped by the accuracy of information. Therefore, it is expected of decision-makers to ensure transparent and accurate knowledge sharing to avoid misinformation. Prospect theory furthers this, suggesting that decision-makers may underestimate the risks of disinformation, assuming that their internal knowledge systems are sufficient to mitigate these risks. From here, prospect theory highlights ethical vulnerabilities that may emerge where flawed decision-making processes could be based on incomplete or biased information. Heuristics compound this issue highlighting that where a cognitive shortcut is used by a decision-maker in this regard, that such a decision maker may rely too heavily on external experts. When clarified through the lens of satisficing heuristics, then it should be understood that decision-makers may settle for minimal information verification processes, assuming that the basic checks meet the necessary standards. This "good enough" approach can lead to reliance on superficial information-sharing practices that risk spreading disinformation if underlying claims are not rigorously validated. From an availability heuristics lens, it emerged that decision-makers might over-rely on familiar sources or prominent external experts without fully vetting their information, assuming these sources to be reliable based on past experience or reputation. Together, these heuristics highlighted that these cognitive shortcuts could create blind spots, where critical verification is overlooked, potentially amplifying the risk of misinformation if the expert knowledge is flawed or incomplete.

To understand the ethical implications and the considerations with respect to this finding, the typology of meta-ethics, normative ethics and applied ethics was engaged. From a meta-ethical perspective, truth and honesty are fundamental to ethical decision-making. This theoretical lens asserts that decision-makers must ensure that their knowledge sources are transparent, accurate, and subject to continuous scrutiny to prevent ethical lapses caused by misinformation. This view is broadened through the lens of normative ethics, particularly from a rights-based perspective, where it holds that decision-makers have an obligation to ensure that stakeholders are not misled by inaccurate or biased information. This is reinforced by the lens of applied ethics, where focus is placed on establishing rigorous fact-checking protocols and internal knowledge validation processes. In light of this, applied ethics asserts that decision-makers must prioritise transparency in knowledge management, and to ensure that the information used for decision-making is thoroughly vetted to prevent disinformation from compromising organisational integrity.

Against this backdrop, the technoethics recommendation that decision-makers invest in developing internal expertise and rigorous information validation mechanisms, necessitates that a decision-maker establish robust knowledge validation frameworks that prioritise transparency, accuracy, and accountability. This will ensure that both internal and external information sources are rigorously vetted, preventing flawed decision-making processes that could harm stakeholders or compromise organisational integrity.

2.2.3.1. Theoretical Implications

In the context of long-term sustainability, the findings reveal that decision-makers may face critical ethical challenges in pursuit of balancing operational gains with ethical responsibilities. This strategic pursuit categorises long-term ethical considerations that guide sustainable drone integration; examining competitive pressures;

ethical business practices; and reliance on accurate information. Each risk area reflects new findings that inform a technoethics-based decision-making framework aligned with ethical, operational, and societal expectations. From here, the findings under dimension three were theoretically translated into strategic ethical challenges that has to be incorporated into strategic planning as follows:

i. **Strategic Ethical Challenge 1: Competitive Pressure versus Ethical Business Practices**

According to findings, several business leaders (participants) demonstrated a limited view of drones as primarily functional tools. This supports theoretical theme one in so far that this limited view could impede long-term innovation and hinder their potential to drive significant industry advancements in areas like data integration, advanced analytics, and supply chain transparency. Furthermore, participant GM02 highlighted that early adopters of drone technology may gain a competitive edge; however, technoethics asserts that this could create barriers for smaller players, particularly in emerging markets such as South Africa. This insight aligned with the technoethical principles of fair competition and sustainability, emphasising the ethical obligation for decision-makers to avoid monopolistic practices. Thus, If early adopters dominate the market, social constructivism suggests that this could normalise competitive strategies that prioritise profits over equitable market access. From here, the theoretical implication for a decision maker is the ethical responsibility of balancing competitive strategies with fairness and sustainability. This should involve decisions that establishing internal ethical guidelines that discourage monopolistic practices and support market access for SMEs. Moreover, encouraging industry-wide standards or codes of conduct that prevent large corporations from stifling competition, fostering a balanced market that allows smaller enterprises to benefit from drone technology.

Against this backdrop, the theoretical implications of this finding addressed RO1 by identifying fair competition as a key ethical consideration, crucial in navigating competitive pressures within a permissive regulatory framework. Moreover, it contributes to RO2 by recommending ethical guidelines and industry-wide standards that establish best practices, ensuring a responsible approach to market competition. Furthermore, it reinforces RO3 by supporting a monitoring framework that promotes fair competition and long-term sustainability over immediate market gains. In light of this, theoretical framework Theme Three was supported through the technoethics perspective on fair business practices. This reinforced this theme, advocating for ethical business practices that prevent monopolistic behaviours and support market equity. Furthermore, theoretical framework Theme One was expanded by the contribution of the technoethics perspective on autonomy and Privacy. The expansion of this theme by technoethics asserts that a decision maker should have regard for corporate autonomy, where fair competition and ethical standards are prioritised in corporate decision-making processes.

ii. **Strategic Ethical Challenge 2: Misinformation and Disinformation Reliance in Decision-Making**

The theoretical insight from this finding revealed that reliance on external drone advocates[193] and a lack of cross-functional expertise could lead to poor knowledge management structures within an organisation. The risk that emerged is that it can adversely impact decision-making. Thus, technoethics asserted that without diverse expertise within teams, decision-makers risk making decisions based on incomplete or biased advisement and data, potentially compromising alignment with organisational goals (as highlighted by findings on reliance on external advocates). From here, the technoethical perspective suggests an obligation for decision-makers to maintain robust knowledge-sharing systems, fostering collaboration and reducing dependence on external sources that may hold commercial biases.

Against this backdrop, the implication for decision-makers within the cold supply chain is to establish rigorous internal knowledge validation frameworks to ensure transparency, accuracy, and informed decision-making. To this end, the findings expanded theoretical framework Theme Four since this strategic

193 As expounded in the literature review

challenge stresses the importance of knowledge validation and internal expertise to ensure reliable decision-making, expanding on Theme Four's focus on robust knowledge structures. Thus, technoethics promoted the development of internal knowledge frameworks and rigorous information validation processes, to reduce dependency on external information, ensuring data integrity and ethical decision-making. This addressed RO2 by promoting best practices in knowledge validation and reducing reliance on external sources, emphasizing the importance of well-informed, ethically sound decision-making. In addition to this, RO3 was addressed by technoethics assertion that embedding knowledge accuracy into a scalable monitoring framework, will ensure that reliable data guides decisions over time.

Strategic Ethical Challenge 3: Long-Term Innovation and Environmental Sustainability

The findings highlight that a decision-maker that directs focus on short-term benefits, limits the exploration of transformative potential of drones for long-term sustainability. This was premised on the fact that participants viewed drones mainly as functional tools, rather than platforms for driving innovation in environmental and social impact areas. Against this backdrop, technoethics argued that responsible technology adoption should prioritise long-term benefits over immediate operational gains. This aligned with the findings on the broader commitment to sustainable development and was reinforced by applied ethics that urged decision-makers to balance operational efficiency with environmental stewardship, reinforcing the duty to innovate responsibly.

The implication that emerges for a decision maker, is that a decision-maker must balance immediate gains with long-term sustainability goals, which includes: 1) investing in sustainable R&D initiatives that maximise the potential of drones for environmental and social impact; and, 2) Setting measurable sustainability targets that ensure drones are used not only for operational efficiency but also for advancing ethical goals like emissions reduction and resource efficiency. This was affirmed in the findings by Haessler (2020) and Gurnani (2020) , who contend that leaders must balance shareholder interests with environmental and social responsibilities, integrating sustainability into strategic decision-making. This perspective challenges decision-makers to consider how drones could advance broader societal goals, such as reducing carbon footprints, improving transparency, and supporting sustainable supply chain practices. In light if this, technoethics highlights that the failure of a decision maker to fully harness drones' sustainable potential could represent a missed opportunity to contribute to broader industry and societal transformation. This perspective reinforces the need for decision-makers to adopt forward-looking strategies that integrate sustainability into the core business model.

The theoretical implication under this finding expanded theoretical framework Theme Three, by highlighting that sustainability and social responsibility are integral to ethical business practices, ensuring long-term ethical alignment with corporate goals. This addressed RO1 by emphasising that sustainability is a key ethical consideration, highlighting the need for responsible drone adoption that promotes long-term environmental and social welfare. Furthermore, the findings also supported theoretical framework Theme Four by reinforcing the concept continuous improvement as a sustainable innovation strategy, thereby advocating for ongoing improvement in operational areas and also in sustainability as an ethical consideration. This addresses RO2 by establishing continuous improvement as a best practice that integrate sustainability into operational and strategic goals, ensuring drones are adopted with ethical and social considerations in mind. Moreover, the theoretical perspective also reinforces RO3 by incorporating sustainability into a scalable framework that evaluates drones' ethical impact over time.

2.2.3.2. Strategic Decision-Making Framework

From the findings, technoethics emphasised that integrating drone technology into strategic operations is not purely a technical endeavour but inherently involves ethical considerations, including fair competition, data integrity, and sustainability. Thus, technoethics emerged as a critical perspective, highlighting the need for a strategic decision-making framework that embeds ethical principles into strategic planning. The framework offered by technoethics anticipates ethical challenges and aligns with contemporary ethical and operational requirements, providing decision-makers with a proactive approach to responsible innovation. Moreover, the framework identifies three primary strategic ethical challenges that decision-makers face when considering drone-related strategies in a landscape characterised by competition, information complexity, and sustainability demands. Therefore, emphasising fairness, transparency, and sustainability within the framework empowers a decision-makers to achieve competitive and operational advantages while meeting societal expectations and regulatory standards.

The framework illustrated in Figure 45, demonstrates a strategic decision-making model that encompasses ethical decision-making in drone technology adoption that extends beyond mere regulatory compliance. The model positions itself as fundamental to achieving long-term viability and resilience. Therefore, institutionalising ethical practices within this framework creates a robust foundation for responsible innovation, thereby contributing to sustainable industry growth. Moreover, for decision-makers operating in the cold supply chain industry, that would have to navigate a rapidly evolving technological landscape, technoethics offers this framework as a strategic pathway that aligns both with immediate operational requirements and long-term ethical responsibilities. Additionally, the framework's adaptable, scalable design allows it to incorporate insights from ongoing developments such as pilot testing, ensuring a sustainable and socially responsible approach to adoption and integrating drone technology.

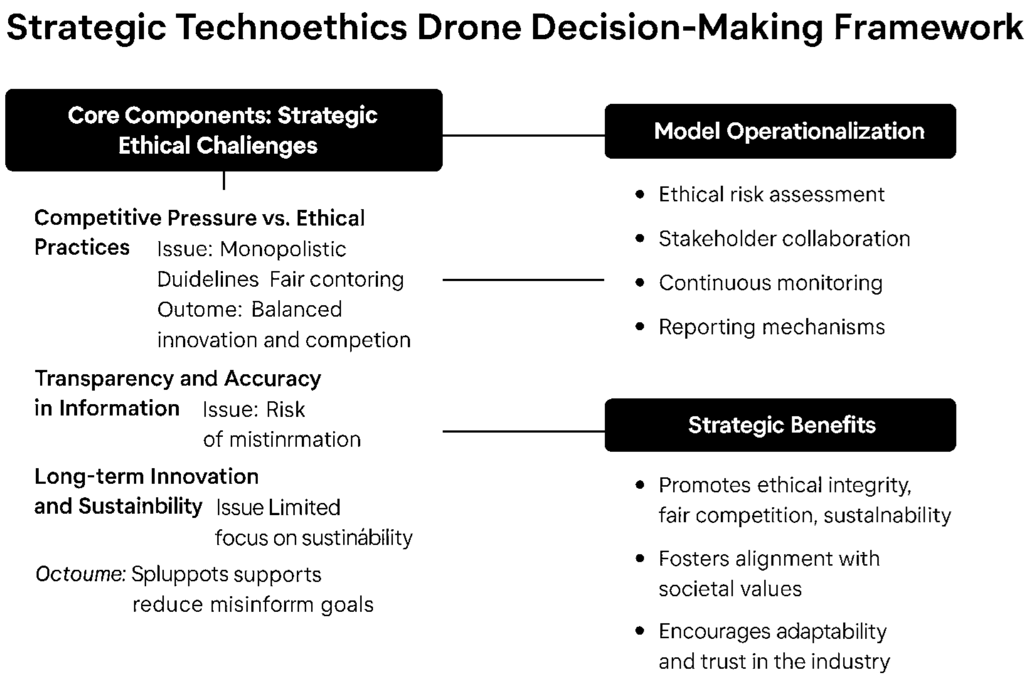

Figure 44 Strategic Technoethics Drone Based Decision Making Framework

At the core of the framework is three strategic ethical challenges: competitive pressure versus ethical business practices; transparency and accuracy in information; and long-term innovation with a focus on sustainability. Each of these challenges is closely tied to the theoretical perspectives in ethics and social responsibility, and they represent areas where strategic decisions can either align with or diverge from ethical principles. The first strategic ethical challenge highlighted by technoethics addresses the tension between leveraging drones for competitive advantage and maintaining ethical business practices. This challenge was highlighted by technoethics with the intention to guide early adopters of drone technology as the anticipated drone adoption within the cold gain considerable market power, there is a risk of monopolistic behaviour that could exclude smaller players, particularly in emerging markets. The issue that was highlighted speaks directly to the ethical principles of justice and fairness, as posited by social constructivist theory, which suggests that powerful organizations can set market norms that prioritise profit over equitable access[194]. The framework responds by advocating for internal ethical standards to discourage monopolistic practices, along with industry-wide standards to support fair competition. This dual approach not only promotes innovation but also ensures that competitive strategies do not disadvantage smaller enterprises. Thus, embedding fair competition practices within the framework supports long-term industry sustainability, helping to create a market where ethical competitiveness and social responsibility coexist.

The second challenge strategic ethical challenge articulated by technoethics within the framework concerns the accuracy and transparency of information. Given the complex data environments that drones operate within, decision-makers are often at risk of relying on biased or incomplete information, especially when sourcing data from external parties who may have commercial motivations. This dependency can lead to misinformation, resulting in decisions that misalign with both organisational goals and broader societal values. Grounded in technoethics, the framework emphasises the ethical responsibility of seeking reliable, accurate information. It does so by recommending knowledge validation systems and cross-functional collaboration to verify information sources, thereby fostering a culture of transparency. This focus on data integrity is intended to minimise misinformation risks, ensuring that decisions are informed by robust, unbiased data. This technoethics emphasises as imperative for building stakeholder trust. Thus, through transparency monitoring, a decision maker can demonstrate their commitment to ethical information management, which from the findings emerged as a critical factor in sustaining credibility in data-driven sectors.

The third strategic ethical challenge articulated by technoethics is the tension between immediate operational gains and long-term sustainability. The findings revealed that while drones offer significant efficiency benefits, focusing exclusively on short-term results may limit the potential to address environmental and social impacts. The framework therefore encourages a decision maker to look beyond immediate returns by investing in sustainable research and development and setting measurable sustainability targets. This approach aligns with applied ethics which holds that a decision maker has a duty to consider the broader ecological footprint of their actions by having regard for environmental ethics and sustainability ethics. Here, technoethics asserts that prioritising sustainable innovation within the framework enables a decision maker to integrate environmental stewardship into their strategic goals, thus aligning with global sustainability initiatives and best practices. In doing so, a decision maker can better respond to the increasing demand for corporate social responsibility and position themselves as leaders in sustainable technological advancement.

To operationalise the model, a decision maker can use the foundational ethical guidelines as actionable and ingrained decision-making steps within organisational practices. To this end, the framework includes four key processes to embed these principles into daily operations as: 1) Ethical Risk Assessment, 2) Stakeholder Collaboration, 3) Continuous Monitoring and Transparent Reporting.

194 This means SME's and the gig economy workers

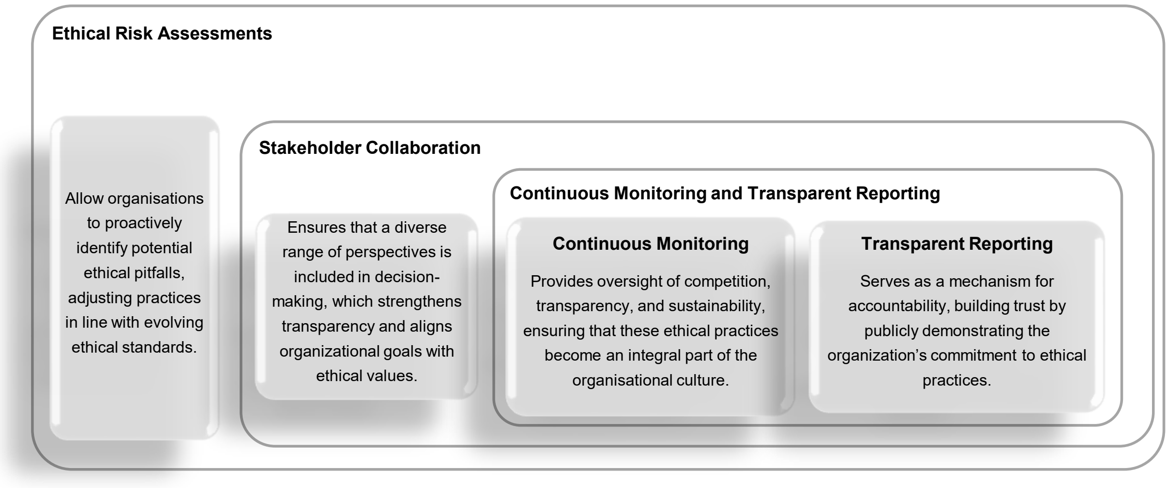

Figure 45 Strategic Ethical Decision-Making Considerations

Collectively, these operational guidelines support the institutionalisation of ethics within strategic decisions regarding drone technology. This ensures that the ethical guidelines are not merely aspirational but become part of the fabric of daily operations. This commitment to ethical practices fosters resilience, allowing the organisation to adapt to regulatory changes and societal expectations over time. The model thus anticipates the immediate needs of ethical compliance and the dynamic nature of ethical obligations in a rapidly evolving technological landscape.

In relation to the strategic benefits of the framework, the technoethics approach reinforces the organisation's ethical standing and operational sustainability. Firstly, it enhances the organization's integrity and reputation, by facilitating the fostering of a culture of ethical responsibility that resonates with both internal and external stakeholders. This focus on ethical integrity builds public trust, which is crucial in industries where technology can significantly impact privacy, security, and the environment. Secondly, the framework promotes fair competition and the minimising of misinformation. Moreover, the framework fosters a market environment where decision making lead to innovation that is accessible to a diverse range of players, thereby creating a more equitable and competitive landscape. Additionally, the framework's emphasis on sustainability aligns the underpinning decision making with global environmental goals, encouraging a responsible approach to technology adoption that benefits both the organisation and society at large. Through this commitment to sustainable innovation, the decision maker positions the organisation as a forward-thinking industry leader, that has taken preparatory steps to meet the ethical and environmental expectations of the prospective contemporary drone markets.

Researcher Reflection and Proposal

Reflecting critically on the technoethics-based strategic ethical decision-making framework, the researcher recognised both its strengths and certain limitations that emerged. While the framework provides a solid foundation for promoting industry standards, fair competition, and ethical practices, applying it uniformly across diverse regulatory landscapes may lead to challenges. In light of the findings, the researcher reflected on how each industry or and province within South Africa brings its own set of regulatory[195] expectations, ethical norms, and practical constraints. This complexity raises questions about the framework's adaptability and effectiveness in environments with varying degrees of regulatory maturity and ethical sensitivity. The researcher reflected on the literature review findings, and held that in practice, enforcing universal standards may be unrealistic and could unintentionally hinder smaller organisations with limited resources and less established ethical oversight structures.

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Another key insight from this reflection was the resource-intensive nature of the framework's recommended monitoring and reporting processes. These processes are critical for maintaining transparency and accountability, yet they demand significant financial and human resources. Considering the tension of this between the findings and the literature review investigations, then for larger organisations this might be achievable, but for smaller organisations, the level of oversight proposed could be overwhelming, creating a potential barrier to ethical integration. This issue points to a fundamental limitation: the framework, as it currently stands, may unintentionally privilege well-resourced organisations, thus compromising its inclusivity and scalability.

These reflections led the researcher to propose an evolution of the framework to address these gaps. In this regard, the researcher held that creating scalable, modular components within the framework could allow it to be adapted to organisations of different sizes and capacities. This would involve decision making that designs flexible guidelines and adaptable monitoring practices that can be tailored to meet varying levels of regulatory rigor and organisational resources. Such scalability within decision making would enable smaller organisations to engage with the framework meaningfully, allowing for the prioritisation of ethical standards without overwhelming operational capacity. This approach would also allow organisations in regions with less established regulatory environments to adopt core ethical practices, gradually building towards more comprehensive oversight as they grow.

The conclusion of this reflection was that the strategic value of the technoethics-based strategic ethical decision-making framework can be translated into a theoretically grounded tool for guiding the ethical integration of drone technology. Moreover, focusing on principles of fair competition, transparency, and sustainability, the framework effectively addresses both the immediate operational needs and the long-term ethical responsibilities that necessitates strategic decision in the context of the strategic value of drone technology. However, the researcher was cognisant that the findings has highlighted on several occasions that ethical decision-making in drone technology adoption is not simply a regulatory formality; but that it is a strategic imperative that fosters resilience and builds trust. This, the researcher asserts that for the framework to truly fulfil its purpose, it must support decisions that build a resilient ethical foundation that is achievable at all levels of resource availability.

With these proposed modifications to enhance flexibility, scalability and accessibility, the researcher was confident that this framework can serve as a vital resource for organisations navigating the ethical complexities of modern technology adoption. Moreover, the framework would enable guided and informed decision making of practical and the inclusive application of the commercial use of drone technology. In this way, the organisation will be positioned as an industry leader with the potential to empower organisations across industries to adopt drone technology for commercial use responsibly, aligning innovation with the ethical and societal expectations within a rapidly evolving 4IR era. This approach will also ensure that as industries embrace technological advancement, and that they do so with a commitment to social responsibility and environmental stewardship that serves as a contribution of a more ethically grounded technological landscape.

2.3. Proposed Technoethics Ethical Decision-Making Framework

Emerging from the exploration of the findings and the theoretical implication on decision makers, was the proposed conceptual technoethics-based ethical decision-making framework discussed in the background discussions. This ethical decision-making framework premised on technoethics principles synthesises insights from both the findings of the study and the theoretical framework to create a multidimensional structure that supports ethical decision-making at every stage of drone technology adoption and integration into an organisation operating within the cold supply chain. Thus, through the leveraging of technoethical principles, the framework addresses critical themes identified, including the need for discerning drone capabilities, ethical data management, fair business practices, and sustainable innovation.

Moreover, the theoretical framework themes paved the foundation for understanding the prospective ethical landscape of harnessing the commercial application and benefits of drone technology. Thus, the gaps that emerged between theoretical expectations of technoethics and organisational realities emerging from the primary data analysis, were addressed structuring ethical decision-making guidance across three dimensions: Risk Taxonomies for Decision-Making, Operational Readiness Ethical Challenges, and Long-Term Sustainability Strategies. To this end, the Technoethics-Based Ethical Decision-Making Framework comprising the core ethical themes was conceptually formulated to ensure that decision-makers have practical tools to navigate the prospective ethical terrain of the commercial use of drones with the cold supply chain industry of South Africa.

The technoethics-based ethical decision-making framework was conceptually presented in figure 46 below as follows:

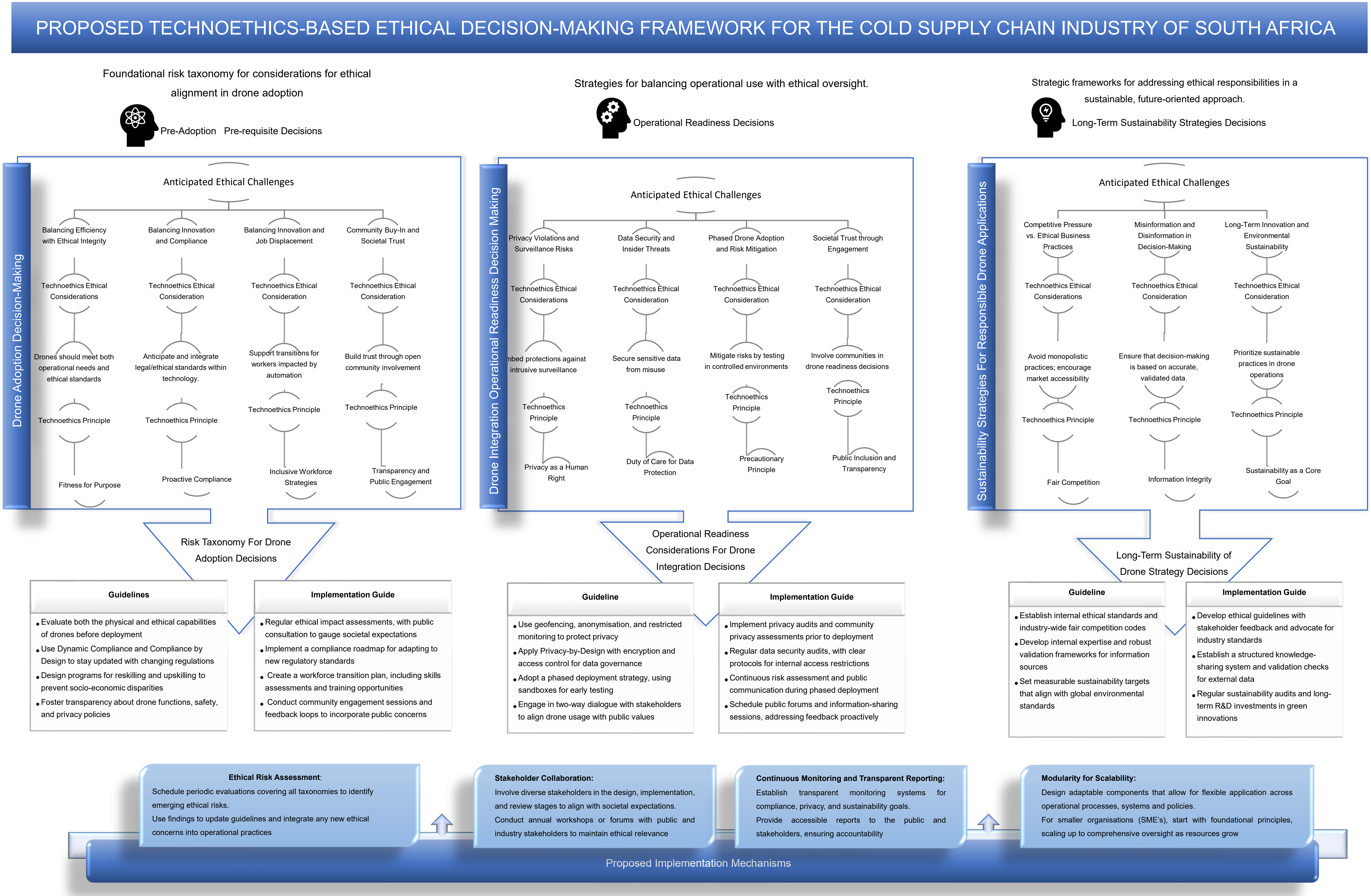

Figure 46 Proposed Technoethics Ethical Decision-Making Framework

3. Conclusion

From the interpretation and discussion in this chapter, an emphasis emerged about the transformative potential of the *Technoethics-Based Ethical Decision-Making Framework*, as a guiding model for the responsible adoption of drone technology within the cold supply chain industry. This framework, grounded in technoethics principles, bridges the gap between theoretical ideals and practical applications. For example, the contribution of this ethical framework builds on the Alternative Technology Adoption Framework, developed by Maghazei *et al*. (2022) as shown in figure one below:

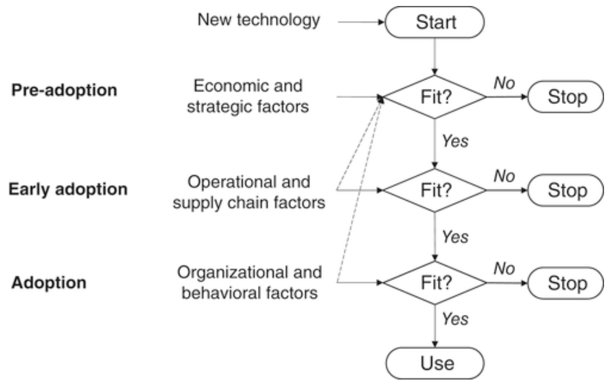

Figure 47 Alternative Drone Technology Adoption Framework for Emerging "Industry 4.0" Technologies

The framework depicted in figure 47, developed by Maghazei *et al*. (2022) suggests a roadmap for the adoption of drone technology. Additionally, the framework sets out that the successful adoption of Drone technology is reliant on aligning economic, strategic, operational, and supply chain factors. While this proposed study recognises the assertions and findings of Maghazei *et al*. (2022), a critique of this framework by this study is that the alignment should incorporate a tool that ensures that the decisions that drive the alignment during each phase is based on a process that mandates ethical compliance. This assertion is supported by Nanda (2021). The author postulates that for an organisation to succeed, it requires the prioritisation of decision-making as a strategy before the application of technology and the consideration of financial benefits.

In light of this critique, this study posits that where a decision maker uses the *Technoethics-Based Ethical Decision-Making Framework* and adapts it as would be the case with frameworks such as the Privacy-by-Design; then, this study proposes that an *Ethical Evaluation Process* Step be incorporated into such framework. For example, in the framework of Maghazei *et al*. (2022), the proposed *Ethical Evaluation Process* during each alignment phase of the framework developed by Maghazei *et al.* (2022) should become a mandatory pre-requisite that must be satisfied before proceeding with latter decisions or considerations. This means that the alignment phases will succeed or fail based on the combination of the technoethics principles of the *Technoethics-Based Ethical Decision-Making Framework.* Essentially, the proposed process steps which is the *Technoethics-Based Ethical Decision-Making Framework* will act as a criterion that must be met first, before moving on to the next step in the model. Thus, the *Technoethics-Based Ethical Decision-Making Framework* offered a structured approach to address ethical, operational, and societal challenges associated with drone technology. Furthermore, for decision-makers, the framework offered a practical toolkit, equipping them to address prospective ethical issues inherent in drone adoption with clear, actionable steps. Additionally, the scalability of the framework can be tailored across the broader supply chain industries and frameworks such as those of Maghazei *et al.* (2022). This also includes the broader economic sectors of South Africa in line with their unique contexts. This will ensure that both large and small entities can adopt an ethically robust approach to drone technology.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

1. Introduction

This chapter aims to articulate how the study has contributed to understanding the prospective ethical challenges associated with drone technology in the context of the central claim of the study. Furthermore, this chapter will highlight how the research findings have addressed the central research question, research objectives, and the research problem. The discussion will also engage with the theoretical framework, emphasising its significance in shaping strategic and ethical decision-making processes within the cold supply chain industry. This will demonstrate how the study advances knowledge in the field and provides actionable insights for decision-makers.

To orientate the chapter, the discussion is organised to provide a cohesive discussion that bridges the research problem with practical and theoretical outcomes. It begins by restating the research problem, research question, and objectives, as a foundation for a synthesis of the main findings. This synthesis will explore both the strategic benefits and ethical challenges of integrating drone technology. Following this, the theoretical framework will be revisited to underscore its relevance in informing ethical best practices and policy implications. Subsequent to this, the chapter will also address the limitations of the study thereby offering a balanced view of the research and identifying areas for future exploration to address existing gaps. The conclusion will emphasise the broader significance of the study, advocating for sustained ethical engagement and strategic foresight as the industry will adapt to the evolving landscape of drone technology prospectively.

2. Restatement of the Focus of the Study

This study cantered on investigating the prospective ethical challenges that may emerge when restrictive conditions on the commercial use of drone technology in South Africa are relaxed. The central claim posited that as regulatory constraints ease, new and complex ethical issues previously non-existent in the current regulatory environment will arise. This includes the cold supply chain industry and across the economic sectors of South Africa. The research therefore emphasised the need for a strategic and ethical approach to decision-making that will addresses prospective challenges that may arise in the new permissible commercial drone environment, while leveraging the significant commercial benefits that drones can offer.

To address this need, the study was guided by the central research question of this study: *What ethical decision-making framework can assist decision-makers in the South African cold supply chain industry to navigate these emerging ethical challenges while maximizing the benefits of drone technology in a more permissive regulatory landscape?*

To answer this question, the study aimed to identify and analyse the potential ethical challenges associated with drone technology, and to propose a conceptual framework to guide ethical decision-making. This aim was broken down into three key research objectives, namely:

RO1: Identify and evaluate the critical ethical considerations that must be addressed by decision-makers when confronted with ethical challenges in a more permissive regulatory environment.

RO2: Examine the best practices associated with these ethical considerations, which should be incorporated into an ethical decision-making framework to address the challenges encountered.

RO3: Determine how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.

In fulfilling these objectives, the study utilised a technoethics framework to explore the moral and social responsibilities associated with drone technology. This framework provided a structured approach for decision-makers to navigate any prospective complex ethical landscapes. Moreover, this framework served as a foundational guide for balancing the need for innovation with the imperative of ethical responsibility. This was envisaged to equip decision-makers in the cold supply chain industry to anticipate and address ethical challenges in a forward-thinking, socially responsible manner.

3. Key Findings of the Study

3.1. Key Findings of the literature review investigations

The literature review was segmented into two distinct but interlinked parts, each addressing essential aspects of integrating drone technology into the cold supply chain industry of South Africa. Part One provided a foundational understanding of the strategic and technological benefits and challenges, while Part Two focused on the ethical considerations, using a structured framework grounded in normative, applied, and meta-ethical theories. Together, these discussions revealed the following findings emergent form the literature review investigations:

Finding One: Complexity and Technological Understanding of Drone Systems

In part one, the literature review investigations emphasised that drone technology is not a monolithic concept but comprises a range of systems with varying capabilities. The literature review then went on to distinguish amongst the classes and categories of drones as expounded by (Strawbridge, 2022; Agostinho & Maurer, 2020). A finding that emerged from here was that if a decision maker within the cold supply chain industry fails to differentiate between an autonomous and remotely an operated drone and how these technologies function, that significant operational and ethical challenges could result. In part two, an ethical analysis of this challenge to understand the ethical implications. It was revealed that the principle of *respect for autonomy* emerged as an ethical challenge that a decision maker may confront as well as the fact that the autonomous nature of some drones will compound the ethical issue by introducing substantial risks, such as unauthorised surveillance, data breaches, and privacy infringements. From here, the review established that decision-makers must be equipped with a deep understanding of drone technology to mitigate these risks. Moreover, the review also established that a decision maker would need more than technical knowledge and should therefore be guided by an ethical framework that ensures transparency and respects the autonomy of individuals whose data may be captured. The implication for a decision maker was that organisations must prioritise ethical guidelines that detail how data is collected, processed, and safeguarded, especially in crisis situations where autonomous decisions may be necessary as expounded by Mekdad *et al.* (2023).

In light of this, the literature review finding directly addressed the research problem of navigating the ethical challenges that arise from drone use in a permissive regulatory environment. The findings emphasised that understanding the complexities, classifications and functionalities of drone technology is fundamental to formulating strategic, ethically responsible decisions. This discussion therefore addressed RO1 by identifying the critical ethical considerations, such as privacy and data security. It also lays the groundwork for RO2, as the emphasis on informed consent and data protection represents best practices for ethical drone use.

Finding Two: Strategic Benefits and Ethical Governance

The literature investigations in part one illustrated that drones could revolutionise the cold supply chain logistics by reducing operational costs, improving efficiency, and ensuring timely delivery of perishable goods as expounded by Canon (2023) and Matsiyana (2023). The Business Model Theory framework leveraged highlighted how drones can provide a competitive advantage by optimising supply chain processes. However, the ethical analysis in part two revealed that these benefits must be considered alongside potential negative impacts, such as workforce disruptions and anti-competitive behaviour (Ovans, 2015; Schwab & Davis, 2018). To this end, the ethical principle of *fairness* emerged as a crucial concern. From here, the ethical analysis in part two established that the adoption of drone technology could inadvertently disadvantage smaller enterprises, exacerbating market inequalities. Through the lens of deontological ethics, it was emphasised that the importance of fairness will require that a decision maker on behalf of an organisation act in ways that promote equal opportunities and avoid monopolistic practices. Seymour *et al.* (2022) validated this, asserting that the socio-relational nature of fairness can be exploitative or coercive if not implemented equitably. The author contended that this was the case even if the technology is beneficial.

The implications for decision making emerged as ethical governance that would be required to address these concerns. Against this backdrop, the literature review established that a decision maker must embed fairness into their business models. This must involve adhering to regulatory standards, such as the South African Competition Act, and implementing measures to prevent anti-competitive practices. Decision-makers must also ensure that workforce disruptions are minimized through reskilling and that drone technology does not disproportionately benefit large corporations at the expense of SMEs and individual workers (Shih, 2020; Latici, 2019).The findings of the literature review addressed the research problem by emphasising the duality of drone technology that while it offers significant economic benefits, it also poses ethical challenges that must be managed. The review therefore suggested that decision-makers would need to adopt a holistic approach that balances innovation with ethical responsibility. Moving from this premise, the literature review findings addressed RO2 by outlining best practices for fair business and labour practices. Here, it was asserted that the principles of fairness and regulatory compliance must be ensured in a manner that integrates drone technology in a way that promotes ethical labour practices and fair competition. Furthermore, the literature review findings also supported RO3 by emphasising the need for monitoring mechanisms to ensure ongoing compliance with ethical and regulatory standards. This approach emerged as a clear path for decision-makers to ethically leverage drone technology, and thus implicitly answered the research question.

Finding Three: Interoperability and Transparency

In part one, it emerged that the integration of drone technology into existing systems requires seamless data exchange and high levels of interoperability. However, this complexity introduces the risk of software development waste (SDW) and other inefficiencies (Cooper, 2021; Zemrane *et al*., 2020). Against this backdrop, the literature pointed out the importance of managing these technological challenges through structured processes and transparent practices. From the ethical analysis in part two, the ethical challenge of transparency was identified. The review emphasised that transparency would be necessary during software development to integrate drone technology, and also during the data lifecycle management. This was furthered in the argument of Felzmann *et al.* (2019) and Belli *et al.* (2020), who contended that transparency ensures legitimacy and trust, while Hosseini (2016) warned that a lack of transparency can lead to deceptive practices and inefficiencies. Against this backdrop, Hayes *et al.* (2022) and Ofem *et al.* (2022) proposed models that articulated how process and information transparency can be operationalised to prevent ethical pitfalls.

The implication for a decision maker that emerged, was that transparent technological practices is crucial for maintaining public trust and ensuring ethical data handling. On this basis, the literature review findings posited that decision-makers must implement clear guidelines and communication strategies to ensure that all stakeholders understand how drone data is managed. This also involves minimising SDW by adopting efficient software development practices and ensuring that data interoperability does not compromise security or privacy (Sedano et al., 2017). This implication addressed the research problem by highlighting the importance of transparency in managing the ethical complexities of drone technology. The findings emphasised that ethical data management practices can mitigate risks related to privacy, inefficiencies, and regulatory non-compliance. The assertion of a transparency as a fundamental principle, answered the research question since the implication assertion was offered as a practical solution for managing data and software development ethically. Moreover, this this ensured that decision-makers would have a clear understanding of how to implement drones in a compliant and responsible manner. From here, the RO3 was addressed by emphasising the need for monitoring and evaluation mechanisms to ensure ethical compliance. Moreover, the literature review findings also supported RO1 and RO2 by identifying transparency as a key ethical consideration and outlining best practices for data management.

Finding Four: Legal and Ethical Accountability

This finding that emerged in part one and was identified as a significant legal risk. Moreover, legal risks such as liability under South African law and the potential for drones to be used in illicit activities necessitated that the principle of *accountability* be central in decision making that involves drones. This was especially so given the literature review findings of ambiguity in distinguishing between the roles of drone operators and pilots (Thompson, 2019; Caboz, 2022; Emma-Iwuoha, 2018). In light of this, the ethical analysis in part two highlighted that the principles of *accountability* and *responsibility*, as expounded by Lechterman (2021) must extend beyond simple compliance to include ethical responsibility for the consequences of drone operations. Thus, the literature review findings were that a decision maker must be informed by an accountability framework that clearly delineates roles and responsibilities, especially for autonomous drone decisions, which can complicate traditional notions of liability.

The implication emerging from this finding is that a decision maker must be prepared to handle legal repercussions in the context of drones and should therefore ensure that accountability frameworks are robust. This includes being proactive in managing the risks associated with autonomous decision-making. This is especially important as the law of agency, as discussed in the literature review, makes organisations liable for drone-related actions, which heightens the need for ethical governance (Weber Wentzel, 2022). Against this backdrop, the research problem was addressed by emphasising the need for comprehensive accountability mechanisms. The findings highlighted that ethical and legal accountability must be integrated into organisational practices to manage the risks associated with drone technology. This directly answered the research question by outlining how to handle liability and ethical responsibilities. Furthermore, the finding addresses RO1 by identifying accountability as a crucial ethical consideration and RO2 by proposing best practices for ethical governance. The emphasis on monitoring tools also supported RO3 by ensuring that accountability is continuously assessed and managed.

Finding Five: Employment Impact and the Gig Economy

This finding emerged in part one and highlighted the potential for job displacement due to drone automation. This finding emerged as significant in so far that South Africa suffers with high unemployment rates and a digital divide. In addition to this, the literature review also established that the rise of the gig economy presents new challenges related to job security and labour rights as expounded by Kim *et al*. (2018); Manyika and Sneader, (2018) and Kavese *et al.* 2022). For the ethical analysis in part two, it emerged that the ethical implications of automation would have a direct impact on the workforce management, as explored through the lens of distributive and social justice. In this context, Manyika *et al*. (2018) and Nunes (2021) presented opposing views on whether automation will create or destroy jobs. Against this backdrop, the ethical analysis cited the ethical principle of *fairness* that requires that workers are not unfairly disadvantaged by technological advancements. Hanna (2021) added to this by emphasising that there is a need for ethical labour practices, in order to ensure equitable resource distribution.

Moving from this premise, the implications for drone-based decision making, is that robust strategies would need to be in place to combat the ethical challenges of job displacement. The literature review established that potential solution can be investing in workforce reskilling and creating fair employment opportunities. However, it was established that the gig economy adds complexity, as flexible work arrangements can lead to exploitation. To this end, it was established that ethical labour practices must be prioritised to ensure that drone technology benefits the workforce rather than exacerbating inequalities (ITF, 2021; Jumah, 2022). From here, this finding acknowledged the social and economic impact of drone technology. The review emphasised that ethical frameworks must include strategies for workforce reskilling and protection to prevent negative outcomes. This offers decision-makers practical guidance on managing labour-related ethical challenges. On this basis, the finding addressed RO2 by outlining best practices for ethical labour practices, and RO1 by identifying the social justice implications of automation. The emphasis on reskilling also supported RO3, as continuous monitoring and adjustment will be necessary to address workforce impacts.

3.2. Key Primary Research Findings

The key findings of the study were interpreted using a technoethical lens, supported by the theoretical framework of the study. This approach assisted to identify the critical factors that decision-makers must consider for responsible drone adoption, integration and responsible use commercially. From the findings across the three dimensions of decision-making comprising: drone adoption decision-making, drone integration decision making as follows:

Dimension One: Risk Taxonomy for Drone Adoption Decision-Making

From the thematic analysis, the findings were interpreted under the first decision making dimension which explored the complexities and ethical dilemmas inherent in drone technology adoption. The technoethics principle that emerged at the core of this dimension was balancing operational efficiency with ethical integrity. This principle emphasised the need for decision makers to weigh the potential benefits of drones, such as speed, efficiency, and data integration, against ethical responsibilities related to privacy, data security, and social impact. This was premised on the finding that that balancing operational efficiency with ethical obligations is crucial. For example, privacy and data security emerged as critical areas where drone technology can intrude on individuals' rights, while the automation potential raised concerns about job displacement. Additionally, participant views concurred that there would be a pressing need for community engagement to build trust and transparency, particularly in addressing fears surrounding surveillance and data use.

Against this backdrop, the findings from this dimension contributed to the creation of the *Risk Taxonomy Framework*. This framework organised the potential risks identified into categories and prioritised them to enable a decision-maker to proactively identify, assess and manage these risks. The establishing of the risk framework as guideline for ethical data use; workforce reintegration strategies; and, transparent community engagement, created a foundation for a comprehensive ethical approach to drone adoption decision making. This, structured method to evaluate and prioritise risks associated with drone technology adoption decision making, ensures that ethical considerations are integrated from the outset. Thus, this dimension emphasises the importance of continuous risk assessment and proactive engagement with stakeholders to align drone operations with societal and regulatory expectations. Against this backdrop, this dimension addressed the research problem by providing a methodical way to handle the ethical and operational challenges of drone adoption. Moreover, it fulfilled RO1 by identifying key ethical concerns, such as privacy and job displacement, and proposing solutions to mitigate these issues. The contribution of a clear risk management strategy answered the research question, in terms ethically integrating drone technology into operations while balancing efficiency and compliance.

Dimension Two: Operational Readiness Ethical Challenges and Considerations

From the thematic analysis, the findings were interpreted under the second decision making dimension, and uncovered significant ethical challenges related to the operational implementation of drones, especially concerning privacy, data security, and AI-driven decision-making. The findings stressed that drones' ability to collect vast amounts of real-time data introduces risks of surveillance without consent, making comprehensive privacy safeguards essential. Moreover, data security emerged as a critical concern, with the potential for insider threats and cyber-attacks. Additionally, the use of AI and autonomous systems introduced complexities in accountability, necessitating clear governance frameworks. The research findings under this dimension therefore highlighted the value of phased implementation and continuous ethical assessment as strategies to manage these risks. Against this backdrop, the technoethics principle that highlighted the ethical challenges, also highlighted the need for ethical governance in autonomous systems. Technoethics revealed that as drones become more sophisticated and data-driven, that decision makers would need to uphold ethical governance by embedding transparency, accountability, and proactive risk management into their operations. To this end, the findings informed the *Operational Readiness Ethical Framework* for drone integration decision making. The tenants of this framework emphasised that adaptive governance, phased adoption, and continuous monitoring must be tested and implemented through pilot programs. Moreover, that ongoing ethical assessments are necessitated to ensure that drone operations remain transparent, secure, and aligned with societal expectations.

From here, the findings revealed that decision-makers would need to adopt a phased approach to the operational integration and the commercial drone deployment, starting with controlled pilot projects to identify and mitigate risks. The emphasis on ethical governance ensures that data security measures are robust, and that AI systems are used responsibly, with clear accountability structures in place. Against this backdrop, this dimension directly addressed the research problem by providing a governance model that ensures drones are deployed ethically and securely. Moreover, the findings under this dimension fulfilled RO2, by offering operational strategies that integrate ethical oversight and adaptive governance. Furthermore, the findings provided an explicit answer to the research question in so far that a phased approach and continuous assessment of drone integration decision making was offered. Moreover, that ensuring that drone operations can evolve in a way that upholds societal and regulatory expectations.

Dimension Three: Long-Term Sustainability Strategies

The third dimension emphasised the need for sustainable and ethically responsible drone strategies that underpin decision making processes in the first two dimensions. The findings revealed a tension between the desire for short-term profits and the necessity of long-term ethical commitments. Furthermore, the findings also revealed that monopolistic behaviour as a risk, where early adopters might establish market dominance, limiting opportunities for smaller enterprises. In addition to this, the findings also highlighted the ethical obligation to invest in environmentally sustainable practices and to prevent misinformation and disinformation that could misguide strategic decisions. To this end, technoethics posited that decision makers must focus on long-term impacts of drone use as it evolves within the ambit of 4IR technological advancements and beyond. Moreover, the strategies must also consider scalable and futuristic integration of corporate social responsibility (CSR).

These insights led to the development of the *Sustainability and Innovation Ethical Framework* emerged that advocate for investment in green technology; the establishment of industry-wide ethical standards; and measures to combat misinformation. In other words, the importance of internal knowledge management systems to combat misinformation and ensure that decisions are based on accurate, reliable data The technoethics principle driving this framework was the balance between technological innovation and environmental and social sustainability. This principle emphasised that drone technology should serve broader societal goals, not just immediate operational efficiencies. Against this backdrop, decision-makers are urged to adopt forward-looking strategies that integrate environmental stewardship and ethical business practices. This includes setting measurable sustainability goals, promoting fair competition, and investing in robust knowledge systems to make informed decisions. The emphasis on ethical innovation ensures that drone technology contributes positively to society and the environment. From here, this dimension addressed the research problem by offering strategies for sustainable and ethical drone integration. Moreover, it fulfilled RO3 by proposing long-term innovation practices that balance economic benefits with societal and environmental impact. Furthermore, the focus on sustainability and fair competition answered the research question by providing an approach to using drone technology responsibly and ethically.

3.3. Insight from the Findings of the Literature Review and Primary Research

The insight that emerged from the convergence of findings from both the literature review and the primary research revealed gaps in the existing literature guiding the ethical and operational integration of drone technology. These gaps highlighted the need for a more holistic and adaptive approach to ethical governance, especially in industries such as the cold supply chain where drone technology is poised to improve operational efficiency; however, intersect with critical ethical concerns. This is premised on the fact that the literature review emphasised the ethical complexities inherent in drone adoption, focusing on issues such as privacy violations, data security vulnerabilities, and environmental impacts. However, it lacked thorough strategies that could be practically applied across different scales of operations, economic sectors and various regulatory landscapes. To this end, the primary research findings highlighted the real-world challenges that would be prospectively faced by decision-makers, should the widespread adoption be permissible within South Africa. Furthermore, constructs such as societal resistance to surveillance; the risks of insider threats; and the practical difficulties of balancing short-term gains with long-term sustainability emerged as empirical findings that demonstrated that existing theoretical constructs did not adequately address the operational realities and evolving nature of drone technology.

From this convergence, the *Technoethics Ethical Decision-Making Framework* emerged as a practical and theoretically grounded solution. This decision-making framework, rooted in technoethics, emphasised the ethical responsibilities surrounding technological advancements. It was enriched by complementary theories to offer a multi-dimensional approach that would addresses both immediate and long-term prospective ethical challenges. Moreover, the framework has the ability to guide decision-makers in the cold supply chain industry to navigate the ethical and operational complexities of drone technology. Moreover, it provided structured protocols for risk assessment, emphasised the importance of phased implementation and adaptive governance, and promoted the integration of sustainability into strategic planning. Thus, The *Technoethics Ethical Decision-Making Framework* represents a theoretical insight that emerged from the convergence of findings from both the literature review and primary research, directly addressing the research question: *How can ethical, operational, and societal challenges associated with drone technology be effectively managed within the cold supply chain industry?*

To this end, the framework addresses the research problem by offering an approach to managing the ethical complexities and challenges that have been identified, and that may prospectively emerge in a permissible environment. Drawing from *Dimension One*, it incorporates a *Risk Taxonomy* that enables decision-makers to identify and prioritise ethical risks, such as privacy violations, data security threats, and the environmental impact of automation, ensuring continuous assessment and proactive management. This component directly fulfils Research Objective 1, which focuses on identifying and mitigating key ethical concerns associated with drone technology.

From *Dimension Two*, the framework adopts *Adaptive Governance Practices*, emphasising phased implementation and ongoing ethical monitoring, which are critical for maintaining data security and accountability in the face of evolving AI-driven drone technologies. These strategies fulfil Research Objective 2, which aims to propose operational practices for maintaining ethical and secure drone usage. Thus, by incorporating adaptive governance, the framework ensures that drones will be deployed in a way that is compliant with evolving regulations and societal expectations, thereby ensuring responsible integration.

Dimension Three integrates *Sustainability Strategies* that promote long-term environmental and social responsibility; advocating for fair competition; the prevention of monopolistic behaviour; and robust knowledge management to counter misinformation. This component addresses Research Objective 3 by promoting ethical practices that balance short-term operational benefits with long-term societal and environmental impact. Through these strategies, the framework ensures that drone technology contributes positively to society, emphasising sustainable innovation and ethical business practices.

Collectively, these findings that led to the formulation of the *Technoethics Ethical Decision-Making Framework* provided a holistic solution, that addressed each research objective. The framework identifies ethical challenges and offers actionable strategies for secure, compliant, and sustainable drone integration. In this way, the research question was answered, equipping decision makers on behalf of an organisation with a robust ethical foundation for navigating the complexities of drone technology in the cold supply chain industry. From here, it is important to explore the practical implications of the *Technoethics Ethical Decision-Making Framework to* inform actionable, ethical, and scalable practices for decision-makers and the broader industry are as follows:

3.1. Implications for Decision-Makers in the Cold Supply Chain Industry

For individual decision-makers, this framework provides a practical and structured approach to navigate the ethical complexities of drone technology adoption. Moreover, it aims to align day-to-day operations with long-term ethical and regulatory goals. Stemming from the findings and the alignment with the theoretical framework, the following practical implications on a decision maker operating within the cold supply chain industry of South Africa emerged:

Enhanced Accountability and Ethical Oversight:	Implication: Decision-makers are empowered with a clear roadmap to integrate ethical considerations into every aspect of drone decison making and usage, from risk assessment to community engagement. Moreover, decison makers are accountable for balancing operational efficiency with ethical integrity, ensuring that their decisions align with the framework's principles.
	Application: Decison makers can endevour to establish internal guidelines and conduct regular assessments that measure ethical alignment. This will attempt to ensure operational decisions that reflect the "fitness for purpose" principle and comply with privacy and regulatory standards.
Data Privacy and Security Management:	Implication: The framework stresses Privacy-by-Design and data security measures. This places a responsibility on decision-makers to ensure that robust protections against data breaches, insider threats, and unauthorised access underpin decsions.
	Application: Decision-makers should implement multi-layered data protection strategies, that includes encryption and access controls, and conduct regular data security audits. The embedding of these practices will see decison makers proactively address and anticipate ethical risks associated with drone-generated data, particularly in sensitive supply chain environments.
Workforce Transition and Fair Business Practices:	Implication: Ethical considerations for labor practices and market competition necessitate that decision-makers foster fair business practices. This includes supporting SMMEs, preventing monopolistic behavior, and addressing the potential workforce displacement due to automation.
	Application: Decision-makers can develop adaptable workforce transition programs, such as reskilling initiatives, that prepare displaced employees for new roles created by drone technology. Additionally, they can create partnerships with SMMEs to ensure fair competition within the industry.
Proactive Community Engagement and Transparency:	Implication: Decision-makers should endevour to actively build societal trust through transparent operations and community engagement. This responsibility must include educating the public on drone technology's benefits, addressing privacy concerns, and incorporating public feedback into operational strategies.
	Application: Decsion makers should host community forums, publishing transparent reports on drone activities, and establishing clear privacy policies. Thus, decision-makers can foster a positive relationship with the community and avoid societal pushback.
Scalable and Adaptive Compliance Strategies:	Implication: The framework's scalable nature allows decision-makers to adopt compliance strategies that adapt with organisational growth. This means smaller organisations can start with foundational practices while larger entities expand their ethical and compliance capabilities as they grow.
	Application: Decision-makers should implement a dynamic compliance roadmap, initially focusing on essential regulatory requirements and gradually expanding to incorporate complex ethical standards as drone autonomy and operational scope increase.

Figure 48 Implications for a Decision Maker within the Cold Supply Chain Industry

3.2. Implications for the Cold Supply Chain Industry

On a broader level, the *Technoethics-Based Ethical Decision-Making Framework* provides a strategic direction for the cold supply chain industry, establishing a standardised, ethical approach to integrating drone technology. The practical implications and applications that emerged involve industry-wide improvements in internal regulatory and compliance alignment, labour practices, sustainability, and scalability as follows:

Standardised Ethical Framework and Industry-Wide Best Practices:	Implication: The framework offers the cold supply chain industry a standardized approach for ethical drone adoption. By defining core ethical practices, the framework supports the establishment of industry-wide standards that ensure consistent compliance, data security, and ethical labor practices.
	Application: Industry bodies and regulatory authorities can adopt this framework as a guideline for creating sector-wide standards, promoting consistency across companies of various sizes. This standardization helps ensure that all industry players adhere to ethical benchmarks, fostering a culture of responsible drone usage.
Sustainable Growth and Environmental Accountability:	Implication: The industry is encouraged to integrate sustainable practices that align with global environmental standards. By prioritising long-term sustainability goals, such as emissions reduction and resource efficiency, the industry can contribute to eco-friendly advancements while benefiting from the operational efficiencies of drone technology.
	Application: Cold supply chain organisations are incentivised to set measurable sustainability targets and incorporate green practices, such as eco-efficient drone technology, into their operations. Industry collaborations can focus on research and development (R&D) to further these sustainability goals.
Sustainable Growth and Environmental Accountability:	Implication: The industry is encouraged to integrate sustainable practices that align with global environmental standards. By prioritising long-term sustainability goals, such as emissions reduction and resource efficiency, the industry can contribute to eco-friendly advancements while benefiting from the operational efficiencies of drone technology.
	Application: Cold supply chain organisations are incentivised to set measurable sustainability targets and incorporate green practices, such as eco-efficient drone technology, into their operations. Industry collaborations can focus on research and development (R&D) to further these sustainability goals.
Support for Small, Medium, and Micro Enterprises (SMMEs):	Implication: The framework highlights the importance of fair competition and advocates for the inclusion of SMMEs within the evolving drone economy. This reduces the risk of market monopolization by larger corporations, encouraging innovation and resilience across the industry.
	Application: Large companies can actively support SMMEs by engaging them in supply chain partnerships, creating opportunities for smaller players to leverage drone technology. Industry coalitions can establish guidelines to prevent anti-competitive practices, fostering a more equitable market landscape.
Increased Data Security and Privacy Standards:	Implication: Industry-wide adoption of stringent data protection standards reinforces data privacy and security, mitigating risks associated with drone-generated data. This is crucial in a cold supply chain context where sensitive information, such as tracking data for perishable goods, is handled.
	Application: Industry-wide frameworks for data privacy can include mandatory encryption, restricted access protocols, and regular audits. Cold supply chain organizations can implement these standards, ensuring that data integrity is maintained throughout the logistics cycle.
Enhanced Public Trust and Community Relations:	Implication: The framework's emphasis on community engagement and transparency builds a foundation of public trust, vital for long-term industry acceptance of drones. Open communication and inclusive practices ensure that public concerns are addressed, preventing opposition to drone technology.
	Application: The industry can adopt a collective approach to public engagement by establishing clear communication channels that educate the public on drone benefits, privacy protections, and safety measures. Such transparency strengthens community relations and reduces resistance to drone integration.
Scalability and Adaptability to Evolving Technological Landscapes:	Implication: The framework is designed to scale with both organizational growth and technological advancements, allowing it to adapt to new regulations, ethical standards, and innovations. This scalability ensures that the cold supply chain industry can integrate increasingly autonomous drone technology responsibly.
	Application: Industry leaders can apply a phased approach to implementing ethical standards, initially focusing on foundational practices and gradually incorporating more complex ethical considerations as technology advances. This adaptable model allows the framework to remain relevant as drone capabilities expand.

Figure 49 Practical Implications for the Cold Supply Chain Industry

3.3. Overarching Practical Implications

Given the findings and discussions surrounding this study, implementing a *Technoethics-Based Ethical Decision-Making Framework* offers a structured approach to ethically address the technological, operational, and regulatory challenges faced during drone-based decision making. Moreover, the technoethics principles provide decision-makers with a foundation to translate the principles into actionable insights for balancing innovation with ethical accountability. Furthermore, the translation of the technoethics principles also ensures alignment with industry standards. To this end, the framework's adaptability makes it a valuable tool for broader supply chain sectors, that fosters a scalable, ethically grounded approach to emerging technologies across industries as follows:

Enhanced Ethical Oversight and Compliance	Practical Implication: The embedding of technoethics ethical principles such as "fitness for purpose" and as a standard and best practice, as well as Privacy-by-Design will ensure that organisations are better equipped to proactively address regulatory requirements and societal expectations.
	Application: Compliance frameworks such as Dynamic Compliance and Compliance by Design, allow decision-makers to stay ahead of evolving regulations, reducing the likelihood of legal repercussions and fostering trust in autonomous drone operations. This is particularly valuable in jurisdictions with strict privacy and consent laws, such as South Africa's Actio Injuria.
Informed Decision-Making through Risk Taxonomies	Practical Implication: This structured risk taxonomies provides clear pathways for addressing various ethical challenges, from balancing innovation with compliance to managing socio-economic impacts such as workforce displacement.
	Application: Decision-makers can use this taxonomies to assess the ethical risks in real-time, allowing them to make informed decisions that consider both short-term operational gains and long-term social impacts. For example, before deploying drones that may impact jobs, decison making processes can be informed by the framework to plan reskilling programs, and to support affected employees, demonstrating corporate social responsibility.
Strengthened Community Relations and Societal Trust	Practical Implication: The framework highlights the importance of community buy-in and societal trust asserting that public engagement and transparent communication are critical to ethical drone adoption.
	Application: The involving of communities through regular engagement and feedback loops, can assit an organisation to reduce public resistance and build long-term trust. This includes hosting informational sessions about the prsoepective use of drones by the organisation, its role in enhancing customer services, privacy safeguards, and their contributions to public welfare, such as environmental monitoring or logistics support.
Improved Data Governance and Privacy Protection	Practical Implication: The framework holds that data governance structures and privacy protections (such as encryption, access control, and anonymiation) are essential to maintaining public and regulatory trust in drone technology.
	Application: With the framework's emphasis on data security, organisations will be equipped as a safegaurd against both external cyber threats and insider threats. Privacy-by-Design mechanisms embedded in drones ensure that data is handled responsibly, with stringent access protocols and regular audits to prevent misuse.
Proactive Workforce Transition Strategies	Practical Implication: As automation becomes more integrated, the framework's focus on inclusive workforce strategies allows organisations to manage job displacement responsibly.
	Application: Companies adopting drone technology, particularly in logistics and cold supply chains, can use this framework to implement reskilling initiatives and integrate gig economy workers fairly. This reduces the potential socio-economic for inequalities and supports a sustainable transition to a tech-driven workforce.
Sustainability and Environmental Accountability	Practical Implication: The embedding of environmental sustainability within drone operations in the framework aligns with global sustainability goals and supports long-term organisational resilience.
	Application: Decision-makers are encouraged to set measurable sustainability targets and invest in green R&D initiatives that reduce environmental impact. Drones can be leveraged for eco-friendly practices, such as reducing carbon emissions in supply chains, contributing to a positive corporate reputation and compliance with international environmental standards.
Enhanced Competitive Advantage through Fair Business Practices	Practical Implication: The framework's emphasis on fair competition allows decision-makers to establish ethical business practices that discourage monopolistic behavior, especially in emerging markets.
	Application: By avoiding anti-competitive behaviors and supporting smaller market entrants through the technoethics principles within the framework allows organisations to foster a balanced market environment. This approach benefits an orgnaisations reputation, but also encourages a sustainable, innovation-driven ecosystem.
Reliable Knowledge and Information Structures	Practical Implication: Reducing dependency on external, potentially biased sources in liu of fostering a centralised knowledge center, mitigates misinformation risks and strengthens internal expertise.
	Application: Organisations can establish robust information validation protocols to ensure that decisions are based on accurate, internally validated data, enhancing overall decision quality and public accountability. This is crucial as external reliance can introduce risks of misinformation, especially in rapidly evolving fields like drone technology.
Adaptive and Scalable Framework for Organizational Growth	Practical Implication: The framework's modular design allows it to be scaled up or down to evolve alongside 4IR technological evoloutions and based on organisational resources, making it accessible to both large enterprises and smaller businesses.
	Application: Organisations can start with foundational ethical principles and gradually incorporate more comprehensive monitoring and compliance systems as they grow. This adaptable approach enables organizations of all sizes to responsibly adopt drone technology, supporting inclusive industry growth.
Fostering Innovation with a Technoethical Foundation	Practical Implication: The framework supports innovation without sacrificing ethical integrity, promoting a culture of responsible technological advancement.
	Application: Organisations can use technoethics principles to inform R&D strategies that prioritise responsible innovation, ensuring that new drone capabilities align with ethical and regulatory standards. This prepares organizations for the future while remaining aligned with societal values, regulatory expectations, and environmental considerations.

Figure 50 Overarching Practical Implication of the *Technoethics Ethical Decision-Making Framework*

4. Conclusions and Recommendations:

Insight from the convergence of findings from both the literature review and the primary research revealed gaps in current approaches to ethical integration of advanced technologies such as drone technology. In light of this, one of the main conclusions that this study can draw, is that that while drones enhance operational efficiency, their ethical implications necessitate robust governance. Moreover, the researcher also drew the following conclusions:

Conclusion One: Enhanced Ethical Compliance and Privacy Protection Through Technoethics Principles

Building on the findings from the primary research study, it can be concluded that addressing the ethical complexities requires structured protocols for embedding regulatory adherence directly within drone operations. To address this, it is recommended that robust policies must be informed by frameworks such as Privacy-by-Design and Dynamic Compliance frameworks for decision making. These incudes how a decision maker is informed on how to navigate issues such as responsible data collection, particularly as autonomous drones possess increased surveillance capabilities. This is particularly pertinent as autonomous drones possess the ability to make decisions independently, raising substantial concerns about privacy intrusions without informed consent. From here, Spiekermann (2012) asserts that for privacy to be embedded in the system development life cycle and in organisational processes, that companies must be ready to embrace the domain.

This means that practically, when there is an absence of a unified approach to drone technology, that such practices may lead to questionable practices affecting an organisations logic, or "domain logic". In the context of this study, domain logic refers to the crucial role in governing the exchange of information, and data within computer programs. Frankenfield (2020) explains that an organisations logic also referred to as "domain logic," encompasses custom rules and algorithms governing the exchange of information between a database and a user interface within a computer program. This logic constitutes the essential component that defines and constrains the operation of the organisation. Furthermore, since operational policies, expressed in true or false binaries may present harmful or incorrect information that may become visible in workflows, this renders an impact to the data flow and decision guidance. Thus, Spiekermann (2012) contends that only if we force organisations that design advanced technoethical systems and process to embrace bottom-up ways to embed laws, only then can ethics be an embedded code that can serve to really protect the core values of our democracies and constitutions.

Therefore, it can be concluded that as organisations grow and potentially adopt autonomous drones, that decision makers would require advanced compliance mechanisms that cater to the complex regulatory and ethical landscape these drones operate within. In light of this, it can be concluded that the *Technoethics Ethical Decision-making Framework* has the ability to ensure that as drone autonomy increases, that ethical oversight grows proportionately.

Conclusion Two: Building Community Trust and Ensuring Societal Buy-In Through Technoethics Principles

From the literature review findings, it emerged that the central tenants of technoethics advocates for heightened moral and social responsibility among technologists and engineers regarding their technological creations (Luppicini, 2018). To this end, the findings revealed that by promoting transparency and community engagement, decision-makers can build trust and understanding within society. It is therefore inferred that the implication on decision making is that informed consent extends beyond individual privacy to community awareness, helping to prevent resistance and establishing drones as ethically accepted tools within logistics and supply chain operations. A conclusion that can be drawn from here is that in a real-world context, a decision maker in a larger organisation can invest in ongoing stakeholder engagement programs that actively seek public input on drone usage policies as opposed to smaller companies may only be able to begin with local information sessions to address local concerns.

Thus, it is recommended that decision makers in larger organisations should endeavour to implement continuous engagement programs to manage their broader societal impact. This scalable approach allows the technoethics decision making framework to adapt decision making to ensure that community trust-building is incorporated as a core ethical practice as operations expand. Moreover, this adaptability allows organisations despite its size to scale their community trust-building practices in line with their operational growth, reinforcing ethical integrity and public acceptance across varying organisational capacities. Additionally, this scalable approach will assist with engaging communities to prevent resistance and align with public values, which is essential in a field where drones can be seen as invasive or monopolistic.

Conclusion Three: Proactive Risk Management for Data and Technology Integration

The primary research findings emphasised the secure and ethically aligned technology integration should be undertaken through phased deployment and pilot testing. The findings with empirical evidence revealed that these practices enable decision-makers to pre-emptively manage ethical risks associated with data security and ensure interoperability within existing systems. Thus, it can be concluded that by testing in controlled environments, decision makers can mitigate the risk of harm by drones; mitigate compliance risks; mitigate the unintended data capture and any unauthorised access that would compromise ethical integrity in data handling. This conclusion aligns with the assertions of Tiribelli *et al*. (2022), that striking a balance between leveraging the strategic benefits of drones and upholding ethical considerations are paramount.

This practical focus on data security and interoperability highlights the importance of proactive risk management when integrating drones into existing technological infrastructures. Thus, it can be concluded that addressing the complexity of integrating drones into established technological frameworks, will help to mitigate potential ethical and compliance issues related to data security and system compatibility. This scalable approach to risk management allows both small and large companies to uphold ethical compliance in complex technology integrations involving drones, ensuring that ethical risk assessment is proportional to operational scope.

Conclusion Four: Enhanced Ethical Compliance and Privacy Protection

The practical implications reinforce the focus on transparency; data governance and embedding Privacy-by-Design into data management safeguards against privacy violations and insider threats. However, Partelow (2023) contends that many frameworks exist, but it is not always clear how they are developed or can be applied. It is also often vague on how new or existing frameworks are positioned and therefore often lacks transparency in how they were developed and how they can be applied. From this, it can be inferred that a decision maker would need to ensure that data governance structures are ethically sound and aligns operational practices with ethical transparency. This means that data management protocols must protect sensitive information, especially so in cold chain logistics industries where data integrity is critical. This aligns with the literature review assertion of Eryurek *et al.* (2021) that the Data Lifecycle Management (DLM)[196] processes of an organisation must align to industry best practices such as ISO/IEC 27050:2016[197], requires organisations to comply with regulations regarding data privacy and safety. Thus, the *Technoethics Ethical Decision-making Framework* emphasis on

196 Data Lifecycle Management (DLM) combines the best practices from the various stages of the data life cycle: production, data cleansing, data management, data protection, and data governance. It defines how the data is captured, prepared, transported, managed, analysed, and governed at each phase of the data life cycle (Eryurek, Gilad, Lakshmanan, Kibunguchy-Grant, & Ashdown, 2021)

197 As expounded in the literature review investigations, ISO/IEC 27050:2016 that sets out the best practices in relation to the handling of Electronically Stored Information (ESI) (Eryurek, Gilad, Lakshmanan, Kibunguchy-Grant, & Ashdown, 2021)

transparent practices will assist a decision maker to prevent unauthorised access and will ensure that data handling aligns with ethical standards. This is particularly important for larger organisations, where data exposure risks are magnified by operational complexity.

To this end, it can be concluded that for decision makers to implement fundamental privacy controls, such as limited access and basic encryption, that multi-layered data protection frameworks ensure the safeguarding of sensitive data while supporting complex operations. This scalability is essential in allowing organisations to prioritise data security without compromising ethical standards, regardless of size and can be interpreted as a flexible approach to data governance that can somewhat guarantee that ethical transparency is maintained regardless of organisational size.

Conclusion Five: Adaptable Workforce Transition Programs

The findings revealed that adaptable reskilling programs directly addressed the potential displacement of workers by equipping them with skills for new roles created by drone technology, ensuring fair and equitable treatment of the workforce. To this end, it can be concluded that adaptable workforce transition programs support employees impacted by drone automation. Moreover, that by providing reskilling opportunities, that these programs will address the potential displacement of workers and equip them with the skills needed for emerging roles within the industry. This implication is especially pertinent for the cold supply chain, where drones may replace manual tasks, potentially disrupting labour markets. It is therefore recommended that in a practical context, that decision makers implement transition plans that address specific needs within the workforce and include reskilling options that lead to career pathways. This scalability ensures that both small and large organisations can uphold ethical labour standards.

Conclusion Six: Knowledge Structures for Responsible Drone Use and Risk Mitigation

The findings highlighted the importance of robust knowledge structures for responsible drone usage. The importance of this was articulated in the literature review findings, where it was held that unregulated advice may introduce ethical issues and missed educational opportunities for accurate knowledge creation about drone technology (Edet, 2022). Furthermore, the application of such advisement may also result in the adoption of questionable practices, that may have an adverse impact on knowledge management and decision-making processes (Frankenfield, 2020). Thus, it can be concluded that the ethical decision-making framework offers practical measures, such as phased deployment and pilot testing that support continuous evaluation of ethical risks associated with drone technology. Moreover, it can be concluded that for decision-makers, this approach mitigates misinformation risks and ensures that knowledge structures within organisations are regularly validated and aligned with ethical standards. It is therefore recommended that decision makers initiate knowledge validation with pilot programs that allows them to assess ethical risks in a manageable scope. Moreover, an adoption of extensive testing frameworks that continuously evaluate risks as technology scales is also advised. Against this backdrop, this structured approach to knowledge management provides flexibility, allowing decision makers to expand knowledge validation practices as drone integration becomes more complex.

Conclusion Seven: Sustainable Practices for Long-Term Ethical Compliance

The practical implication of the findings emphasised that continuous improvement in pursuit of long-term sustainability requires setting measurable environmental targets, where decision-makers must align drone operations with long-term sustainability goals. In this regard, the *Technoethics Ethical Decision-making Framework* advocates for a focus on initial sustainability goals, and to invest in extensive Research and Development for sustainable technology. This will ensure that drone-based service growth aligns with ethical and environmental priorities. Thus, it can be concluded that for the cold supply chain industry, where sustainability is increasingly critical, this focus on environmental accountability is key to fostering long-term ethical practices. This aligns with the industry’s broader goals of reducing environmental impact and supporting sustainable logistics.

To implement this, it is recommended that a decision maker consider making decisions that contribute to responsible growth without exceeding operational capacity. Moreover, that a decision maker invest in research and development focused on green technology, thereby advancing long-term innovation and environmental stewardship.

5. Limitations of the Study

Building on the findings and the conclusions drawn in terms of this study, it becomes important to acknowledge the limitations that emerged as follows:

5.1. Rapid Technological Evolution

A temporal limitation of this study was that the proposed *Technoethics Ethical Decision-Making Framework* might require regular updates to stay relevant within the evolving field of drone technology and artificial intelligence (AI). Moreover, the findings may need to be re-evaluated as new technological capabilities emerge and societal attitudes evolve. This limitation is significant since the ethical, operational, and societal challenges identified in the study may shift or become more complex as drone technology continues to advance.

5.2. Reliance on Current Ethical and Theoretical Frameworks

The study is primarily grounded in technoethics, along with supplementary ethical theories such as deontological ethics, social constructivism, and prospect theory. While these frameworks provide a solid foundation for analysing ethical dilemmas, they may not comprehensively address all emerging issues, especially those that future technological developments might present. Thus, the reliance on existing theoretical paradigms could limit the ability of the study to predict or respond to entirely new ethical challenges.

5.3. Participant and Data Limitations

Albeit the researcher did make an effort to approach the lawmakers of South Africa, participation was dependant on having rights to the research and dictating on its findings. This presented a limitation since the researcher needed to ensure the rigour and integrity of the study. Moreover, the South African Civil Aviation Authority (SACAA) was consulted and after more than four follow ups emails and telephone calls, no positive response was received especially given the nature of the study. The challenges in obtaining the participation of these critical entities presented a limitation in terms of participant diversity. Since the study had legal components that required expert opinions on the ambit of legal consequences, the limitation became a blind spot that affected the generalisability of the findings. Thus, the perspectives gathered may not represent the full spectrum of ethical and operational challenges that may potentially be faced by all actors involved in drone technology adoption and integration decision making. This is especially so for those in smaller or less-resourced organisations.

5.4. Practical Implementation Challenges

While the *Technoethics Ethical Decision-Making Framework* provides a theoretically robust approach to managing drone technology ethically, its practical implementation may face challenges. For example, smaller organisations may struggle with the resource-intensive nature of implementing the specified data governance structures, privacy-by-design, and adaptive governance practices. Therefore, it is important to acknowledge the potential limitation of the scalability of the framework may vary and have a dependency on the size, budget, and existing infrastructure an organisation.

5.5. Ethical and Regulatory Variability

The study acknowledges that the ethical and regulatory standards may vary widely across different jurisdictions within South Africa. The framework's recommendations, while detailed and context-specific, may not fully align with or be adaptable to other regulatory frameworks, especially in regions with either more stringent or more lenient regulations. This variability could limit the framework's effectiveness or require significant adjustments to meet different compliance requirements.

These limitations highlighted areas for future research that can deepen the understanding and application of the Technoethics Ethical Decision-Making Framework for drone technology adoption and integration. These key areas for future research were identified as follows:

i. Cross-Industry Applicability and Comparative Studies

Future research could explore the applicability of the *Technoethics Ethical Decision-Making Framework* beyond the cold supply chain industry. Comparative studies would be required across various sectors such as healthcare, agriculture, and construction to provide insights into how ethical considerations differ and how the framework might be adapted and scaled to meet unique industry requirements. This cross-industry analysis would assist to validate the framework's flexibility and scalability.

ii. Longitudinal Studies on Technological and Societal Evolution

Given the rapid evolution of drone and AI technologies, longitudinal research could assist to assess how ethical and societal challenges change over time. Studying the long-term impact of drone technology adoption and tracking how societal attitudes evolve, can assist futuristic research to identify new ethical dilemmas and refine the framework to remain relevant. This could include examining shifts in public perceptions of privacy and data security as drone technology becomes more ubiquitous.

iii. Regional and Cultural Variability

Further research could investigate how regional and cultural differences influence the ethical challenges associated with drone technology. Understanding how local regulatory environments, cultural norms, and societal values shape ethical decision-making would be valuable. Moreover, undertaking research in this context can contribute to the domain of social constructivism within a technoethical context This research could help customize the *Technoethics Ethical Decision-Making Framework* for different regions and explore how it can be adapted to align with varying legal and cultural standards.

iv. Practical Implementation and Scalability Studies

Exploring the practical implementation of the Technoethics Framework in organizations of different sizes and capacities is another key area for future research. Studies could examine the challenges and successes of implementing the framework in both small and large organizations, identifying best practices for scaling data governance, adaptive governance, and sustainability measures. This research could also develop case studies that provide concrete examples of how organizations can effectively implement ethical practices.

v. Emerging Ethical Dilemmas and Theoretical Refinement

As technology advances, new ethical dilemmas are likely to arise. Future research could focus on identifying and addressing these emerging challenges, such as the ethical implications of more advanced autonomous decision-making systems or the potential for drones to contribute to environmental degradation. Additionally, researchers could refine the theoretical underpinnings used within this study and that of the framework, integrating new ethical theories that address future challenges more comprehensively.

vi. Ethical Risk Management Frameworks for AI Integration

Given the increasing use of AI in drone technology, future studies could focus specifically on the ethical risk management of AI-driven autonomous systems. This research could develop frameworks that account for the unique challenges posed by AI, such as algorithmic bias, accountability in autonomous decisions, and the transparency of AI systems. These studies would be crucial in refining the Technoethics Framework to ensure robust ethical oversight in the integration of AI with drones.

vii. Stakeholder Engagement and Public Trust

Research could also delve deeper into effective strategies for stakeholder engagement and building public trust in drone technology. Investigating methods of transparent communication, public consultation, and community involvement would help refine the framework's recommendations for societal buy-in. This could include exploring how different demographic groups perceive drone technology and what measures are most effective in addressing their concerns. Moreover, such research endeavours should focus on how regional differences, such as cultural values and legal standards, influence ethical governance. This includes investigating these variations in terms of how it would provide insights into how the framework can be customised for different jurisdictions, contributing to the social constructivist understanding of technology ethics.

viii. Adaptive Governance in Response to Regulatory Changes

Future research could explore how adaptive governance models can respond effectively to changing regulations. As drone technology is subject to evolving legal frameworks, studies could examine how organizations can stay compliant while also anticipating future regulatory shifts. This research could provide strategies for maintaining ethical governance even as legal landscapes change, ensuring that organizations remain proactive rather than reactive.

ix. Environmental Impact Assessment and Green Technologies

Given the emphasis on sustainability in your findings, research could focus on the environmental impact of drone technology and the development of eco-friendly solutions. This could include evaluating the carbon footprint of drones, exploring renewable energy sources for drone operations, and assessing the long-term environmental benefits and drawbacks. Studies could also investigate the potential for drones to contribute positively to environmental monitoring and conservation efforts.

6. Concluding Remarks:

This study has made significant contributions to the understanding of the ethical challenges that may confront decision makers during drone adoption and integration of drone technology within the cold supply chain industry. The identifying and addressing gaps between the literature review and primary research findings, has highlighted critical areas for ethical oversight, including the need for adaptive governance, proactive risk management, and community engagement. Furthermore, the findings emphasised that ethical considerations are not just regulatory checkboxes but strategic imperatives that influence organisational resilience, public trust, and sustainable industry growth. A key strength of this study lies in its integration of technoethics as the central lens, complemented by theories such as deontological ethics, social constructivism, and prospect theory. This multidisciplinary approach has allowed for an understanding of the complex ethical landscape surrounding drone technology, addressing both immediate operational concerns and long-term societal impacts.

Thus, the contribution of the *Technoethics Ethical Decision-Making Framework* has provided a theoretically grounded model that addresses the prospective ethical, operational, and societal challenges that may be posed by drone technology in a more permissible commercial environment. The framework offered decision-makers structured guidance for balancing the efficiency and innovation benefits of drones with the ethical imperatives of privacy protection, data security, environmental sustainability, and social responsibility. However, despite its contributions, the study acknowledged certain limitations, such as the challenges in participant diversity and the framework's dependency on organisational capacity and regulatory variability. In light of these limitations, avenues for future research emerged, encouraging scholars to explore the framework's applicability across different industries, regions, and technological contexts.

Thus, the Technoethics Ethical Decision-Making Framework serves as a vital resource for navigating the ethical complexities of that may be introduced by the prospective harnessing of drone technology for commercial use. Moreover, as drone and AI technologies continue to evolve, the framework's emphasis on adaptability, transparency, and sustainability will remain crucial. Thus, this research contributes to creating a more ethically aware technological landscape, empowering decision makers to harness the potential of drones in ways that are both innovative and socially responsible.

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Appendix A: Literature Review Evidence Matrix

QUES Criteria	Keyword Searches	Data Source	Data to be Collected	Inclusion Criteria	Exclusion Criteria	Temporal Scope
Quality	Ethical considerations in drone integration within cold supply chains	▪ Peer-reviewed academic journals *inter alia*: ScienceDirect, JSTOR, EBSCOhost ▪ Conference proceedings relevant to logistics, supply chain, or drone technology ▪ Books from reputable publishers ▪ Scholarly websites of relevant research institutions	▪ Empirical evidence on ethical challenges of drone use in supply and cold supply chains e.g., privacy, safety, security. ▪ Frameworks for addressing ethical issues in advanced and emerging technologies including where possible, drone technology applications within cold chain and general supply chain logistics.	▪ Publications from reputable academic journals and conferences ▪ Empirical studies providing robust evidence on ethical considerations	▪ - Non-peer-reviewed sources - General articles not specifically addressing ethical issues in cold supply chain drone use	Last 5-10 years, with a focus on the most recent developments in the field
	Technoethics application within emerging technologies	▪ Books from reputable publishers and other industry related literature ▪ Scholarly websites of relevant research institutions	▪ Concepts and theories of technoethics relevant to drone technology and its applications. ▪ Ethical considerations in emerging technologies e.g., data privacy, security, environmental impact as they apply to technology and drone.	▪ Reputable books and industry literature ▪ Scholarly articles on technoethics	▪ - Non-scholarly websites - Non-reputable book publishers	Past 5-10 years, including seminal works that have significantly influenced the field
Usability	Privacy concerns in drone delivery, applications, use in supply chain etc.	All data sources	▪ Studies and industry reports directly addressing ethical challenges from drone integration in South African cold supply chains ▪ Prioritise data offering empirical evidence (case studies, surveys) or robust theoretical frameworks for ethical analysis.	▪ Empirical evidence (case studies, surveys) or robust theoretical frameworks for ethical analysis	▪ - Irrelevant sources (online forums, blogs for general enthusiasts) ▪ Articles lacking empirical or theoretical rigor	Recent studies and reports within the last 5-10 years
Extent	Recent developments in drone technology and ethics	▪ Reports from international bodies (e.g., FAO, World Bank, International Institute of Refrigeration) ▪ Industry association reports (drone industry bodies in South Africa)	▪ Data reflecting current drone technology, regulations, and ethical considerations ▪ reports from relevant government agencies, industry associations, and international organisations.	▪ Consider grey literature (reports from reputable organizations) alongside academic sources. ▪ Range of publication dates past 5-10 years for recent developments.	▪ Outdated publications (older than 10 years unless seminal) ▪ Grey literature from non-reputable sources	Last 5-10 years, including relevant seminal works

Scope	International best practices in drone use	▪ Reports from international bodies (e.g., FAO, World Bank, International Institute of Refrigeration) ▪ Case studies published by industry leaders or research institutions ▪ South African government reports (Department of Transport, Civil Aviation Authority) ▪ Industry association reports (drone industry bodies in South Africa)	▪ Include case studies of drone use in cold supply chains globally, focusing on ethical considerations and best practices. ▪ Analyse regulations and guidelines specific to South Africa alongside international best practices.	▪ Case studies and reports from reputable international and national organisations ▪ Comparative studies on international best practices and regulations	▪ Non-specific international reports not addressing cold supply chain ▪ General regulatory reports not focused on drone	Last 5-10 years, with a focus on the most relevant and recent developments in best practices and regulations

Appendix B: Unit of Analysis, Unit of Observation and Inclusion and Exclusion Criteria for the Sample Population of the study

Theme	Unit of Analysis	Unit of Observation		
Theme One: The critical importance of discerning capabilities and functionalities between remotely operated and automated drones	How decision-makers navigate the ethical and legal implications of remotely operated vs. autonomous drones (privacy, rogue actions, informed consent).	Interviews and insights from decision makers on policy development, investment decisions, and technology implementation.	▪ Decision-makers involved in strategic or operational decisions that would have the mandate to decide on the adoption of drone technologies. ▪ Individuals that would be responsible for assessing ethical and legal implications of drone technology in supply chain operations.	▪ Individuals without decision-making authority. ▪ Professionals not involved in addressing privacy and security aspects of technology at a strategic level.
Theme Two: Ethical considerations linked to the technological integration of drone technology within an organization's existing technological estate	How decision-makers handle the technical integration, transparency, and ethical concerns in SDLC and data management.	Observing the compliance frameworks and operational processes that ensure the ethical integration of drone technology.	▪ Decision-makers that would be responsible for technology integration and compliance within the organisation. ▪ Professionals involved in operational decision-making processes regarding technology and technological applications and processes. ▪ Individuals who participate in the Software and Systems Development Life Cycle (SDLC) and data handling processes.	▪ Individuals not involved in compliance, technology, or operational decision-making. ▪ Professionals without a role in SDLC or data handling related to technology.
Theme Three: Ethical considerations linked to fair business practices and the broader implications for labou and employment practices	How decision-makers ensure fair competition and address labour concerns (job displacement, gig economy).	Insights from SMEs and operational managers on how drone technology affects competitiveness, labour practices, and workforce dynamics.	▪ Senior decision-makers that would be responsible for the strategic adoption of technology. ▪ Professionals involved in ensuring compliance with labour and employment practices. ▪ Individuals involved in technological and operational decision-making regarding technological adoption.	▪ Individuals without senior decision-making authority. ▪ Professionals not involved in labour, compliance, or operational aspects of technology.
Theme Four: Knowledge structures informing best practices, guidelines, and responsible use of drone technology	How decision-makers develop and enforce guidelines for responsible and sustainable drone use.	Insights into the development of best practices, compliance monitoring, and risk mitigation frameworks.	▪ Decision-makers that would be responsible for strategic decisions on the adoption, integration, and operation of technology, and that would be involved in decisions of drone technology. ▪ Professionals influencing the use of technology within the cold supply chain industry. ▪ Individuals involved in developing best practices, skills development policies and guidelines for technology use within organisations.	▪ Individuals not involved in strategic decision-making regarding drone technology. ▪ Professionals outside the cold supply chain industry or with no influence on drone technology use.

Appendix C: Primary Data Collection Evidence Matrix

Decision Maker	Decision Making Capacity	Q	U	E	S	Information Power Analysis
		Quality of Evidence	**Usefulness of Evidence**	**Extent of Evidence**	**Scope of Evidence**	
Strategic Manager	Executive Management	High (Insights into potential challenges and ethical considerations in cold chain)	High (Critical for understanding industry-specific ethical concerns)	Broad (Ethical concerns across cold supply chain drone operations - safety, security, privacy, etc.)	Moderate (Focus on high-level ethical considerations, may lack specific operational details)	High information power due to strategic decision-making, industry knowledge, and potential to influence the harnessing of commercial drone use across the cold supply chain industry.
Operational Managers	Middle Senior Management	Moderate (Practical insights into ethical issues during operations)	Moderate (Focus on specific areas like route planning, temperature control)	Moderate (Detailed descriptions of ethical concerns in their domain - e.g., data security during delivery)	Moderate (Focus on high-level ethical considerations, may lack specific strategic outlook on operational details)	Moderate information power due to decision-making on specific drone operational strategies, and potential insights into practical ethical concerns.
Compliance Managers	Middle Senior Management	High (Directly relevant to identifying new ethical gaps with relaxed regulations)	Moderate (Focus on compliance with existing regulations, may need prompting to explore broader issues)	Detailed (Analysis of how relaxed regulations might create new ethical challenges in cold chain drone operations)	High (Focus on potential ethical considerations, but may lack specific operational details)	High information power due to expertise in regulations and ability to identify ethical gaps arising from relaxed regulations in the cold chain context.
Technology Managers	Middle Senior Management	Moderate (Insights into technical aspects of ethical challenges - data privacy, security breaches)	Moderate (Focus on technology - e.g., data encryption, drone malfunctions)	Detailed (Analysis of technical risks and potential ethical implications specific to cold chain drone operations)	High (Focus on potential ethical considerations, but may lack specific operational details)	Moderate information power due to expertise in drone technology, but may lack broader understanding of strategic and operational ethical or social implications specific to cold supply chain industry.

Appendix D: Interview Question Framework for Senior Managers, Compliance Mangers and Operational Managers

Question	SPICE Framework alignment		Research Objectives
What is your current capacity/designation?	Situation	n/a	RO1: Understanding the respondent's current role provides context on their perspective, informing critical ethical considerations.
What is your education background linked to technology?	Situation	n/a	RO1: Insight into the respondent's education helps assess their foundational knowledge, which is relevant for ethical decision-making.
Can you share your general understanding of drone technology and your perceptions or assumptions you may have, even if it's based on informal use or media portrayals?	Situation or Scenario	Theme One: This question explores participants' understanding of drones, aligning with the need to differentiate between drone types and their functionalities.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
How do you perceive the role of technological advancements, specifically drone technology, in shaping the future of the cold supply chain industry?	Situation or Scenario	Theme Two: This question investigates the role of drone technology in future advancements, aligning with the technical and operational integration of drones in the cold supply chain.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
How prepared do you think organisations within the cold supply chain industry are for the adoption and integration of Drone technology?	Problems or Perceptions	Theme Two: This question examines organizational preparedness for drone integration, which aligns with the sub-theme on interoperability challenges within existing systems.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
In your perspective, do you agree that these specific strategic benefits may be derived from incorporating drone technology into their operations?	Problems or Perceptions	Theme Three: This question assesses the strategic benefits of drone technology, aligning with fair business practices and ensuring competitive positioning in the market.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
In what ways could organisations leverage Drone technology to differentiate themselves from competitors and enhance their market position?	Impact or Implication	Theme Three: This question examines the competitive advantages of drone technology, aligning with the sub-theme on preventing anti-competitive behaviour and supporting fair market practices.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
Can you describe your understanding of the differences between remotely operated and automated drone?	Situation or Scenario	Theme One: This question focuses on the differences between drone types, aligning with the theme of discerning capabilities and functionalities in decision making.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
Do you believe it is necessary for an executive management or senior management of an organisation to understand these differences, or should the responsibility be left to the technology manager?	Problems or Perceptions	Theme One: This question evaluates leadership's understanding of drone differences, aligning with the operational need for management to comprehend drone capabilities.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
As a decision maker, what are your views on the collection of data in a manner that is balanced with respecting broader societal rights?	Choices	Theme One: This question addresses the ethical aspects of data collection, aligning with the theme on ethical constructs, especially around privacy and informed consent.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
In your opinion, what challenges or limitations can you foresee confronting an organisation operating within the cold supply chain, and how will these impact the adoption feasibility of Drone initiatives within the cold supply chain industry?	Problems or Perceptions	Theme Two: This question explores potential challenges for drone adoption, aligning with the technical and operational challenges of integrating drones into existing supply chains.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
In your opinion, what ethical considerations should be integrated into the assessment and decision-making processes concerning the decision to adopt drone technology?	Choices	Theme One: This question examines the ethical considerations in adopting drones, aligning with the ethical constructs involved in drone deployment.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
From your perspective, should an ethical reasoning framework underpin a decision-maker's drone-based decisions?	Choices	Theme One: This question focuses on the need for an ethical framework in drone decision-making, aligning with the theme of ethical constructs and moral behaviour.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
From your perspective, how would you navigate the ethical responsibility between leveraging the strategic benefits and innovation offered by Drone technology while upholding fair business practices?	Choices	Theme Three: This question explores balancing innovation with fair business practices, aligning with the theme of ensuring ethical business conduct while adopting new technologies.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
Are you familiar with the term Gig economy?	Evaluation or Experiences	Theme Three: This question assesses familiarity with gig economy concepts, aligning with the impact of drones on labour and employment practices.	RO3: Determine how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.
From your perspective, how would you approach the polarising perspectives of job creation versus job destruction based on the automation by drone when taking the decision to adopt drone technology?	Impact or Implication	Theme Three: This question examines the implications of drone automation on jobs, aligning with the labour and employment sub-theme, particularly regarding job displacement.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
Would you be of the opinion that an organisation is responsible for the actions of a drone operator, and that the liability of "gig-economy" workers are their sole responsibility?	Choices	Theme Three: This question addresses the responsibility for gig-economy workers, aligning with the theme of labour implications and organisational liability.	RO3: Determine how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.
From your perspective, how would you approach the implications of automation by drone, and prioritise fairness and equity of existing workers vs gig economy engagement?	Impact or Implication	Theme Three: This question examines fairness between current workers and gig workers in light of drone automation, aligning with the ethical imperative of fair labour practices.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
From your perspective, do you foresee any litigation by employees with respect to their expectation of job creation versus job destruction by an organisations decision to adopt drone, and their right to litigation in this respect?	Impact or Implication	Theme Three: This question explores potential legal disputes over job displacement, aligning with the theme of labour implications and employment law concerns.	RO3: Determine how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.
How would you approach the risk of tort liability for harm and injury resulting from Drone operations accentuates the responsibility of organizations to adhere to ethical guidelines?	Impact or Implication	Theme One: This question examines legal risks and liability, aligning with the sub-theme on the legal implications of drone operations and the importance of adherence to ethical guidelines.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
How would you approach the risk mitigation strategies with respect to a rogue decision made by an autonomous drone post the decision made and as a cause of injury to a member of society?	Impact or Implication	Theme One: This question explores risk mitigation in autonomous drone operations, aligning with legal ramifications and organizational responsibility in drone decision-making.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
In your opinion, should an organisation have a drone-based centre/knowledge structure?	Choices	Theme Four: This question focuses on the importance of establishing knowledge centers, aligning with the theme of knowledge structures to support ethical decision-making.	RO3: Determine how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.
How much of a drone-based advocacy group would you approach to underpin the knowledge of drone within your organisation and for yourself as a decision maker for that matter?	Evaluation or Experiences	Theme Four: This question explores the engagement of advocacy groups for drone knowledge, aligning with the need for reliable and centralized knowledge structures.	RO3: Determine how the ethical decision-making framework can be developed into a scalable monitoring and evaluation tool for ongoing assessment of drone-based decisions.
What best practices do you think should be put in place for an organisation that would be adopting and utilizing drone in the cold supply chain industry?	Evaluation or Experiences	Theme Four: This question examines best practices for drone adoption, aligning with the theme of risk mitigation and compliance with industry standards.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.
What are your views toward the current restrictive regulatory environment that constrains the commercial exploitation of drone within the cold supply chain industry?	Evaluation or Experiences	Theme Four: This question addresses regulatory challenges, aligning with the theme of ensuring compliance to mitigate risks in drone-based operations.	RO1: Identify and evaluate the critical ethical considerations that must be addressed when confronted with ethical challenges in the new and more permissive regulatory environment.
Should governments provide support for the commercial exploitation of drone within the cold supply chain industry?	Evaluation or Experiences	Theme Three: This question explores the role of government in promoting fair competition and market support, aligning with the sub-theme of ethical challenges and anti-competitive behaviour.	RO2: Examine the best practices associated with the established ethical considerations that must be incorporated into an ethical decision-making framework to address ethical challenges encountered.

Appendix E: Interview Questions for Technology Manager and Skills development Seta

Question	SPICE Framework alignment	Themes of the theoretical framework	Research Objectives
What is your current capacity/designation?	Situation	**Theme One: This question explores general perceptions of drone technology, aligning with the differentiation of drone types and understanding their capabilities.**	RO1: Understanding the respondent's current role provides context on their perspective, informing critical ethical considerations.
What is your education background linked to technology?	Situation	Theme Two: This question focuses on technological advancements and future benefits, aligning with the theme of drone integration within the supply chain.	RO1: Insight into the respondent's education helps assess their foundational knowledge, which is relevant for ethical decision-making.
Can you share your general understanding of drone technology and your perceptions or assumptions you may have, even if it's based on informal use or media portrayals?	Situation	Theme One: This question addresses decision-making challenges in differentiating drone types, aligning with understanding the functional distinctions between drones.	RO1: Gauging general understanding and perceptions aids in identifying potential ethical challenges from different knowledge levels.
As a technology manager, what do you envision as the most significant advancements in the commercial harnessing of drone technology within the next 5-10 years, particularly in the context of the supply chain industry?	Impact	Theme Three: This question explores the use of drone technology for competitive advantage, aligning with addressing anti-competitive behaviour and market positioning.	RO1: Anticipating advancements helps in identifying future ethical considerations that need to be addressed.
What challenges do you anticipate organizations facing when decision makers discern the capabilities and functionalities between remotely operated and automated drone in the future regarding the adoption of drone technology for commercial benefits?	Problems/Perceptions	Theme Two: This question focuses on integration issues, aligning with the theme of challenges related to drone technology interoperability within existing systems.	RO1: Understanding anticipated challenges aids in identifying specific ethical considerations related to decision-making.
How do you envision organisations leveraging the commercial application of drone technology to gain competitive advantages and to address potential operational inefficiencies in the cold supply chain industry of the future?	Choices	Theme Two: This question examines ethical concerns surrounding data security and privacy in drone technology integration, aligning with the ethical implications of the data lifecycle.	RO1, RO2: Evaluating strategic applications aids in identifying ethical challenges and best practices for leveraging drone technology.
In your experience, what are the main interoperability challenges that an organization may face or that you foresee being encountered with the integration of drone technology with existing systems and processes?	Problems/Perceptions	Theme Four: This question explores the impact of decision-making on trust and legitimacy, aligning with ethical frameworks and the continuous improvement of decision-making processes.	RO1: Identifying interoperability challenges highlights key ethical considerations in technology integration.
In your opinion, do you believe interoperability challenges may impact the ethical dimensions of drone technology integration, particularly in terms of data management, privacy, and security?	Impact	Theme Two: This question examines ethical concerns surrounding data security and privacy in drone technology integration, aligning with the ethical implications of the data lifecycle.	RO1: Exploring the ethical impact of interoperability challenges helps in identifying necessary ethical considerations.
How do you perceive the role of decision-making approaches in distinguishing between automated and unautomated technology that leads to legitimacy and trustworthiness in decision-making, particularly in the context of the Fourth Industrial Revolution technologies such as drone technology?	Evaluation/Experiences	Theme Four: This question explores the impact of decision-making on trust and legitimacy, aligning with ethical frameworks and the continuous improvement of decision-making processes.	RO1: Understanding decision-making approaches aids in identifying ethical considerations necessary for legitimacy and trustworthiness.
Do you agree with this finding or do you have a different perspective on this? (Referring to findings on SDW and DLM) "Findings of the literature review recognised that the manifestation areas of SDW have implications for the data-lifecycle management (DLM) process of Drone-based data. On this basis, the literature review asserts that there is a need for transparency to be embedded in the drone-based Data Lifecycle Management (DLM) processes. Moreover, that this is critical during drone-based data collection as the lack of transparency regarding data handling, storage, and transmission may raise ethical implications about privacy and data security."	Evaluation/Experiences	Theme Two: This question assesses the participant's views on Software Development Waste (SDW) and Data Lifecycle Management (DLM), aligning with transparency in data management and ethical practices.	RO1, RO2: Engaging with findings helps to refine and validate the ethical considerations identified. Validating the need for transparency helps identify critical best practices for ethical data management.
At this point of the interview, would you be of the opinion that there would be a demand for variation of technologies?	Choices	Theme One: This question probes the need for technological variation, aligning with how different drone types can be utilized based on their operational differences.	RO1: Understanding the demand for technological variation helps in identifying ethical considerations tied to diverse technologies.
Given the intricate nature of drone technology, are you of the opinion that the integration into the existing infrastructure of an organisation has the potential for Software Development Waste (SDW)?	Impact	Theme Two: This question examines the risk of SDW during drone integration, aligning with transparency and operational efficiency in drone-based processes.	RO1: Identifying SDW potential helps highlight ethical concerns in technology integration and development.
How would you approach erroneous feature development, potential malpractice, and resource misallocation in IT-based plans to ensure efficient development processes and resource utilization within your organization?	Choices	Theme Two: This question addresses decision-making strategies to prevent resource misallocation, aligning with transparency in development processes.	RO1, RO2: Exploring strategies for mitigating malpractice and resource misallocation aids in identifying best practices.
How would you make decisions around transparency in drone-based processes with regards to drone-based data along within the data lifecycle management?	Choices	Theme Two: This question explores transparency in the data lifecycle, aligning with ethical considerations in managing drone-based data.	RO1, RO2: Understanding transparency decision-making helps in identifying best practices for ethical data management.
What would be your approach to risk mitigation plans that would enhance ethical considerations associated with interoperability challenges?	Choices	Theme Two: This question probes how to address ethical issues related to drone interoperability, aligning with strategies for mitigating risks in system integration.	RO1, RO2: Exploring risk mitigation strategies helps identify best practices for addressing ethical interoperability challenges.
What best practices do you think should be put in place for an organisation that would be adopting and utilizing drone in the cold supply chain industry?	Evaluation/Experiences	Theme Four: This question explores best practices for drone adoption, aligning with the need for compliance and operational efficiency in the supply chain.	RO1, RO2: Identifying best practices directly informs the development of an ethical decision-making framework.
As a technology manager, how would you address any challenges associated with informed consent during the deployment of drone technology within the cold supply chain industry?	Choices	Theme One: This question addresses informed consent challenges, aligning with ethical considerations in drone-based decision-making.	RO1, RO2: Exploring informed consent challenges aids in identifying critical ethical considerations and best practices.
As a technology manager, how would you address any challenges associated with regulatory complexities and responsible governance in the deployment of drone technology within the cold supply chain industry?	Choices	Theme Four: This question explores governance and regulatory complexities, aligning with best practices and responsible governance in drone deployment.	RO1, RO2: Addressing regulatory challenges helps identify best practices for responsible governance.
In your opinion, what role should organizations play in policy development and stakeholder collaboration to address regulatory challenges and promote responsible drone technology deployment within the cold supply chain industry?	Evaluation/Experiences	Theme Four: This question examines policy development and collaboration, aligning with establishing a knowledge structure for responsible drone use.	RO1, RO2: Exploring organizational roles in policy development helps identify best practices for responsible deployment.
In your opinion, what knowledge base should organizations rely on in terms of their drone-based policy development and training initiatives to promote responsible commercial drone use and drone technology implementation?	Evaluation/Experiences	Theme Four: This question focuses on the knowledge base for policy and training, aligning with knowledge structures and the need for centralized drone expertise.	RO1, RO2: Identifying knowledge bases helps inform the development of training initiatives and best practices.
How do you envision the establishment of a centralized drone knowledge center enhancing collaboration, mitigating misinformation risks, and facilitating informed decision-making among stakeholders within the cold supply chain industry?	Choices	Theme Four: This question addresses how knowledge centers facilitate decision-making, aligning with the mitigation of misinformation risks through centralized knowledge sharing.	RO2: Understanding the impact of a centralized knowledge center helps develop a framework for ongoing ethical decision-making.
How much of a drone-based advocacy group would you approach to underpin the knowledge of drone within your organisation and for yourself as a decision maker for that matter?	Choices	Theme Four: This question explores the role of advocacy groups in drone knowledge, aligning with the importance of centralized knowledge structures in decision-making.	RO1: Exploring advocacy group engagement helps identify ethical considerations for knowledge dissemination.
Should governments provide support for the commercial exploitation of drone within the cold supply chain industry?	Evaluation/Experiences	Theme Three: This question examines government support for drones, aligning with preventing anti-competitive behaviour and promoting fair market practices.	RO1, RO2: Assessing governmental support helps identify ethical considerations and best practices for responsible exploitation.
As a decision maker, would you benefit from a drone-based ethical decision-making framework, and is it needed in the cold supply chain industry?	Choices/Evaluation/Impact	Theme Four: This question addresses the need for ethical frameworks in decision-making, aligning with continuous improvement and the need for ethical guidance in drone technology adoption.	RO1, RO2: Understanding the need for a decision-making framework directly informs the development of best practices and ongoing assessment.

Appendix F: Research Participant Letter of Information

Participant Information Sheet

Dear Prospective Research Participant,

I trust this communique finds you well.

My name is Amanda Vester, a PhD candidate currently enrolled at the University of the Witwatersrand Digital Business School in Johannesburg, South Africa. You have been identified as a prospective research candidate to participate in my PhD study titled: *Navigating drone-based ethical decision making: A technoethics framework for the responsible use of drone technology within the cold supply chain industry of South Africa*

My research focuses on investigating the potential ethical challenges that may arise if the current restrictive regulatory environment and lack of South African government support, impeding the widespread commercial adoption and utilisation of Drone technology within the cold supply chain industry in South Africa is relaxed. To this end, your insights and perspectives are crucial to the success of this study, in so far that a decision maker such as yourself would be able to shed light on the prospective challenges and ethical considerations that would need to be accounted for during drone based decision making when adopting for commercial use thereof.

Moving form this premise, I am specifically seeking to conduct a 30-minute interview with you, to enhance an understanding of the ethical considerations associated with drone technology adoption, and to establish its application during decision making of drone technology within the cold supply chain industry of South Africa. Please note that this study has been cleared by the ethics committee of the University of Witwatersrand, under ethics clearance number H23/10/32. Should you have any questions, the committee is contactable on:

The University Human Research Ethics Committee (Non-Medical),
T: +27(0) 11 717 1408
E: hrecnon-medical@wits.ac.za.

Should you need to check the authenticity of this study, you are more than welcome to contact my research supervisor:

Professor Eric Schaling
T: +27 11 717 3660
E: Eric.Schaling@wits.ac.za

If you decide to participate in this critical study, your participation in this research study will last about 30-min, and will be conducted through a Microsoft Teams online meeting platform. Alternatively, if you

Page **1** of **2**

Participant Information Sheet

are within the Cape Town metropole area, and wish to have a contact session, I am willing to meet with you for a contact interview. With your permission, the interview will be audio recorded to assist myself as the principle researcher with the transcription of the interview for data analysis purposes only.

The interview will be treated as confidential and your identity will remain anonymous. No personal information will be required to be provided by you, and neither are you required to provide any of your organisation's details. The study is purely seeking your insight and perspective. Therefore, if you decide to take part in the research study, it should be because you volunteer to do so. Furthermore, your rights will be respected in terms of abstaining from answering any questions during the interview, and that you can stop your participation in this study at any time.

Furthermore, data that I will collect during this interview will only be used for the purposes of this study, and toward the completion of my degree. During this reporting process, I will not include your name or anything else that could identify you. This data will be stored in password protected cloud storage folder that is only accessible by myself as the principle investigator, and will only be kept for 1 year and deleted thereafter. Therefore, only myself as the principle researcher will have access to the data.

Taking part in the research study will not cost you anything, and you will not be paid for participating in this research study. Moreover, you will not lose any services, benefits or rights you would normally have if you decide not to participate.

Lastly, there are no known risks that has been identified by the university's ethics committee for this research study. Furthermore, this research study will be written up as a research report, and will be available on the university's library website post the examination thereof for your information.

I appreciate your consideration in advance toward your willingness to contribute to this research, and therefore look forward to the possibility of your participation.

Kind Regards,
The Principal Researcher: Amanda Vester
PhD Candidate University of the Witwatersrand Digital Business School Johannesburg, South Africa
T: 063 619 4398
E: 2649135@students.wits.ac.za

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Appendix G: Research Participant Consent Form

Wits Business School

Research Participant Consent

Dear Research Participant,

Thank you for your willingness to participate and contribute your insights and perspectives in this critical study.

This consent form is a necessary artefact required as part of my PhD examination and to suffice the ethics committee requirements in terms of conducting my study.

You do not have to supply your name or any other personal or company information.

Sign in to Google to save your progress. Learn more

* Indicates required question

Date of scheduled interview *

Date: yyyy/mm/dd

Time: :

I, as the research participant completing this consent form agree to participate in the research study titled: "*Navigating drone-based ethical decision making: A technoethics framework for the responsible use of Drone technology within the cold supply chain industry of South Africa*" *

On this basis, my consent is subject to the terms and conditions of my consent contained herein

- ◯ I agree
- ◯ I disagree

I confirm that the nature of this research study has been thoroughly explained to me, and I understand the purpose of the study. *

- ◯ Yes
- ◯ No
- ◯ I agree, but look forward to the interview to fully understand the nature of the study

I understand that I am participating in this study on a voluntarily basis, and that I have the option to withdraw at any time without facing any consequences. *

- ◯ Yes
- ◯ No

I agree to an interview with the principal research investigator Amanda Vester, and also agree that any direct quotations only from my interview may be used within her research report/thesis and subsequent publications stemming from this research study, to the exclusion of any form of identification of myself as the research participant *

- ◯ Yes
- ◯ No

I consent to the audio recording of my interview with the principal researcher, and understand that the recording will only be used for transcription purposes of my interview only. *

- ◯ Yes
- ◯ No

I acknowledge that my participation will contribute to this study, but as a participant, my identity will strictly remain anonymous, and that my interview data will be referenced as "a participant operating in the cold supply chain industry, as well as my decision making capacity and industry". *

I agree that this is the only reference that will be recorded together with my verbal participation.

- ◯ Yes
- ◯ No

I acknowledge that by completing this consent form, that I give the principal research investigator Amanda Vester, consent to participate in the study that she is conducting whilst being a PhD candidate at the University of Witwatersrand. *

- ◯ I agree
- ◯ I disagree

Submit — Clear form

Appendix H: S1 Emergent Codes

	Row Labels	Count of L1 Emergent Code
Code	Automated Temperature Monitoring	1
Code definition	Benefits of automated temperature monitoring	1
Code	Drone Travel Distance	1
Code definition	Concerns about how far drone can travel	1
Code	Efficiency Improvement	1
Code definition	Expectation of improved efficiency and turnaround times	1
Code	Future Expectations	1
Code definition	Expectations about the future size and capacity of drone	1
Code	Impractical for Bulk	1
Code definition	Perception of drone being impractical for bulk transportation	1
Code	Limitation of Technology	1
Code definition	Limitations in technology acceptance	1
Code	Packaging and Safety	1
Code definition	Concerns about packaging and food safety	1
Code	Potential in Cold Supply Chain	1
Code definition	Drone' potential use in cold supply chain	1
Code	Refrigeration and Quality	1
Code definition	Importance of refrigeration and quality requirements	1
Code	Sensory Capacity	1
Code definition	Awareness of sensory capacity within warehousing systems	1
Code	Strategic Benefits	1
Code definition	Benefits of drone for the organization	1
Code	Best Practices and Standards	1
Code definition	Need for best practices and standards	1
Code	Government Support	1
Code definition	Support for local drone initiatives	1
Code	Preparedness of Organizations	1
Code definition	Readiness of organizations to adopt drone technology	1
Code	Regulatory Compliance	1
Code definition	Compliance requirements for transporting cold foods	1
Code	Digital Divide	1
Code definition	Digital divide impacting drone technology adoption	1
Code	Literacy and Digital Divide	1
Code definition	Challenges due to literacy issues and digital divide	1
Code	Ethical Considerations	1
Code definition	Ethical considerations in drone usage	1
Code	Importance of Explicit Knowledge	1
Code definition	Necessity for GMs to have explicit knowledge of drone technology	1
Code	Need for Ethical Framework	1
Code definition	Necessity of an ethical framework for drone use	1
Code	Profit vs. Ethics	1
Code definition	Balancing profit and ethical considerations	1
Code	Privacy and Safety	1
Code definition	Concerns about privacy and safety with drone use	1
Code	Privacy Concerns	1
Code definition	Privacy issues with drone collecting data	1
Code	Legal Implications	1
Code definition	Potential legal implications of selecting the wrong drone	1
Code	Limited Scope of Current Use	1
Code definition	Current limited scope of drone technology	1
Code	Operational Inadequacies	1
Code definition	Potential operational inadequacies from selecting the wrong drone	1
Code	Regulatory Compliance	1
Code definition	Following government regulations while considering ethical implications	1
Code	Risk Mitigation	1
Code definition	Best practices for risk mitigation	1
Code	Safety Concerns	1
Code definition	Concerns about safety issues with drone	1
Code	Warehouse Management	1
Code definition	Existing use of warehouse management systems	1
Code	Strategic Benefits	1
Code definition	Strategic benefits associated with technology	1
Code	Environmental Impact	1
Code definition	Environmental impact considerations related to drone technology	1
Code	Impact on Small Enterprises	1
Code definition	Impact of drone on small and micro enterprises	1
Code	Responsibility to SMEs	1
Code definition	Responsibility to support small enterprises	1
Code	Unfair Business Practices	1
Code definition	Concerns about unfair business practices and anti-competitive behaviour	1
Code	Gig Economy	1
Code definition	Understanding and impact of the gig economy	1
Code	Gig Economy Understanding	1
Code definition	Familiarity with gig economy	1
Code	Responsibility for Gig Workers	1
Code definition	Responsibility for actions of gig economy workers	1
Code	Understanding of Gig Economy	1
Code definition	Understanding of gig economy and its implications	1
Code	Workforce Protection	1
Code definition	Balancing technological advancement with workforce protection	1
Code	Current Drone Laws	1
Code definition	Awareness of current drone laws	1
Code	Need for government support and regulation	1
Code	Skill Scarcity	1
Code definition	Scarcity of skills and reliance on gig economy	1

Code	Skill Shortage	1
Code definition	Impact of skill shortage on drone operations	1
Code	Upskilling Challenges	1
Code definition	Difficulty in upskilling current workforce	1
Code	Data Collection	1
Code definition	Concerns about data collection by drone	1
Code	Operational Transparency	1
Code definition	Need for transparency about data collection and drone use	1
Code	Autonomous Drone	1
Code definition	Legal implications of autonomous drone	1
Code	Data Security	1
Code definition	Security of data with drone technology	1
Code	Legal Implications	2
Code definition	Legal implications of drone technology	1
Code	Potential legal implications of drone adoption	1
Code	Ethical Decision-Making Framework for problem-solving	1
Code definition	Need for external consultation for impact assessment	1
Code	Knowledge and Training	1
Code definition	Responsibility for knowledge and training	1
Code	Need for Knowledge	1
Code definition	Need for more knowledge on drone technology	1
Code	Privacy Concerns	1
Code definition	Privacy concerns with drone	1
Code	The role, use and reliance on drone advocacy groups	1
Code definition	Trust in drone advocacy groups	1
Code	Learning from Others	1
Code definition	Learning from other establishments already using similar technology	1
Code	Robotic Systems	1
Code definition	Plans to implement robotic systems in new cold storage facilities	1
Code	Automation and Job Loss	1
Code definition	Impact of automation on employment	1
Code	Job Creation vs. Destruction	1
Code definition	Balancing job creation and destruction with autonomous drone	1
Code	Role of Fairness	1
Code definition	Equity and fairness in employment decisions	1
Code	Workforce Impact	1
Code definition	Impact of automation on existing workforce	1
Code	Digital Divide	1
Code definition	Impact of digital divide on technology adoption	1
Code	Lack of Research	1
Code definition	Lack of research on legality and broader use of drone	1
Code	Business Logic	1
Code definition	Importance of business logic in programming drone	1
Code	Cost Implications	1
Code definition	Cost implications of automation and skilled labour	1
Code	Existing Infrastructure	1
Code definition	Mention of existing infrastructure like rail systems used in the past	1
Code	Facility Adaptations	1
Code definition	Need for special adaptations to facilities for drone integration	1
Code	Feasibility and Limitations	1
Code definition	Potential limitations of drone adoption	1
Code	Loading Infrastructure	1
Code definition	Existing loading infrastructure is designed for trucks, not drone	1
Code	Organizational Preparedness	1
Code definition	Belief that organizations are unprepared for drone adoption	1
Code	Technological Advancements	1
Code definition	Acknowledgment of AI and autonomous vehicles	1
Code	Trust in Technology	1
Code definition	Trust issues with local vs. international technology	1
Code	Technological Advancement	1
Code definition	Acknowledgment of technological advancements in the supply chain	1
Code	Societal Acceptance	1
Code definition	Acceptance of technology by broader society	1
Code	Informed Consent	2
Code definition	Challenges in informed consent and broader societal acceptance	1
Code	Need for community informed consent	1
Code definition	Regulatory Standards	1
Code	Need for regulatory standards for drone	1
Code definition	Social Inequality	1
Code	Impact of social inequality on technology adoption and training	1
Code	Job Creation vs. Job Destruction	1
Code definition	Balancing job creation and job destruction	1
Code	Human Error vs. Machine Error	1
Code definition	Comparison of human error and machine error	1
Code	Risk of Automation	1
Code definition	Risks associated with autonomous drone	1
Code	Competitive Differentiation	1
Code definition	Potential for drone to differentiate a company competitively	1
Code	Cost Reduction	1
Code definition	Expectation of cost reduction with drone implementation	1
Code	Infrastructure Investment	1
Code definition	High cost of infrastructure investment, such as generators	1
Code	Maintenance Cost Savings	1
Code definition	Potential for cost savings from reduced maintenance	1
Code	Market Differentiation	1
Code definition	How drone can provide a competitive edge	1
Code	Autonomous Drone	1

Code definition	Preference for autonomous drone over remotely operated	1
Code	Autonomous vs. Remotely Operated Drone	1
Code definition	Understanding of the difference between autonomous and remotely operated drone	1
Code	Management Understanding	1
Code definition	Importance of executive management understanding drone technology	1
Code	Understanding of Remote and Autonomous Drone	1
Code definition	Difference between remote-operated and autonomous drone	1
Code	Drone Carrying Capacity	1
Code definition	Concerns about the limited carrying capacity of drone	1
Code	Drone Operation Understanding	1
Code definition	Understanding of drone operation methods	1
Code	General Understanding of Drone	1
Code definition	Participant's basic knowledge about drone	1
Code	Drone Limitations	1
Code definition	Limitations of drone for heavy logistics	1
Code	Online and Retail Use of drone	1
Code definition	Potential use of drone for online retail and medical sectors	1
Code	Small Consignment Use of drone	1
Code definition	Awareness of drone use for small consignments from conversation with Ghana contact	1
Code	Stocktaking Innovation of drone	1
Code definition	Acknowledgment of drone' potential for stocktaking and warehouse operations	1
Code	Balancing Good and Bad in the context of drone and drone technology	1
Code definition	The difficulty of balancing technological adoption with job preservation	1
Code	Government Framework	1
Code definition	Need for legally binding laws and frameworks established by the government for drone operations	1
Code	Government Intervention	1
Code definition	Belief that government intervention is needed to regulate drone rollout and protect employment	1
Code	Sectoral Collaboration	1
Code definition	Need for collaboration between private and government sectors or NGOs for successful implementation	1
Code	COVID-19 Vaccine Rollout	2
Code definition	Experience and challenges during the COVID-19 vaccine rollout in South Africa	2
Code	Direct experience with Drone	1
Code definition	Limited exposure to commercial drone use, specifically for vaccine delivery in Ghana	1
Code	Geographical Challenges	2
Code definition	Challenges faced due to the geographical layout in South Africa	2
Code	Military vs. Commercial as understanding of drone	1
Code definition	Differentiation between military and commercial drone applications	1
Code	Multinational Experience	2
Code definition	Experience working within a multinational company with extensive cold chain drone operations	2
Code	Offering of Industry Contacts	1
Code definition	Offering to provide contact information for further insights	1
Code	Public Information	2
Code definition	Mention of public availability of information on drone trials	2
Code	Applicability of drone based ethical framework in CSC Industry	1
Code definition	Applicability of the framework to specific sectors within the industry	1
Code	Autonomous Drone Impact	1
Code definition	Interest in the potential of autonomous drone to handle significant payloads	1
Code	Complexity of Implementation	1
Code definition	Recognition of the complexity and multi-faceted approach required for successful drone implementation	1
Code	Continued Need for Drivers	1
Code definition	Assertion that drone will not completely replace drivers and other logistics roles	1
Code	Corporate Priorities	1
Code definition	Recognition that corporations prioritize financial gains over individual employment impacts	1
Code	Decision-Making Variables	1
Code definition	Decision-making based on different variables for different countries	1
Code	Digital Divide	1
Code definition	Acknowledgement of the digital divide within South Africa	1
Code	Environmental Concerns	1
Code definition	Concerns about the environmental impact of drone production and usage	1
Code	Ethical Decision Making	2
Code definition	Making decisions based on ethical considerations rather than just financial	1
Code	Necessity of including ethical decision-making frameworks in drone operations	1
Code definition	Ethical Decision Making in drone adoption decisions	1
Code	Importance of ethical decision making despite relaxed laws	1
Code definition	Ethical Stance	1
Code	Affirmation of the importance of an ethical stance in decision-making	1
Code definition	Fairness and Ethics	1
Code	Principle of fairness and respect in decision-making	1
Code definition	Financial and People Impact by drone	1
Code	Balancing financial sense with the impact on staff and broader society	1
Code definition	Impact of drone linked to Poverty Concerns	1
Code	Concern about increasing poverty and unemployment due to technological advancements	1
Code definition	Importance of Inclusion of workers in decision making	1
Code	Need for including workers in decision-making processes	1
Code definition	Industry Need for ethical frameworks	1
Code	Need for an ethical decision-making framework within the cold chain logistics industry	1
Code definition	Laws and Rights of society against drone adoption	1
Code	Balancing relaxed laws with individual rights	1
Code definition	Moral Considerations regarding drone	1
Code	Questioning the moral implications of drone technology for the country	1
Code definition	Necessity of ethical Framework	1
Code	Confirmation of the necessity of an ethical decision-making framework	1
Code definition	Organizational Structure	1
Code	Explanation of organizational decision-making structure involving multiple silos and final CEO approval	1

Code definition	People-Centric Approach	2
Code	Importance of a people-centric approach in decision-making	2
Code definition	Perspective on the concept of ethics	1
Code	View on ethics not being based on rewards	1
Code definition	Pilot Projects	1
Code	Recommendation to start with pilot projects for specific areas before national rollout	1
Code definition	Potential Job Loss	1
Code	Acknowledgement of potential job losses due to drone technology	1
Code definition	Profit from commercial drone vs People	1
Code	Profits should be based on looking after people	1
Code definition	Responsibility to Society	1
Code	Consideration of society in decision-making processes	1
Code definition	Self-Regulation on drone use and integration	1
Code	Necessity for self-regulation in advancing technologies	1
Code definition	Skills and Automation	1
Code	Balancing the need for skills and the impact of automation	1
Code definition	SME Involvement	1
Code	Suggestion to involve SMEs in drone operations as part of the logistics ecosystem	1
Code definition	Social Responsibility	1
Code	Using drone for social responsibility projects to mitigate job losses	1
Code definition	Socioeconomic Needs	1
Code	Priority of addressing basic socioeconomic needs before adopting new technology	1
Code definition	Stakeholder Pressure to adopt drone	1
Code	Pressure from stakeholders to adopt drone	1
Code definition	Tacit Contributions of workers	1
Code	Recognition of the intangible contributions of workers	1
Code	Contractual Agreements	1
Code definition	Need for comprehensive agreements to manage liability in gig economy employment	1
Code	Ethical Challenges	1
Code definition	Identification of potential ethical challenges with drone use	1
Code	Legal and Regulatory Needs	1
Code definition	Need for clear legal and regulatory frameworks for drone operations	1
Code	Legal and Risk Management	1
Code definition	Importance of legal and risk management teams in the decision-making process	1
Code	Malicious Use of drone	1
Code definition	Acknowledgment of the risk of malicious use of drone	1
Code	Operator Accountability	1
Code definition	Accountability of drone operators within responsible parameters	1
Code	Organizational Liability	1
Code definition	Acknowledgement of organizational liability in drone operations	1
Code	Organizational Responsibility	1
Code definition	Responsibility of the organization to ensure operator qualifications and adherence to SOPs	1
Code	Principal-Agent Liability	1
Code definition	Legal implications and liability in employing gig economy workers	1
Code	Regulatory Barriers	2
Code definition	Mention of regulatory barriers and the need for regulatory approval	1
Code	Mention of regulatory barriers preventing the rollout of drone services	1
Code definition	Regulatory Compliance	1
Code	Importance of adhering to legislation and guidelines	1
Code definition	Risk of Anti-Competitive Behaviour	1
Code	Concern about anti-competitive behaviour and ensuring fair market practices	1
Code definition	Risks associated with the gig economy	1
Code	Acceptance of inherent risks in the gig economy	1
Code definition	Syndication Risk	1
Code	Mention of syndicate risk in logistics that could affect drone operations	1
Code	Combination of Roles	1
Code definition	Prediction of a future balance between traditional logistics roles and new drone-related roles	1
Code	Balancing the need for Autonomy vs Privacy	1
Code definition	Protecting autonomy and privacy rights in the use of drone	1
Code	need for technology embedded Policies	1
Code definition	Preference for embedding policies within the technology	1
Code	Policy vs. Technology powerplay	1
Code definition	Discussion on whether policies should drive technology or vice versa	1
Code	Differing contextual perspectives among key stakeholders and differences in decision making	1
Code definition	Agreement that decision-making and reasoning would differ based on the context	1
Code	Logistics Footprint	1
Code definition	Discussion on the current logistics footprint in South Africa and its sustainability	1
Code	Corporate Social Responsibility	1
Code definition	Responsibility to support SMEs and ensure fair business practices	1
Code	Consultative Process regarding job losses	1
Code definition	Emphasis on consultation with workers when implementing new technology	1
Code	Ethical Implications of job displacement	1
Code definition	Discussion of ethical considerations in balancing job creation and destruction when adopting new technology	1
Code	Exploitation Risk in gig economy	1
Code definition	Concerns about exploitation in the gig economy	1
Code	Gig Economy	1
Code definition	Understanding the gig economy and its role in the context of drone operations	1
Code	Gradual Implementation	1
Code definition	Emphasis on the gradual implementation of drone technology to balance job displacement	1
Code	Imported Skills	1
Code definition	Acknowledgement that the skillset for drone operations might need to be imported	1
Code	Unemployment Concerns owing to impact of drone	1
Code definition	Concern about high unemployment rates and job displacement due to drone	1
Code	Education and Respect	1
Code definition	Importance of education and respect in building a functional society	1
Code	Educational Needs	1
Code definition	Need for education and skill sets for drone pilots	1

Code	Harnessing Skills required to transition to drone age	1
Code definition	Need to harness skills and technology within technologically advanced industries	1
Code	Sector-Specific Impact	1
Code definition	Mention of specific sectors within logistics that might be more affected by drone integration	1
Code	Training and Upskilling	2
Code definition	Emphasis on ethical training as part of organizational practice	1
Code	Importance of upskilling current employees to transition to new roles	1
Code definition	Training Needs	1
Code	Questioning the ability of current logistics drivers to transition to drone pilots	1
Code definition	Upskilling Workers in 4IR	1
Code	Concept of upskilling existing workers for new technology roles	1
Code	Interest in Findings	1
Code definition	Participant's interest in the findings presented	1
Code	Query on the fit of drone in the CSC Environment	1
Code definition	Interest in how drone technology fits within their environment	1
Code	Knowledge Structure	1
Code definition	Need for an internal knowledge structure for drone within the organization	1
Code	Knowledge Structures	1
Code definition	Necessity of structured knowledge and management's role in it	1
Code	Personal Distance	1
Code definition	Personal decision to distance from certain advocacy groups due to perceived risks	1
Code	Regulatory Knowledge	1
Code definition	Importance of having regulatory knowledge in-house or accessible	1
Code	The role, use and reliance on drone advocacy groups	1
Code definition	Role and potential risks of advocacy groups in the drone industry	1
Code	Scalability of drone for Other SCM areas	1
Code definition	Potential applicability of drone for other logistics companies	1
Code	Importance of Advancement of advanced technology	1
Code definition	Importance of technological advancement and efficiency	1
Code	Broader discussion on Automation by drone	1
Code definition	Broader discussions on automation and robotic systems within the industry	1
Code	Limited Industry Discussions	1
Code definition	Limited discussions on drone within the industry	1
Code	Budget Constraints	1
Code definition	Mention of budget constraints and financial challenges in implementing drone technology	1
Code	Challenges presented by drone and drone technology	1
Code definition	Agreement with the concerns raised about drone technology	1
Code	Community Buy-In	1
Code definition	Need for community stability and buy-in to protect and support drone operations	1
Code	Cultural and Regional Differences between South Africa and Global counterparts	1
Code definition	Acknowledgement of cultural and logistical differences between South Africa and other regions	1
Code	Desire for practical Demonstration of drone in CSC	1
Code definition	Interest in seeing practical demonstrations of the technology	1
Code	Economic Impact of drone adoption	1
Code definition	Need for technological advancements to contribute to job creation	1
Code	End User Scenario of drone	1
Code definition	View that drone are more suitable for end user scenarios rather than bulk logistics	1
Code	Geographic Concerns on drone deployment	1
Code definition	Concern about the impact of technology based on geographic location	1
Code	National Concerns regarding readiness of drone adoption	1
Code definition	Doubt about the suitability of drone for the country's economic situation	1
Code	Rural Focus	1
Code definition	Belief that drone technology will be more beneficial and likely to be used in rural areas	1
Code	Training and Infrastructure	1
Code definition	Importance of proper training and infrastructure for drone operations	1
Code	Potential Job Redundancy	1
Code definition	Acknowledgement of potential job redundancy due to drone technology	1
Code	Projected Job Loss	1
Code definition	Estimation of the actual number of job losses over the initial years	1
Code	Strategic Benefit of drone	1
Code definition	Agreement that drone can have strategic benefits	1
Code	Strategic Benefits	1
Code definition	Confirmation of strategic benefits from drone technology in South Africa	1
Code	Acknowledging importance of understanding the differences in drone types and its technology	1
Code definition	Importance of executive team understanding the differences in drone technology	1
Code	Differing contextual perspectives among key stakeholders and differences in decision making	2
Code definition	Confirmation of understanding technology differences	1
Code	Different perspectives from IT managers regarding drone technology	1
Code definition	Intricacies of Technology drone	1
Code	Need for understanding the intricacies of the technology	1
Code definition	Legal Responsibility of drone adoption decision and use	1
Code	Legal responsibility in case of incorrect drone usage	1
Code definition	Technology Differences in drone remote vs autonomous	1
Code	Understanding differences between remotely operated and autonomous drone	1
Code definition	Understanding of Drone	1
Code	Confirmation of understanding drone technology	1
Code	Autonomous vs. Remotely Operated Drone	1
Code definition	Understanding the differences and implications of autonomous versus remotely operated drone	1
Code	Expanded Drone Concept	1
Code definition	Acceptance of broader drone-related technology beyond flying drone	1
Code	Perceived usage of drone: Point A to Point B	1
Code definition	Understanding of drone as systems that move products from one point to another	1
Code	Interest in Study	1
Code definition	Positive interest in and validation of the study	1
Code	recognition of the power of drone as an energy Crisis Solution	1
Code definition	Recognition of the potential for drone technology to address energy crisis	1
Code	Technological Complexity	1

Code definition	Acknowledgment of the complexity of the technology and its fit within their expertise	1
Code	Technology Benefits of drone	1
Code definition	Acknowledgment of potential benefits of drone technology	1
Code definition	Reaction to the use of PowerPoint presentation and inclusion of findings	1
Code	Acknowledgment of summarizing the study's findings	1
Code	Participant's Drone Experience	2
Code definition	Participant sharing their limited personal experience with drone	2
Code	Cost Considerations	2
Code definition	Mentioning the potential costs associated with drone technology	2
Code	Open Communication	2
Code definition	Importance of open communication and stakeholder engagement	2
Code	Privacy vs. Benefits	2
Code definition	Balancing privacy concerns with the benefits of drone technology	2
Code	Temporary Objections	2
Code definition	Expectation that societal objections to drone will be temporary	2
Code	Drone Regulations	2
Code definition	Lack of awareness of current drone regulations	2
Code	Legal Challenges	2
Code definition	Potential legal challenges associated with drone surveillance	2
Code	Privacy Issues	2
Code definition	Addressing the privacy issues related to drone technology	2
Code	Risk Mitigation	2
Code definition	Importance of mitigating risks with drone technology	2
Code	Operational Efficiency vs. Ethics	2
Code definition	Balancing operational efficiency with ethical considerations	2
Code	Ethical Approach	2
Code definition	Business takes an ethical approach to major decisions	2
Code	Gig Economy	2
Code definition	Understanding of the gig economy and its implications	2
Code	Ethical Decision-Making Framework for problem-solving	1
Code definition	The role of problem-solving in addressing ethical issues with drone	1
Code	Regulatory Frameworks	2
Code definition	Mention of the need for regulatory frameworks to guide technology use	2
Code	Flexibility Demand	2
Code definition	Addressing the demand for flexibility in the industry	2
Code	Industry Transformation	2
Code definition	Discussing the potential transformation of the industry through drone technology	2
Code	Technological Advancements	2
Code definition	Recognizing the impact of technological advancements on the industry	2
Code	Job Creation	2
Code definition	Commitment to job creation despite technological advancements	2
Code	Drone adoption readiness	2
Code definition	Assessing the readiness of organizations to adopt drone technology	2
Code	Marketing and Public Relations	2
Code definition	The role of marketing and public relations in addressing societal concerns	2
Code	Public Perception	2
Code definition	Discussion of society's awareness and acceptance of surveillance technologies	2
Code	Societal Impact	2
Code definition	Consideration of the societal impact of drone use on brand and public perception	2
Code	Competitive Advantage	2
Code definition	Highlighting how drone adoption could provide a competitive advantage	2
Code	Strategic Benefits	2
Code definition	Identifying the strategic benefits of drone adoption	2
Code	Senior Management Understanding	2
Code definition	Importance of senior management understanding the differences between drone types	2
Code	Understanding of Drone Technology	1
Code definition	Explaining the utility and potential of drone technology.	1
Code	Drone adoption ethical challenges, considerations and decision making	5
Code definition	Human Element in Technology	1
Code	Emphasizing the need for human involvement in technology.	1
Code definition	Need for Ethical Framework	1
Code	Stressing the necessity of an ethical framework in decision-making	1
Code definition	Professional Experience	1
Code	Describing professional experience in relevant fields.	1
Code definition	Responsibility Allocation	1
Code	Stating that all management is accountable.	1
Code definition	Technological Advancement	1
Code	Noting the advancement and adoption of drone technology.	1
Code	Best Practices	2
Code definition	Sharing best practices for organizations adopting drone tech.	2
Code	Central Regulatory Body	1
Code definition	Supporting the idea of a central regulatory body for drone.	1
Code	Compliance with Regulations	2
Code definition	Importance of complying with statutory regulations.	2
Code	Legal Implications	1
Code definition	Discussing potential legal implications of automated drone.	1
Code	Relationship Between Ethics and Technology	1
Code definition	Describing the relationship between ethics and technology.	1
Code	Government Support	1
Code definition	Advocating for government support in relaxing drone laws.	1
Code	Curriculum Development	1
Code definition	Describing the need for specific drone-related curriculum.	1
Code	Job Reskilling	1
Code definition	Importance of reskilling workers whose jobs are replaced by drone	1
Code	Skills Development	2
Code definition	Need for relevant skills and upskilling in drone technology.	2
Code	Legal Implications	1

Code definition	Discussing potential legal implications of automated drone.	1
Code	Trust in Advocacy Groups	1
Code definition	Trusting advocacy groups for information and support.	1
Code	Role of Academia	1
Code definition	Emphasizing the role of academia in drone technology education.	1
Code	Challenges presented by drone and drone technology	1
Code definition	Agreeing with the existence of challenges in drone technology.	1
Code	Creating Opportunities	1
Code definition	Belief that drone technology creates opportunities for SMEs.	1
Code	Difference Between Drone	1
Code definition	Clarifying the difference between types of drones.	1
Code	Drone Terminology	1
Code definition	Explaining the different terminologies related to drone.	1
Code	Understanding of Drone	1
Code definition	Describing the understanding and potential of drone technology.	1
Code	Understanding Technology	1
Code definition	Importance of understanding drone technology across management	1
Code	AI embedment risks associated with drone technology	7
Code definition	AI risks and drone related to privacy	1
Code	AI and mathematical complexity introduction	1
Code definition	AI-controlled drone risks	1
Code	Concern about AI integration with drone	3
Code definition	Risks of AI and drone related to privacy	1
Code	Delivery Efficiency	1
Code definition	Discussing potential efficiency in deliveries	1
Code	Delivery Scepticism	1
Code definition	Scepticism about drone use in deliveries	1
Code	Limited Significance	1
Code definition	Mentioning limited significance in other areas	1
Code	Operational Inefficiencies	1
Code definition	Mentioning operational inefficiencies drone can address	1
Code	Potential to Save Lives	1
Code definition	Discussing potential of drone to save lives	1
Code	Rescue and Safety Perspective	2
Code definition	Mentioning drone' use in rescue and safety	2
Code	Safety and Rescue Benefit	1
Code definition	Highlighting the benefits of drone for safety and rescue	1
Code	Technological Advancements	1
Code definition	Participant's view on how technological advancements will impact the cold supply chain industry.	1
Code	Balancing Good and Bad in the context of drone and drone technology	8
Code definition	Concern about criminal use of drone	2
Code	Discussing crime prevention benefits	2
Code definition	Discussing the potential criminal uses of drone	1
Code	Mentioning the balance between the benefits and risks	3
Code definition	Indoor vs. Outdoor Use	1
Code	Differentiating between indoor and outdoor drone use	1
Code	Importance of Maintenance	1
Code definition	Highlighting the importance of maintenance	1
Code	Personal Drone Experience	1
Code definition	Sharing personal experience with drone	1
Code	Cost and Quality Issues	1
Code definition	Linking cost and quality issues in IT	1
Code	Country-Specific Ethics	1
Code definition	How ethical considerations might vary based on the country.	1
Code	Development Quality	1
Code definition	Emphasizing quality of development and maintenance	1
Code	Ethical Responsibility	1
Code definition	The need for an ethical reasoning framework to guide decision making.	1
Code	Informed Consent and HR Role	1
Code definition	Role of HR in ensuring informed consent	1
Code	IT and HR Collaboration	1
Code definition	Collaboration between IT and HR for compliance	1
Code	Proper Implementation	1
Code definition	Ensuring proper implementation and hiring	1
Code	Quality of Personnel	1
Code definition	Importance of hiring quality personnel	1
Code	Remote Access Concerns	1
Code definition	Discussing concerns about remote access	1
Code	Responsibility	1
Code definition	Responsibility from top management to IT	1
Code	Training Necessity	1
Code definition	Emphasis on training for technology adoption	1
Code	Confidentiality	1
Code definition	Importance of confidentiality	1
Code	Data Integrity	1
Code definition	Maintaining data integrity and avoiding personal gain	1
Code	Indifference to Camera	1
Code definition	Participant indifferent to camera being on or off	1
Code	Long-Range Cameras	1
Code definition	Mentioning the capability of drone with long-range cameras	1
Code	Privacy Concerns	3
Code definition	Mentioning privacy concerns	3
Code	Business Practices and Certification	1
Code definition	Challenges in business practices and certification	1
Code	Corruption Concerns	1
Code definition	Concerns about corruption	1
Code	Data Management Similarity	1

Code definition	Similarity in data management across technologies	1
Code	Drone Advocacy Groups	1
Code definition	Perspective on drone advocacy groups	1
Code	Human Factor in Data Security	1
Code definition	Human element in data security	1
Code	Legalization and Approval	1
Code definition	Importance of legal and government approval	1
Code	Main Concerns	1
Code definition	Reiterating main concerns of security and privacy	1
Code	NDA and Privacy Statements	1
Code definition	Importance of signing NDAs and privacy statements	1
Code	Ransomware Risks	1
Code definition	Mentioning the risk of ransomware	1
Code	Right People in Positions	1
Code definition	Emphasizing the importance of having the right people	1
Code	Security and Legal Compliance	1
Code definition	Ensuring security and legal compliance	1
Code	Security and Privacy	1
Code definition	Highlighting security and privacy as main concerns	1
Code	The use of visual and audio for data collection by drone	1
Code definition	Inclusion of visual and audio data in drone technology development	1
Code	Security and Privacy	1
Code definition	Highlighting security and privacy as main concerns	1
Code	Security Concerns	2
Code definition	Discussing security concerns and infrastructure	1
Code	Highlighting security concerns	1
Code definition	Security Risk	1
Code	Highlighting security risks	1
Code	Breaches and Implementation	1
Code definition	Discussing potential breaches and implementation quality	1
Code	Certified Training	1
Code definition	Need for certified training	1
Code	Control and Security	1
Code definition	Discussing control and security in technology use	1
Code	Demand for Variation	1
Code definition	Affirming demand for variation in technology	1
Code	Diverse Information Sources	1
Code definition	Need for diverse sources of information	1
Code	Hacking Risks	1
Code definition	Risks associated with hacking in the context of drone technology.	1
Code	Importance of Transparency	1
Code definition	Importance of transparency in technology	1
Code	Integration Issues	1
Code definition	Mentioning potential issues in integration	1
Code	Investment in Infrastructure	1
Code definition	Preference for investing in infrastructure	1
Code	Multiple Access Points	1
Code definition	Mentioning multiple points of access to servers	1
Code	Need for Testing	1
Code definition	Emphasizing the need for testing	1
Code	New Developer Challenges	1
Code definition	Challenges faced by new developers in drone technology	1
Code	Software Certification	1
Code definition	Importance of software certification	1
Code	Third-Party Access	1
Code definition	Discussing third-party access to servers	1
Code	Third-Party Verification	1
Code definition	Role of third-party verification in drone technology	1
Code	Training and Implementation	1
Code definition	Importance of training and proper implementation	1
Code	Variation of Technologies	1
Code definition	Importance of recognizing and managing the variation in drone technologies.	1
Code	Perimeter Issues	1
Code definition	Discussing issues with drone operating outside perimeters	1
Code	Privacy and Business Advantage	1
Code definition	Discussing privacy concerns and business advantage risks	1
Code	Informed Consent and HR Role	1
Code definition	Role of HR in ensuring informed consent	1
Code	IT and HR Collaboration	1
Code definition	Collaboration between IT and HR for compliance	1
Code	Over-Certification	1
Code definition	Issue of over-certification and continuous study	1
Code	Proper Implementation	1
Code definition	Ensuring proper implementation and hiring	1
Code	Training Importance	1
Code definition	Emphasis on regular training and updates	1
Code	Underpayment in IT Sector	2
Code definition	Issue of underpayment in IT sector	2
Code	Unfair Business Practice	1
Code definition	Potential implications of unfair business practices emerging due to the adoption of drone.	1
Code	Government Support	1
Code definition	Whether government should support drone manufacturing and technology.	1
Code	Hobbyist Drone Perspective	1
Code definition	Discussing perspective on hobbyist drone	1
Code	Local Manufacturing	1
Code definition	Importance of local manufacturing for drone.	1
Code	Need for Rules	2

Code definition	Emphasizing the need for proper rules and regulations	2
Code	Regulatory Environment	1
Code definition	Views on current regulations impeding drone technology usage.	1
Code	Comprehensive Training	1
Code definition	Advocating for comprehensive training	1
Code	Over-Certification	1
Code definition	Issue of over-certification and continuous study	1
Code	Training and Certification	1
Code definition	Mentioning the importance of training and certification	1
Code	Training Importance	1
Code definition	Emphasis on regular training and updates	1
Code	Training Necessity	1
Code definition	Emphasis on training for technology adoption	1
Code	Training Requirements	1
Code definition	Reiterating the need for mandatory training	1
Code	Cloud Migration	1
Code definition	Discussing the trend of moving to cloud services	1
Code	Interoperability Challenges	2
Code definition	Challenges of integrating drone technology with existing technological estate.	1
Code	Mentioning potential interoperability challenges	1
Code definition	Software and Hardware Quality	1
Code	Emphasizing the importance of software and hardware quality	1
Code definition	Software Development Waste	1
Code	Discussion on whether lack of transparency leads to software development waste.	1
Code definition	Transparency in SDLC	1
Code	Importance of transparency in the software development lifecycle (SDLC).	1
Code	Data Flow and Handling	1
Code definition	Discussing data flow and handling	1
Code	Data Handling	1
Code definition	Difference in handling data collected by drone versus traditional methods.	1
Code	Data Handling Concerns	1
Code definition	Concerns about data handling	1
Code	Data Integrity	1
Code definition	Maintaining data integrity and avoiding personal gain	1
Code	Data Source Development	1
Code definition	Development of data sources	1
Code	Data Storage	1
Code definition	Importance of storing data for future reference and legal cases.	1
Code	Data Usage and Privacy	2
Code definition	Handling of data and privacy concerns	2
Code	Existing Data Types	1
Code definition	Existing types of advanced data collection practices already in use such as mail and files and photos and video recordings and sound recordings from different devices	1
Code	Lack of Proper Solutions	1
Code definition	Mentioning the lack of proper solutions for data handling	1
Code	Many Hands in the Pot	1
Code definition	Mentioning multiple stakeholders involved in data handling	1
Code	Transparency Issues	1
Code definition	Issues with data transparency	1
Code	Business Practices and Certification	1
Code definition	Challenges in business practices and certification	1
Code	CEO's Role in Implementation	1
Code definition	Discussing the CEO's role in technology implementation	1
Code	IT Manager's Responsibility	1
Code definition	IT manager's responsibilities vs other decision maker responsibility to understand drone	1
Code	Legal and Security Compliance	1
Code definition	Ensuring legal and security compliance	1
Code	Legal Implications	2
Code definition	Potential legal implications of using drone.	2
Code	Legalization and Approval	1
Code definition	Importance of legal and government approval	1
Code	Privacy	1
Code definition	Participant's perspective on privacy issues related to drone.	1
Code	Responsibility	1
Code definition	Responsibility from top management to IT	1
Code	Security and Legal Compliance	1
Code definition	Ensuring security and legal compliance	1
Code	Drone Advocacy Groups	1
Code definition	Trustworthiness of drone advocacy groups for providing information.	1
Code	Knowledge and Control	1
Code definition	Emphasizing knowledge and control in implementation	1
Code	Knowledge Management	1
Code definition	Establishment of knowledge management systems	1
Code	Knowledge of Drone Types	1
Code definition	Understanding different types of drones	1
Code	Responsibility in Knowledge	1
Code definition	Discussing responsibility for knowledge about drone	1
Code	Ethical Decision-Making Framework for problem-solving	4
Code definition	Benefit of an ethical framework for decision making.	1
Code	Considering ethical dimensions of technology integration	1
Code definition	Ethical usage of drone technology	1
Code	Value of an ethical decision-making framework	1
Code	Importance of Universities	1
Code definition	Role of universities in drone technology research	1
Code	Potential New Group Formation	1
Code definition	Formation of new groups for drone knowledge	1
Code	Use Cases of Drone	1
Code definition	Describing different use cases of drone	1

Code	Conditional Benefit	1
Code definition	Conditional benefit of drone technology	1
Code	Corruption and Crime	2
Code definition	Issues of corruption and crime	2
Code	Corruption in Government	1
Code definition	Issue of corruption in government	1
Code	Delivery Scepticism	1
Code definition	Scepticism about drone use in deliveries	1
Code	Government and Private Sector Collaboration	1
Code definition	Need for collaboration between government and private sector	1
Code	Preparedness of Organizations	2
Code definition	How prepared organizations are to adopt drone technology.	2
Code	Technology Readiness	2
Code definition	Current state of technology readiness	2
Code	Worth of Drone Technology	1
Code definition	Scepticism about the worth of drone technology	1
Code	Competitive Advantage	1
Code definition	Discussion on how small businesses might struggle with adopting drone technology due to financial constraints.	1
Code	Strategic Benefits	2
Code definition	The strategic benefits that can be derived from drone technology.	2
Code	Autonomous Drone	1
Code definition	Definition of an autonomous drone	1
Code	Autonomous vs. Remotely Operated Drone	2
Code definition	The distinction between autonomous and remotely operated drone.	2
Code	Types of Drones	1
Code definition	Understanding the different types of drones and their applications.	1
Code	Understanding Drone Technology	1
Code definition	Understanding of drone technology	1
Code	Manual Drone	1
Code definition	Definition of a manual drone	1
Code	Types of Drones	1
Code definition	Understanding the different types of drones and their applications.	1
Code	Understanding of Drone	1
Code definition	Participant's general understanding and perception of drone.	1
	Grand Total	**465**

Appendix I: Pattern Analysis and Theme Development

Pattern Identified	Recurrence of Patterns:	Synthesis Of Pattern
Adoption and Integration Process	▪ The term "adoption" is closely linked with "implementation," indicating a focus on the steps and methods needed to introduce drone technology. ▪ "Training" and "infrastructure" are repeatedly emphasised as essential to the adoption process.	This pattern emerged from the consistent focus on the careful and strategic process of adopting and integrating drone technology emerged. This pattern combined the need for planning, training, infrastructure development, and implementation steps. Moreover, it reflected an approach where the introduction of drone technology is seen as a significant change that requires careful preparation and execution.
Risk Management and Pilot Testing	▪ The repeated mention of "projects" and "pilot" reflected a cautious approach to adoption through testing and iteration. ▪ "Objections" pointed to the need for anticipating and managing resistance or concerns.	This pattern emerged from the consist emphasises on the importance of managing risks through pilot projects and addressing potential objections. This pattern therefore captures the stakeholders' preference for a controlled, step-by-step approach to drone adoption, where potential challenges are identified and mitigated early in the process.
Impact on Workforce and Efficiency	▪ The term "job" indicates recurring concerns about the impact of drone technology on employment. ▪ "Efficiency" is a key expected outcome of adoption, pointing to the broader goal of improving operations.	This pattern emerged from the dual focus on achieving operational efficiency through drone technology while also addressing the implications for the workforce. This pattern represents the balance between the desire to enhance efficiency and the need to manage the socio-economic impact of technological change, particularly on employment and job roles.
Leadership and Decision-Making in Technology Adoption	▪ The frequent mention of "management" and "roles" underscores the importance of leadership and decision-making in the adoption of drone technology. ▪ The emphasis on "responsibilities" highlights concerns about accountability and the ethical management of new technologies.	This pattern emerged from the emphasises on the critical role of leadership in guiding the adoption of drone technology. This includes making informed decisions, understanding the roles and responsibilities of various stakeholders, and ensuring that ethical practices are upheld. This pattern highlights the need for strong, accountable leadership to navigate the complexities of integrating new technologies into existing systems.
Technological Autonomy and Risk Management	▪ The prominence of "autonomous" reflects concerns about the risks associated with autonomous drones and the implications for safety and operational efficiency. ▪ The repeated mention of "legal and risk management" points to the critical importance of managing risks and ensuring compliance with legal regulations.	This pattern emerged from the dual focus on the technological autonomy of drones and the associated risks. It highlights the importance of managing the risks that come with increased autonomy, including legal and safety concerns. Furthermore, the pattern highlighted how decision makers are concerned with ensuring that autonomous drones operate within a framework that prioritises safety and adheres to legal standards, reflecting a need for robust risk mitigation strategies.
Stakeholder Engagement and Compliance	▪ The prominence of "stakeholders" highlights the need for involving various internal and external parties in the adoption process. ▪ The frequent mention of "compliance" indicates a strong focus on adhering to regulatory and legal standards.	This pattern emerged from the importance of engaging a wide range of stakeholders in the process of adopting drone technology. It emphasises the need for collaboration between management, employees, regulatory bodies, and advocacy groups to ensure that the adoption process is inclusive. Furthermore, the pattern highlighted how compliance with legal and regulatory standards is seen as a crucial element of this collaborative approach, ensuring that the technology is adopted responsibly and sustainably.
Ethical Considerations and Informed Consent	▪ The repeated mention of "informed consent" highlights concerns about the ethical implications of drone technology, particularly regarding transparency and stakeholder engagement. ▪ The scepticism surrounding "advocacy" groups also ties into concerns about the reliability of information and the ethical management of drone adoption.	This pattern emerged from the practical challenges and considerations of integrating drone technology into existing operations. It highlights the need for careful planning and management of the day-to-day aspects of drone use, ensuring that the technology is not only adopted but also effectively utilized within current systems. This pattern therefore reflects a pragmatic approach to adoption, where operational realities are given significant attention.
Operational Readiness and Practical Implementation	▪ The frequent use of the term "operational" reflects a focus on the practical aspects of implementing drone technology, including integration into existing workflows and day-to-day management.	This pattern centers on the practical challenges and considerations of integrating drone technology into existing operations. It highlighted the need for careful planning and management of the day-to-day aspects of drone use, ensuring that the technology is not only adopted but also effectively utilized within current systems. Thus, this pattern reflects a pragmatic approach to adoption, where operational realities are given significant attention.
Technological Integration in Supply Chain Operations	▪ The frequent mention of "technology" emphasizes its central role in the discussions about integrating drone technology into the cold supply chain industry. ▪ "Operations" and "Advancement" frequently appear together, focusing on the practical implementation and day-to-day management within this sector. ▪ The term "Systems" also appears repeatedly, indicating concerns about how drone technology will fit into existing infrastructures.	This pattern emerged from the focus on how drone technology would be integrated into existing supply chain operations to improve efficiency. This pattern captured the practical aspects of implementing new technology, including the need for seamless integration with current systems and the emphasis on operational advancements. The recurring mention of technology and operations suggests that stakeholders are deeply concerned with how these innovations will enhance day-to-day management and overall supply chain performance.
Future-Oriented Potential and Applications	▪ The prominence of "Potential" reflects a forward-looking perspective on the capabilities and impact of drone technology. ▪ "Applications" is another prominent term that suggests a focus on the various ways drone technology can be utilized across different sectors.	This pattern emerged from the forward-looking nature of the discussions, where the potential of drone technology was explored in terms of its transformative impact and versatility. The focus on applications suggested that stakeholders are interested in identifying and capitalising on practical use cases across various sectors. This pattern reflects an optimism about the future possibilities that drone technology could unlock, as well as a desire to explore its diverse applications.
Labor Market and Workforce Implications	▪ The prominence of "Gig Economy" reflects concerns about how drone technology, particularly its automation capabilities, will affect the labour market. ▪ The term "Autonomous" points to advanced capabilities and the potential risks associated with self-operating systems. ▪ "Implications" appears frequently, indicating a broader concern with the consequences of adopting drone technology, including social and economic impacts.	This pattern emerged from how drone technology will influence the labour market, particularly through automation and the rise of flexible work arrangements. The discussion around the gig economy and autonomous drones suggests that decisions makers must be aware of the potential disruptions and are considering the broader socio-economic implications of these technological advancements. This pattern reflects the need to understand and manage the transformative impact of drones on employment and economic structures.
Challenges of Integration and System Design	▪ The term "Integration" is repeatedly mentioned, indicating ongoing discussions about the challenges of merging new technologies like drones with existing operations. ▪ The repetitive use of "Systems" further reinforces the focus on how drone technology will integrate into current infrastructures.	This pattern emerged from the complexity and challenges associated with integrating drone technology into existing systems. The narratives reflected a recognition that successful implementation requires careful consideration of how new technologies will interact with and enhance traditional workflows. This pattern therefore highlights the importance of addressing the technical and infrastructural challenges that come with adopting advanced technologies, ensuring that they are effectively incorporated into existing operations.
Legal and Regulatory Concerns	▪ The frequent appearance of the terms "legal" and "regulatory" emphasizes the central focus on legal responsibilities, implications, and the need for regulatory frameworks in the use of drone technology. ▪ The term "compliance" also emerged prominently, reflecting the need to adhere to these legal and regulatory standards.	This pattern emerged from the importance of legal compliance and the establishment of clear regulatory frameworks to guide the adoption and use of drone technology. This pattern reflects the necessity for well-defined rules and guidelines that ensure operations are conducted within the bounds of the law, thereby mitigating legal risks and avoiding potential conflicts. The focus on compliance and frameworks indicates

	▪ The repetition of "frameworks" underscores the importance of establishing comprehensive guidelines to manage the legal and regulatory complexities associated with drones. ▪	that stakeholders view the legal and regulatory environment as crucial to the successful and responsible deployment of drones.
Security and Risk Management	▪ The high frequency of the term "security" indicates significant concerns regarding the protection of data, preventing the malicious use of drones, and safeguarding systems against breaches. ▪ The term "risks" is frequently mentioned alongside legal and regulatory discussions, highlighting the broader concern with identifying and mitigating risks associated with drone technology.	This pattern emerged from the pervasive concerns with security and the need for comprehensive risk management strategies. The focus on security reflects the need to protect against a variety of threats, including data breaches and the potential for unethical or malicious drone use. The broader concern with risks, encompassing legal, security, and operational risks, suggests that stakeholders recognize the importance of proactive risk management to ensure the safe and responsible deployment of drones.
Ethical Implications and Societal Values	▪ The prominence of the term "ethical" indicates a strong focus on the ethical implications of drone technology, particularly in balancing efficiency with ethical considerations and addressing privacy concerns. ▪ The repeated mention of "challenges" ties into the ethical and societal concerns that need to be addressed for successful technology adoption.	This pattern emerged from the ethical challenges associated with drone technology, particularly in ensuring that its adoption aligns with societal values. The pattern reflected a concern with balancing the efficiency and operational benefits of drones with the need to uphold ethical standards, protect privacy, and ensure that the technology is used in a way that aligns with broader societal expectations. Moreover, this pattern emphasised the importance of integrating ethical considerations into the decision-making processes related to drone adoption.
Automation and Workforce Impact	▪ The term "automation" is repeatedly mentioned in discussions about risks, indicating concerns about the impact of advanced automation on employment, skills, and operational efficiency. ▪ The focus on "challenges" also encompasses the socio-economic implications of increased automation.	This pattern emerged from the concerns related to the impact of drone technology, particularly automation, on the workforce. The narrative reflected the worries about potential job displacement, the need for upskilling, and the broader implications of automation on operational efficiency and employment. Against this backdrop, this pattern suggests that while automation is seen as a path to greater efficiency, it also presents significant challenges that need to be managed to avoid negative socio-economic impacts.
Decision-Making and Legal Considerations	▪ The frequent mention of the term "Decision" highlights a central focus on the decision-making processes regarding drone adoption and automation. ▪ The term "Legal" appears frequently, indicating that legal aspects, including regulations, compliance, and frameworks, are integral to the decision-making process. ▪ The repeated mention of "Policy and Regulation" emphasizes the importance of shaping policies within organizations to address technological advancements and mitigate risks.	This pattern emerges from the importance of informed decision-making that is grounded in a strong legal and regulatory framework. This pattern reflects the need for decisions regarding drone adoption and automation to be made with careful consideration of legal implications, regulatory compliance, and the establishment of clear policies. The emphasis on decision-making suggests that stakeholders prioritize a structured and legally sound approach to integrating new technologies.
Stakeholder Involvement and Consultative Processes	▪ The frequent use of the term "Involvement" indicates a pattern where stakeholder involvement is emphasized in decision-making processes. ▪ The term "Stakeholder" prominently appears alongside discussions on decision-making, policy formation, and technology adoption. ▪ The repetition of "Influence and Stakeholder" together in discussions highlights the perceived importance of diverse perspectives in shaping decisions and policies.	The pattern emerged from the importance of informed decision-making that is grounded in a strong legal and regulatory framework. This pattern reflects the need for decisions regarding drone adoption and automation to be made with careful consideration of legal implications, regulatory compliance, and the establishment of clear policies. The emphasis on decision-making suggests that stakeholders prioritize a structured and legally sound approach to integrating new technologies.
Adoption and Integration of Advanced Technologies	▪ The frequent mention of "Adoption" highlights the central focus on the challenges and strategies involved in adopting drone technology and other innovations. ▪ The term "Automation" appears frequently, emphasizing discussions around integrating automated systems, robotics, and other technological advancements into the cold supply chain industry. ▪ The repetition of "Adoption and Technology" emphasizes the narrative's focus on integrating new technologies into existing operations.	This pattern emerged from the strategic considerations necessary for adopting and integrating advanced technologies like drones and automation into existing systems. The narrative reflects a focus on the practical aspects of technology adoption, including overcoming challenges and developing strategies to ensure smooth integration. This pattern also highlighted the importance of understanding the broader implications of technology adoption on operations and industry practices.
Awareness and Ethical Implications	▪ The prominence of "Awareness" indicates discussions around the public's and stakeholders' awareness of technological advancements and their implications. ▪ The term "Surveillance" emerges as a critical issue, often connected to legal concerns, societal awareness, and ethical debates. ▪ The repeated mention of "Personal and Risks" reflects concerns about personal decision-making related to perceived risks in the context of adopting drone technology.	This pattern highlighted the importance of ethical awareness and the consideration of risks when adopting new technologies. The narratives reflected concerns about the potential ethical implications of drone technology, particularly in areas like surveillance and privacy. There was also a strong emphasis on ensuring that stakeholders and the public are aware of these implications and that personal and societal risks are carefully considered in the decision-making process.
Ethical Practices and Frameworks	▪ The frequent mention of "Ethical" and "Practices" indicates that ethical considerations are central to the narrative. These terms emphasize the importance of moral integrity in drone technology operations and decision-making. ▪ The term "Framework" appears frequently, highlighting the need for structured ethical frameworks to guide decisions and ensure consistency and accountability. ▪ The repetitive pairing of "Ethical" and "Framework" further underscores the necessity of having clear guidelines to ensure responsible and ethical use of drone technology.	The pattern emerged from the emphasis on structured ethical governance. This pattern reflected the need for well-defined ethical frameworks and practices that guide decision-making and operations in drone technology. The frequent mention of ethical considerations suggests that stakeholders see the development and adherence to these frameworks as crucial for ensuring moral integrity, consistency, and accountability in the use of drones.
Fairness and Transparency in Operations	▪ The frequent mention of "Fairness" highlights concerns about ensuring equitable treatment in decision-making processes, particularly in employment, training, and data handling within the drone technology context. ▪ The emphasis on "Transparency" reflects the importance of open and clear decision-making processes, especially in drone-based data handling and commercial applications. ▪ The repetition of "Fairness" and "Transparency" together indicates that these values are seen as interrelated and vital for fostering trust and accountability in drone technology usage.	This pattern captures the importance of fairness and transparency in all aspects of drone technology usage. The narrative reflects a strong emphasis on ensuring that decisions are made transparently and that fairness is upheld in operational practices, including employment and data handling. This pattern suggests that stakeholders believe these principles are essential for building trust and maintaining accountability in the adoption and application of drone technology.
Training and Ethical Preparedness	▪ The prominence of "Training" indicates a focus on the need for educating and upskilling the workforce in preparation for adopting drone technology. ▪ The repetitive mention of "Training" alongside "Practices" highlights the emphasis on equipping individuals with the necessary skills and knowledge to uphold ethical standards in drone operations.	This pattern emerges from the importance of training and education in ensuring that individuals involved in drone technology are well-prepared to handle ethical challenges. The narrative suggests that ethical preparedness is seen as critical, with a focus on providing the workforce with the skills and knowledge needed to operate drones responsibly and in accordance with established ethical frameworks.
Privacy, Social, and Economic Considerations	▪ The frequent mention of "Privacy" reflects significant concerns about protecting personal data and ensuring confidentiality in drone operations. ▪ The prominence of "Economic" suggests a focus on balancing ethical concerns with economic benefits, particularly in the context of job creation and socioeconomic impacts. ▪ The term "Social" reflects the importance of considering the social impacts of drone technology, including addressing social responsibility and mitigating job losses.	This pattern captures the need to balance ethical considerations with economic and social impacts. The narratives highlighted concerns about privacy and the importance of protecting personal data while also considering the economic benefits of drone technology, such as job creation. Additionally, the pattern reflects the importance of addressing the social implications of drones, including the need for social responsibility and efforts to mitigate negative impacts, such as job displacement.

Knowledge Management and Dissemination	▪ The frequent use of the term "Knowledge" emphasizes the importance of acquiring, managing, and disseminating knowledge within organizations. This includes the sources of knowledge, how it is shared internally, and its role in the successful implementation and operation of drone technology. ▪ The combination of "Knowledge," "Management," and "Dissemination" further highlights the focus on effective information handling within organizations.	This pattern emerges from the emphasis on strategic knowledge management and reflects the need for organisations to focus on the systematic acquisition, management, and dissemination of knowledge to ensure the successful adoption and operation of drone technology. In this pattern, effective knowledge management is seen as crucial for maintaining organisational efficiency and ensuring that all relevant stakeholders are informed and equipped to handle new technologies.
Data Integration and Management	▪ The prominent frequency of the term "Data" reflects its critical role in drone technology, including data management practices, integration, collection methods, and ensuring data reliability and security. ▪ *The repeated mention of terms such as "data," "collection," "integration," and "management" emphasizes the focus on how data is handled as a crucial aspect of drone technology.*	This pattern emerged from the importance of comprehensive data management and integration in the context of drone technology. The narratives reflected a strong emphasis on the need to manage data effectively, from collection to integration and security. This pattern therefore underscores the role of data as the backbone of drone operations, highlighting the need for robust systems that ensure data is handled reliably and securely within organizational frameworks.
Training and Certification for Workforce Readiness	▪ The term "Training" emerged frequently, highlighting the necessity for skill development, certification of drone pilots, and proper training programs to prepare the workforce for drone technology. ▪ The prominence of "Certification" indicates the need for official recognition and validation of skills and practices to ensure that drone operations are carried out by qualified personnel. ▪ *The pairing of "Software" and "Certification" reflects the importance of ensuring that software used in drone technology meets high standards and is certified.*	This pattern emphasises the importance of training and certification in preparing the workforce for the adoption of drone technology. The narratives reflects the need for comprehensive training programs and official certification to ensure that personnel are equipped with the necessary skills to operate drones safely and effectively. This pattern also highlights the importance of maintaining high standards in software development and certification, ensuring the reliability and safety of the technology.
Collaboration with Academic and Research Institutions	▪ The prominence of the term "Academic" underscores the importance of collaboration between organizations and academic institutions in driving research, innovation, and development in drone technology. ▪ *The frequent use of the term "Research" indicates a strong focus on advancing drone technology and embedding ethical approaches in policies and frameworks.*	This pattern captures the importance of collaboration between organizations and academic institutions in advancing drone technology. The narrative reflects the need for ongoing research and innovation, driven by scholarly work, to enhance the understanding and implementation of drones. This theme highlights the role of academic partnerships in ensuring that drone technology is developed responsibly and that its adoption is supported by cutting-edge research and ethical frameworks.
Integration and Management of Drone Technology	▪ The term "Integration" was frequently mentioned, emphasizing the importance of incorporating drone technology into existing systems, policies, and data management practices. ▪ The prominence of the term "Management" reflects the importance of managing various aspects of drone technology, including knowledge, data, and training. ▪ *The term "Implementation" suggests that successful integration of drone technology requires careful planning and execution.*	This pattern focused on the holistic integration and management of drone technology within organizations. The narratives reflected the need for a comprehensive approach to integrating drones into existing systems, ensuring that all aspects ranging from knowledge and data management to training and implementation are carefully coordinated. This theme emphasises the importance of planning and executing the integration of drone technology in a way that ensures seamless operation and sustainability.
Collaboration Across Sectors	▪ The frequent use of the term "Collaboration" indicates a strong emphasis on working together across various sectors, including private, public, and community organizations, to ensure the successful implementation and operation of drone technology. ▪ The clustering of related terms such as "collaboration," "stakeholders," and "community" points to a recurring theme of the necessity for joint efforts and cooperative interactions among different entities.	This pattern emphasizes the critical importance of collaboration across different sectors to ensure the successful adoption and integration of drone technology. The narratives reflected a strong belief that only through coordinated efforts between private companies, public institutions, community organizations, and other stakeholders can the potential of drone technology be fully realized. This pattern highlighted the idea that cross-sector partnerships are vital for addressing the complex challenges and opportunities presented by drones.
Stakeholder Engagement and Community Involvement	▪ The frequent mention of "Engagement" and "Community" highlights the necessity of involving local communities and other stakeholders in decision-making processes. ▪ The clustering of "engagement," "community," and "stakeholders" reflects a recurring emphasis on ensuring that the adoption and use of drone technology are inclusive and participatory.	This pattern centers on the importance of actively involving a wide range of stakeholders, including local communities, in the processes surrounding drone technology. The narrative suggests that successful adoption depends on inclusive engagement practices that ensure all voices are heard and considered, particularly those of the communities directly affected by drone operations. This theme also highlights the role of engagement in securing informed consent and building trust among stakeholders.
Communication and Ethical Practices	▪ The frequent use of the term "Communication" reflects the need for open and transparent dialogues between all parties involved, ensuring alignment in decision-making processes. ▪ The repetitive appearance of terms such as "Ethical," "informed consent," and "ethical practices" underscores the necessity of integrating moral considerations into all interactions and decisions.	This pattern emerged from the emphasizes on the need for clear and open communication channels between all stakeholders involved in drone technology, ensuring that everyone is well-informed and aligned. It also highlights the critical role of ethical practices in all interactions, particularly in maintaining transparency, securing informed consent, and upholding moral standards in the deployment and use of drones. Furthermore, this pattern reflected the narrative's focus on building trust and accountability through transparent and ethical engagement.
Support and Stability for Sustainable Adoption	▪ The prominence of terms like "Support" and "Stability" suggests that backing from various entities, including communities, government, and private sectors, is crucial for the success and sustainability of drone operations. ▪ The combination of "support" and "stability" with ethical business practices indicates the importance of creating a supportive environment for Small, Medium, and Micro Enterprises (SMMEs) and new market entrants.	This pattern focuses on the importance of providing strong support systems to ensure the long-term success and stability of drone technology implementations. The narrative highlights the need for ethical business practices that support SMMEs and other stakeholders, fostering an environment conducive to sustainable growth and innovation. This pattern therefore underlines the role of support structures in creating a stable foundation for the widespread adoption of drone technology.
Strategic Benefits and Competitive Advantage	▪ The terms "Strategic" and "Benefits" frequently appear together, indicating a strong focus on the strategic advantages of adopting drone technology. This pattern emphasizes the potential for these technologies to enhance business operations and provide a competitive edge. ▪ The frequent mention of "competitive advantage" as a concept reinforces the idea that drone technology can significantly differentiate a company in the marketplace, leading to innovation and market leadership.	This pattern highlights the strategic benefits of adopting drone technology, particularly in terms of gaining a competitive advantage. The narrative reflects a belief that integrating drones into business operations can position a company as a market leader, offering enhanced capabilities that set it apart from competitors. This pattern underscores the importance of technology adoption as a means of achieving long-term strategic goals and maintaining a competitive edge in the industry.
Operational Efficiency and Financial Gains	▪ The combination of "operational" and "efficiency" indicates a recurring emphasis on how drone technology can streamline operations, reduce costs, and improve overall efficiency in organizational processes. ▪ The prominence of "Efficiency" suggests that financial efficiency, particularly through reduced operational and maintenance costs, is a key benefit associated with the adoption of drone technology.	This pattern centres on the operational and financial efficiencies that can be achieved through the adoption of drone technology. The narratives suggests that drones offer significant opportunities to optimise processes, reduce operational costs, and enhance overall efficiency within organisations. This pattern highlights the economic benefits of technology adoption, particularly in improving the bottom line and enhancing operational effectiveness.
Innovation and Market Positioning	▪ The term "Innovation" frequently appears in discussions, highlighting the role of new technologies in creating opportunities for growth and differentiation in the market. ▪ The prominence of "Positioning" reflects the strategic importance of technology in enhancing an organization's standing within its industry, contributing to long-term success and competitiveness.	This pattern emphasises the role of innovation in driving market leadership and positioning organizations for long-term success. The narratives reflects a focus on how drone technology can facilitate innovation, allowing companies to differentiate themselves and achieve a stronger market position. This pattern underscores the importance of being at the forefront of technological advancements to capitalize on new opportunities and secure a leading role in the industry.

Safety, Security, and Societal Impact	▪ The recurring mention of terms like "crime prevention," "safety," "South Africa," and "security" highlights a pattern that emphasizes the potential of drones to enhance safety and security. These discussions suggest that the benefits of drone technology extend beyond operational efficiency to include broader societal impacts. ▪ The narrative also reflects concerns and queries related to these themes, indicating a nuanced view of the potential and challenges associated with drone technology in these areas.	This pattern captured the broader societal benefits of drone technology, particularly in enhancing safety and security. The narratives suggests that drones have the potential to contribute to crime prevention, improve safety, and provide significant societal benefits, particularly in contexts like South Africa. However, this pattern reflected the need to address concerns and challenges associated with these applications, ensuring that the technology is used responsibly and effectively.
Empowerment of Small and Medium-Sized Enterprises (SMEs)	▪ The term "SMEs" underpins a pattern that emphasizes the potential benefits that small and medium-sized enterprises can gain from adopting new technologies. This includes driving innovation and achieving market growth through the strategic use of drone technology.	This pattern emerged from the role of drone technology in empowering SMEs, providing them with the tools to innovate and grow within the market. The narratives reflects a focus on how these enterprises can leverage drone technology to enhance their competitiveness, drive innovation, and achieve significant growth. This pattern underscores the potential of technology adoption to level the playing field for smaller businesses, enabling them to compete more effectively in the market.

Appendix J: Thematic Analysis for Common and Divergent Patterns

Overarching Themes and Sub-Themes	Common Patterns	Divergent Patterns
Overarching Theme One: Strategic and Balanced Drone Adoption		
Sub-Theme 1: Pilot Testing and Iterative Adoption	▪ Risk Management and Pilot Testing: There is a focus on cautious adoption through pilot projects to test drone technology in controlled environments, reducing risks. ▪ Operational Readiness: Adoption is treated as a strategic process that requires readiness assessment before full integration.	Speed of Adoption vs. Pilot Testing: Tension exists between the need for slow pilot projects and the pressure for rapid scaling to remain competitive.
Sub-Theme 2: Integration into Existing Operational Systems	▪ Technological Integration in Supply Chain: The practical aspects of integrating drones into cold supply chains are seen as essential for operational efficiency.	Resistance vs. Strategic Implementation: Some stakeholders may resist the introduction of drones into established workflows, creating tension between the innovative potential of drones and legacy system constraints.
Sub-Theme 3: Worker Displacement and Job Transformation	▪ Impact on Workforce and Efficiency: Drones are expected to bring efficiency gains, but the patterns reflect concerns about the potential for worker displacement due to automation. These concerns are linked to the theme of balanced adoption, where stakeholders are cautious about the social impacts of drone technology. ▪ Automation and Workforce Impact: Patterns highlight how automation through drone technology can disrupt traditional job roles, requiring reskilling or potentially reducing employment in sectors where drones can replace manual tasks.	Efficiency Gains vs. Workforce Impact: Tension exists between the drive for operational efficiency through automation and the concern for job losses or role changes within the workforce. While drones are viewed as a tool to enhance efficiency, this can come at the cost of significant shifts in the labour market, creating social and ethical challenges.
Overarching Theme Two: Risk Taxonomy Decision Making		
Sub-Theme 1: Legal Compliance and Regulatory Adherence	▪ Legal and Regulatory Concerns: Both the overarching theme and patterns emphasize the importance of adhering to regulatory frameworks and compliance with legal standards. ▪ Risk Management: The patterns highlight the need to align drone adoption with existing legal frameworks to mitigate risks related to privacy and security.	Compliance vs. Innovation: Tension exists between the legal constraints that slow adoption and the desire for innovation that drives rapid drone deployment.
Sub-Theme 2: Privacy and Security	▪ Security and Risk Management: Patterns show a strong focus on privacy concerns and data security, aligning with the broader theme of risk management. ▪ Data Protection: Privacy and security risks are central to both the theme and patterns, where data governance frameworks help ensure safe operations.	Ethical Concerns vs. Efficiency: Tension arises when security measures, such as data privacy protections, slow down operational efficiency and automation efforts.
Sub-Theme 3: Ethical Decision-Making in Risk Scenarios	▪ Ethical Considerations and Informed Consent: Ethical decision-making is seen as critical to ensuring transparency in how risks related to privacy and legal issues are managed. ▪ Involvement of Stakeholders: Ethical decisions must include the input of stakeholders to ensure broad consensus and informed consent.	Ethical Constraints vs. Business Goals: Ethical concerns may slow down business goals such as fast-tracking drone adoption, creating friction between ethical oversight and business ambitions.
Sub-Theme 4: Data Management and Governance	▪ Data Integration and Management: The theme and patterns emphasize the need for strong data governance systems to ensure privacy, security, and compliance. ▪ Technological Autonomy and Risk Management: Autonomous drones generate large volumes of data, increasing the need for strict data management practices.	Automation vs. Ethical Data Handling: The push for automated drones creates challenges in maintaining ethical data governance, particularly in the areas of privacy and data security.

Overarching Theme Three: Knowledge Structures for Sustainable Drone Adoption		
Sub-Theme 1: Knowledge Management and Dissemination	▪ Knowledge Management and Dissemination: Strong knowledge structures are necessary for sustainable drone adoption, ensuring that decision-makers have access to accurate, up-to-date information. ▪ Support and Stability: Both the theme and patterns highlight the importance of support systems that ensure knowledge is managed and disseminated effectively.	Internal Knowledge vs. External Sources: There is tension between relying on external knowledge sources (which might lead to misinformation) and the desire to develop internal knowledge systems that can be more reliable.
Sub-Theme 2: Ethical Implications of Misinformation	▪ Ethical Considerations and Informed Consent: Ethical concerns are central when it comes to misinformation from external sources, with both the theme and patterns stressing the need for transparency and ethical knowledge management. Stakeholder Involvement: Engaging with stakeholders to prevent misinformation aligns with the need for ethical decision-making.	External Reliance vs. Internal Integrity: There is a recurring tension between relying on external knowledge providers (potential misinformation) and developing internal systems to safeguard knowledge accuracy.
Overarching Theme Four: Ethical Considerations in Business Practices		
Sub-Theme 1: Competitive Advantage and Market Leadership	▪ Strategic Benefits and Competitive Advantage: Both the theme and patterns emphasize the strategic role of drones in providing competitive advantage and market leadership. ▪ Innovation and Market Positioning: Innovation through drone technology is seen as a way to differentiate in the marketplace.	Innovation vs. Ethical Boundaries: While competitive advantage drives market success, ethical boundaries (such as privacy and fair business practices) may limit how far a company can push its technological advantage.
Sub-Theme 2: Fair Business and Competition Practices	▪ Ethical Practices and Fair Competition: Ethical concerns related to fair business practices and transparency are consistent across both the theme and patterns. ▪ Fairness and Transparency in Operations: Ethical business practices are seen as essential for maintaining fair competition and market trust.	Competitive Push vs. Fair Business: There is a tension between pushing for market leadership through drone adoption and ensuring fair competition practices, especially in industries where drones might provide an overwhelming advantage.