BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF COMMERCE

Evaluating the Impact of Artificial Intelligence on Supply Chain Efficiency in Zimbabwean Disaster Management Processes

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE MASTERS OF SCIENCE DEGREE IN PURCHASING AND SUPPLY CHAIN MANAGEMENT

(JUNE 2024)

Mike Gotami

B223840B

DEDICATION

This project is dedicated to Ms Chidzawo a supply chain management consultant and to all donors and non-governmental organisations who have interest in disaster management. Processes in Zimbabwe.

APPROVAL FORM

The undersigned certifies that they have supervised, read and recommended to Bindura University of Science Education for acceptance a research project entitled "The effects of e-procurement on the procurement performance" submitted in partial fulfillment of the requirements of Msc Degree In Purchasing and Supply Chain Management.

…………………………………………………………12/…06…/2024

Signature of Student Date

…………………………………………………………02/10/24

Signature of Supervisor Date

…………………………………………………………03/10/24

Signature of the Chairperson Date

…………………………………………………………/……/……/…

Signature of the Examiner (s) Date

ACKNOWLEDGEMENTS

Firstly, I give praise to God the Almighty for wisdom, strength and guidance through this research. I wish to acknowledge my colleague Mr Hwacha who helped me find qualified respondents for the research instrument. I also thank Mr Makau who connected me many supply chain experts serving in the NGOs.

My deepest gratitude to Dr Chari my academic supervisor who was always a call way to give me guidance and corrections throughout the research study. Lastly, many thanks to BUSE and faculty of commerce for providing me with a platform to carry out the research from start up until the end.

ABSTRACT

The study focused on evaluating the impact of evaluating the impact of artificial intelligence (AI) on supply chain efficiency in Zimbabwean disaster management process. The study was carried out in Harare, Zimbabwe's capital. The study was inspired by the interest to know if AI systems employed by different organisations including parastatal departments are optimising disaster management supply chains. The motive came after assessing and noticing challenges people, livestock and infrastructure face following different types of natural and human made disasters. The study results were achieved following determining the level of adoption of AI systems and tools that optimise disaster management supply chains across interested organisations in Zimbabwe. Secondly, the researcher went on to find the relationship of artificial intelligence systems and efficiency in the supply chain. The study was achieved by employing quantitative method through the questionnaire. The data was collected and analysed through regression method followed by analysis of descriptive statistics off the SPSS software. The sample was collected using purposive sampling technique. A sample totalling 75 individuals representing various organisations was collected and questionnaires were shared to them. Despite having 51 of the respondents managing to return completed questionnaire, the sample size was still effective following a good response rate. From the findings of the study, the result shows that AI systems and tools have been adopted well across various organisations and clearly, they are serving the right purpose to influence optimisation of supply chains during disaster phases. The result showed that there is a direct relationship between artificial intelligence and efficient information flow across supply chain which relatively means efficient supply chains. The result showed that increase investment in AI systems relatively means increase in supply chain efficiency during disaster management phase,*(holding other factors constant)*. As the third goal of the study suggestions were made after finding out that the problems and challenges encountered by Zimbabwe in managing disasters are not mainly influenced by under utilisation or little adoption of AI across organisations. One of the main recommendations was that AI systems alone they are not enough, they must have resources Sbacking them up. These include rescue teams, rescue resources such as helicopters, food supplies and more just depending on the nature of disaster.

List of Tables

Table 3.1 : Likert Scale ……………….26
Table 4.1 : Response rate………………28
Table 4.2 : Current or former employees….29
Table 4.3 : Years of experience…………..30
Table 4.4: Data Presentation…………….31
Table 4.5: Data Presentation…………….31
Table 4.6: Data Presentation……………..32
Table 4.7: Data Presentation……………..33
Table 4.8: Data Presentation……………..33
Table 4.9: Data Presentation……………..34
Table 4.2.1: Data Presentation……………34
Table 4.2.2: Data Presentation…………….35
Table 4.2.6: Data Presentation…………….35
Table 4.6.1: Data Presentation…………….36
Table 4.4: Data Presentation………………36
Table 4.4: Data Presentation……………….37
Table 4.4: Data Presentation……………….41
Table 4.4: Data Presentation……………….42
Table 4.4: Data Presentation……………….45

LIST OF FIGURES

FIGURE 1: Pie Chart …………………….32

FIGURE 2: Rating Graph…………………42

FIGURE 3: Set Making……………………44

FIGURE 4: Set Representation……………44

TABLE OF CONTENTS

Contents

DEDICATION i

ACKNOWLEDGEMENTS iv

ABSTRACT v

List of Tables vi

LIST OF FIGURES vi

CHAPTER 1: INTRODUCTION 1

1.1Background of the Study 1

1.2 Statement of the Problem 4

1.3 Research Questions 5

1.4 Research Objectives 5

1.5 Significance of the Study 5

1.6 Limitations of study 6

Chapter 2: Literature Review 8

2.0: Introduction 8

2.1 Disaster Management 8

2.1.1Types of Disasters in Zimbabwe 10

2.1.2: Disaster Management in Zimbabwe 12

2.2: ARTIFICIAL INTELLIGENCE 14

2.2.1Global Importance of AI in Disaster Management 15

2.2.2: Artificial Intelligence in Zimbabwe 16

2.2.3: AI Intelligent Drones in Zimbabwe 17

2.3.4: Artificial Intelligence in Disaster Management across the World 18

2.3: Supply Chain Efficiency 19

2.3.1: Integration 19

2.3.2: Operations 20

2.3.4: Purchasing 20

2.3.4: Distribution 21

2.3.5: Supply Chain Efficiency Metrics in Disaster Management 21

CHAPTER 3: METHODOLOGY 23

3.1: Introduction 23

3.2 Study Area 23

3.3 Research Design 23

3.4: Subjects Population and Sampling 24

3.4.1:. Population........24
3.4.2: Sampling........24
3.5: Research Instruments........25
3.6 Data Collection and Procedures........25
3.7 Pilot Study........26
3.7.1 Validity Testing........26
3.7.2: Ethical Considerations........27
3.8: Presentation and Analysis of Data........27
CHAPTER 4: DATA INTREPRETATION AND ANALYSIS........28
4.1: Introduction........28
4.2 Rate of Responses........28
4.3 Demographic Profiles of the Respondents........29
4.3.1 Current or Former Employees........29
4.4: DATA PRESENTATION AND ANALYSIS........31
4.4.1: SET 1........31
4.4.2: SET 2........37
4.6 Further Analysis........43
4.6.1 Filtered Data........43
4.7 Conclusions........46
CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS........48
5.1 Introduction........48
5.2 Summary........48
5.3 Conclusions........49
5.3.1: Objective 1........49
5.3.2: Objective 2........49
5.4 Recommendations........50
References........52
APPENDICES........55
APPENDIX 1: RESEARCH QUESTIONNAIRE........55
Turn it In page........58

CHAPTER 1: INTRODUCTION

Natural disasters pose a significant threat to developing economies like Zimbabwe. Disruptions to supply chains caused by floods, droughts, and cyclones can lead to food and medicine shortages, economic hardship, and exacerbate existing vulnerabilities. Effective disaster management hinges on the ability to deliver critical resources quickly and efficiently to affected populations. This requires a robust and resilient supply chain infrastructure, which nowadays is enhanced by artificial intelligence.

Artificial intelligence is the simulation of human intelligence by machines (Tucci, 2022). (Kvestyk, 2021)Defined it as a field that combines computer science and robust datasets to solve problems and make informed decisions. Is this human-like technology being fully utilised in Zimbabwe's supply chain efficiency in disaster management? The researcher is about to find out.

1.1Background of the Study

Zimbabwe has faced a couple of disasters in the previous five to ten years. Responsible authorities work very hard to mitigate impacts of these disasters. They implement and execute tasks that thrive to restore victims' standards of living. For the aid to reach an optimum number the planning and the execution of the relief processes need to be done efficiently. It is usually a challenge for the government, the donors, NGOs and other interested parties to efficiently and effectively deliver aid to the victims. The emergence of artificial intelligence provides a shove in ensuring effective and efficient delivering of aid as it combines the complex elements of disaster management and provides informed decisions.

Artificial intelligence through its leveraging of historical data it brings insightful information and informed decisions which can give a heads up to any interested part in managing disasters. The involvement of drones, satellites and GIS processes are already in use in Zimbabwe in disaster relief programmes. This research study is aiming to find out how the AI is currently efficient in smoothening the disaster management operations. The disaster management which is usually divided in three phases which are, pre-disaster phase, disaster phase and post disaster management phases. All these phases having different critical and crucial importance and requiring excellent process and resource management.

Zimbabwe aiming to further enhance and adopt more of the technological initiatives that AI is continuously bringing across various industries around the globe, the nation is fortunate that it has somewhere to refer to around the world. In 2020, the National Oceanic and Atmospheric Administration (NOAA) collaborated with two tech companies to implement the new AI system for Hurricane forecasting in Florida which would then be used by the rest of USA states if it becomes successful (Sammon & Ambisha, 2021). The system analyses a wider range of data points than traditional methods, including ocean temperatures, atmospheric pressure variations, and even social media data on storm surge concerns. To this date, this is allowing more precise predictions of hurricane intensity, path, and potential flooding, giving coastal communities valuable extra time to prepare for evacuations and storm surge defences.

Furthermore, following the disastrous Nepal earthquake of 2015 several organizations utilized AI-powered damage assessment tools (Schilling & Layaraman, 2020). These were used as well as the drones and GPS in order to identify areas of collapsed buildings, blocked roads and landslides. This information was then shared to prioritize search and rescue efforts in the most critically affected areas.

Traditionally, disaster management supply chains have relied on human expertise and reactive strategies. However, the emergence of Artificial Intelligence (AI) is offering a new paradigm for optimizing disaster response. AI applications have the potential to revolutionize various aspects of supply chain management, leading to improved efficiency, faster response times, and ultimately, a greater ability to meet the needs of disaster-stricken communities.

This research has been triggered out by the challenge of disaster management in Zimbabwe. Zimbabwe, like many developing countries, faces a multitude of challenges in managing its supply chains during disasters. Some key factors contributing to this vulnerability include, limited infrastructure such as poor road conditions, inadequate storage facilities, and unreliable communication networks can significantly hamper the movement and distribution of relief supplies.

The researcher is also motivated to embark on this research study due to the full potential of AI that it has proved to have in different industries and have a chance to be fully adopted in supply chain during disaster management in Zimbabwe. Although some elements and operations of AI are already taking place around the world and even in Zimbabwe, the researcher is wants to evaluate its effectiveness and assess how great is Zimbabwe leveraging on the pros of AI. Analysts are saying that AI has an influence of 68% of the jobs currently

(Kong & Baruch, 2021) with an estimated expected annual growth rate of 39% from 2023 to 2030. With hundred thousands of organisations across the world having invested in bespoke software specifically for their operations in their respective fields having it to leverage their competitiveness and efficiency. This is influenced by the world of big data that we are currently living in and AI leveraging on that big data with tools like machine learning and root analysis (Laskowski, 2022) which facilitate predictive analysis of trends for accurate forecasts and analysis based on that data.

AI as an element that offers a variety of tools and functionalities that can address the challenges faced by disaster management supply chains in Zimbabwe. Some of the best applications and innovations that AI has proved to provide include the following:
Demand Forecasting: in this AI, algorithms can analyse historical data on disasters and predict the types and quantities of resources needed in different locations. This allows for more proactive procurement and allocation of supplies, reducing stock outs and delays. With automated data analysis, datasets of algorithms from various sources including weather forecasts, satellite imagery, and social media random feeds can be used to provide insights into the evolving needs of disaster stricken areas. This information can then be used to tailor relief efforts to the most critical areas.
Route Optimization: AI-powered logistics platforms can analyse real-time traffic conditions, weather patterns, and infrastructure limitations to identify the most efficient routes for delivering aid. This minimizes transportation times and ensures resources reach those in need faster.
Real-time Visibility: AI-powered tracking systems can provide real-time data on the location and status of relief supplies throughout the logistics chain. This allows for better coordination and facilitates informed decision-making.

The researcher's got caught by the vast amount of literature that is developing around AI as a subject and specifically on the impact of AI on supply chain management efficiency. Studies have shown that AI can improve various aspects, including lead-time reduction, inventory optimization, and overall supply chain visibility. However, the specific application of AI in disaster management is a relatively growing field. As a result the researcher embarked on this study to verify the impact levels of AI towards the efficiency of supply chains during disaster management.

1.2 Statement of the Problem

The biggest problem is the researcher believes that Zimbabwean government, NGOs and other disaster interested, we mostly employ reactive traditional methods of managing disasters and we are currently underutilising artificial intelligence. Only when the disaster starts that is when governments and people respond to the problem. Modern disaster management starts before the disaster happens, when they are merely speculations of the disaster (pre- disaster management stage) up until after the disaster has taken place that is post disaster management phase.

Another motivation of this research study is to bring out the findings of this research as quickly as possible so that it can aid in providing insights about disaster management supply chains by artificial intelligence in Zimbabwe. Currently there seem to be limited literature specifically for artificial intelligence systems tailored to optimise supply chains in Zimbabwe during disasters. The resercher Recently Zimbabwe declared 2024 as a drought year being caused by the Elnino effect, relatively this means the evaluation of AI are crucially needed as they may influence how the supply chains of victim reliefs may be delivered and managed.

Leveraging from AI the research is going to display how best disasters can be managed in Zimbabwe using modern methods and fully utilising artificial intelligence.

When we compare the flooding and cyclones that occur in Zimbabwe with those that occur in Western countries, it becomes evident how inefficient traditional disaster management is. Even though meteorological authorities predicted Cyclone IDAI a week before it made landfall in Zimbabwe, not much was done to ensure the safety of people, property, and livestock. On the other hand, in July 2023, floods in Turkey were predicted three weeks in advance, and a significant number of people were evacuated to safer locations, resulting in just one recorded death (Davies, 2023). Of course this can only be achieved with sufficient resources for the problem and AI tools are capable of estimating resources for the problem based on real time data.

The 2021 Cyclone Freddy in Malawi destroyed thousands of homes and displaced over 200,000 people. The same cyclone was projected to also hit Zimbabwe but by the time it reached Zimbabwe had already weaken. Limited communication infrastructure and lack of real-time data on affected areas hindered initial response efforts, delaying the arrival of crucial aid and jeopardizing lives (Mortlock, 2023).

Having a number of problems concerning the management of disasters in Zimbabwe, this has led the researcher to embark on this journey to evaluate the impact to which AI and its relative tools are optimising supply chains during disasters.

1.3 Research Questions

1) How prevalent is the use of AI technologies in disaster management supply chains across Zimbabwe?
2) How has the implementation of AI affected the efficiency of disaster management supply chains in Zimbabwe?
3) Considering AI adoption and its impact, what can disaster management professionals in Zimbabwe do to optimize their supply chains?

1.4 Research Objectives

1) To determine the extent of AI adoption in disaster management supply chains of Zimbabwe.
2) To determine the impact of AI on supply chain efficiency during disaster management in Zimbabwe
3) To recommend disaster management professionals in Zimbabwe on how they can optimise supply chains during disaster management.

1.5 Significance of the Study

Disasters pose a constant threat to millions of lives and livelihoods across Zimbabwe. Effective disaster management hinges on efficient supply chains to deliver critical aid promptly and minimize suffering. While traditional approaches face numerous challenges, Artificial Intelligence (AI) emerges as a potential game-changer. This research hinges onto evaluating the significance of investigating AI's potential to revolutionize disaster management supply chains in Zimbabwe.

The research study is going to be significant on enhancing efficient disaster management operations. The researcher aims to provide a comprehensive understanding of how AI is currently streamlining information gathering, resource allocation, and route planning, and by understanding the current level of adoption and use, the result will determine if underutilisation or inadequacy of AI systems is the current constraint on relief operations. By optimizing logistics and decision-making. AI has the potential to significantly reduce response times, minimize resource waste, and ensure critical aid reaches those in dire need promptly. This translates to saving lives, minimizing damage, and accelerating recovery for vulnerable communities.

The findings of this research will strengthen the instrumental in informing policy and practice related to disaster management in Zimbabwe. By identifying best practices and success stories of AI implementation, the study equips policymakers and practitioners with valuable insights and recommendations for responsible and effective utilization of this technology. This knowledge can guide the development of policy frameworks, capacity-building programs, and investment strategies to harness the potential of AI for improved disaster preparedness and response across the continent.

Disasters are a complex and ever-evolving challenge. This research contributes to building long-term resilience for Zimbabwe by exploring the extent to which AI has been adopted when managing supply chains during disasters. By understanding how well we have adopted AI currently we get to know whether we are fully leveraging on the potentials and against limitations of AI, stakeholders can proactively prepare for future disasters, invest in necessary infrastructure and capacity building, and ultimately create more robust and responsive disaster management systems that safeguard lives and livelihoods across Zimbabwe.

In conclusion, this research holds significant value for its potential to improve disaster management efficiency, inform policy and practice and contribute tor building long-term resilience for Zimbabwe. By exploring the multifaceted impact of AI in disaster management supply chains, the study aims to pave the way for a future where technology empowers communities to overcome disasters and thrive.

1.6 Limitations of study

The researcher went into a few but significant challenges. A major hurdle was the researcher's limited extensive network. The ideal participants were busy experts from specific NGOs and government agencies. It was hard to recruit enough people to fill out the questionnaires especially individuals coming from different organisations, and when considering the target sample size of 75. Fortunately, by leveraging on fellowships and reaching out to colleagues, the researcher was eventually able to collect the necessary data.

Time was also challenge. It posed a challenge because initially the researcher estimated and suggests a two-week data collection period, but it eventually took three to four weeks. This delay was not entirely surprising given the busy schedules of the target participants. The response rate was slow, with many questionnaires taking a long time to be returned and over ten remaining unanswered.

Chapter 2: Literature Review

2.0: Introduction

This is a chapter that comprises of commentary, outlaying and analysis of what the previous professionals and authors wrote on these pertinent subjects. It looks deeply into varying perspectives of authors on disaster management, artificial intelligence and supply chain efficiency. The primary goal is to gather all relevant and current literature on the mentioned subjects on a variety of sources, which includes professional journals, newspaper articles, textbooks, and internet in general, and more.

2.1 Disaster Management

According to the United Nations Office for Disaster Risk Reduction (UNDRR), disaster management involves organizing, planning, and taking actions to get ready for, respond to, and recover from disasters (UNDRR & Pokker, 2023). It is a big undertaking with several important steps that must be followed to lessen the number of casualties and the harm caused by any kind of disaster. Disasters themselves are defined as serious disruptions to a community or society, large or small. These disruptions are caused by dangerous events interacting with factors like vulnerability, exposure, and ability to cope. Disasters can lead to losses and damage to people, property, the economy, and the environment (Geer & Hanraads, 2021).

Emergency, is another word that is often used interchangeably with the term disaster (Perki, 2021) for example, in the context of biological and technological hazards or health emergencies, which, can also relate to hazardous events that do not result in the serious disruption of the functioning of a community or society.

Any catastrophic incident, whether natural or man-made, that results in a significant loss of human life or in the devastation of the environment, private property, or public infrastructure is also considered a disaster (Beamoin & Kotleba, 2020). Disasters can happen quickly, particularly in situations like oil spills, earthquakes, the aftermath of an ongoing pandemic, or climate change. Droughts, fires, floods, landslides, and volcanoes are examples of natural catastrophes. Devastating events can also result from human calamities including factory accidents, building collapses, fires, plane crashes, and acts of terrorism. Disasters can include even massive forced migrations brought on by conflict.

Whether or whether not an incident qualifies as a disaster depends on its frequency and effect level (Dimitruk & Paul, 2021). Disasters are typically declared by government authorities when they occur infrequently but have a significant impact (in terms of significant economic and human losses), such as when a tropical cyclone, severe earthquake, flood, or famine kills many people or releases large amounts of poison gas from a chemical plant. Certain events can be considered typical or routine if they occur frequently and have a minor impact, such a seasonal illness epidemic, the lack of rain during the dry season, or the annual number of fatal car accidents. However, judging what is high and low might be arbitrary and depend on factors including culture, past experiences with the same kind of incident, and reaction capacity. As such, similar disasters may be seen differently depending on the context.

For effective disaster management, (Oloruntoba & Gray, 2019) outlined a cycle of all the stages necessary for effective disaster management process. He outlined them as follows:

1. Prevention

Proactive response to a crisis is the best course of action. This entails spotting possible risks and coming up with precautions to lessen their effects. While this phase of the cycle entails implementing long-term strategies to reduce the likelihood of disasters, it is critical to recognize that disasters are not always avoidable. Prevention entails situations like the Planning and building a city to reduce the risk of flooding, such as by using locks, dams, or channels to divert water away from populated areas, and putting into practice an evacuation plan in a school that instructs teachers on how to guide students to safety in the event of a tornado or fire.

2. Mitigation

The goal of mitigation is to reduce the number of lives lost in the event of a disaster. It is possible to take both structural and non-structural actions. A structural measure involves modifying a building or environment's physical attributes to lessen the impact of a disaster (Schilling & Layaraman, 2020). To prevent hazardous storms from toppling trees and sending them crashing into residences and public buildings, for instance, trees should be removed from close proximity to houses. Adopting or changing building codes are examples of non-structural techniques that maximize safety in all upcoming building construction.

3. Preparedness

Being prepared is a continuous process that helps people, communities, companies, and organizations make plans and practice plans for what to do in case of an emergency. To ensure maximum preparedness, continuous training, assessment, and remedial action are necessary. Preparedness exercises includes activities such as fire drills, active shooter drills, and evacuation rehearsals (Kwechiku & Ukrobas, 2018).

4. Response

Response is what happens after the disaster has occurred. It includes both short and long-term responses. Ideally, the disaster management leader will coordinate the use of resources including people, supplies and equipment to help restore personal and environmental safety, as well as to reduce the risk of any further property damage. During this stage, any ongoing hazards are removed from the area for instance, in the aftermath of a wildfire, any lingering fires will be put out, and areas that pose a high flammability risk will be stabilized.

5. Recovery

Recovery is the fifth phase of the disaster management cycle. This may require several years or even decades to complete depending on the severity and nature of disaster. An example of the real cases are the several parts of New Orleans that are still recovering from Hurricane Katrina in 2005 (Parrel & Osmo, 2024). This stage entails bringing the region under control and resuming all necessary communal operations. Prioritization is necessary for recovery; less essential services will be restored later, with food, clean water, utilities, transportation, and healthcare being restored first. Helping people, communities, businesses, and organizations return to normal or a new normal, depending on the impact of the disaster is ultimately the goal of this stage. (Wassenhove & Noel, 20222) described this phase under the post disaster management phase.

2.1.1Types of Disasters in Zimbabwe

As alluded in the definitions disasters come as either natural or human induced disasters, it is also due to the frequency and impact of the events which influence governments to declare that the events are disasters. This is also a norm in Zimbabwe as the country faces different disasters often and thrives to manage them optimally. (Mzondi & Gumuzenzo, 2022) mentioned that landlocked nations have low chances of experiencing the common types of natural disasters but nevertheless in recent years they do face disasters and as a result they have to be effectively managed and Zimbabwe is not an exception on this.

The following are the common types of disasters in Zimbabwe:

Drought; Zimbabwe is a landlocked country in Southern Africa that experiences frequent droughts as of recent decades, just like most of its neighbouring countries . In Zimbabwe, agriculture accounts for 19% of the GDP (Machona, 2022). (Madzwamuse, 2020) Estimates that 80% of Zimbabweans rely on this primarily rain-fed agriculture for their livelihoods. Zimbabwe used to be a country that exported food, with surpluses in food production practically annually. The unpredictable and below-average rainfall volumes have been identified as a major contributing reason to the country's recent agricultural production drop. This year (2024) the Zimbabwean president already declared the drought a national disaster. This has been triggered by the global Elnino climatic effect (Shumba, 2024). The drought disaster management and response processes are mostly traditional with development partners (NGOs) assisting the government in carrying out projects that alleviate the severe drought conditions by supplying water and food to various impacted communities. Droughts have a significant impact on livestock as well, particularly when they last for a long time. Additionally, the Vet Field Services Department collaborates with FAO to supply additional feeds for animals in impacted areas (Mukoko & Ndlovu, 2018). Nonetheless, the Ministry of Agriculture has a key role in guiding the Zimbabwean government's response to emergencies including the drought. Development partners (NGOs) only enter the picture to assist the government in carrying out initiatives that tackle severe circumstances like recent droughts by giving food assistance to various areas. Droughts causes a variety of problems, including food shortages, water scarcity, and wildfires.

Floods; Floods are another common disaster in Zimbabwe. Floods can be caused by heavy rains, tropical cyclones, or the bursting of dams. Floods causes widespread damage to infrastructure and property, and in many cases they have led to displacement of people from their homes. In February 2023, tropical cyclone Freddy caused flooding and destruction in many parts of Zimbabwe. Although the cyclone was foreseen in due course very limited efforts were made to minimise its impact. It is fortunate that the tropical cyclone wave weakened as it reached some parts of the eastern and southern part of the country. Unlike what is regarded as the most impactful cyclone to hit Zimbabwe and even Mozambique, the cyclone Idai of 2019, which result in more than 300 people losing their lives and thousands of livestock killed (Sibanda & Mukwada, 2021). Although floods are often managed traditionally by reactional methods the government of Zimbabwe and various NGOs have put control and updated systems which predict the weather patterns and influence proactive disaster management methods.

Disease outbreaks; Zimbabwe is also susceptible to disease outbreaks, such as cholera, typhoid, and malaria. These outbreaks have been frequent since the early 2000s up to today, with the most recent Cholera outbreak being first reported in 2023 and crossed over to 2024. Having a number of cases rising to 207 as at February 2024 (Jongwe, 2024). These disease outbreaks are caused by a number of factors, including poor sanitation, inadequate healthcare, and climate change. On these outbreaks preventive measures are often put in place but they have proved to be insufficient as the health sector end up reacting to the diseases and try to cure and minimise the spread and deaths.

2.1.2: Disaster Management in Zimbabwe

The cornerstone of disaster management in Zimbabwe is the Civil Protection Act of 1989. This legislation lays out the legal framework for disaster preparedness, mitigation, response, and recovery. The Department of Civil Protection (DCP), housed under the Ministry of Local Government, Public Works, and National Housing is the one that spearheads national coordination efforts.

The policy emphasizes a holistic approach, involving various government ministries, local authorities, and communities. The National Policy for Civil Protection underscores the responsibility of every citizen to contribute to disaster mitigation. Existing environmental laws, like the Environment Management Act, complement this by aiming to prevent environmental degradation that can worsen disasters.

Disaster management in Zimbabwe follows a cyclical process encompassing four key stages:

- **Prevention and Mitigation:** The goal of this stage is to lower the danger of disaster. The DCP identifies regions that are vulnerable to hazards and puts mitigation strategies in place, such as early warning systems, land-use planning, and encouraging conservation practices, in coordination with other stakeholders. Programs such as *Food for Work* which the government of Zimbabwe initiated in October 1989 (Mapfunde, 2021), it was designed to supplant large scale distribution of free food that had taken place annually since the 1981 drought.

Preparedness**:** Here, the emphasis shifts to being ready for an impending disaster. The DCP coordinates with relevant ministries and local authorities to develop contingency plans, stockpile essential supplies, and conduct training for communities and emergency responders. Public awareness campaigns educate communities on disaster risks and safety measures. Third parties such as NGOs also participate well enough in this. In their respective organisations or in collaboration with local authorities such as rural district councils, they compile database and plan for contingency supplies.

Response**:** When a disaster strikes, the focus is on immediate life-saving interventions. The DCP activates the national civil protection mechanism, deploying emergency teams for search and rescue, providing food, shelter, and medical care to affected populations. International aid organizations often play a crucial role during this stage. Recently after the president of Zimbabwe declared the current drought a disaster organisations such as UN are already working on it, with the recent call made by UN and SADC settling on a regional appeal to seek USD5.5 billion to provide urgent lifesaving assistance (Mtombeni & Gumbodete, 2024).

Recovery and Rehabilitation**:** The final stage focuses on rebuilding livelihoods and infrastructure damaged by the disaster. Reconstruction efforts involve providing financial assistance, rebuilding homes and schools, and restoring agricultural productivity. Psychosocial support plays a vital role in helping communities cope with trauma and rebuild their lives.

Despite the established framework, Zimbabwe faces significant challenges in effectively managing disasters. Limited resources due to economic hardship often hinder preparedness efforts. Additionally, the policy framework, while robust, can struggle with implementation at the local level. Furthermore, climate change is exacerbating existing vulnerabilities. Droughts are becoming more frequent and severe, while erratic rainfall patterns increase the risk of floods.

Despite the challenges, Zimbabwe has made strides in disaster management. Early warning systems have helped save lives during floods and cyclones. Community-based initiatives aimed at building resilience are showing promise. Collaboration with international organizations provides crucial support during large-scale disasters.

Looking ahead, resource allocation for disaster preparedness needs to be prioritized in Zimbabwe. It is important to foster community ownership of risk reduction initiatives and to strengthen local capability. It is important that disaster management plans take climate change into account. Zimbabwe may strengthen its resilience and better prepare for the future by tackling these issues and developing its framework for managing disasters.

2.2: ARTIFICIAL INTELLIGENCE

(Parkh & Isakow, 2022) mentioned that it is hard not to experience the brilliance of AI in this generation. They also mentioned that all internet system, social media applications, industrial material requirement systems and more are utilising AI to provide feed to users. In the first chapter the researcher provided the simplified definition of AI from (Laskowski, 2021) which is the simulation of human brilliance by machines. However, here is the full description and explanation of what AI is and how it figures out information and data to be named as human-like systems. (Tucci, 2022) mentioned that to this day when we use our mobile phones and use the face recognition feature, the google search and predictive texting on messaging applications, it is all AI operating silently.

(Manning, 2020) defined artificial intelligence (AI) as a vast area of computer science that involves the development of intelligent agents, or autonomously reasoning, learning, and acting computers. In essence, artificial intelligence (AI) is the branch of computer science that focuses on building intelligent machines that can replicate human cognitive processes. This covers learning, thinking, problem-solving, and decision-making tasks. But unlike human intelligence, which is flexible and adaptive, artificial intelligence (AI) systems usually perform better at narrowly defined tasks.

AI has been an appealing concept to humans for many years, showing up in both science fiction and philosophical discourse. But with the development of powerful computers and advances in algorithms, the area really took off. These days, there are a wide range of subfields within AI research, each focusing on various aspects of intelligence.

Machine Learning (ML): Without direct programming, this branch enables machines to learn from data. ML algorithms are able to find patterns and forecast outcomes by examining large datasets. Machine learning is used by spam filters, recommendation systems, and facial recognition software. One of the most common example of ML is predictive texting and suggestive words on each and every smartphone.

***Deep Learning*:** A subset of machine learning influenced by the structure of the human brain. Artificial neural networks, which are networked nodes that process information similarly to neurons, are used in deep learning. These networks perform highly in tasks like natural language processing, picture and speech recognition. These are the systems that powers virtual assistants such as Alexa and Siri and most commonly Google voice

***Computer Vision*:** Gives machines the tools they need to interpret visual data. This technology supports facial recognition security systems, self-driving automobiles, and medical picture analysis in the healthcare industry.

***Robotics*:** Makes intelligent robots by combining mechanical engineering and artificial intelligence. Robotics is used in many different industries, including deep sea research, bomb disposal, and manufacturing and assembly lines.

The impact of AI is undeniable. It has revolutionized industries, from healthcare where AI assists in disease diagnosis and drug discovery, to finance where AI algorithms power high-frequency trading. AI is also transforming transportation with self-driving cars and delivery drones, and even creative fields are embracing AI for music generation and content creation.

2.2.1Global Importance of AI in Disaster Management

1. Preparedness: Predicting and Preventing Disasters

Early Warning Systems; AI is able to more accurately forecast possible disasters by analyzing huge amounts of data, such as previous weather patterns, earthquake activity, and sensor readings. This makes it possible for authorities to proactively allocate resources, evacuate high-risk regions, and give timely warnings. Among the countries who have invested more in these AI systems, Bangladesh one of them having invested more than USD $10 million in 2019 on an AI-powered flood forecasting systems to anticipate floods days in advance, allowing people and resources to be mobilised appropriately (Rajjev & Kumar, 2021).

Risk Assessment and Mitigation: AI algorithms can assess a region's vulnerability to disasters (Parkh & Isakow, 2022). By analyzing factors like land use, population density, and infrastructure, they can identify high-risk areas and recommend mitigation strategies. For example, in earthquake-prone zones, AI can help design earthquake-resistant buildings and infrastructure.

2. Response: Faster and More Effective Actions

Optimizing Resource Allocation; during a disaster, resources are often scarce. AI can analyse real-time data on damage, needs, and available resources to optimize their allocation. This ensures critical supplies, like food and medicine, reach those who need them most quickly.

Search and Rescue; AI-powered drones and robots can be deployed in dangerous or hard-to-reach areas to locate survivors and assess damage. This can significantly improve the effectiveness of search and rescue operations, saving valuable time and lives.

Communication and Coordination; AI-powered chat-bots can be used to provide real-time information and answer frequently asked questions from affected people. This frees up human responders to focus on critical tasks and ensures a smooth flow of information.

3. Recovery: Rebuilding and Moving Forward

Damage Assessment: AI can analyze aerial imagery and satellite data to assess the extent of damage to infrastructure and property. This rapid damage assessment helps authorities prioritize reconstruction efforts and allocate resources effectively.

Recovery Planning: AI can be used to analyze past recovery efforts and identify areas for improvement. This data-driven approach can help develop more efficient and effective recovery plans for future disasters.

2.2.2: Artificial Intelligence in Zimbabwe

The main purpose of this research is to assess the impact of artificial intelligence during disaster management in Zimbabwe. This is going to be achieved by analysing and measuring the level of the current adoption of AI systems by disaster management stakeholders and assessing the level of efficiency the AI systems have. However the researcher is also interested in assessing the general use of AI systems across all entities in the country.

In agriculture, AI is being explored to address challenges in agriculture, a major sector in Zimbabwe. For instance, AI tools are being developed to identify crop diseases with high accuracy using smartphone cameras, helping farmers make informed decisions. On the other hand, banks in Zimbabwe have begun to embrace digital tools, with some exploring AI-powered chatbots for customer service, although adoption is still on the lower.

2.2.3: AI Intelligent Drones in Zimbabwe

The Chattered Institute of Logistics and Transport board of Zimbabwe (CILT ZIMBABWE) articulated in praise of the progressive rise of awareness and adoption of modern logistical tools and other forms or technology in the logistics and transport industry across Zimbabwe. In the institution's 2024 magazine (Biza, 2024) stressed out that AI is a key component in revolutionizing the ability of drones to be equipped with different capabilities for specific tasks. The AI functionalities is allowing drones to interact with environments and be able automatically track objects, avoid them, measure area size and more. The government of Zimbabwe understands the magic work of AI and drones and has allowed even private individuals to leverage on it, this was followed by tailoring of drone regulations through the law SI 271 of 2018 under the Civil Aviation Authority of Zimbabwe (CAAZ). The drone systems went on to be adopted by the following organisation, all with the integration of AI, NGOs, ZINGSA, ZESA, ZIMPARKS, ZIMASCO, ZIMPLATS, UNKI mine and more. Apart from drones there are other tools which are functioning holistically upon AI, mobile devices, mapping services, forecasting software- on weather, demand and inventory and more.

With all this in place the researcher is interested in assessing the impact of AI currently during disaster management. The country happens to have a couple of organisations that are improving daily in their use of artificial intelligence and technology, recently ZINGSA successfully conduct aerial mapping to identify dysfunctional areas in cities by drones and provide local authorities with information about areas of illegal occupancy (Biza, 2024). Through use of drones, the geospatial agency (ZINGSA) is in the process of mapping land for the assessment of 99-year agricultural leases. Drones continue to be useful in terms of inspection of infrastructure such as boosters by telecom companies, buildings, pipelines, and ZESA power lines (Ndlovu, 2024). The Civil Protection Unit (CPU) has been equipped with emergency preparedness drones to be used in search and rescue missions such as the recent devastating Cyclone Idai. In such instances it is used to access areas that are not accessible for assessment, search, and rescue. When it comes to town planning and rural planning, it is now easier for the authorities to make informed decisions.

2.3.4: Artificial Intelligence in Disaster Management across the World

Improving early warning systems is one of the most important uses of AI. These systems have historically depended on human processing of little information or established thresholds. On the other hand, AI is capable of analyzing huge amounts of data from social media, satellites, and weather stations. Artificial intelligence (AI) can issue more accurate and timely warnings by seeing minute patterns in air pressure, ocean temperatures, and social media postings of unexpected weather phenomena. This might save lives by giving people more time to get ready and flee. For example, to estimate flooding threats more accurately, AI-based flood prediction models can examine rainfall data, historical river levels, and land cover.

Traditional resource allocation techniques can be swiftly overwhelmed by disasters, resulting in inefficiencies or delays. By examining real-time data on damage assessments, infrastructure interruptions, and population relocation, artificial intelligence (AI) provides a solution. The deployment of first responders, relief supplies, and medical assistance is then optimized using this data. AI guarantees a quicker and more efficient response by focusing resources on the areas with the most pressing demands. AI-driven logistics platforms can also be useful in this regard, since they can optimize delivery schedules and routes for essential commodities.

Communication channels can become overloaded during disasters, hindering the flow of information. AI-powered chat-bots can provide a solution by offering 24/7 access to vital information. These chat-bots can answer frequently asked questions related to shelters, evacuation routes, and missing persons, freeing up human emergency service personnel to focus on critical tasks like rescue operations and medical care. Chat-bots can also be multilingual, catering to diverse populations and ensuring everyone has access to crucial information.

Another area where AI is making a difference is in faster damage assessment. Traditional methods often rely on personnel venturing into dangerous or hard-to-reach areas. AI-controlled drones equipped with high-resolution cameras and sensors can be deployed to quickly survey disaster zones, collecting visual data and damage assessments. This not only reduces risk to human life but also provides valuable data for quicker recovery efforts. AI can then analyze drone footage to identify damaged infrastructure, estimate the number of affected people, and prioritize areas for rescue and rebuilding.

Finally, AI can contribute to efficient recovery and rebuilding. By analyzing data on past disasters, including recovery strategies, resource allocation methods, and their effectiveness, AI can identify best practices for post-disaster recovery and rebuilding. This allows communities to make informed decisions about infrastructure development and resource allocation. AI can also be used to model the potential impact of different rebuilding strategies, leading to a more prepared, responsive, and resilient future in the face of disasters.

2.3: Supply Chain Efficiency

Another broad term with lot of definitions. Firstly according to (Rozze & dasten, 2019) supply chain refers to the use of all available resources, including financial, human and physical ones, to meet customer demand economically and speedily as possible. Its efficiency is measured by different metrics but despite the variance in the definitions the ultimate meaning of a supply chain is the movement of goods, services and related information from the manufacturer to the final consumer (Bahagia, 2021).

(Oham & Dholakia, 2023) Pointed out that the supply chain efficiency can be measured by analysing the supply chain performance objectives on whether they are achieved and how they are achieved. He mentioned that the efficiency could be assessed by individually analysing performance objectives that are speed, dependability, cost, quality and flexibility.

As for organisations when they are measuring supply chain efficiency they would be ensuring that they are not wasting resources when delivering goods or services to customers. In the disaster management concept the major objectives are to be able to provide relief to victims in as quick as possible to limit the impact of the disasters

2.3.1: Integration

Integration is the first element of Supply Chain Management, connecting all four elements. It means aligning the strategies, processes, information, and technology of Supply Chain functions and partners. Integration allows goods and services, data, and communication to flow smoothly and seamlessly throughout the Supply Chain. It also helps to reduce costs, errors, delays, and risks by removing unnecessary and inconsistent activities.

Integration needs a strong commitment and involvement from the company's leadership. It also requires a clear vision, mission and goals, and a thorough analysis of the internal and external environment. Establishing efficient channels for coordination and cooperation with vendors, clients, and other stakeholders is another aspect of integration. In addition, integration requires the use of appropriate systems and tools to facilitate the gathering, storing, sharing, and analysis of data. Improved customer satisfaction and loyalty through meeting needs and expectations, increased competitive advantage through value creation and differentiation, increased operational efficiency and productivity through resource and process optimization, decreased waste, and minimized inventory overstocking and understocking are just a few advantages of integration.

2.3.2: Operations

Operations, the second component of SCM, is concerned with carrying out activities efficiently. It include overseeing the manufacture, handling, distribution, and storage of products and services. Planning, scheduling, tracking, and managing the effectiveness, procedures, and assets of the supply chain are all included in operations. Standards for sustainability, quality, safety, and compliance are also guaranteed.

A thorough understanding of the capabilities and limitations of the supply chain partners, as well as the patterns of demand and supply, is necessary for operations. To attain optimal efficiency and efficacy, the Supply Chain's resources and procedures must be continuously assessed and improved.

2.3.4: Purchasing

Purchasing, the third component of supply chain management, is concerned with obtaining products and services from the provider. It include overseeing the procurement, negotiation, contracting, evaluation, and selection of suppliers. Building and sustaining long-term supplier relationships on the basis of mutual respect, cooperation, and benefit is a key component of purchasing. In addition, it entails upholding social, ethical, and environmental accountability. Purchasing necessitates a strategic approach to acquiring products and services in line with the aims and objectives of the company. In-depth examinations of the supplier market, product and service quality, pricing, availability, and dependability are also necessary. Implementing efficient supplier management practices and instruments to track and evaluate the performance and satisfaction of the supplier is another aspect of purchasing.

2.3.4: Distribution

Distribution is the next component of supply chain management and it deals with getting products and services to consumers. It addresses handling customer service, transportation, warehousing, and the significance of logistics. Distribution is the process of making sure that products and services are supplied to clients in a timely, accurate, and economical manner. It also entails providing value-added services including disposal, maintenance, repair, and installation.

2.3.5: Supply Chain Efficiency Metrics in Disaster Management

Speed; In the aftermath of a disaster, every second counts. The quicker aid reaches those affected, the higher the chances of saving lives, preventing further injuries, and minimizing long-term damage. Speed is crucial for search and rescue operations, where locating and extracting trapped individuals is a race against time. Rapid deployment of medical teams and supplies ensures prompt treatment for the injured, potentially preventing complications and fatalities. The emergence of AI and other technological innovations is thriving to ensure that speed to rescue casualties and disaster victims is achieved to its best. (Bahagia, 2021) Mentioned that speed doesn't mean rushing headfirst into the situation, it begins from careful planning and pre-positioning of resources near disaster-prone areas can significantly improve response times. Investing in communication technologies, AI systems emergency and broadcast systems allows for faster coordination between rescue teams and facilitates the flow of critical information.

Dependability; forms the backbone of any effective disaster response. Rescue equipment needs to be robust and reliable to function under challenging conditions. Shelters must be structurally sound to protect people from the elements, while communication systems should be resilient enough to withstand disruptions caused by the disaster itself.

Stockpiling of essential supplies, such as food, water, and medicine, plays a vital role in ensuring dependability. These supplies need to be regularly inspected and replaced to guarantee their quality and effectiveness when needed. Building trust in the system comes from consistent and dependable support throughout the response phase.

***Flexibility*;** Disasters rarely behave according to a script or be deemed to be perfectly managed (Machub, 2019). Having a flexible disaster management plan that can adapt to evolving situations is paramount. This includes the ability to adjust resource allocation based on the specific needs of the affected area. For instance, a hurricane response plan may need to be modified if it's accompanied by unexpected flooding, demanding additional resources for water rescue and flood mitigation. Flexibility also extends to accommodating changes in the environment. For instance, aftershocks following an earthquake may damage previously established shelters, requiring a swift shift to alternative locations. A flexible plan empowers response teams to make real-time decisions while maintaining focus on the overall objectives.

CHAPTER 3: METHODOLOGY

3.1: Introduction

The research assumed a quantitative methodology of data gathering and analysis. Data was collected using in depth questionnaires that were distributed to designated respondents. This chapter intent to display the study approach and area following the gathering of quantitative information from the area.

3.2 Study Area

The study was carried across Harare Zimbabwe specifically the urban area. The researcher found it as a very suitable place for the research as it is the capital of Zimbabwe and consists of lot of organisations interested in disaster management, a lot of non-governmental organisations, the head of government department which oversees disaster management and relief programs and to a huge contribution the disaster management stakeholders such as donors and more, not leaving out logistics experts in public and private organisations in Harare. With the city having over 200 NGOs with their headquarters located in there, the researcher found it having a higher chance that it is a lucrative pool as many of the NGOs maybe interested in the topic of disasters and anything along the research area.

3.3 Research Design

This study employed a quantitative research design using a questionnaire survey. This approach allowed for the collection of standardized data from the sampled respondents, enabling statistical analysis to assess the impact of AI on disaster management supply chains in Zimbabwe.

(Conflay & Givon, 2021) outlined that questionnaires structured to feed quantitative research allows one to gather information from a large number of people relatively quickly and easily. He explained that it is particularly beneficial when the research requires data from a widely dispersed population or a large sample size to ensure generalizability of findings. On the other hand, quantitative research relies on numerical data, which minimizes bias and allows for more objective results.

3.4: Subjects Population and Sampling

3.4.1:. Population

The target population were individuals involved in disaster management supply chains in Zimbabwe. This included personnel from government agencies (e.g., Department of Civil Protection), NGOs involved in disaster relief, logistics companies, and private sector organizations that contribute to disaster responses, or any individual with an experience in logistics and management of disasters.

From a pool of over a hundred of organisations that enabled the research to have power, be robust and more generalizable. According to (Davison Pakkey, 2019) larger sample reduces the chance that your results are due to random sampling error. This strengthens the reliability of your findings, meaning they are more likely to be replicated in future studies (Babbie, 2019)

Furthermore, with more data points, you have greater statistical power to detect significant relationships between variables. This helps one draw more confident conclusions about the impact of certain factors on your research topic (Cohen, 1988).

3.4.2: Sampling

A purposive or judgemental sampling technique was used to select participants who meet the inclusion criteria. This involved collaborating with relevant organizations to identify individuals with the required knowledge and experience. The method falls under the umbrella of non-probability sampling, where selection relies on justified judgement rather than random chance.

The researcher found this ideal on this research because he required experienced experts in the field of supply chain in general, logistics and disaster management. The other reason is, despite having a lot of NGOs and logistics personnel, experts and individuals who have the disaster management experience are relatively few hence purposive sampling allowed the researcher to target individuals with the specific knowledge and experience.

The ideal sample size ranged from 50 to 100. This was deduced after the calculation of the ideal sample size with the confidence level of 95% and margin of error of 5% using a sample size of 200.

The researcher worked with a sample size of 51 despite the questionnaire being distributed to 75 individuals.

3.5: Research Instruments

The researcher used a questionnaire as his sole research instrument. The questionnaire comprised of three sections. The first question was the respondents' profile or simply the demographics section. The second section was "SET ONE" a group of questions specifically aimed to answer the first research question and to achieve the first objective. The same was applied to "SET TWO".

According to (Folland, 2020) there is no better way of gathering in-depth responses in a standardised and efficient way than using a well-designed questionnaire. (Rastern, 2022) Also mentioned that a good questionnaire allows for prompt detailed and thoughtful responses from participants.

The researcher made use of different types, techniques and skills in designing the questions. Some questions were closed ended questions; to ensure specific straight responses some were open-ended questions to enable extraction of valuable insights. Some were follow up probing questions just to gather more insights for quality data analysis.

The questionnaire was distributed to 65 experts. The researcher expected higher response rate as these questionnaires were distributed directly after confrontation to the respondents.

3.6 Data Collection and Procedures

As alluded, the data was collected through a questionnaire only. Different types of questions were asked in order to effectively achieve the research objectives. The respondents were given the questionnaire to complete under the supervision of the researcher. Before distribution of the questionnaire, the researcher clearly articulated and explained the purpose of the process and the importance. Likert scales were frequently used in the questionnaire to determine the respondents' perceptions of various implications on this area of study. Respondents were inducted to tick the most preferred option which corresponded to a specific value on the Likert scale. 1 indicating that they are strongly agreeing and 5 indicating strong disagreement. Below is the Likert Scale table:

Question/Statement	Strongly Agree (1)	Agree (2)	Neither Agree nor Disagree (3)	Disagree (4)	Strongly disagree (5)
How much do you agree?					

Table 3.1

3.7 Pilot Study

3.7.1 Validity Testing

In enhancing the validity and robustness of the study's findings, the researcher implemented regression analysis. This statistical method offered several advantages to the research, primarily enabling the examination of the relationship between variables, such as AI integration level and perceived information flow efficiency, in a quantitative manner. By providing objective insights into the impact of AI on supply chain efficiency during disaster management, regression analysis complemented the data gathered from the survey. Additionally, it facilitated the identification of significant factors influencing the outcome variable, pinpointing key drivers of information flow efficiency in disaster management supply chains. Furthermore, regression analysis played a pivotal role in promoting validity testing by providing a systematic framework to assess the reliability and validity of the research instrument in this case, the questionnaire. Before administering the questionnaire to the respondents, the researcher conducted a pilot study, a crucial step in research methodology. This pilot study allowed for testing the relevance and purpose of the questions in relation to the study objectives, measuring respondents' completion time, and ensuring question clarity. Feedback from a small group of friends and classmates involved in the pilot study was utilized to rectify errors and improve question phrasing as necessary. This iterative process significantly enhanced the validity and reliability of the questionnaire, ensuring it effectively captured the intended data and contributed to the overall validity of the research findings.

3.7.2: Ethical Considerations

In this study the researcher displayed utmost ethical awareness. Firstly, no information was hidden to the respondents, the whole purpose and the aims of the study were made clear to each and every respondent. Despite most respondents having no problem or rather willing to be revealed off their identities and profiles including names and positions they hold in various organisations, the researcher found it safe to keep the information confidential. The major reason being to avoid exploitation of personal information in other unauthorised actions and secondly because not everyone amongst the respondents accepted to reveal out their identities, hence the researcher ended up deciding not to reveal names of all the respondents and their respective organisations.

The information collected by the researcher was used only in relation to this study and records kept are only kept with the intention of supporting this research study.

3.8: Presentation and Analysis of Data

The researcher thoroughly analysed his findings after collection. As mentioned above this research was fully a quantitative research, meaning that data analysis and outcomes are numbers or statistically justified. The data was coded in a statistical tool from IBD called SPSS version 28. Analysis and commentary was supported by descriptive statistics such as frequencies, percentages, skewness and standard deviation. Statistical tables were created for clear representation of data and results. Charts and graphs were also derived from SPSS in order to bring out the clear representation of the results apart from statistical figures.

CHAPTER 4: DATA INTREPRETATION AND ANALYSIS

4.1: Introduction

This fourth chapter consists of the display and analysis of the results found from the research and reveals the outcome from the analysed data. The outcomes are going to be presented in tables. The researcher's goal was to find the impact of artificial intelligence towards supply chain during disaster management specifically in Zimbabwe. The research was facilitated by collecting data through a questionnaire from individuals who are current and former workers of organisations who have an interest or work just to manage disasters. The researcher's objectives were to firstly find out the extent of adoption of artificial intelligence technologies, systems and tools in Zimbabwe. Secondly, the researcher aimed to find the impact of artificial intelligence on supply chain efficiency during disaster management.

4.2 Rate of Responses

The population around the study area are difficult to come up with a specific number but the researcher decided to estimate them at 200 organisations in Harare basing on a variety of factors. Using different mathematical formulas the researcher found out that 50 to 100 was the optimum sample size. As a result, 75 questionnaires were sent to selected individuals who met the criteria described above. These individuals were either current or former employees of Civil Protection Act of Zimbabwe or current or former employees of NGOs who assist during disasters. Among the 75 questionnaires which were distributed 51 were returned. The table below show the response rate.-

	Questionnaires Sent	**Completed Questionnaires**	**Rate of Responses**
Questionnaires	**75**	**51**	**68%**

Primary Data: Table 4.1

The table above is showing that response rate from the questionnaire is 68%. (Kumar, 2019) recommended that if the rate of responses is above 50% meaning any rate from 51% validates the research, at 68% the research was clearly safe and valid.

4.3 Demographic Profiles of the Respondents

4.3.1 Current or Former Employees:

	Value	Frequency	Percentage%
Current	**1**	**39**	**76%**
Former	**2**	**12**	**24%**
Sum		**51**	**100**
Mean	**1.24**		
Mode	**1**		
Skewness	**1.29**		

Primary Data: Table 4.2

The table above is showing the numbers of the respondents who are active and non-active in the field of disaster management along supply chain processes in their respective organisations. The table is showing that 39 of the respondents were still actively working in respective organisations at the time at which they answer the questionnaire. Only 12 of the respondents were former employees of organisation or organisations which are somewhat responsible along disaster management and its supply chains.

The motivation behind this question was to ensure the validity and quality analysis of data. Although artificial intelligence has been around for a couple of years now, it keeps on improving day by day and both currently serving and former servers employees may be having differing opinions on the questions asked. The other reason for collecting this information was to ensure further streamlined analysis that was later carried out by the researcher.

As a result, the modal class of 1 and the mean of 1.24 relatively shows that most the dominant class was the one of current employees who are still serving in their respective organisations in the supply chain field. The skewness of 1.29 which is considered highly skewed shows that a greater number are currently serving employees, which is exactly what the researcher was expecting when he collected the sample due to the nature of the study and subjects involved.

4.3.4: Years of experience:

Years	Value	Frequency	Percentage%
0-2	**1**	**11**	**22%**
3-5	**2**	**15**	**29%**
6-8	**3**	**11**	**22%**
8-10	**4**	**9**	**17%**

10+	**5**	**5**	**10%**
Sum		**51**	**100%**
Mean	**2.7**		
Median	**2.00**		
Mode	**2**		
Skewness	**.35**		

Primary Data: Table 4.3

The table above shows the number of working experience of all the respondents that took part in the questionnaire. These number of years were strictly the time on which one was working in any work related with disaster management supply chain. For example procurement, demand planning, forecasting, logistics, mapping , resource and inventory management and more. From the table above 11 participants (1) have 2 years and under, 15 respondents have been working in this field for three to five years, 11 have six to eight years working experience (3), nine and five of the respondents have eight to ten(4) and over ten years(5) of working experience respectively.

The reason why the researcher found the question relevant was that, he had to confirm if he the questions were asked well experienced personnel in this field. Advantages of having experienced people in this study was for them to give out detailed and quality responses about their respective organisations. The other reason is experienced people have served and worked through all the phases of artificial intelligence, stretching back to where it was not even a thing, its introductory phase up to present day, as a result they are bound to give out quality and well informed and backed up logical responses.

The modal class consists of individuals with working experience between three and five years (2). With the average of 2.7 meaning that the average lies between a class of respondents with three to five years (2) and close to the (3) class of respondents with working experience ranging from six to eight years. The skewness of .35 supports that from the data there are no outliers and the distribution curve is approximately symmetrical. All this supports that the generally all the respondents were well experienced in this field of supply chain and disaster management which relatively mean quality and relevant responses were highly to be an outcome.

4.4: DATA PRESENTATION AND ANALYSIS
4.4.1: SET 1

1) In general artificial intelligence (AI) technologies are widely used to optimize supply chains during disasters in Zimbabwe.

Value Label	Value	Frequency	Percent
Strongly Agree	1	4	8
Agree	2	13	25
Neutral/Neither Agree nor Disagree	3	15	29
Disagree	4	11	22
Strongly Disagree	5	8	16
Sum		51	100
Mean	3.1		
Mode	3		
Standard Deviation	1.2		
Skewness	.1		

Primary Data: Table 4.4

To come out with information which would lead the researcher to achieve his first objective. The motivation behind this statement was to deduce perception of the respondents on how they perceive the management of supply chains during disasters. This was not just about their respective organisations but the overall supply chains and disaster management. With the mean of 3.1, standard deviation 0f 1.2 and the modal class being neither agree nor disagree (3) this means that a lot of respondents were lie in the (3) category. 33% of the respondents were either agreeing (2) or strongly agreeing (1). On the other hand 38% were either disagreeing (4) or strongly disagreeing (5), whilst 29 percent were in the modal class.

Merely from the descriptive statistics, the data shows almost a symmetrical distribution, with a skewness of 0.1. This means the respondents represented each class in almost the same numbers which makes it difficult to conclude the adoption of AI in disaster management at this point. This is because the same numbers are agreeing, disagreeing and also not sure. The pie chart below *PIE (1)* shows that the segments are almost equally represented as blue and yellow segments ultimately means agreeing and disagreeing respectively.

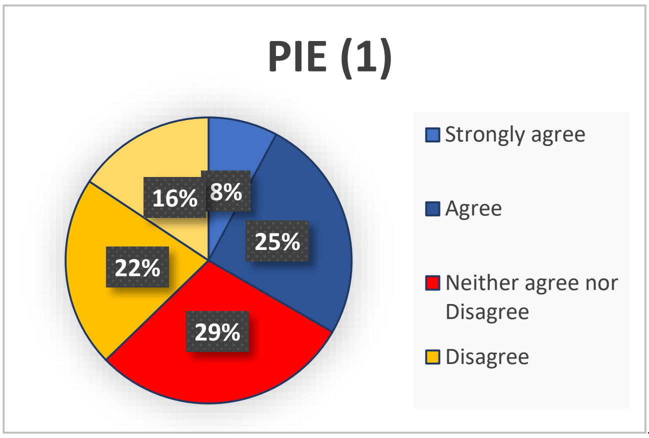

Fig 1

2) My organisation or (former organisation) actively implements (implemented) AI solutions to optimize logistics during disaster response.

Value Label	Value	Frequency	Percent
Strongly Agree	1	25	49
Agree	2	7	14
Neutral	3	0	0
Disagree	4	6	12
Strongly Disagree	5	13	25
Sum		51	100
Mean	2.51		
Standard Deviation	1.8		
Mode	1		
Skewness	.52		

Primary Data: Table 4.4

The table above shows statistics of respondents to the statement above. From the table above 49% of the respondents strongly agreed that the organisations which they are currently working for or in which they served actively implements AI solutions to optimise supply, chain processes. 25% and 12% of the respondents strongly disagree and disagree to the statement.

The mean of 2.5 and the relative standard deviation of 1.8 shows that most respondents falls into the values (1) and (2) this also supported by the modal class of (1) which is strongly agree. Also the skewness of 0.52 shows a positive skewed data distribution supporting that the values are heavily falling on class (1) and (2).

From the data in table above it shows the researcher that Artificial intelligence has relatively been adopted by significant number of organisations which deals with disaster in Zimbabwe. Experts which are in this the respondents 63% of them agreed that organisations which they work for or they once worked for are actively implementing AI solutions to assist them to better manage the disasters that fall in Zimbabwe. 37% were surely disagreeing with the statement which is less than to the ones that agreed but 37% is quite a significant. According to the statistics above it shows that AI has been relatively adopted by many of the institutions to optimize their disaster management supply chains although it has not been adopted by the rest in Zimbabwe at this moment.

3) My (former) organisation has relatively improved or increase investing in AI systems than it was 5 years ago.

Value Label	**Value**	**Frequency**	**Percent**
Strongly Agree	**1**	**30**	**65**
Agree	**2**	**14**	**25**
Neutral	**3**	**0**	**0**
Disagree	**4**	**2**	**2**
Strongly Disagree	**5**	**5**	**8**
Sum		**51**	**100**
Mean	**1.6**		
Mode	**1**		
Skewness	**2.19**		
Kurtosis	**4**		

Primary Data: Table 4.5

The aim of the statement was to find out if the respondents think that their respective organisations are working towards having Artificial intelligence as part of their systems. Any result that would have come out of this would tell if either there is progress or no progress in the adoption of AI in disaster management supply chains across Zimbabwe.

From the table above 90% of the combined respondents strongly agreeing (1) and agreeing (2) group, agreed to the statement. None of the respondents were neither agreeing or disagreeing with on 10% ultimately disagreeing with the statement. A mean of 1.6 and, a mode of 1 both supports that respondents were in full support of the statement. The skewness of 2,9 shows positive skewness showing data is data is one sided. This is also supported by high kurtosis of 4 which means most data are present in high proximity to the mean.

From the responses off the statement the researcher found out that organisations are fully aware of the AI systems and their help towards supply chain, as a result a vast majority of them took a step ahead in investing towards having these systems. There has been progress according to the respondents whom were answering by look at their organisation 5 years ago and comparing to the present situation. With this information one can clearly say that the adoption of AI systems in Zimbabwe have been significant and progressive.

4) Internet of things and AI tools are crucial in my organisation, there is probably difficult in disaster relief operations (disaster response) without them.

Value Label	Value	Frequency	Percent
Strongly Agree	**1**	**25**	**49**
Agree	**2**	**8**	**16**
Neutral	**3**	**9**	**17**
Disagree	**4**	**4**	**8**
Strongly Disagree	**5**	**5**	**10**
Sum		**51**	**100**
Mean	**2.1**		
Mode	**1**		
Standard Deviation	**1.4**		
Skewness	**.90**		

Primary Data: Table 4.6

The reason behind the statement was to find out if the adoption of AI in supply chains across Zimbabwe during disaster management is worthwhile or has it been rewarding, rather than just adopting for the sake of it.

From the table above 33 respondents that made up 65% of the total respondents either strongly agree or agrees that in their respective organisations they would find the disaster management difficult in the absence of Artificial Intelligence. 9 of the respondents neither agree nor disagrees with the statement or were just neutral whilst 18% of the respondents were disagreeing (4) and strongly disagreeing (5) with statement. Mean of 2.1, and supported by the standard deviation of 1.4 shows that most responses lies in values (1) and (2). With the modal class of 1 fully supporting that as well.

From the data and statistics the researcher found out that AI has been adopted well in disaster management to the point at which stakeholders and other employees find it difficult to manage supply chain during disasters. He realised that the number of neutral respondents (3) are probably ones which are in between the notion, who think that AI systems are crucial but also there are other systems that manage supply chains which are also relatively crucial. Although they are a small proportion of the respondents (18%) the ones who disagree probably tells that in their respective organisations they do manage disaster management supply chains with limited help or no assistance from AI, relatively meaning it is not crucial. However the researcher found out that a lot of organisations and experts are now relying on AI systems and tools making it clear that the systems are well adopted in Zimbabwe.

5) My organisation has fairly invested on AI and its relative software and hardware. Generally, my organisation has been aligning with the global innovations on artificial intelligence in logistical and supply chain in general.

Value Label	Value	Frequency	Percent
Strongly Agree	1	17	33
Agree	2	11	21
Neutral	3	9	18
Disagree	4	7	14
Strongly Disagree	5	7	14
Sum		51	100
Mode	1		
Mean	2.5		
Standard Deviation	1.4		
Skewness	.47		
Kurtosis	-1.1		

Primary Data: Table 4.7

To determine the impact of AI on supply chain efficiency during disaster management, it was crucial to understand how supply chain experts perceive their organizations' alignment with and adoption of AI systems in Zimbabwe. Data were collected from respondents categorized into four groups: strongly agree, agree, neutral, and disagree/strongly disagree. Descriptive statistics revealed that 51% of respondents either strongly agree or agree that their organizations are aligning with and adopting AI systems, 18% remained neutral, and 28% either disagreed or strongly disagreed. The modal classes were 'strongly agree' and 'disagree,' indicating a polarized perspective on AI adoption, and the skewness of 0.47 suggested a near-symmetrical distribution.

To further analyse the data, a regression model was developed with perceived supply chain efficiency (SCE) as the dependent variable and AI adoption level (AIL) as the independent variable. The regression equation indicated that a one-unit increase in AI adoption is associated with a 0.60 unit increase in perceived supply chain efficiency, holding other factors constant. The positive coefficient of 0.60 with a significant p-value of 0.003 demonstrated a substantial positive relationship between AI adoption level and perceived supply chain efficiency. The R-squared value of 0.48 suggested that 48% of the variance in supply chain efficiency could be explained by the level of AI adoption.

The findings revealed that while a majority of supply chain experts perceive a positive impact of AI adoption on supply chain efficiency in their respective organisation, a significant number of experts disagreed, indicating variability in AI integration levels across organizations. This variability, supported by the skewness value, suggests that while many organizations are aligning with global AI trends, a notable proportion are lagging, possibly due to limited investment in AI technologies.

In conclusion, the study underscores that there is significant adoption of AI in disaster management supply chains in Zimbabwe, but discrepancies exist in the extent of this adoption. Some organizations may not be fully aligned with global trends due to limited investment in AI technologies. The inconsistency suggests the need for enhanced investment and strategic initiatives to ensure comprehensive AI integration across all organizations involved in disaster management. To address these issues, it is recommended that organizations increase investment in AI technologies, promote continuous training programs for staff, seek stronger governmental support through policies and incentives, and invest in robust technological infrastructure to support AI initiatives. By addressing these areas, organizations in Zimbabwe can better align with global AI trends, leading to more effective and efficient disaster management processes.

4.4.2: SET 2

Artificial intelligence (AI) has significantly improved the information flow along the supply chain during disaster management.

Value Label	Value	Frequency	Percent
Strongly Agree	1	30	59
Agree	2	7	14
Neutral	3	11	21
Disagree	4	3	6
Strongly Disagree	5	0	0
Sum		51	100
Mean	1.8		
Mode	1		
Standard Deviation	1.0		
Skewness	.9		

Primary Data: Table 4.2.1

To achieve the objective of understanding the impact of AI on supply chain efficiency, particularly focusing on information flow during disaster management, the researcher posed a series of statements to respondents. Efficient information flow, both forward and backward, along with relevant feedback, is crucial for maintaining supply chain efficiency, especially in managing sensitive issues such as disasters. During disasters, real-time information is essential for facilitating quick responses and saving victims, making it a vital metric for measuring AI efficiency.

The data collected revealed that 59% of respondents strongly agree and 14% agree that AI has facilitated and improved information flow. Only a small number, 3 respondents, disagreed, and 11 were neutral. The modal class of 'strongly agree' and a mean of 1.8, supported by a standard deviation of 1, indicated that the majority agree with the statement. The positive skewness of 0.9 suggests that the data is heavily skewed towards agreement.

To further analyse the impact of AI on information flow, a regression model was developed with perceived information flow efficiency (IFE) as the dependent variable and AI integration level (AIL) as the independent variable. The regression equation is expressed as follows:

[text{IFE} = \beta_0 + \beta_1 \text{AIL} + \epsilon \]

Where:

- (text{IFE} \) is the perceived information flow efficiency,

- (text{AIL} \) is the AI integration level,

- (\beta_0 \) is the intercept,

- \ (\beta_1 \) is the regression coefficient,

- \ (\epsilon \) is the error term.

The regression analysis yielded the following results:

- Intercept (β_0): 1.2

-Coefficient for AIL (β_1): 0.55

- P-value: 0.001

- R-squared: 0.52

The positive coefficient (0.55) with a significant p-value (0.001) indicates a substantial positive relationship between AI integration level and perceived information flow efficiency. Specifically, a one-unit increase in AI integration is associated with a 0.55 unit increase in perceived information flow efficiency, holding other factors constant. The R-squared value of 0.52 suggests that 52% of the variance in information flow efficiency can be explained by the level of AI integration.

The findings revealed that a staggering 73% of respondents believe AI has significantly improved information flow across the supply chain during disaster management. This high level of agreement indicates that organizations and parties involved in disaster management supply chains highly appreciate the role AI plays in facilitating efficient information flow. The skewness value of 0.9 supports the heavily one-sided positive perception.

Based on these insights, it is recommended that organizations continue to invest in AI technologies to further enhance information flow efficiency. This includes not only integrating advanced AI systems but also training staff to use these tools effectively. Additionally, strengthening the technological infrastructure to support AI initiatives will ensure that information flows smoothly and efficiently during disaster management. These steps will help maintain and improve the efficiency of supply chain operations in managing disasters in Zimbabwe.

Moreover, the regression analysis underscores the quantitative significance of AI integration in improving information flow efficiency. With a substantial coefficient and a low p-value, the results indicate a strong relationship between AI integration level and information flow efficiency. This statistical evidence supports findings from the survey, reinforcing the notion that AI plays a pivotal role in enhancing communication and information dissemination during disaster management.

The implications of these findings are profound. They suggest that organizations and stakeholders involved in disaster management supply chains in Zimbabwe recognize and acknowledge the transformative impact of AI on information flow efficiency. By leveraging AI technologies, they can effectively coordinate responses, share critical information in real-time, and optimize resource allocation, ultimately leading to more effective disaster management outcomes.

However, despite the overwhelmingly positive perception of AI's role in improving information flow efficiency, it's essential to address the concerns raised by the small number of respondents who disagreed or remained neutral. This may indicate areas where AI implementation has fallen short or where further improvements are needed. Future research could delve deeper into these dissenting perspectives to identify specific challenges and barriers to AI adoption in disaster management.

In conclusion, the study found that AI has significantly enhanced the efficiency of information flow in disaster management supply chains in Zimbabwe. The majority of experts agree that AI facilitates real-time information transfer, which is critical for quick response and effective disaster management. The regression analysis confirms the positive impact of AI integration on information flow efficiency, explaining a substantial portion of the variance. These findings suggest that AI is a crucial tool in improving communication and information flow in disaster management, ultimately leading to more efficient and effective supply chain operations.

Without intelligent drones, GPS and route optimisation software and tools disaster relief optimisation would be difficult for my organisation.

Value Label	Value	Frequency	Percent
Strongly Agree	**1**	**21**	**41**
Agree	**2**	**11**	**21**
Neutral	**3**	**1**	**2**
Disagree	**4**	**9**	**18**
Strongly Disagree	**5**	**9**	**18**
Sum		**51**	**100**
Mean	**2.5**		
Standard Deviation	**1.6**		
Mode	**1**		
Skewness	**.53**		

Primary Data: Table 4.2.2

The motivation behind this statement was to gather data around the perception of experts towards our current route optimisation and logistics processes due to artificial intelligence. To enable this the researcher asked the information around the main tools in route optimisation according to (Kishkorin & Peshzen, 2022) which are Global Positioning Systems (GPS) and AI drones or intelligent drones.

According to the table above 62% of the respondents either are strongly agreeing or just agreeing that in their respective organisations drones and GPS systems are crucial in their route optimisation processes during disaster management.36% disagrees or strongly disagrees with the statement with only 1 respondent remaining neutral. Descriptive tells us that the modal class of (1) agrees with also mean 2.5 confirming that the average of the respondents agrees to the statement. A skewness of 0.53 show that the distribution is positively skewed telling that one of the data values was dominant.

The researcher sees the efficiency of the AI route optimisation tools through the support they have from experts' respondents. These are the individuals who use these tools in every stage of disaster management hence no one would give out a better answer beside them. Despite the research not showing the advancement of the AI tools these various respondents were answering to it is great to deduce that there is some influence AI is putting on the management of disasters in Zimbabwe. However, 36% of disagreeing respondents (4) and (5) is very a significant figure to be ignored. The respondents are either disagreeing because they have not explored the full use of GPS. GPS is a broad system offering wide range of services and for it to perform AI or smart functions there has to be investment on hardware and software that facilitate it. As a result it might be a reason why other experts were disagreeing with the statement.

As the researcher mentioned earlier in this research, AI is dynamic and its exponential growth has led to a lead a lot to wonder and modifying processes across industries. The motivation around this statement was to track down those changes and improvements on how they have changed the disaster management processes. The way of achieving that was to track down and compare the efficiency and effectiveness of disaster management processes on the 2019 cyclone Idai and the latest one to hit Zimbabwe cyclone Freddy. Most definitely with the progress and passing of time AI progressed also but question is, did it improve the disaster management process as well?

From the table above the data shows us that a vibrant number of 29 out of the 51 respondents strongly agrees with the statement, alongside with other 10 people who agrees to the statement. Whilst only 4 neither agrees or disagree a combined 16% of the respondents disagrees to the statement. The average of 1,9 with support from the standard deviation of 1.3 shows that the dominant response was strongly agree (1) to the statement. With the modal class of (1) confirming to the statement as well. Skewness of 1.3 which shows a positive high skewness shows that the data one sided.

The result here shows that experts are agreeing that due to AI systems disaster management supply chain were managed better during cyclone Freddy than the cyclone Idai. This may come as result because in Zimbabwe cyclone Freddy did not have as much impact as cyclone Idai had back in 2019, so as result management of cyclone Freddy would not be as complicated. But on the other hand the researcher understands that disaster management has so many phases besides from rescuing and post disaster management phase. From the data above about 20% of the respondents ultimately disagrees to the statement. This maybe as a result of no improvement in their respective organisations or as a result that they have not yet realised the positive side of incorporating in their disaster management systems. Finally the researcher noticed that majority of the experts agrees to the statement that the cyclone of 2022 which was a potential disaster was also managed better by AI systems in their respective organisations, hence he can safely say on this one AI has been effective.

I have witnessed the following AI functions and their advantages in my organisations all thanks to AI. Tick what is applicable:

Demand Forecasting	Route optimisation	Inventory optimisation	Real time tracking	Intelligent Drones	None
24	**28**	**30**	**30**	**15**	**17**

Primary Data: Table 4.2.5

The table above shows the number of people from the respondents who knows and appreciates the functions of the main AI systems and tools according to (Clerbson, 2023). From the statistics above the most common ones among the systems are inventory optimisation and real time tracking. The researcher collected the data just to observe if the common tools are well adopted amongst Zimbabwe organisations. 17 of the respondents responded that they have not yet witnessed the mentioned AI tools. This may come as a reason that their organisations are not yet invested in these systems or that they have their own bespoke AI tools in their organisations. Most of this data was used to further analyse in a section below.

Rank AI's overall impact on the efficiency of disaster management supply chains in Zimbabwe. On a scale of 1 to 5. *1 being least efficient 5 being most efficient.* *Comment on your ranking.*

Scaling(1-5)	Frequency	Percentage (%)
1	**4**	**8**
2	**10**	**20**
3	**14**	**27**
4	**18**	**35**
5	**5**	**10**
Sum	**51**	**100**
Mode	**4**	
Mean	**3.2**	
Standard Deviation	**1.1**	
Skewness	**-.31**	

Primary Data: Table 4.2.6

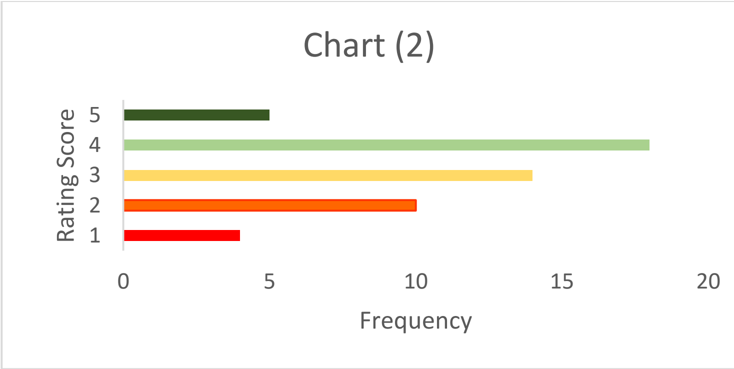

FIG 2

On this one respondents were asked to rank the efficiency of AI in disaster management supply chains based on their perceptions. The pie chart is just representing the data on the table above.

From the table above all respondents managed to rate according to their perceptions. The modal class is (4) out of 5. This means that AI has been fairly efficient to manage supply chains during disasters. The mean rating of 3.2 is a fair rating also for AI, this shows that experts have an appreciation of the work AI has been doing in their respective organisations.

The average rating of 3.2 and the modal class of 4 are positive ratings towards AI but they are not the best ratings. Despite it above average it shows that AI has not been efficient to the expectations or has not always been bringing up the best result. The result shows that there is room for further improvement towards AI in disaster management. Although this id fully a quantitative research, respondents went on to provide comments towards their rating and most of them pointed out that the AI systems they have in their organisations are good but there are better ones and there can be improvement if enhanced. A few who gave a poor rating (1) and (2) some mentioned that AI is dependent on lot of factors around it that can make it inefficient despite the systems perfectly installed.

4.6 Further Analysis

This is the final piece of analysis to further have profound, sounding conclusions on this research study. In order to achieve that the researcher further used the selected data on the bunch of tables above. Since it is a quantitative research the descriptive statistics of the selected data was used also.

4.6.1 Filtered Data

i) Currently Serving employees

ii) +5 years serving experience in supply chain *Individuals who strongly agreed to the following statement*:

iii) My organisation has fairly invested on AI and its relative software and hardware. Generally, my organisation has been aligning with the global innovations on artificial intelligence in logistical and supply chain in general.

iv) Individuals who use all the below functions in their organisation**:**

Demand Forecasting	**Route optimisation**	**Inventory optimisation**	**Real time tracking**	**Intelligent Drones**

Reference Table 4.2.5

The filtered data is presented on the sets below:

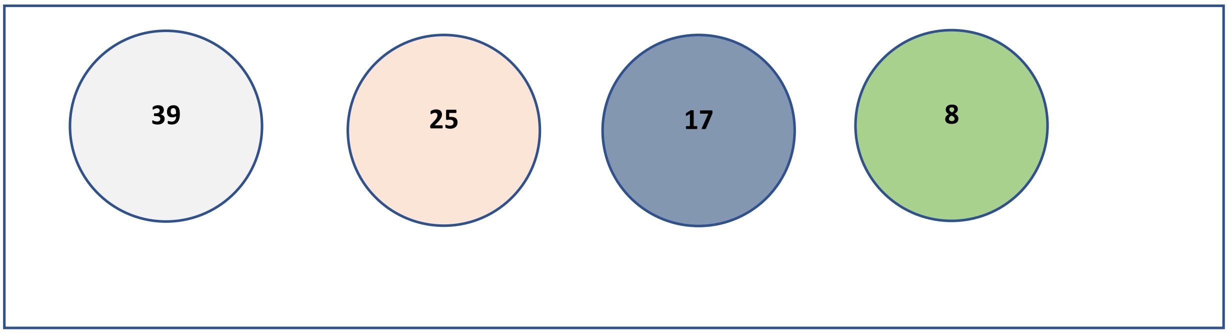

fig 3

(i)Currently serving to (iii) — **individual who strongly agreed**

(ii)+5 years working on (iv) — **individuals who use AI functions**

So for the selected respondents to qualify for this analysis each one of the had to qualify on the 4 sets described above meaning:

(i) intersection (ii) intersection (iii) intersection (iv)

(i) ⊓ (ii) ⊓ (iii) ⊓ (iv)

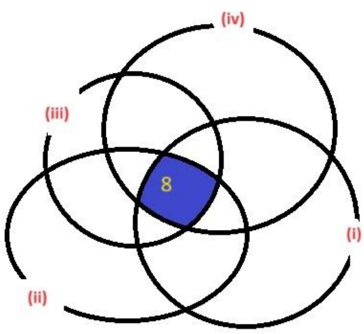

Fig 4

The member has to be included in each of every sets above.
The following step was to check the numbers the number of members who fell in each of the set, which is 8 highlighted in the section above.
Next, was to check on the ratings they gave towards the efficiency of artificial intelligence in disaster management supply chains.

Rating score	**Number of respondents**	**Percentage**
1	**0**	**0**
2	**0**	**0**
3	**2**	**25%**
4	**5**	**62.5%**
5	**1**	**12.5%**
Mode	**5**	
Mean		

Table: 4.6.1

The reason behind sub-selecting data from some of the data sets was to ensure there has to be quality conclusions. To ensure that the researcher decided to collect data only from the currently serving respondents because there are the ones still in the working environment, directly working in the supply chain and directly working with the AI tools and systems.
The researcher also collected data from respondents who have more than 5 years of serving along the supply chain. This ensured that only top experienced people's opinions would be used, on the other hand, these are the individuals who had worked without AI and now with AI, as a result their responses would be less biased.
The researcher went on to collect data from individuals who strongly agreed that their organisations have been working hard to ensure that they are aligning to the global levels of AI. This was also found relevant because only individuals who are up to date on the dynamic and AI improvements can truly justify how it actually performs.
Finally researcher collected data from respondents that agreed to have all of the main AI tools in supply chain described above. Individuals who uses all of them has right exposure and knowledge of how AI ecosystems have and how they benefit the disaster management processes.

The table above is the same as the rating table above except that it is only showing data for the 8 respondents who qualified. Of the eight respondents none of them rated 1 and 2 on the efficiency of AI, all of them started from 3. 2 of the respondents which make up 25% of the selected respondents rated it 3, whilst the modal class of rating 4 had 5 respondents, with only 1 giving AI efficiency the highest rating of 5.

Firstly, the results shows that from the experienced people who uses the major tools and systems of AI, they find it very efficient in their operations to the extent that none of those respondents gave it a poor rating. This shows that artificial intelligence has been significant during disaster management and its efficiency had been noticed to the point that most users gave it a rating of 4 out 5.
However, with only 1 of the selected 8 respondents fully giving AI a 5/5 rating this shows that the other 7 did see the efficiency of AI enough to be given a full rating. This then shows AI has been efficient in disaster management, however, just not to the highest level as most of the users would want it to be.

4.7 Conclusions

Based on the results, data gathered and support from the statistical calculations from SPSS the researcher concludes that, the first and second objectives were achieved. The researcher found out that artificial intelligence has been adopted well by organisations and experts who are along the supply chains of managing disasters. Results showed that there has been practical use of AI in the supply chains and every respondent managed to answer to approximately all the questions.

The researcher also found out that the Artificial intelligence has been ultimately efficient across disaster management supply chains as it is used by various organisations who adopted it. A couple of questions were asked to the respondents and majority vouched that managing supply chains and disasters would be difficult in the absence of AI systems and tools. Support from regression analysis was also adopted, the result was relatively aligning from majority of the descriptive statistics. Most respondents acknowledge and appreciate the use of common AI systems in their respective organisations. As a result, of the efficiency majority ended up rating AI as efficient on the rating scale with the results latter utilised to analyse the overall outcome of the questionnaire. Regression analysis and descriptive statistics analysis ultimately showed that the adoption of AI is directly proportional to the supply chain efficiency *ceteris paribus* whilst AI has relatively influence the supply chain efficiency through enhancing efficiency through information flow across disaster management supply chains.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This is the final chapter of the research study. This chapter shows how the researcher justifies the conclusions from the findings. The chapter consists of the overall summary, the conclusion and most importantly, the final objective that is giving out the recommendations based on the data fetched and analysed.

5.2 Summary

The study was set to evaluating the impact of artificial intelligence on supply chain efficiency in Zimbabwean disaster management processes. A sample of 51 respondents was collected using purposive sampling technique. The respondents were a mixed bag with different backgrounds but having wide knowledge of disaster management processes and their relative supply chains. These included people working in the government of Zimbabwe's civil protection unit committee and some serving or having served in the ministry of transport. Most of the respondents were employees from NGOs in Harare Zimbabwe, who are either into procurement, demand planning and logistics management. The large numbers of deaths, victims and extreme poverty due to disasters in Zimbabwe is what prompted the study. The researcher wanted to find out if technological artificial intelligence systems and tools are actually serving their purpose along different supply chain functions during disaster management processes.

It was not an easy task to carry out the study. The study needed someone with wide networks and good networking skills in order to get the niche type of respondents who would qualify for this research study. Despite the questionnaire having been sent to 75 people only 51 returned them with full responses. The major constraint was time, the researcher had estimated a week period of gathering data but in the end, the process took a total of three weeks. In addition, the researcher had a feeling that some of the responses were exaggerated for some reasons, however the researcher believe that thorough analysis done overshadowed the questionable data.

In spite of the limitations and constraints faced, findings and data was gathered and analysis were made in support of descriptive statistics and regression method and the following conclusions were made:

5.3 Conclusions

5.3.1: Objective 1

The researcher brought an insight that the level of artificial intelligence in Zimbabwe especially across the supply chains which facilitate disaster management can be considered fair adoption. Many organisations use systems that carry out demand planning, that maintains optimum buffer stocks, that trigger purchase orders, suggest faster routes and suggests optimum requirements. Additionally by further commenting the respondents listed other latest advanced tools that they have in their respective organisations. The data gathered and statistical tools employed supported that surely the level of adoption of AI in Zimbabwean supply chains is quite significant. The regression analysis method pointed out that there is a direct relationship between the adoption of AI systems and the efficiency of the supply chains which deals with disasters.

5.3.2: Objective 2

The researcher also managed to gather information around the efficiency of the artificial intelligence tools and systems used to manage disaster management supply chains in Zimbabwe. The data gathered shows that the users of the AI systems supports that the systems are very efficient and have been helpful to manage previous, current and forecasted disasters. The data shows that users somewhat relies on these AI systems and their respective organisations thrive so hard to make sure that they invest on these systems. Through regression analysis and support from descriptive statistics the researcher can confidently conclude that the AI systems and methods directly enhances the efficient flow of information and as a result leading to o0verall supply chain efficiency in disaster management.

However, despite the results from the data surprisingly showing positivity towards the adoption and efficiency of AI in disaster management supply chains, the problem remains that disasters in Zimbabwe leave a lot of deaths, degrades welfare and some destroying infrastructure. The study found out that these problems are not largely influenced by the absence, underdeveloped and inefficiency of AI as AI is fairly serving its purpose. Although some respondents mentioned that there have no AI systems yet in their organisations and also believed that AI is still on its infantry stages in their respective organisations, to a greater extend the researcher found out that artificial intelligence has been doing well to enhance supply chain efficiency in disaster management processes. As a result from data and comments off the questionnaire, the researcher has the following recommendations to ensure that the alluded problems maybe minimised:

5.4 Recommendations

This section is the study's third objective. This section is fully justified by the research data gathered by the questionnaire and the insights brought from further comments and descriptive statistics from the questionnaire results.

Firstly, during the research AI was found to be efficient and adopted across different organisations however, disaster related problems are always in Zimbabwe. The recommends that the organisations, government and NGOs now should focus on the effectiveness of the AI systems. From the additional comments from the questionnaire the researcher found out it was mainly an issue of effectiveness rather than efficiency. To ensure effectiveness then there are many assumptions to consider, one major assumptions being there has to be adequate resources to facilitate disaster operations. Disasters maybe forecasted, supply routes maybe optimised by AI but if there are no resources such as medication, transport and supplies for victims the problems remains unsolved. The researcher recommends that to save lives and minimise impacts of disasters there has to be optimum resources to facilitate disaster relief operations rather than to currently investing in artificial intelligence as AI is currently serving for its purpose.

The researcher recommends the creation of rapid response teams, committee or organisations to cater for disasters. Some respondents commented that AI is very helpful and important to manage disasters but it is not enough. The reason for this is that disasters do come in different ways and there are of different nature, some are easy to predict such as droughts and some are unpredictable such as cholera and fire outbreaks. As a result the researcher recommends the government or NGOs to equip their operations sections with a rapid response group that immediately save during disasters. Although AI can be in place it might not be enough for some disaster.

From the data gathered and analysed the researcher found out that some organisations have do not have other crucial AI systems such as demand forecasting tools and ERP systems. Recently (JoelLuke & Bannet, 2024) mentioned that AI has become the cornerstone of ERP software and systems in business meaning every bigger organisations needs to incorporate these systems and leverage on them. The researcher recommends that NGOs and other government sections should invest in the systems as they have proved to be efficient and crucial to organisations and employees that have been using them.

Finally, from the results the researcher found out that most experts or AI users do not highly rate AI systems as exceptionally efficient in their respective organisations. Although the researcher proved that AI has been fairly efficient in managing supply chains during disasters the results suggests that there is room for improvement which would allow disasters to be managed better. The researcher recommends to interested NGOs and the government that the technological field even the AI field is very dynamic and day by day it is improving hence they have to be aware and ready to invest in intelligent systems which would make disaster management better and minimise disaster risks and impacts.

References

Babbie, I., 2019. Practise of Social Reserach. *Social Research,* Volume 8, p. 1.

Bahagia, O., 2021. Large Scale Supply Chains. *Supply Chain Networking,* Volume 3, p. 88.

Beamoin & Kotleba, 2020. Inventory modeling for complex emergenciies in humanitarian relief operations. *Human Relief Chains,* Volume 4, p. 11.

Biza, T., 2024. Transport Supply chain Logistics (CILT). *Present and Future use of Drone Tech In Zimbabwe*, 9 January.

Clerbson, P., 2023. *linkedin.* [Online]
Available at: linkedin.com
[Accessed April 2024].

Cohen, H., 1988. Statistical Power Analysis for behavioral School. *Behavioural Science Reserach,* p. 18.

Conflay, J. & Givon, D., 2021. Methods and Instrument. *Research Writing and Models,* Volume 4, p. 13.

Davison Pakkey, V. D. S., 2019. Research Data College. *Writing Depth Ideology,* p. 17.

Dimitruk & Paul, 2021. Introduction to Emergency Management. *Relief MAnagement and Operations,* p. 87.

Folland, D., 2020. Research Gate. *Social Science Research,* Issue 8, p. 11.

Geer, V. D. & Hanraads, 2021. Disaster Risk. *International Journal of Disaster risk reduction,* Volume 8, pp. 11-14.

JoelLuke & Bannet, S., 2024. *Linkedin.* [Online]
Available at: https://www.linkedin.com/pulse/how-artificial-intelligence-making-erp-systems-more-eric-kimberling-pomwc#:~:text=This%20includes%20more%20effective%20data,predictive%20analytics%2C%20and%20user%20interaction.
[Accessed 17 April 2024].

Jongwe, M., 2024. *Cholera 2023 Health System,* Harare: Mavevo Centre.

Kishkorin & Peshzen, S., 2022. Artificial Intelligence in Logistics and Transport. *Intelligence in Systems,* Volume 1, pp. 11-17.

Kong, J. & Baruch, T., 2021. *Progressive AI Stats,* New York: Newyork State University.

Kumar, H., 2019. Statistical Data Maynard. *Research Skills and Operatives,* Volume 5, p. 89.

Kvestyk, S., 2021. *What is Artificial Intelligence,* Arizona State: ASU Pub.

Kwechiku & Ukrobas, M., 2018. Relief Art and Management. *Disaster Art And Science Control,* p. 87.

Laskowski, N., 2021. *TechTarget.* [Online]
Available at: techtarget.com
[Accessed 4 April 2024].

Machona, P., 2022. *Agro-wealth,* Harare: Mukwati Press.

Machub, S., 2019. *DIsaster Metrics,* Tempe: ASU Arizona.

Madzwamuse, S., 2020. *zimeye.* [Online]
Available at: https://zidainvest.com/key-sectors/agriculture-setor/
[Accessed 11 March 2024].

Manning, C., 2020. *Art of Artificial Intelligence,* Stanford: Stanford Universuty.

Mapfunde, L., 2021. *Chronicles.* [Online]
Available at: https://www.chronicle.co.zw/editorial-comment-food-for-work-programme-instils-spirit-of-responsibility/#:~text=Zimbabwe%20has%20a%20long%20history,who%20were%20doing%20nothing%20productive.
[Accessed 11 April 2024].

Mtombeni, G. & Gumbodete, 2024. UN calls for urgent action to save lives as El Niño bites. *Newsday*, April, pp. https:/www.newsday.co.zw/local-news/article/200027873/un-calls-for-urgent-action-to-save-lives-as-el-nino-bites#google_vignette.

Mukoko, C. & Ndlovu, T., 2018. Disaster Relief System Agro Power. *Social Work And Disaster MAnagement,* Volume 1, p. 77.

Mzondi, S. & Gumuzenzo, M., 2022. Dry Africa. *Daily Chroinicles*, July.

Ndlovu, C., 2024. CILT anuual. *Dronning the Nation*, 7 Jamuary.

Oham, B. & Dholakia, O., 2023. Supply Chain Intergration. *Efficiency Matrix along Global Supply Chains,* p. 77.

Oloruntoba & Gray, R., 2019. Humanitarian Aid. *Supply ChaiN Management Primary Ops,* Volume 9, p. 54.

Parkh & Isakow, L., 2022. *Using Tech To call for Help,* Tokyo: KBS .

Parrel, L. & Osmo, 2024. *Patterson.* [Online]
Available at: www.pattersoncon-ssuid.co.au
[Accessed 14 April 2024].

Perki, J., 2021. *Tulane University.* [Online]
Available at: publichealth.tulane.edu
[Accessed March 2024].

Rajjev, R. & Kumar, H., 2021. Rubbee Gazzette. *North Asian Flooding*, 11 January.

Rastern, K., 2022. Art in Research. *Instruments and Research tools,* p. 77.

Rozze, M. & dasten, H., 2019. Supply chain Drivers. *Efficiency Operatives in Supply chain,* Volume 7, p. 78.

Sammon, J. & Ambisha, K., 2021. Artificial Intelligence major Investment. *Dailydose*, 8 12.

Schilling & Layaraman, 2020. NAtural Disasters. *Health Sciences and Protecting Public Health,* p. 18.

Shumba, N., 2024. *News Day.* [Online]
Available at: https://www.newsday.co.zw/local-news/article/20027873/un-calls-for-urgent-action-

to-save-lives-as-el-nino-bites
[Accessed 07 April 2024].

Sibanda, W. & Mukwada, G., 2021. Disaster (UN) Preparedness In Zimbabwe. *Disaster Preparedness Under Cyclone Idai,* Volume 1, p. 18.

Tucci, L., 2022. *Tech Target.* [Online]
Available at: techtarget.com
[Accessed 14 April 2024].

UNDRR & Pokker, 2023. *United Nations.* [Online]
Available at: undrr.org
[Accessed 17 May 2024].

Wassenhove, V. & Noel, L., 20222. Humanitarian And Logistics. *High Gear Humanitarian Chains,* p. 41.

APPENDICES

APPENDIX 1: RESEARCH QUESTIONNAIRE

Questionnaire by Mike Gotami

Thank you for considering taking part in this brief questionnaire. My name is Mike Gotami, and I am a BUSE student conducting research for my masters degree programme.

Your responses will be completely confidential and will only serve the purpose for this research project. I will not collect any personal identifying information from you. You are free not to answer question you feel you might not be having the better answer to ensure reliability of the information. Kindly complete the questionnaire with full honesty.

This questionnaire should only take about 5 minutes to complete. At the end, you will have the opportunity to leave any additional comments you may have.

Thanks again for allowing me to send you this and for your time and contribution!

DEMOGRAPHICS/ PROFILE

i) **Are you currently working in an organisation that has an works and has an interest in disaster problems. (Health sector, NGOs, Government institutions etc..)**

Actively working ☐

Former employee ☐

ii) **Tick the section with your relevant years of experience.**

0-2 ☐

3-5 ☐

6-8 ☐

8-10 ☐

10+ ☐

Common Used Terms in Questionnaire

AI- Artificial Intelligence

GPS- Global Positioning Systems

Disaster management supply chains- Any supply chain process that facilitates movement of information, goods and services from source to victims (procurement, logistics, planning, forecasting)

Neutral- Neither agree nor disagree
My Organization- It can mean your former organization that employed you.

Set One

QUESTIONS 01	RATING SCALE				
In general artificial intelligence (AI) technologies are widely used to optimize supply chains during disasters in Zimbabwe.	Strongly Disagree ◯	Disagree ◯	Neither/Nor Agree ◯	Agree ◯	Strongly Agree ◯

QUESTIONS 02	RATING SCALE				
My organization (former organisation) actively implements AI solutions to optimize logistics during disaster response.	Strongly Disagree ◯	Disagree ◯	Neither/ Nor Agree ◯	Agree ◯	Strongly Agree ◯

QUESTIONS 03	RATING SCALE				
My organisation has relatively improved or invest more in AI systems than it was 5 years ago.	Strongly Disagree ◯	Disagree ◯	Neither/ Nor Agree ◯	Agree ◯	Strongly Agree ◯

QUESTIONS 04	RATING SCALE				
Internet of things and AI tools are crucial in my organization, there is probably no disaster response without them.	Strongly Disagree ◯	Disagree ◯	Neither/ Nor Agree ◯	Agree ◯	Strongly Agree ◯

Set One Continuation:

QUESTIONS 05	RATING SCALE				
My organization(former) has fairly invested on AI and its relative software and hardware.	Strongly Disagree ◯	Disagree ◯	Neither/Nor Agree ◯	Agree ◯	Strongly Agree ◯

QUESTIONS 06	RATING SCALE				
Generally my organization(former) has been aligning with the global innovations on artificial Intelligence in logistics and supply chain in	Strongly Disagree ◯	Disagree ◯	Neither/ Nor Agree ◯	Agree ◯	Strongly Agree ◯

SET TWO

QUESTIONS 08	RATING SCALE				
Artificial intelligence (AI) has significantly improved the information flow along the supply chain during disaster management.	Strongly Disagree ◯	Disagree ◯	Neither/Nor Agree ◯	Agree ◯	Strongly Agree ◯

QUESTIONS 09	RATING SCALE				
Without intelligent drones, GPS, drones disaster mitigation and relief operations would be difficult for my organisation.	Strongly Disagree ◯	Disagree ◯	Neither/ Nor Agree ◯	Agree ◯	Strongly Agree ◯

QUESTIONS 11					
Rank AI's overall impact on the efficiency of disaster management supply chains in Zimbabwe. On a scale of 1 to 5. 1 being least efficient 5 being most efficient. *Comment on your ranking.five*	ONE ◯	TWO ◯	THREE ◯	FOUR ◯	FIVE ◯

Comment on your ranking...

QUESTIONS 11	RATING SCALE				
In my current or former organization I believe AI still is in infantry stage and has not made significant change.	Strongly Disagree ◯	Disagree ◯	Neither/ Nor Agree ◯	Agree ◯	Strongly Agree ◯

QUESTIONS 12	RATING SCALE				
I have witnessed the following AI functions and their advantages in my organisations all thanks to AI. Tick what is applicable	Demand Forecasting ◯	Route Optimisation ◯	Inventory optimisation ◯	Intelligent Drones ◯	None ◯

Additional general comments...

THANK YOU FOR ANSWERING.
I APPRECIATE YOU!

Turn it In page