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Kasera, Lawrence Mwakio
School of Computing and Engineering Sciences
Strathmore University

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Lawrence Mwakio Kasera

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Declaration and Approval

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the research itself.

Lawrence Mwakio Kasera [Name of Candidate]

 [Signature]

4th July 2022 [Date]

Approval

The thesis of Lawrence Mwakio Kasera was reviewed and approved for examination by the following:

Dr. Bernard Shibwabo

Senior Lecturer, School of Computing and Engineering Sciences,

Strathmore University

Dr. Julius Butime,

Dean, School of Computing and Engineering Sciences,

Strathmore University

Dr. Bernard Shibwabo,

Director of Graduate Studies,

Strathmore University

Abstract

As part of the employee exit in an organization, the clearance process is a mandatory requirement that guarantees that the employee leaves formally, returns all organization property, and gets the final paycheck. It is commonplace for this process to entail filling and submitting an exit clearance form. For each area of responsibility in the clearance process, an ascertainment of completion is marked by the use of signatures or clearance approvals from the requisite personnel. The review of literature showcased that this process often employs the use of physical forms, which means printing, filing, and tones of record keeping. On the other hand, some organizations use automated means, which are still largely human reliant, leading to delays, inconsistencies and lots of redundancies. The aim of this study was to develop an intelligent chatbot implementation for employee auto clearance using Deep Learning. A chatbot is an Artificial Intelligence (AI)-driven software tool that simplifies the interaction between humans and computers. Among many other advantages, a chatbot reduces the overall costs in mundane tasks, enhances the user experience and has greater availability. This research employed the qualitative design to explore the different ways and approaches that make up the clearance process, alongside their challenges, in formal organizations, within Nairobi, Kenya. The proposed deep learning chatbot model was developed using 2 hidden layers and trained on 2,000 epochs. The training data dictionary was categorized as tags, patterns and responses. The model was able to correctly match 99.91% of the input pattern data points to their corresponding response output data points, and where an input pattern seemed unclear, the model was able to respond accordingly. The model could successfully make the API calls to the web service, where digital signatures are appended, and finalize the exit clearance process with a complete and signed clearance form.

Keywords: *AI, Chatbot, Deep Learning, Employee, Exit Clearance, Machine Learning, Web Service.*

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List of Abbreviations

AI - Artificial Intelligence

DL - Deep Learning

HCM - Human Capital Management

HR - Human Resource

IT - Information Technology

ML - Machine Learning

NLP - Natural Language Processing

UML - Unified Modelling Language

Definition of Terms

Artificial Intelligence (AI) - The part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit characteristics we associate with intelligence in human behavior – understanding language, learning, reasoning, solving problems, and so on (Barr & Feigenbaum, 1981).

Chatbot - An AI-driven software tool that simplifies the interaction between humans and computers (Expert.ai Team, 2021).

Deep Learning - A subset of machine learning, which is essentially a neural network concerned with algorithms inspired by the structure and function of the brain (Oppermann, 2021).

Employee Clearance - An official process of obtaining approvals that aims at validating that the employee has no outstanding obligations when resigning, or retiring from the job (CDC, 2011; Los Angeles Community Colleges, 2007).

Machine Learning - The study of computer algorithms that improve automatically through experience (Mitchell, 1997).

Unified Modelling Language - UML, is a graphical modelling language that provides us with a syntax for describing the major elements (called artifacts in the UML) of software systems (Larman & Craig, 1998).

Acknowledgement

This project would not have been possible without the Almighty God's great deal of favor, life and good health, which I eternally cherish. I would like to acknowledge and thank my supervisor, Dr. Bernard Shibwabo, whose extensive know-how was indispensable in the drawing up of this research project. Your wise feedback impelled me to better my thinking and elevate my work to a higher level. In the same token of appreciation, I would like to bestow my gratitude to Dr. Vincent Omwenga for his informed and enlightening ideas which fine-tuned my research skills. I would also like to fundamentally thank Strathmore University, particularly the ICT Services department for offering me a partial scholarship to undertake my Master's degree. In addition, to all those who inspired me to push myself, I do not take that for granted.

Dedication

I dedicate this research to my family; my parents Mr. Milton Owade Kasera and Mrs. Faustina Mkanyika Kasera, your staunch support kept me going, thank you for your wise counsel and sympathetic ear. To my siblings, I can't thank you enough for your unwavering encouragement. God bless you all.

Chapter 1: Introduction

1.1 Background

Clearance is the process of obtaining approvals (CDC, 2011). Exit Clearance is the process of validating that the employee has no outstanding obligations upon his/her separation from the employer (Los Angeles Community Colleges, 2007). The employee clearance process is a full and final settlement and a requirement imposed by the management on an employee to settle all debts and obligations, including return of Company properties or documents, to be cleared of any accountability and be issued a clearance document (Del Puerto, 2021; MMS, 2004).

The discourse around providing employees with a positive experience is largely devoid of strategies to make the exit process simple and convenient for the employee (Cushing, 2016; Laurano, 2013; Seth 2018). In addition, an audit done by SEC (2000) found that the clearance process for separating employees needs improvement. This process entails obtaining clearances from various departments (Department of Education, 2008), for instance; the HR, IT, accounts and admin, where a government certified clearance form must be filled after approvals by relevant stakeholders. The HR being the front facing department of this activity prepares exit checklists, a task which Ali et al. (2006) observed as labor-intensive and cumbersome when done manually. Some organizations have applied technology to facilitate this business process through the use of automated exit management tools (Laurano, 2013; Marbaniang et al., 2016), these tools yield a fast, systematic and a detailed account of the operation.

Some of these tools include the *Empxtrack exit management tool*, which helps the organization prepare department-wise exit checklists systematically and the *Automated exit management system* that gives organizations a reliable and centralized platform that is used to process and store all resignation-related information, including reasons for resignation, dates of employment, issued ID cards and other equipment, and also work data related to the resigning employee (EmpXtrack Software Features, 2020). These tools muster useful information for use in planning, controlling and operation of businesses, this is in line with the observation made by Beckman and Rosenfield (2008) that automation also provides an organization with the ability to collect data about the performance of its process and to analyze the variables that contribute to achievement of performance objectives.

The employee clearance process has many touch points that entail going to and from various departments, making it a very mechanical experience, thankfully we face a new wave of automation whose main effect is machines replacing humans in routinized tasks (Bernazzani et al., 2018). The main drivers being saving time and money, round the clock availability, delightful clients and ruling out human error. Haar (2018) shows that a greater awareness of new technologies is positively related to turnover intentions. The advent of the COVID-19 pandemic gave further impetus to automation by ensuring that it becomes a greater part of our work, the paramount motivating factors being health and safety concerns.

Rapid developments within the computing industry and the large reduction of computerization costs have resulted in an exponential growth towards dependency on computing technologies, for an array of services (Yuchi, 2020; Knudsen & Panchal, 1998). Artificial intelligence (AI) is one such technology that has been applied to serve a plethora of relevant use cases, in its various forms. For instance, The *HR-One*, which is an intelligent enterprise-ready Human Capital Management (HCM) suite that has been put to use by some organizations, with its main task being auto assigning responsibilities to users based on their role(s) (Kumar, n.d.).

Notable applications are the HR bots, like *Leena AI*, which develops a human resource management platform that transforms employee experience with conversational AI. Its platform operates as an AI-powered HR assistant providing instant responses to employee queries over chat and voice, enabling organizations to get access to a platform, which resolves HR services queries fast and improves the employee experience (Leena AI, 2015). The *Leena AI* employee exit formality entails; taking the employee through the pre-decided and unidirectional process of exiting the organization in a step-by-step fashion. This bot resolves the issue of movements to different departments to fill forms, by collating all of them in one place. Additionally, the flow of the process and conversation can be designed to trigger the next step only when the previous one is complete (Employee Experience Platform for Enterprises, n.d.). What sets Leena chatbot apart is that it is all about saving HR from routine questions by responding to parallel employee queries, such as leave application, payroll management and making the ticketing process more transparent. In essence, Leena assistant is like Siri for employees, used to automatically answer employee HR questions. In addition, it does not have a 'hands on' grip on the employee exit clearance process, where the clearance forms can be digitally signed, and has no mention of the use of deep learning.

The focus of this research was to understand the employee exit clearance process, appreciate the deep learning models for building chatbots, and leverage them to construct an intelligent chatbot for an automated exit auto-clearance process, thereby opening up useful avenues of value creation inside organizations.

1.2 Problem Statement

Employee attrition is one of the most glaring challenges facing organizations today (Embuhira, 2011; HR Affiliates, 2019), this requires strategies that ensure the exit process is efficient, smooth and error-free. This time-consuming process, mostly involves very labor-intensive tasks by HR departments dedicated towards processing paperwork, followed by approvals and clearances from all the relevant departments and key players. Part of the exit process is the exit interview, usually between the off-boarding employee and a HR member. This process not only slows down the organization, but also prevents it from being as efficient and productive, and puts it at a competitive disadvantage. Automation makes things faster, not necessarily better. Existing automated solutions are still predominantly people reliant in the sense that users are required to use systems to perform the tasks that would have otherwise been done by humans. In addition, there is a learning curve associated with the use of these solutions. Employing a chatbot with Artificial Intelligence in the internal processes' automation will bring value to both the organization and its employees. This is because it can learn on the job, it is great at mundane and repetitive tasks, and thereby allowing professionals time to handle more complex and strategic tasks, and will generally help deliver more personalized experiences.

1.3 Objectives

1.3.1 General Objective

The aim of this study was to develop an intelligent chatbot implementation for employee auto clearance using Deep Learning.

1.3.2 Specific Objectives

i. To investigate the challenges in employee clearance.

ii. To examine the existing systems used for employee clearance.

iii. To develop an intelligent chatbot implementation for employee auto clearance using Deep Learning.

iv. To test the proposed solution.

1.4 Research Questions

i. How is employee clearance conducted: and what are the challenges?

ii. How effective are the existing systems used for employee clearance?

iii. How can an intelligent chatbot implementation for employee auto clearance using Deep Learning be developed?

iv. How can the proposed solution be tested?

1.5 Justification

The relevance of the outcome of this study is providing a solution that is better attuned to the evolving nature of the organization, as technology allows us to continually reinvent ourselves, in organizations, part of this reinvention translates to new approaches towards ensuring efficiency and productivity. Since AI is an invaluable application to businesses process automation, a chatbot based upon this technology can evolve with the organization through Deep Learning. The chatbot will learn everything related to the employee clearance process, from the organization data and even human-to-human dialogue, as it takes better charge of the process, thereby yielding a seventh heaven on the employee service team.

The parties involved in the employee clearance process from the HR to ICT and accounts departments can enjoy faster and smoother service delivery. The other gain is elimination of inconsistencies, avoidance of redundancies, and around the clock availability – subject to organizational preferences.

Many organizations have policy statements that guide the employee clearance procedure(s) (The University of Dayton, 2020), the policy's implications from the findings and contribution of this research will result to further or advanced policies, which will help organizations better address the discourse around providing employees with a positive exit experience.

As the chatbot culls information about the clearance process from existing entries, part of the process is maintaining the approval process. This project seeks to integrate the chatbot with a digital signature mechanism, in areas that need approval. Deep Learning chatbots are the easiest way of making software native to humans because they provide an experience of talking to another person (Lewkowitz, 2014). In addition, they ensure minimal or no human interference in the process. Guenole and Feinzig (n.d.) acknowledge that leading organizations understand the impact of AI on business models, workforce demographics, and the changing experiences expected by customers and employees alike.

1.6 Scope and limitation

The scope of this study covers the employee clearance process during their exit in an organization and does not address other areas of employee management. This study is limited to formal organization within Nairobi County, Kenya.

Chapter 2: Literature Review

2.1 Introduction

The processes by which members prepare to exit organizations have received little attention in socialization research (Davis & Myers, 2012). In fact, Klatzke (2008) confirms that indeed little is known about how people communicate during the exit process. Yet, it has an enormous impact on both leavers and those who remain in the organization, and is one of the fundamental organizational transitions that people make throughout their work lives. Moreland and Levine (1982) define socialization as the reciprocal process of individuals and organizations attempting to meet eithers' needs. This discussion uses the term socialization to refer to the overall process of exiting organizations, which generally constitutes meeting part of the needs of the involved parties. In this section we look at the concepts and existing solutions in employee exit clearance that undergirded the plan to carry out this research and establish its relevance. The bot in question here is a software program, the business process is the employee exit clearance, and automation means the mechanical execution of this process by the software program or bot.

2.2 Empirical Framework

Sitienei (2020) observed that a bot is a scalable, versatile and non-invasive tool that can revolutionize various industry domains and functions such as HR, where it can be used in processes such as recruitment, on-boarding and off-boarding (employee exit). This systematic exit process needs to be handled in a manner that ensures consistency and reduces risk to the organization. However, Jankowski (2017) noted that a large number of organizations handle employee off-boarding, through loose, and manual processes like emails, phone calls, and private conversations. This segment explores some of the ways that the socialization process has been and is being implemented in various organizations.

2.2.1 Criteria for and Challenges in Employee Clearance

In organizations, the operational policy framework includes a guide on employee exit procedure and actions the respective departments should take (Department of Education, 2020; Murray State University, 2019; Delta State University, 2017). These actions include notifying the HR, Payroll and other relevant departments immediately upon ascertaining that an employee is terminating his/her employment (either voluntary or involuntary). Formal organizations have a well-structured socialization approach (exit formalities) that provides employees and their departments with overarching criteria that has to be satisfied in relation to

exiting (Klatzke, 2008; Osborne & Hammoud, 2017; Russell & Holton III, 1999), part of it entails:

i. Return of all organization property.

ii. Verification by department head(s) that all departmental business is cleared by the last working day.

iii. Mandatory completion of the relevant exit processing form(s).

This process should take place over the length of the employee's notice period (CPNI, 2019), and signatures or clearance approvals are required from a designated individual for each area of responsibility in the clearance procedure, indicating completion.

2.2.1.1 Challenges in Employee Clearance

The way an employee perceives how he or she is treated during the termination process can impact your business (Jacobs, 2018). There are a number of key good practice points that employers follow during the socialization process, but Lilly (2019) opines that employee departures can potentially have a long lasting and negative ripple effect within an organization, and thus it is essential to put structure into place to ensure a smooth transition and even capitalize on the opportunity to review workflow and help the company function better. This being the final interaction between an employee and the organization, handling this process with grace and sensitivity will ensure the employee feels valued. Some of the identified problems associated with this process are:

i. *Communication* – The exiting employee has to communicate about the resignation to the HR Department, which then communicates the same with the employee's team and necessary departments, alongside employee's exit date, thereby setting the ground for a smooth transfer of work (Azmi, 2021). Delays in this process will eventually lead to an inefficient process, and probably hostility toward the organization.

ii. *Timing* - Timing is critical, all checklist items should be cleared as per their order. iii. *IT permissions and access* - A terminated employee getting access to organization systems can be a huge liability risk (Leitner, 2016). In fact, researchers at identity management firm *OneLogin* polled 500 IT decision makers to learn about how they provision and de-provision, or terminate, staff login information in-house, and it was found that 50% of ex-employees can still access corporate apps (Sheridan, 2017;

Leitner, 2016). It is therefore essential and critical that access is revoked at the right time.

iv. *Exit Interviews* – A disgruntled employee, who, say is in a rush to travel abroad for a new job, and is not getting the right assistance with the exit process, may give a dull feedback that may not point out the areas of improvement to produce better results.

2.2.2 Methods, Techniques, Approaches and Systems used for Employee Clearance

2.2.2.1 Manual Employee Clearance Processes

The process of smoothly managing the exit of the employee involves multiple departments and key players. Clearance forms are used to control this process and the HR is in charge of all the paperwork regarding the termination of the contract (The University of Scranton, 2018). Ardo (2021) notes that manual clearance processes are done by moving from one office to another and having records on paper, this creates an unreliable system that is confusing to keep the correct track of the records, and can be very overwhelming and stressful to say the least. In addition, Lim (2015) points out that part of the obvious disadvantages with the manual process is the fact that the excessiveness of the paperwork makes it very labor intensive and cumbersome.

2.2.2.2 Use of Technology in Employee Clearance

Technological innovations are changing the industrial landscape. As technology transforms the world, the HR function needs to focus on embracing automation and other technologies that promise efficiency, service effectiveness and cost savings (Balasundaram & Venkatagiri, 2020). The period from which an individual announces exit to when he/she exits the organization can happen in a manner of minutes to months (Wrench & Punyanunt-Carter, 2013). Investing in technology, the facilitator of business process automation, will not only deliver value faster but will also ensure a systematic process (Owuor 2003). Below are automated exit management tools that help in the socialization process:

i. *Empxtrack exit management tool*, which helps the company prepare 'department-wise' exit checklists systematically.

ii. *Automated exit management system* also known as 'Offboarding,' which gives organizations a reliable, centralized platform that is used to process and store all resignation-related information, including reasons for resignation, dates of employment, issued ID cards and other equipment, and also work-related data related to the resigning employee.

iii. *Digital HRMS* is a customized HR software platform that offers dedicated modules for every HR function, including leave and attendance management.

iv. *WorkflowGen* - An innovative digital process automation solution used to design and deploy business-critical, process-driven web and mobile applications, its exclusive productivity features include quick mass approval to handle dozens of requests in seconds.

v. *BambooHR®* - A tool that allows users to plan and execute compliant exit process the right way every time, with checklists to ensure compliance and automation to help them concentrate on the person and not the transaction.

vi. *HR-One* - An intelligent enterprise-ready Human Capital Management (HCM) suite that automates HR processes simplifies human interactions and delivers actionable insights to build better workplaces. It is primarily tasked with auto assigning responsibilities to users based on their role(s).

2.2.2.3 Artificial Intelligence Chatbots in Employee Clearance

People are no longer afraid of bots since they have experienced how AI and Deep Learning can improve the way they work in a very pragmatic way (Oracle & Future Workplace, 2019). AI and automation leverages training models to identify changes and patterns across heaps of data and identify information that is essential to the socialization process. Some organizations have invested in AI-driven chatbots due to their promise of efficiency, service effectiveness and cost savings. The comparative analysis of these chatbots is shown in Table 2.1, they are:

i. *Christina* - A human resources chatbot built by DRUID, a company specialized in developing AI-powered chatbots for enterprise companies, is an AI-driven virtual assistant that automates HR tasks. These tasks are; recruitment, on-boarding, induction trainings, generating contracts, updating data, etc. (Druidai, n.d.).

ii. *Mila* - An internal chatbot developed by the HR folks at *Overstock* to improve user experience for employers and is made available through a dedicated hotline. After the employee calls in sick, s/he gets a sympathetic message, like "*I am very sorry, I hope you get better soon*" and then asks a few questions to deal with the required paperwork related to employer's absence (Mlab.Ai, n.d.).

iii. *Zia* - Zoho's AI assistant, is a useful tool that helps employees with everyday HR situations like clocking in and out for the day, applying for time off, and getting

reliable answers to HR questions. It uses machine learning to empower your employees to find answers to their HR problems or complete HR tasks on time. Employees can apply for leave by giving Zia the requested days, reason, and type of leave. With this info, Zia will complete the entire leave application process on their behalf. The other task is generating pending task lists (Zoho, n.d.).

iv. *Leena AI* – A human resource management platform that transforms employee experience with conversational AI. It is equipped with NLP and machine learning and its platform operates as an AI-powered HR assistant providing instant responses to employee queries over chat and voice, enabling organizations to get access to a platform that resolves HR services queries fast and improves the employee experience (Ray, 2021).

Table 2.1 Comparative analysis of the AI chatbots.

Bot	**Primary support**	**Roles/Tasks**	**Serves in employee exit clearance?**	**Contains a digital signature feature?**
Christina	HR	• *Recruitment* • *On-boarding* • *FAQs and policies* • *Induction trainings* • *Compensation and benefits* • *HR Admin tasks*	Not mentioned/ demonstrated	Yes
Mila	HR	• *Automate the process when an employee calls in sick* • *Schedule holidays* • *Know about payment* • *Asks questions about benefits* • *Update the work schedule*	Not mentioned/ demonstrated	Not showcased

Zia	HR/ CRM	• *Detects anomalies* • *Suggests workflows and macros* • *Advises salespeople the best time to contact a prospect.* • *Clocking in and out for the day* • *Applying for time off.* • *Getting reliable answers to HR questions.*	Not mentioned/ demonstrated	Not showcased
Leena AI	HR	• *Employee case management* • *Helps discover trends with sentiment analysis.* • *Helps predict attrition* • *Leverages AI-driven analysis of employee feedback.*	Not mentioned/ demonstrated	Not showcased

2.2.3 Deep Learning and Natural Language Processing (NLP)

This sub-section goes beneath the Artificial Intelligence (AI) umbrella for a closer investigation of two subfields i.e. Deep Learning and Natural Language Processing (NLP). The keen interest is to understand what they are and how they can be applied, and their similarities and differences.

2.2.3.1 Deep Learning and Artificial Neural Networks (ANN)

Malik (2005) stated that an Artificial Neural Network is a functional imitation of a simplified model of the biological neurons and their goal is to construct useful computers for real world problems. Deep Learning, a subset of Machine Learning, simulates how the human brain works by leveraging its composition of multiple hidden layers of Artificial Neural Networks (Vargas et al., 2017). Simply put, Deep Learning imitates the way humans gain certain types of knowledge (Brush & Burns, 2021), its algorithms attempt to draw similar conclusions as humans would by continually analyzing data with a given logical structure (Oppermann, 2019). Figure 2.1 shows how Deep Learning uses Neural Networks to learn and identify patterns from input *x* and classify to obtain a prediction vector *y.*

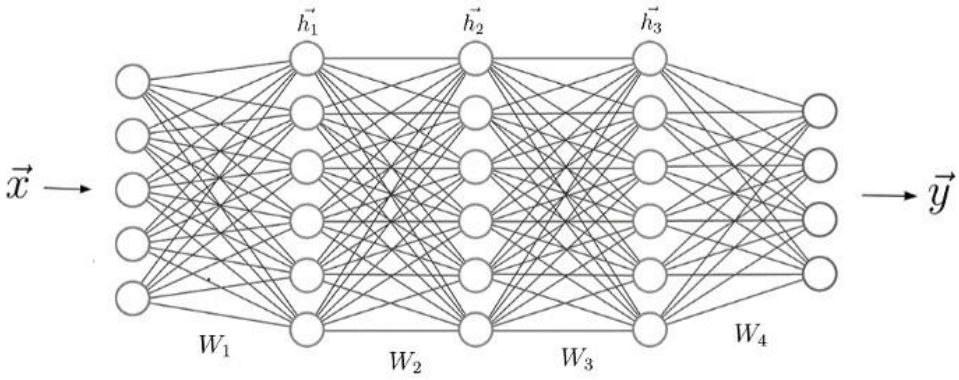

Figure 2.1 A Neural Network (Oppermann, 2019)

Oppermann (2019) and Cerpa and Walczak (2003) explain it this way; a connection between any two neurons is represented by a numerical value, called *weight (W_i).* These weights have *indices*, which carry a meaning, for instance; the first value of the indices represents the number of neurons in the layer from which the connection originates. On the other hand, the second value represents the number of the neurons in the layer to which the connection leads. In between the input and output layers are multiple hidden layers *(h).* Figure 2.2 below shows a simplified layered connection that demonstrates the weight representation between each connection.

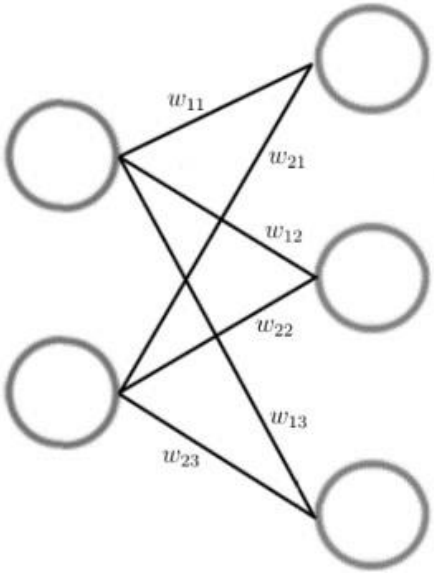

Figure 2.2 A two layered Neural Network (Oppermann, 2019)

A weight matrix represents all the weights between two neural network layers, and it has the same number of entries as there are connections between neurons (Oppermann, 2019; Echelpoel et al., 2015). These weights are the details utilized by the Artificial Neural Networks to solve a specific problem (Javatpoint, n.d.), and they are the most important factor

in converting an input to impact the output since they determine how strongly each of the neurons affects the other (Venkateswaran, 2017). Venkateswaran (2017) simplifies it this way; in a given neuron, for the inputs x1, x2, and x3, an activation function is applied to define how the weighted sum of the inputs, i.e. w1, w2, and w3, is transformed into an output i.e. the output y, which becomes the input of another node in a subsequent layer. This procedure is repeated for all the nodes to generate the final output, and when all the input features are zero (0), a bias input (not included in the image) is used to help train the model (Dertat, 2018). See Figure 2.3.

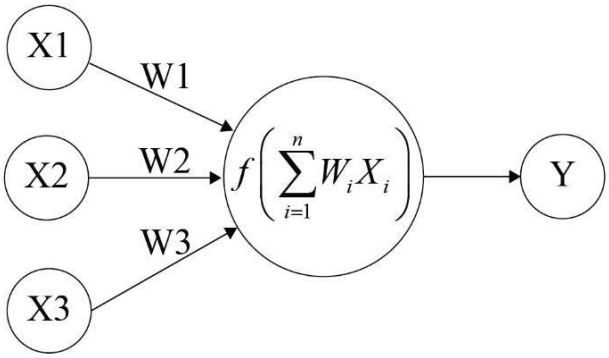

Figure 2.3 Application of the activation function (Venkateswaran, 2017)

Dertat (2018) stated that Artificial Neural Networks is a flexible and powerful Deep Learning technique that can model any complex function, otherwise stated, Deep Learning is a state-of-the-art Artificial Neural Network (Williams, 2018). Some among the number of advantages offered by this Neural Network layered architecture as mentioned by Tu (1996) include: requiring less formal statistical training, ability to implicitly detect complex nonlinear relationships between dependent and independent variables, ability to detect all possible interactions between predictor variables, and the availability of multiple training algorithms (Tu, 1996). Figure 2.6 showcases these benefits on the performance of Deep Learning compared to older learning algorithms, with increase in data.

2.2.3.2 Natural Language Processing (NLP)

A component of AI, Natural Language Processing (NLP) is the ability of a computer program to understand human language as it is spoken and written (Lutkevich & Burns, 2021). This is done by detecting patterns in data, with the help of accumulated semantic knowledge and linguistics models, to comprehend user inputs. As a result of the semantic knowledge, the responses from NLP are meaningful phrases and sentences in the form of natural language,

this is implicit of semantic meaning. Two components make up the NLP and they are; Natural Language Understanding (NLU), which takes the data input and maps it into natural language (Ghosh, 2018; Lutkevich & Burns, 2021), and Natural Language Generation (NLG), which acts as a translator that converts the computerized data into natural language representation through information extraction and retrieval and sentiment analysis, among other approaches (Javatpoint, n.d; Ghosh, 2018). Figure 2.4 illustrates the NLP model in action.

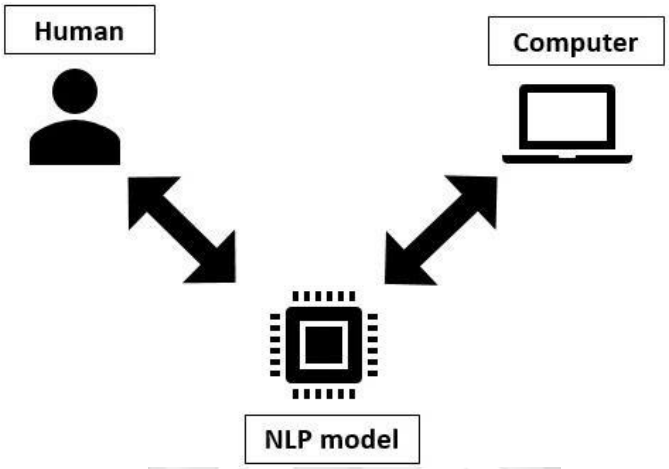

Figure 2.4 Natural Language Processing (Bokka et al., 2019)

To understand the 'context' of human communication, Ghosh (2018) expressed that the training algorithm studies vast amounts of examples of text, words, sentences, and paragraphs written by humans. This is the work of the NLU component which uses syntactic and semantic analysis to determine the meaning of text or speech (Wigmore, 2021), this is done even when there are mispronunciations or transposed letters and words. The other half of having dialog with a computer using natural language involves the NLG component, which allows computers to generate natural language (humanlike text) automatically, in a way that mimics a human writer. NLP has far-reaching application areas, among them include: Siri and Alexa which are smart assistants that use Artificial Intelligence; the predictive text, autocorrect and autocomplete are another application on smartphone devices, the Gmail's email classification (in the categories: primary, social or promotions) is also an application of NLP (Banerjee, 2020), the other application is in the chatbot implementation.

2.2.3.3 Deep Learning vs Natural Language Processing (NLP) in Chatbot Creation

Natural language processing (NLP) and Deep Learning are both AI models that are not far apart, however, NLP has a strong linguistics component (Sigmoidal, 2020). This close reltionship has in fact been demonstrated by various researchers and scholars. Ponteves et al. (2021), Sigmoidal (2020) and Banerjee (2020) illustrate this relationship in Figure 2.5.

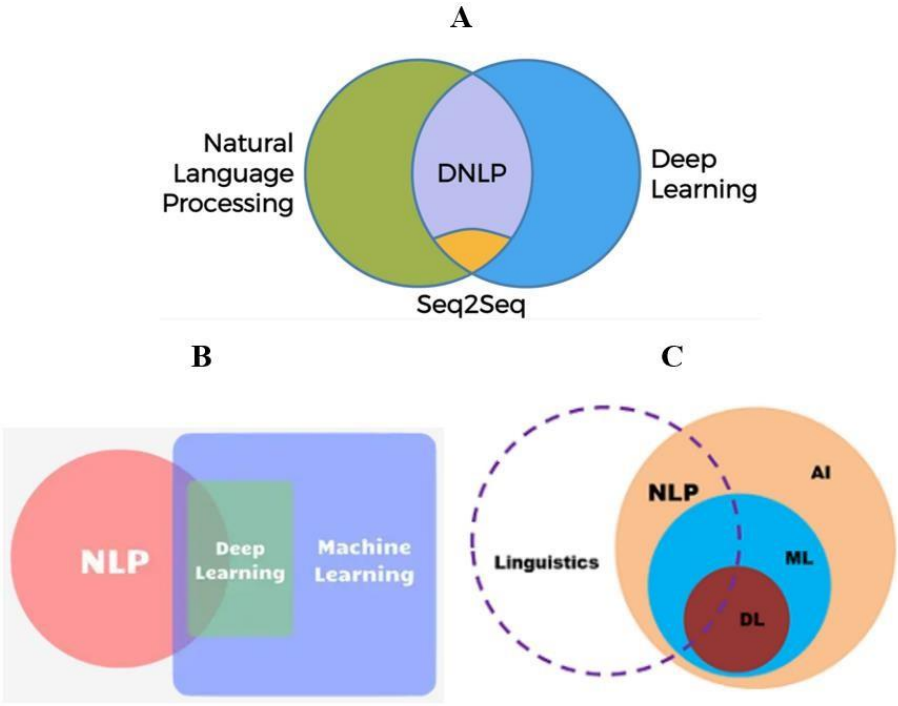

Figure 2.5 Venn diagrams for the relationship between NLP and Deep Learning (Ponteves et al., 2021; Sigmoidal, 2020; Banerjee, 2020)

In the image *'A,'* in Figure 2.5 by Ponteves et al. (2021), the non-overlapping part on the left is purely NLP and on the right side is Deep Learning which includes ANN, these two parts are mutually exclusive. In the overlapping section there is the Deep Natural Language Processing (DNLP) model, which takes advantage of both Deep Learning and NLP. The DNLP model includes one of the most powerful and cutting-edge models, the sequence to sequence (Seq2Seq) model. Sigmoidal (2020) upholds this view in the image *'B'*, which graphically shows this relationship, and Deep Learning is one of the techniques in the area of Machine Learning. Banerjee (2020) adds the computational linguistics component of NLP that enables computers and humans to communicate seamlessly in image *'C.'*

One of the most significant modern implementations of software robotics is with chatbots (Mandelbaum, 2021), these AI-based software instances can be implemented by both models reviewed above. Neural networks have been found to perform better than other methods in constructing a complex semantic model that can abstract themes out of expressions, and discern generality and typical behavior (Pashaei et al., 2020; Futia et al., 2020; Roy, 2017). This project chooses the Deep Learning model to build the employee clearance chatbot, in essence, it seeks to employ Deep Neural Networks for an understanding of natural language

by the machine. Table 2.2 is a comparative description of an NLP-driven chatbot against a Deep Learning chatbot.

Table 2.2 Comparative description of Deep Learning and Natural Language Processing

	Deep Learning	**NLP**
Text feature extraction	Deep Learning models such as Convolution Neural Network and Recurrent Neural Network are used for text feature extraction (Liang et al., 2017), and it has produced extremely promising results for various tasks in natural language understanding (Collobert et al., 2011).	Deep Learning technology is applied in common NLP tasks, such as information retrieval, information extraction, including named entity recognition, text generation, and semantic parsing (Liang et al., 2017; Wang et al., 2020)
Comprehension of natural language	Uses deep neural networks for natural language understanding and its algorithms are also used in fields such as image recognition and speech processing.	Combines AI and computational linguistics to enable computers and humans communicate seamlessly
Learning from experience	Uses data from past conversations to allow the bot to understand language and context and to 'reason' and 'learn' as a human would, and hence it can solve almost any problem that requires 'thought' to figure out	A rule-based reasoning system that focuses on understanding user inputs by detecting patterns in data through linguistics models and accumulated lexical, and semantic knowledge.

Following the increase in data creation, Deep Learning capabilities have grown in recent years (Ye, 2021; Mihajlovic, 2019). As Brush and Burns (2021) point out, one of the wellsprings of this is because most of the data humans and machines create is unstructured and is not labeled, and Deep Learning attempts to make a better analysis and can learn massive amounts of unlabeled data (Brush & Burns, 2021). Another factor for pedestalization of Deep Learning as mentioned by Alafif et al. (2021) is that even in exceptional cases where

large-scale data is not needed to train, Deep Learning offers transfer learning and generative models for training the algorithm. Further to this is the fact that in real-world applications, it is often expensive and time-consuming to obtain labeled examples, hence the need for knowledge transfer from related domains (Belhaj et al., 2018). As evidence shows, the two models i.e. Deep Learning and Natural Language Processing have a considerable relationship. In as much as this project opts for the Deep Learning model, where need be and where necessity was found to use some part of the Natural Language Processing model for the chatbot creation, this project sought to draw the maximum advantage by leveraging a combination of the two.

2.2.4 The Gap in Employee Clearance Process

As the study points out, the employee clearance process is an area of little to very little focus in many organizations. The HR digital assistant chatbots reviewed lack a well laid out employee clearance process mapping and the actual automated implementation, this creates a research gap. Further research is needed on the chatbot that solely focuses on employee auto clearance, with the use of digital signatures where approvals are required.

2.3 Theoretical Framework

Osborne and Hammoud, (2017) opined that, successful programs that focus on employees who are leaving can have dramatic impact on organizational growth and performance. They added; the use of advanced technologies, skilled labor, best practices, and education has helped increase the efficiencies in many major organizations and firms. However, Balasundaram and Venkatagiri, (2020) observed that process automation offers the hope that ensuring consistency in people processes and driving value through talent can be achieved with use of technologies that include intelligent process automation, i.e., artificial intelligence and other related new technologies, something that for reasons difficult to fathom has eluded HR (Balasundaram & Venkatagiri, 2020). This theoretical framework explores the employee exit clearance process, AI, and Deep Learning and its application in chatbots.

2.3.1 Employee Exit Clearance

Employees are critical stakeholders in an organization, post hiring, the organization commits to providing them with facilities that enable smooth running of their operations (Marbaniang et al., 2016). There are two types of organizational exit: voluntary exit where employees leave on their own volition (Bluedorn, 1978) and involuntary exit which can occur for a

number of reasons (Nicholson & West, 1988). Part of this exit process includes the responsibility of the employees to return all organization property, the ascertainment of this activity forms the employee exit clearance process.

Involuntary exit followed by an unstructured exit clearance process may present legal challenges to the organization, this is due to the lack of a clear audit trail of key events. One such challenge is unfair dismissal claims. The other challenge is that disgruntled former employees could become a very big source of data security breach, if their system access rights are not revoked on time. Voluntary exit also does not fall short of challenges, there is a common expression that when employees join, they join organizations but when they leave they leave managers. This implies that when an employee tenders a resignation notice, how the manager responds is dependent on their relationship with the employee. This response can have a huge impact on the employee exit experience, for instance, a needy boss may ignore personal boundaries and even interfere with the exit clearance process. Socialization is a critical part of the employee's work life, done well, this process will provide management with information that assists in developing or modifying programs to enhance organizational performance (Phillips, 2005).

2.3.2 Artificial Intelligence Concepts

AI conventionally provides a broad class of technologies that allow a computer to perform tasks that normally require human cognition (Valery et al., 2018). Owuor (2003) observed that the mere automation of ineffective processes cannot eliminate their fundamental performance deficiencies. As such, it is more important to use a smart technology that allows computers to learn from and make or recommend actions based on previously collected data, a differentiating factor of an AI system from a standard software system (Hermes, 2020).

In terms of human resources management, AI can be applied in many different ways to streamline processes and improve efficiency (O'Connor, 2021). A survey done by Oracle and Future Workplace revealed that the use of AI in the workplace can present opportunities for mastering new skills and gaining more free time, allowing HR professionals to expand their current roles in order to be more strategic within their organization (Oracle & Future Workplace, 2019). The discussion here is narrower, centering on a sub-class of algorithms within AI that is Deep Learning and chatbots, principally on the socialization process.

2.3.3 Chatbots and Deep Learning

Chatbots or bots, being conversational AI or digital assistants, interact with users via voice or text channel. The use of these bots in process automation is a technical emulation of a human worker with the objective of efficiently and cost-effectively carrying out structured tasks (Slaby & Fersht, 2012). The motivation for deploying chatbot virtual agents in the exit clearance process automation, and client support, is profound. They offer immediate feedback to user requests and ensures that the entire exit clearance process is duly followed, which guarantees efficiency, and they also yield plenty of room for creativity. The use of AI powered chatbots can help unveil crucial employee behavior during the exit clearance process by analyzing the most frequent pattern of inquiries or requests. Though customization, these intelligent chatbots can be given a personality or be personalized, subject to organizational requirements. The principal aim of personalizing a chatbot is to endow it with a consistent persona to behave like an actual human being. This can be achieved through: training the chatbot with domain specific knowledge of the responsibilities it is supposed to undertake, or via sentiment analysis, which equips a chatbot with the ability to understand emotions and the state of mind of the users by analyzing their input text. Deep Learning empowers these chatbots with the power to learn and master any new procedures and processes.

Deep Learning finds patterns from the training data and uses them to process new data, it has become increasingly common in some data-rich contexts and has brought us closer to true AI (Yakubovich et al., 2019). Natural Language Processing (NLP) is the foundation of AI-based chatbots. By using sophisticated algorithms of NLP, chatbots can process the input text: understand, conclude, and determine what was said or written and then state a list of all suitable actions (Barker, 2021; Ayanouz et al., 2020). However, the crucial part of building any chatbot is modeling of the conversation. In addition, Vamsi et al. (2020) observed that despite many developments in NLP and AI, creating a good chatbot model remains a significant challenge in this field even today. There are many Deep Learning frameworks e.g., Keras, Apache Spark, PyTorch, Sonnet, and more (Xu, 2020).

One of the key benefits of Deep Learning as outlined by Bengio (2012) is that the algorithms seek to exploit the unknown structure in the input distribution in order to discover good representations. In another article, Bengio (2009) pointed out that Deep Learning methods aim at learning feature hierarchies with features from higher levels of the hierarchy formed by the composition of lower-level features. Automatically learning features at multiple levels

of abstraction allows a system to learn complex functions, mapping the input to the output directly from data, without depending completely on human-crafted features. Section *2.2.3* gives a comprehensive elaboration of Deep Learning and NLP. Figure 2.6 illustrates the comparison between Deep Learning and other learning algorithms in terms of performance.

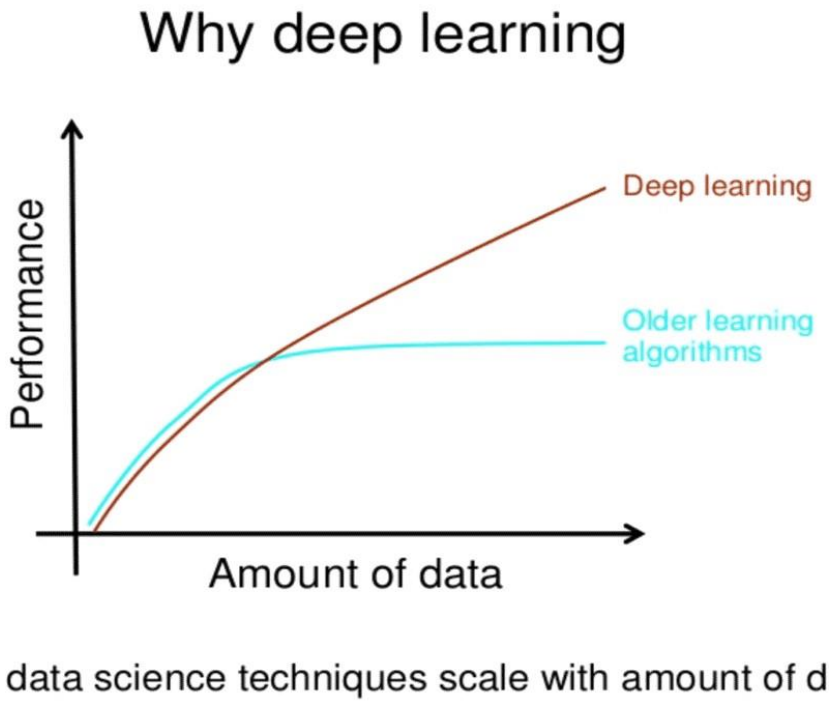

Figure 2.6 Deep Learning Neural Network models increase in performance with more data, without reaching a plateau (Brownlee, 2020)

2.3.3.1 Development of an Ontology and Chatbot Creation

Ontology refers to explicit formal specifications of the terms in the domain and relations among them, or in this case, preparation and refinement of data points for the Deep Learning chatbot (Barker, 2021; McGuinness & Noy, 2000; Gruber 1993; Hahn & Dahlem, 2009). The next step is selection of the type of chatbot to be created. The two main types of Deep Learning chatbots are; *Generative based models* (where the chatbot does not use any sort of predefined repository and are helpful when the queries are complex) and *Retrieval based models* (where the chatbot has a repository of responses that it uses to solve simple queries) (Barker, 2021; Hajela et al., 2020).

Part of the necessary components are pre-trained vectors or code generated word vectors, these are mathematical representations of the meaning of a word, and are used to model the representational content that helps teach the computer the meaning of words (Alizadeh, 2021; Cui et al., 2016). Put differently, the chatbot makes use of these vectors to recognize

the semantics of a word rather than just the word itself. This gives it the ability to analyze relationships across words, sentences, and documents, and enables things like speech recognition and machine translation (Yin, 2021). Programming tools like TensorFlow and Python can be used to create and train a Deep Learning chatbot. A Deep Learning chatbot consists of different architectures and building blocks, these help foster its accessibility and efficiency in Deep Learning, as it starts from raw data then end with predictions in the '*wild*' (Ruban, 2020; Bhagwat, 2018). See Figure 2.7.

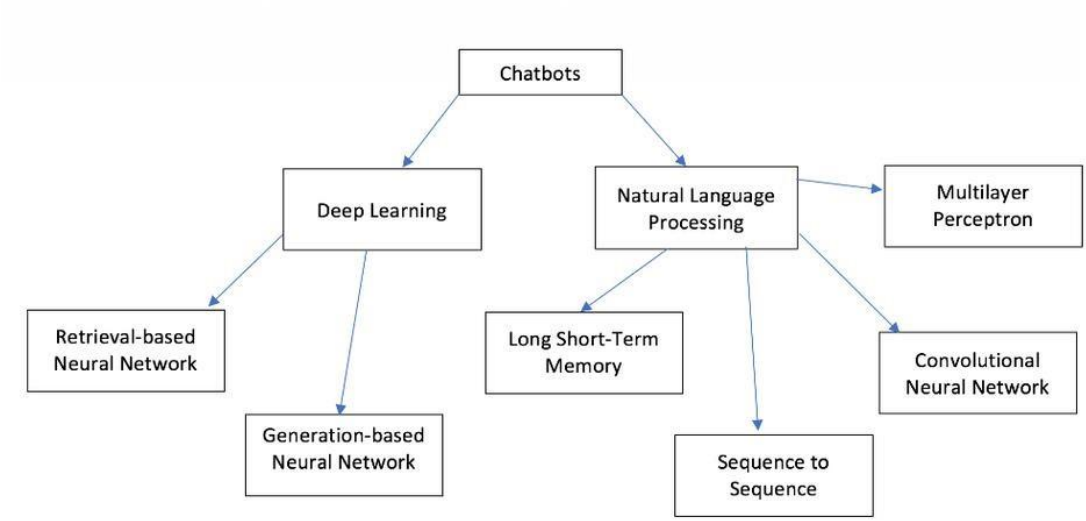

Figure 2.7 : Conceptual map of a chatbot using Deep Learning(Bhagwat, 2018)

2.3.3.2 How Chatbots Work

In the past, hand-written instructions and patterns or statistical methods and rules were used for the constructions of chatbot architectures (Hajela et al., 2020). Ayanouz et al. (2020) acknowledge that the development of Deep Learning and deep neural network models have helped a lot in building self-learning chatbots, these models help the chatbot to understand the user input or intents and provide a meaningful response. Chatbots require huge amount of data to give accurate results, and the more users interact with the bot, the better the precision they get (Ayanouz et al., 2020). Those that interact with users through voice require a speech recognition engine to transform the voice into text. There can also be structured or unstructured conversations, with the downside of the former being highly scripted conversations that limit the possible questions a user can ask.

2.3.3.3 Digital Signatures

Cybrsecurity & Infrastructure Security Agency - CISA (2020) defines a digital signature as type of electronic signature, i.e., a mathematical algorithm routinely used to validate the

authenticity and integrity of a message (e.g., an email, a credit card transaction, or a digital document). It is analogous to a handwritten/paper signature or a stamped seal (ClickSSL, 2021; Entrust, 2021). It offers far more inherent security than paper signatures and is by far the most easily verified and the most reliable with respect to providing document integrity (Entrust, 2021). There are different types of digital signatures as outlined by ClickSSL (2021) as follows:

i. *Approval Signatures* - A kind of signature that is used in the organization's workflow and helps to enhance the organization's approval process. ii. *Visible Signatures* - They show on a document similar to a physical document, and they allow a single or multiple users to sign a document.
ii. *Invisible Signatures* – Used when someone wishes not to display their signature, however, an indication of authenticity and integrity has to be provided.

Chatbots have been able to gain electronic signature capabilities, for example; DRUID (2020), a company specialized in developing AI-powered chatbots for enterprise companies has electronic signature capabilities in all DRUID chatbots. For instance, Christina, a HR chatbot, has been configured with approval flows for managers, and all internal documents such as leave requests, time sheets, expense requests, certificate, employment contracts, can be signed electronically with Christina's help. The manager's chatbot assistant, allows signing client and supplier contracts, operational budgets, employment contracts, in just a couple of minutes, by simply going through the electronic signature process (Druid Enterprise Chatbots, 2020).

Similarly, CommBox AI-Powered chatbot can send and receive digital signed forms using the same channel, for a seamless non-interrupted customer experience (CommBox, 2020). It works as follows:

i. Upload a PDF file and define the fields that needs to be filled in (both required and optional fields). See Figure 2.8.
ii. The bot will identify and will automatically fill in the required fields in the form, using the customer answers generated from the interactions. As shown in Figure 2.9.
iii. Finally, the complete digitally signed PDF file will be sent to the relevant customers and agents. Figure 2.10 portrays how the signed file is submitted.

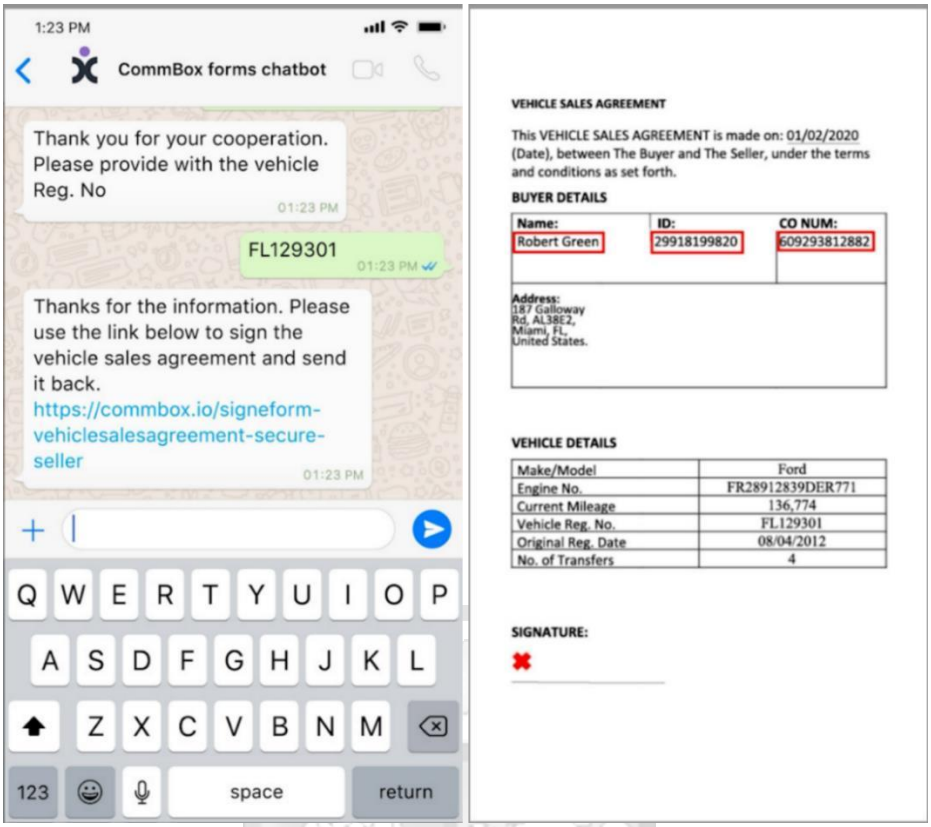

Figure 2.8 Access file - CommBox chatbot electronic signature capabilities(CommBox, 2020)

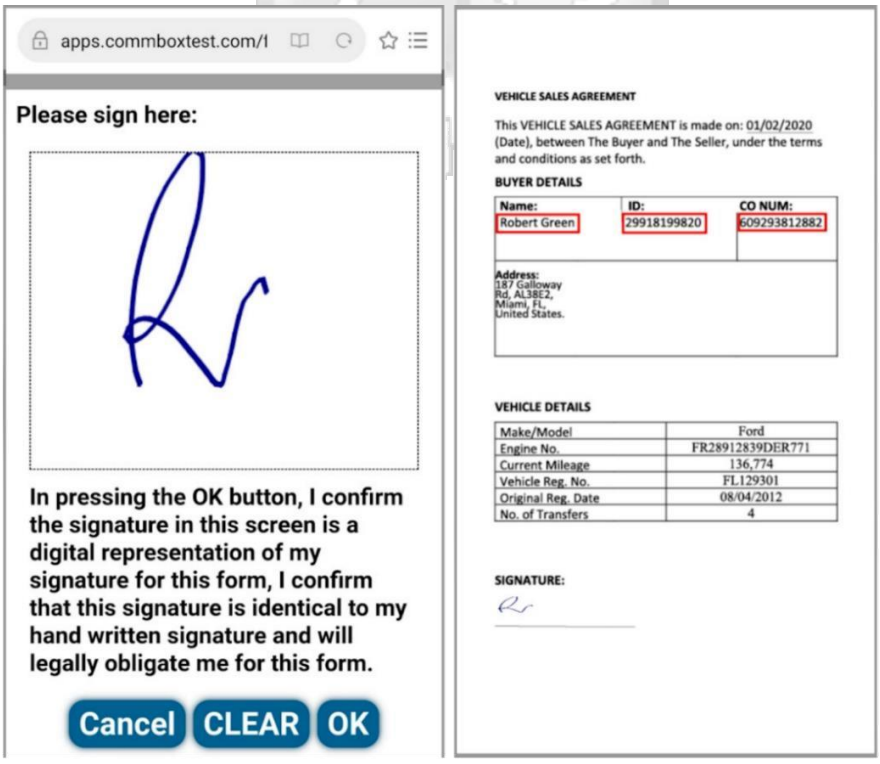

Figure 2.9 : Sign file - CommBox chatbot electronic signature capabilities(CommBox, 2020)

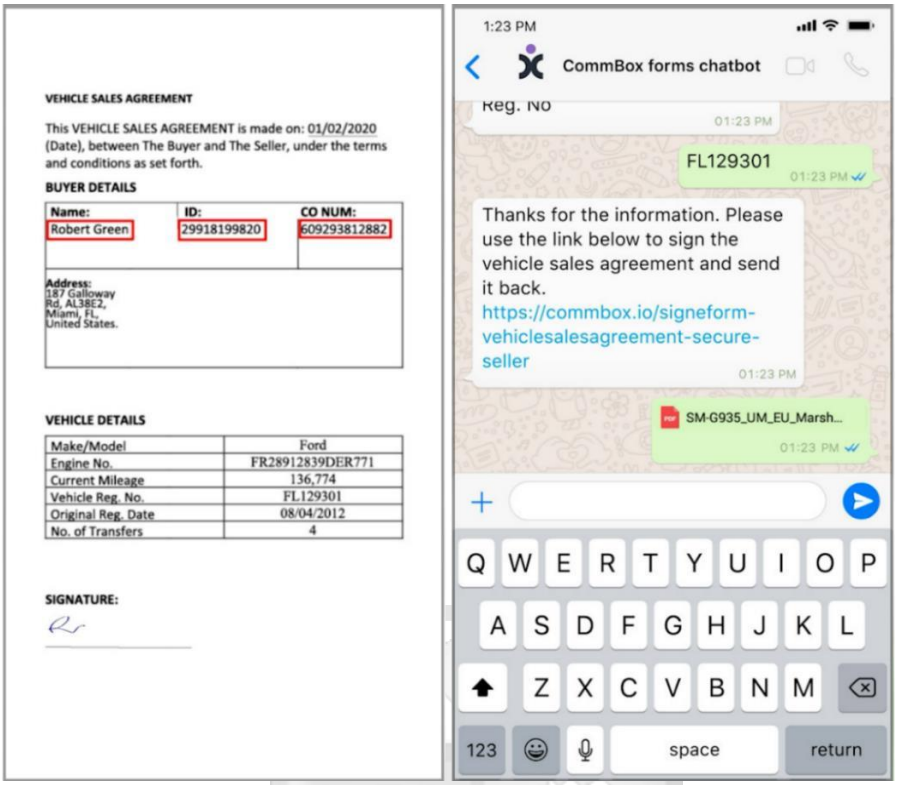

Figure 2.10 Submit file - CommBox chatbot electronic signature capabilities(CommBox, 2020)

2.3.3.4 Limitations of Chatbots

Chatbot technology does have its limitations, the prominent being the challenge of modelling natural conversation to achieve effective and efficient conversation with the chatbots, this has led to quite a number of major drawbacks. Yin (2021) identified some as follows:

i. The retrieval model rarely fails to 'hit the target' since it simply retrieves data. Nonetheless, it can appear too rigid and the responses may not seem 'human.'

ii. Chatbots need data to learn from in order to personalize the user experience, but strict regulations can make this more difficult to achieve. iii. They can only be programmed with a finite set of answers and responses, and they can't always ask extra questions if clarification is required.

In a nutshell, the NLP technology is still in its infancy, hence chatbots are far from flawless.

2.4 Conceptual Framework

The conceptual framework is a theoretical model of how the researcher makes rational sense of the relation between the various factors defined as relevant to the problem (Sekaran 2003). No doubt, the Covid-19 pandemic upended many traditional business practices. By substituting human work with automated activities, technology can have liberating effects,

especially if this substitution regards heavy, hazardous (the risk of human-to-human contact) or repetitive work (Stefano, 2018). What better technology than one that evolves with the organization? To achieve this goal, the chatbot will constantly be monitoring and studying user behavior and organizational changes through Deep Learning. Figure 2.11 illustrates this concept.

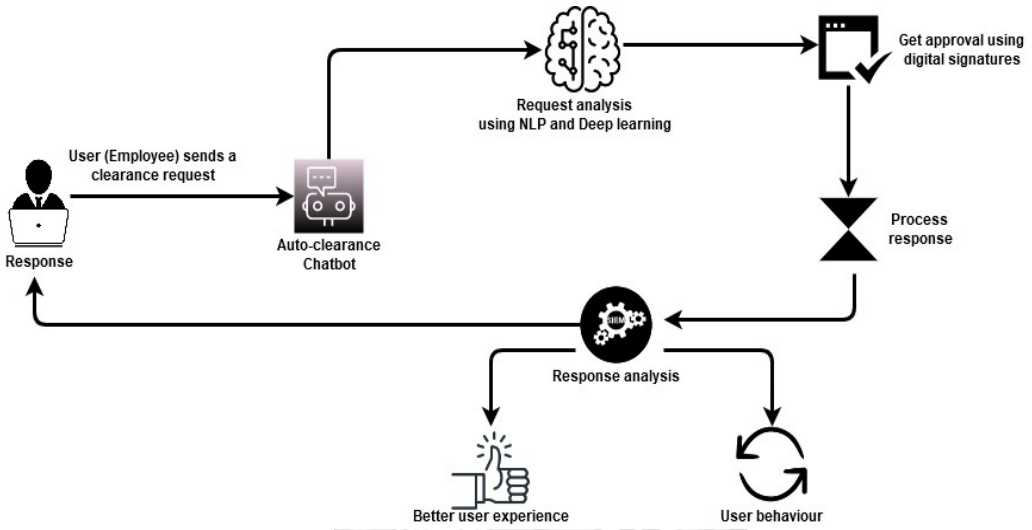

Figure 2.11 Conceptual Framework of the proposed solution(Own elaboration)

i. The exiting employee initiates the process by sending a clearance request to the chatbot.

ii. The chatbot receives and analyzes the request, a process that involves checking all the systems integrated to the chatbot, where the user exists.

iii. The chatbot requests for approvals via digital signatures, from the key personnel, where s/he is indeed certain that the exiting employee has no outstanding obligations. Automatic system account deactivation happens in this stage.

iv. The bot processes the response, if the employee has an outstanding obligation, say, a lost property, the bot responds appropriately based on step (*iii)* above.

v. The bot analyses the response by monitoring user behavior, for better user experience.

Chapter 3: Research Methodology

3.1 Introduction

The purpose of this chapter is to outline the research design, target population and criteria for inclusion in the study, sampling technique, and instruments of data collection. This applied research used the qualitative method, which enabled an in-depth understanding of the employee clearance process in organizations. The Object-Oriented System Analysis and Design (OOSAD) development approach was adopted since it aims towards improving the system quality and productivity of systems analysis and design by making it more usable (Lin, 2011). Further details on the applicability of the aforementioned method and the approach are discussed in this chapter. Other primary components of this section also discussed are; the approach to systems analysis and design, the data analysis methods and the ethical issues that will be followed.

3.2 Research Design and System Development Approach

3.2.1 Research Design

The role of a research design is to ensure that the evidence obtained enables you to effectively address the research problem as unambiguously as possible (Barbara, 2006). The exploratory nature of the qualitative research design allowed for an understanding of the employee exit clearance process through the subjective experiences, beliefs, and concepts from/of the respondents. This qualitative design was used to find answers to these research questions:

i. How is employee clearance conducted: and what are the challenges?
ii. How effective are the existing methods, techniques, approaches and systems used for employee clearance?

The exploratory research design tries to explore and not to predict the outcome. It focuses on the '*why'* and '*how'* questions (McCombes, 2020; Khoiriyah et al. 2020). This approach allowed for flexibility in designing the research. Narrative research can be defined as collecting and analyzing the accounts people tell to describe experiences and offer interpretation (Overcash, 2003). As part of this research design, narrative inquiry and storytelling helped investigate the lived experiences of some former employees with the exit clearance process, and explored their subjectivity. Narratives are important tools in constructing an organization, in fact, individual and collective narratives about critical events, compete in defining the organization and making sense of the challenges faced in organizational change processes (Søderberg, 2006). One-on-one conversations with selected former employees, from formal

organizations selected for this research, in the form of *interviews*, formed part of the data collection method, further details in the *Data Collection* section.

3.2.2 System Development Approach

The OOSAD approach combines data and the processes that act on the data into things called objects, which represent people, things, transactions and events (Singh & Ruhil, 2021). For instance; employees, department heads, contracts, and obligations. Unified Modeling Language (UML) was used to represent the various views and functionalities of the system. This approach was applied within the *agile* methodology, which according to Concas et al. (2008), is iterative and incremental and is performed in a highly collaborative manner to produce high quality software. The specific *agile* methodology that was adopted is the *Agile (Unified Process)*, which is based on the granddaddy of all the agile methods—the Rational Unified Process (RUP) (Hughes, 2016). The Agile Unified Process (AUP) is a solid process framework that can be applied to all sorts of software projects, large or small (Edeki, 2013). In addition, it is a method that augments incremental development with the phases of the Unified Process, and it defines the software delivery cycle as composed of four major phases: *Inception*, *Elaboration*, *Construction* and *Transition* (Díaz, 2011; Ambler, 2005). The Agile UP lifecycle is serial in the large, iterative in the small, delivering incremental releases over time, (Ambler, 2005).

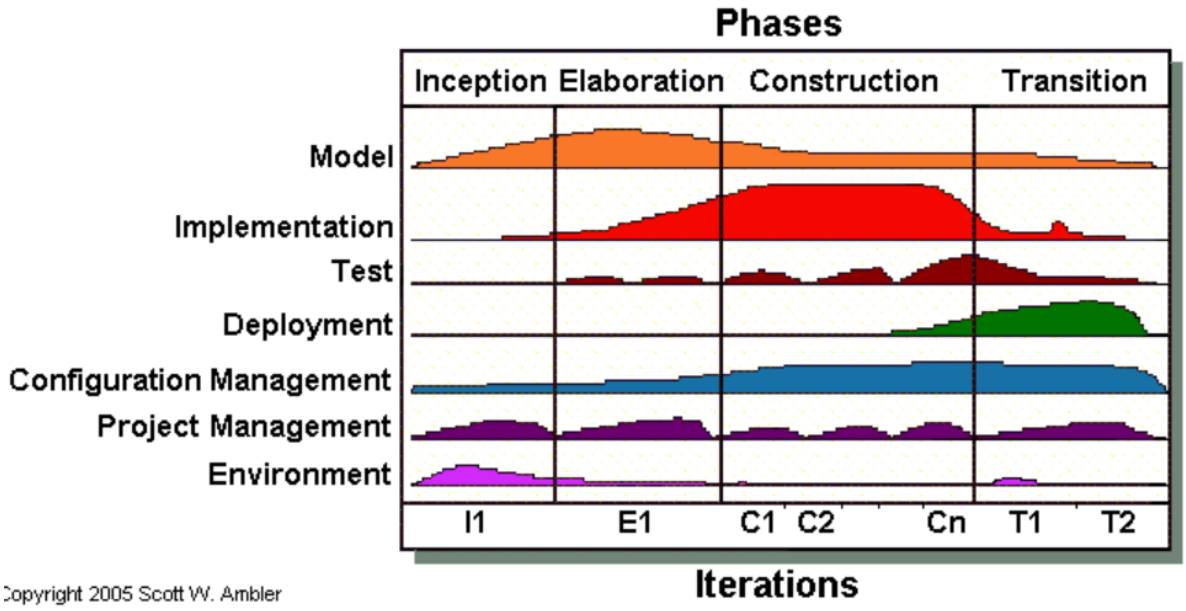

Figure 3.1: Agile Unified Process Phases (Ambler, 2005)

3.2.2.1 The Inception Phase

The key elements of this project that make up its scope are as outlined in this simple project scope statement tailored to the user's ease of understanding:

Scope Statement

The project succeeds the data collection and analysis.
The employee exit auto-clearance chatbot delivers the exit clearance functionality only and does not address other aspects of employee management in organizations.

Project Deliverable **-** A conversational software powered by AI that utilizes NLP and Deep Learning to communicate with employees, primarily via text.
Project Exclusions **-** This project does not outsource research services from external vendors.
Assumptions **-** The project was carried out by one software engineer.
Project Constraints **-** Any communication delays, changes in scope, and technical difficulties.

The conceptual framework for the solution in Figure 2.11 demonstrates the system architecture.

3.2.2.2 The Elaboration Phase

All the aspects of performance expectations were made clear in this phase, as part of this process, the activities are:

i. *Defining the solution approach* – This includes establishing the architectural baseline for the chatbot system, which comprises of functional modelling through the use of use cases. For instance, drawing a conceptual model of the interaction between the exiting employee and the chatbot. This gave a static representation of how the users will exchange information with the chatbot, thereby keeping the development team grounded on what was expected, and inadvertently rightfully commit the available resources towards the delivery of the solution.

ii. *Bringing the technical risks under control* – A clear understanding of the high risks and establishing an elaborate plan to mitigate them is essential for the success of the project. Part of this is the clear specifications of performance-related requirements, which is *risk avoidance. Risk reduction* is another mitigation strategy that guided the

development efforts to use approaches that lowered the probability of occurrence of any unforeseen risks.

iii. *Outlining the integration interface* – This entailed a thorough analysis of the systems the chatbot was to be integrated to, e.g. services systems and databases (web service), from a feasibility standpoint, and a subsequent drafting of a documentation of the same.

iv. *Planning for the construction phase* – Since this phase precedes the construction phase, ensuring that pivotal tools, processes, standards, and guidelines have been observed and put in place for the succeeding phase was validated and elaborated.

3.2.2.3 The Construction Phase

In accordance with the requirements in the elaboration phase, this phase implemented the chatbot system components and features that include UIs, the integrations with other systems and data access, and the business logic.

3.2.2.4 The Transition Phase

This phase availed the production ready chatbot system, after the system functions had been validated through beta testing. End user training and a user manual could also be delivered during this phase.

3.3 System Analysis and System Design (OOAD)

The goal of Object-Oriented Analysis and Design (OOAD) is to improve system quality and productivity of systems analysis and design by making it more usable (Kalinga, 2017). Pei (2007) opines that there are three main tools used in object-oriented analysis and design techniques:

i. Class diagrams/templates.
ii. Object diagrams.
iii. Object state diagrams.

3.3.1 System Analysis (Object-Oriented Analysis-OOA)

Parsons and Saunders, (2004) noted that the analysis phase focuses on understanding the needs of the organization, and the activities to be undertaken in this phase entail subdividing the substantial and complex project or product into small, manageable parts, for a detailed analysis of each piece. This phase offers an investigation of the problem and requirements, by presenting concepts in the problem domain. As part of this investigation, this project made use

of partial domain models to give a visual dictionary that shows the relationships between the identified conceptual classes and objects in the chatbot system, their dynamic behavior, and the required processing in the clearance process. This was inspired by clearance activities per departments, in the selected organizations.

The main focus here was on what the chatbot will do as opposed to how it will perform the task(s). Lee (1999) simplifies it by observing that the goal is making the theory and plan work together in the context of a given organization. He adds; it is about making an assessment of the match between the project's objectives and the method's capabilities. Inspired by Lee, the assessment this project conducted was; designing for reuse and maintenance and preparing for object-oriented design and programming. Since this narrows down to objects, the key activity was identifying and defining these objects, after the data collection.

3.3.2 System Design (Object-Oriented Design-OOD)

In the design stage, the conceptual classes identified in the OOA were mapped into class diagrams, showcasing their attributes, behavior, and interactions. The key focus in this phase is providing a conceptual solution (Conrad et al., 2015), i.e. If OOA is the what: then OOD is the how. The class diagram helps present a static abstraction view depicting the chatbot system as a single bubble. This diagram was subdivided into an object diagram to show a snapshot of the system at a particular moment. The idea here was to design and implement the analyzed object, an activity that is independent of the programming technology to be used (Conrad et al., 2015).

Modelling the object *behaviors*, *states* and *characteristics* was achieved through the use of state diagrams and SSDs. SSDs depict the external entities and interacting systems, with the chatbot. As a sub-process, these SSD use case models visually illustrate the operations that the external actor (clearing employee) will request from the system. Accordingly, the chatbot interaction with the key personnel in the approval level in the clearance process, through the web service, was also modelled. The state diagrams help understand how objects respond to events, i.e. how they maintain their state(s) across method invocations.

3.4 System Implementation

The purpose of system implementation is the deployment and the transition, it entails taking all possible steps to ensure that these activities occur smoothly, efficiently, and flawlessly (NYS Project Management Guidebook, 2021). This project adopts the *pilot implementation*

which, according to Bansler et al. (2010) is a powerful approach for identifying design flaws and implementation issues. The other advantage is that pilot implementations allow users to experience a system design under realistic conditions and developers to get feedback from realistic use while the design is still malleable (Hertzum et al. 2012). To improve the chances of success, these best practices guide on how to do the deployment:

i. Making note of the necessary requirements, for example, the hardware and software, the licenses, and networking.
ii. Breakdown of the roles and responsibilities of involved personnel.
iii. Incorporating the lessons learned into the final solution.
iv. Documenting the potential risks of the pilot.

3.5 System Testing

The aim is to deliver a high-quality product, and as such, testing methodologies ensure that the product is fit for purpose. The black-box testing was the primary testing method and the adopted testing approaches were:

i. Unit testing – Where a given component of the chatbot system was tested individually, the aim was to curb many defects and prevent critical bugs.
ii. Integration Testing – This is a follow up to the unit testing where all the components were assembled and tested together to ensure they are working together as expected
iii. System Testing – This involved testing the entire system for errors and bugs.
iv. Acceptance Testing – End-users can test the system to ensure it operates as expected
v. Non-functional Testing – This checks for usability security and performance.

3.6 Target Population and Sampling

3.6.1 Target Population

The target individuals for this study were the key players in various departments, in formal organizations selected for this research, who are involved in the clearance process, and some former employees who have gone through the exit clearance process.

3.6.2 Sampling

This research used the *non-probability sampling* strategy, i.e. a combination of *purposive sampling* and *snowball sampling*. In purposive sampling, the researcher chose only the presented individuals from departments that participate in the clearance process. In the snowball sampling, any individual involved in the clearance process, e.g. Information

Technology (IT) admins, suggested the next person and so on. In addition, some may be in touch with some former employees, who were also persons of interest in this study.

3.6.3 Sample Size

Bhatti (2019) found that the rate of penetration of Chatbot AI technologies within institutions in Kenya stands at 7%. With this proportion, the sample size was calculated using the formula below:

$$\text{Sample size} = \frac{Z_{1-\alpha/2}^2 p(1-p)}{d^2}$$

$Z_{1-\alpha/2}$ = is standard normal variate (at 5% type 1 error ($P<0.05$) it is 1.96 and at 1% type 1 error ($P<0.01$) it is 2.58). As in majority of studies P values are considered significant below 0.05 hence 1.96 is used in formula.

p = Expected proportion in population based on previous studies or pilot studies.

d = Absolute error or precision – Has to be decided by researcher.

$$\text{Sample size} = \frac{1.96^2 \times 0.07(1-0.07)}{0.05^2} = 100$$

3.7 Data Collection

As part of the qualitative research design, the tools for the data collection were *observations* and *interviews* through one-on-one or online conversations with selected staff members involved in the clearance process or former employees who officially cleared from their employers.

Interviews

The data captured here is centered on feelings, emotions, or subjective perceptions of something (Muhammad, 2016). Semi-structured interviews were suitable towards obtaining detailed information about the experiences of some former employees, though open-ended questions, where the perception may differ from different individuals. Things like the body language, expressions and other reactions to the questions were key.

Observations

One of the important aspects of this research project was getting an actual '*look and feel*' of the exit clearance process in the natural setting. Both direct and indirect observation at the workplace through sight and hearing were applicable. The indirect observation was procured from the satisfaction drawn from the process phenomenon reported by secondary sources. This was followed by analysis and making of inferences.

3.8 Data Analysis

The obtained data was cleaned, transformed, and modelled to discover useful information for decision-making purposes, which is the basis for the analysis. The qualitative data analysis method used a mix of *content analysis* and *narrative analysis* to analyze content from interviews on experiences shared by the interviewees.

3.9 Model Development

To create a Deep Learning based chatbot implementation, data is essential for training the model. However, as Jurgita (2020) observed, organizations usually own small domain-specific datasets of question–answer (QA) pairs about their products, services, or used technologies. That notwithstanding, this project's focus is on building a generative-based chatbot using the Seq2Seq Deep Learning model by training it on small or even extremely small datasets, this was done using *Python* programming language and the *TensorFlow* library. A generative chatbot derives new responses by applying Deep Learning techniques on historic data and previous conversations (Sil & Chowdhury, 2020). The steps involved are:

i. Obtaining the training data.
ii. Data cleaning/pre-processing.
iii. Developing the Seq2Seq model.
iv. Validation of the model through experiments and results.

3.9.1 Obtaining the Training Data

The domain of interest is the employee clearance process in formal organizations, as such, a small domain-specific dataset of QA pairs was manually created. To supplement this, free datasets such as Kaggle that contain human responses and bot responses (Kaggle, n.d.), were explored and applied where applicable.

3.9.2 Data Cleaning/Pre-processing

Data wrangling or cleaning focused on setting up data for analysis, the tasks here include:

i. Ensuring the text is homogenous, this means that one vector will be used for words that have the same meaning, for instance; 'Clearance' and 'clearance,' thereby cutting down the computation pressure and storage.

ii. Tokenization or breaking a problem into the smallest meaningful part guarantees ease of understanding and micro-analysis (Sil & Chowdhury, 2020). This includes handling punctuation, to enable the generative chatbot generate responses with punctuation marks as necessary.

iii. The third step is adding the broken parts in step (ii) into the vocabulary for comparison and analysis in the future.

3.9.3 Developing the Seq2Seq Model

This step empowers the chatbot to generate maximum relevance responses to user inputs. Jurgita (2020) explains the Seq2Seq task as follows: Let $(x_1, x_2, \ldots x_n)$ be an input (question) sequence and $(y_1, y_2, \ldots y_m)$ be an output (answer) sequence, not necessarily of the same length $(n \neq m)$, the architecture of the Seq2Seq model contains two base components: (1) an *encoder*, responsible for encoding the input $(x_1, x_2, \ldots, x_n)$ into an intermediate representation $h_n(Q)$ (which is the last hidden state of the encoder), and (2) a *decoder*, responsible for decoding the intermediate representation $h_n(Q) = h_0(A)$ into the output $(y_1, y_2, \ldots, y_m)$. See Figure 2.6.

3.9.4 Validation of the Model through Experiments and Results

The quality of the chatbot and its output was evaluated using the three main chatbot evaluation schemes; content evaluation, user satisfaction, and chat function as observed by Pongnumkul et al. (2019). This was done through the use of various metrics outlined by Majot et al. (2019).

Content Evaluation

i. Bot Messages: This refers to the total number of messages sent by the chatbot in each interaction. This measures the length of a conversation between a user and the bot. The expectation is that the number of messages will be high.

User Satisfaction

ii. Total number of users: This is the most basic metric, which captures the number of people using the chatbot.

Chat Function

iii. Miss Messages: These are messages that the bot cannot process. This metric requires the times the bot misinterprets an input. For instance: an input pattern to the chatbot that is unrelated to the domain of the training data fed to the chatbot.

iv. Fallback Rate (FBR): This metric checks whether or not the chatbot failures happen regularly or in some extreme cases. The Fallback Rate is the percentage of times the bot failed or experienced a near-failure situation; the aim is to keep the failure down. A high fallback rate may mean trying new data sources or training sets to improve the performance.

v. Goal completion Rate (GCR): This captures the percentage of successful engagement through the chatbot, it shows the number of times the bot successfully processed an employee clearance.

3.10 Research Quality

Reliability is the extent to which the results can be reproduced when the research is repeated under the same conditions (Wilson, 2010; Middleton, 2021). This research ensured that reliability was achieved by employing the below methods outlined by Sauro (2015):

i. Inter-Rater Reliability – This is essentially a disagreement in judgement, in other words, the fact that respondents will respond the same way to the interview questions is a measure of reliability.

ii. Cronbach's alpha - This is a reliability metric used to determine how well the components in the collection respond to each other in a positive way. Put differently, it measures how consistently participants respond to one set of items (Sitienei, 2020; Sauro 2015)

Validity refers to an extent at which requirements of scientific research method have been followed during the process of generating research findings Oliver (2010). In accordance with Haradhan (2017), this research ensured validity in the following ways:

i. By achieving a representation of the population through the use of precise description, to allow for study replication across different populations and settings.

ii. The respondents were not pressured in any ways to give specific answers to any of the questions.

3.11 Ethical Approval

The clearance of this research project by the institution required the researcher to seek institutional ethical approval (from Strathmore University – Institutional Ethics Review Committee) and the NACOSTI permit to collect data. The researcher also sought permission from the organization of the study and informed the participants about the purpose of the study before participating in the interviews. The obtained data was treated to utmost confidentiality and was only used for scholarly purposes. This research cites previous work and acknowledges original authors.

Chapter 4: System Analysis, Design and Architecture

4.1. Introduction

This chapter discusses the findings, the data analysis and the results of this study through detailed presentations. In addition, it contains elaborate illustrations of the system design and architecture of the proposed solution, as guided by the conceptual framework in Figure 2.11. The system components and their interaction with users has been modelled through the use of Unified Modelling Language (UML) diagrams.

4.2. Requirements Analysis

The three classes that make up the requirements for this project are: the functional requirements, the non-functional requirements and the usability requirements.

4.2.1. Functional Requirements

Functional requirements focus on the system input, processing, and output. They describe the functions that the chatbot can perform.

i. The chatbot should be able to access the electronically stored or generated information related to the employee exit clearance process, for model training purposes.
ii. The chatbot should integrate to other systems used in the clearance process and those with the clearing employee data.
iii. The chatbot should disable clearing employee user accounts and append a digital signature on the clearance form.
iv. The chatbot should leverage deep learning, and NLP where applicable, to analyze the context of a conversation.

4.2.2. Non-Functional Requirements

i. The chatbot should take less than 30 seconds to respond to users' queries.
ii. Dialogue with the chatbot should feel like talking to an actual person.
iii. Users should authenticate themselves before being able to query information from the chatbot.
iv. The system should maintain an easy-to-use interface across all functionalities, for all users.
v. The knowledge base should be safe from attacks and unauthorized access.

4.2.3. Usability Requirements

Usability requirements specify the ease of use of the system and must therefore be meaningful and precise. Formal organizations that have a well-defined employee exit clearance process are the intended beneficiaries of this chatbot system. With that said, the main users are the employees involved in the exit clearance process or those that are exiting their employer organization. To ensure that the automated process is seamless, the system must be easy to learn, efficient, straightforward, and easy to understand. As for the deep learning part, the chatbot is able to generate accurate and appropriate responses.

4.3. Data Analysis

Data from the primary source is one which a researcher collects firsthand from the sources, mainly the research participants. The primary data for this research was collected using interviews and a formatting of the interview guide as an open-ended questionnaire, due to convenience issues and requests by some participants. The interviews were conducted online via Google Meet among other platforms, subject to social distancing protocols due to Covid-19.

4.3.1. Nature of the Data

This data collection exercise employed the qualitative approach, the data was then analyzed using content and narrative analysis approaches.

4.3.2. Employee Exit Clearance

4.3.2.1 Exit Clearance Experiences

Narrative analysis focuses on the stories that people express about themselves or others. The narrative analysis in Table was used to investigate the lived experiences of individual

Table 4.1 Narrative Analysis

Lived Experiences of the Clearing Employees		
Participant stories, observations, quotes	**What the investigator learnt from them**	**Areas of Change**
I remember at my previous workplace, they couldn't let me go. The boss was so rude and	The respondent had a hard time dealing with a difficult boss and eventually left without clearing.	Management may need to do some soul searching, this also highlights the importance of a system

refused to sign the clearance form.		which has no emotions in such a process.
I did not clear in my last organization, the order of doing things was not well organized and there was no formal process for clearing.	There is no well laid out structure for employee exit clearance, which makes it arduous to even think of how to clear.	A well organized and documented framework for exit clearance. I may add, an integrated ecosystem of systems for management of the clearance processes.
It took me a while to finally get cleared, because my new contract was to start in a few days and I did not give notice on time, so I cleared after I started working in my new workplace.	There was no specific challenge as regards to the exit clearance process, the respondent did not issue a notice on time. However, eventually the clearance was done.	An intelligent automated solution can be used to seal potential loopholes of former staff earning salaries continuously. This solution can track the system access frequency through conversation analysis. This will also help monitor the effectiveness of current employees.
The process was long and tedious, there was a lot of paperwork and it was time consuming.	This was a noticeable hassle on the part of the clearing employee, there was a lot of back-and-forth movements to obtain clearance from various departments.	First proposal is automation, secondly, it will be far beneficial to ensure the clearance process is centrally managed and monitored. This will help the organization keep better track of the clearing employee.
Proposals for the Clearance Process by the Respondents		

If the process was more automated	The respondent was eager to have the process move towards automation.	Implementation of automation.
Automate with technology	Adopt technology that automates this process	Adoption and application of automation technology in the exit clearance process.
Automated	Proposal to automate.	Implementation of automation.
In my opinion, it could be an automated process where we do away with the physical form. All we have is a system where a user submits a clearance request then on the back-end all the involved parties do their process and the clearing staff receives a complete document signed or cleared by the relevant sections and with comments where necessary.	The respondent did not wish to know what happens in the clearance process, all they were concerned about is a smooth process which issues them with the final signed clearance form.	Implementation of automation aided by technologies that implement encapsulation which hides the background processes. In other words, they foster a seamless process.
Automate, most organization have a form that - a simple system can assist in clearing employees quick and efficiently	It was observed that the manual forms that are in place can easily be converted into an automated process.	Implement automation.
Through a centralized clearance system	The respondent recommended a centrally managed clearance process that does not necessarily involve users too much.	Implement an integration enabled by automation where systems can communicate with each other.

4.3.2.2 Recommended Solution

Content analysis is concerned with concepts and ideas, the word frequency analysis of the most common percentage of words used by the respondents, as a recommendation for the exit clearance process are as shown in the word cloud in Figure 4.1. The words used more often are bigger, and the ones used less often are smaller.

Figure 4.1 Word Document Analysis

After applying *stopwords* and *English words* filters, the largest word in the document is *'automated.'* This analysis of content has demonstrated a strong emphasis on the need for automation of the exit clearance process.

4.4. System Architecture

Figure 4.2 depicts the chatbot system architecture. The clearing employee (user) will initiate the chat with the bot instance through the bot interface. In the backend, the bot instance uses NLP, where applicable, and deep learning to model the dialogue with the user and take control of the exit auto clearance process. The NLP and deep learning module is fed with the training data from the data storage section, whereas the knowledge is used to make inferences, which are refined over time, using deep learning. The web services are integrations with other applications that are either used in the clearance process or contain user information. They feed this information to the chatbot system.

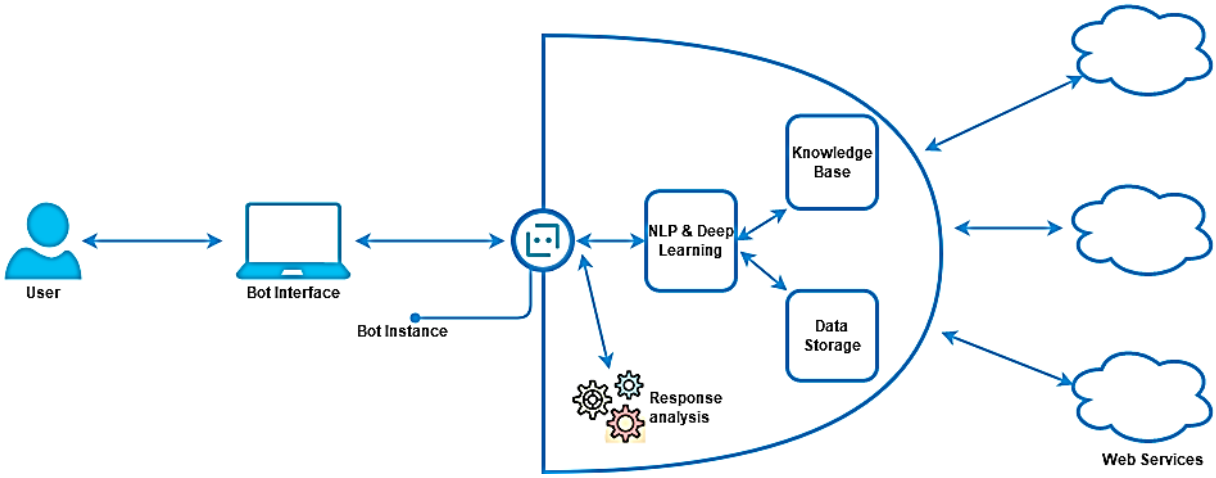

Figure 4.2: System architecture

4.5. System Design

The system design phase uses design diagrams to convert the specified requirements into a format that was implemented.

4.5.1. Use Case Diagram

Figure 4.3 is a use case diagram that summarizes the different ways that the users (actors) can interact with the system. The system actors are the clearing employee, the administrator, the clearance approver and the web services systems. The clearing employee initiates the chat with the chatbot, which asks questions accordingly, to ensure that the clearance process is successful. The administrator maintains the system and ensures that the training data for model learning has been cleaned and pre-processed. The clearance approver is a stakeholder involved in the clearance process, with authority, who provides his/her signature which appears on the final clearance form. The web service systems are other relevant systems containing information related to the clearing employee. They represent and are used by the respective departments where the clearing employee is registered as a holder of either a role or a pending item. Tables 4.2, 4.3, 4.4 and 4.5 elaborate the main use cases in the chatbot system and their success scenarios.

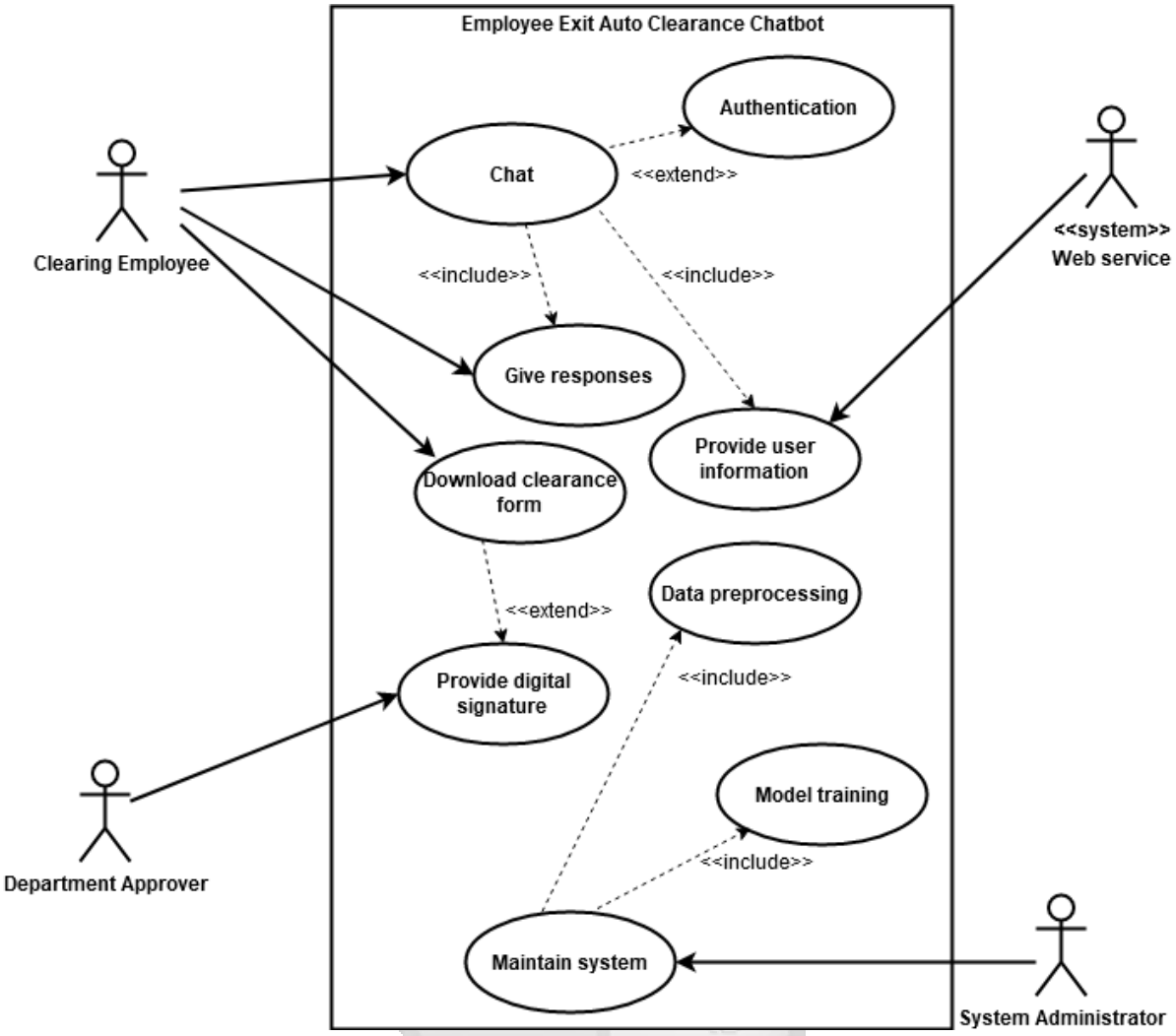

Figure 4.3: A Use Case Diagram

Table 4.2: Data preparation for model training

Use Case: Data Pre-processing, Model Training	
Primary Actors: Administrator	
Precondition: Define Intents, Data Preparation, Define Seq2Seq Model.	
Post-condition: Validation of the model through experiments and results	
Main Success Scenarios	
Actor Intention	**System Responsibility**
1. Load Data.	
2. Fit the Model.	
	3. Inference with the highest confidence score.
	4. Mimic real-life conversations.

Table 4.3: Clearing employee use case scenario

Use Case: Exit Auto-Clearance	
Primary Actors: Employee	
Precondition: Access to the Auto Clearance Chatbot.	
Post-condition: Signed Clearance Form.	
Main Success Scenarios	
Actor Intention	**System Responsibility**
1. Open Chat.	
	2. Acknowledge User.
	3. Ask questions.
4. Respond to Queries.	
	5. Issue signed clearance form.

Table 4.4: Clearance approver use case scenario

Use Case: Provide Digital Signature.	
Primary Actors: Approver.	
Precondition: Access to the auto clearance chatbot, Electronic signature capability	
Post-condition: Apply e-signature to the clearance form.	
Main Success Scenarios	
Actor Intention	**System Responsibility**
1. Open the electronic signature process.	
2. Add an e-signature, similar to signing on paper.	
	3. Apply e-signature to clearance form.
	4. Electronically archive the digital document.

Table 4.5: Web service use case scenario

Use Case: Provide Clearing Employee Information.
Primary Actors: Web service.
Precondition: Internet Access.

Post-condition: Provide user information, Disable user account where applicable.	
Main Success Scenarios	
Actor Intention	**System Responsibility**
	1. Request for user information using unique username or ID
2. Generate user data including active status on the system.	
	3. Deactivate user account where applicable.
	4. Give feedback to employee.

4.5.2. System Sequence Diagram

Figure 4.4 represents the system sequence diagram. The user (clearing employee) begins chat with the chatbot, which verifies the user account and responds. The dialogue between the chatbot and the user continues for all the user and system queries. Once all matters regarding the clearance process have been settled, the user ends the clearance dialogue and the chatbot issues him/her with the signed clearance form.

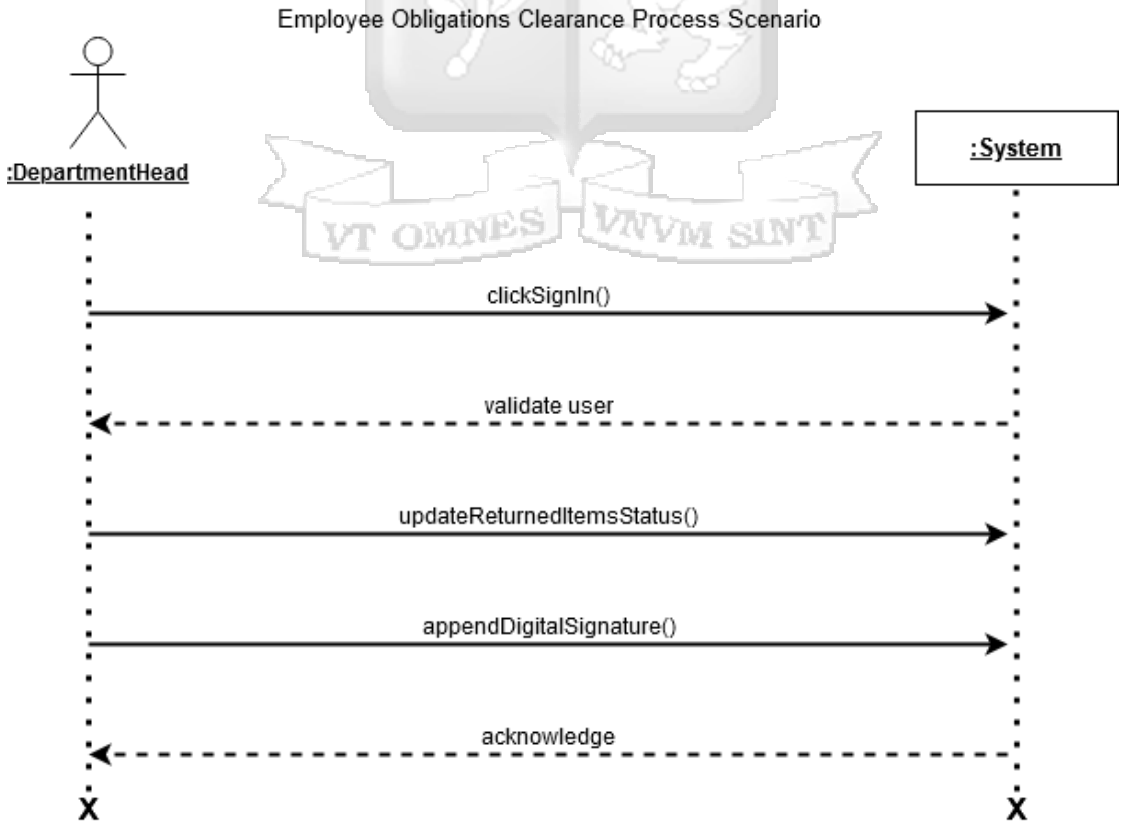

Figure 4.4: System sequence diagram

4.5.3. Conceptual Classes for the Chatbot System

The candidate conceptual classes are identified in Table 4.6. The class interactions in the system and their corresponding attributes are shown in Figure 4.5.

Table 4.6: Candidate conceptual classes

Conceptual Class Identification	
Physical or tangible objects	Organization Property
Specifications, Designs or Discipline of Things	Property Specification, Account Status
Places	Department
Transactions	Clearance
Roles of People	The Clearing Employee, Administrator, Approver
Container of Other Things	Office
Things in Container	Staff, Item
Other Computer or Electro-mechanical Systems external to System	Web Services
Organizations	Employer Organization.
Events	Clearance, Maintenance, Signing
Processes	Clearing Employee
Rules and Policies	Clearance Policy
Catalogs	Property Catalog
Common Associations List	
X is physical part of Y	Property - Building
X is logical part of Y	User Account - System
X is physically contained in Y	Item - Store
X is logically contained in Y	Property Specification - Database
X is a description for Y	Property Specification - Property

X is a line item of a transaction or report of Y	Maintenance Job - Maintenance-Log
X is known/ logged/ recorded/ reported/ captured in Y	Clearance - Register
X is a member of Y	Staff - Department
X uses or manages Y	Staff – Office Property
X is next to Y	Department - Department

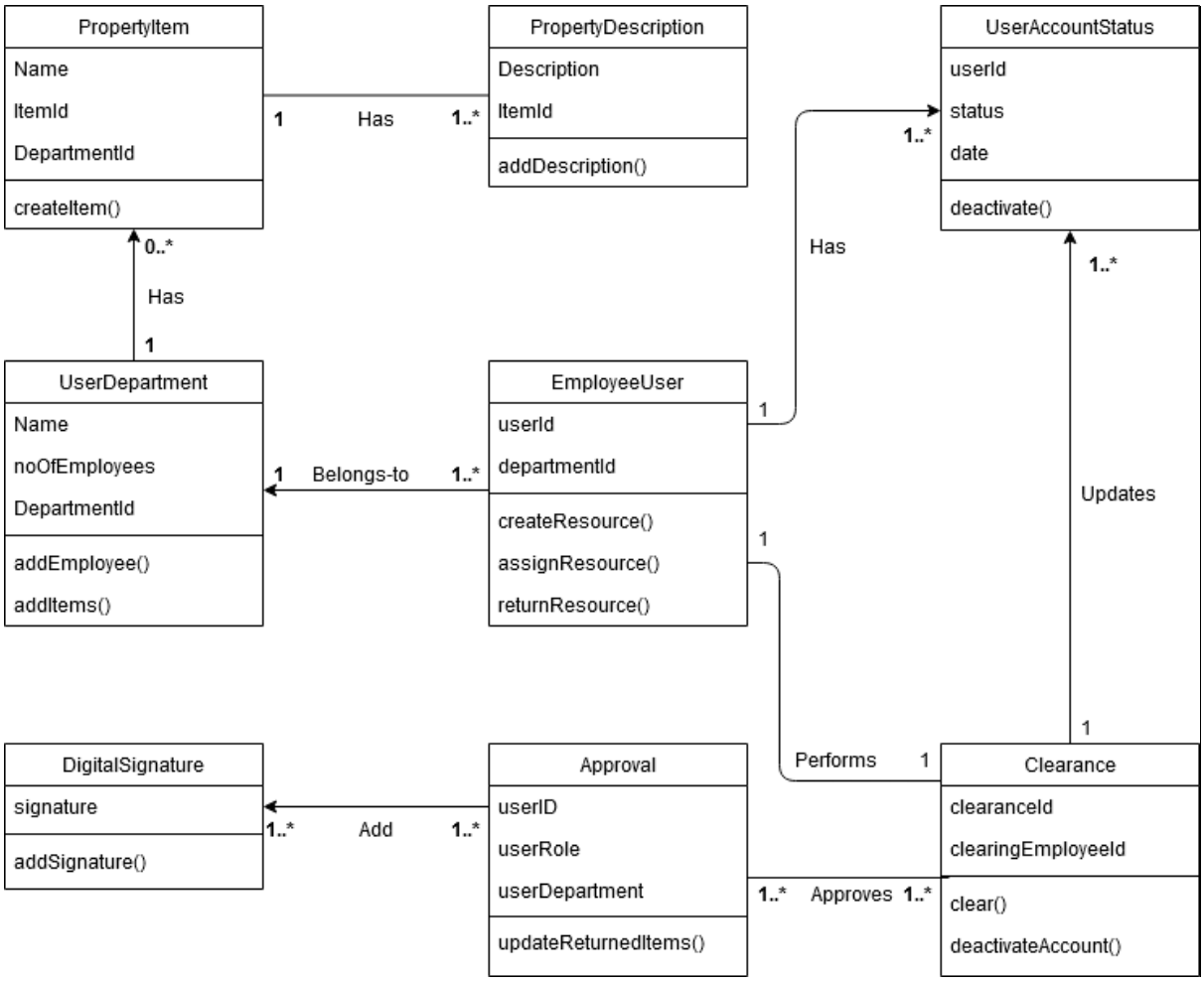

Figure 4.5: Class diagram

4.5.3.1. Object Diagram

Objects are instances of the classes and their attributes; Figure 4.6 is a runtime object state diagram for the *Clearance* class. To fulfill the responsibility of clearing the user from other departments through the user accounts on their respective systems, the *UserAccountRecord* needs to know account status of the user. *WebService* is an information expert which is tasked

with giving this feedback. Thus, to fulfill the responsibility of clearing the employee, three responsibilities were assigned to three design classes of objects.

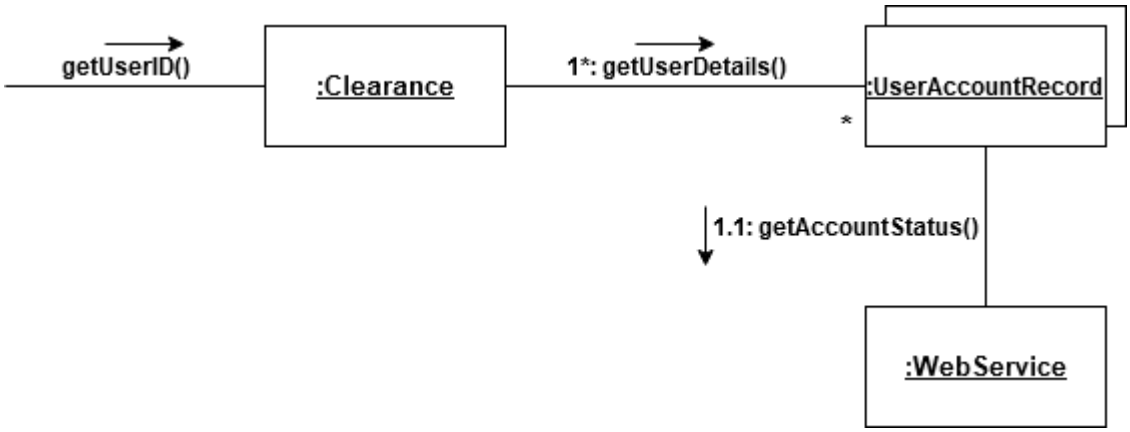

Figure 4.6: Object diagram

Chapter 5: System Implementation and Testing

5.1. Introduction

This chapter addresses the chatbot implementation and testing, the implementation part explores the various components of the system and their structure, whereas the testing ensures that the chatbot satisfies the aforementioned requirements and objectives. This advanced form of a chatbot can learn and be trained to handle never seen before requests through the Deep Learning process.

5.2. Chatbot Model

The basic type of chatbot designed is generative-based which is anchored on the Seq2Seq Neural Networks circuits.

5.2.1. Generative Chatbot

Through the use of the Seq2Seq architecture this chatbot can handle user requests without the need for predefined responses, in addition, this architecture allows for training of the chatbot on small or even extremely small datasets. The approach taken is outlined in the following sub-sections.

5.2.1.1. Obtaining the Training Data

Human interactions dataset on exit clearance is the primary data source for training the model to comprehend human language as text and respond via the same medium, this data is also known as corpus. The corpus can either be manually designed or made up of interactions accumulated over time in an organized fashion and can be drawn from multiple sources within the same general domain. The corpus can be organized in a spreadsheet form, capturing probable questions the users are likely to ask the chatbot. This can pave the way for the understanding of the intents to be trained, the intents file, which is a python dictionary of JavaScript objects with different tags for given word patterns, contains information about the type of questions the chatbot should be expecting, and typical responses. Figure 5.1 is a snippet of this project's intents file, and its contents are:

Tag – For a given intent, a tag groups similar text instances and applies them as targeted outputs to train the model.

Patterns – Which are probable questions expected as inputs from the end user.

Response – These are responses or options the chatbot will choose randomly as outputs to the end users. They can be fetched from a database of texts for updated responses by the chatbot.

```
{"intents":
  [
      {"tag": "clearance",
       "patterns": ["Clear", "Clearance", "Clear me", "Help me clear", "I want to clear"],
       "responses": ["Okay enter your user ID (staff number)", "Enter your staff ID"]
      },
```

Figure 5.1: Structure and contents of the intents file.

5.2.1.2. Data Cleaning/Pre-processing

The data cleaning and pre-processing was carried out throughout the entire chatbot creation process. The goal was getting it ready for the subsequent steps entailing data generation and modeling. This was achieved using the NLTK (Natural Language ToolKit) library tools for cleaning up and preparing the text data for deep learning algorithm. These tools have been applied as follows:

Tokenization – In order to use textual data for predictive modeling, the text must be parsed to remove certain words, this process is called tokenization. It splits the corpus into smaller units, such as individual words or terms. The NLTK *tokenize()* module was used.

Text lemmatization – This refers to the reduction of a word to its base or dictionary form which is known as the lemma. This was done using the NLTK *WordNetLemmatizer()* module.

The others formatting tasks include conversion to lower case, removal of punctuation and conversion of binary values (0,1) to bipolar values (1,-1).

A major concern with modeling text is that it is messy, and techniques like deep learning algorithms work well with well-defined fixed-length inputs and outputs. Therefore, the raw text must be converted into a vector of numbers, this was achieved using the bag-of-words model (BoW), which is a way of extracting features from text for use in modeling. This model applies vectorization, a process which counts the number of times each word appears in a document then calculates its frequency of appearance in a document out of all the words in the document.

5.2.1.3. Developing the Seq2Seq Model

The Sequence-to-Sequence (Seq2Seq) model was created using the *TensorFlow* AI platform, which has a rich ecosystem of tools, libraries, and community resources. This model is

responsible for summarizing the user input into fixed length vector then predicting the target words from that fixed length vector. Technically, the model is a neural machine translation model that learns a given number (preferably large) of sequence pairs, then generates one from the other. Figure 5.2 is an example I/O of Seq2Seq.

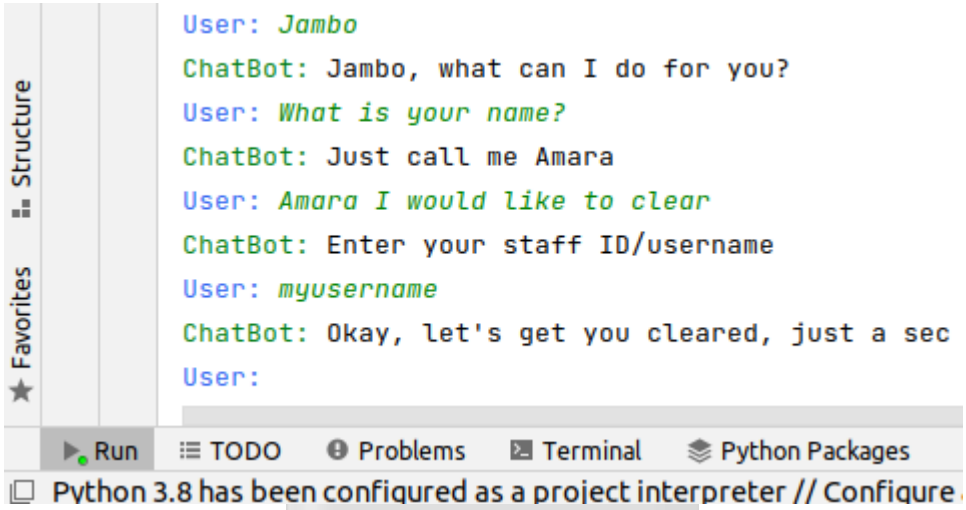

Figure 5.2: I/O of Seq2Seq model

The output above is a seq2seq model trained using the patterns in the intents file. More comprehensive conversational exchanges were captured in the training.

5.2.1.4. Model Training and Testing

The model was created with two hidden layers and given 10,000 rounds of training (number of times the model saw the same training dataset). Figure 5.3 shows the results of the training, which gave the final accuracy score of 0.9991; meaning that the model could classify 99.91% of data points correctly, put differently, these are the data points which the model can give the most appropriate response based on the user query.

```
Step: 9945  | total loss: 0.07382 | time: 0.011s
epoch: 1989 | loss: 0.07382 - acc: 0.9990 -- iter: 40/40

Step: 9950  | total loss: 0.07680 | time: 0.009s
epoch: 1990 | loss: 0.07680 - acc: 0.9994 -- iter: 40/40

Step: 9955  | total loss: 0.06760 | time: 0.007s
epoch: 1991 | loss: 0.06760 - acc: 0.9996 -- iter: 40/40

Step: 9960  | total loss: 0.58269 | time: 0.012s
epoch: 1992 | loss: 0.58269 - acc: 0.9390 -- iter: 40/40

Step: 9965  | total loss: 0.37276 | time: 0.008s
epoch: 1993 | loss: 0.37276 - acc: 0.9640 -- iter: 40/40

Step: 9970  | total loss: 0.25318 | time: 0.011s
epoch: 1994 | loss: 0.25318 - acc: 0.9787 -- iter: 40/40

Step: 9975  | total loss: 0.17056 | time: 0.011s
epoch: 1995 | loss: 0.17056 - acc: 0.9874 -- iter: 40/40

Step: 9980  | total loss: 0.13498 | time: 0.011s
epoch: 1996 | loss: 0.13498 - acc: 0.9926 -- iter: 40/40

Step: 9985  | total loss: 0.10018 | time: 0.011s
epoch: 1997 | loss: 0.10018 - acc: 0.9956 -- iter: 40/40

Step: 9990  | total loss: 0.09665 | time: 0.011s
epoch: 1998 | loss: 0.09665 - acc: 0.9974 -- iter: 40/40

Step: 9995  | total loss: 0.07717 | time: 0.010s
epoch: 1999 | loss: 0.07717 - acc: 0.9985 -- iter: 40/40

Step: 10000  | total loss: 0.07860 | time: 0.013s
epoch: 2000 | loss: 0.07860 - acc: 0.9991 -- iter: 40/40
```

Figure 5.3 Model training results

The two hidden layers were selected to improve the prediction accuracy of the model. The model's ability to meet the functional requirements was tested as per the use cases below.

Table 5.1 Model Test Cases

ID	1
Test Case	Functional: Access to training data
Description	The chatbot should be able to access the electronically stored or generated information related to the employee exit clearance process, for model training purposes.
Priority	High
Results	The chatbot was able to access the data and perform the training, as captured in Figure 5.3
Pass/Fail	Pass
ID	2
Test Case	Functional: Integration to other systems
Description	The chatbot should integrate to other systems used in the clearance process and those with the clearing employee data
Priority	High
Results	The chatbot was able to access user information on clearance from the web service
Pass/Fail	Pass
ID	3
Test Case	Functional: Update clearance status
Description	The chatbot should disable clearing employee user accounts and append a digital signature on the clearance form.
Priority	High
Results	Based on the details of the web service that captured the employee eligibility to clear, the chatbot could make a post request to update the employee clearance status.
Pass/Fail	Pass
ID	4
Test Case	Functional: Leverage NLP and Deep Learning
Description	The chatbot should leverage deep learning, and NLP where applicable, to analyze the context of a conversation.
Priority	High

Results	Based on the details of the web service that captured the employee eligibility to clear, the chatbot could make a post request to update the employee clearance status.
Pass/Fail	Pass
ID	5
Test Case	Functional: Consistent output for the same input
Description	Does the model respond with a consistent result for a similar input pattern?
Priority	Moderate
Results	The Model gives the same feedback for the same input pattern. Figure 5.4 shows a greeting intent in different patterns from the user, the system responds with a variety of patterns for the same greeting intent.
Pass/Fail	Pass

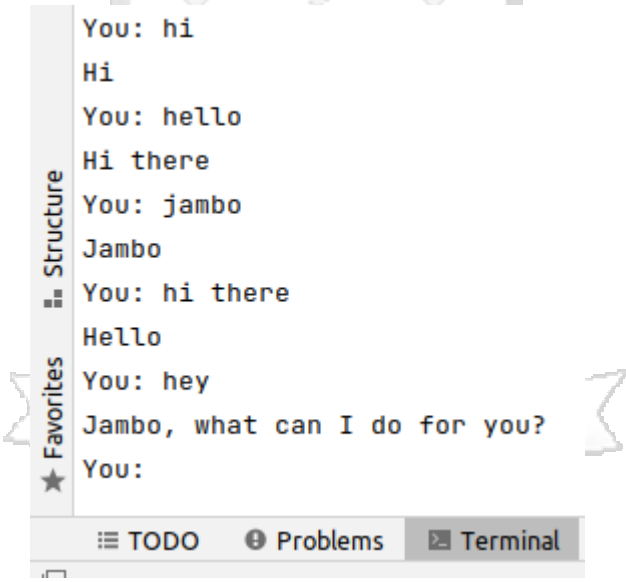

Figure 5.4 Consistent output pattern for the same input pattern

5.3. Web Service

This is the backend engine that communicates with the chatbot behind the scenes. The web service also provides a platform for management of department items issued to and returned by the clearing employee. Figure 5.5 shows the web service interface.

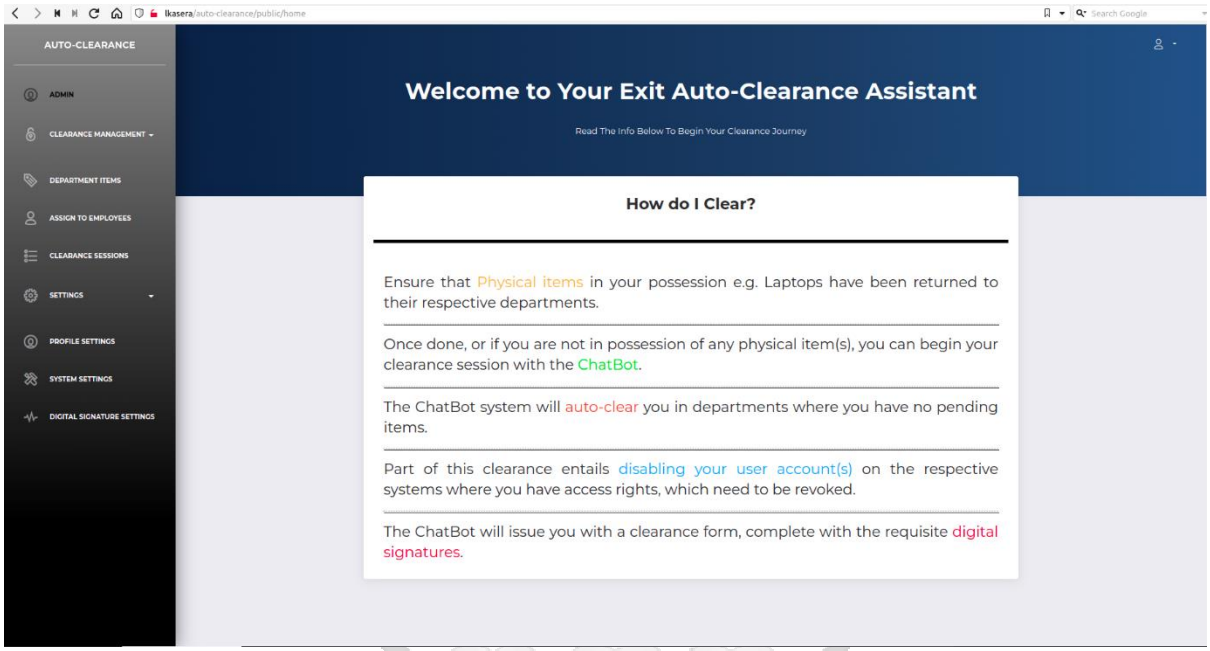

Figure 5.5 Web Service Interface

Physical items must be physically returned to the respective departments where they belong. This allows the department to update the status of issued items as *returned*, which ensures a smooth clearance process by the chatbot.

5.2.2.1 Digital Signature

Physical documents like clearance forms need a handwritten signature to validate their authenticity, and in order to maintain the smoothness of this exit clearance process, the web service provides a digital signature pad for adding a digital signature which then appears on the final clearance form. Figure 5.6 shows the digital signature pad on the web service.

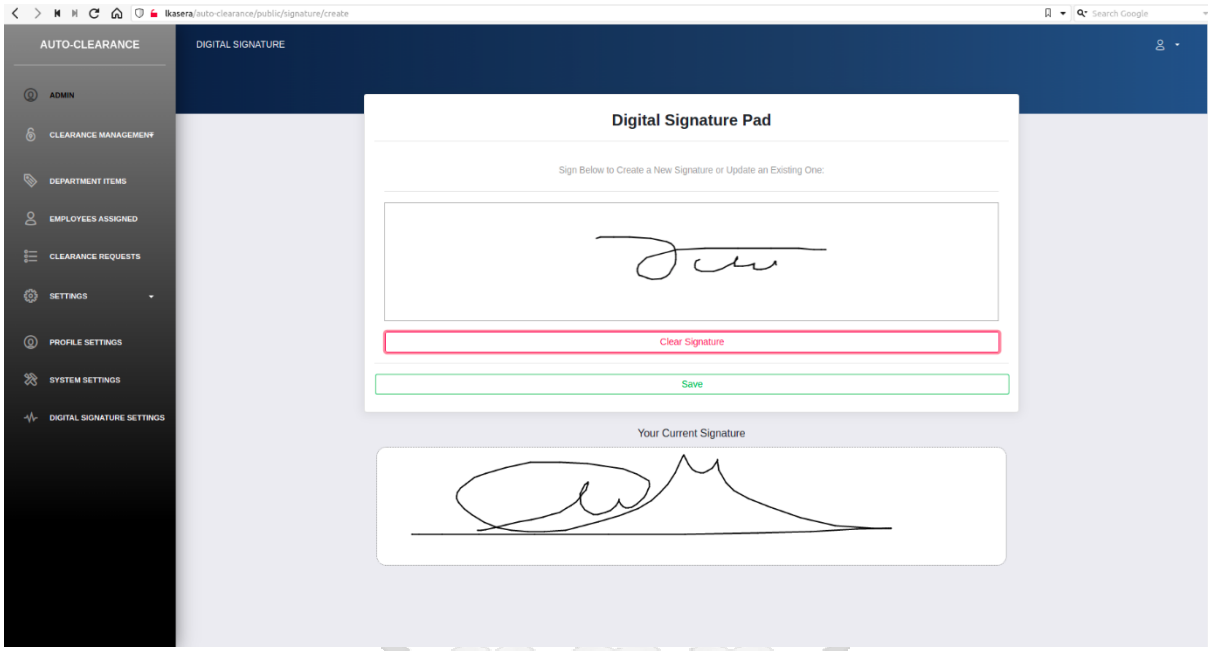

Figure 5.6 Digital Signature Pad on the Web Service

5.4. The Exit Auto-Clearance Process

The complete process for the exit auto-clearance is straightforward and entails the following procedure:

i. Ensure that Physical items in your possession e.g. Laptops have been returned to their respective departments.
ii. Once done, or if you are not in possession of any physical item(s), you can begin your clearance session with the ChatBot.
iii. The ChatBot system will auto-clear you in departments where you have no pending items.
iv. Part of this clearance entails disabling your user account(s) on the respective systems where you have access rights, which need to be revoked.
v. The ChatBot will issue you with a clearance form, complete with the requisite digital signatures.

Chapter 6: Discussion of Results

6.1. Introduction

This chapter discusses the main research findings of the study. The purpose of this research was to identify the most taxing issues that employees go through during the exit clearance process when leaving organizations, then to design, develop and test an AI powered Deep Learning chatbot for employee exit auto-clearance, and validate that the chatbot addresses the main identified issues in the exit clearance process.

6.2. Model Components

The building blocks in this deep learning model are three sets of layers, an input layer, two hidden layers, and the output layer. Each of these layers receive weighted inputs, uses a given function to transform it, then gives it to the next layer as its output, and so on. The final output value processed by the last layer (the output layer) is the target value, in this case the best fitting response for a given user query. Figure 6.1 is a graphical depiction of a two (hidden) layered deep learning model. In this case, $\boldsymbol{X}$ is the input or user request sent to the model, the model then does the weighting ($\boldsymbol{W_1}$, $\boldsymbol{W_2}$, and $\boldsymbol{W_3}$), using the bag-of-words approach. For every hidden layer ($\boldsymbol{h_1}$ and $\boldsymbol{h_2}$) the weights are computed to give the final target output $\boldsymbol{Y}$ or the best fitting response by the chatbot.

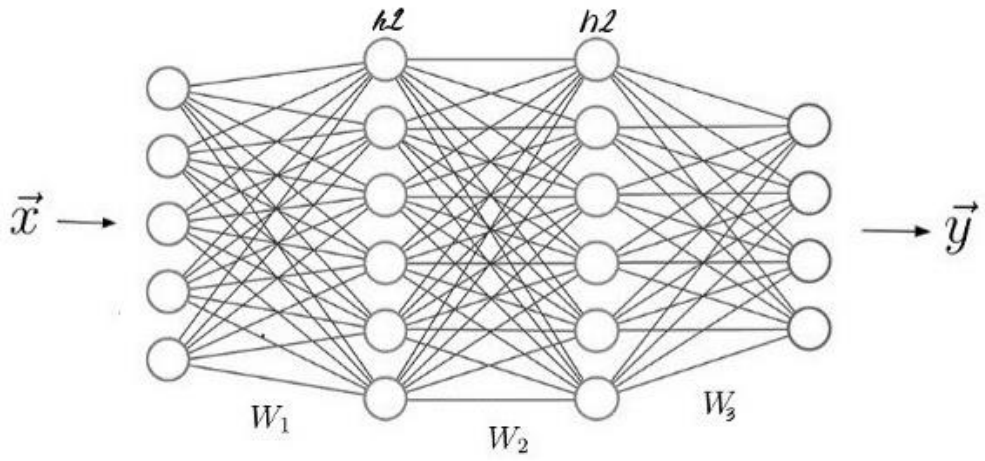

Figure 6.1 A two hidden layer deep learning model

6.3. Model Validation

The prediction accuracy of the developed model was achieved by calling the *model.predict()* function which takes the user input and checks against the training corpus, by using the bag-of-words approach. The prediction accuracy of the model was given for each user input as

shown in Figure 6.2. The model was also able to respond appropriately where the user query did not seem clear.

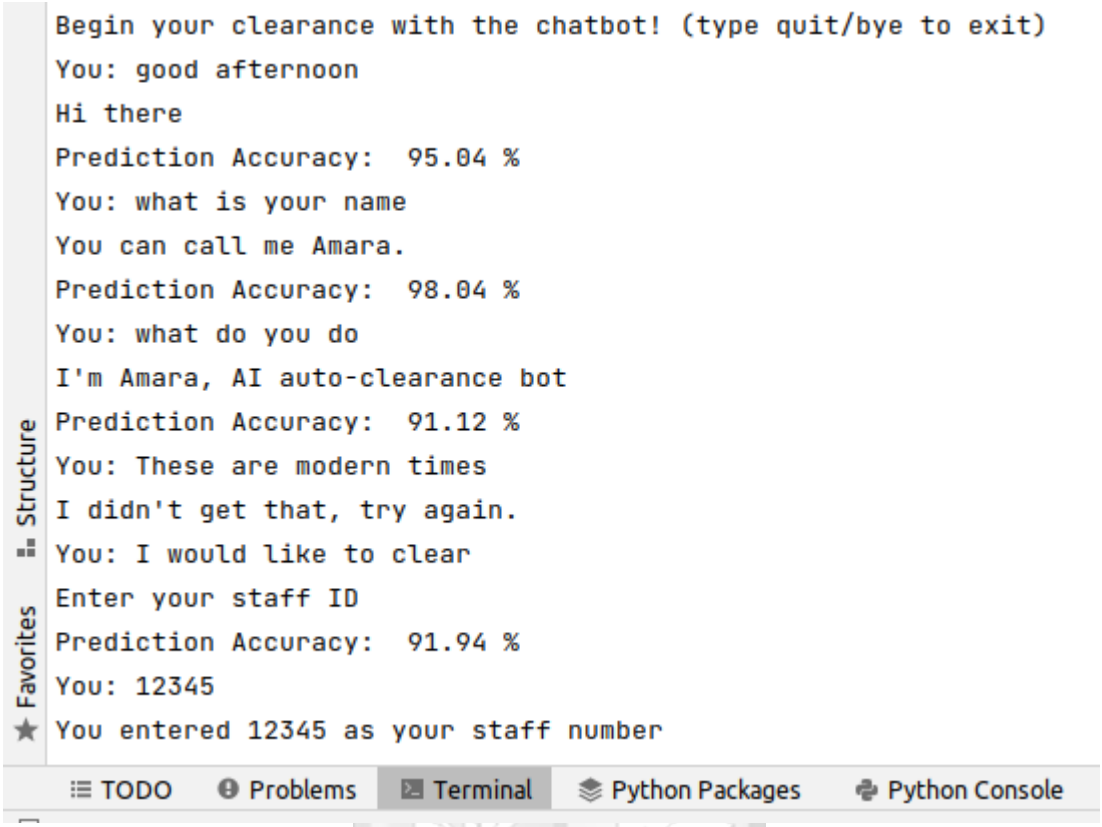

Figure 6.2 Model prediction accuracy for a given user query

6.4. Model Interface with Web Service

The chatbot model is integrated with the web service API which allows for information sharing with the chatbot, users are thus allowed to maintain a continuous session with the chatbot without the need to login to another application for the exit clearance process. In summary, the benefits realized with this integration are:

i. Client Authentication.
ii. Exponential increment of efficiency.
iii. Making the clearance procedure easier for the clearing employee.
iv. Expansion of the chatbot features.
v. Sharing of clearance documents.

6.5. Contribution to Research

This purpose of this deep learning intelligent chatbot model is to improve the general off-boarding process in formal organizations through automation. The findings have revealed a very mechanical exit clearance process which entails movements to and from different offices.

This chatbot model helps to not only cut down on the labor costs but also improve efficiency and record keeping in the clearance process. The exit clearance process involves manual clearance forms, which can sometimes be disadvantaged by duplication and misplacement due to the requirement of appending of a signature by every stakeholder involved. The model resolves this by centrally managing a clearance form for every clearing employee where digital signatures are appended based on the eligibility to clear by the exiting employee.

6.6. Limitations and Challenges of the Chatbot System

These are the conditions that will prevent the desired functionality of the chatbot:

i. Lack of internet access – The chatbot application requires internet access to communicate with the web service.
ii. Lack of consistent training – Training the chatbot is required for every new knowledge it acquires, this will help improve its prediction accuracy.
iii. The chatbot is text-based – Users can only interact with the chatbot through typing.
iv. As pointed out in section 3.9.1, most of the training data was manually created due to lack of availability of quality exit clearance related data during the study.

Chapter 7: Conclusion, Recommendations and Future Work

7.1. Conclusion

This research investigated the employee exit clearance process in formal organizations within Nairobi County, Kenya. The goal was to implement an intelligent chatbot that uses deep learning, to be the exit auto-clearance assistant. In unison, the results of the data analysis revealed an exit clearance process that is not well laid out and clearly organized, which makes it compounded. This inspired and impelled the development of the chatbot model alongside the web service for seamless user experience. The summary of how the objectives set out in section 1.3.2 were met is as follows:

i. The first objective was to investigate the challenges in employee clearance. This objective was addressed using data collection from the field where employee lived experiences in the exit clearance process were captured and analyzed. To supplement this, the empirical framework review of how this process is structured in various organizations was done.

ii. To examine the existing systems used for employee clearance – This was the second objective, a review of relevant literature and on processes, systems and chatbots that support the exit clearance process was done.

iii. The third objective sought to develop an intelligent chatbot implementation for employee auto clearance using Deep Learning. The chatbot model was developed using the Python programming language via the *PyCharm* development environment. The model was given two hidden layers to improve the accuracy of responses.

iv. To test the proposed solution was the fourth objective, which was achieved using metrics used to test and validate the model, among them being typing of random messages unrelated to clearance, then checking the response by the chatbot, Figure 6.2 shows the model prediction accuracy for a given user input.

7.2. Recommendations

This chatbot model is strongly biased towards organizations that have applied automation in handling of their processes, this is because of the reduced learning curve in such cases. In light of this, this study recommends that organizations embrace automation systems and technologies, more so where almost all or entire business processes are carried out manually.

7.3. Challenges Encountered

There were no repositories found with conversational data on employee exit clearance process. Also, getting access to data from organizations that have automated their processes was unworkable, thus a small manually created domain-specific dataset of QA pairs was used.

7.4. Future Research

For all intents and purposes this study champions for and proposes the adoption of an intelligent chatbot in the employee exit clearance process, for a seamless experience. Nonetheless, several limitations were encountered and consequently this report recommends the following issues to be considered for future research:

i. Adoption of an integrated ecosystems for data center, systems and other electronic communication facilities – Organizations can employ complete IT ticketing software for the entire enterprise, this will generate optimal conversation data to be used in training and developing the model for better contextual responses.

ii. AI-powered voice and text - multilingual chatbots – The chatbot system in this study was limited to text. Therefore, this study proposes a chatbot that can capture, interpret, and analyse vocal input given by the speaker and respond in a similar natural language used. The chatbot will allow users to interact with it using voice commands then respond using contextualized, relevant responses.

iii. Sentiment analysis – This will enable the chatbot to frame empathetic responses based on the user query or input, put differently, the chatbot will comprehend user emotions and apply them in a real-time communication.

iv. Personalized, menu-driven graphical user interface tailored to the organization requirements, with features such as intuitive graffiti boards for appending of digital signatures, and dynamic effects like animated transitions.

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Appendices

Appendix A: Interview Guide

Interview Guide for the Thesis Project Titled: An Intelligent Chatbot Implementation for Employee Exit Auto-Clearance using Deep Learning

Date: _____

Interviewer: Lawrence Kasera **Interviewee: _____**

Interview Mode: _____

Interviewer Script

Introduction and Brief Explanation of the Project

Provide a brief introduction of who you are, what the project is about, and the purpose of the interview including the expected duration. Explain how the information will be put to use and how confidentiality will be maintained.

Topic	**Question**	**Probe**
Icebreaker	Introduce yourself, optionally say something about where you work, and what your day at work is like.	*Establishing the profession, organization and role of the interviewee, at work.*
Employee Exit Clearance Clearance is an essential process that must take place when an employee is leaving an organization.		
Exit Clearance	1. Would you say that you are at the front line of this process in your current organization?	*Inspect if they are involved in the exit clearance process.*
	2. Have you worked in a different organization before?	

	If Yes 2a. What was your exit clearance experience? 2b. Do you think the employee exit clearance process in that organization can be done differently? **If Yes** 2c. Kindly give your recommendation.	*This questions aims to know their clearance experience.*
	3. Would you say that your current organization has applied automation in the employee exit clearance process? **If Yes** 3a. In what way?	*Inspect if their organization has automated the exit clearance process.*
	4. Are there any automation ideas you can recommend for the clearance process in your current organization? **If Yes** 4a. Kindly outline them	*Check for their exit clearance automation ideas.*
Artificial Intelligence and Automation Automation and computerization has undoubtedly revolutionized many ways in which businesses operate and conduct business, on the other hand, AI is transforming the future.		

Automation	1. Have you ever heard of Artificial Intelligence? **If Yes** 1a. Do you think it can be applied in your organization as part of automation? **If Yes** 1b. Kindly list the areas of potential application.	*Check if their organization can apply AI*
Chatbots Chatbots are automated online services (some are AI based) that you interact with in text-based conversations, they can be found in instant messaging platforms such as Facebook Messenger, Kik, Slack, and Telegram.		
Use of Chatbots	1. Have you used such chatbots? **If Yes, proceed with the next questions.** 1a. For how long have you used chatbots, or the messaging platforms which use chatbots? If you can't remember, how often do you use the chatbots? 1b. What is your main reason (motivations and experiences) for using chatbots? 1c. Do you think chatbots which interact with a user,	*Check their knowledge on chatbots* *Examine their chatbot usage*

	just like a normal person, and assist in the exit clearance process, can be applicable to your current organization? **If Yes** 1d. Kindly give a short explanation of how and name the potential application areas, i.e. What departments can benefit from such a chatbot 1e. What benefit do you think such a chatbot will bring to this exit clearance process?	*Inspect if the exit clearance chatbot can be applicable in their organization.* *Explore on the pressing issues that the chatbot will address, if adopted.*
Closing Remarks	Thank the interviewee for participation and open the forum for any questions and discussions that can be helpful in this interview, and to the project at large.	

Appendix B: Ethical Approval

Strathmore UNIVERSITY

11th March 2022

Mr Kasera, Lawrence
lawrence.kasera@strathmore.edu

Dear Mr Kasera,

RE: An Intelligent Chatbot Implementation for Employee Auto-Clearance using Deep Learning

This is to inform you that SU-IERC has reviewed and **approved** your above **SU- masters'** research proposal. Your application reference number is **SU-IERC1212/21.** The approval period is **11th March 2022 to 10th March 2023.**

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-IERC.
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-IERC within 48 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-IERC within 48 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to SU-IERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology, and Innovation (NACOSTI) https://research-portal.nacosti.go.ke/ and obtain other clearances needed.

Yours sincerely,

for: **Dr Ben Ngoye,**
Secretary; SU-IERC

Cc: Prof Fred Were,
Chairperson; SU-IERC

STRATHMORE UNIVERSITY INSTITUTIONAL ETHICS REVIEW COMMITTEE (SU-IERC)
11 Mar 2022
Email:ethicsreview@strathmore.edu
P.O BOX 59857-00200
NAIROBI-KENYA

Appendix C: NACOSTI Research License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **919286**

Date of Issue: **26/April/2022**

RESEARCH LICENSE

This is to Certify that Mr.. Lawrence Mwakio Kasera of Strathmore University, has been licensed to conduct research in Nairobi on the topic: An Intelligent Chatbot Implementation for Employee Exit Auto-Clearance using Deep Learning for the period ending : 26/April/2023.

License No: **NACOSTI/P/22/16899**

919286

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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Appendix D: Similarity Report

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Document Information

Analyzed document	An Intelligent Chatbot Implementation for Employee Exit Auto-Clearance using Deep Learning.docx (D133402636)
Submitted	2022-04-11T23:50:00.0000000
Submitted by	
Submitter email	Lawrence.Kasera@strathmore.edu
Similarity	1%
Analysis address	library.strath@analysis.urkund.com

Sources included in the report

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SA	**TRANSFORMER article journal.docx** Document TRANSFORMER article journal.docx (D114435757)	4