BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCES AND ENGINEERING COMPUTER SCIENCE DEPARTMENT COMMPUTER SCIENCE

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE BACHELOR OF SCIENCE HONOURS DEGREE IN COMPUTER SCIENCE

Developing a farmer`s WhatsApp Chatbot using Natural Language processing

Approval form

The undersigned inform with certainty that they have supervised the computer science student **Bothwell Mushayavanhu** (B191564B) research project entitled, **“**

Farmers Chatbot using Natural Language Processing”, submitted in partial fulfilment of the departmental requirements for an Honors Degree in Computer science at Bindura University of Science Education.

STUDENT: **DATE:**

…… **…….**

SUPERVISOR: **DATE:**

…… **……..**

CHAIRPERSON: **DATE:**

…… **…….**

EXTERNAL EXAMINER: **DATE:**

…… **…….**

Dedication

I dedicate this to the Mushayavanhu family, for their loyalty, love and support. Without you I could not have made it this far!

Acknowledgements

First of all, I would like to thank God for His generosity in allowing me to reach this point in my academic life. I have only made it this far because of God's favor. May he be honored and given glory. Mr. O. Muzurura, my supervisor, deserves huge appreciation for helping me through this project. I'd also like to thank the entire Computer Science department at the Bindura University of Science Education for their expertise. Lastly but not least, I would like to thank all my friends and individuals who made a contribution to my life in which without their support I would not have made it this far, these include all my classmates, friends and family.

Abstract

There is a great need for a quick response to farmers to assist them in any query they ask about farming practices. This is what has brought about this intelligent chatbot farmers system for farmers to get information about farming practice. This dissertation explores the design and implementation of a maize farmers' WhatsApp chatbot. The chatbot is designed to provide farmers with real-time information on maize farming best practices, market prices, weather updates, and pest and disease management. The chatbot utilizes natural language processing (NLP) and machine learning algorithms to understand and respond to farmers' queries in an efficient and user-friendly manner. The study applies a mixed-methods research approach, including qualitative research methods such as interviews and focus groups to gather data on farmers' information needs and preferences. The quantitative data is collected through surveys to evaluate the chatbot's effectiveness in providing relevant and timely information to farmers. The study concludes that the maize farmers' WhatsApp chatbot is an effective tool for providing real-time information to farmers, improving their knowledge and decision-making ability, and contributing to increased productivity and profitability. The study recommends further research on the scalability and sustainability of the chatbot, as well as its potential integration with other digital agricultural tools.

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Chapter 1: Problem Identification

1.1 Introduction

Food security is a pressing issue for most developing countries especially in the Sub Saharan Africa. Zimbabwe experienced falling agricultural output for the past ten years, which adversely affected individual households and the economy at large. With agriculture contributing around thirty percent of the GDP in Sub Saharan Africa, it would be of interest to note that the majority of the population lives in the rural areas, where they solely depend on agriculture. In Zimbabwe, Agriculture has been a major contributor to our country's food security. The economy is also agro based. With the majority of the population depending on it, in Zimbabwe agriculture creates employment, enhances food security, improves standards of living, and promotes GDP growth and a healthy economic well-being of the society as a whole. It is reported that more farmers hit the road not because of the poor rainfall or poor soils in Zimbabwe but because they lack sufficient information on how to contact farming. Lack of access to agriculture knowledge and information about the latest farming practices resulting in very poor yields especially to new, small scale holder farmers and middle scale holder farmers. Currently in Zimbabwe farmers are getting information about agriculture practices from agro-experts, local agricultural extensions officers and some radio programs which is a slow way of getting information for example if a farmer rely on the information from experts sometimes they are busy with other farmers whilst one need argent help. There is a growing interest in intelligent interactive systems, which are machine agents serving as natural language user interfaces for data and service providers. The most frequently reported motivational factor for the use of interactive intelligent systems is "productivity"; With the growing use and development in artificial intelligence and a growing number of new joining farmers, it is good to considering the use of interactive systems as an economically and fast solution to educate farmers.

Background

In Zimbabwe most farmers are getting knowledge about all farming practices from local agricultural extension officers for example in Chimanimani District agricultural extension officers are responsible for educating famers and help them by answering their day to day queries and receive farmers complains. After receiving complains they report the issue to the District Agriculture Officer, from District Agriculture Officer to the Provincial Officer. The Provincial Officer report to the Head Quarter (Ministry). As you can see the process is to long for the farmers concern to be addressed. To easy the process there is a need for a WhatsApp Chatbot that will automatically answer farmer's queries, provide farmers with up-to-date information, advice on best farming practices.

1.2 Problem Statement

Due to continuous poor yields by new joining farmers and smallholder maize farmers because of lack of information, and poor farming practices in Zimbabwe, there a is need for a fast and reliable technological way of helping farmers on how to contact their farming practices using latest techniques that will assist them from the beginning up to an end. The chatbot can assist farmers by providing better and up to date farming techniques resulting in high farming production and output that will encourage most people to join the farming sector and at the end the country's Gross domestic product rises.

1.3 Research Objectives

The primary goal of this research is to develop a WhatsApp Chatbot to interact with farmers in a conversational manner as one would with Agritex Officer to solve a self-help problem or to provide

sufficient information on information request. The objectives to be met at the end of the research are:

i) To design and develop a WhatsApp Chatbot that interact with farmers and respond to their request.
ii) To implement natural language processing to improve user experience by providing optimum response to the user request.
iii) To analyze the effectiveness of chatbot in maize farming.

1.4 **Research Questions**

Generally, the research should be able to address the problems identified in the problem definition by answering the following:

- Can the Chatbot improve user experience?
- How can the proposed Chatbot assist maize farmers to get better yields?
- What are the main benefits of using Farmers WhatsApp Chatbot?

1.5 Research Propositions / Hypothesis

The research postulates that the use of artificial agents in the farming sector can improve yields and food security in the country. The system might also help the Agritex Officers in reducing their workload since farmers can ask their queries to the system. The system is also supposed to improve user experience and respond to the user as needed, when needed. This thereby gives the following hypothesis:

i. H0 Farmers WhatsApp chatbot system will improve user experience and help farmers to answer their farming queries.
ii. H1 Farmers WhatsApp chatbot system will not improve user experience and help farmers to answer their farming queries.

1.6 Justification

There is high rate of farmers leaving the agriculture sector in Zimbabwe, the main reason why these farmers quit farming includes poor rainfall, high production cost, but the main catalyst is poor farming practices by farmers due to lack of adequate information on best farming methods

especially farmers from remote area where there is poor access to information even from Agriculture experts. Chatbot can help to reduce the amount of time spent on searching for information online or consulting experts resulting in high production. Farmers prefer to get assistance when they need it, as they need it, hence the Chatbot acts as an intermediary to quickly process requests and lessen the workload of the Agritex Officers. It also provides accurate information about farm operation since the information from the chatbot is being tested before implementation as compared to the information from some Agriculture experts. The Chatbot helps farmers to make informed decisions and assist them in troubleshooting resulting in the improvement of farmers' productivity and efficiency of their farming practices since the information on all farming practices are always available anytime of the day. With large technological companies such as Facebook investing in automation of service provision through Chatbot and other forms of bots, the study could benefit the student and institution in keeping up with the latest trends in the implementation and deployment of intelligent digital system.

1.7 Assumptions

- Users will have at least a small amount computer literacy.
- All requesting is farming related problem.
- Most of the farmers have little or no idea that the conversation is with an intelligent system

1.8 Limitations/challenge

- The time period to fully implement the full capabilities of the system may be small. The conversational structure and control flow may need intricate designing, which requires a continuous updating.

- There is no audio processing/ voice recognition for voice commands. In order to implement a voice recognition software, this requires more hardware and time resources that may delay the production of the software to acquire.
- There is no image processing for image queries, since it requires more hardware and time to process images.

1.9 Scope/delimitation of the research

The study focuses on Natural language processing techniques and Machine learning to develop an optimized response to repetitive questions or frequently asked questions. The study also aims to produce a system that will engage users through a text based conversation and using control flows, provide a solution just as an expert system would.

1.1.0 Definition of terms

Natural language processing – a theoretically motivated range of computational techniques for analyzing and representing naturally occurring texts at one or more levels of linguistic analysis for the purpose of achieving human-like language processing for a range of tasks or applications. (D. Liddy, 2001)

Machine Learning –the science of getting computers to act without being explicitly programmed. (Alpaydın, 2014)

Chatbot – A software program that interacts with users using natural language. (Brandtzaeg and Følstad, 2017)

Chapter 2: Literature Review

2.1 Introduction

This chapter aims at reviewing the past and recent studies done in relation to intelligent conversation agents (chatbots) and the techniques used in building these agents. Area of Artificial intelligence is very vital in this chapter as it is the main driving force behind chatbots creation and its implementation. Just as people use language for human communication with each other, they also want to use the same concept when communicate with computers. (Zadrozny, 2000) agreed that the best way to facilitate Human Computer Interaction (HCI) is by allowing users "to express their interest, wishes, or queries directly and naturally, by speaking, typing, and pointing". This was the driver behind the development of chatbots. (Abu Shawar and Atwell, 2007)

2.2 Conversational agents (chatbot)

Chatbots are primarily designed to conduct a conversation with humans using natural language dialogues via auditory or textual methods, in such a way that humans can easily communicate with the chatbots (Shafquat Hussain, Omid Ameri Sianaki, and Nedal Ababneh). Conversational bots are sometimes referred to as conversational robots, conversation agents, chatbot, chatter bot or just simply 'bots' but have the same target of interacting with humans using natural language and generate a meaningful conversation. Chatbots use Natural Language Processing and advanced machine learning algorithms to lean from data insights. For this purpose, a well-known measurement or test to the performance and capabilities of a chatbot (Turing test) was developed and will be discussed later on in detail in this chapter.

2.2.0 TYPES OF CHATBOTS

Chatbots can be categorized into three types: rule based or linguistic, Artificial Intelligence chatbots and Hybrid chatbots. Here, we see how chatbots can be classified using other parameters too such as level of interaction, and method of response generation.

- **2.2.1 Artificial Intelligence chatbots**: are systems designed for extended conversations, set up to mimic the unstructured conversational or 'chats' characteristic of human-human interaction, rather than focusing on a particular task (Omid Ameri Sianak). Such bots can talk about general topics and respond appropriately for example ChatGPT, it uses machine learning concept and learns from previous experiences.
- **2.2.2 Rule-based chatbots**: Such bots are focused on a particular knowledge domain and might fail to respond to other questions. This can be also called Simple chatbots, it has limited capabilities, and are usually called rule-based bots, they are task-specific and are predetermined intents and responses to user questions. This type of chatbots have no interference from past interactions, also they are best suited for straightforward dialogues or questions.. These chatbots do not possess general knowledge and you cannot ask them trivia questions. Rather, they are goal oriented chatbots focused on helping you achieve a specific goal (Paras Chopra).
- **2.2.3 Hybrid Chatbots**: It is the combination of both artificial intelligence and rule-based chatbots. When it receives a query, hybrid chatbots tries to respond from previous experiences, if not in the previous experiences, then it displays default responses (Paul. Bank).

2.2.4 Different between AI and Rule-based Chatbots

Rule-based Chatbots	**Artificial Intelligence Chatbots**
- Key-driven	- Driven by deep learning algorithms
- Responds based on manually drafted rules.	- Responds based on its understanding and learning
- Difficult to scale	- Highly scalable due to a broader range of decision making skills
- Difficult to train	- Learns from real interactions
- Need to update rules in order to optimize the bot performance	- Training is easy via historical data

Table 1: different AI and Rule based Chatbots

2.3 Artificial Intelligence

The term Artificial Intelligence (AI) was first introduced at a workshop held at Dartmouth College in 1956 which saw the necessary to separate it from other fields of study (Russell and Norvig, 2010). It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence (T. H. Huxley), there are four categories of AI, namely, thinking humanly, acting humanly, thinking rationally and acting rationally. The categories are explained below;

2.3.1 Thinking humanly

Thinking humanly is an approach to artificial intelligence that aims to model the way humans think and reason, with the goal of creating more human-like AI systems. The idea behind this approach is that by understanding how humans think, we can create AI systems that are more intuitive, natural, and easy to use. One of the pioneers of thinking humanly in artificial intelligence was cognitive psychologist and computer scientist Allen Newell, who co-founded the field of cognitive psychology and developed the General Problem Solver, a computer program designed to solve problems in a way that mimicked human problem-solving strategies (Newell & Simon, 1972).

2.3.2 Acting humanly

Acting humanly is an approach to artificial intelligence that aims to create AI systems that behave in a way that is indistinguishable from human behavior. The goal of this approach is to create AI systems that can interact with humans in a natural and seamless way, without the need for users to adapt to the limitations of the machine. One of the earliest examples of the acting humanly approach in AI was the Turing test, proposed by computer scientist Alan Turing in 1950 (Turing, 1950). The Turing test involves a human evaluator who engages in a natural language conversation with both a human and a machine, without knowing which is which. If the evaluator is unable to distinguish between the human and the machine, then the machine is said to have passed the Turing test.

2.3.3 Thinking Rationally

The study of mental faculties through the use of computational models. (Charniak and McDermott, 1985) Thinking rationally is also defined as the study of the computations that make it possible to perceive, reason and act (Winston, 1992).

2.3.4 Acting Rationally

Computational intelligence is the study of the design of intelligent or rational agents. (Poole, 1998) It is mainly concerned with the building of rational or intelligent agents. From the work referenced above the common goal of artificial intelligence then can be summarized to be the study of how to improve human efficiency by creating computers that perform tasks done by humans in a better way and mimic human behavior to interface well with human beings. Hence it can be concluded that the main drive and motive behind chatbots is the use and study of artificial intelligence. General design behind chat bots aims at creating a rational agent that act humanly and an agent cannot act humanly if its computations are not made in a humanly manner. (Think humanly) Hence a chatbot to an extent epitomizes the main goal of artificial intelligence. The picture below gives a summary of the history of artificial intelligence.

2.4 Natural Language Processing

Natural Language Processing (NLP) is a subfield of artificial intelligence that focuses on the interaction between computers and humans using natural language. NLP allows computers to understand, interpret, and generate human language, which enables a wide range of applications, including machine translation, sentiment analysis, and chatbots. One of the earliest developments in NLP was the creation of the first machine translation system in the late 1940s by Warren Weaver at the Rockefeller Foundation (Weaver, 1955). This system used a set of rules to translate text from one language to another, but it was limited in its capabilities. In the 1950s and 1960s, researchers began to explore the use of statistical models for natural language processing. One notable example was the development of the Markov Model by Claude Shannon, which used statistical methods to predict the probability of words and phrases in a given text (Shannon, 1951).

2.5 The Turing Test.

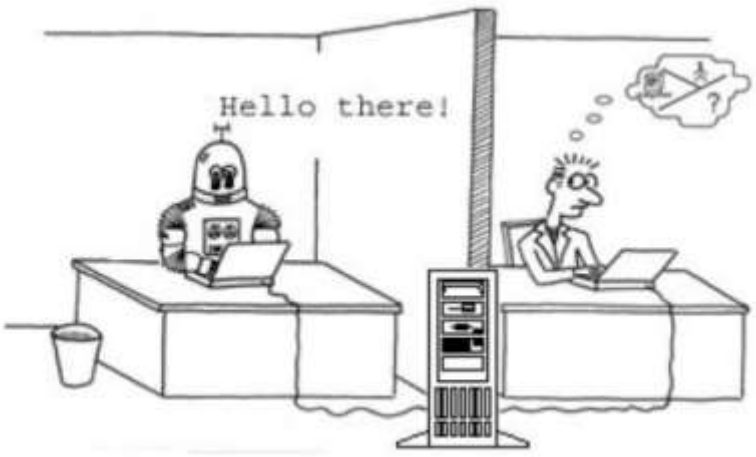


Fig 2.2 Turing test (Lim and Goh, 2016)

A computer can be considered to be *smart* only when a human interviewer, "conversing" with both an unseen human being and an unseen computer, cannot determine which is which. (Turing, 1950). Turing's question of "Can machines thinks?" brought the view to machine intelligence. The introduction of this test brought the birth of the very first known intelligent conversation systems. Alan Turing's 1950 article Computing Machinery and Intelligence (Turing, 1950) discussed conditions for considering a machine to be intelligent. He argued that if the machine could successfully pretend to be human to a knowledgeable observer then you certainly should consider it intelligent. This test would satisfy most people but not all philosophers. The observer could interact with the machine and a human by teletype (to avoid requiring that the machine imitate the appearance or voice of the person), and the human would try to persuade the observer that it was human and the machine would try to fool the observer. The Turing test is a one-sided test. A machine that passes the test should certainly be considered intelligent, but a machine could still be considered intelligent without knowing enough about humans to imitate a human. (Daniel Dennett's book Brainchildren 1898) has an excellent discussion four of the Turing test and the various partial Turing tests that have been implemented, i.e. with restrictions on the observer's knowledge of AI and the subject matter

of questioning. The Turing test brought a lasting impact to the study of Artificial intelligence, however, some scholars argue that it is not an accessible goal and its testing matrix is somehow difficult and unattainable. (Hayes and Ford, 1995) They further argue that the test limits artificial entities to act as human and mimic some human traits that result from mistakes in order to pass the test. Traits such as misspellings and typos in text-based conversation agents. Some authors argued on the basis of the modules of the test to determine the intelligence of an entity. For example, unintelligent behavior is witnessed in intelligent beings and on the other hand, dumb machines may perform a lot of tasks more intelligently and accurately than intelligent human beings (Khanna *et al.,* 2015) Hence the use of the Turing test as a way of evaluating the intelligence of a chatbot may be viewed as limited as it is only restricted to human abilities.

2.6 History of Chatbots

The first chatbot was Eliza developed by Joseph Weizenbaum, which was created in 1966. Eliza`s key method of operation involves the recognition of clue words or phrases in the input and the output of the corresponding pre-prepared or pre-programmed responses that can move the conversation forward in an apparently meaningful way. Its goal was to behave as a Rogerian psychologist. It used simple pattern matching and mostly returned users' sentences in the form of questions. (D. Liddy, 2001; Abu Shawar and Atwell, 2002; Bradeško and Mladenić, 2012; McNeal and Newyear, 2013). Its conversational ability was not very good, but it was enough to confuse people at a time when they were not used to interacting with computers and to start the development of other chatbot systems. The first such a system that was actually evaluated using some sort of Turing Test was PARRY (Colby, 1975) PARRY was designed to talk as a paranoid person. Its transcripts were given to psychiatrists together with transcripts from real paranoia patients for comparison. The psychiatrists were able to make the correct identification only 48% of the time (Bradeško and Mladenić, 2012). The Turing test and the building of chatbots were the main foundation of the Loebner Prize competition. The history of chatbots outlined in the following section is as according to the winners of the Loebner Prize competition. Chatbots have also become increasingly common in customer service and support, with many businesses implementing chatbots to handle customer inquiries and support requests.

According to a study by Grand View Research, the global chatbot market is expected to reach $9.4 billion by 2024 (Grand View Research, 2019).

2.7 Technical approaches and algorithms used in the creation of Chatbots

Below are some of the techniques used in the winning chatbots in the Loebner Prize competition.

2.7.1 Pattern Matching

Pattern matching is the most commonly used approach in chatbots to classify the user input as and produce a suitable response stored in. These pairs are hand crafted. Although pattern matching techniques are used in both early and modern chatbots, the complexity of the algorithms used in them differs. Early chatbots like ELIZA used simple pattern matching rules, as compared to A.L.I.C.E, which uses more complex pattern matching rules and associates some degree of conversational context while searching the stored categories for a matching. Pattern matching technique is mostly used in QA chatbots. This technique has advantage of being flexible to create conversations. The approach has some disadvantages in terms of scaling as all the possible patterns are built manually and it's not a trivial task. Due to the scaling issue, chatbots information extraction capabilities are limited, and its responses could be predictable and repetitive (Ramesh. K, et al, 2017). This technique is more commonly used in chatbots and there are several variations of algorithms for pattern matching that exist. The pattern matching approaches may differ in complexity, but the ideas is the same for all. It is a technique of artificial intelligence used in the design of a Chatbot. The input is matched with the inputs saved in the database and corresponding response is returned (M. Dahiya). This technique was used in earlier chatbots such as ELIZA and PC Therapist. For example, while using ELIZA pattern matching would be done as follows: -

Pattern: "I need a? X"

Response: "What would it mean for you if got a? X"

The response generated would be as according to the pattern of the string input from the user. Such techniques were used in the early 90s, the Loebner prize winners from 1991 up to 1995 mainly used pattern matching techniques to generate responses.

2.7.2 Parsing

Textual parsing is a method of converting the original text into a set of words (lexical parsing) with features, mostly to determine its grammatical structure (Bradeško and Mladenić, 2012). Lexical structure of the tree can further be analyzed to check if it follows or forms allowable expressions (syntactical parsing). In Python's Natural Language Toolkit (NLTK) the use of trees is the very same method used in string parsing. String parsing is very good at deducing the intent of an interrogator by a certain phrase he/she inputs into the system. An example of such string parsing would be that sentences "Can you get the gold" and "Please take the gold" would be both parsed into "take gold". With this approach, a chatbot with limited set of patterns and responses can cover multiple inputs from the user.

2.7.3 Markov Chain Models

Markov chain is used in chatbots to build responses based on a probability model to give responses that are more applicable probabilistically and consequently more correct (Abdul-Kader and Woods, 2015). The idea behind Markov chain is that each occurrence of a letter or a word in a certain text dataset occurs with a fixed probability. Chatbots which use Markov chain models to construct responses, give responses which are probabilistically viable (Bradeško and Mladenić, 2012). Hence in summary, Markov chains make use of mathematical probabilities to predict or produce a statistically correct solution.

2.7.4 Ontologies

Domain ontologies are used in chatbots to replace hand crafted domain knowledge with ontological domain knowledge. Use of ontologies is not new as they have been used within specific dialogue system modules, for example in language generation as the basis of the systemic grammar approach. The main advantage of using domain ontology in a chatbot is that the chatbot can explore the concepts nodes of an ontology to establish the relationship between concepts that are used in conversation but can also imply new reasoning. However more general use of ontologies in chatbots is relatively small

(Ramesh, K., et al,2017). It is also defined as a set of hierarchically and relationally interconnected concepts. These concepts can have natural language names and can be used directly in chatbots to figure out the hyponyms, synonyms and other relations between the concepts (Bradeško and Mladenić, 2012). To simply put it, ontologies are semantic networks, a set of concepts connected, hierarchically and relationally. The aim of using ontologies in a Chatbot is to compute the relation between these concepts, such as synonyms, hyponyms and other relations which are natural language concept names. The interconnection between these concepts can be represented in a graph enabling the computer to search by using particular rules for reasoning (Milward. D, Beveridge. M,2011).

2.7.5 Chat-Script

Chatscript is an open source authoring tool for building Chatbots. Chatscript is a combination of natural language engine and dialog management system designed for interactive conversation while maintaining user state across the conversations. It is a rule-based engine where rules are created in program scripts through a process called dialog flow scripting. These scripts can be stored as a normal text file. Machine learning tools can also be used to mine user's conversations logs to improve your dialog flows. Chatscript make use of concepts. A concept of all nouns or adverbs can be created. An existing database of some 2000 predefined concepts and scripters can also easily write their own concepts (Ramesh, K., et al,2017).

2.8 Applications of WhatsApp Chatbot

- **Customer Support**: Businesses can use chatbots to provide customer support 24/7. Chatbots can answer frequently asked questions, provide support for issues, and direct customers to the right resources.
- **E-commerce**: Chatbots can be used in e-commerce to assist customers by giving them available products, making orders and making payments.
- **News and Information**: News organizations can give updates to its supporters about any trending news through the use of WhatsApp chatbots.
- **Educational Purposes**: Chatbots can be used in education to provide support to students for, for example assist them to answer questions and assignments.

- **Financial Institutions**: Chatbots can be used as financial institutions for example banking systems to help customer to have access to their bank accounts, funds transfers and other functionalities.

Overall, chatbots can be used in any application where there is a need for automated communication with customers or users. (Tejaswi Raghuramaiah).

2.8 WhatsApp Chatbot Trending Currently

ChatGPT is a chatbot built on top of the GPT (Generative Pre-Trained Transformer) language model, which was developed by OpenAI. The GPT language model is a state-of-the-art deep learning model that has been pre-trained on vast amounts of text from the internet, allowing it to generate human-like responses to text-based prompts. The GPT model was first introduced in 2018 by OpenAI as part of their efforts to advance the state-of-the-art in natural language processing. The GPT model was trained on a massive corpus of text from the internet using an unsupervised learning approach, which allows the model to learn patterns and relationships in the data without human supervision. The GPT model is based on the Transformer architecture, which was introduced by Vaswani et al. in 2017 (Vaswani et al., 2017). The Transformer architecture uses self-attention mechanisms to allow the model to focus on different parts of the input sequence during training and inference, which improves its ability to model long-range dependencies in the data. The GPT model has been used for a wide range of natural language processing tasks, including language modeling, machine translation, and question answering. The model has achieved state-of-the-art results on many benchmarks, including the GLUE benchmark for natural language understanding (Wang et al., 2018). ChatGPT builds on the GPT model by fine-tuning it on a large corpus of conversational data to improve its ability to generate human-like responses in a chatbot setting. The fine-tuning process involves training the GPT model on a dataset of conversational data, such as customer support chats or social media conversations, with the goal of teaching the model to generate responses that are relevant and appropriate in a chatbot setting. ChatGPT uses a variety of techniques to improve the quality of its responses and make them more human-like. One technique is to use a persona model, which allows the chatbot to generate responses that are consistent with a particular personality or style of communication. Another technique is to use context-aware generation, which allows the chatbot to generate responses that

are tailored to the specific context of the conversation. ChatGPT has been used in a wide range of applications, including customer service, personal assistance, and social chat. The chatbot is able to handle a wide range of inputs and generate appropriate responses, making it a powerful tool for automating conversations and improving the user experience.

2.9 Previous Studies on Farmers Chatbots.

1. The International Maize Growers Association (ITGA) is a non-profit organization that represents the interests of maize farmers worldwide. The organization was founded in 1984 and is based in Brazil.

The ITGA works to promote the sustainable development of the maize sector by advocating for the rights and interests of maize farmers, providing technical assistance and training, and promoting best practices in maize farming.

One of the key roles of the ITGA is to provide a platform for maize farmers to voice their concerns and to engage in dialogue with governments, international organizations, and other stakeholders in the maize industry. The organization is also involved in research and advocacy related to the social and economic impacts of maize farming, including issues related to labor rights, food security, and rural development.

The ITGA has a global membership of over 30 national and regional maize grower associations, representing more than 30 million maize farmers worldwide. The organization works closely with these members to ensure that the voices and needs of maize farmers are heard and addressed in policy discussions and decision-making processes related to the maize sector.

2. The International Maize and Wheat Improvement Center (CIMMYT) is a non-profit research organization that works to improve the productivity, sustainability, and resilience of maize and wheat farming systems worldwide. The organization was established in 1943 and is based in Mexico.

CIMMYT works with national agricultural research systems, farmers, and other partners to develop and promote sustainable agricultural practices and technologies that can improve food security and livelihoods, especially in developing countries. The organization conducts research on various aspects of maize and wheat farming, including plant breeding, crop management, soil health, and pest and disease management.

One of CIMMYT's most notable achievements is the development of high-yielding, disease-resistant maize and wheat varieties, which have helped to improve food security and increase farmers' incomes in many parts of the world. CIMMYT's research has also contributed to the development of sustainable agricultural practices, such as conservation agriculture and integrated pest management, which can help to reduce the environmental impact of farming while increasing yields and profitability.

CIMMYT also works to build the capacity of national agricultural research systems and farmer organizations, providing technical assistance, training, and support to help them develop and implement sustainable agricultural practices and technologies. The organization is committed to sharing its knowledge and expertise with farmers, researchers, and policymakers around the world, in order to promote sustainable agriculture and improve food security and livelihoods.

3. Khojastehpour, M., & Zare, A. (2020). Evaluation of the effectiveness of agricultural chatbot in Iran. Journal of Agricultural Science and Technology, 22(2).

4. Praokongchao, P., Thamrongrat, N., & Klongdee, N. (2019). Development of chatbot for pest management in rice farming. Computers and Electronics in Agriculture.

5. Kamble, S. S., & Dhande, A. R. (2018). Design and development of a chatbot for providing weather and crop-related information to farmers. Computers and Electronics in Agriculture.

2.10 WhatsApp Chatbot Trends in Zimbabwe

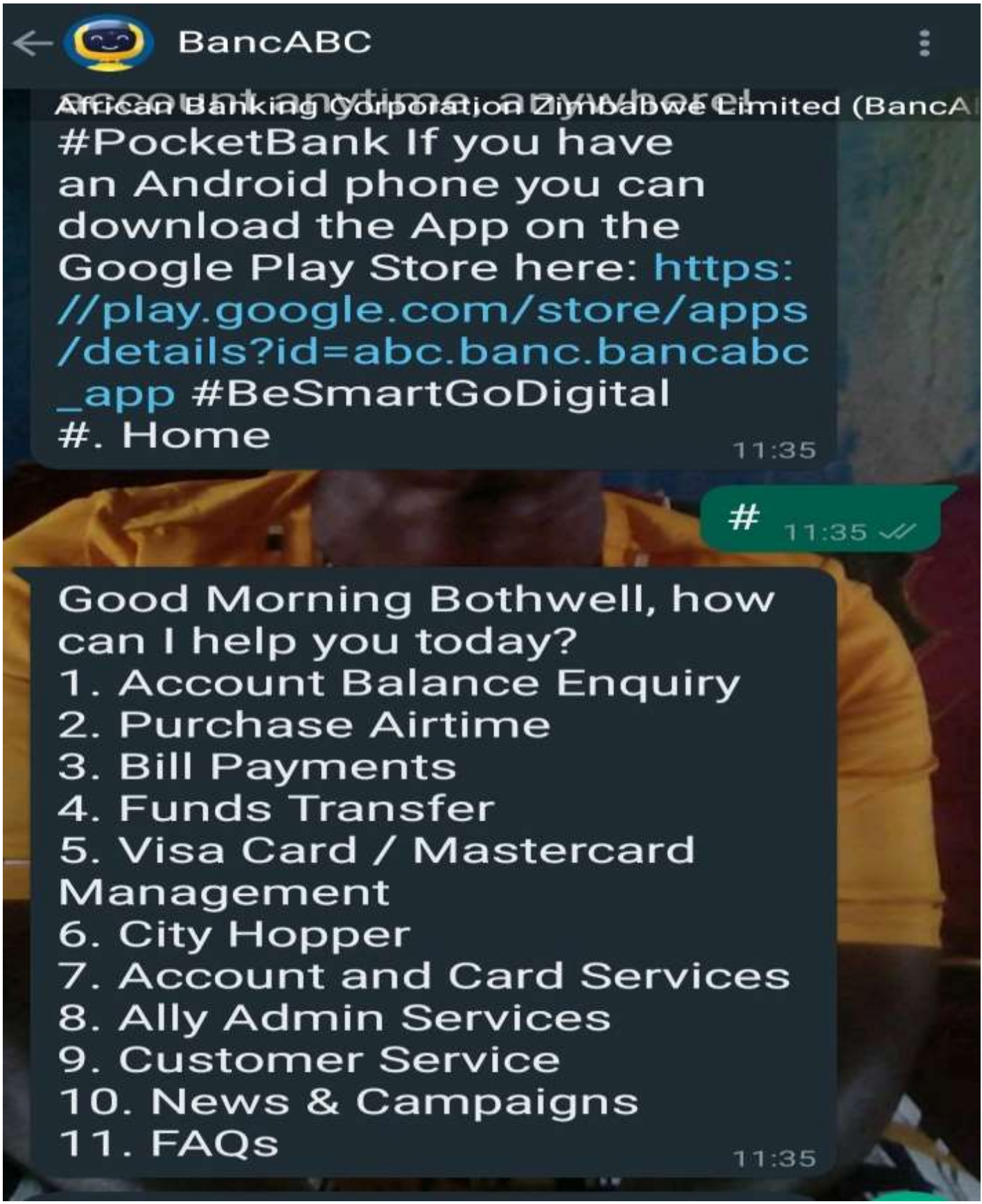
There are several companies in Zimbabwe that specialize in the creation and management of Chatbots like WhatsApp Chatbots for enterprise environments. These companies involve banking sectors, network service provider, local authorities and private companies. In Zimbabwe chatbots are mostly used to cater for customer`s queries and managing customer queries for business management.

BancABC Chatbot

BancABC released a WhatsApp chatbot platform to help its customers with: -

- Account Registration
- Pin Resets
- Bank Transfers
- Airtime Purchase
- Account Enquiries and More

The chatbot will walk the customer through a verification process and checks their account number and pin number before giving critical options for the customer to choose from, for example money transfers. Below are snapshots a typical conversation with the Bank chatbot.


BancABC
African Banking Corporation Zimbabwe Limited (BancA
#PocketBank If you have an Android phone you can download the App on the Google Play Store here: https://play.google.com/store/apps/details?id=abc.banc.bancabc_app #BeSmartGoDigital
#. Home
11:35
#
11:35
Good Morning Bothwell, how can I help you today?
1. Account Balance Enquiry
2. Purchase Airtime
3. Bill Payments
4. Funds Transfer
5. Visa Card / Mastercard Management
6. City Hopper
7. Account and Card Services
8. Ally Admin Services
9. Customer Service
10. News & Campaigns
11. FAQs
11:35

2.11 Why Chatbots are gaining popularity

According to a survey done by Mind Browser and Accenture, it revealed that most companies came to know about chatbots only recently. Business insider predicts that by the year 2020, almost 80% of businesses will have their customer services and interactions being done by chatbots. (Sandbank et al., 2017).

The greatest rise in the use of chatbot is in the E-Commerce division with major companies like Amazon making use of chatbots on their E-Commerce, in banking industry where customers can interact with their bank accounts using WhatsApp and perform some operations like transfer funds, and conduct transactions. Locally we have Banking Sector like BankABC that uses chatbot to communicate with its customers in terms of customer enquiries, pin or password changes, buying airtime, money transfers and many more. The following the main reasons why WhatsApp chatbot are gaining more popularity: -

2.11.1 24/7 Availability: WhatsApp chatbot is available at any time that users can interact with it wherever there are rather than communicate with human who can be unavailable sometimes. According to a study by Oracle, 80% of businesses plan to use chatbots by 2020, with 36% already using them. The study also found that one of the main reasons for using chatbots was their ability to provide 24/7 availability, leading to improved customer satisfaction (Oracle, 2017).

2.11.2 Cost Savings: WhatsApp is now a popular communication form that most people are using and it is cheaper than other communication forms like phone calls. A report by Juniper Research found that chatbots could save businesses up to $8 billion per year by 2022, with cost savings being a primary driver for their adoption (Juniper Research, 2017).

2.11.3 Improved Customer Service: A study by HubSpot found that 47% of consumers would buy items from a chatbot, and 71% of consumers were willing to receive customer assistance from a chatbot (HubSpot, 2017). This shows that chatbots can provide an improved customer service experience.

2.12 Failures in Chatbots

While chatbots have gained popularity for their ability to improve efficiency and reduce costs, they are not without their failures. Here are some documented failures in chatbots, along with in-text referencing:

1. **Misunderstanding User Intent**: Chatbots can misunderstand user intent, leading to incorrect or irrelevant responses. This can result in frustration for users. For example, Microsoft's chatbot was shut down after it made racist and sexist comments due to misunderstandings of user intent (BBC News, 2016).

3. **Technical Issues:** Chatbots can experience technical issues that can lead to downtime or errors in responses. For example, Facebook's chatbots experienced technical issues in 2017, leading to bots responding with nonsensical messages (The Verge, 2017).

4. **Lack of Contextual Understanding**: Chatbots can struggle to understand the context of user queries, leading to irrelevant or incorrect responses. This can result in frustration for users and a negative customer experience. A study by Comm100 found that 33% of consumers felt chatbots were not able to provide relevant answers to their questions (Comm100, 2020).

5. **Inability to Handle Complex Queries**: Chatbots can struggle to handle complex queries that require human intervention. This can lead to frustration for users and a negative customer experience. A study by Forrester found that 53% of consumers were frustrated when chatbots were unable to answer their questions (Forrester, 2018).

6. **Security and Privacy Concerns**: Chatbots can pose security and privacy concerns, especially when handling sensitive information such as personal data or financial information. This can result in a loss of trust from users. A study by Capgemini found that 63% of consumers were concerned about the security of their personal data when interacting with chatbots (Capgemini, 2019).

2.13 Ways of Improvement

The aim of this research project is to improve and encouraging the use of WhatsApp chatbot. Here are some of the improvements from the product of this research project that may improve the above mentioned areas of concern.

2.13.1 Introduction.

When the user starts the conversation with the chatbot, the chatbot first gives a description that hints the user that they are not talking to a real human intelligence but he/she is talking to the system. This allows the user to be more accommodating for any unintended mistakes in answering from the bot. This allows the novelty of the chatbot to appeal to the user and fascination may also allow the user experience to be improved. Has at conversation instantiation, a function that calls a greeting protocol was used in order to generate the following message depicted in the image below

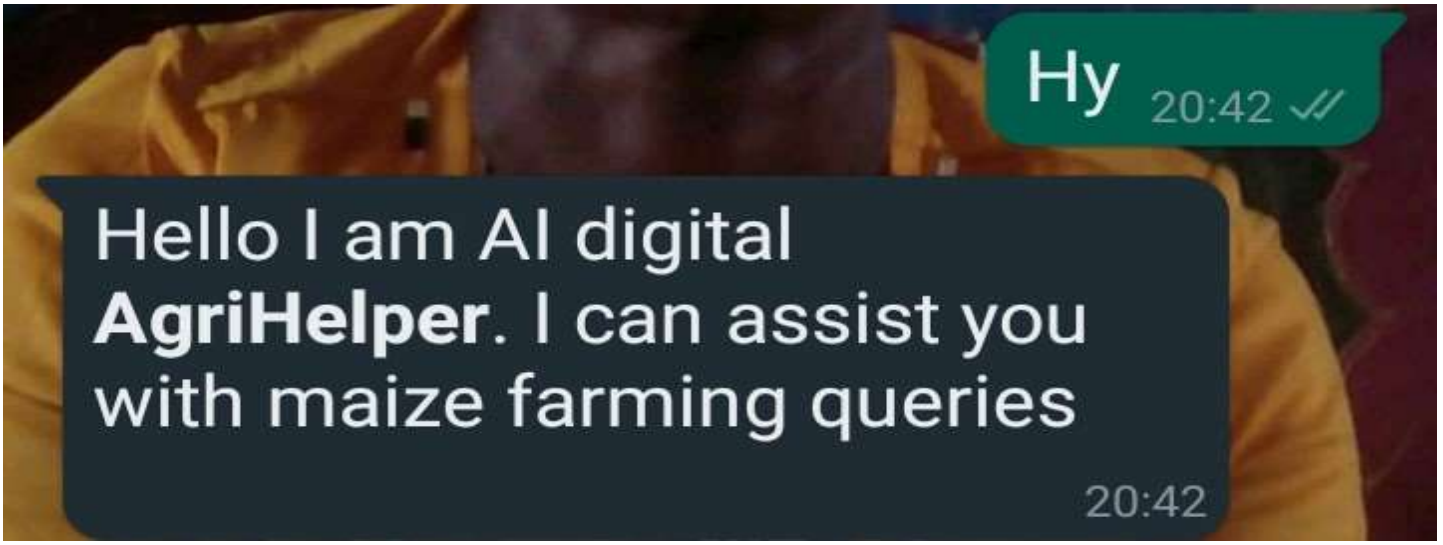


Figure 2.10 – Greeting message from the proposed bot

2.13.2 Narrowing of domain

As mentioned earlier, most chatbots tend to fail due to their generalization. This usually brings problems to the developer in predicting the possible outcomes of a user's input. This comes about because of the undeniable fact that chatbots are not intelligent, but are however based on the developer's creativity and ability to encompass the domain of the chatbot. Chatbot logic is mainly based on tree logic in graph theory, hence if the domain of the chatbot is not narrowed and if not enough time is given to completely map the conversation flow graphs, most chatbots fail.

Summary

The proposal of machines that can think in the late 1950s brought the birth of artificial intelligence. The Turing test was developed to test the validity of such machines. The Hugh Loebner prize competition which was started in 1991 uses the Turing test to determine its winners. Some scholars argue that the Turing test is unattainable and a far-fetched dream. Other scholars argue that using humans as a comparison will actually limit the capabilities of the intelligent agent as it may also need to mimic any shortcomings by humans in order to be deemed human like. The closest intelligent system that can be tested with the Turing test is the chatbot. The use of chatbots in service provision is rising Facebook launching its chatbot API and with Microsoft's CEO Satya Nadella proclaiming that chatbots are the next big apps, the greatest trends are visible in e-commerce, banking and healthcare divisions. The businesses that can benefit from the use of conversational agents are mainly in customer service provision hence the need for this research.

Chapter 3: Research Methodology

3.0 Introduction

The main goal of this chapter is to describe the strategies and tools used to archive the set objectives of the intended system and also aims to expand how the research was carried out. It will give a clear look at how the researcher collected data and how the system was implemented. With the research objectives in mind, the researcher had to compile the necessary tools to complete the research.

3.1 Data Collection Approaches

Data collection is to be done with the following ideas in mind

3.1.1Time differences between start and end of resolved conversations

Performance of the chatbot is rated using the time differences from the time a request was send to the system up to the time the request being answered.

3.1.2 Number of unresolved conversations vs resolved

Since the number of resolved requests shows the success of the system, and unresolved conversations show a failure, then the comparisons made of failed and successful runs will give a clear view of system's effectiveness. If the number of unsolved request from the users are greater than resolved problem, it means the system has poor effectives.

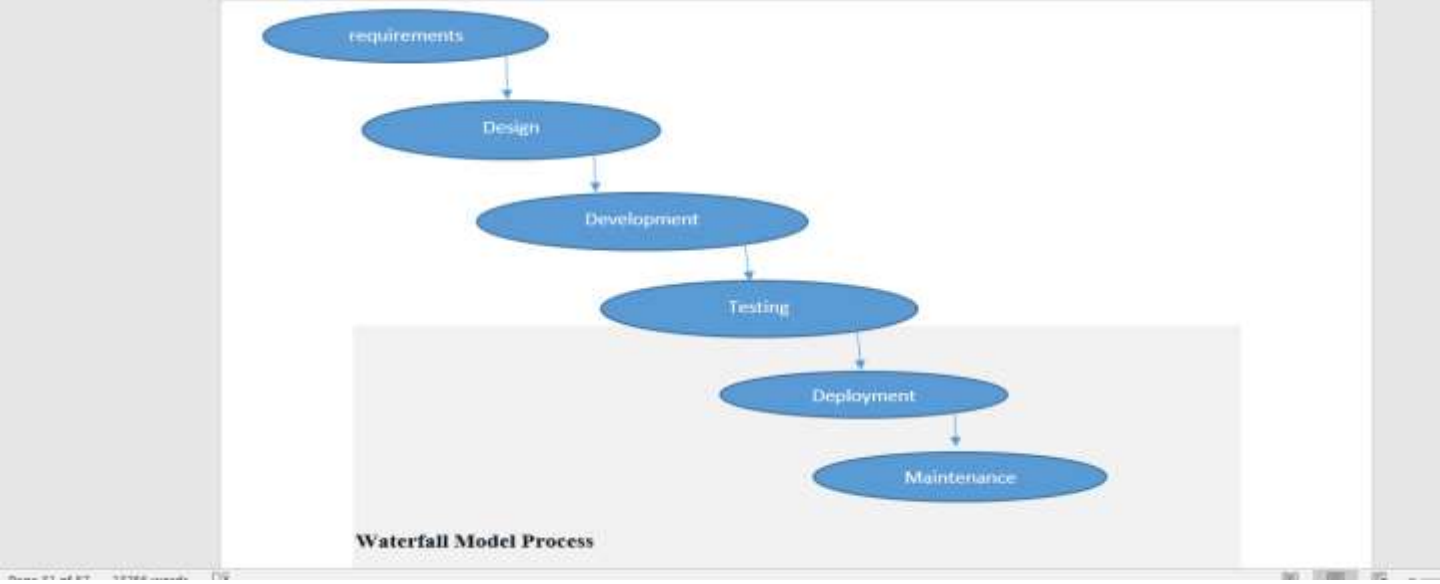
3.1.3 Surveys taken by user at the end of the conversation

At the end of the conversation, the user is requested to take a survey which allows users to rate the system conversation on a scale of 1 – 10. 10 being the best performance of the system conversation and 1 being the worst performance of the system.

3.2 Development Methodology

Due to the nature of the project, which requires huge flexibility in designing the knowledge base and the ever changing needs of the customer. For this research, the researcher implemented the Waterfall Model methodology. The waterfall model is a breakdown of project activities into linear sequential phases, meaning they are passed down onto each other, where each phase depends on the deliverables of the previous one and corresponds

to a specialization of tasks. The approach is typical for certain areas of engineering design (Winston W. Royce, 1970).Below are the stages in waterfall model as designed by the researcher: -



1. **Requirements gathering**: In this phase, the requirements of the software are gathered and documented. This may involve discussions with stakeholders, analysis of existing systems, and other research.

2. **Design: In this phase**, the software's architecture and design are defined, based on the requirements gathered in the previous phase. This may involve creating diagrams, flowcharts, and other visual representations of the software.

3**. Implementation**: In this phase, the software is developed according to the design specifications. This may involve programming, testing, and debugging.

4. **Testing**: In this phase, the software is tested to ensure that it meets the requirements and functions correctly. This may involve unit testing, integration testing, and system testing.

5. **Deployment**: In this phase, the software is deployed to the production environment, ready for use by end-users.

6. **Maintenance**: In this phase, the software is maintained and updated as needed to fix bugs and address any issues that arise during use (Boehm, B. W. 1988).

3.3 System Requirements.

The section below shows the functional and non-functional requirements of the system. These are the basic requirement that the researcher aims to achieve with the given system.

3.3.1 Functional Requirements

- System should allow registration of new users.
- System should assist users in their maize farming related problems via conversation means.
- System should enable users to rate their conversation for evaluation
- System should allow researcher to alter knowledge base

3.3.2 Non- Functional Requirements

Performance – the system should be able to operate efficiently and respond to user requests within acceptable response times.

Availability – Users require a service that is readily available at their disposal and ready to respond.

Usability or user-friendly – The system should have an intuitive and easy to use interface that simplifies the communication process for users.

Robustness – It should be able to handle exceptions and errors gracefully, ensuring users receive error-free responses.

Scalability – The Chatbot should be designed in such a way it can handle large volumes of user requests and remain responsive even during peak usage periods.

3.4 Design Tools

In this section is the list of the design tools used by the researcher to design the WhatsApp farmer's chatbot

3.4.1 JavaScript Programming language – The researcher chose to use JavaScript to develop the chatbot because Easy Integration with Other Technologies: JavaScript can easily integrate with other technologies such as APIs and libraries, making it easy to incorporate external services into chatbots. This can help improve the functionality and performance of the chatbot.

3..4.2 Node.js- Node.js is an open-source, cross-platform JavaScript for run time environment that allows developers to build server-side applications using JavaScript. Node.js is particularly popular for building real-time applications such as chatbots, as it can handle a large number of concurrent connections with low latency.

3.4.3 Facebook Developer Console: The Facebook Developer Console is a platform provided by Facebook for developers to create and manage their applications, pages, and other integrations with the Facebook platform. It offers a range of tools and features to help developers build applications that can integrate with Facebook and other platforms. To use the Facebook Developer Console, developers must first create a Facebook account and register as a developer. Once registered, they can access the Developer Console by logging in to their account and navigating to the "My Apps" section. From there, developers can create new applications, configure settings, and manage their existing applications. They can also access various tools and resources, such as documentation, tutorials, and the Facebook API, to help them develop and test their applications. The Facebook Developer Console also provides access to analytics and insights data, which can help developers understand how their applications are being used by users and identify areas for improvement.

3.4.4 ChatGPT API: ChatGPT API is an application programming interface (API) that allows developers to integrate the ChatGPT natural language processing (NLP) model into their applications. ChatGPT is a pre-trained language model developed by the OpenAI

research lab, based on the GPT-3 architecture. ChatGPT is designed to understand and respond to natural language input from users, making it ideal for use in chatbots and other conversational applications. The ChatGPT API provides developers with a simple and easy-to-use interface for integrating the ChatGPT model into their applications. Developers can send natural language queries to the API and receive responses generated by the ChatGPT model. The API supports a range of programming languages, including Python, Java, and JavaScript. One of the key benefits of using the ChatGPT API is that it can help developers save time and resources by providing pre-trained models that are ready to use out of the box. This can be especially useful for developers who do not have the expertise or resources to train their own NLP models from scratch. Overall, the ChatGPT API is a powerful tool for developers looking to build chatbots and other conversational applications that can understand and respond to natural language input from users. The API provides a simple and easy-to-use interface for integrating the ChatGPT model into applications, allowing developers to focus on building high-quality user experiences.

3.4.5 Microsoft Azure: Microsoft Azure is a cloud computing platform and service offered by Microsoft. It provides a wide range of cloud-based services, including infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS) offerings. Azure allows organizations to build, deploy, and manage applications and services in the cloud.

Azure provides a wide range of services, including:

- **Virtual machines**: Azure offers a variety of virtual machine sizes and configurations to support different workloads and applications.
- **Storage**: Azure provides scalable and durable storage solutions, including blob storage, file storage, and object storage.
- **Databases**: Azure offers a range of database services, including SQL databases, NoSQL databases, and in-memory databases.

  Internet of Things (IoT): Azure provides services for building and managing IoT solutions, including IoT Hub, Event Hubs, and Stream Analytics.

- **DevOps**: Azure offers services for continuous integration and deployment, including Visual Studio Team Services and Azure DevOps.
- **Security and compliance**: Azure provides a wide range of security and compliance services, including identity and access management, encryption, and threat detection.

3.5 System Design

This section describes the tools and concepts used by the researcher to do implementation of the system. The following are the tools and concepts behind the farmer`s chatbot system.

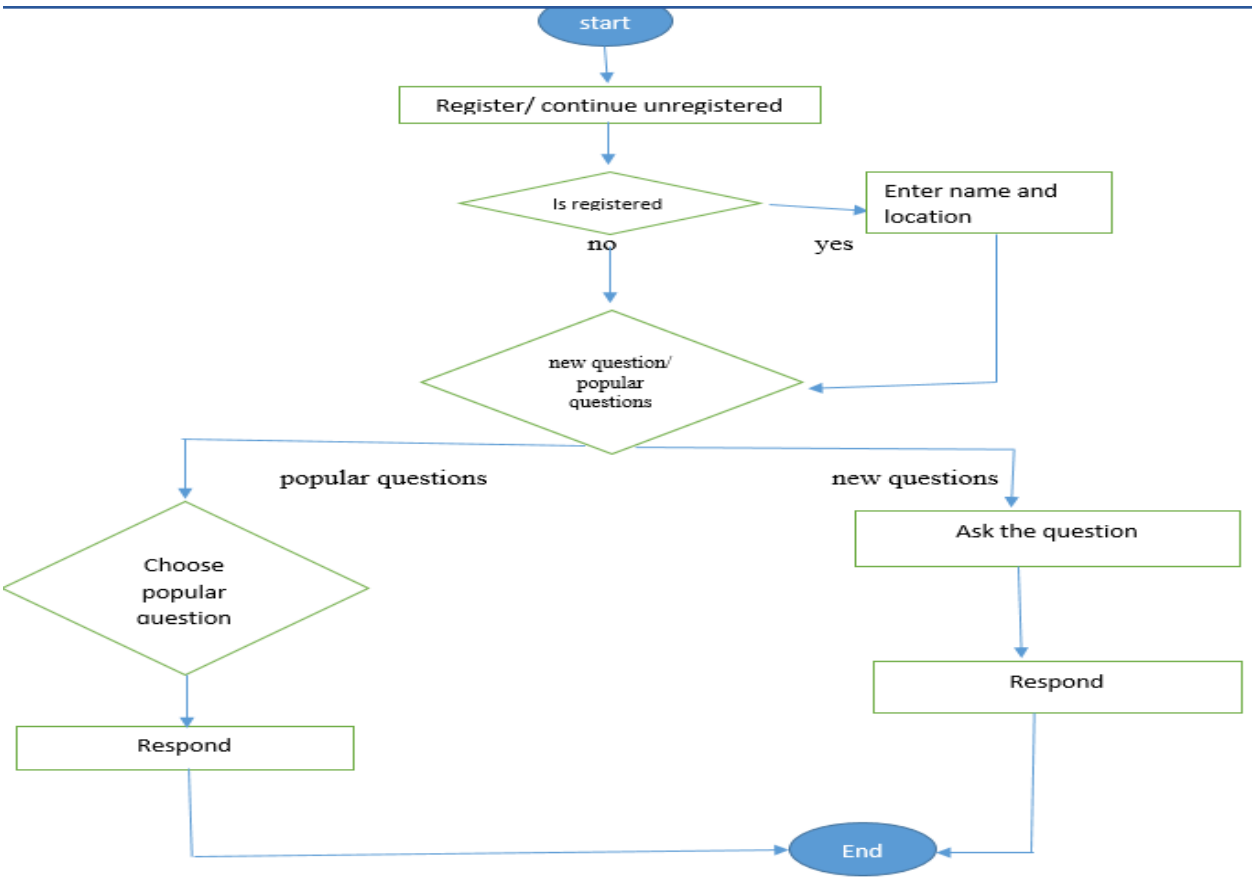
3.5.1 Chat

The system first asks the user if he/she wants to register, when the user registers to use the system, they are requested to provide name and location to the system. Once registered in the system, the user has access to the chat interface. The first messages after providing details is the greetings messages from the chatbot and the menu option pop up for a user to choose either to ask popular questions or new questions. If the user chooses to ask new questions which is out of the database, the chatbot escalates the request to ChatGPT and return the solution to the user. Below is a picture showing how one conversation can transpire.

kjhkgjkhgkjhk

Fig 3.1 – Chatbot conversation

The following diagram shows how the user is expected to make use of the system in overall from the starting of the conversation up to the end when the farmers receives the respond from the chatbot.



3.6 System Users

In system design, the use of Use case diagrams helps to show the functional requirements in an abstract way that can easily be understood even by the stakeholders of the system, therefore acting more like a communicating tool between the stakeholders and the developers.

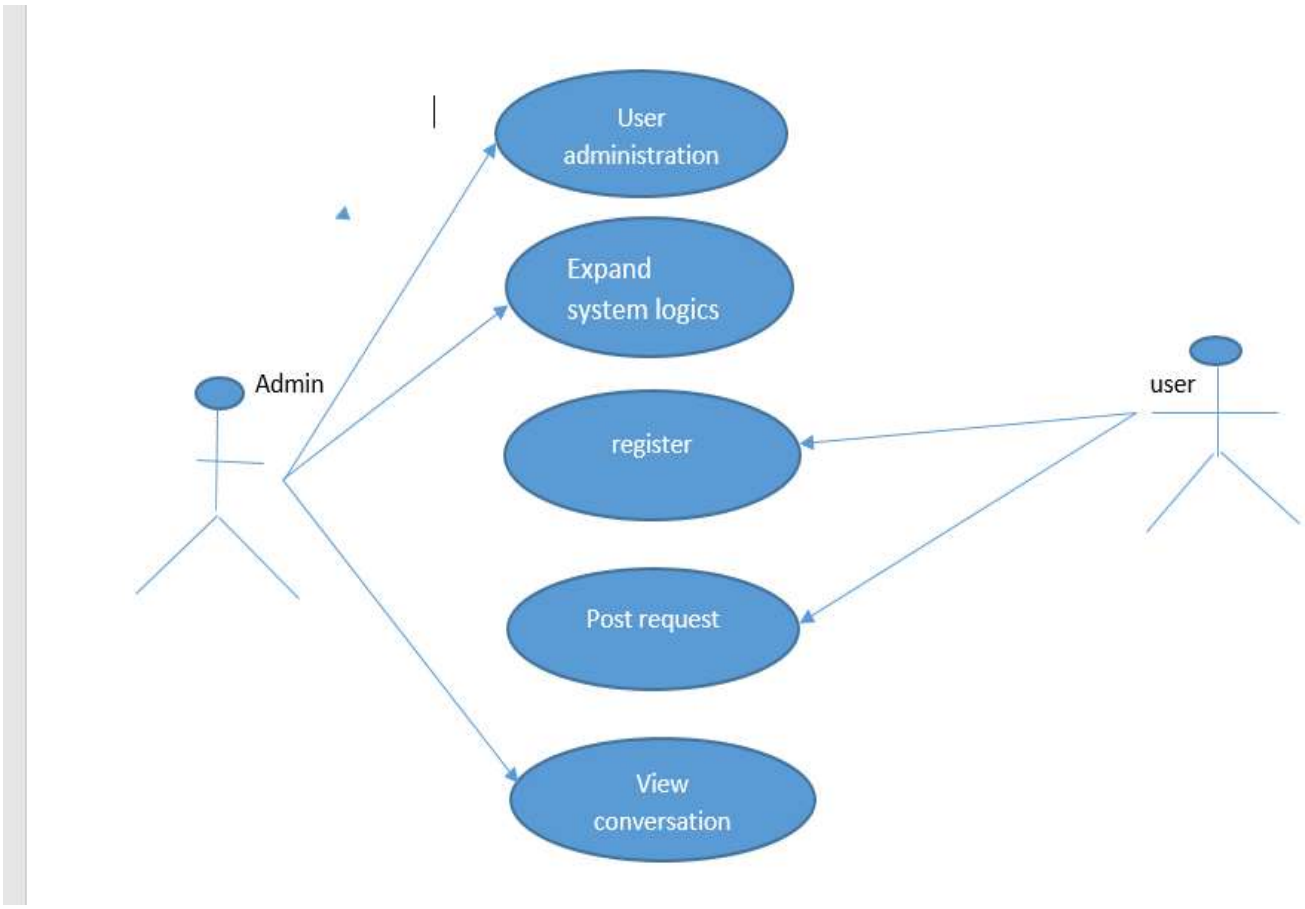


***Fig 3.4 – Use-case* diagram**

3.6.1 Administrator – in order for the system to continue functioning, there is need of administrator. The administrator is responsible for viewing the system for evaluation, expanding the knowledge base of the system in order to make changes to the system conversation in order to meet up to date responses to user requests, setting up and maintaining the system, this includes

configuring the chatbot to respond appropriately to user requests, performing reviews on the conversations that have transpired between the user and the system in order to determine the weakness and loopholes in the system's knowledge base for quality evaluation.

3.6.2 The End User – The main actor or audience of the chatbot system is the end user. The end user of the system is anyone who needs assistance with various tasks and requests, such as individuals, businesses or organizations. In this case every user must get the same response to popular asked questions.

3.7 Summary

This chapter focuses mostly on the technologies that helped the project achieve its goal. By incorporating all features, design tools, and their relationships, the project's goals were met. These tools include JavaScript, node.js, ChatGPT API, Microsoft azure. In the operational environment, the sequence of events and the flow of information from the beginning to the end of the system were also stressed in the chapter. The next chapter, which covers data presentation, analysis, and interpretation, builds on this foundation.

Chapter 4: Data Presentation, analysis and interpretation

4.1 Introduction

This chapter summarizes the research findings and provides a summary of the researcher's meaningful insights in a concise manner, this a critical analysis of data is done in line with the key areas of the research questions. It involves the organization, analysis and interpretation of the data to drive meaningful insights and conclusion. The data can be presented in various forms such as graphs, tables or other visual aids that can highlight the essential information present in the research, it is essential to choose the appropriate form of data visualization that can provide a clear understanding of the research findings. Once the data is organized and presented, the next step is to analyze it. The analysis can be done using various statistical techniques such as correlation analysis, regression analysis, and factor analysis, among others. The analysis of the system helps researchers to link different variables and provide a deep understanding of the research problem.

4.2 Testing

It is very important to test the system or any software after development in order to see if the system if it means the requirements and what is it supposed to do. Testing is defined as a critical part of software development that involves evaluating the quality and functionality of software products to ensure they meet the requirements and expectations of users. (Takanori. Seki, 2010). In this chapter, the researcher will show type of testing undertaken for this topic as follows:

4.2.1 Black Box Testing:

This type of testing focuses on the external behavior and the functionality of the system without having the knowledge internal structure of the system. In this type of testing, the tester is not worried about the logic of the system being tested. Instead, the user focuses on the performance of the system towards inputs being entered into the system and its output. Black box testing is often used to evaluate the software system from the end-user's perspective. (Unmesh Gundecha, 2012). Below shows how the system handles the black box testing after a user input any input which is not recognized by the system.

Fig 4564: black box testing

4.2.2 Fuzz testing:

Fuzz testing, also known as fuzzing, is a type of software testing that involves providing invalid, unexpected, or random inputs to a software system to detect bugs and vulnerabilities. Fuzz testing is a black box testing technique, and it is often used to test the robustness and resilience of a software system against unexpected or malicious inputs. Fuzz testing works by generating random or semi-random inputs and feeding them into the software system being tested. The inputs are designed to trigger errors or unexpected behavior in the system, such as input validation failures, buffer overflows, or crashes

4.3 Data Presentation and Analysis

The main data collection mentioned in the previous chapter was the survey based on user sentiment and views. The data is displayed in the form of Bar charts and tables to give a summarized view of the data collected.

4.3 Survey Question Responses

Shown below are questions used in the survey handed out to the sample population that was able to use the system and the data gathered during that interaction with the chatbot.

4.3.1 Question 1: What challenges do you face when it comes to maize farming?

Farmers were asked to provide information on challenges they face during their farming practices. The frequency distribution provided in the table below shows that most of the sampled users face the problem of maize diseases. For the sake of improving maize yields, the Gross Domestic

Product and food security of the country, the system should give a clear response to ways of controlling pests and diseases in maize since this is main challenge they are facing.

What challenges do you face in maize farming?

Challenges	Frequency	Percent
Pest and diseases	12	60
Climate and weather changes	8	40
Total	20	100

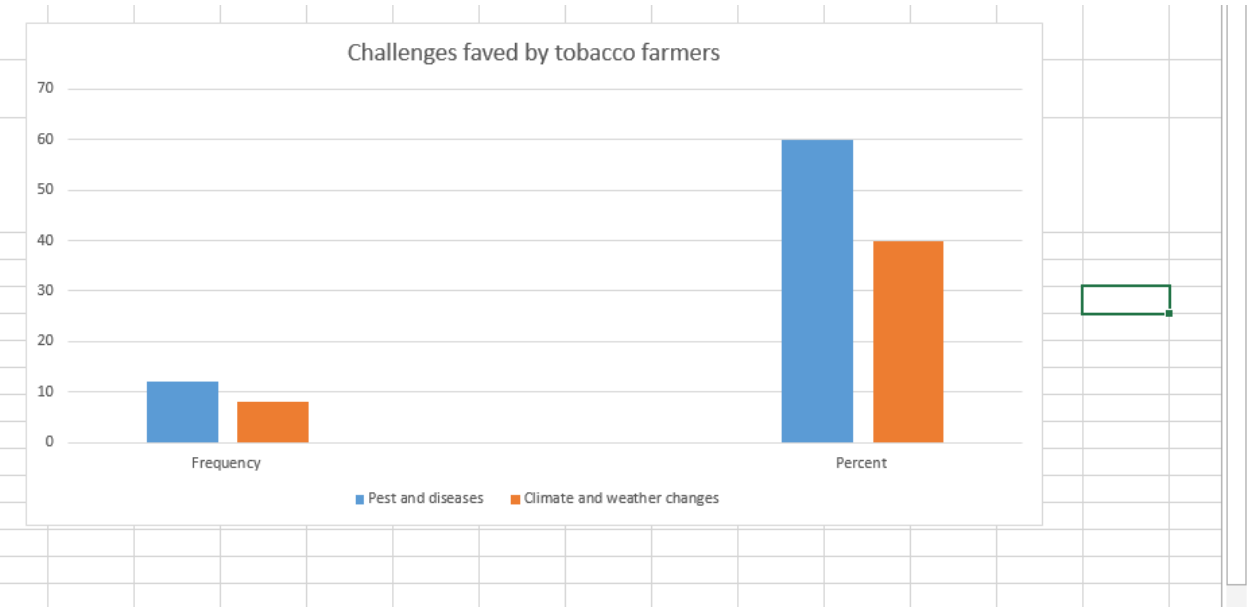


Fig 4.1 Graph showing challenges faced by farmers

4.3.3 Question 2: Where do you get help when facing farming challenges?

Maize farmers were asked to provide information on where do they get assistance when facing maize challenges. After farmers were asked that question, it was noted that most farmers depend on Agritex officers within the area to get assistance, some confirm that they get assistance from other farmers, especially those who are in maize farming for a long time, and very few farmers confirmed that they post their query on google to get help. This question aims to find if it's a better move to introduce WhatsApp Chatbot to assist farmers in case the Agritex Officer is not available. Below is a table showing responses from maize farmers.

Responses	Number	Percent
Agritex Officer	15	75
Other farmers	10	50
Google	5	25
Total	20	150

From the table above, it shows that most maize farmers are getting advice and help from local government workers for example Agritex officers, who are the experts on maize farming. It means that if the Agritex officer is not available farmers will wait until he/she gets available, this implies that, there is a greater chance for a farmer to get respond from the expert after some days due to unavailability of the expert resulting in poor output, this also proves that it is helpful to introduce WhatsApp chatbot that interact with farmers to respond to the same questions they want to ask Agritex Officer.

Table 4.5 Table Showing Frequency distributions of the response periods from Agritex Officer.

Time	Frequency	Percent
Under 30mins	6	24
Under I hour	2	8
After an hour	7	28
After 10 hours	8	32
After a day	2	8
	25	100

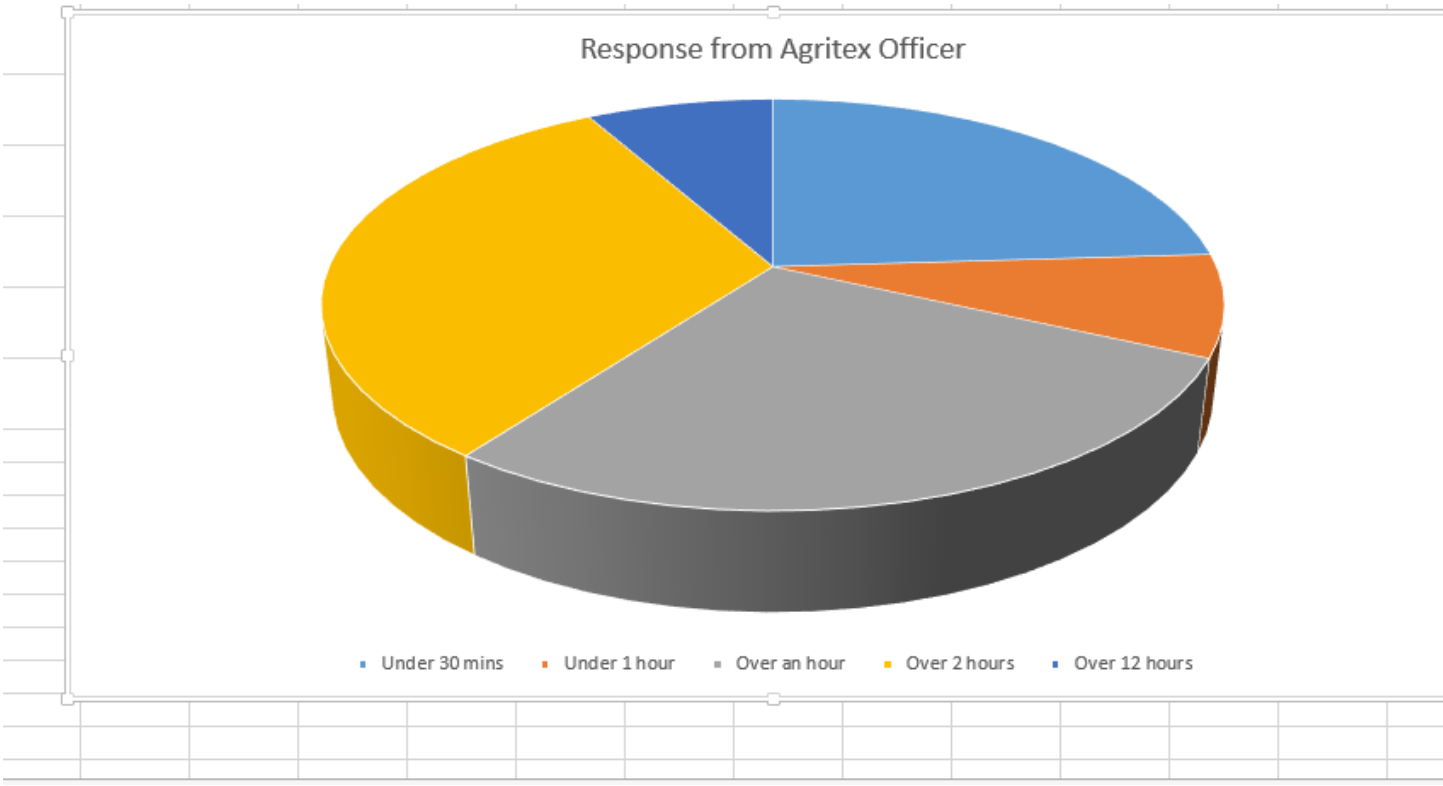


Fig 4.2 Response from Agritex Officer

4.4 Proposed System Analysis

After asking respondents to converse with the system, the data gathered is shown below.

Table 4.3 Table showing the response times for the proposed system

Time	Frequency	Percent
Under 2 seconds	15	75
Under 10 seconds	5	25
Total	20	100

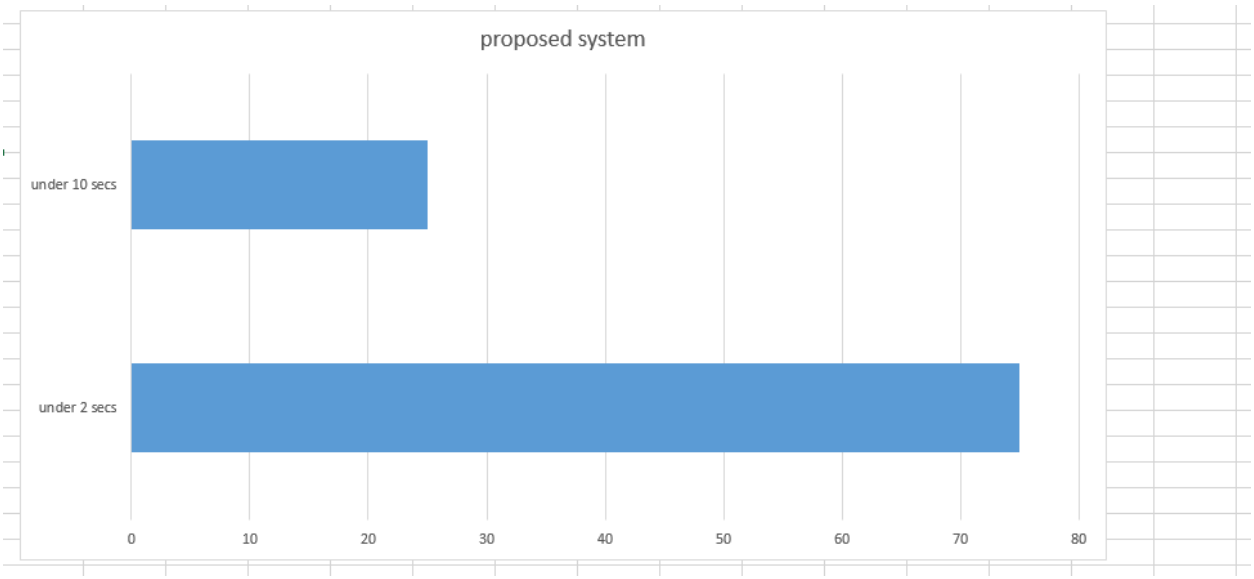


Fig 4.3 Pie Chart showing the Frequency distribution of the response times for the proposed system

4.5 Accuracy measurements

The main goal of this recommender system is to provide the best and most dependable recommendations to its users. As a result, an accuracy number is used to evaluate the system's performance and efficacy, as illustrated below.

Accuracy = number of valid results / total number of results * 100%.

Number of times the system returned valid or acceptable results	The number of times the system returned invalid and unacceptable results	Total test runs	Accuracy
17	3	20	85%

4.6 Analysis of the effectiveness of intelligent chatbot system for maize farmers

Effectiveness is the degree to which something achieves its intended purpose or produces the desired results. In other words, effectiveness measures how well something performs in achieving its goals or objectives. To analyze the effectiveness of a WhatsApp chatbot, the researcher must consider some metrics as follows:

Customer satisfaction: This metric measures the level of satisfaction that users have with the chatbot experience.

Response time: This metric measures the time it takes for the chatbot to respond to user inquiries. A fast response time can improve user engagement and satisfaction.

Error handling: Error handling refers to the process of detecting, diagnosing, and resolving errors or exceptions that occur during the operation of the chatbot.

Cost savings: This metric measures the cost savings that the chatbot provides compared to traditional service channels.

In conclusion the benefits of analyzing the effectiveness of the system is that, the researcher can identify weakness and strength of the system and identify areas for improvement. Below shows one of the above metric used to analyze the effectiveness of the chatbot.

4.5.2 User Acceptance

The final question in the survey to the user was pertaining to the proposed system. The user was asked to respond on if given the chance, they would use the system again. User acceptance refers to the process of verifying that a product, service or system meets the requirements and expectations of the end-users. It involves testing the product to ensure that it functions as intended and that it is user-friendly and meets the needs of the target audience. User acceptance testing (UAT) is a critical part of the software development process where the product is tested by actual users to determine whether it meets the requirements and expectations of stakeholders. From the data gathered on the sample users, 65% would use the system again, 20% said no and 15% were uncertain but would consider it. Below is the data for the general user sentiment on the use of the proposed system.

Table showing the general sentiment on the use of the proposed system.

Would you use this system to help you resolve the system again?

Responses	Frequency	Percent
Yes	9	65
No	5	20
Maybe	6	15
Total	20	100

Table 4.5 Prosed System Sentiments

4.6 Findings

According to the survey taken by the researcher, it shows that most maize farmers get information and farming practices, and this is incapable of interacting with farmers in time, hence the users have to for the Agritex Officer to take notice of the request and then respond resulting in poor yields of maize. Hence the requests take longer to be responded to. Approximately 68% of the request are responded to after more than an hour. Hence an improvement in service provision provided by the proposed system is essential in such a situation. The proposed system in contrast to the current system being used by farmers resolved 90% of its request within the stipulated time limit. The proposed system is helpful in the following fast response, availability, and saving costs. The user experience objectives outlined in Chapter 1 is greatly achieved if the system's coherence has a value at least 1 and above. Given the calculation made in part 4.5.1 in this chapter, the proposed system's coherence still needs optimization. However, since the value still meets the minimum requirement hence the user can still get their information as they need. Given that users have prior knowledge to the nature of the system before continuing with the conversation, they can be forgiving in the event that the chatbot's responses are flawed.

Chapter 5: Conclusions and Recommendations

5.1 Introduction

This Chapter aims to draw conclusions on the results obtained in the previous chapter. This chapter also aims to acknowledge the short comings of the proposed system and how it can be improved further in the event further research in the same line of research. The following parts show a discussion of the research objectives and results.

5.2 Aims and Objective Realization

In Chapter 1 of this research project is an outline of the research objectives. Below is a table showing the research objectives that have been met and ones that might have provided issues for the researcher.

Research Objective	Objective Met	Objective Not Met
i) To design and develop a WhatsApp Chatbot that interact with farmers and address their request.	yes	
ii) To implement natural language processing to improve user experience by providing optimum response to the user request.	yes	
iii) To analyze the effectiveness of chatbot in farming sector.	yes	

Based on the results acquired, it is fair enough to conclude that the farmer`s Chatbot system is able to give reliable recommendations in helping maize farming to contact up to date farming techniques and ways to overcame farming problems such as disease and pest control methods.

5.3 Research Questions

At early chapters, the research posed questions, which the researcher aimed to answer or provide answers to those questions. In summary, the answers to the research questions are provided below

1. **Can the famer`s Chatbot improve user experience?**

Yes. The proposed system can improve the user experience as outlined in Chapter 4 of this research project as the system showed an improvement in response time and coherence. User experience, often abbreviated as UX, refers to the overall experience that a person or user has while using a product, service, or system. It encompasses the user's feelings, attitudes, perceptions, and responses to the various aspects of the product or service they're using, such as its design, functionality, usability, ease of use, and accessibility. User experience design aims to create products and services that are user-friendly, intuitive, enjoyable, efficient, and effective.

2. **How can the proposed Chatbot assist maize farmers to get better yields?**

Through the use of natural language processing and real time responses to users in the absence of Agritex officers allowed the system to improve the user experience. The farmer`s WhatsApp chatbot can assist maize farmers to get better yields in the following ways:

1. **Providing information on best practices**: The chatbot can provide farmers with information on the most effective farming techniques, including planting, fertilizing and harvesting, to help them improve their yields.

2. **Offering support**: The WhatsApp chatbot can assist farmers at any time of the day, the support includes diseases and pets control and any other support a farmer can request resulting in high productivity.

Overall, an intelligently customized chatbot can assist maize farmers by offering relevant and timely information, provide them with expert advice, offer flexible learning resources and community support in their attempt to increase yield and promote better crop management

3. What are the main benefits of using Farmers WhatsApp Chatbot?

The proposed WhatsApp Chatbot can bring more benefits to maize farmers. These benefits include availability of the system that a farmer can ask a question at any time, it save costs than using other methods of getting help like using google which requires money to get access to the internet.

5.4 Challenges

There are various challenges associated with WhatsApp chatbot development, which includes:

- **Restrictions on access to the WhatsApp API**: WhatsApp APIs are not just easy to get, it has some restrict measures in order to get access, and it allows only approved sources to access their platform. This makes it difficult for developers to integrate his/her application with WhatsApp.
- **Limited functionality**: WhatsApp chatbots have limited functionality compared to other chatbots that are built for platforms like Facebook Messenger. This can make it challenging to create a robust chatbot that meets all the requirements.
- **Training and maintenance**: Developing a chatbot requires ongoing training and maintenance to ensure that it continues to operate effectively. This can be a

challenge, especially when dealing with large volumes of data and complex natural language processing models.

5.5 Recommendations

In the development of projects like WhatsApp chatbot meant to help users, it is recommended to feed the system with more data so that it gives users more information than to return more errors. The use of menu option is a good idea in order to reduce the input of wrong data or query from users that might cause the program to crush. However, the program still needs more data to be added to the system database, by doing so, it will allow the system to bring more and better results to the user. For example, more maize information will be provided to farmers.

Furthermore, the researcher suggests the use of Hybrid Chatbots, it is the combination of both artificial intelligence and rule-based chatbots. When the chatbot receives a query, hybrid chatbots tries to respond from previous experiences, if not in the previous experiences, then it displays default responses, by so doing it produces more accuracy responses to the users.

5.6 Future work

Though the researcher has covered an area in this research, there is still room for future recommendations. This is so because we are living in a fast passed world, where technological advancements are a part of our living. The researcher recommends further building of the intelligent system, with the inclusion of more data to the knowledge base and the following can be done to enhance this project:

1. More rules can be added in the database in order to enhance the quality of the given output. For example, map a person's traits and subjects of interest then recommend a degree program
2. The system is text based conversation where the users communicate with chatbot in the form of texting a message, but there is room for the user to communicate with chatbot using voices, that is voice recognition chatbot, also give the farmer option to send

images, for example pest images to the system for it to determine type of pest and methods to control such type of pest.

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