ENHANCING THE USABILITY OF A UNIVERSITY STUDENT SUPPORT SERVICES FAQ CHATBOT

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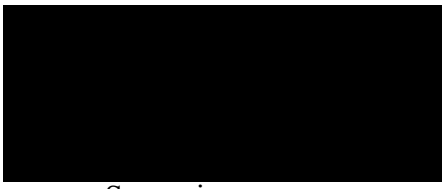
Declaration

I, Luthfiya Essop, declare that this dissertation is a representation of my own work both in conception and execution. This work has not been submitted in any form for another degree at any university or institution of higher learning. All information cited from published or unpublished works has been acknowledged.

Luthfiya Essop Date: 15 August 2024

Approved for final submission.



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Dedication

Bismillahir Rahmanir Rahiim.

I praise and thank All Mighty Allah for giving me guidance, strength, and courage to complete this dissertation. In addition, may peace and salutations be given upon the Beloved, the best out of all creations Prophet Muhammad ﷺ)Sallallahu Alayhi Wa Salaam), His family and companions. I am also profoundly grateful to Hazrath Khwaja Garib Nawaaz رضي الله عنه, Hadrath Soofie Saheb رضي الله عنه and Ammijaan for making dua on behalf of me to Allah.

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Abstract

Chatbots play a vital role in customer facing interaction. They offer real-time text or voice responses via intuitive human interaction systems and are often driven by AI technologies. Despite widespread adoption, their optimisation for university environments remains elusive.

With a lens on Universities of Sub-Saharan Africa, this dissertation positions *usability* as essential in a chatbot's ability to provide effective support for student support services. This dissertation identifies with the dire need for more rigorous design and development in line with the needs of a modern, inclusive university sensitive and responsive to its students' varying degrees of multiculturalism, multilingualism, socio-economic standing and technology and digital literacy baseline skills. The topic of chatbot integration in University systems has received significant attention in recent years but few have focused on the interplay between usability factors such as, anthropomorphism, NLP, or UX. This has limited our understanding of how best to enhance chatbots, specifically in University student support services.

This study aimed to identify the key design factors for an enhanced usability FAQ chatbot, tailored for University student support services. In pursuit of this aim, a usability design framework as well as a FAQ chatbot was developed and tested in a popular University in South Africa. The base functional requirements were inferred from extant literature and then fused with data collected from students and administrative members of staff. The design framework was also influenced by well-known usability principles and standards from ISO, Nielsen and Shneiderman and others. Google Dialogflow was used to develop the chatbot, architected by the design framework.

Based on the DSR paradigm, the research followed a systematic approach encompassing usability design, framework development, tool evaluation, and FAQ chatbot development and testing. First-year students and administrative staff members were active participants and served as change agents during the iterative DSR process. Thematic analysis was used to carefully analyse the feedback from participants during the development stages and seed this into the ongoing design process. This iterative process of development and refinement allowed for a richer understanding of how users perceive and interact with the chatbot. During analysis of the final evaluation feedback, PLS-SEM illuminated relationships, dependencies and interactions among various usability design factors which influence the chatbot's overall usability.

The major contribution is a blueprint for the design and development of an effective University student support services FAQ chatbot. Theoretical contributions include a usability design framework, iterative DSR development process and evaluation and feedback instruments using robust analysis techniques. There is a need for further research and refinement at the confluence of NLP, anthropomorphism and FAQ chatbot design frameworks.

Keywords: Chatbot, FAQ, University Administration, Design Science Research, Partial Least Squares Structural Equation Modelling (PLS-SEM), Anthropomorphism.

List of Publications

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Table of Abbreviations

Abbreviation	Full Form or Meaning
FAQ	Frequently asked questions
HEI	Higher education institutions
ICTAS	Information Communications Technology and Society
UI	User interface
UX	User experience
NLP	Natural language processing
ML	Machine learning
LLM	Large language models
DSR	Design science research
PLS-SEM	Partial least squares structural equation modelling
4IR	Fourth industrial revolution
DUT	Durban University of Technology
FAI	Faculty of Accounting and Informatics
DF	Design Features (persona)

Chapter 1: Introduction

This chapter frames the research undertaking by describing the context, research problem, aim, objectives, and research question. It provides an overview of the research design and the intended contributions to the body of knowledge, universities, and the practitioner community.

1.1 Background and motivation

A chatbot is an artificial intelligence (AI) program that is designed to simulate a conversation with a human user in a natural language conversation via text or voice. Chatbots are built to provide users with an efficient and effective way of getting responses in real-time without human intervention. AI chatbots can be classified according to their AI proficiency, functionalities, and the technologies they utilise. Various AI chatbot types emerge from this categorisation, each showcasing distinct characteristics and applications:

- **Rule-based chatbots:** Rule-based chatbots operate on predetermined rules and conditions. They provide predefined responses based on keyword matching and follow a structured conversation flow. While they lack adaptability and learning capabilities, rule-based chatbots are quick to implement and are suitable for scenarios where interactions are well-defined and predictable (Radziwill and Benton 2017; Adamopoulou and Moussiades 2020b).

- **Machine language (ML) based chatbots:** ML based chatbots leverage algorithms to recognise patterns in data and enhance responses over time. Unlike rule-based counterparts, ML chatbots can adapt to user input patterns. They improve their understanding through continuous learning, making them more flexible and capable of handling evolving conversations. ML chatbots excel in scenarios where interactions are dynamic and may involve nuanced language, allowing for a more adaptive and context-aware conversational experience (Zhou *et al.* 2020).

Natural language processing (NLP) chatbots: NLP chatbots utilise advanced language understanding techniques to interpret user intents and provide context-aware responses. Within NLP chatbots, intent recognition chatbots focus on extracting the meaning behind user queries, while entity recognition chatbots identify and extract specific information from user input. These chatbots excel in understanding natural language, enabling more sophisticated and human-like interactions by deciphering user intentions, and extracting relevant details. NLP chatbots are well-suited for applications where a deeper

understanding of user input is crucial, such as customer support or information retrieval (Radziwill and Benton 2017; Adamopoulou and Moussiades 2020b). Types of NLP chatbots:

- **Generative chatbots:** These are often open-domain chatbots, employ natural language generation techniques to dynamically create responses. These chatbots can engage in more open-ended conversations, simulating human-like dialogue without relying on predefined responses. Additionally, content creation chatbots within this category can generate creative content like articles or poetry based on user input or specific guidelines. Generative chatbots showcase a higher degree of creativity and adaptability, making them suitable for diverse applications such as interactive storytelling, content creation, and engaging in open and fluid conversations (Vinyals and Le 2015).

- **Contextual chatbots:** These chatbots excel in maintaining context across interactions, enhancing the coherence and relevance of responses. Context-aware chatbots consider previous user inputs, enabling a more seamless and natural flow in conversations. Memory-augmented chatbots within this category leverage external memory or context storage to recall and reference past interactions, further improving their ability to provide personalised and relevant information. Contextual chatbots are well-suited for applications where the continuity and depth of conversation are essential, such as personalised customer support or dynamic problem-solving scenarios (Khurana *et al.* 2023; Min *et al.* 2023).

- **Hybrid chatbots:** These chatbots integrate multiple technologies and approaches to combine the strengths of different models. A combination of rule-based and AI integration chatbots merge rule-based systems with ML or NLP capabilities. Scripted and dynamic content chatbots blend scripted responses with dynamic content generation, balancing control and flexibility in conversations. Hybrid chatbots are designed to harness the advantages of both rule-based and AI-driven systems, offering adaptability, learning capabilities, and predefined structure. They are versatile solutions suitable for scenarios where a combination of rule-based guidance and adaptive, intelligent responses are desired (Tran, Pallant and Johnson 2021; Yan, Li and Yu 2022).

- **Voice-enabled chatbots:** These chatbots leverage speech recognition technology to convert spoken language into text, enabling seamless interaction through voice input. They cater to a more natural and hands-free user experience (UX). Additionally, text-

to-speech chatbots within this category can convert textual responses into spoken language, enhancing the overall conversational flow. Voice-enabled chatbots are well-suited for applications where users prefer or need to communicate verbally, such as in-car virtual assistants, hands-free devices, or scenarios where manual input may be challenging. They contribute to a more accessible and user-friendly interaction model by incorporating spoken language capabilities (Malodia *et al.* 2021; Lu *et al.* 2024; Pucci *et al.* 2024).

- **AI assistants:** Includes virtual assistants such as Siri, Google Assistant, and Alexa, which provide comprehensive services across various aspects of users' daily lives. These assistants can answer queries, perform tasks, and assist with a wide range of functions. They leverage a combination of technologies, such as NLP, ML, and voice recognition, to understand user commands and provide relevant information or execute requested actions. AI assistants are characterised by their versatility and ability to integrate with various devices and applications, offering users a seamless and personalised experience across different platforms. They play a pivotal role in enhancing user convenience and accessibility in the rapidly evolving landscape of AI-driven interactions (Tang *et al.* 2016; Malodia *et al.* 2021).

- **Emotionally intelligent chatbots:** These chatbots are designed to analyse and respond to user emotions, creating more engaging and empathetic interactions. Emotion recognition chatbots within this category can analyse user input to understand emotional cues, while empathy-driven chatbots simulate empathy in responses, aiming to establish a more emotionally connected interaction. These chatbots are particularly relevant in applications where a human-like touch is desired, such as mental health support or customer service. By incorporating emotional awareness, these chatbots enhance UX by adapting responses to the user's emotional state, fostering a more meaningful and empathetic engagement (Xu *et al.* 2019; Bilquise, Ibrahim and Shaalan 2022).

- **Transactional chatbots:** Designed to facilitate specific transactions and tasks. E-commerce chatbots assist users in making purchases, tracking orders, and providing information about products. Banking chatbots handle financial transactions, check account balances, and offer banking-related information. These chatbots streamline processes, providing users with efficient and convenient ways to conduct transactions

within their respective domains. Transactional chatbots are valuable in industries where seamless and secure interactions for tasks like online shopping, financial transactions, or information retrieval are essential. Their primary focus is on delivering a smooth and hassle-free experience for users engaged in specific transactional activities (Madotto, Wu and Fung 2018; Bai *et al.* 2023).

These chatbots are often employed in situations where providing accurate and predefined information is the primary goal.

The implementation of chatbots in general has grown exponentially in popularity due to their efficiency in performing tasks without the need of human supervision (Anon 2022). The idea of chatbots gained prominence over the past few years, with the adoption of chatbots in various industries such as e-commerce, medicine, human resource, travel industry, real-estate, banking, hospitality, food-tech, and education (Fernandes 2022). Research suggests that chatbots have the potential to change the way students interact with technology (Winkler and Soellner 2018). Chatbots in education have assisted students to easily access their educational resources. For instance, chatbots can be used to provide personalised feedback to students, help them access their learning materials and provide administrative support. While the benefits of chatbots in education has led to a wide range of chatbots being adopted, researchers have primarily focused on the development of chatbots such as tutoring systems in higher education (Lidén and Nilros 2020; Lopez and Qamber 2022). Recently attention has shifted to the effectiveness of chatbots in providing students with improved administrative support (Wolff *et al.* 2019). Literature portrays this as an emerging research domain.

Administrative chatbots also known as of frequently asked question (FAQ) chatbots provide informative responses to student queries with regards to support services while helping to reduce the workload of administrative officers (Lee *et al.* 2019b). Yang and Evans (2019) point out that physical help desks receive hundreds of requests from students and staff members. Therefore, there is no quick response time, due to large workloads and staff shortages to assist students with their queries. Heo and Lee (2019) claim that the use of chatbots has proved to be convenient and effective for students enquiring about course programme information and looking for answers to the FAQs about the university.

To keep up with these changes in our digital world, higher education is striving to innovate by embracing Education 4.0 or digitisation. While we are more than two decades into the 21st century, higher education is still primarily focused on providing students with information and

administrative assistance via physical help desks (Redecker and Punie 2017; Shahroom and Hussin 2018). Chatbots are one of the technologies emerging in the fourth industrial revolution (4IR). The implementation of automation through the adoption of chatbots will assist universities that strive to be more digitised (Javaid, Haleem and Singh 2023).

Given the fact that FAQ chatbots are already being rapidly implemented for administrative support services in universities, one area that requires further investigation is usability. Usability of a system can be defined as how well a user can complete a task in the least amount of time Daud, Teo and Zain (2020). However, determining usability for a chatbot is quite different from that of a website or app. This is further complicated when the chatbot needs to cater to a wide range of language and culture, digital skills, and intellect levels, especially in a public university environment (Klopfenstein *et al.* 2017; Følstad and Brandtzaeg 2020).

Considering these challenges and the evolving digital landscape in higher education, the current research aimed to develop a usability framework tailored specifically for a university administration support FAQ chatbot. The focus was to ensure that the usability of this technology aligns with the diverse needs of first-year students, considering factors such as language diversity, cultural variations, varying levels of digital literacy, and intellectual capacities. The framework sought to optimise the UX, thereby enhancing the acceptance and usage of the chatbot among first-year students seeking administrative support services within the university setting.

1.2 Research problem

University administration chatbots have undergone significant evolution to cater to the growing need for automation and self-service. While early chatbots were simplistic and offered limited functionality, mostly restricted to providing basic information like operating hours and contact details, current chatbots are more sophisticated and can provide administrative support to university students while impersonating university administrative staff members.

Several researchers have developed chatbots to assist universities in providing administrative support to students. For example, Asia Pacific University (APU) developed a chatbot called *APU Admin Bot* to provide students with a quicker solution to resolving their queries instead of depending on the administrative offices (Singh, Joesph and Jabbar 2019). The *APU Admin Bot* is a rule-based chatbot designed to answer frequently asked questions related to the university. However, one limitation of the *APU Admin Bot* is the lack of NLP capabilities,

which limits its ability to understand the nuances of natural language, leading to inaccurate or incomplete responses.

Similarly, chatbots developed by Chandra and Suyanto (2019), Lee *et al.* (2019b), and Santana *et al.* (2021) were deemed too basic and unable to handle complex questions or provide personalised responses, resulting in student dissatisfaction with the chatbots' responses. Ahmad *et al.* (2020) also expressed concerns about the need for the *Uniselbot* chatbot to be "more knowledgeable and user-friendly". Mabunda and Ade-Ibijola (2019) expressed similar concerns about the *Pathbot* at the University of Johannesburg.

Despite the increasing use of chatbots in university administrative services, the impact of their implementation has not been thoroughly investigated. Thus, there is still uncertainty about whether a usability-enhanced university administration chatbot can effectively improve the UX of students while potentially reducing the workload of office staff. More research is needed to address these limitations and improve the effectiveness of chatbots in university administrative services.

There is a growing interest in understanding how to assess and improve the interaction with chatbots. However, to the best of this researchers' knowledge, there are currently no standardised tools to reliably assess the end user's satisfaction with chatbots from multiple perspectives. With a lens on FAQ chatbots in higher education, this dissertation views usability of a chatbot as an essential factor in its ability to provide effective support for university administration services. This dissertation sees the need for more rigorous end user evaluation in line with the demands of a university setting which includes, but is not limited to, varying degrees of multiculturalism, multilingualism and varying levels of technology skill and digital literacy. The topic of chatbots in universities has received significant attention in recent years, but has not focused on individual aspects of chatbot usability such as anthropomorphic factors or UX, and not taken a holistic approach that considers the interactions and relationships between these different factors. This approach to usability evaluation has limited our understanding of how chatbots can be designed and implemented to best serve the needs of users in a public university environment. It is envisaged that this approach that encompasses a number of evaluation perspectives will provide a questionnaire that is more rigorous for chatbot evaluation.

1.3 Research question

How can a framework be developed to enhance the usability of a university administration support FAQ chatbot, thereby improving its acceptance and usage among first-year students?

1.4 Research aim and objectives

1.4.1 Aim

To develop a framework that enhances the usability of a university administration support FAQ chatbot to improve the acceptance and usage among first-year students.

1.4.2 Objectives

These objectives collectively provide a systematic approach towards achieving the aim of improving the usability and acceptance of the university administration support FAQ chatbot among first-year students, ensuring it aligns with the specific needs and context of university support service provision.

- **Research Objective 1: To determine the FAQs in the context of university administrative support services**

  This objective aimed to identify and compile a comprehensive list of frequently asked questions relevant to university administrative support services. It served as a foundational step to ensure the FAQ chatbot addresses pertinent queries students might have within the administrative domain.

- **Research Objective 2: To establish a set of usability key design features for a FAQ chatbot**

  This objective involved defining and outlining specific usability key design features crucial for enhancing the functionality and effectiveness of the FAQ chatbot. It contributed to understanding the elements necessary to optimise UX and engagement.

- **Research Objective 3: To develop a usability framework that can be used as a reference for the design and evaluation of the FAQ chatbot**

  Developing a usability framework is essential to guide the design and evaluation processes. This framework served as a reference point, ensuring that the chatbot aligned with established usability standards, fostering a user-centric approach throughout the development and evaluation stages.

- **Research Objective 4: To evaluate development tools and platforms and choose those most suitable for FAQ chatbot university administrative support services**
  This objective focused on the evaluation and selection of appropriate development tools and platforms necessary for creating the FAQ chatbot tailored to university administrative support services. It emphasised the importance of choosing tools that aligned with the specific requirements of the chatbot's functionality and usability.

- **Research Objective 5: To develop a FAQ chatbot in the context of university support service provision and evaluate the FAQ chatbot**
  This objective involved the actual development of the FAQ chatbot based on the determined FAQs and usability design features. Additionally, it included evaluating the developed chatbot to assess its functionality, usability, and effectiveness in improving user acceptance and usage among first-year students seeking support services within the university context.

1.5 Overview of the research design

To achieve the study's objectives, the research utilised a design science research (DSR) methodology. This approach was instrumental in identifying and integrating usability and design acceptance factors within a comprehensive usability framework. The primary focus was on developing an enhanced usability FAQ chatbot tailored to meet the needs of first-year students within the context of university support service provision.

Table 1 illustrates the application of each research approach and method, showcasing their contributions in addressing the research questions, fulfilling the aim, and achieving the specified objectives. It delineates how the usability framework was employed to guide the incorporation of essential usability and design factors into the development process. The ultimate research deliverable aimed to be an FAQ chatbot equipped with a refined usability framework, fostering improved acceptance and usage among first-year students seeking university support services.

1.6 Significance and contribution of the study

The study's significance lies in its specific contribution to the understanding of students as end users and their satisfaction while engaging with chatbots, an area that necessitates unique considerations beyond conventional human-computer interfaces. By delving into the factors specific to chatbot interactions, this research makes a unique contribution to the existing

knowledge base, adding depth and clarity to an evolving field that lacks standardised approaches.

Moreover, this study's relevance extends beyond academia, directly benefiting universities by enhancing administrative services through improved chatbot usability. Indirectly, it supports universities' digital transformation initiatives and aligns with the global push towards the 4IR. This dual impact, both direct and indirect, underscores the study's potential to drive positive changes within university settings, facilitating smoother operations and fostering technological advancement.

1.7 Chapter outline of this dissertation

The outline of each chapter of this dissertation is as follows.

Chapter 1: Introduction

This chapter frames the research undertaking by describing the context, problem, aim, objective, and research questions. It provides an overview of the research design and the intended contributions to the body of knowledge, universities in 4IR and practitioner community.

Chapter 2: Literature review

The literature sets out to provide a foundational knowledge on the use and design of FAQ chatbot in universities, highlighting the current significance of the features that contribute to the adoption of chatbots, and explaining how this research improves the already existing chatbot design elements.

Chapter 3: Research methodology

The research methodology chapter describes and motivates the DSR methods used for this research.

Chapter 4: Design, development, and evaluation of the FAQ chatbot using semi-structured interview

This chapter focuses on the design, development, and demonstration phases, particularly the intricate details involved in shaping the FAQ chatbot's functionality and features.

Chapter 5: Evaluation of the FAQ chatbot

This chapter elaborates on the final evaluation of the FAQ chatbot in order to gather insight into the FAQ chatbot after the redesign was applied, and uncover potential relationships and patterns within the data that could inform the development and refinement of the FAQ chatbot.

Chapter 6: Summary, future research, and limitations

This chapter provides a clear answer to the research questions of this study, summarises the key findings, and the limitations of this research.

Table 1: Research questions; aims and objectives; research approach and methods; research deliverables

Main Research Question	**Research Aim**	**Research Approach**	**Research Deliverables**	**Chapter where objective is achieved**
How can a framework be developed to enhance the usability of a university administration support FAQ chatbot, thereby improving its acceptance and usage among first-year students?	The aim was to construct a comprehensive usability framework for an FAQ chatbot tailored to university administrative support services, focusing on augmenting efficiency and user acceptance, specifically among first-year students.	The research employed a mixed-methods approach, encompassing literature review, empirical data collection through semi-structured interviews, and usability evaluations. Design science research (DSR) methodology was used to identify, incorporate, and assess key usability design features crucial for the FAQ chatbot's enhanced effectiveness.	The study aimed to achieve the development and implementation of an enhanced FAQ chatbot tailored to university administrative support services. This comprehensive chatbot incorporates a refined list of FAQs, critical usability design features, and a specifically designed usability framework. Additionally, the research encompassed the evaluation and selection of appropriate development tools and platforms. Ultimately, the consolidated deliverable is a fully developed and assessed FAQ chatbot catering to the needs of first-year students, emphasising improved administrative support within the university context.	Chapter 2 to 5
Sub-Questions	**Research Objectives**	**Research Method**	**Research Deliverables**	
What are the FAQs concerning university administrative support services relevant to first-year students?	To determine and compile a refined list of FAQs that address the specific needs and queries of first-year students regarding administrative support services at the university.	Conduct semi-structured interviews with first-year students and administrative staff at Ritson campus handling FAQs to gather comprehensive feedback and identify recurring queries.	Compilation of a refined list of FAQs relevant to university administrative support services, intended for integration into the chatbot.	Chapter 4
What are the essential usability design features	To establish a set of usability design features crucial for	Conduct a literature review to identify and analyse previous	Identification and establishment of critical	Chapter 2 and 3

necessary for optimising the acceptance and usability of the FAQ chatbot among first-year students?	improving the acceptance and usability of the FAQ chatbot among first-year students.	studies on usability design features that contribute to improved acceptance of chatbots, especially among first-year students.	usability design features aimed at enhancing the FAQ chatbot's acceptance and usability, specifically tailored for first-year students.	
What are the key elements required to develop a comprehensive and adaptable usability framework tailored for the FAQ chatbot in the university context?	To create a usability framework that acts as a reference guide for designing and evaluating the FAQ chatbot, addressing the specific requirements of university support services.	Develop the framework based on identified usability and design acceptance factors from the literature review, incorporating elements such as usability heuristics, UI, UX, key design features, anthropomorphism, and NLP.	Development and implementation of a comprehensive and adaptable usability framework designed specifically for the FAQ chatbot, customised to suit university support services.	Chapter 2 – usability framework Chapter 4 – design and development of the chatbot
What are the key criteria for evaluating and selecting suitable development tools and platforms for constructing the FAQ chatbot tailored to university administrative support services?	To evaluate and select development tools and platforms that align with the specific requirements and functionality needed for the FAQ chatbot in the university context.	Investigate potential development tools and platforms through a comparative analysis based on criteria such as ease of integration, features, adaptability, adherence to the usability framework, and suitability for university administrative support services.	Evaluation and selection of appropriate development tools and platforms optimal for constructing the FAQ chatbot.	Chapter 4
How effective is the developed FAQ chatbot in addressing the needs of first-year students for improved administrative support within the university context?	To develop and evaluate a fully functional FAQ chatbot that effectively provides improved administrative support services for first-year students at the university.	Develop the FAQ chatbot incorporating the compiled refined FAQs, usability design features, and usability framework. Evaluate the FAQ chatbot through semi-structured interviews, questionnaire, and analytical tools to assess its effectiveness and usability.	Creation and assessment of a fully developed FAQ chatbot catering to the needs of first-year students, emphasising improved administrative support within the university context.	Chapter 4 – development of FAQ chatbot Chapter 5 – results of the evaluation of the chatbot

Chapter 2: Literature Review

2.1 Introduction

The chapter begins with establishing a definition of a chatbot, setting the stage for a comprehensive exploration of their role in university administration. Chatbots, as conversational agents powered by artificial intelligence, have become increasingly prevalent in various industries, including higher education. Understanding the essence and capabilities of chatbots is essential for harnessing their potential in improving administrative processes and enhancing the overall UX within universities.

Following the definition, the chapter delves into a review of AI-based chatbot systems specifically designed for higher education institutions. This review provides valuable insights into successful implementations and showcases the impact that chatbots can have on streamlining administrative tasks and providing effective support to students. To navigate the diverse landscape of chatbots, a taxonomy is presented, categorising chatbots based on different dimensions. These dimensions include the knowledge domain, input processing and generation methods, goal-oriented nature, type of interfaces, and the process of choosing the right interface for ensuring an effective UX. By understanding the taxonomy, administrators can make informed decisions regarding the selection and customisation of chatbots that align with their specific administrative needs.

The chapter also addresses the usefulness of FAQ chatbots in various aspects of university administration. From academic advising and registration to housing and accommodation, navigating venues, and managing financial aid and scholarships, FAQ chatbots can play a vital role in facilitating these processes and providing timely and accurate information to students. However, designing effective chatbots comes with its own set of challenges. This chapter highlights some of these challenges, such as providing relevant information, crafting friendly responses, ensuring ease of use, and integrating chatbots with existing systems seamlessly. Moreover, the chapter emphasises the unique factors that African universities need to consider when developing FAQ chatbots. Factors such as multilingualism, the prevalence of multi-digital skilled students, the requirement for low bandwidth solutions, and cost-effectiveness shape the design and implementation of chatbots in this context.

The chapter explores the determinants of usability design and process flow for university administration FAQ chatbots. This includes considerations for user interface, UX design, NLP,

anthropomorphism in chatbots, the importance of personas, and the integration of these components within a conceptual design framework. Lastly, the chapter delves into choosing the appropriate architectural model for chatbots, by developing a conceptual framework. This framework provides a structured approach to integration and evaluation of key components in FAQ chatbot development, ensuring seamless functionality and effectiveness in supporting university administration.

By exploring these various aspects, the chapter aims to provide administrators with a comprehensive understanding of chatbots' potential and the key considerations involved in developing and implementing FAQ chatbots tailored to university administration.

2.2 Literature review method

This research aims to identify the key acceptance factors to improve the usability of FAQ chatbots for first-year university student administrative support. To explore in detail the research questions of this research, The Association of Computing Machinery (ACM) digital library, IEEE Xplore, Science Direct, Springer Link, Web of Science, and Emerald Insight were explored to find papers. Google, ResearchGate, and Google Scholar were used as resources to find papers and websites for the literature. The literature review is a content analysis based and a combination of the following keywords was applied in the search.

Table 2: Keywords used for search

Research Areas:	**Keywords:**
Implementation of chatbots in university.	FAQ chatbots in university environments, Anthropomorphism chatbots in universities, Chatbot applications and methods.
Previous developed and designed chatbots.	Key development platforms used to create FAQ chatbots, Evaluating and informing the design of chatbots.
Developing chatbots with Dialogflow, and NLP.	Dialogflow for creating FAQ chatbots, Natural Language Processing for chatbots in e-learning, Tools used to design and develop chatbots.
UX for chatbots.	Perceived usefulness, Perceived ease of use, User experience (UX) for universities students with regards to FAQ chatbots.
Design aspects for chatbots.	Design models used to create chatbots, Key design acceptance factors for chatbots in university, Usability factors for university students.
Chatbot usability.	Chatbot efficiency, effectiveness, and user satisfaction, acceptance, and use.

The keywords listed in Table 2 were combined to broaden the search results and cast a wide net. The purpose of the literature review was to provide a foundation of knowledge on the topic, and gain an understanding of the existing research and debates relevant in identifying the design aspects for an anthropomorphic chatbot in a university setting.

2.3 Chatbot systems: definition, evolution, and taxonomy

The first section discusses the definition, history, and taxonomy of chatbots.

2.3.1 A definition of chatbots

According to the Oxford English Dictionary, the definition of a chatbot is as follows:
chatbot (n.): "A computer program designed to simulate conversation with human users, especially over the Internet." Nuseibeh (2018)

The term 'chatbot', also known as chatterbot, conversational agent, bot, or chatter robot, is frequently used to describe a conversational computer program designed to assist users via text to accomplish specific goals. Current researchers have also provided their view on how they perceive chatbots. For instance, chatbots are robots used to communicate with users in a natural language to understand what users want and carry out the user request through a user interface (Long, Yuan and Lee 2019). In some cases, chatbots are described as the ultimate virtual assistant that assists in answering questions on a topic or in a specific domain in a conversational way (Ranoliya, Raghuwanshi and Singh 2017; Smutny 2020). The interaction of a chatbot is in a similar format to instant messaging.

In this dissertation, the adopted definition of a chatbot is "A conversational robot that uses texts in a natural language to provide services to accomplish a well-defined goal". This definition considers the commonly accepted definition of a chatbot as a computer program designed to simulate conversation with human users, especially over the internet, and incorporates the researchers' views on how chatbots are perceived as robots that communicate with users in a natural language to understand and carry out specific goals, and as the ultimate virtual assistant that assists in answering questions in a conversational way. The definition is used as a foundation for the research conducted in this dissertation and provides a clear understanding of the scope and nature of chatbot technology discussed.

2.3.2 A taxonomy of chatbots

By following a rigorous development process, the taxonomy provides a detailed understanding of the different categories of chatbots, which can be used as a framework for chatbot design and development. The process followed to derive the taxonomy involved thematic analysis of the extant literature. Thematic analysis is a qualitative method used to identify, analyse, and report patterns (themes) within data. This process included systematically reviewing and coding the literature to identify key themes and categories relevant to chatbot design and functionality. To provide a clear overview of how existing literature contributed to the development of the taxonomy, Table 3 synthesizes the key findings from reviewed articles and their influence on the taxonomy's categories.

Table 3: Synthesis of literature review and influence on taxonomy development.

Source	Taxonomy	Key Findings	Influence on taxonomy
AbuShawar and Atwell (2015);Hussain, Ameri Sianaki and Ababneh (2019);Adamopoulou and Moussiades (2020b);(Kim and Kim 2022)	Knowledge domain	Discussed the importance of knowledge domains in chatbots.	Influenced the categorization into open domain and closed domain chatbots.
Qiu *et al.* (2017);Gapanyuk *et al.* (2018);Skjuve *et al.* (2021);Khosrawi-Rad *et al.* (2022)	Input processing and generation method	Explored hybrid chatbots combining rule-based and AI approaches.	Helped define hybrid methods in input processing and generation.
Serban *et al.* (2016); Vtyurina and Fourney (2018); Ke, Lin and Lu (2022);Tiwari, Talekar and Patil (2017)	Goal oriented	Discussed retrieval-based, generative-based, and hybrid chatbots.	Integrated into the goal-oriented and input methods categories.
Vtyurina and Fourney (2018); Følstad and Skjuve (2019);Pereira and Díaz (2019);Rapp *et al.* (2023)	Types of interfaces	Highlighted the benefits of predetermined instructions for controlled interactions.	Reinforced the use of predetermined responses in input processing.
Adam, Wessel and Benlian (2021);Isinkaye, AbiodunBabs and Paul (2022);Jo	By location	Developed location-based chatbots to enhance user experience.	Led to the inclusion of location-based chatbots in taxonomy.

(2023);Molnár and Szüts (2018)			

By synthesizing these key findings, the taxonomy was shaped to comprehensively cover the various dimensions of chatbot design and functionality. This table 3 provides a transparent view of the literature that informed the development process and highlights the contributions of different studies to the final taxonomy. To assist chatbot designers in creating effective and efficient chatbots that meet basic user requirements, chatbots are categorised into different types. Figure 1 displays a taxonomy developed as a result of the current research study. This taxonomy provides a detailed understanding of the different categories of chatbots, which can be used as a framework for chatbot design and development. By utilising this taxonomy, chatbot designers can ensure that they are meeting the basic user requirements and creating chatbots that are tailored to specific needs.

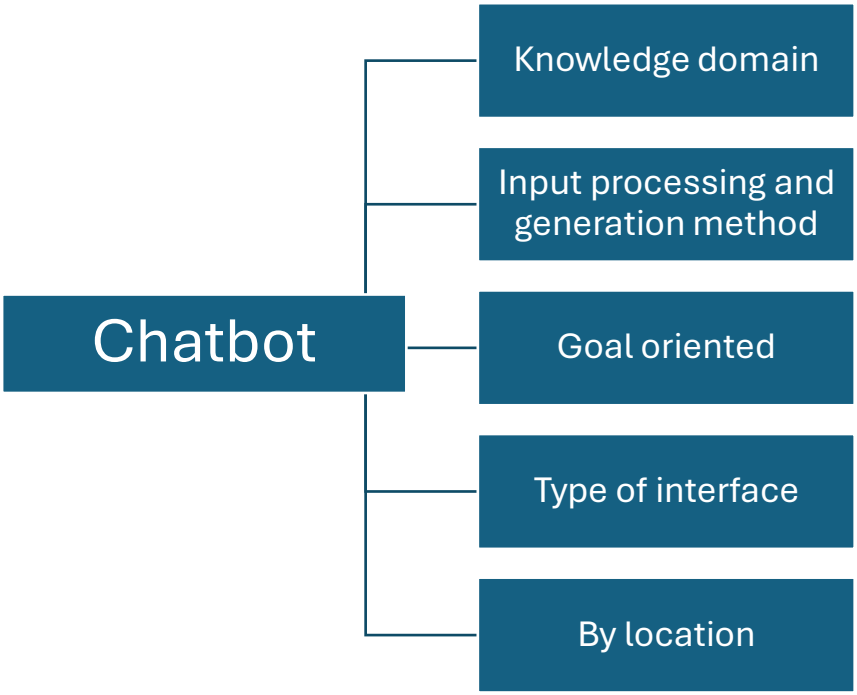

Figure 1: Taxonomy of chatbots

2.3.4 Knowledge domain

Understanding a chatbot's knowledge domain is crucial for chatbot designers to develop more effective and efficient chatbots. Identifying the knowledge domain and purpose of a chatbot is essential to determine the necessary amount of knowledge and training needed to develop the chatbot (Adamopoulou and Moussiades 2020a). Chatbots can be categorised into open domain

and closed domain. Open domain chatbots can discuss general topics and are not confined to a particular environment or sector (Nimavat and Champaneria 2017). In contrast, closed domain chatbots provide users with a more specific environment (Nimavat and Champaneria 2017). For instance, a closed domain chatbot may respond to inquiries about programming software, but its responses would be limited to such queries and unable to respond to general topics.

2.3.5 Input processing and generation method

NLP is essential to the input processing and generation methods of chatbots as it aids in understanding the user query. The processing of user input requests and generating the appropriate response goes hand-in-hand with the knowledge domain. The two most common input processing and generation methods are predetermined responses and hybrid methods. Predetermined responses or rule-based systems are known for pattern matching. Pattern matching is used when the possible outcomes are fixed with similar scenarios. For instance, Banfi (2018) developed a chatbot called *Swelly* that allows its users to select from a list of options and vote on pictures. The list is a pre-programmed feature that limits users to selecting only what is available. However, Joshi (2020) disagrees and points out that the use of predetermined instructions provides a more controlled environment that allows for better interaction.

Hybrid chatbots or 'smart' chatbots combine predetermined responses and machine learning (ML) (Gapanyuk *et al.* 2018). Hybrid chatbots assist in improving the approach to responding to user queries more efficiently. For example, a hybrid chatbot developed by Wu *et al.* (2020) was used to assist students with an e-learning platform. The core response context of the chatbot was not only designed with course materials in mind but also everyday conversation and chitchat (Wu *et al.* 2020). The tools used to develop the chatbot included NLP, a retrieval-based model (predetermined instructions), and a QANet model. QANet is for general learning problems and casual chitchat or conversation with students that mimics a real learning mate or companion (Wu *et al.* 2020). The implementation of hybrid chatbots allows for better communication compared to predetermined chatbots that restrict users to certain tasks or queries.

2.3.6 Goal-oriented

Chatbots are developed to achieve primary goals, including informative, conversational, and task-based chatbots (Nimavat and Champaneria 2017). Informative chatbots are designed to aid users with information available from a fixed source, while conversational chatbots include

human characteristics, providing users with more friendly responses without sounding robotic. Task-based chatbots help users perform specific tasks, such as a FAQ chatbot that aids users with answers to their queries for a specific environment.

Another taxonomy mentioned in the paper by Piro (2021) includes retrieval-based chatbots, generative-based chatbots, and hybrid chatbots. Retrieval-based chatbots retrieve pre-defined responses from a knowledge base or database, while generative-based chatbots use deep learning techniques to generate responses based on input data. Hybrid chatbots combine both approaches, using a combination of pre-defined responses and generated responses to create more natural and coherent conversations.

Recent advancements in ML and NLP have led to the development of more advanced chatbots that can understand and respond to user input more accurately and naturally. For example, the *QANet* architecture is designed for general learning problems and casual chitchat or conversation with users. It uses a combination of self-attention and convolutional neural networks to process user input and generate responses.

2.3.7 Type of interfaces

The use of chatbots has gained significant popularity for enabling efficient and convenient communication with users. With advancements in chatbot technology, it is crucial to explore the various interface options available. The interface serves as the channel through which users engage with the chatbot, impacting the overall UX. Table 4 presents a range of interface types applicable to chatbots.

Table 4: Interface types of chatbots

Type	Explanation	Reference
Text-based interfaces	These are the most common type of interface, where users communicate with the chatbot using text input and receive text output.	Dale (2016);Shawar and Atwell (2007);Colace *et al.* (2018);Vtyurina and Fourney (2018)
Voice-based interfaces	These interfaces allow users to interact with the chatbot using their voice, usually through a virtual assistant or smart speaker device.	Hoy (2018);Kopp *et al.* (2005);Choi *et al.* (2020);Cho *et al.* (2024)
Visual interfaces	These interfaces use graphical elements, such as buttons or menus, to enable users to interact with the chatbot.	Choi *et al.* (2020);Gnewuch, Morana and Maedche (2017);Følstad and Skjuve (2019);Pereira and Díaz (2019)
Hybrid interfaces	These interfaces combine multiple modalities, such as voice and text, to provide a more flexible and natural way for users to interact with the chatbot.	Gnewuch, Morana and Maedche (2017); Pérez-Soler *et al.* (2019); Ma (2024);Rapp *et al.* (2023)

Augmented reality interfaces	These interfaces use computer-generated graphics and animations to create a more immersive experience for users.	Billinghurst, Clark and Lee (2015);Baltrušaitis, Ahuja and Morency (2018);Rietz, Benke and Maedche (2019);Goundar and Kumar (2022)

Gaining knowledge about the various chatbot interface options and comprehending their advantages and limitations can assist chatbot designers in selecting the most appropriate interface for their unique chatbot and user needs. Furthermore, designers must prioritise the UX by ensuring that the interface is intuitive, accessible, and user-friendly. As chatbots continue to advance and find increased usage across diverse industries, it is essential for chatbot designers to continuously explore and enhance different interfaces to optimise the efficiency and UX of chatbots.

2.3.8 By location

Designing a chatbot for university use requires careful consideration of regional and cultural differences. The following aspects should be tailored to ensure the chatbot meets the specific needs of students in different locations:

- Multilingual Support: Universities in multilingual regions or with diverse international student populations may require chatbots to support multiple languages. The chatbot needs to handle various languages, including local dialects, to communicate effectively with students (O'Leary 2024).
- Localized Expressions: Chatbots must be able to understand and use local idioms, slang, and expressions that are specific to a region. This makes the interaction more natural and relatable for users (Abdalkader 2023).
- Communication Style: The tone and style of communication can vary significantly by region. For instance, a more formal tone might be necessary in some cultures, while others might prefer a more casual, friendly interaction. Cultural nuances in communication need to be respected in the chatbot's design (Kim 2024).
- Content Relevance: The chatbot should be designed to provide information that is culturally relevant and sensitive. For example, topics like holidays, social events, or university traditions should align with local practices and values (Farias-Gaytan, Aguaded and Ramirez-Montoya 2023).
- Data Protection Laws: Different regions have different regulations regarding data privacy and storage. For instance, GDPR in Europe mandates strict rules on data

handling. Chatbots need to be designed with these regulations in mind to ensure compliance with local laws (Yilma 2022).

- Internet Connectivity: In areas with limited or unreliable internet access, chatbots must be optimized for low bandwidth usage. This may involve simpler interfaces, reduced data processing requirements, or offline functionality (Farahani *et al.* 2024).
- Device Compatibility: The common devices and platforms used by students can vary based on geographical location. Chatbots should be designed to work seamlessly across the most popular devices and platforms in the target region (Goundar and Kumar 2022).
- Student Needs: The specific needs and concerns of students may vary by region. For example, students in some countries may require more support with visa information, while others might need more assistance with housing or financial aid. The chatbot's functionality should address the most relevant issues for the student body in that geographical area (Ade-Ibijola and Okonkwo 2023).
- Cost Sensitivity: In regions where students are more cost-conscious, chatbots can be designed to offer advice on budget-friendly options, scholarships, or financial aid (Al-Hashimy *et al.* 2022).
- Natural Disasters and Local Crises: In regions prone to certain natural disasters or political unrest, chatbots can be designed to provide information and updates during crises. They can offer resources, contacts, and instructions relevant to the local situation (Akpan *et al.* 2024).

2.3.9 Categorising chatbots and choosing the right interface for effective user experience

Gaining a comprehensive understanding of the various chatbot interface types and their respective strengths and limitations empowers chatbot designers to select the most fitting interface for their specific chatbot and user requirements. Additionally, designers should prioritise the UX by ensuring that the interface is intuitive, accessible, and user-friendly. With chatbots increasingly prevalent across industries, continuous improvement and experimentation with different interfaces are vital to enhance UX and maximise chatbot efficiency. Choosing the appropriate platform is crucial for chatbot developers, as it should align with the chatbot's intended purpose and target audience. By identifying the most suitable platform, developers can optimise the chatbot's effectiveness and efficiency, resulting in an improved UX (Nimavat and Champaneria 2017; Adamopoulou and Moussiades 2020b).

In summary, chatbots can be classified into various types based on factors such as their

knowledge domain, input processing and generation methods, goals, and interfaces. By comprehending these different categories, chatbot designers can create more effective and efficient chatbots that fulfil essential user requirements. Recent advancements in ML and NLP have resulted in the development of more sophisticated chatbots capable of understanding and responding to user input with greater accuracy and naturalness. The choice of interface for a chatbot also plays a crucial role in shaping the overall UX. Therefore, it is imperative to consider the range of available interfaces for chatbots to ensure efficient and convenient communication with users.

2.4 The usefulness of FAQ chatbots in university administration

The integration of chatbots in universities has revolutionized the way students receive information. By providing real-time responses to frequently asked questions, chatbots have eliminated the need for students to physically visit their universities. This has not only benefited students but has also relieved administrative offices from handling many queries. In the past decade, universities have increasingly adopted chatbots due to their efficiency in responding to university-related queries (Sandu and Gide 2019; Nunes 2022). However, the usefulness of chatbots is not limited to just answering FAQs. They can play a significant role in various aspects of higher education administration (Gonzalez-Bonorino and Lauría 2022; Izadi and Forouzanfar 2024).

This section will focus on the different applications of chatbots in higher education administration under separate sub-headings. This will demonstrate the varied roles that chatbots can play in assisting students and administrative staff in universities.

2.4.1 Academic advising

Chatbots can be used to provide academic advice to students. For example, the FAQ chatbot developed by de Lacerda and Aguiar (2019) for the University of Brasilia imitated an academic adviser to provide students with assistance in answering their queries. The chatbot included dialogue flows, chatbot personality, and vocabulary to increase the UX of students. This type of chatbot can assist students in selecting courses, understanding programme requirements, and identifying academic resources.

2.4.2 Registration

Chatbots can also assist with student registration processes. For instance, the *KuduBot* created for the University of Witwatersrand, Johannesburg (Anon 2020) provides students with 24/7

support on the university website. This chatbot can answer queries related to registration deadlines, required documents, and eligibility criteria. It can also provide step-by-step guidance on how to complete the registration process, ensuring that students can complete their registration without needing to physically visit the university.

2.4.3 Housing and accommodation

Chatbots have proved to be a helpful tool for students inquiring about housing and accommodation related queries. The University of Cape Town has implemented a chatbot accessible via WhatsApp to assist students with university-related queries, including housing and accommodation related queries (Krige 2021). This chatbot provides students with useful information on available accommodation options, application processes, and move-in dates. By using the chatbot, students can access up-to-date information in real-time without having to visit the university, which is particularly useful for international students or those who live far away. Moreover, the chatbot has reduced the workload of administrative staff by handling frequently asked questions related to housing and accommodation. This kind of application has significantly streamlined the process of finding accommodation for students and improved the efficiency of the university's administrative services.

2.4.4 Navigating venues

Chatbots can also be used to assist students in locating venues on campus. For example, the FAQ chatbot developed for the University of Cape Town by Krige (2021) aids students with university-related queries, including finding specific buildings or rooms on campus. This type of chatbot can be particularly helpful for new students who are unfamiliar with the campus layout. The chatbot can help students find buildings, classrooms, and other campus locations. It can also provide information on accessibility and parking options.

2.4.5 Financial aid and scholarship

Chatbots have been introduced in universities to assist students with financial aid and scholarship related queries. For instance, Ramirez (2021) developed an AI chatbot to assist first-generation Hispanic students with financial aid and scholarship-related queries. The chatbot provided personalised assistance to students and could answer questions related to financial aid, scholarships, and other university-related queries.

The chatbot also helped students with the application process for financial aid and scholarships by providing step-by-step guidance. It was able to provide information on different types of

financial aid, eligibility criteria, and the application deadline. Additionally, the chatbot helped students understand the terms and conditions of financial aid, including repayment plans and interest rates. Students found the chatbot helpful in providing them with quick and accurate information, which they could access at any time. The chatbot also helped reduce students' anxiety and stress levels when navigating the complex process of applying for financial aid and scholarships.

In summary, the integration of chatbots in universities has proven to be highly beneficial in improving the efficiency of administrative services and enhancing the student experience. The use of FAQ chatbots has allowed students to receive real-time responses to their queries, reducing the need for physical visits to universities. Chatbots have also demonstrated their usefulness in various aspects of higher education administration, such as academic advising, registration, housing, and accommodation, navigating venues, financial aid and scholarship assistance. By providing personalised assistance, step-by-step guidance, and up-to-date information, chatbots have significantly streamlined administrative processes and reduced the workload of administrative staff. Therefore, universities should continue to explore and implement the use of chatbots to improve their services and support their students.

2.5 Some challenges of chatbot design

While chatbots have become increasingly popular in higher education, they still pose some challenges for chatbot developers and their users. Chatbots designed to provide administrative support for university students can face several challenges after implementation. In particular, users may encounter issues related to the chatbot's ability to provide relevant information, communicate in a friendly manner, and offer a usable interface. Design features and anthropomorphism may also play a role in users' experiences. In this section, we will explore these challenges in greater detail and consider potential solutions to improve the UX.

2.5.1 Providing relevant information

One of the critical challenges of chatbot design is providing relevant information, especially for those designed to support university students with administrative tasks. Despite the progress made in developing chatbots for universities, there are still limitations in the provision of accurate and useful information to users. For instance, the chatbot developed by Hien *et al.* (2018) for the University of Hong Kong suffered from slow response times and provided less information than the programme booklet, making it less reliable for students seeking accurate and relevant information. Similarly, Ahmad *et al.* (2020) reported that *UniselBot*, developed to

assist students with marketing queries, lacked informative responses. These findings suggest that chatbot designers need to explore innovative ways to improve chatbots' ability to provide accurate and informative responses while avoiding the robotic responses that undermine the UX.

In addition to the challenges of providing relevant information, chatbot designers also need to ensure that the chatbot can understand and respond to user queries accurately. This is a crucial aspect of chatbot design as users rely on the chatbot to provide them with the information they need. One possible solution to this challenge is to incorporate NLP into the chatbot's design. NLP allows the chatbot to understand and interpret the user's query, even if it is phrased in an unconventional way or includes errors. By using NLP, the chatbot can provide more accurate responses and reduce the likelihood of misunderstandings.

2.5.2 Friendly responses

One challenge of chatbot design is creating friendly responses that make the chatbot feel less robotic. Users are more likely to engage with a chatbot that feels approachable and human-like. Ho *et al.* (2018) found that their chatbot, while seen as a novelty, was not yet something to rely upon due to its slow interaction and lack of efficiency. Similarly, Tsivitanidou and Ioannou (2021) expressed that current chatbot developers need to incorporate content-related topics, personalised guidance, and feedback to learners. Chatbot designers can use anthropomorphism to make the chatbot feel more approachable and less robotic. Anthropomorphism involves designing the chatbot with human-like features and behaviours, such as using a name, avatar, and personality. Additionally, designers can use NLP techniques to create more human-like responses to user queries, making the chatbot feel more like a human conversation partner.

2.5.3 Navigating venues

Another challenge of chatbot design is creating an intuitive navigation system that guides users to the information they need. A poorly designed navigation system can lead to frustration and disengagement from users. Chatbot designers need to carefully consider the chatbot's menu and structure, ensuring that it is easy to navigate and understand (Mabunda and Ade-Ibijola 2019). They can use buttons and quick-reply options to provide users with pre-set options for common queries, allowing them to quickly access the information they need. Additionally, designers can use ML algorithms to understand user behaviour and optimise the navigation system accordingly. By creating an intuitive navigation system, chatbot designers can improve the UX and increase user engagement.

2.5.4 Usability

In addition to providing accurate and friendly responses, chatbot designers must also prioritise usability to ensure that users can easily interact with the chatbot and find the information they need. Usability refers to the overall ease-of-use and efficiency of a chatbot's interface. A lack of usable interface is a common challenge in chatbot design. Ho *et al.* (2018) found that their chatbot had poor interaction efficiency, making it difficult for users to find the information they needed. Mabunda and Ade-Ibijola (2019) also noted that their *PathBot* chatbot lacked a visual map, which could have made it more user-friendly and easier to navigate. von Wolff *et al.* (2019) point out that many FAQ chatbots for universities still have limitations in terms of usability.

To address these challenges, chatbot designers should prioritise usability testing throughout the development process to ensure that the chatbot is user-friendly and efficient. This may involve incorporating features such as clear navigation menus, visual aids, and streamlined interaction flows to help users find the information they need quickly and easily. Chatbot designers need to prioritise usability when designing their chatbots, ensuring that users can easily interact with the chatbot and find the information they need.

2.5.5 Integration with other systems

When designing a chatbot to provide administrative support for university students, one important aspect to consider is integrating the chatbot with other relevant university systems. This includes integrating the chatbot with the university's enrolment system, academic advising system, and other administrative systems. By doing so, the chatbot can provide students with accurate and up-to-date information, such as enrolment deadlines, course availability, and academic requirements (Smutny and Schreiberova 2020; Nguyen *et al.* 2024). It also allows the chatbot to provide personalized support to students based on their academic records and other relevant information stored in university systems (Aleedy, Atwell and Meshoul 2022).

Therefore, chatbot designers should prioritize the integration of their chatbot with relevant university systems to enhance the user experience (UX) and provide more effective support to students. Ensuring seamless integration with existing systems allows the chatbot to act as a comprehensive administrative tool, improving overall efficiency and user satisfaction (Laranjo *et al.* 2018).

In summary, while chatbots have gained popularity in higher education, developers and users still encounter various challenges. These challenges encompass delivering relevant

information, crafting friendly responses, designing an intuitive navigation system, ensuring usability, and integrating the chatbot with relevant university systems. To overcome these challenges, chatbot designers should prioritize usability testing throughout the development process, incorporate natural language processing (NLP), employ anthropomorphism to create a more human-like chatbot, and consider integrating the chatbot with other pertinent university systems (Følstad, Nordheim and Bjørkli 2018). By enhancing the UX through these approaches, chatbots have the potential to revolutionize administrative support services in higher education, simplifying and streamlining student access to essential information.

2.6 Unique factors African universities need to consider when developing FAQ chatbots

Each university has unique requirements that need to be taken into consideration, especially for African universities. This section focuses on identifying the unique needs of African students to allow chatbot designers to understand and ensure that these requirements are met when developing FAQ chatbots for African universities. The following sub-sections outline some of the unique factors that African universities need to consider.

2.6.1 Multilingualism

African universities often struggle to provide informative and reliable information in official languages that students can understand (Mabrouk *et al.* 2021). This is because African institutions face the need to improve communication across digital channels and struggle to make the information as reliable as possible. Additionally, African universities have students who speak different languages and dialects, making it challenging to provide information in a single language (Mittelmeier *et al.* 2019). Therefore, chatbot designers need to ensure that FAQ chatbots developed for African universities support multilingualism and can provide information in various languages(Ade-Ibijola and Okonkwo 2023).

2.6.2 Multi-Digital Skilled Students

Another factor to consider is the digital divide that exists in African universities. African universities have students who are both tech-savvy and non-tech-savvy, which puts a strain on universities (Mabrouk *et al.* 2021). To cater to all types of students, universities must invest in costly measures. Therefore, chatbot designers need to develop FAQ chatbots that are user-friendly and require minimal digital skills to operate.

A significant digital divide persists in African universities, where both tech-savvy and less digitally proficient students coexist (Mabrouk *et al.* 2021). This gap necessitates substantial investment from universities to accommodate the varying digital skills of their student populations. In South Africa, for example, the integration of digital tools and platforms has shown promise in enhancing student engagement and learning, yet it also highlights the challenge of unequal digital proficiency (Ngcamu 2019). To bridge this gap, it is crucial for chatbot designers to create user-friendly interfaces that do not demand extensive digital skills, thereby ensuring accessibility for all students (Matizirofa *et al.* 2021; Opesemowo and Adekomaya 2024).

By addressing these unique factors, chatbot designers can develop chatbots that meet the needs of African students, improving communication and providing reliable information.

2.6.3 Low Bandwidth Requirement

Many African countries have limited internet access, with slow internet speeds and high data costs (Faloye and Ajayi 2022). Therefore, it is crucial to design chatbots that have a low bandwidth requirement, enabling them to function effectively in low internet connectivity environments. Designing chatbots for low bandwidth ensures that students can access essential information without being hindered by connectivity issues. This approach also helps to bridge the digital divide, making educational resources more accessible to a broader range of students regardless of their internet capabilities (Johnson *et al.* 2016).

2.6.4 Cost-Effective Solutions

African universities face financial challenges due to the limited budget allocated to higher education (Faloye and Ajayi 2022). It is costly for universities to provide experienced staff members to assist students in answering their queries. The implementation of FAQ chatbots in African universities can cater to the unique needs of students by providing them with reliable real-time information in different languages, and at a lower cost than hiring staff members (Chisom, Unachukwu and Osawaru 2023).

Overall, it is essential for chatbot designers to understand the existing challenges in post-implementation in chatbots, as this will allow them to develop chatbots that are more efficient and effective for students. Additionally, chatbot designers need to identify the unique needs of students. This study identified how African universities face similar challenges as universities in developed countries, but with specific considerations that are relevant to the African context.

By addressing these unique factors, chatbot designers can develop chatbots that meet the needs of African students, improving communication and providing reliable information.

2.7 Determining the usability design and process flow of a university administration FAQ chatbots

Chatbots have become an increasingly popular tool for streamlining administrative processes. However, the development of effective and user-friendly chatbots requires careful consideration of various design aspects. This section will explore the design aspects that are crucial for creating successful chatbots in higher education administration systems as well as the importance of usability, user interface (UI), user experience (UX), the role of NLP, anthropomorphism, and design personas. By examining these design aspects, we aim to provide insights into how chatbots can be developed to effectively meet the needs of higher education administrators and students.

2.7.1 Usability

Usability is defined as a "system's capacity to allow users to carry out their tasks safely, effectively, efficiently, and enjoyably" (Bacigalupo *et al.* 2013; Lee *et al.* 2019a). In other words, usability assists chatbot designers to ensure that their users can successfully achieve a specific goal using the chatbot. Usability improves the overall UX and increases adoption of the chatbot (Ren *et al.* 2019a). Therefore, chatbot designers need to understand the role of usability in existing research to ensure that usability is present in the chatbots they develop.

2.7.1.1 A key aspect for HEI FAQ admin chatbot in the unique African situation

In the context of a higher education institution (HEI), FAQ chatbots usability play a crucial role in ensuring that students, staff, and other stakeholders can use the chatbot to carry out their tasks safely, effectively, efficiently, and enjoyably. HEI FAQ chatbots are designed to assist users in finding answers to their questions about academic programs, admission requirements, financial aid, campus life, and other related topics. If the chatbot is not usable, users may get frustrated and abandon the chatbot, resulting in a poor UX and reduced adoption rates.

One of the main challenges of designing a usable HEI FAQ chatbot is the unique African situation. As discussed in section 2.6 Unique factors African universities need to consider when developing FAQ chatbots factors such as language diversity, low digital literacy rates, and unreliable internet connectivity pose significant challenges for chatbot designers. To address these challenges, chatbot designers need to incorporate usability features that cater to the

specific needs of African users. For instance, the chatbot should be able to understand and respond to different African languages, provide clear and concise answers, and work offline or with low bandwidth internet connections.

2.7.1.2 Usability heuristics for HEI FAQ admin chatbot design

It is necessary to explore the types of usability design areas to determine the best suitable usability features that closely relates to chatbots. For instance, the Schneiderman's eight golden rules designed by Ben Schneiderman (Shneiderman and Plaisant 2004), is a commonly used approach in designing effective human-computer interaction interfaces. Figure 2 shows Schneiderman's eight golden rules for usability design. These eight golden rules were initially introduced in 1986 long before the common implementation of chatbots we see today.

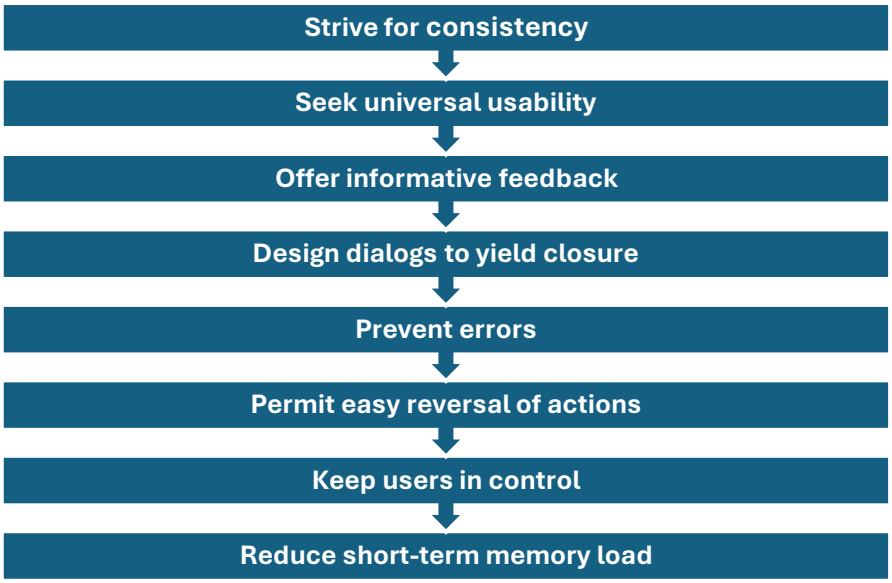

Figure 2: Shneiderman's Eight Golden rules
Source: (Shneiderman and Plaisant 2004)

An additional usability design area is Nielsen's ten usability heuristics (Jiménez *et al.* 2012). Usability heuristics are a measurable process used to improve the ease of use during the design process (Nielsen 2005; Mazumder and Das 2014). Figure 3 sows Nielsen's ten usability heuristics.

Figure 3: Nielsen's ten usability heuristics
Source: (Nielsen 2005)

Chatbot designers can apply the use of usability heuristics features to improve the usability of a chatbot. Several authors have considered the adaptation of the Schneiderman's eight golden rules, and Nielsen's usability heuristics and related them to usability features for chatbots. For instance, a different approach was taken by Holmes *et al.* (2019) with the use of Schneiderman's eight golden rules and Nielsen's usability heuristics. Holmes *et al.* (2019); Chung and Lee (2020) suggest that these usability design areas do not closely relate to chatbots, as they do not focus on the conversational intelligence, chatbot personality and chat interface of the chatbot. Hence, it is essential to explore which design areas of usability closely relate to chatbots and not only to the user interface of a system. Chatbot designers need to keep in mind that the main areas that make up a chatbot are conversational intelligence, personality, and interface, when selecting usability design areas (Ciechanowski *et al.* 2019; Kamis *et al.* 2020).

To ensure that the HEI FAQ chatbot is usable, chatbot designers need to incorporate usability design areas that closely relate to chatbots. Nielsen's ten usability heuristics, adapted by Langevin *et al.* (2021) for chatbots, is a useful framework for designing usable chatbots. The usability heuristics focus on key areas such as visibility of system status, a match between the system and the real world, user control and freedom, consistency, and standards, helping users recognise, diagnose, and recover from errors, help and guidance, flexibility and efficiency of use, aesthetic, minimalist, and engaging design, error prevention, trustworthiness, and context preservation (Javaid, Haleem and Singh 2023).

By incorporating these usability heuristics into the design of the HEI FAQ chatbot, chatbot designers can ensure that the chatbot is easy to use, provides relevant and accurate answers, and offers an enjoyable UX. For example, the chatbot should provide clear feedback to users, allow users to make mistakes and undo actions, use consistent language and actions, offer helpful suggestions for error resolution, and provide adequate help and guidance (Höhn and Bongard-Blanchy 2020). The chatbot should also have an engaging and user-friendly design that aligns with the HEI's brand and values (Wiboolyasarin *et al.* 2024).

Langevin *et al.* (2021) expanded Nielsen's ten usability heuristics so that it closely relates to chatbots. The features of the usability heuristics are as follows: the visibility of system status; a match between system and the real world; user control and freedom; consistency and standards; help users recognise, diagnose, and recover from errors; help and guidance; flexibility and efficiency of use; aesthetic, minimalist and engaging design; error prevention; trustworthiness; and, context preservation. What chatbot designers overlooked was the importance of usability in chatbots and not only focus on their user interface features. Therefore, the usability heuristics proposed by Langevin *et al.* (2021) were used in the current research to develop the FAQ chatbot, to ensure that user adoption and UX is achieved. Table 5 summarises the usability heuristics presented by Langevin *et al.* (2021) and their application by various authors in the context of chatbots for HEIs.

Table 5: Usability heuristics in the context of chatbots for HEIs

Usability Heuristics	**Supporting Publications in HEI Chatbot Context**
Visibility of the system status, "keeping users informed about what is going on through appropriate feedback", within a reasonable time without overwhelming the user	Höhn and Bongard-Blanchy (2020)
The match between the system and the real world involves the chatbot understanding and responding to a user in their natural language	Lin (2019); Langevin *et al.* (2021)
User control and freedom allow the user to commit mistakes and permits them to undo actions without having to go through extensive dialogue	Ayobami, Hector and Hammed (2012)
Consistency and standards involve the user not having to wonder what certain words, opinions, and actions mean. Responses and actions should be kept simple and consistent even if they commit the same function multiple ways	Pedroli *et al.* (2018)
Helping users recognise, diagnose and recover from errors, the chatbot should be able to identify the problem and constructively suggest a solution to the user	Castro *et al.* (2019)
Help and guidance, chatbots should be able to guide their users to retrieve and search to allow users to	Langevin *et al.* (2021)

achieve their goal while making actions and options visible when appropriate	
Flexibility and efficiency of use should support the user with appropriate input and output modality and hardware	Castro *et al.* (2019)
Aesthetic, minimalist and engaging design of the chatbot dialogues, should not contain irrelevant information. The interface should support short interactions and expand on the conversation if the user chooses	Langevin *et al.* (2021)
Error prevention in the chatbot must involve the use of good error messages along with careful design of the interface to reduce the likelihood of an error occurring	Castro *et al.* (2019)
Trustworthiness in chatbots is to ensure the privacy of user data	Langevin *et al.* (2021)
Context preservation should maintain the conversation topic and allow the user to refer to past messages	Höhn and Bongard-Blanchy (2020); Langevin *et al.* (2021)

Table 5 serves as a helpful resource for developers and researchers working on chatbots for HEI, as it provides a comprehensive overview of the different heuristics that can be applied to improve usability, thus forming the usability framework for this research. By incorporating these heuristics into the design and evaluation of chatbots, developers can create more effective, efficient, and satisfying UXs for students and staff at HEIs.

2.7.1.3 Usability framework for a FAQ chatbot

Utilising these heuristics forms the foundation of a comprehensive usability framework for chatbots in HEI. Cross-referencing with ISO standards ensures alignment with global best practices and standards, enhancing the credibility and reliability of the usability framework. The ISO 9241 are concepts related to usability with an emphasis on effectiveness, efficiency, and satisfaction (Casas *et al.* 2020). Analysing the identified usability heuristics in Table 5 against the ISO concepts of effectiveness, efficiency, and satisfaction helps elucidate their alignment with these fundamental principles, showcasing how each heuristic contributes to improving the overall UX of chatbots within HEIs.

Effectiveness:

- *Visibility of the system status*: Aligns with effectiveness as it ensures users are informed about system operations within a reasonable time, preventing confusion and aiding users in achieving their goals (Höhn and Bongard-Blanchy 2020).

- *Match between the system and the real world*: A chatbot understanding and responding in natural language enhances effectiveness by reducing cognitive load and improving communication efficiency (Lin 2019; Langevin *et al.* 2021).

- *Helping users recognise, diagnose, and recover from errors*: By enabling users to recover from errors seamlessly, effectiveness is increased as it reduces interruptions and allows users to continue their tasks smoothly (Castro *et al.* 2019).

Efficiency:

- *User control and freedom*: Allowing users to undo actions and recover from mistakes efficiently without extensive dialogue supports efficiency (Ayobami, Hector and Hammed 2012).

- *Consistency and standards*: Maintaining consistency and simplicity in responses and actions improves efficiency by reducing the need for users to learn multiple ways of interacting (Pedroli *et al.* 2018).

- *Flexibility and efficiency of use*: Supporting users with appropriate input and output modalities and hardware enhances the efficiency of interactions (Castro *et al.* 2019).

Satisfaction:

- *Aesthetic, minimalist, and engaging design*: Creating engaging dialogues with relevant information contributes to user satisfaction by providing a pleasant and engaging experience (Langevin *et al.* 2021).

- *Help and guidance*: Guiding users effectively towards their goals contributes to user satisfaction by aiding them in accomplishing tasks efficiently (Langevin *et al.* 2021).

- *Trustworthiness and context preservation*: Ensuring privacy, maintaining conversation context, and preserving user data contribute to user satisfaction and trust in the system (Höhn and Bongard-Blanchy 2020; Langevin *et al.* 2021).

2.7.1.4 Mapping heuristics to usability

In their comparison of usability heuristics and accessibility guidelines, (Casare *et al.* 2016) highlighted the overlap and synergy between heuristic evaluation methods and established usability standards. Similarly, in the context of chatbot design for higher education institutions

(HEIs), the mapping of usability heuristics to the core principles of efficiency, effectiveness, and satisfaction reveals significant overlaps that enhance the overall user experience.

For instance, heuristics such as visibility of system status and error recovery align with the principle of effectiveness, ensuring users are well-informed and can smoothly overcome issues, thereby achieving their goals more effectively (Langevin *et al.* 2021). Efficiency is bolstered by heuristics that emphasize user control and freedom, as well as consistency and standards, which streamline user interactions and reduce cognitive load (Rosala 2020; Chagas *et al.* 2023). Satisfaction is enhanced by heuristics focusing on aesthetic and minimalist design, as well as help and guidance, ensuring interactions are pleasant and user-friendly (Höhn and Bongard-Blanchy 2020; Langevin *et al.* 2021).

These overlaps not only validate the relevance of heuristics in improving chatbot usability but also ensure that chatbots provide a more effective, efficient, and satisfying user experience, this can be seen in figure 4. The application of these principles is further supported by recent studies that emphasize the importance of adapting usability heuristics specifically for chatbot interfaces, taking into account conversational intelligence, personality, and the unique interaction patterns of chatbots (Ciechanowski *et al.* 2019; Holmes *et al.* 2019; Chung and Lee 2020; Kovacevic *et al.* 2024).

By integrating these usability heuristics into the design and evaluation process, chatbot developers can create more robust and user-friendly systems that meet the diverse needs of HEI students and staff, ultimately leading to higher engagement and satisfaction levels (Essel *et al.* 2022).

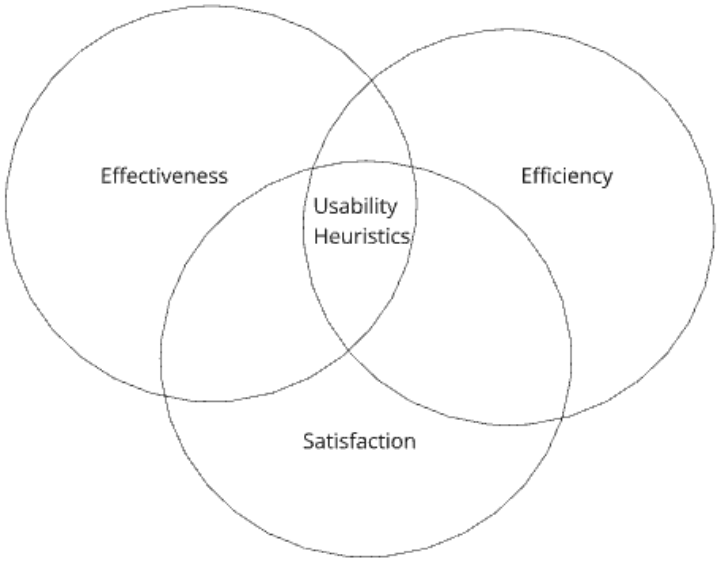

Figure 4: Mapping of usability heuristics to core usability principles

The Figure 4 illustrates the mapping of usability heuristics to the core principles of effectiveness, efficiency, and satisfaction within the framework of chatbot design.

2.7.2 User interface

UI plays a key role as it determines if a user is going to continue to use the application or not. Hannah (2019) defines UI as a point of human-computer interaction and communication on a particular device. UI allows users to interact with the application through input devices. Chatbot designers mainly focus on the conversational interaction between the chatbot and the user. To demonstrate this, Karahanna, Straub and Chervany (1999) reveal that users regularly use or reject new technological interfaces and recommendations of use. Similarly, Hannah (2019) admits that a good UI is vital as it draws in users and facilitates interactions between the user and the application. This indicates that despite the age gap, over the years, users' views of UI and their impact on the user have not changed as they still rely on good and easy UI to be developed.

2.7.2.1 Importance of UI in HEI administration chatbot design

UI is a critical aspect of chatbot design for HEI administration as it determines whether users will continue to use the application or not. The chatbot's UI should draw in users and facilitate interactions between the user and the application. However, developing a good UI can be challenging for chatbot designers. Users have different expectations of the chatbot, and it is

essential to identify the features that contribute to a good UI. These include perceived ease of use, perceived usefulness, performance expectancy, effort expectancy, social influence, and facilitating conditions, among others.

Identifying the features that contribute to UI can assist chatbot designers in developing chatbots with improved UIs that contribute to student acceptance and adoption of the chatbot. Cho, Cheng and Lai (2009) claim that perceived ease of use and user satisfaction are essential strategies for developing such chatbots. Similarly, Sheehan (2018) suggests a list of various UI factors of chatbot technology which enhances the user's experience. The list includes perceived ease of use, perceived usefulness, performance expectancy, effort expectancy, social influence, and facilitating conditions.

Additionally, Fiore, Baldauf and Thiel (2019); Banerjee (2021) outline several UI features that contribute to the acceptance of chatbots. They highlight the importance of ease of task completion, allowing users to complete their tasks with minimal effort, and user-friendly interactions that facilitate ease of task completion. Context awareness is crucial, as understanding the user context and task flows enables fine-tuning of the UI. Personalization creates an enjoyable experience by tailoring the chatbot interactions to individual users, while effective brand communication builds trust by conveying the brand value.

By focusing on these UI features, chatbot designers can create more effective and engaging user interfaces that promote user acceptance and adoption.

2.7.2.2 Challenges and factors in developing a UI for an HEI administration chatbot

Developing a good UI can be challenging. Factors such as user context, task flows, and personalisation need to be considered, and the design should allow users to complete their tasks with ease. Additionally, the UI should communicate the brand value to create trust among its users. Furthermore, there are other challenges that come with developing a chatbot UI. For instance, the chatbot needs to be designed to handle a range of user inputs, which can be difficult to predict. Additionally, chatbots need to be designed with NLP capabilities to understand the user's intent and respond appropriately. This requires an understanding of the user's language, tone, and context.

Another challenge in UI design is ensuring that users can navigate the chatbot easily. Chatbot designers need to ensure that the chatbot's user interface is intuitive and easy to use, as this can greatly impact user adoption and satisfaction. Additionally, chatbot designers need to ensure that the chatbot's UI is consistent across all channels and devices.

Given the intended use of a chatbot in HEI administration, designing a user-friendly and efficient UI is critical. The chatbot needs to be designed to provide accurate and relevant information to students, staff, and faculty, and enable them to complete tasks with ease. Additionally, the chatbot's UI should be designed to communicate the institution's brand value and create trust among its users. By addressing these challenges and considering the factors mentioned, chatbot designers can develop an effective UI that supports the chatbot's intended use in HEI administration.

2.7.2.3 Google's Material Design and Facebook Messenger's design guidelines for FAQ chatbots

Google's Material Design and Facebook Messenger's design guidelines offer valuable insights into creating user-friendly and visually appealing interfaces for chatbots. These guidelines, as discussed by Banfi (2018); Lubbe and Ngoma (2021); Božić (2023); Cho *et al.* (2024), provide a set of principles and best practices for creating user-friendly and engaging interfaces.

Google's Material Design

- **Consistency**: Material Design emphasises maintaining visual and interaction consistency. This means that the FAQ chatbot's design should align with other components and elements of Material Design. Consistency in colour schemes, typography, layout, and design language creates a cohesive and familiar UX.
- **Clarity and readability**: Material Design places a strong emphasis on clear and legible typography. For FAQ chatbots, this means using readable fonts and ensuring that questions and answers are presented in a format that is easy for users to read and understand.
- **Visual hierarchy**: Creating a clear visual hierarchy is crucial. Users should easily distinguish between questions and answers. Material Design provides guidelines on how to structure information to make it easily scannable and accessible.
- **Quick navigation**: Providing users with efficient navigation options is important. For FAQ chatbots, this can include offering a search bar or a list of frequently asked questions as clickable options. Users should be able to quickly find relevant answers without frustration.
- **Conversational tone**: While maintaining a conversational tone in responses is essential, it's equally important to balance it with clarity. Material Design encourages

friendly interactions but advises against sacrificing clarity for the sake of friendliness. Responses should be concise and informative.

Facebook Messenger Design Guidelines

- **Consistency**: Facebook Messenger places a strong emphasis on maintaining a consistent design language. For FAQ chatbots, this means aligning the chatbot's interface with Facebook's design principles. Consistency ensures that users feel comfortable and confident while interacting with the chatbot.
- **Clarity and readability**: As in Material Design, readability is crucial. Use clear fonts and ensure that text-based responses are easy to read. Avoid long paragraphs and opt for concise and scannable content.
- **Visual hierarchy**: Create a clear visual hierarchy in the chatbot's interface. Users should be able to differentiate between questions, answers, and other elements easily. This helps in guiding users to the information they seek.
- **Quick navigation**: Offer users quick and intuitive navigation options. Provide clickable buttons or lists that allow users to explore topics or questions efficiently. A user should never feel lost or overwhelmed within the chatbot.
- **Conversational Tone:** Facebook Messenger encourages a conversational tone but also stresses the importance of maintaining professionalism and clarity. Ensure that the chatbot's responses are not overly casual and that they align with the tone expected in an educational or institutional setting.

By implementing these design guidelines from Google's Material Design and Facebook Messenger, FAQ chatbots can offer a visually pleasing, user-friendly, and efficient UX. These guidelines help in creating interfaces that users find intuitive and enjoyable to interact with, ultimately enhancing the chatbot's effectiveness and usability.

2.7.3 User experience design

A crucial aspect of chatbot design is ensuring a positive UX. According to Patil *et al.* (2016), UX design involves understanding system users to provide them with a helpful, easy-to-use, and enjoyable interaction. To encourage chatbot adoption, designers must pay attention to how the chatbot presents content to the user, including the length of text and size of images (Fadhil 2018). Therefore, it is essential for chatbot designers to understand and apply UX design guidelines to create chatbots with enhanced UXs. This is not only limited to the user interface, but also involves improving the conversational experience in chatbots.

2.7.3.1 The significance of UX design for HEI FAQ admin chatbot

HEIs in Africa, the implementation of an FAQ admin chatbot could serve as a solution to the challenges faced by students and staff. As discussed in Section 2.6 Unique factors African universities need to consider when developing FAQ chatbots the unique African situation presents challenges such as a large student population, limited resources, and lack of access to information. Therefore, the design of the chatbot must be focused on providing users with a seamless experience. A well-designed chatbot with a good UX makes it easier for users to access information and receive prompt responses to their queries. This leads to increased efficiency in the administration of HEIs, as staff will have more time to attend to other pressing issues. Additionally, students will be able to obtain relevant information without having to physically visit the administrative offices or wait for long periods to receive a response to their emails. Incorporating UX design in the development of an HEI FAQ admin chatbot also addresses the challenge of usefulness discussed in Section Designing a chatbot for university use requires careful consideration of regional and cultural differences. The following aspects should be tailored to ensure the chatbot meets the specific needs of students in different locations:

- Multilingual Support: Universities in multilingual regions or with diverse international student populations may require chatbots to support multiple languages. The chatbot needs to handle various languages, including local dialects, to communicate effectively with students (O'Leary 2024).
- Localized Expressions: Chatbots must be able to understand and use local idioms, slang, and expressions that are specific to a region. This makes the interaction more natural and relatable for users (Abdalkader 2023).
- Communication Style: The tone and style of communication can vary significantly by region. For instance, a more formal tone might be necessary in some cultures, while others might prefer a more casual, friendly interaction. Cultural nuances in communication need to be respected in the chatbot's design (Kim 2024).
- Content Relevance: The chatbot should be designed to provide information that is culturally relevant and sensitive. For example, topics like holidays, social events, or university traditions should align with local practices and values (Farias-Gaytan, Aguaded and Ramirez-Montoya 2023).
- Data Protection Laws: Different regions have different regulations regarding data privacy and storage. For instance, GDPR in Europe mandates strict rules on data

handling. Chatbots need to be designed with these regulations in mind to ensure compliance with local laws (Yilma 2022).

- Internet Connectivity: In areas with limited or unreliable internet access, chatbots must be optimized for low bandwidth usage. This may involve simpler interfaces, reduced data processing requirements, or offline functionality (Farahani *et al.* 2024).
- Device Compatibility: The common devices and platforms used by students can vary based on geographical location. Chatbots should be designed to work seamlessly across the most popular devices and platforms in the target region (Goundar and Kumar 2022).
- Student Needs: The specific needs and concerns of students may vary by region. For example, students in some countries may require more support with visa information, while others might need more assistance with housing or financial aid. The chatbot's functionality should address the most relevant issues for the student body in that geographical area (Ade-Ibijola and Okonkwo 2023).
- Cost Sensitivity: In regions where students are more cost-conscious, chatbots can be designed to offer advice on budget-friendly options, scholarships, or financial aid (Al-Hashimy *et al.* 2022).
- Natural Disasters and Local Crises: In regions prone to certain natural disasters or political unrest, chatbots can be designed to provide information and updates during crises. They can offer resources, contacts, and instructions relevant to the local situation (Akpan *et al.* 2024).

2.3.9 Categorising chatbots and choosing the right interface for effective user experience

Gaining a comprehensive understanding of the various chatbot interface types and their respective strengths and limitations empowers chatbot designers to select the most fitting interface for their specific chatbot and user requirements. Additionally, designers should prioritise the UX by ensuring that the interface is intuitive, accessible, and user-friendly. With chatbots increasingly prevalent across industries, continuous improvement and experimentation with different interfaces are vital to enhance UX and maximise chatbot efficiency. Choosing the appropriate platform is crucial for chatbot developers, as it should align with the chatbot's intended purpose and target audience. By identifying the most suitable platform, developers can optimise the chatbot's effectiveness and efficiency, resulting in an improved UX (Nimavat and Champaneria 2017; Adamopoulou and Moussiades 2020b).

In summary, chatbots can be classified into various types based on factors such as their

knowledge domain, input processing and generation methods, goals, and interfaces. By comprehending these different categories, chatbot designers can create more effective and efficient chatbots that fulfil essential user requirements. Recent advancements in ML and NLP have resulted in the development of more sophisticated chatbots capable of understanding and responding to user input with greater accuracy and naturalness. The choice of interface for a chatbot also plays a crucial role in shaping the overall UX. Therefore, it is imperative to consider the range of available interfaces for chatbots to ensure efficient and convenient communication with users.

2.4 The usefulness of FAQ chatbots in university administration. The chatbot must provide relevant and accurate responses to users' queries. It is essential to understand users' needs and preferences to create a chatbot that is user-friendly and easy to navigate. This makes the chatbot more appealing and increase its adoption rate among students and staff.

The African context presents unique challenges such as limited access to technology and low digital literacy levels among some students and staff. Therefore, the chatbot must be designed to cater to users with varying levels of digital literacy. The UX design must be simple and easy to navigate, with clear instructions on how to use the chatbot.

2.7.3.2 Selection and evaluation of UX chatbot guidelines for an HEI FAQ chatbot

The success of a chatbot largely depends on the user experience (UX) it provides. Given the specific challenges and unique African context of an HEI FAQ chatbot, it is imperative to choose the most suitable UX guidelines. The interface of the chatbot and its responses significantly contribute to the UX. The ease of interaction between the chatbot and user also plays a crucial role. Various developer tools like Google Assistant LaMDA (language model for dialogue applications) and IBM Watson Assistant offer UX guidelines, but they have some restrictions and shortcomings.

According to Moore (2018), the adoption of LaMDA has some restrictions, including its inability to handle out-of-scope queries effectively. Similarly, Nithuna and Laseena (2020) found shortcomings in IBM Watson Assistant, such as its inability to provide meaningful responses to certain queries. To ensure the HEI FAQ chatbot delivers a satisfactory UX, it is essential to evaluate and choose the most appropriate UX guidelines. These guidelines should address the specific challenges and unique African context discussed earlier.

One such guideline is the Interaction Design Foundation (IDF) chatbot design guidelines, which cover various aspects of chatbot design, including usability, usefulness, and

conversational design (Srivastava and Prabhakar 2020). These guidelines are comprehensive, focusing on the overall usability and effectiveness of chatbots. However, they may lack specific insights into the visual and interactive design elements crucial for creating a user-friendly and engaging interface (Revicki 2014; Almahri, Bell and Merhi 2020; McMahon 2020).

Google's Material Design guidelines offer a comprehensive framework for designing interfaces and interactions that are intuitive and accessible to users (Seeger, Pfeiffer and Heinzl 2017). These guidelines emphasize visual and interaction consistency, clarity and readability, visual hierarchy, quick navigation, and a conversational tone (Liu *et al.* 2020; Barone 2021; Beena, Kokilavani and Amalarethinam 2021). The consistency in color schemes, typography, layout, and design language creates a cohesive and familiar UX, which is crucial for user engagement and satisfaction (Lidén and Nilros 2020).

Additionally, the Nielsen Norman Group's chatbot design guidelines emphasize the importance of conversational design and personalization in chatbot interactions (Brendel, Kolbe and Diederich 2020). These guidelines are valuable for creating effective conversational interfaces but might not provide as detailed a framework for visual and interaction design as Google's Material Design (Nielsen 1994; Qiu *et al.* 2017; Nordheim 2018).

Facebook Messenger’s design guidelines also provide a comprehensive framework for designing conversational interfaces. These guidelines focus on creating a consistent and user-friendly experience for users interacting with chatbots on the Facebook Messenger platform (Lu *et al.* 2024). They emphasize readability, clear visual hierarchy, quick navigation, and maintaining a conversational tone while ensuring professionalism and clarity (Bickmore and Picard 2005; Onaolapo 2018; Lu *et al.* 2024).

It is essential to evaluate these and other available UX guidelines carefully and select those most appropriate for the HEI FAQ chatbot. Based on the evaluation and comparison of various UX design guidelines, it can be concluded that the chosen set of guidelines, namely Google's Material Design and Facebook Messenger's design guidelines, are the most suitable for the HEI FAQ Admin Chatbot in the African context. These guidelines were selected because they prioritize the user's experience, providing a visually appealing and intuitive interface that supports easy interaction between the user and the chatbot (Haristiani 2019; Chung and Lee 2020; Stephanie 2021).

Incorporating these guidelines into the overall chatbot design framework ensures that the HEI FAQ admin chatbot is user-centric, easy to use, and enjoyable to interact with. The chatbot

design framework emphasizes a user-centered approach, focusing on the needs and preferences of the user. By implementing Google's Material Design and Facebook Messenger's design guidelines, the chatbot framework incorporates a consistent visual language, logical organization, and an intuitive flow of information, enhancing the UX and providing a more effective solution to the user's needs (Gabrielli *et al.* 2020; Zhou *et al.* 2020; Krige 2021).

Overall, the selected UX design guidelines are crucial to the success of the HEI FAQ admin chatbot, as they create an engaging and intuitive UX, leading to increased adoption and usage. Integrating these guidelines into the chatbot design framework ensures that the HEI FAQ admin chatbot is well-designed, user-friendly, and efficient in meeting users' needs.

2.7.4 Natural language processing

Jassova (2019) explains NLP as a type of technology that aims to interpret, recognise, and understand user requests in the form of free language. NLP-based chatbots can decipher the user's query written in their natural language and answer them immediately (Handoyo *et al.* 2018). Notably, the implementation of NLP can assist chatbot designers in developing chatbots that provide their users with appropriate responses. For instance, a user might ask a chatbot a question, and the chatbot may respond with an irrelevant answer or fail to provide a satisfactory answer. Such instances can lead to a frustrating UX, and the user may abandon the chatbot altogether. With the implementation of NLP, chatbots can better understand the user's natural language and provide accurate and relevant responses to their queries. This, in turn, can improve the UX and increase user engagement with the chatbot.

2.7.4.1 Technical workings of NLP in chatbots

NLP capabilities typically involve a pre-processing step that converts user input into a structured format that can be understood by the NLP algorithm. NLP algorithms perform tasks such as named entity recognition, part-of-speech tagging, and sentiment analysis to understand the user's input and intent. The system then matches the user's input to predefined intents and provides an appropriate response. Through ML techniques, the system can learn from user interactions and improve its understanding of natural language over time. Overall, the NLP capabilities of such platforms enable chatbots to understand and respond to user input in a more natural and conversational way.

2.7.4.2 Support for multi-languages

The use of NLP in chatbots can enable effective and efficient support services to students with a first language other than English. However, there is a need to consider the use of multi-languages in chatbots, especially in the context of South African universities where there is a push to promote multilingualism. The recent colloquium on the Department of Higher Education and Training's National Language Policy Framework for Higher Education Institutions highlighted the challenge of promoting multilingualism in South African universities (Villiers 2021). However, the development of chatbots that support multiple languages is currently limited in the context of indigenous African languages (Haruna *et al.* 2020). To address this limitation, chatbot designers can incorporate language models or language tools that support multilingualism, such as providing the responses in commonly used African languages. Supporting multi-languages in chatbots can improve access to support services for students with diverse language backgrounds. The adoption of NLP together with multilingualism in chatbots can lead to a more inclusive and accessible higher education environment.

2.7.4.3 Integrating NLP into the chatbot conceptual design framework

In the context of chatbot design, NLP is a type of technology that aims to interpret, recognise, and understand user requests in the form of free language (Stephanie 2021). The role of NLP in a chatbot is to understand the user's query typed in their own natural language and formulate an accurate and timeous response (Jassova 2019). Multilingualism is the consideration of differing language written texts. The adoption of NLP together with multilingualism in chatbots is a key feature, particularly within the widespread language and cultural diversity typical of a university environment (Handoyo *et al.* 2018). Evaluating the NLP and multilingual capabilities of a chatbot is focused on stringent analysis of the conversations and responses of the chatbot (Villiers 2021).

2.7.4.4 Significance of NLP in multilingual chatbot design for HEI administration: intended use, challenges, and factors

The design of chatbots for HEI administration must consider the diverse linguistic backgrounds of their users. The use of NLP in chatbot design can aid in providing support services to students who have a first language other than English. Multilingualism can pose a challenge for HEIs in South Africa due to the lack of robust African language repositories used in the development

of university chatbots. Therefore, chatbot designers need to consider the importance of multilingualism and NLP when designing chatbots for HEI administrations.

NLP can assist chatbots in understanding and responding to user input more naturally and efficiently. It can also aid in the identification of user intent and sentiment analysis. This, in turn, can improve the overall UX by providing appropriate responses to user queries. The use of NLP together with multilingualism in chatbots can help HEIs provide effective and efficient support services to students, regardless of their language background.

Furthermore, HEIs should consider the cultural and contextual factors of their users when designing chatbots with NLP capabilities. Different cultures may use language in different ways, and these variations should be considered when training the NLP algorithms. Additionally, the availability and quality of language data sets should also be considered when designing chatbots that support multilingualism. This will ensure that the chatbot is trained on data that is representative of the language and cultural context of its users.

In conclusion, the use of NLP and multilingualism in chatbot design is crucial for HEI administration. The diverse linguistic backgrounds of students and staff at HEIs in South Africa make it necessary to design chatbots that can support multiple languages. By using NLP and considering cultural and contextual factors, chatbots can provide effective and efficient support services to all users, regardless of their language background.

2.7.5 Anthropomorphism, chatbots, and service provision

Anthropomorphism, the attribution of human-like characteristics to non-human objects, is a widely used approach in conversational systems such as chatbots (Brendel, Kolbe and Diederich 2020). The use of anthropomorphic features in chatbot design can enhance the user's experience by creating a sense of familiarity and human-likeness. This is particularly important in the context of student support services, where the chatbot's ability to establish a connection with students can impact its acceptance and adoption. Understanding the role of anthropomorphic factors in chatbot design can assist designers in developing chatbots that are more relatable to their users. Empirical studies have indicated that the effectiveness of anthropomorphism features in chatbots depends on how similar the human-likeness features of the technology are to those of its users (Brendel, Kolbe and Diederich 2020).

2.7.5.1 The importance of anthropomorphism in HEI administration chatbot design

Anthropomorphism is an essential aspect of chatbot design for HEI administrations. It refers to the practice of assigning human-like characteristics and traits to a non-human object or entity, such as a chatbot. Chatbot designers use anthropomorphism to enable better interaction between the chatbot and the user, thereby improving the user's experience. Research has shown that the implementation of anthropomorphic features in chatbots can lead to higher user satisfaction and engagement (Brendel, Kolbe and Diederich 2020). In the context of HEI administration, chatbots with anthropomorphic features can provide students with a sense of familiarity and ease when interacting with the system. This is particularly important given the challenges students face in navigating the complexities of university systems, such as registration and financial aid processes.

Designers of HEI administration chatbots should be aware of the factors that influence the acceptance of anthropomorphic chatbots by users. For example, chatbots that closely mimic human-like features such as speech, tone, and personality are more likely to be accepted by users (Brendel, Kolbe and Diederich 2020). It is important for chatbot designers to strike a balance between incorporating anthropomorphic features while avoiding the "uncanny valley" effect, where the chatbot appears too human-like and may cause discomfort or confusion among users. Incorporating anthropomorphic features in HEI administration chatbot design can also help to address the challenge of student retention. According to a study by Israfilzade (2023), chatbots with anthropomorphic features can provide students with a sense of support, leading to higher levels of engagement and a higher likelihood of student retention. Therefore, designers of HEI administration chatbots can leverage anthropomorphic features to enhance the student experience and improve retention rates.

2.7.5.2 Factors affecting anthropomorphism in chatbots

Anthropomorphism is a key aspect for HEI administration chatbot design, given its intended use, challenges, and factors. Blut *et al.* (2021) developed a comprehensive model to investigate the relationship between anthropomorphism, its antecedents, and consequences in the context of service provision. The factors of the comprehensive model are animacy, intelligence, likability, safety, and social presence. Animacy refers to the degree of human likeness of a chatbot, while intelligence and likability pertain to how it learns, solves, and responds to user queries, and the attractiveness of the user's first impression, respectively. Safety pertains to how users perceive the chatbot in terms of feeling safe or in danger, while social presence refers to

the chatbot having a more human-like communication appearance, to the extent that the user feels that they are interacting with a person instead of a chatbot.

The language used by a chatbot is an essential factor that enhances UX. Despite being limited to appearing more human-like, a chatbot may still rely on language that is enriched by emotional semantics or expression of emotions through emojis (Rietz, Benke and Maedche 2019). The adoption of multilingualism in chatbots contributes to making them more human-like and less robotic, thus enhancing their UX. Jung, Cho and Kim (2021) suggest that multilingual capabilities aid in attracting users and contribute to the relationship of anthropomorphism to add favourability to chatbots. Heo and Lee (2019) note that the persona of a chatbot is important because it directly engages and interacts with a prospective user. Thus, the persona must be anthropomorphised for it to be able to successfully converse with the user. Multilingualism in chatbots can assist in giving the chatbot more human-like qualities, which is useful for universities that consist of multilingual students.

Some chatbot designers still disapprove of the anthropomorphic features, as certain users prefer chatbots that function in a non-human manner. Goudey and Bonnin (2016) suggest that human-like qualities in chatbots make some users feel uncomfortable. On the other hand, Sheehan (2018) defends the use of anthropomorphic features, that there is a decrease in the adoption of chatbots when there is an absence of human-like qualities. Araujo (2018) also agrees with the use of anthropomorphism factors in designing the chatbot, as one of the factors contributing to the overall satisfaction and emotional connection with the user. Therefore, chatbot designers need to ensure that the anthropomorphic features are not overused, as they can cause certain users' discomfort.

2.7.5.3 Importance of emotional semantics, multilingualism, and anthropomorphism in chatbots

A chatbot may rely on language that is enriched by emotional semantics or expression of emotions (Blut *et al.* 2021). Measuring anthropomorphism in chatbots can assist in understanding how well the chatbot performed in portraying human characteristics and attracting multilingual users (Fu *et al.* 2020). These authors report that multilingualism in chatbots can assist in portraying more human-like qualities. Measuring the presence of anthropomorphism in chatbots can assist chatbot developers in analysing and understanding how well the chatbot performed in portraying human characteristics.

Emotional semantics, multilingualism, and anthropomorphism are all important factors in chatbot design, especially for HEI administrations. Emotional semantics refers to the use of language that expresses emotions, which can enhance the user's experience by creating a sense of empathy and understanding. Multilingualism is important for chatbots in HEI administration, as it can help them to better connect with multilingual students and provide more personalised support. Anthropomorphism is also crucial in chatbot design, as it can create a sense of familiarity and ease for users when interacting with the system. To help designers create a chatbot that is both helpful and approachable, this research has synthesised a set of guidelines for applying anthropomorphism to a university administration chatbot as shown in Table 6.

Table 6 Guidelines for applying anthropomorphism to a university administration chatbot

Guideline	Description
Determine the chatbot's purpose	Clearly define the chatbot's purpose and functionality to avoid creating unrealistic expectations.
Choose an appropriate persona	Choose a persona that aligns with the chatbot's purpose and the university's brand.
Use appropriate language	Use language that is appropriate for the audience and aligns with the chatbot's persona.
Give the chatbot a name	Give the chatbot a name that is memorable and aligns with the chatbot's persona.
Provide feedback and acknowledgements	Provide feedback and acknowledgement to users to create a sense of connection and empathy.
Use humour with caution	Use humour with caution and avoid controversial topics or jokes that may be offensive.
Use visual design to support persona	Use visual design to support the chatbot's persona and create a consistent experience.
Ensure transparency	Ensure that the chatbot is transparent about its limitations and capabilities to avoid frustration and confusion.
Test and iterate	Test and iterate the chatbot to ensure that it is meeting its intended purpose and to gather feedback for improvement.

In conclusion, incorporating anthropomorphism into a chatbot can prove valuable in boosting user engagement and creating a more personalised experience. However, it is crucial to approach this with thoughtfulness and intentionality, considering the limitations and potential drawbacks of giving technology human-like qualities. By adhering to the guidelines presented in Table 6, developers can ensure that their chatbot strikes the right balance, being friendly and approachable, while also respecting boundaries and safeguarding user privacy. Ultimately, the success of a chatbot hinges on its ability to effectively fulfil its intended purpose and deliver a

positive UX, and anthropomorphism can serve as a powerful tool in accomplishing this objective.

2.7.6 FAQ chatbot design considerations

Understanding the design and architectural process used for chatbots can make the process of developing the chatbot easier. Chatbot designers need to explore the different types of design features they can use in chatbots to provide their users with efficient chatbots. Therefore, this sub-section discusses the types of design features that can improve acceptance, a selection of architectural models, importance of user interface, and the type of platforms used for developing chatbots.

2.7.6.1 Personas

Identifying personas that contribute to a user's acceptance and adoption is a key design consideration. Personas are administrable elements of the chatbot used to obtain a desired performance (Bickmore and Picard 2005). However, for chatbots to be effective, their design must be carefully considered. Design elements such as images, videos, and clickable lists can greatly contribute to the chatbot's adoption and acceptance by the user. In order to develop effective and efficient chatbots, designers must identify the key design features that contribute to a user's acceptance and adoption. Previous research has explored this topic, highlighting the importance of design elements in chatbot performance. For example, Zierau *et al.* (2020) emphasise the role of design principles in increasing user trust and adoption, while Bii, Too and Langat (2013) emphasise the need for informative responses and the capability to display images and videos.

In addition to clickable bubbles, lists, and interactive questions, there are other design features that can also contribute to an effective and engaging chatbot experience for university students. For instance, providing a clear and concise navigation system within the chatbot interface can help students find the information they need more easily (Bonanno *et al.* 2018). Another design feature to consider is the use of visuals such as images, videos, and infographics. Visuals can help to break up long blocks of text, making the information more digestible for students. They can also enhance the overall UX by providing a more engaging and interactive interface (Kumar and Ali 2008). Furthermore, the use of humour or playful language can make the chatbot more approachable and enjoyable for students to interact with, leading to increased usage (Bickmore and Picard 2005).

The use of personas can increase adoption and acceptance among its users. To demonstrate this, Bii, Too and Langat (2013: 4) emphasise that along with informative responses, "there is also a need to add the capability to display images and videos to improve chatbot response speed". The need for design elements with images and videos will provide perceived usefulness in performing a specific task. Images and videos can be used as additional tools to aid the user in a friendly approach. Leah (2021) takes a different approach with the implementation of clickable bubbles or clickable lists, which allows for a more friendly and free approach than overwhelming users with long responses that can discourage users. Sethi (2020) supports the idea of interactive questions as this eliminates the traditional approach of text-based queries. The implementation of clickable lists, images and videos show their importance of being a part of the design elements of a chatbot.

Overall, incorporating a range of design features in chatbots for university students is important to ensure their successful adoption and usage. By considering the user's needs and preferences, as well as incorporating design elements such as gamification, visuals, and accessibility features, chatbot designers can create engaging and effective chatbots that provide valuable support to students.

2.7.6.2 Personas for effective chatbots in university education

Chatbots are becoming increasingly popular in various fields, including education. They provide a quick and efficient way of delivering information and answering students' queries, making them an ideal administrative support tool for universities. However, for chatbots to be effective, their design must be carefully considered. This section will discuss some of the key design features that contribute to a user's acceptance and adoption of chatbots in university education.

2.7.6.3 Interactive design elements

Design elements such as clickable bubbles, lists, and interactive questions can greatly contribute to the chatbot's adoption and acceptance by the user. For example, implementing clickable bubbles or clickable lists allows for a more friendly and free approach than overwhelming users with long responses that can discourage them. Interactive questions, on the other hand, eliminate the traditional approach of text-based queries. For instance, a student who wants to know the examination date for a particular course can simply click on the corresponding course bubble, and the chatbot would provide the information they need. This approach provides a more interactive and user-friendly interface that enhances the UX.

According to Følstad and Brandtzæg (2017), using interactive design elements like buttons and quick replies can streamline the interaction, making it more efficient and user-friendly. This is supported by other studies, such as that by Daza, Peralta Robles and Salazar Jiménez (2023), which highlight that interactive elements can significantly improve user satisfaction and engagement.

2.7.6.4 Visuals

The use of visuals such as images, videos, and infographics can help break up long blocks of text, making the information more digestible for students. They also enhance the overall UX by providing a more engaging and interactive interface. For example, a university chatbot can use images and videos to explain complex concepts or to provide a visual representation of information. A chatbot designed for a biology course can use a video to explain the process of photosynthesis or use an image to show the structure of a plant cell. This approach makes learning more interactive and engaging for students, leading to increased adoption and usage of the chatbot. According to Baskara (2023), the inclusion of multimedia elements in educational chatbots significantly enhances user engagement and learning outcomes. Further, research by Stieglitz, Brachten and Kissmer (2018) supports the effectiveness of visuals in improving comprehension and retention of information.

2.7.6.5 Chatbot personality

Incorporating a chatbot personality can further improve the UX by generating more context-related responses and making the chatbot appear more human-like. By incorporating elements such as emojis, GIFs, and jokes, the chatbot can provide a more engaging and personalised experience that caters to the needs and preferences of students. For example, a university chatbot designed for a student counselling service can incorporate a friendly and approachable personality that helps to put students at ease. This approach can make it easier for students to seek help and support from the chatbot, leading to increased usage and better outcomes.

In summary, incorporating a range of design features in chatbots for university students is important to ensure their successful adoption and usage. By considering the user's needs and preferences, and incorporating design elements such as gamification, visuals, interactive design elements, and chatbot personality, chatbot designers can create engaging and effective chatbots that provide valuable support to students.

2.7.6.6 Impact of personas on enhancing chatbots in South African universities

The design elements discussed in Chapter 2 such as clickable bubbles and interactive questions can greatly enhance the usefulness and effectiveness of chatbots for university students. However, incorporating a chatbot personality, as suggested by Peng and Ma (2019), can further improve the UX by generating more context-related responses and making the chatbot appear more human-like. This can be especially important in the unique African situation where students may feel more comfortable interacting with a chatbot that exhibits personality traits that are familiar and relatable.

Furthermore, the adoption of a chatbot personality can also help address some of the challenges discussed in section 2.7.6 FAQ chatbot design considerations, such as the need for more personalised and culturally relevant support. By incorporating elements such as emojis, GIFs, and jokes, the chatbot can provide a more engaging and personalised experience that caters to the needs and preferences of African students. Additionally, the use of images and videos, as suggested by Chekalov (n.d), can further enhance the cultural relevance and accessibility of the chatbot by incorporating visual elements that are familiar to African students.

Overall, the incorporation of design elements such as clickable bubbles, interactive questions, and chatbot personality can greatly improve the usefulness and effectiveness of chatbots for university students in the African context. By considering the unique needs and preferences of African students and incorporating design features that enhance the UX, chatbot designers can create more engaging and culturally relevant chatbots that can provide valuable support to African students.

2.7.6.7 Fitting design features into the conceptual design framework

The incorporation of design features into chatbots for university students can be viewed within the conceptual design framework, which emphasises the importance of identifying personas that contribute to a user's acceptance and adoption. Design elements such as clickable bubbles, interactive questions, and images and videos can greatly contribute to the chatbot's adoption and acceptance by the user.

Furthermore, incorporating a chatbot personality, as suggested by Peng and Ma (2019), can further improve the UX by generating more context-related responses and making the chatbot appear more human-like. This can be viewed as a way of incorporating the persona of a friendly and approachable chatbot that appeals to the needs and preferences of African students.

Overall, the incorporation of design features such as clickable bubbles, interactive questions, and chatbot personality can greatly improve the usefulness and effectiveness of chatbots for university students in the African context, while fitting within the conceptual design framework that emphasises the importance of identifying personas that contribute to user acceptance and adoption.

2.8 The conceptual design framework

The conceptual design framework for chatbots consists of various stages that are essential for creating a successful and effective chatbot. These stages include defining the problem statement, identifying the target audience, determining the chatbot's scope and functionality, designing the chatbot's conversational flow, and testing and refining the chatbot's performance. Figure 5 outlines the major steps involved in the conceptual design framework, starting with defining the problem and requirements and ending with producing the final product. Along the way, designers conduct research, generate, and evaluate design concepts, and refine and improve the design until it is finalised.

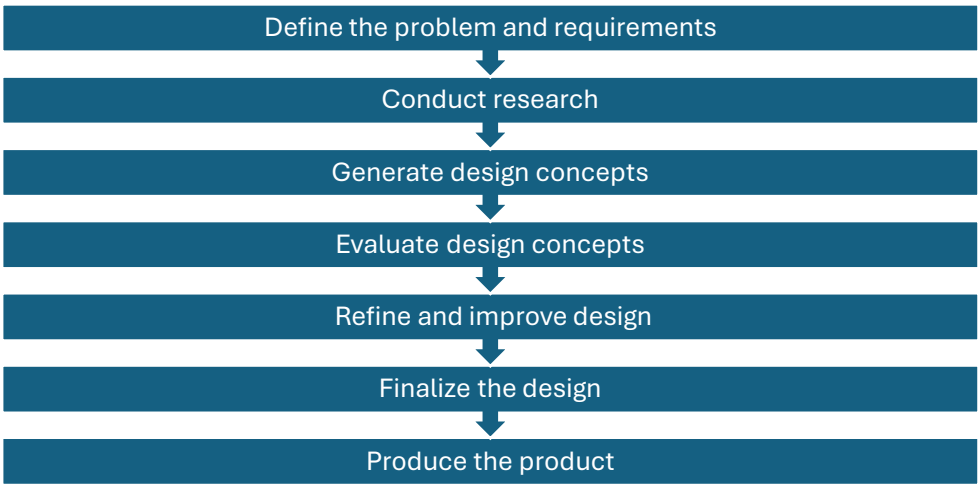

Figure 5: Steps followed in the conceptual design framework for product development
Source: (Anon 2023)

The personas discussed in the previous section, such as clickable bubbles, interactive questions, and chatbot personality, fit within this conceptual design framework by addressing specific design considerations at each stage. For example, at the problem statement stage, designers must identify the specific needs and preferences of the target audience, which includes determining the types of questions and issues that the chatbot will need to address. By incorporating clickable bubbles and interactive questions, designers can create a conversational

flow that addresses the most common queries and concerns of university students, ensuring that the chatbot provides relevant and helpful support.

At the conversational flow stage, designers face important decisions regarding the tone, style, and response types of the chatbot. Introducing elements of personality, such as emojis and jokes, can contribute to a more human-like and captivating chatbot experience, ultimately boosting user satisfaction and engagement. Furthermore, incorporating visuals like images and videos can enrich the conversational flow by offering supplementary information and context to users. For instance, if a student inquiries about a particular subject, the chatbot can provide a relevant image or video to enhance the explanation and provide clearer understanding.

By considering the personas discussed in the previous section within the broader conceptual design framework, chatbot designers can create more effective and engaging chatbots that provide valuable support to university students. These personas help to address specific design considerations at each stage of the chatbot design process, ensuring that the chatbot meets the needs and preferences of its target audience.

2.8.1 Integration of usability, UI, UX, NLP, anthropomorphism, and personas in the conceptual framework

The conceptual design framework plays a vital role in addressing various aspects such as usability, UI, UX, NLP, anthropomorphism, and personas.

- Usability holds significant importance within the conceptual design framework. It ensures that products and systems are designed to be user-friendly, efficient, effective, and aligned with the user's needs. Usability is achieved through intuitive interface design, clear instructions, and effective feedback mechanisms.
- The UI and UX are pivotal elements within the conceptual design framework. This framework ensures that the UI is designed to be intuitive, user-friendly, and visually appealing. Simultaneously, it emphasises crafting a satisfying and engaging UX that meets the user's expectations.
- NLP is another aspect that the conceptual design framework considers. The framework ensures that the design of products and systems considers the user's language and communication needs. This consideration helps to ensure that products and systems are designed to be user-friendly and easy to communicate with.
- Anthropomorphic factors are critical elements that shape the design of products and systems that interact with humans. The conceptual design framework ensures that these

factors are considered in the design process. For example, the framework considers factors such as emotional semantics, multilingualism, animacy, intelligence, likability, safety, and social presence.

- Personas are also a crucial aspect of the conceptual design framework. The framework helps to ensure that products and systems are designed to meet the needs of specific user groups by creating user personas. These personas represent typical users with their specific characteristics, goals, and needs. This consideration helps to ensure that products or systems are designed to meet the needs of different user groups effectively.

After considering the various design features that can contribute to an effective and engaging chatbot experience for university students, a range of elements must be considered to create a chatbot that is useful and widely adopted. From clickable bubbles and lists to interactive questions and chatbot personalities, each design element has the potential to enhance the UX and provide valuable support to students. However, it is important to note that the design elements discussed in this section must be considered within the broader conceptual design framework of the chatbot. This framework should be informed by user research and incorporate elements such as user needs, preferences, and cultural context. By taking a holistic approach to chatbot design, incorporating design features that enhance the UX while also considering the broader conceptual framework, designers can create effective and engaging chatbots that meet the unique needs and preferences of university students.

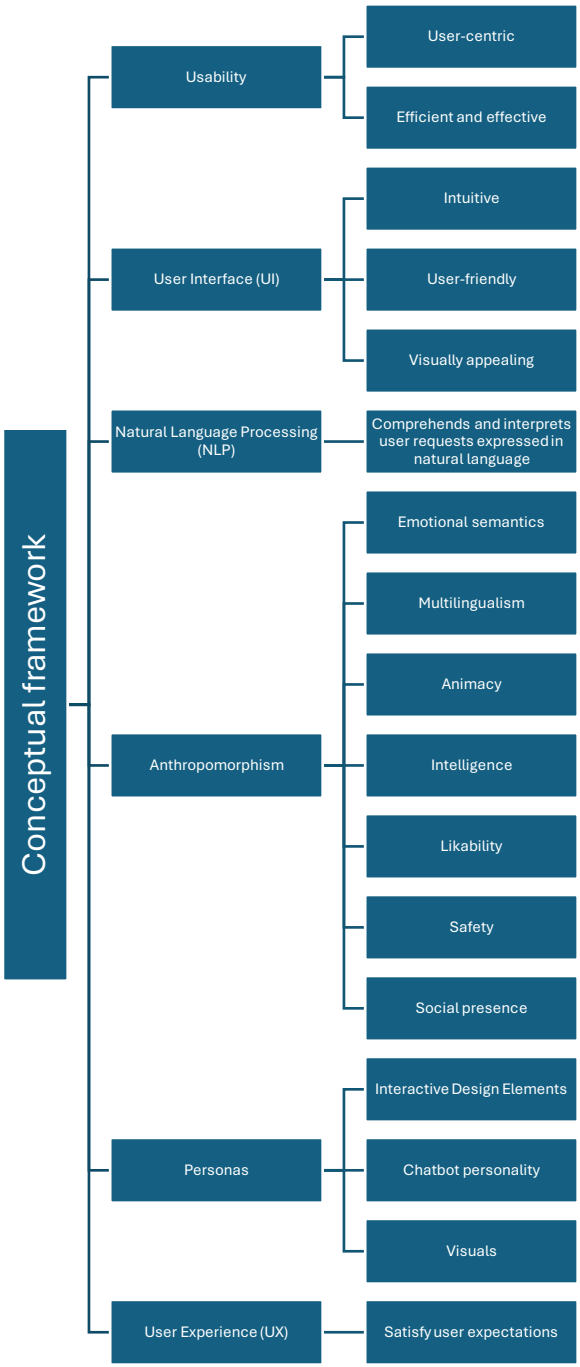

Figure 6: Conceptual framework

The conceptual design framework for chatbots, as presented in Figure 6, integrates various critical aspects such as usability, user interface (UI), user experience (UX), natural language processing (NLP, anthropomorphism, and personas. This framework aims to provide a holistic approach to chatbot design, ensuring that the developed chatbots are not only functional and efficient but also engaging and user-friendly.

2.9 Conclusion

This literature review has provided a comprehensive exploration of chatbot technology in the context of university administration. By establishing a clear definition of chatbots as conversational robots that use natural language to provide services, the research has laid a solid foundation for understanding the scope and nature of chatbot technology discussed.

The study has highlighted the increasing use of chatbots in university administrative services and emphasised the need for further research to evaluate their impact on UX and workload reduction. While chatbots have shown potential in streamlining administrative processes and providing timely support to students, there is still a need to address limitations and enhance their effectiveness in university settings. The classification of chatbots based on various dimensions has provided valuable insights for designers and administrators, enabling them to create more effective and efficient chatbots tailored to specific needs. The choice of interface also plays a crucial role in shaping the overall UX, highlighting the importance of considering a range of options for efficient communication with users. The integration of FAQ chatbots in university administration has demonstrated their usefulness in various aspects, including academic advising, registration, housing, navigation, and financial aid. These chatbots have significantly streamlined administrative processes and reduced the workload of staff, providing personalised assistance and up-to-date information to students.

However, designing effective chatbots comes with its own set of challenges. Providing relevant information, crafting friendly responses, ensuring usability, and integrating chatbots with existing systems seamlessly are some of the key challenges that need to be addressed. Furthermore, considering the unique factors and needs of African universities, such as multilingualism and low bandwidth solutions, it is crucial to design chatbots that cater to the specific context. Usability, design and process flow for university administration FAQ chatbots have been explored, emphasising the importance of user interface, UX design, NLP, anthropomorphism, and the integration of these components within a conceptual design framework. By adopting a user-centred approach and considering personas, designers can create chatbots that meet user needs effectively.

Usability principles like Schneiderman's eight golden rules and Nielsen's ten usability heuristics were discussed, adapting them for chatbot design beyond traditional interfaces. Specific usability heuristics were detailed, focusing on system visibility, user control, error prevention, and trustworthiness. These principles can be integrated for an intuitive UX through

aligning these heuristics with ISO standards to fortify the overall usability framework and ensure global best practice compliance.

The dissertation has also highlighted the significance of choosing the appropriate architectural model for chatbots, with the conceptual framework being a suitable choice for evaluating chatbots in university settings. The integration and evaluation of key components in FAQ chatbot development, such as usability, UX, anthropomorphism, persona, NLP, and UI, are crucial for creating effective and user-friendly chatbots.

In conclusion, this dissertation provides valuable insights and guidance for administrators and designers in harnessing the potential of chatbot technology in university administration. By addressing the challenges, considering user needs, and adopting appropriate design principles, chatbots can revolutionise administrative support services, improve UX, and simplify student access to essential information.

Chapter 3: Research Methodology

3.1 Research design

This chapter presents the research methodology employed in enhancing the usability of a university student support services FAQ chatbot. The study follows the DSR methodology, which is well-suited for addressing complex problems related to the chatbot's ability to provide relevant information, communicate in a friendly manner, and offer a usable interface.

DSR is characterized by its focus on the development of innovative artifacts and its iterative approach to problem-solving. Unlike other research methodologies, such as those found in behavioral sciences, which aim to understand phenomena through empirical validation, DSR emphasizes the creation and utility of artifacts to advance knowledge (Peffers *et al.* 2007; Maric 2018; Rodsawang *et al.* 2020). This methodological approach complements other scientific paradigms by focusing on the design, utility, and innovation of artifacts, addressing specific challenges in practical contexts (Hevner *et al.* 2004; Peffers *et al.* 2007).

Incorporating insights from Hevner *et al.* (2004); Peffers *et al.* (2007); Thusi and Maduku (2020), DSR's distinctiveness lies in its emphasis on creating and iterating innovative artifacts rather than solely validating existing theories. This methodological approach necessitates careful construction of research questions to effectively guide and direct the development of novel solutions. As such, the study utilizes DSR to address the limitations and challenges faced by current FAQ chatbots, ensuring a comprehensive and iterative approach to enhancing usability and effectiveness.

The DSR methodology is particularly relevant for developing chatbots, as it supports the creation of sophisticated solutions tailored to complex needs. The approach involves six phases: problem identification and motivation, objectives of a solution, design and development, demonstration, evaluation, and communication. The research methods used in this study were semi-structured interviews and a questionnaire. Table 7 illustrates how the DSR stages were used as the underlying framework for this study.

Table 7: DSR stages as the underlying framework for this study

General DSR phases	Cycle 1: FAQ chatbot focused	Cycle 2: Questionnaire focused
Problem identification and motivation	Key challenges + limitations + motivation	Key challenges + limitations + motivation
Objectives of a solution	Creating more efficient systems, enhancing UX, user satisfaction and acceptance	Systematic assessment and measurement of key constructs

		and variables for FAQ chatbot development and evaluation
Design + development	Design and develop a FAQ chatbot	Design and develop a questionnaire that focuses on evaluating FAQ chatbots
Demonstration	Conduct semi-structured interviews Participants involved: First year Faculty of Accounting and Informatics (FAI) students and FAI administrative staff members	To test the questionnaire validity + reliability the following tests were conducted: • Cronbach's alpha • Composite reliability (CR) • Average variance extracted (AVE) and rho_A
Evaluation	Thematic analysis used to identify themes and sub-themes from the semi-structured interviews	Exploratory analysis: Smart PLS 4 to identify path coefficient
Communication	Knowledge connectors were identified to help address the themes identified during the thematic analysis	FAQ chatbot evaluated using a questionnaire that focuses mainly on FAQ chatbots that provide administrative support.

3.2 Design science research methodology

In this study, the DSR methodology was applied to develop and evaluate a FAQ chatbot that provides university administrative support, with the objective of addressing the limitations and challenges faced by current FAQ chatbots.

3.2.1 Motivation for employing DSR methodology

The motivation for selecting the DSR methodology as the research method for enhancing the usability of a university student support services FAQ chatbot can be articulated as follows (Tavanapour and Bittner 2018; Feine, Morana and Maedche 2020; Reinkemeier and Gnewuch 2022):

1. **Addressing complex problems**: The development and improvement of conversational agents, particularly FAQ chatbots, involve intricate challenges related to their ability to provide relevant information, maintain friendly interactions, and offer a user-friendly interface. DSR was chosen as the research method because it is well-suited for addressing complex and multifaceted problems. It provides a structured framework for systematically tackling these challenges.

2. **Proven relevance in chatbot development:** DSR has demonstrated its relevance in the development of conversational agents, including chatbots. Existing research studies,

such as those by Peffers *et al.* (2007); Maric (2018); Rodsawang *et al.* (2020) have successfully applied DSR principles to develop innovative chatbot solutions. This track record of effectiveness in similar contexts serves as a motivation for adopting DSR in this study.

3. **Creation of innovative artefacts:** DSR methodology seeks to enhance human knowledge through the creation of innovative artefacts. In the context of developing a student support services FAQ chatbot, this methodology aligns with the goal of creating a cutting-edge and sophisticated chatbot that goes beyond conventional solutions. DSR encourages the design of novel features and capabilities that can significantly improve the UX and address the limitations of existing FAQ chatbots.

4. **Systematic problem solving:** DSR is characterised by a structured approach that involves a series of research phases, from problem identification to communication of results. This systematic problem-solving approach ensures that each aspect of chatbot development is thoroughly analysed, designed, implemented, and evaluated. It provides a clear roadmap for progressing from problem statement to innovative solution.

5. **Adherence to six DSR steps:** DSR's adherence to six well-defined steps, namely, problem identification, objective specification, design and development, demonstration, evaluation, and communication, demonstrates a commitment to rigour and methodological consistency. This commitment enhances the credibility of the research process and showcases the successful implementation of DSR principles.

In summary, the motivation for employing DSR as the research method lies in its ability to effectively address complex challenges, its proven relevance in chatbot development, its focus on creating innovative solutions, its systematic problem-solving approach, and its structured framework with clear research phases. DSR aligns with the goal of enhancing the usability of the university student support services FAQ chatbot by providing a robust and methodical approach to creating an advanced conversational agent that meets the evolving needs of users.

3.2.2 Problem identification and motivation phase

3.2.2.1 Problem identification

To identify the existing challenges and detect possible solutions from prior research, the problem was formulated by investigating the usage of FAQ chatbots that provide student

administration support. The problem was determined from a literature perspective by examining several studies that adopted service chatbots.

The identified problem arises from an in-depth investigation into FAQ chatbots' utilisation for student administration support, drawing insights from prior studies employing service-oriented chatbots. The problem centred on the deficiencies and constraints observed within current FAQ chatbots tailored for student administration tasks in educational institutions. This encompasses shortcomings in their usability features and framework, inadequacies in the design phase of the chatbots, and limitations in evaluating the chatbot's usability. These challenges impact the effectiveness and efficiency of these chatbots in providing seamless support for student administration within educational settings.

3.2.2.2 Key challenges and limitations

This problem is characterised by several key challenges and limitations as listed in Table 8.

Table 8: Problems identified in the literature review

Problem	Reference	Description
Absence of NLP capabilities	Radziwill and Benton (2017)	Chatbots lack the ability to effectively understand and respond to natural language, making interactions less intuitive and limiting their capacity to comprehend user queries in a human-like manner.
Limitations in handling complex queries	Brandtzaeg and Følstad (2018)	Current chatbots struggle when confronted with intricate and multifaceted queries, often providing inadequate or irrelevant responses, which can frustrate users seeking detailed information or assistance.
Unfriendly interactions	Chung and Lee (2020)	Interactions with these chatbots are often perceived as unfriendly or unhelpful, diminishing user satisfaction and engagement.
Poor navigation	Ayobami, Hector and Hammed (2012)	Users may encounter difficulties in navigating the chatbot's interface or finding relevant information efficiently, leading to a suboptimal UX.
Usability concerns	Ren *et al.* (2019b)	Usability issues encompass a range of factors, such as user interface design and overall user-friendliness, affecting the chatbot's effectiveness in delivering information and assistance.
Multilingualism requirements	Villiers (2021)	Addressing the diverse linguistic needs of university students, including support for multiple languages, presents a significant challenge that must be addressed to ensure inclusivity and accessibility.
Addressing the digital divide	Foster (2023)	Bridging the digital divide among students in universities is paramount, as disparities in access to technology and digital

		resources must be considered to ensure equitable access to chatbot services.

Collectively, these challenges underscore the pressing need to enhance the functionality and usability of FAQ chatbots within the educational context, particularly in universities. Addressing these issues is driven by the goal of creating a more efficient, user-friendly, and inclusive chatbot system that can effectively support students and streamline administrative processes.

3.3 CYCLE 1: Chatbot design and semi-structured interview evaluation first cycle through DSR

The initial cycle through DSR involved the iterative process of chatbot design followed by semi-structured interview evaluations. The participant pool for this cycle consisted of first-year university students and administrative staff members from the Ritson campus of the Durban University of Technology (DUT).

3.3.1 Define the objectives of the solution phase

The first phase of this study formulated precise design objectives. These objectives encompassed several key aspects, such as accuracy in responses, human-like interactions to foster user engagement, seamless multilingual support, intuitive navigation to facilitate effortless user interactions, and efficient task completion for users seeking information. These design areas and features form the foundation for chatbot developers to create more user-friendly and efficient FAQ chatbots that enhance the overall UX and acceptance.

3.3.2 Design and development phase

During the second phase-design and development of the enhanced FAQ chatbot, a strategic approach was adopted, guided by the conceptual design framework. A conceptual design framework, as outlined in Chapter 2, plays a pivotal role in creating a successful and effective FAQ chatbot. It encompasses various critical stages, including defining the problem statement, identifying the target audience, determining the chatbot's scope and functionality, designing the chatbot's conversational flow, and rigorously testing and refining the chatbot's performance.

To strategically tailor the chatbot for an engaging and user-centric experience, as identified in Chapter 2, specific measures were identified. These measures included the careful selection of the chatbot platform, the implementation of intents, the enhancement of anthropomorphism, and a steadfast commitment to prioritising usability and UX. Furthermore, key design

guidelines were thoughtfully integrated into the development process to ensure a seamless user interaction. These design considerations spanned various facets, such as usability, user interface, UX design, NLP, anthropomorphism in chatbots, and the architectural model of the chatbot. This comprehensive approach aimed to align the chatbot's design with the principles and findings established within the conceptual framework, ultimately contributing to its effectiveness and user satisfaction. The next phase of development involved implementing the identified personas, anthropomorphism, user interface guidelines, NLP, UX design, and usability principles to create a functional chatbot prototype.

3.3.3 Demonstration phase and semi structured interviews

During this third phase, prototype development was initiated, followed by comprehensive fieldwork and solicitation of feedback from participants.

3.3.3.1 Prototype development

In the demonstration phase of the research, the selected platform for developing the FAQ chatbot was Google Dialogflow. This choice was informed by a careful evaluation of available options, considering factors such as functionality, ease of integration, and the alignment of Dialogflow with this study's objective.

The decision to opt for Google Dialogflow was based on several compelling reasons, such as:

- **NLP capabilities:** Google Dialogflow offers robust NLP capabilities, which are crucial for enabling the chatbot to understand and respond to user queries in a conversational and context-aware manner. This aligns with the project's goal of enhancing the chatbot's effectiveness.
- **Ease of integration:** Dialogflow seamlessly integrates with various platforms and communication channels, making it a versatile choice for deploying the chatbot across web and mobile interfaces, as well as other digital platforms.
- **Scalability:** Google Dialogflow's scalability ensures that the chatbot can adapt to the evolving needs of the university's student support services. It can handle a growing user base and accommodate changes in administrative procedures and policies.

3.3.3.2 Demonstration process

During the demonstration phase, the Google Dialogflow-based chatbot prototype was tested and evaluated in a controlled environment. The primary objectives were to:

- **Assess functionalities:** Verify that the chatbot accurately and comprehensively addressed a wide range of user queries related to student administration support.
- **Evaluate user interactions:** Observe how users interacted with the chatbot, including their conversational patterns, query complexity, and overall satisfaction.
- **Gather user feedback:** Conduct semi-structured interviews with first year students, and administrative staff members to gather qualitative insights into their experiences and perceptions of the chatbot. These interviews allowed participants to share their opinions, suggestions, and concerns.

3.3.4 Semi-structured interviews

3.3.4.1 Design of interview questions for the semi-structured interviews

The design of semi-structured interview questions is a fundamental aspect of qualitative research, offering a pathway to gather nuanced and contextually rich data (Suleman 2022). This section delineates the foundational principles and considerations driving the formulation of interview questions in this study, drawing on insights from Chopra and Haaland (2023); ElSayary (2023); Richardson *et al.* (2023); Xiao (2023).

Key considerations

- **Open-ended nature**

Semi-structured interviews inherently adopt an open-ended approach, allowing participants to articulate their thoughts and experiences freely. The interview questions were crafted with open-ended prompts to encourage participants to share detailed insights without constraints.

- **Derivation of interview questions**

The interview questions were inferred from the literature, ensuring their relevance to the study's goals and research objectives. This approach ensured that the questions focused on pertinent topics, enabling participants to provide information that directly contributed to the study's goals.

- **Breadth and depth of inquiry**

The interview questions covered a diverse range of topics related to the research subject. This breadth allowed for a comprehensive exploration of various facets of the subject

matter. Furthermore, the questions were framed to delve deeply into participants' experiences, facilitating detailed responses. Section 4.1.3 dives deeper into how the process was done.

- **Neutral and unbiased**

The interview questions maintained a neutral and unbiased tone to avoid leading participants towards specific responses. They were designed to encourage participants to express their genuine viewpoints without any preconceived notions or influence from the interviewer.

- **Sequenced Logic**

Logical sequencing of questions was employed to establish a natural flow of conversation during interviews. This sequencing built upon prior inquiries, progressively exploring more complex or personal aspects of the research topic. Such logical progression aids participants in feeling comfortable and gradually engaging with deeper insights.

- **Simplicity and clarity**

Simplicity and clarity in question phrasing were prioritised to ensure participants' full comprehension. Complex or convoluted language was avoided to prevent potential confusion or misinterpretation.

3.3.4.2 Site of the fieldwork

The fieldwork was conducted primarily at the Ritson Faculty of Accounting and Informatics (FAI) campus of DUT. This choice was deliberate, aiming to capture insights from a diverse student body pursuing both technological and non-technological fields of study. Additionally, engagement with first-year students and administrative staff members from the FAI campus provided invaluable institutional perspectives. This strategic selection of the research site ensured comprehensive feedback for the development and evaluation of the artefact designed to assist university students with campus navigation and FAQs.

3.3.4.3 Population, sample, sampling technique, inclusion criteria

A population encompasses the entirety of individuals under consideration for research purposes (Lavrakas 2008), while a target population represents a predetermined subset of individuals within the population. A sample, on the other hand, is a specific group of individuals from whom data is collected (McCombes 2019). Sampling techniques serve as methods employed

to select a sample from a given population. McCombes (2019) delineates two primary categories of sampling techniques: probability sampling and non-probability sampling. Probability sampling assigns each population member an equal likelihood of selection, and is predominantly employed in quantitative research (McCombes 2019). Conversely, non-probability sampling selects individuals based on non-random criteria, often leading to a higher risk of sampling bias, where some individuals are systematically more likely to be chosen than others (Bhandari 2020b).

In the context of this research, convenience sampling was employed. Convenience sampling involves selecting participants based on their ready availability and willingness to participate. This approach offers convenience and expediency in participant recruitment.

The research focus centred on the Ritson FAI campus of the DUT encompasses first-year students pursuing both technological and non-technological fields of study. Given the development of an artefact designed to assist university students with campus navigation and FAQs, it was imperative to include administrative staff members from the FAI campus. This strategic inclusion provided valuable insights from a university perspective. Consequently, the artefact evaluation involved first-year FAI students and administrative staff members.

There was only one inclusion criterion, namely, that the study was open to all first-year enrolled students at Ritson campus of DUT, so individuals not meeting this criterion were excluded. The choice of convenience sampling stemmed from time constraints and the challenges associated with recruiting university students for participation. Nevertheless, it is important to exercise caution when interpreting the study's findings, recognising that the sample may not fully represent the broader population.

In summary, this research considered a population consisting of all first-year enrolled students and administrative staff members at the Ritson campus of DUT. The sampling technique employed was convenience sampling, wherein participants were selected based on their availability and willingness to participate.

3.3.4.4 Artefact evaluation workflow for semi-structured interviews

The evaluation process of the artefact adhered to a systematic workflow, drawing inspiration from Griffin *et al.* (2021). This structured approach ensured consistent data collection and analysis.

Task-based testing and semi-structured interviews with first-year students

- First-year students were introduced to the chatbot and provided access to its services.
- They were presented with a predefined set of tasks based on common queries.
- Tasks included directions to specific locations on campus, queries related to departments and services, and other frequently asked questions.
- Concerns over data usage, MS Teams accessibility, sign language interpreter led to shift to email interviews. To assess the usability of the chatbot artifact, a video demonstrating its functions was emailed to participants along with a step-by-step guide. Subsequently, participants were emailed interview questions to gather their perspectives on the chatbot.

Semi-structured interviews with administrative staff

- Subsequently, after task-based testing, semi-structured interviews were conducted with administrative staff members to gather qualitative insights.
- Staff members discussed their experiences with the chatbot, the types of queries they handled, and any observations regarding student interactions.

Data collected from the task-based testing and semi-structured interviews were analysed to identify trends, patterns, and areas requiring improvement. This comprehensive evaluation approach ensured that both quantitative and qualitative feedback were considered in refining the chatbot.

3.3.4.5 Participants

Participants consisted of first-year students and administrative staff. The following sections described their active participation.

The study involved a comprehensive examination of the FAQ chatbot system, executed through two iterative cycles of the Design Science Research Methodology (DSRM). The first cycle focused on qualitative assessment through semi-structured interviews with both first-year students and administrative staff in the Faculty of Accounting and Informatics. Of the 3457 students and 21 staff members initially approached, a select group of 10 students and 5 staff members participated in these interviews, which were later analysed using thematic analysis. The second cycle concentrated on a pilot study and a final exploratory analysis using a developed questionnaire to assess the FAQ chatbot. Initially, 14 students participated in the pilot study to test the questionnaire's validity and reliability. For the final study, 170 students were approached, with 132 ultimately contributing to the exploratory analysis aimed at

identifying features that would enhance the chatbot's usability and improve user experience. Table 9 shows the participant involvement across DSRM cycles.

Table 9: Participant involvement

	Participants		**Role of participant**
Description	First year students in the Faculty of Accounting and Informatics	Administrative staff members in the Faculty of Accounting and Informatics	
Population	3457	21	
Cycle 1			
Total approached for semi-structured interviews	3457 (Flyer was made available to all students via the Facebook page)	10	Conduct semi-structured interviews with students and staff to evaluate the contents of chatbot prototype from a qualitative approach.
Participated in semi-structured interviews (Before data cleaning)	10	5	
Participated in semi-structured interviews (After data cleaning)	10	5	
Total approached for DSR cycle 1	300	0	
Cycle 2			
Participated in DSR cycle 1 pilot study (Before data cleaning)	14	0	Test the questionnaire's validity and reliability using

			Cronbach's alpha, Composite Reliability (CR), AVE, and rho_A
Participated in DSR cycle 2 (After data cleaning)	14	0	
Total approached for DSR cycle 2	300	0	
Participated in final study- exploratory analysis (Before data cleaning)	170	0	Evaluate the FAQ chatbot using the developed questionnaire focusing on which features would contribute to enhanced usability and improving user experience
Participated in final study- exploratory analysis (After data cleaning)	132	0	

3.3.4.6 Choice of candidates

This evaluation involved a group of participants, including first-year students and administrative staff from the Durban Ritson campus. Convenience sampling was used to select participants, and those available at the time were involved in semi-structured interviews. First-year students and administrative staff were chosen for the semi-structured interviews because they represented key stakeholders in the university context. Their involvement provided a well-rounded view of the chatbot's impact, encompassing both the UX and the administrative efficiency aspects. This diverse perspective allowed for a more comprehensive evaluation, ensuring that the chatbot's design and functionality aligned with the needs and expectations of its primary user groups.

3.3.4.7 First-year students' involvement

The semi-structured interviews targeted first-year students at DUT's Ritson campus, aiming to gather detailed feedback on the chatbot artefact's usability. A flyer was created to advertise the research study and encourage student participation. This flyer was shared through the Faculty of Accounting and Informatics Facebook page, where it remained for two weeks before being removed. Ten students responded to the flyer and agreed to participate. Each of these participants was provided with a consent form outlining the research details and contact information via email. Initially, the interviews were planned to be conducted via Microsoft Teams. However, due to concerns about data privacy, difficulties accessing MS Teams, and the need for a sign language interpreter, the interviews were shifted to an email format. Participants received a video and guide via email to familiarize themselves with the chatbot artefact before the interview. The interviews were then conducted through detailed email exchanges where participants provided their feedback on the chatbot's functionality. The semi-structured interviews provided valuable insights into the first-year students' perspectives on the chatbot. The feedback collected during this phase was crucial in refining the chatbot and identifying key areas for improvement. The materials used can be found in the Google One Drive link.

3.3.4.8 Administrative staff members

To gather insights from the administrative perspective, ten administrative staff members who oversee answering FAQs by students at the Durban Ritson campus were approached to participate in the study. A flyer similar to that used for the first-year students was created for administrative staff, urging them to participate by providing their feedback. The flyer encouraged the administrative participants to email if they were interested in participating.

Out of the ten administrative staff members contacted, five responded and agreed to participate in the study. After the participants responded to the flyer, they were sent details for the interview, which included the consent form agreement for participation, the time and date of their Microsoft Teams interview, and a link to the chatbot. The participants were urged to sign and email the consent forms and interact with the chatbot before the interview. The link to the chatbot was set to be active for one week to allow for the semi-structured interviews to be held. Materials used during the interaction like the consent forms, semi-structured interview questions, and link to the chatbot can be found in this Google One Drive Link.

3.3.4.9 Designing the set of administrative FAQs

To address Research Objective 1, which focused on identifying and compiling a comprehensive set of frequently asked questions (FAQs) for university administrative support services, a methodical approach was employed. Initially, a literature review was conducted to understand common administrative concerns in higher education settings. This literature review helped identify gaps in existing chatbot functionalities and highlight areas where chatbots could better support students. Based on this analysis, a list of FAQs was developed to ensure it covered the most pertinent topics and issues faced by students. The list was refined to address deficiencies identified in current chatbot systems and to align with best practices in administrative support. Table 10 presents these FAQs along with their corresponding answers, which were designed to address common queries and support students effectively.

Table 10: Sample set of administrative FAQs

Question	Answer
Problems with registration phone for help with registration	New first-year students experiencing challenges with online registration should contact the Department of Student Admissions at: Tel: 0313735005. Alternatively, you can contact via WhatsApp numbers: 0834451282, 0834460459, 0834541495, 0834543477, 0834516751, 0834413766.
Email for help with registration	First-year students can email: 1styrstudentreg@dut.ac.za and visit the DUT website for guidance related to online off-campus registration: DUT Student Registration.
Problems with registration phone for help with registration	New first-year students experiencing challenges with online registration should contact the Department of Student Admissions at: Tel: 0313735005. Alternatively, you can contact via WhatsApp numbers: 0834451282, 0834460459, 0834541495, 0834543477, 0834516751, 0834413766.
As a first-year student, how do I register and where to register for a module?	Visit DUT Student Registration.
Can I reset my ITS login password using the Self-	No, you can only reset your Active Directory (dut/dut4life email) password.

service Password portal?	
Do I need to register each time to reset my password?	No, the Password Registration is a once-off process.
What happens if I forget the answer to my questions?	You can change the answers to the questions at any time. Simply browse to Password Questions, enter your username and password, and submit new answers.
Can I reset my password from outside the DUT network?	Yes, as long as you have access to an internet connection, you should be able to access the password reset page: Password Reset.
Can my answers to the questions be a two or three alphabet word?	No, the minimum number of characters allowed is 4.
Do I need to register each time to reset my password?	No, the Password Registration is a once-off process.
What happens if I forget my password for my email and answers to my questions?	Please call the ITSS service desk on 9111 for assistance.
What happens if I forget the answer to my questions?	You can change the answers to the questions at any time.
Do I need to register each time to reset my password?	No, the Password Registration is a once-off process.

3.3.4.10 Semi structured interview analysis

The design and evaluation of the semi-structured interview questions drew extensively on insights acquired through the literature review. This review formed the basis for identifying the

key areas of inquiry and determining the pertinent topics to be covered by the questions. By leveraging existing research on chatbot development and focusing on the specific needs of first-year students, the design process was guided by established knowledge and best practices. The carefully crafted open-ended questions allowed the interviewee to provide detailed and nuanced responses, while ensuring clarity and relevance in addressing the research objectives. The subsequent evaluation process examined how effectively the questions captured relevant aspects of university administrative support service provision and the FAQs typically encountered by first-year students, as well as their ability to elicit valuable feedback. The data analysis for both the first year students and administrative staff can be found in section 4.1.3.

3.3.5 Evaluation and communication

In the fourth phase of the DSR methodology, the focus shifted to applying the artefact developed in the previous phase to address the identified problem. These phases involved identifying the changes that need to be made to the FAQ chatbot using semi-structured interviews. This section focuses on the data analysis method used for the results from the semi-structured interview.

3.3.5.1 Data analysis method used for semi-structured interviews

Selecting an appropriate data analysis method is crucial to effectively understand and apply the collected feedback. Various qualitative research methods are available, such as qualitative content analysis, narrative analysis, discourse analysis, thematic analysis, grounded theory, and interpretive phenomenological analysis. Among these methods, thematic analysis stands out as a highly beneficial and widely used approach for understanding experiences, thoughts, or behaviours related to an artefact.

3.3.5.2 Identified themes from the semi-structured interviews

Thematic analysis is a systematic process of identifying, analysing, and interpreting patterns within qualitative data. It offers a structured framework for organizing and examining feedback. Kiger and Varpio (2020); Mortensen (2020) advocate the adoption of thematic analysis, considering it to be the most advantageous method for comprehensively exploring experiences, thoughts, and behaviors within a dataset. By employing thematic analysis, researchers can uncover underlying themes or patterns emerging from the data, providing valuable insights into participants' perspectives and needs. The feedback obtained from the semi-structured interviews was carefully analysed and integrated into the chatbot's design and functionality. The themes that emerged from these interviews included improved navigation

assistance, better financial aid support, access to comprehensive support information, enhanced responses, and reduced workload for administrative staff. This iterative process ensured that user input was used to enhance the chatbot and address identified issues.

While knowledge connectors were not explicitly mentioned by interviewees, the themes that emerged from the interviews—such as the need for improved navigation assistance, better financial aid support, access to comprehensive support information, enhanced responses, and reduced workload for administrative staff—served as a catalyst for identifying potential solutions. Reflecting on these themes and the existing literature, this research recognized the potential of knowledge connectors in addressing these needs.

Implementation of Knowledge Connectors

To demonstrate the practical application of knowledge connectors, the following examples are drawn from the actual data collected during the semi-structured interviews. These examples illustrate how knowledge connectors were integrated into the chatbot to address specific user needs identified in the thematic analysis.

Example 1: Support Information

Feedback from Interview: "Access to academic records and email. A participant suggested that the chatbot should be able to direct first-year students on how they can print their academic records and it can assist students in resetting their email passwords as these issues are often faced by students."

Implementation with Knowledge Connectors

- Functionality: The chatbot connects to a detailed registration help database that includes information on some of the FAQs that can help for support information, as seen in figure 7.

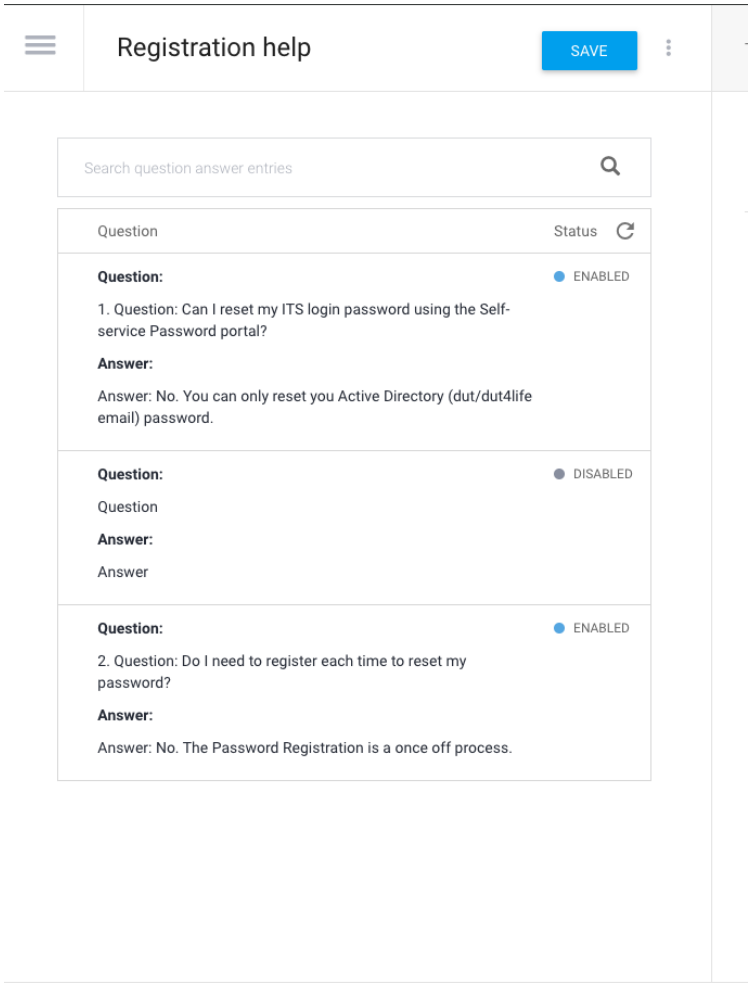

Figure 7:Support registration knowledge connector

- Outcome: When a student asks for support, in terms of resetting their ITS password, the chatbot provides precise information, figure 8.

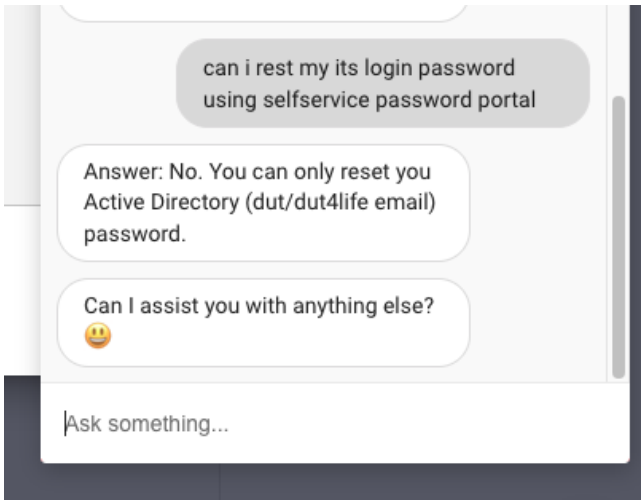

Figure 8: Support registration using knowledge connector chat

Example 2: Registration

Feedback from Interview: "Online normally tells them when they are trying to register, they don't know the codes because now we are using the codes. Like finance tells them it says RA, but it does say financial reason, but I think they don't read or they don't understand, so they come to us and say unblock or I can't register online and every time when we check we find that it's a finance block. So we have to direct them to finance. I think especially for first years because they don't understand the codes we need maybe if you can create something you know that can explain the codes to them."

Implementation with Knowledge Connectors

- Functionality: The chatbot integrates with the first year queries system, providing students with direct access to contact details and links, as seen in figure 9.

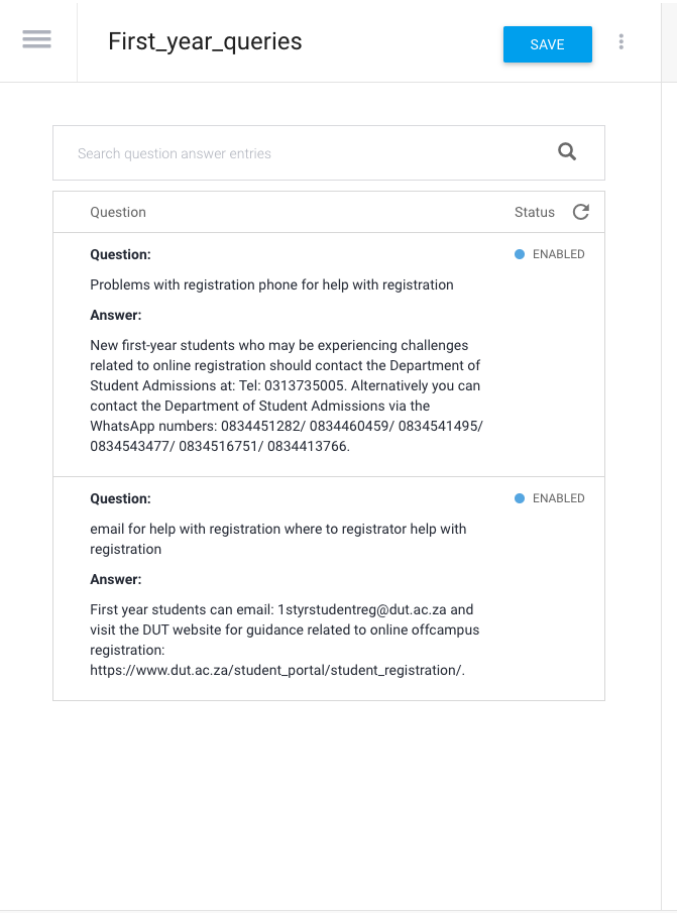

Figure 9: Registration knowledge connector

- Outcome: Students receive accurate and up-to-date contact details without needing to visit the university this can be seen in figure 10.

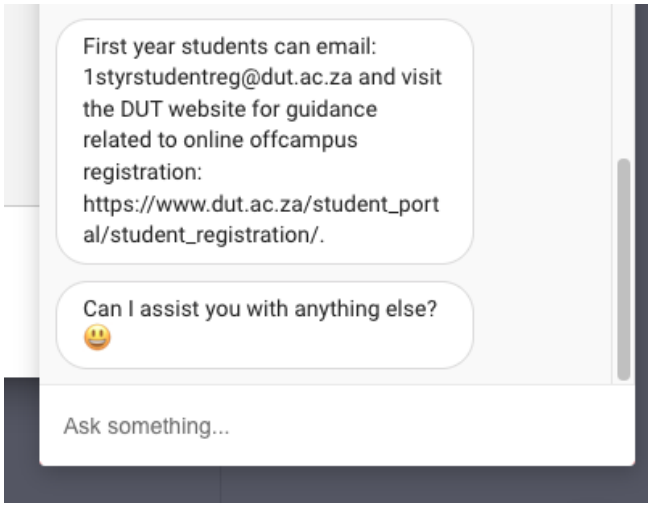

Figure 10: Registration using knowledge connector chat

Example 3: Support Information

Feedback from Interview: "Online normally tells them when they are trying to register, they don't know the codes because now we are using the codes. Like finance tells them it says RA, but it does say financial reason, but I think they don't read or they don't understand, so they come to us and say unblock or I can't register online and every time when we check we find that it's a finance block. So we have to direct them to finance. I think especially for first years because they don't understand the codes we need maybe if you can create something you know that can explain the codes to them."

Implementation with Knowledge Connectors

- Functionality: The chatbot connects to an first year queries repository, ensuring students can easily access common FAQs around registration, shown in figure 11.

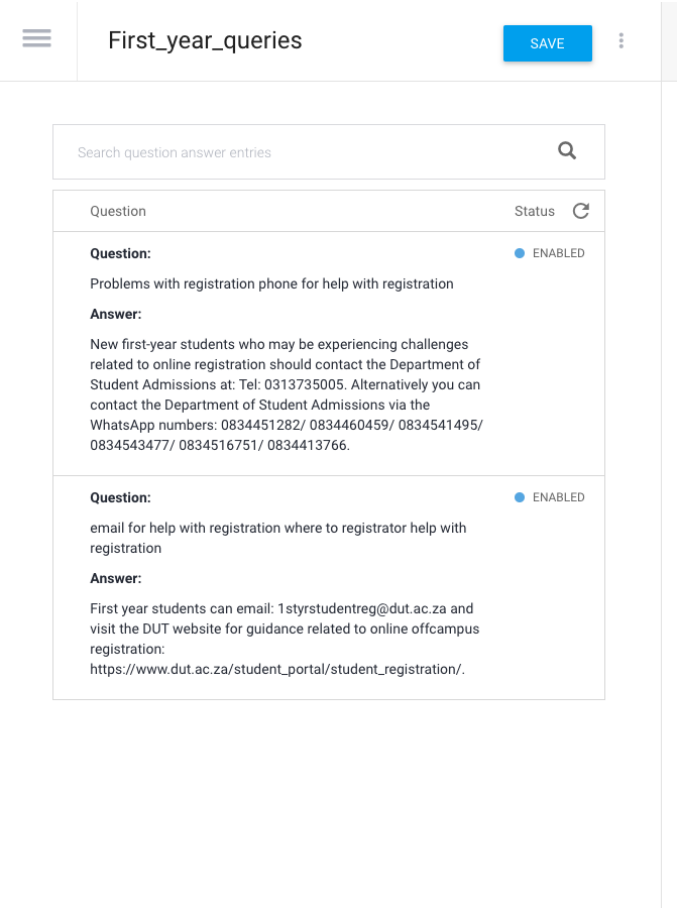

Figure 11: Support queries knowledge connector

- Outcome: Students can find and use the correct links, reducing the administrative workload and minimizing errors, as seen in figure 12.

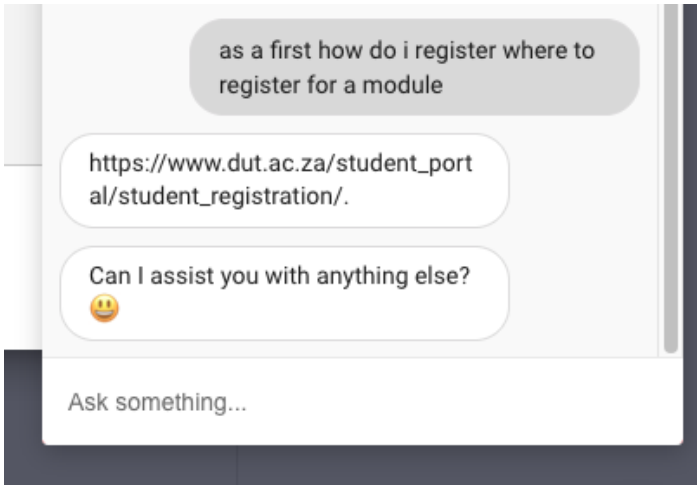

Figure 12: Support queries using knowledge connector chat

These examples illustrate how knowledge connectors were effectively implemented to enhance the chatbot's functionality based on user feedback. The detailed step-by-step guide of implementing knowledge connectors to an artefact along with additional visual illustrations can be found on this Google drive link.. Although not initially considered during the chatbot's initial development, the insights gained from the thematic analysis prompted a reassessment of the chatbot's functionality. Subsequently, the decision to implement knowledge connectors was grounded in the feedback received, aiming to directly address user needs and enhance the chatbot's effectiveness.

Presentation of Findings from the Semi-Structured Interviews

The following narrative shows a clear interpretation of the data while reflecting the selected themes. The information presented in the following subsection presents only a portion of the feedback received from the interviews with the FAI administrative staff members. The detailed feedback from both the first year students and the administrative staff members can be found in the here Google One Drive Link.

1. Navigation around Ritson Campus

Most participants mentioned that navigation, including the locations of certain departments, labs, the faculty office, and the various blocks on Ritson campus, was a common concern. Participants suggested that these should be included in the chatbot to make it easier for students to move around the campus.

- "Directions to faculty office, labs, and departments. Some participants mentioned that students often got confused between the faculty office and the department, and this would provide students with more clarity on where certain department and labs are."
- "Most of the students come to the offices asking for the faculty because they think things are done at the offices rather than the faculty. So it's better to know where the block and which level it is—one or two. Like departments, faculty."
- "Questions students ask are where is the Faculty of Accounting and Informatics, along with where are certain departments. It's nice to have because most students get confused. And where is the IT student lab?"
- "Different departments have different labs. IT and Information and Corporate Management as well."

- "Students often ask where the faculty office is. And more about the departments would be nice."
- "One participant highlighted that not only should the chatbot direct to the department but if it could also direct and help students distinguish between the different blocks in Ritson, it would be helpful."
- "Like the departments, like if you want the IT department because some of the offices have numbers for departments because those are the things students usually go for. It's a good one to add building names and numbers so that it will be easy for the students to find that."

2.Financial Aid

Most participants mentioned they often received queries related to finance, and this was something that the chatbot should be able to offer.

- "Contact details of finance department. One participant suggested that students need to be directed to the correct officials for help regarding finance."
- "Payment of fees for students, who need to clear them, they always direct their queries to us when they need to direct them to finance. They ask us to unblock them to be able to register."
- "Finance queries. Some participants highlighted that student queries are often related to finance."
- "The questions we usually get would be about finance, financial aid, and the faculty office—they don't know the difference."
- "Finance queries are mostly asked by students, payment of fees."

3.Registration Codes

One participant elaborated on why registration codes need to be added and their importance for students, especially during registration time.

- "Online normally tells them when they are trying to register, they don't know the codes because now we are using the codes. Like finance tells them it says RA, but it does say financial reason, but I think they don't read or they don't understand, so they come to us and say unblock or I can't register online and every time when we check we find that it's a finance block. So we have to direct them to finance. I think especially for first

years because they don’t understand the codes we need maybe if you can create something you know that can explain the codes to them."

4.Handbooks

Some participants highlighted the role of handbooks and their importance. Most participants received queries that can often be answered by the handbooks.

- "It's necessary for students and myself because I would normally go and see it. It should be a general handbook and a fee one. Because it has everything for DUT, departments as well as the fees for every other subject that is offered by DUT. One more thing I think for international students, if you can add something for international students, what you can do I think is add a handbook for international students. It has everything that a student can need. So if on this app you can put the international students' handbook, it has the numbers and everything. Because the handbook has everything."
- "Finance handbook is what students normally use to know the amount for a module."

5.Support Information

Most first-year students have difficulty in acquiring information and they end up running around the campus to gather the right information. Many participants mentioned that it would be good for the chatbot to assist them with acquiring the accurate information that students would need.

- "Official forms required by students. A participant mentioned that official DUT forms are usually asked by first-year students and most of the students end up using the incorrect form. This subtheme came through the experience faced by many students."
- "Student forms—these are any forms the students need. There are forms that the students use like the ones that allow them to add a module. But be careful of those forms because sometimes students use the incorrect form and we have to then correct the student."
- "Student housing queries. One participant highlighted that it would be nice if the chatbot could also cover student housing as it would contribute to making the chatbot more informative."
- "Students normally ask about student housing. You've got everything covered, as most first years need help with housing and financial aid."

- "Access to academic records and email. A participant suggested that the chatbot should be able to direct first-year students on how they can print their academic records and it can assist students in resetting their email passwords as these issues are often faced by students."
- "Like I said earlier, if a student needs an academic record maybe they don't know where to get it, so if this system can cover that. Most of the time students block their email addresses and wish to reset it. So it's nice to have that too."

6.Accessibility of Chatbot

Some participants provided insights into making the chatbot stand out and to increase its exposure.

- "Where you can put the chatbot, have actual screens around the campus that allow students to have more access to the chatbot."
- "I would like for us to have a special machine that directs students. Like when you want to check the departments, maybe you would like to go to the IT department. Maybe by the entrance gate or somewhere the security can say go there and check the information that you want to check. Because some have phones but they don't have data because they are not connected with WiFi. So, if they want to go to the IT department, it's there at the back, so you find especially first years don't know where the IT department is and they run around the campus not knowing."

7.Responses of the Chatbot

Many participants highlighted their views on the chatbot's responses.

- "Responses came across as friendly and not robotic, but improvement of error messages is needed. In terms of wording, it's different. Like please rephrase the question instead of having, 'Can you say that again?'"
- "These are friendly and helpful, clear answers when requesting. The responses are responsive."
- "The responses are friendly and it takes you where you want to go."
- "It's very friendly and information is informative and it's most things we come across with."

Tabular Summary of Identified Themes

Table 11:Administrative Staff Members themes

Themes	Description	Subthemes
Navigation around Ritson Campus	Providing the user with directions to certain areas in the campus such as the faculty office, the different departments, and directions to blocks.	Directions to faculty office, departments, labs, blocks in Ritson campus.
Financial Aid	Assisting regarding financial queries and the relevant contact details for the fees department.	Contact details of finance department, finance queries.
Registration Codes	Students are presented with error codes that indicate the reason for incomplete registration.	Registration codes.
Handbooks	Handbooks that detail each department's requirements and subjects along with their respective fees, providing students with detailed insight.	Various handbooks for departments and fees.
Support Information	Assistance with information regarding forms required by students, queries regarding student housing, and directing students to access their records.	Student forms, housing queries, access to academic records, email reset assistance.
Accessibility of Chatbot	Enhancing the visibility of the chatbot and ensuring it is accessible to students in various ways across the campus.	Increasing chatbot visibility through screens or special machines across the campus.
Responses of the Chatbot	The chatbot's replies to user queries, ensuring the responses are friendly, helpful, and informative while improving error messages.	Friendly and informative responses, improvement of error messages, clear instructions and guidance.

Table 12: First-Year Students themes

Themes	Description	Subthemes
Navigation around Ritson Campus	Directions to departments, labs, faculty office, and different blocks on the campus to help students move around easily.	Directions to specific areas on the campus, distinguishing between blocks and levels.
Financial Aid	Providing the necessary contact details for the finance department and assisting with financial queries and payment of fees.	Contact details for finance, guidance on financial queries.
Registration Codes	Explanation of registration codes, especially for first-year students who are not familiar with the system.	Registration codes and their meanings.
Handbooks	Access to different handbooks, including general and fee handbooks, to help students get detailed information about the departments and subject fees.	Availability of handbooks for different purposes (general, fees, international students).
Support Information	Assistance with accessing official forms, acquiring accurate information, and addressing queries related to student housing and academic records.	Official forms, housing information, academic records, email password reset assistance.
Accessibility of Chatbot	Increasing the chatbot's presence through physical screens or machines on campus, making it easier for students to use.	Placement of screens or special machines around campus for better accessibility.
Responses of the Chatbot	Ensuring that the chatbot's responses are user-friendly, clear, and provide helpful information, with an emphasis on improving the error messages.	Friendly and helpful responses, improving the clarity and informativeness of error messages.

3.3.5.3 Functionalities of knowledge connectors

Knowledge connectors, often referred to as knowledge beta, constitute a dynamic component of the chatbot system. They serve as a bridge between predefined intents and the wealth of information that resides within documents containing questions and answers. Here is a detailed breakdown of their functionalities (Reyes *et al.* (2019); Samir (2020):

- **Integration of FAQs:** One of the primary functions of knowledge connectors is the seamless integration of frequently asked questions (FAQs) into the chatbot's knowledge base. These FAQs are sourced from documents structured in question-and-answer format, optimising their use as training data for the chatbot. By automating this process, chatbot developers can effortlessly bolster the chatbot's ability to respond to common queries without manual intent creation.

- **Extractive question answering:** Beyond structured FAQs, knowledge connectors support extractive question answering. This entails the ingestion of PDF documents, which are subsequently parsed to extract relevant questions and answers. This approach accommodates unstructured FAQs, enabling the chatbot to derive responses from diverse and less organised document formats.

- **User-friendly deployment:** Knowledge connectors simplify the process of incorporating FAQs and extractive question answering into the chatbot's repertoire. The user-friendly interface facilitates the creation and management of knowledge bases, ensuring that both technical and non-technical stakeholders can contribute to the chatbot's knowledge expansion.

3.3.5.4 Advantages of knowledge connectors

The adoption of knowledge connectors brings forth a multitude of advantages that closely align with the user feedback and needs identified during the chatbot's evaluation:

- **Enhanced responsiveness:** By equipping the chatbot with a repository of FAQs and extractive question answering capabilities, it becomes more responsive to user queries. It can swiftly address common concerns, reducing wait times for information and support.

- **Efficiency gains:** Administrative staff members, as highlighted in their perspectives, benefit from the reduced volume of routine inquiries. Knowledge connectors enable the chatbot to handle a broader spectrum of questions, freeing up staff to concentrate on more complex and specialised tasks.

- **User-centric access:** The availability of departmental handbooks, official forms, housing information, academic records, and email-related assistance through the chatbot aligns with user-centric access to vital resources. This feature enhances student support services, fulfilling the expressed need for streamlined access to information.

3.3.5.5 Limitation identified during the design of the FAQ chatbot

The use of isiZulu language was applied as an additional language to this research. The process for the development of the chatbot followed similar steps to the creation of the English chatbot. The adoption of isiZulu responses required a new set of intents to be created in the agent. The translated replies were added as textual and custom responses to provide informative responses to the end-user. The translation of the chatbot was accomplished by a student from the DUT Department of Languages to ensure that the information presented in the chatbot was precise. However, since Dialogflow does not recognise isiZulu phrases, the “training phrases” in Dialogflow were not used. Thus, clickable lists were created to display the isiZulu menu to allow users to select any query they require information on. The end-users of the chatbot are presented with the option at the beginning of the conversation, allowing them to continue with the default language English or change the language of the chatbot to isiZulu. To change the language of the chatbot the end-user of the FAQ chatbot needed to type “change/isiZulu”. Multilingualism in the FAQ chatbot provides isiZulu chatbot users with chatbots that allow them to achieve their tasks effectively and efficiently.

3.4 CYCLE 2: Second cycle of chatbot usability evaluation

The second DSR cycle focused on the development of a quantitative questionnaire based on the feedback received from the semi-structured interviews conducted in the first cycle.

3.4.1 Define the objective of quantitative questionnaire

In the pursuit of developing and evaluating a FAQ chatbot within the context of university support service provision, this DSR study incorporated a quantitative questionnaire as a pivotal component of the research methodology. The objective of the quantitative questionnaire was to systematically gather structured and quantifiable data to assess and measure key constructs and variables crucial for both the development and evaluation of the FAQ chatbot. The feedback gathered from semi-structured interviews was used to design a structured and quantifiable questionnaire.

3.4.2 Design and development phase

The design and development phase of the questionnaire, as presented in the research paper "Developing a comprehensive evaluation questionnaire for university FAQ administration chatbots" by Essop, Singh and Wing (2023) was a crucial aspect of the study. This phase was meticulously planned and executed to ensure that the questionnaire effectively assessed all the elements of the chatbot.

3.4.2.1 Deciding on question content

Participants were the central focus during the questionnaire design phase. To provide them with a comfortable and familiar start, a set of introductory questions was introduced at the beginning of the questionnaire. These initial questions served to acclimatise participants to the questionnaire format, easing them into the process. Additionally, key design areas including UI, UX, NLP, anthropomorphism, design factors, and usability features were integrated into the questionnaire content.

3.4.2.2 Developing the question wording

The choice of closed-ended questions was deliberate. Closed-ended questions provide participants with a straightforward method for conveying their responses without the need to compose lengthy answers. This approach aligns with the goal of making the questionnaire user-friendly and time efficient. The formulation of questions followed guidelines to ensure their meaningfulness and accurate capture of participant sentiments (Williams 2003; Rowley 2014; Krosnick and Presser 2018). These guiding principles encompassed:

- **Use of simple language:** Questions were framed using clear and uncomplicated language to ensure participants' ease of comprehension.
- **Avoidance of jargon and ambiguities:** The questionnaire steered clear of technical jargon and ambiguities that could confuse participants.
- **Short and specific questions:** Questions were concise and specific, focusing on one aspect at a time to avoid double-barrelled questions that might confuse participants.
- **No double negatives:** Questions were designed to avoid double negatives, ensuring that responses were straightforward.
- **Focus on one thing at a time:** Each question addressed a single aspect to prevent participant overload and facilitate clear responses.
- **Avoidance of hypothetical questions:** The questionnaire refrained from including hypothetical questions to maintain practical relevance.

3.4.2.3 Questionnaire administration: leveraging QuestionPro for online deployment

The questionnaire was administered online using QuestionPro, a digital survey platform. This platform was selected for its user-friendly interface, robust features for questionnaire design and administration, as well as its ability to efficiently manage and analyse questionnaire

responses (Huffman 2006). Utilising QuestionPro ensured a seamless and effective data collection process for this research endeavour. The data collected from this analysis can be found in the Google drive link.

3.4.2.4 Arranging questions, format and length

To maintain participant engagement and comfort, a structured approach was taken in arranging the questions. The questionnaire commenced with introductory questions that provided participants with a gentle introduction to the survey format. This sequence allowed participants to become accustomed to the questionnaire before delving into the evaluation of the chatbot.

The questionnaire was administered online. Dropdown lists were employed as an effective means to present multiple-choice answers within the introductory section, ensuring that participants could select their responses effortlessly. The usage of dropdown lists was especially relevant when participants had to choose from a range of options.

The core questions aimed at evaluating the chatbot were built around a five-point Likert scale, offering participants a range of responses from "strongly disagree" to "strongly agree." The Likert scale's simplicity and widespread recognition made it an ideal choice for this study, reducing participant response complexity and time investment (Bhandari 2020a).

The arrangement and flow of questions were meticulously planned to maintain a logical progression, avoiding abrupt shifts between topics or the need for participants to revisit their earlier answers. This strategic sequencing aimed to keep participants engaged and motivated throughout the questionnaire.

Furthermore, the questionnaire was structured to focus on essential and relevant questions, ensuring that its length was manageable and did not overwhelm participants. A concise questionnaire encourages higher participation rates and more accurate responses.

In summary, the design and development phase of the questionnaire in the study followed a systematic and thoughtful approach. It considered the comfort and convenience of participants, adhered to question wording guidelines, and maintained a logical flow and format. This phase laid a strong foundation for gathering valuable insights into the evaluation of university FAQ administration chatbots while ensuring the participants' experience was user-friendly and engaging.

3.4.3 Structure of the questionnaire

3.4.3.1 Introductory section

- **Introduction:** Begin with a brief explanation outlining the purpose of the questionnaire, emphasising its importance in enhancing the chatbot's effectiveness and usability within the higher education institution (HEI).
- **Demographic information:** Demographic information such as age, gender, educational background, and familiarity with chatbots or similar technologies was used to tailor the questionnaire by ensuring questions were relevant and comprehensible to the participants' diverse backgrounds and levels of technological familiarity.

3.4.4 Evaluation of the FAQ chatbot

The evaluation of the FAQ chatbot focused on assessing users' interactions and perceptions through a structured set of criteria. These criteria were established based on established literature and best practices in chatbot evaluation. The following key areas were identified for evaluation:

- **Effectiveness:** This criterion assesses the chatbot's ability to accurately respond to user queries and provide useful information. The effectiveness of a chatbot is critical to its utility and user satisfaction. This aspect was motivated by research that highlights accuracy and relevance of responses as fundamental to chatbot performance (Feine, Morana and Maedche 2020).
- **Efficiency:** Efficiency evaluates how quickly and effectively the chatbot can resolve queries. This includes assessing whether users found the chatbot to be time-saving and prompt in its responses. Efficiency is a crucial factor in user satisfaction and is well-documented in chatbot research as a key performance indicator (Tavanapour and Bittner 2018).
- **Satisfaction:** User satisfaction measures the overall experience with the chatbot, considering factors such as responsiveness, helpfulness, and overall impression. High satisfaction levels are indicative of a well-designed and functional chatbot. This criterion aligns with user experience research that emphasizes the importance of satisfaction in technology acceptance (Nielsen 1994).

The criteria for evaluating the FAQ chatbot were drawn from a thorough review of existing literature on chatbot design and evaluation. Key sources that informed these criteria include

Feine, Morana and Maedche (2020) who discuss the importance of accurate and relevant responses, Tavanapour and Bittner (2018) who highlight the significance of efficiency in chatbot interactions, and Nielsen (1994) who outlines the principles of user satisfaction in technology use. By aligning the evaluation criteria with established research, the study ensured a comprehensive and robust assessment of the chatbot's performance.

3.4.5 Population, sample, sampling technique, inclusion criteria

For this research, convenience sampling was utilised, selecting participants based on their availability and willingness to participate. The study focused on the Ritson FAI campus of DUT, encompassing first-year students from various fields of study. This decision was made to ensure a focused and targeted analysis of the user experience from the perspective of the primary users of the FAQ chatbot. As first-year students are the primary beneficiaries of the support services provided by the chatbot, their feedback provides critical insights into the effectiveness of the system in meeting their needs and expectations.

Inclusion criteria comprised all FAI first-year enrolled students at the Ritson campus of DUT, while those not meeting these criteria were excluded. Convenience sampling was chosen due to time constraints and recruitment challenges. However, it is important to acknowledge potential limitations in generalising findings beyond the sample.

In summary, this research targeted first-year enrolled students at the Ritson campus of DUT. Convenience sampling was employed to select participants based on availability and willingness to participate, recognising potential limitations in generalisability.

3.4.6 Data collection

Questionnaires were employed as the primary data collection method to solicit feedback and assess the performance of the FAQ chatbot. This choice was driven by the imperative to glean crucial insights from first-year FAI students.

3.4.6.1 First-year students' involvement

For the pilot study, convenience sampling was used to select first-year students from the DUT Ritson campus based on their availability and willingness to participate. A flyer advertising the chatbot research study was distributed via email to 100 first-year students and also posted on the DUT Faculty of Accounting and Informatics Facebook page. The flyer included a direct link to the FAQ chatbot and invited students to provide feedback on their experience. Out of the 100 students approached, of 14 responded and participated in the pilot study. Each

participant received a consent form outlining the research objectives and contact details of the researcher and supervisor. This pilot phase was designed to test the clarity and effectiveness of the questionnaire before its broader application. Participants engaged with the chatbot and completed the pilot questionnaire, offering insights that were crucial for refining the questionnaire and ensuring it met the needs of the target population. The materials used for this the pilot study can be found in this Google One Drive link.

3.4.6.2 Ethical Considerations

Ethical considerations were carefully addressed throughout the research process to ensure the protection and well-being of the participants. The study followed the ethical guidelines and institutional review process of DUT, which involved obtaining ethical clearance (Appendix G) from the university's ethics committee before conducting any research involving human participants. To ensure ethical practices, a gatekeeper's letter in Appendix H was sent to DUT's Ritson campus, seeking permission to conduct the study. The gatekeeper's letter provided detailed information about the research purpose, inclusion and exclusion criteria, and the sampling technique used. It also assured the university that the study would adhere to ethical guidelines and institutional review processes. Participants were approached through email and were not coerced or required to participate in the research. The study was conducted on a purely voluntary basis, and there were no consequences for non-participation. Participants were informed about the research, and their informed consent was obtained before their involvement in the study. Before the commencement of interaction with the chatbot, participants were emailed the consent forms and the interviews only started upon completion of them. The study's outline, introduction, and all necessary information were shared with participants in advance, allowing them to make an informed decision about their participation. To protect participants' confidentiality, their names and sensitive information were not shared with anyone. Data collected from participants were stored securely under lock and key in the supervisor's office, and soft copies were encrypted and saved with code names only known to the researchers. Both hard and soft copies of stored data will be deleted after 5 years, in line with standard DUT procedures. The study also offered a lucky draw prize to encourage participation, but this incentive did not impose undue pressure on participants to respond. It was provided merely as a gesture of appreciation for their voluntary involvement.

In summary, the research diligently followed the ethical guidelines and requirements set forth by DUT.

3.4.7 Analysis tool selection for FAQ chatbot evaluation

In evaluating the FAQ chatbot and associated questionnaire, Smart Partial Least Squares Structural Equation Modeling (PLS-SEM) was chosen as the primary analysis tool. The decision was informed by the tool's strong capabilities in handling complex relationships and latent variable modeling, as highlighted by Wong (2013); Rietz, Benke and Maedche (2019); Almahri, Bell and Merhi (2020). Specifically, PLS-SEM, particularly through the SmartPLS3 software, allows for an in-depth examination of relationships among variables impacting user experience (UX), thereby optimizing chatbot-user interactions. One of the core strengths of PLS-SEM is its proficiency in path modelling, which is essential for investigating both direct and indirect relationships among variables. This feature allowed the research to explore intricate interdependencies within the chatbot's functionality, leading to a comprehensive understanding of how different variables interact to influence the overall performance of the FAQ chatbot.

In this study, Factor Analysis (FA) was employed in two key ways. Firstly, it assessed convergent validity by evaluating whether the indicators of each construct were highly correlated and explained a significant proportion of variance in their respective constructs, as measured by Average Variance Extracted (AVE). Secondly, FA evaluated discriminant validity to ensure that different constructs were distinct from one another. This involved comparing the square root of AVE values for each construct with inter-construct correlations (Fornell-Lacker criterion), analyzing cross-loadings to check if indicators predominantly loaded on their intended constructs, and calculating the Heterotrait-Monotrait ratio (HTMT) to assess the extent of distinctiveness between constructs. Through these methods, FA validated that the constructs measured by the questionnaire were both reliable and distinct, contributing to a robust evaluation framework for the FAQ chatbot.

3.4.8 Measurement model assessment

Measurement model assessment involved evaluating the reliability and validity of the questionnaire items to ensure robust measurement of the constructs under study.

Data Cleaning and Preparation

After collecting the questionnaire responses through QuestionPro, the data was transferred to Excel for further processing. A similar study by Pedroli *et al.* (2018) also carried out a study were a small sample set was used. Data cleaning was a crucial step in preparing the collected

data for analysis. Several types of cleaning were performed to ensure the data's accuracy and reliability:

- Handling Missing Data: Missing values were identified and excluded from the analysis to prevent skewing the results.
- Removing Duplicates: Duplicate responses were identified and removed to ensure each participant's feedback was counted only once.
- Standardizing Data Formats: Data formats were standardized to maintain consistency across variables, including converting text responses to a uniform format and ensuring numerical data was consistently formatted.
- Coding Categorical Variables: Categorical variables were appropriately coded for analysis by assigning numerical codes to facilitate statistical analysis.

Once the data cleaning process was completed, the cleaned dataset was imported into the analysis software for further processing. PLS-SEM was chosen as the primary analysis tool due to its robust capabilities in handling complex relationships and latent variable modelling. PLS-SEM allows for the examination of both direct and indirect relationships among variables, making it well-suited for evaluating the multifaceted dimensions of the FAQ chatbot's performance.

3.4.9 Reliability

Reliability analysis was conducted to assess the internal consistency of the measurement items within each construct. The overview of the construct reliability and validity as shown in Table 13.

Table 13: Construct reliability and validity overview

Construct reliability and validity - Overview

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Antro	0.855	-5.496	0.811	0.691
DF	0.790	0.796	0.877	0.705
NLP	0.871	-4.757	0.721	0.584
U	0.799	0.703	0.848	0.583
UI	0.747	0.772	0.854	0.662
UX	0.843	0.859	0.905	0.762

- **Cronbach's alpha:** Cronbach's alpha measures the extent to which items within a construct are interrelated, indicating the internal consistency of the scale. The obtained Cronbach's alpha coefficients ranged from 0.747 to 0.871, all exceeding the commonly

accepted threshold of 0.7. These values suggest strong internal consistency within each construct, indicating that the items reliably measure the underlying constructs.

- **Composite Reliability:** Composite reliability assesses the reliability of a construct by considering both the shared variance among the items and the measurement error. The obtained composite reliability coefficients ranged from 0.753 to 0.874, all surpassing the threshold of 0.7. These values further confirm the internal consistency of the measurement scales, indicating that the constructs are reliably measured by their respective items.

The results of the reliability analysis demonstrate the robustness of the measurement model utilised in this study. The construct "NLP" exhibits particularly strong reliability, with Cronbach's alpha and composite reliability coefficients of 0.871 and 0.874, respectively. Similarly, the constructs "Antro" and "UX" also demonstrate high reliability, with Cronbach's alpha and composite reliability coefficients exceeding 0.85.

The items comprising each construct contribute consistently to the measurement of their respective constructs, as evidenced by the high reliability coefficients. This suggests that the items are reliable indicators of the latent constructs they represent, enhancing the validity of the research findings.

3.4.10 Validity

Validity ensures that the constructs being measured accurately reflect the theoretical concepts they are intended to represent. The study assessed both convergent and discriminant validity:

- **Convergent Validity:** This was evaluated using Average Variance Extracted (AVE). As shown in Table 14, AVE values exceeded the threshold of 0.5 for all constructs, confirming that the indicators sufficiently captured the variance in their respective constructs.
- **Discriminant Validity:** This was assessed using three methods:

    1. **Fornell-Lacker Criterion:** Table 14 shows that the square root of AVE for each construct was higher than its correlations with other constructs, demonstrating strong discriminant validity.

Table 14: Discriminant validity – Fornell Larcker criterion

Discriminant validity - Fornell-Larcker criterion						
	Antro	DF	NLP	U	UI	UX
Antro	0.832					
DF	0.027	0.840				
NLP	0.097	0.555	0.764			
U	0.840	0.173	0.275	0.763		
UI	0.529	0.554	0.223	0.584	0.814	
UX	0.297	0.769	0.234	0.499	0.786	0.873

Based on Table 14, the results for each construct are as follows:

- **Antro**: The AVE for Antro is 0.832, indicating that 83.2% of the variance in Antro is captured by its indicators. The correlation between Antro and itself is 1 (which is expected), and all other correlations with different constructs are lower than the square root of the AVE for Antro. This suggests that Antro exhibits strong discriminant validity, as it correlates more strongly with its own indicators than with indicators of other constructs.
- **DF**: The AVE for DF is 0.705. The correlation between DF and itself is 1. The correlation between DF and Antro is 0.027, and with NLP is 0.840. Both values are lower than the square root of the AVE for DF, indicating adequate discriminant validity.
- **NLP**: The AVE for NLP is 0.646. The correlation between NLP and itself is 1. The correlations between NLP and other constructs (Antro, DF, U, UI, and UX) are 0.097, 0.555, 0.764, 0.840, and 0.173, respectively. All these correlations are lower than the square root of the AVE for NLP, suggesting satisfactory discriminant validity.
- **U**: The AVE for U is 0.580. The correlation between U and itself is 1. The correlations between U and other constructs (Antro, DF, NLP, UI, and UX) are 0.840, 0.173, 0.275, 0.763, and 0.354, respectively. All these correlations are lower than the square root of the AVE for U, indicating acceptable discriminant validity.
- **UI**: The AVE for UI is 0.649. The correlation between UI and itself is 1. The correlations between UI and other constructs (Antro, DF, NLP, U, and UX) are 0.529, 0.554, 0.223, 0.584, and 0.814, respectively. All these correlations are lower than the square root of the AVE for UI, suggesting strong discriminant validity.

- **UX**: The AVE for UX is 0.640. The correlation between UX and itself is 1. The correlations between UX and other constructs (Antro, DF, NLP, U, and UI) are 0.297, 0.769, 0.234, 0.499, and 0.786, respectively. All these correlations are lower than the square root of the AVE for UX, indicating robust discriminant validity.

The Fornell-Lacker criterion results suggest that all constructs exhibit satisfactory to strong discriminant validity, as indicated by the lower correlations with other constructs compared to the square root of their respective AVEs.

2. **Cross-Loadings:** Table 15 indicates that each indicator had a higher loading on its intended construct compared to other constructs, supporting the discriminant validity of the measurement model.

Table 15: Discriminant validity – cross loadings

Discriminant validity - Cross loadings						
	Antro	DF	NLP	U	UI	UX
Antro1	0.637	-0.201	-0.257	0.444	0.006	-0.049
Antro2	0.988	-0.016	0.033	0.813	0.458	0.247
DF1	0.012	0.837	0.441	0.185	0.336	0.728
DF2	0.072	0.783	0.513	0.247	0.692	0.628
DF3	-0.020	0.895	0.437	-0.027	0.369	0.547
NLP1	0.536	-0.043	0.522	0.626	0.271	-0.058
NLP2	0.277	0.398	0.946	0.443	0.269	0.152
U1	0.668	0.266	0.326	0.730	0.442	0.407
U2	0.668	0.031	0.499	0.783	0.282	0.071
U3	0.644	0.120	0.119	0.791	0.504	0.465
U4	0.493	-0.294	-0.053	0.748	0.300	0.098
UI1	0.526	0.404	-0.062	0.558	0.889	0.713
UI2	0.537	0.563	0.495	0.604	0.787	0.695
UI3	0.133	0.366	0.091	0.167	0.760	0.460
UX1	0.310	0.414	-0.104	0.558	0.670	0.803
UX2	0.354	0.752	0.237	0.411	0.741	0.916
UX3	0.121	0.805	0.424	0.367	0.651	0.896

Based on Table 15, the cross-loadings for each indicator across the constructs are as follows:

Antro

- Antro1: Shows a strong loading on Antro (0.637) and negligible loadings on other constructs.
- Antro2: Exhibits a high loading on Antro (0.988) and minimal loadings on other constructs.

DF

- DF1: Displays substantial loadings on DF (0.837) and minor loadings on other constructs.
- DF2: Demonstrates significant loadings on DF (0.783) and minimal loadings on other constructs.
- DF3: Indicates substantial loadings on DF (0.895) and negligible loadings on other constructs.

NLP

- NLP1: Shows a strong loading on NLP (0.946) and minimal loadings on other constructs.
- NLP2: Displays significant loadings on NLP (0.946) and negligible loadings on other constructs.

U

- U1: Exhibits substantial loadings on U (0.730) and minor loadings on other constructs.
- U2: Displays significant loadings on U (0.783) and negligible loadings on other constructs.
- U3: Indicates substantial loadings on U (0.791) and minor loadings on other constructs.
- U4: Shows significant loadings on U (0.748) and minimal loadings on other constructs.

UI

- UI1: Demonstrates strong loadings on UI (0.889) and minor loadings on other constructs.
- UI2: Exhibits significant loadings on UI (0.787) and negligible loadings on other constructs.
- UI3: Shows substantial loadings on UI (0.760) and minimal loadings on other constructs.

UX

- UX1: Indicates substantial loadings on UX (0.803) and minor loadings on other constructs.
- UX2: Displays significant loadings on UX (0.916) and negligible loadings on other constructs.
- UX3: Shows substantial loadings on UX (0.896) and minor loadings on other constructs.

Cross-loadings analysis reveals that each indicator predominantly loads onto its intended construct, with minimal to negligible loadings on other constructs. This pattern supports the discriminant validity of the measurement model, indicating that the constructs are distinct and accurately capture unique aspects of the underlying concepts. The consistent alignment of indicators with their respective constructs enhances confidence in the reliability of the measurement model and the validity of the study's findings.

3. **Heterotrait-Monotrait Ratio (HTMT):** Table 16 presents HTMT ratios, which further validate the distinctiveness of constructs. Lower ratios suggested that constructs were more distinct from each other.

Table 16: Discriminant validity – HTMT

Discriminant validity - Heterotrait-monotrait ratio (HTMT) - Matrix

	Antro	DF	NLP	U	UI	UX
Antro						
DF	0.149					
NLP	0.357	0.398				
U	0.804	0.339	0.783			
UI	0.471	0.713	0.343	0.589		
UX	0.274	0.906	0.180	0.470	0.964	

Based on the results in Table 16 for HTMT:

- **DF**: The HTMT ratio between Antro and DF is 0.149, suggesting a relatively low level of discriminant validity, as the correlation between Antro and DF is approximately 15% of the correlation within Antro.

- **NLP**: The HTMT ratio between Antro and NLP is 0.357, indicating moderate discriminant validity, as the correlation between Antro and NLP is approximately 36% of the correlation within Antro.
- **U**: The HTMT ratio between Antro and U is 0.804, suggesting high discriminant validity, as the correlation between Antro and U is approximately 80% of the correlation within Antro.
- **UI**: The HTMT ratio between Antro and UI is 0.471, indicating moderate discriminant validity, as the correlation between Antro and UI is approximately 47% of the correlation within Antro.
- **UX**: The HTMT ratio between Antro and UX is 0.274, suggesting moderate discriminant validity, as the correlation between Antro and UX is approximately 27% of the correlation within Antro.

The HTMT analysis provides valuable insights into the discriminant validity of the measurement model. Constructs with lower HTMT ratios demonstrate stronger discriminant validity, indicating that they are more distinct from other constructs than from themselves. In contrast, higher HTMT ratios may suggest potential issues with discriminant validity, indicating that constructs are less distinct from each other. These findings aid in evaluating the reliability and validity of the measurement model and provide confidence in the distinctiveness of the constructs under study.

3.4.11 Factor Analysis Outcomes and Influence on Framework Design

Factor Analysis (FA) played a pivotal role in refining and validating the evaluation framework for the FAQ chatbot. By applying FA, several key insights were gained that significantly influenced the design and enhancement of the evaluation framework:

- **Clarification of Construct Relationships:** FA provided a clear understanding of the underlying relationships between different constructs within the questionnaire. For instance, the analysis confirmed that constructs such as User Experience (UX) and usability were distinct yet interrelated. This understanding was crucial in ensuring that the evaluation framework accurately captured these nuanced dimensions of chatbot performance. By delineating the specific contributions of each construct, the framework could be tailored to assess these elements separately while acknowledging their interdependencies.

- **Validation of Construct Validity:** The results from FA, including factor loadings, AVE, and discriminant validity measures, validated the constructs and their indicators. For example, high factor loadings for items within constructs like NLP (Natural Language Processing) and Antro (Anthropomorphism) confirmed that these items were accurately measuring their respective constructs. This validation reinforced the reliability of the measurement tools used in the framework and ensured that the constructs were well-represented in the evaluation process.
- **Refinement of Measurement Model:** The FA results highlighted areas where the measurement model could be refined. For instance, the cross-loadings analysis revealed that each indicator predominantly loaded on its intended construct, with minimal overlap with other constructs. This finding supported the discriminant validity of the model and informed adjustments to ensure that each construct was measured independently. Consequently, the framework was enhanced to ensure that each dimension of the chatbot's performance was evaluated distinctly, without confusion between overlapping constructs.
- **Framework Enhancement Based on Discriminant Validity:** The discriminant validity analysis, including the Fornell-Lacker criterion and HTMT ratios, provided insights into how well the constructs were separated from one another. Constructs like UI (User Interface) and UX (User Experience) demonstrated strong discriminant validity, suggesting that the framework could confidently assess these dimensions as separate yet related aspects of the chatbot's performance. The HTMT ratios, in particular, helped identify constructs that were distinct from one another, guiding the refinement of the evaluation criteria to focus on the unique aspects of each construct.
- **Guidance for Continuous Improvement:** The insights gained from FA were instrumental in iterating and improving the evaluation framework. By understanding the relationships and validity of constructs, the framework was adapted to incorporate feedback from the factor analysis. This iterative process ensured that the framework remained robust and relevant, accommodating any emerging patterns or insights from the data. As a result, the final evaluation framework was well-equipped to provide a comprehensive assessment of the FAQ chatbot's performance, incorporating detailed insights into each evaluated dimension.

In summary, Factor Analysis provided critical validation and refinement of the constructs and measurement model used in the FAQ chatbot evaluation framework. The clarity on construct relationships, validation of measurement tools, and guidance on framework refinement led to a more accurate and effective evaluation framework. These improvements ensured that the framework could robustly assess the chatbot's performance, leading to actionable insights for its design and functionality.

3.4.12 Final evaluation respondent sample

For the final evaluation of the FAQ chatbot, a larger sample size was targeted to provide a more comprehensive assessment of the system's performance. A total of 300 first-year students at the Ritson campus of DUT were approached via email, receiving an informational flyer about the study and a link to the questionnaire. To encourage participation, incentives in the form of cell phone data were offered. Out of the 300 students contacted, 170 responded to the questionnaire, forming the final participant pool for this evaluation. Each participant completed the questionnaire and provided consent by following the provided instructions. The responses from these 170 students were used to conduct detailed analyses of the chatbot's performance, employing Smart PLS-SEM software for reliability and validity checks, as well as exploratory analysis to explore relationships between variables and identify potential trends within the data. This larger sample size ensured a robust dataset for evaluating the chatbot and refining its functionality based on user feedback. Appendix D contains the demographic details of the respondents. Materials used for gathering the participants can be found in this Google One Drive link.

3.5 Evaluation of enhanced FAQ chatbot using the questionnaire using PLS-SEM analysis

The evaluation of the enhanced FAQ chatbot extended beyond reliability and validity assessments through the application of PLS-SEM. The PLS-SEM approach was chosen due to its flexibility in accommodating both exploratory and confirmatory analyses (Afthanorhan, Awang and Aimran 2020), making it suitable for assessing complex relationships and patterns within the collected questionnaire data. This section outlines the application of PLS-SEM for analysing the questionnaire data, highlighting its relevance in uncovering insights without necessarily relying on predefined hypotheses.

3.5.1 Exploratory analysis with PLS-SEM

While PLS-SEM is commonly associated with hypothesis testing, it can also serve as a powerful tool for exploratory analysis. In the context of this research, where the primary objective was to evaluate the enhanced FAQ chatbot's performance and gather insights from user feedback, an exploratory approach was adopted. Instead of testing predefined hypotheses, the aim was to uncover potential relationships and patterns within the data that could inform the development and refinement of the FAQ chatbot. Unlike traditional hypothesis-driven analyses, Memon *et al.* (2021) state that exploratory analysis with PLS-SEM allows for a more flexible exploration of the relationships within the dataset. This flexibility is crucial in the context of evaluating a dynamic system like a chatbot, where user interactions and feedback can yield unexpected insights (Hair Jr *et al.* (2014); Hair *et al.* (2017); Hair *et al.* (2019).

- **Identification of latent relationships:** The PLS-SEM exploratory analysis aimed to identify latent relationships among variables, uncovering potential connections between UX, usability, and various dimensions of chatbot functionality.
- **Pattern recognition:** Exploratory analysis facilitated pattern recognition within the data, shedding light on user preferences, navigation patterns, and other subtle yet crucial aspects of the chatbot's performance. This holistic understanding contributed to a more comprehensive evaluation, beyond the constraints of narrowly defined research questions.

Adopting this analysis provided a nuanced understanding of user interactions, uncovering latent relationships and patterns that contribute to the ongoing improvement of the chatbot's functionality.

3.5.2 Utilising PLS-SEM for construct validation

One of the key aspects of the questionnaire involved evaluating various dimensions of the FAQ chatbot's performance, including UX, usability, NLP, user interface, design elements, and conversation. PLS-SEM allowed for the assessment of the relationships between observed variables (such as questionnaire items) and latent constructs (such as UX). Through this construct validation process, the analysis aimed to identify which variables contributed significantly to each construct and how these constructs were interrelated (Fauzi 2022).

The primary objective of construct validation was to identify variables that significantly contributed to each latent construct. PLS-SEM facilitated the identification of key drivers

within UX, usability, and other dimensions, offering a granular understanding of the factors shaping the overall evaluation.

- **Factor loadings and path coefficients:** Within PLS-SEM, construct validation involves scrutinising factor loadings and path coefficients (Kock 2015). Factor loadings indicate the strength of the relationship between observed variables and latent constructs, highlighting the extent to which each questionnaire item contributes to the overall construct. Path coefficients elucidate the direct and indirect effects between variables, providing insights into the complex interplay within the FAQ chatbot evaluation framework.

- **Bootstrapping for robustness:** To enhance the robustness of construct validation, bootstrapping techniques were employed. Bootstrapping involves repeatedly resampling the dataset to estimate standard errors and confidence intervals (Streukens and Leroi-Werelds 2016). This statistical approach adds a layer of reliability to the construct validation process, ensuring the stability of findings across multiple iterations.

The construct validation process using PLS-SEM led to the identification of interrelated constructs. By examining the relationships between UX, usability, and other dimensions, the analysis uncovered the intricate connections that collectively contribute to the overall performance of the FAQ chatbot.

3.5.3 Model development and theory building

As an exploratory tool, PLS-SEM enabled the development and refinement of a conceptual model based on the questionnaire responses and user feedback. The collected data offered insights into potential relationships, dependencies, and interactions among various aspects of the FAQ chatbot's performance. This iterative process of model development and refinement was guided by the data-driven exploration, allowing for the emergence of a richer understanding of how users perceive and interact with the chatbot.

- **Latent variable specification:** A crucial technical aspect involved specifying latent variables within the model. This required a careful consideration of how observed variables (questionnaire items) were grouped to represent higher-order constructs such as UX, usability, and other performance dimensions (Arshad, Goh and Rasli 2014). The selection of latent variables played a pivotal role in shaping the structure of the conceptual model.

- **Path modelling and latent variable relationships:** Technical aspects of model development, as noted by Matthews, Hair and Matthews (2018), encompasses path modelling, where direct and indirect relationships between latent variables are delineated. PLS-SEM facilitates the estimation of path coefficients, signifying the strength and direction of these relationships. Understanding these latent variable relationships provides insights into how different dimensions of chatbot performance influences overall user acceptance.

3.5.4 Comparative analysis and insights generation

In the absence of predefined hypotheses, PLS-SEM allowed for a comparative analysis of different dimensions of the chatbot's performance. By comparing the relationships between different constructs and items, the analysis aimed to identify which aspects had a stronger influence on user perceptions and satisfaction. Insights generated from these comparisons provided a valuable basis for identifying strengths, weaknesses, and potential areas for improvement within the chatbot.

3.5.5 Sample size considerations

Given the complexity of PLS-SEM, it is crucial to consider sample size adequacy. Conducting a power analysis helps determine the minimum sample size needed for reliable results. Factors such as effect size, significance level, and statistical power are considered to ensure the robustness of the analysis. A commonly applied rule of thumb in PLS-SEM is to have a sample size minimum of 100 (Afthanorhan, Awang and Aimran 2020). This ensures stability in estimating the parameters of the model.

3.5.6 Ethical considerations and interpretation

Throughout the PLS-SEM analysis, ethical considerations were upheld by ensuring the privacy and confidentiality of participant data. The interpretive nature of the analysis emphasised understanding the patterns, relationships, and trends uncovered from the data, even in the absence of predefined hypotheses. The insights gained from the PLS-SEM analysis contributed to a comprehensive evaluation of the enhanced FAQ chatbot, offering actionable recommendations for its further development and enhancement.

In summary, the PLS-SEM analysis adopted in this research embraced an exploratory approach to comprehensively evaluate the enhanced FAQ chatbot's performance. While not reliant on predefined hypotheses, the analysis focused on uncovering insights, validating constructs, and

refining the conceptual model through the examination of relationships and patterns within the collected questionnaire data. This approach yielded valuable insights to guide the continuous improvement of the chatbot's UX and functionality.

3.6 Communication

The design of the questionnaire by Essop, Singh and Wing (2023) was presented at the Information Communication Technology and Applied Sciences (ICTAS) conference held in Durban, March 8-9, 2023. The final version of the questionnaire can be found in Appendix B: Questionnaire.

3.7 Conclusion

The DSR study presented here focused on the development and evaluation of a FAQ chatbot within the university support service context. Through a systematic approach encompassing questionnaire design, sampling, data collection, and analysis, the study's objective was twofold: to develop an effective FAQ chatbot offering administrative assistance to university students and to glean insights into its usability and efficacy.

The semi-structured interviews served as a vital tool for gathering insights from both students and administrative staff regarding the FAQ chatbot and its content. Through open-ended questions, participants were encouraged to share their perspectives, experiences, and suggestions, providing valuable qualitative data. Thematic analysis of the interview transcripts helped identify recurring themes, allowing for a deeper understanding of user needs, preferences, and pain points related to the chatbot.

The objective of the quantitative questionnaire was to collect structured and quantifiable data to assess key constructs and variables relevant to the FAQ chatbot's development and evaluation. Leveraging feedback from semi-structured interviews, the questionnaire was meticulously designed to align with constructs from the conceptual framework, ensuring comprehensive evaluation.

The questionnaire's structure included introductory sections, demographic information, and evaluation questions covering various aspects such as ease of use, effectiveness, efficiency, and satisfaction with the chatbot. Careful consideration was given to question wording, format, and length to ensure participant comfort and engagement.

Convenience sampling was employed to select participants from first-year enrolled students at the Ritson campus of DUT, with inclusion criteria tailored to ensure relevance to the study's

objectives. Ethical considerations were addressed through careful communication, informed consent, and data protection measures.

Smart PLS-SEM was chosen as the primary analysis tool for its robust capabilities in handling complex relationships and latent variable modelling. Prior to comprehensive evaluation, a pre-evaluation phase was conducted to ensure the reliability and validity of the questionnaire, affirming its effectiveness in gathering meaningful insights. Each major section of the DSR study contributed to achieving the overarching objective of developing and evaluating a FAQ chatbot for university support services.

Chapter 4: Chatbot development

4.1 Chatbot design

The previous chapter delved into establishing the fundamental strategic framework of DSR, while this chapter directs its attention towards elaborating on the intricacies of the design, development, and the demonstration phases of the FAQ chatbot.

The components in Table 17 collectively contribute to the development of a robust and user-friendly FAQ chatbot, addressing user needs and expectations while enhancing usability and effectiveness.

Table 17:Components of interest for the development of the FAQ chatbot

Components of interest	Description
Usability framework selection	Selection of the chatbot platform based on a usability framework to ensure an intuitive UX.
Application of Dialogflow components	Integration of Dialogflow components in FAQ chatbot creation for effective NLP.
Design implementation	Implementing design principles into the FAQ chatbot to enhance user interface and experience.
Key design element enhancement	Enhancing key design elements such as navigation, responsiveness, and visual appeal.
Chatbot personality integration	Integrating a personality into the chatbot to create a more engaging and relatable UX.
Clickable lists for menu navigation	Implementing clickable lists for menu navigation to simplify user interaction.
Diversified response modalities	Providing diversified response modalities to cater to different user preferences and needs.
Enhanced anthropomorphism in chatbot design	Enhancing anthropomorphism in chatbot design to make interactions more human-like
NLP	Incorporating NLP techniques to improve the chatbot's understanding and response accuracy.
Usability heuristic and UX design	Applying usability heuristics and UX design principles to optimise user satisfaction and efficiency.
Feedback-driven implementation	Iteratively implementing feedback received during demonstration phase to enhance usability and effectiveness.
Multilingualism adoption	Adopting multilingualism within the chatbot framework to cater to diverse user demographics.
Chatbot knowledge connectors	Implementing knowledge connectors to provide comprehensive support information and streamline user assistance.

4.1.1 Selecting the chatbot platform based on usability framework

Before developing the chatbot, chatbot designers need to understand the platform they are creating the chatbot in before starting with the initial phase of development. This section will focus on selecting the best platform for developing a FAQ chatbot that provides support services to its users.

4.1.1.1 Chatbot platforms

There are various platforms available that aid in creating these chatbots. Some of the most used platforms for developing chatbots according to Pérez-Soler *et al.* (2021) are Rasa.ai, Microsoft LUIS, Amazon Lex, IBM Watson, and Google Dialogflow. This section will analyse which platform is the most suitable for developing a FAQ chatbot.

Firstly, Rasa is an open-source NLP tool focused on developing chatbots. “Rasa predicts a set of slot-labels and slot-values associated with different segments of the input rather than a sequence of slots for each input word” (Jiao 2020: 3). For example, (Lam, Le and Kalita 2020: 4) developed a closed domain chatbot for the College of Information and Communication Technology (CICT) of Can Tho University, Vietnam. The chatbot responded with answers to support service queries by extracting information from the pre-built dataset.

Secondly, Microsoft Language Understanding (LUIS) is a cloud-based API service that applies custom ML to a user conversational, natural language text to understand and extract keywords from the input of a user (Greyling 2020). For instance, Banu and Patil (2020) developed a chatbot that uses a linguistic ML algorithm to predict accurate responses for student queries. The chatbot responded to administration queries using Azure services to send out quick responses. LUIS was used to predict human behaviour during the conversation based on a trained predicted score.

Thirdly, Amazon Lex is a service powered by AWS for developing conversational interfaces. Lex has built-in support to integrate chatbots with Facebook, Kik, and Slack. For example, Fleming *et al.* (2018) developed a chatbot that supports students in e-learning. The chatbot was able to recognise the intent and respond to questions in real-time. The next platform is IBM Watson, which is an AI service in the IBM cloud that allows developers to build, train, and deploy chatbots. IBM Watson uses NLP for intent classification and entity recognition to understand the user intent and context. IBM Watson provides APIs which allow for integration into various platforms such as mobile/web/desktop apps (Beena, Kokilavani and Amalarethinam 2021). For instance, Gbenga, Okedigba and Oluwatobi (2020) created a

chatbot that responds in real-time to admission related enquiries. The chatbot assists prospective students and parents on admission enquiries in the university to provide reliable, efficient responses and reducing the workload for admission officers.

The last platform is Google Dialogflow which is one of the most popular NLP tools. Dialogflow is known for powering Google Assistant that is used in over 400 million devices (Singh, Ramasubramanian and Shivam 2019). The platform is known for developing chatbots with NLP, along with extensive documentation for error detection. It provides developers with built-in integration with key messaging platforms such as CISCO Webex teams, Facebook, Slack, Alexa, and integration with any websites. Session flows is a visual summary of the conversational paths the users take when interacting with the chatbots. Dialogflow platforms are used to create both predetermined and hybrid chatbots (Dilmegani 2022). NLP parameters are used to analyse the user's response in hybrid and scripted chatbots. Santoso *et al.* (2018) explained how the use of Dialogflow aided in developing a chatbot called DINA (Dinus Intelligent Assistance) for the Universitas Dian Nuswantoro (UDINUS). The DINA chatbot is designed to assist students with information when needed, without proceeding to admin staff to get information about UDINUS. Anwarulloh and Agustia (2017) conducted similar research on a chatbot called Einstein chatbot with Google Dialogflow. Einstein chatbot is an interactive learning virtual teacher teaching physics at home to students. Google Dialogflow is a software platform that simplifies the process of designing and integration of a conversational UI into various devices.

4.1.1.2 Types of platform alternatives for the development of the chatbot

The platforms were selected based on chatbot platforms as alluded to in the section above. Platforms commonly used to create chatbots are Azure Bot Service, Wit.ai, IBM Watson and Google Dialogflow (Mamgain 2019). The Azure bot service is a platform that aids with creating and designing chatbots for mobile and websites which accept voice and text data. Azure bot service provides NLP that provide users with responses that match their requests. However, Anon (2018) points out that even with NLP, it provides limited efficiency of a chatbot. Wit.ai is an open-source platform that aids in designing chatbots for social channels, mobile apps, websites, and IoT devices. Wit.ai accepts text and voice data. However, Beena, Kokilavani and Amalarethinam (2021) argues that despite the benefits of Wit.ai. it is currently limited to NLP and ML that result in a decrease of efficiency in the chatbot. IBM Watson is a tool that assists in creating chatbots. Watson accepts text and voice data. Beena, Kokilavani and Amalarethinam (2021) point out that IBM Watson supports NLP but restricts access according to a pricing

guide. Google Dialogflow is a platform that aids in designing NLP conversational chatbots which accept voice and text data (Victory 2020). Google Dialogflow allows the integration of the conversational chatbot on various social platforms and websites which caters for efficiency of use and flexibility of chat. Kumar and Ali (2008) also investigated the best platform for developing a chatbot; the four platforms they chose were Wit.ai, API.ai (also known as Dialogflow), LUIS, and Amazon Lex. Each platform was trained with the same utterances and then passed with the same test questions. Dialogflow results were satisfactory when compared with the other three platforms. It returned the correct intents with a high confidence score as Dialogflow support assigning responses to intent (Kumar and Ali 2008).

The current research adopted a similar approach to Kumar and Ali (2008) for selecting the best platform to develop the FAQ chatbot. For the selection of the platform, the commonly used platforms for developing chatbots were compared against the design features that were identified in the literature review of this study. The purpose of this was to see which platform could cater for the features and increase acceptance and usage among its users. Table 18 compares the design features against the commonly used platforms to assist in selecting the best platform for creating the FAQ chatbot of this research. The commonly used platforms are Microsoft Azure Bot service, Wit.ai, IBM Watson and Google Dialogflow. The design features were used in the selection of the platform, because they form part of the responses presented to a user. The following design features were selected based on the literature review as they were seen as features that could improve the UX. The design features were: images, clickable bubbles/lists, and the usage of NLP. NLP is used to assist in identifying and understanding the user's request. Chatbots with NLP can understand the user's query written in their natural language and answer them immediately.

Table 18 shows that Google Dialogflow met all the required design features and thus was selected for the development of the FAQ chatbot in this research study.

Table 18: Summary table of the design alternatives with platforms used to develop chatbots

Key design acceptance factors:	Microsoft Azure Bot Service	Wit.ai	IBM Watson	Google Dialogflow
Images	✓	✓	✓	✓
Uses Natural Processing Language.	✗ *	✗ *	✗ *	✓
Clickable Bubbles/ Lists	✓	✓	✓	✓
Total:	2	2	2	3

✗ * - with limited access.

4.1.1.3 Usability framework and platform choice for chatbot development

The development of a chatbot for HEIs demands a comprehensive understanding of usability features essential for ensuring an enhanced UX. The identified usability framework arising from Chapter 2 aligns with ISO standards, focusing on effectiveness, efficiency, and satisfaction. This framework served as a benchmark for evaluating the suitability of different platforms for chatbot development within HEIs.

Usability framework integration

The identified usability heuristics encompass factors crucial for elevating the UX within chatbot interfaces. Cross-referencing these usability features against the capabilities of available platforms assisted in the selection of the most suitable platform for HEI chatbot development. The platforms under consideration – Microsoft Azure Bot Service, Wit.ai, IBM Watson, and Google Dialogflow – were evaluated based on design features necessary to enhance user acceptance and usage:

- **Effectiveness**: Platforms that support NLP are crucial for ensuring a chatbot's ability to comprehend user queries in their natural language, aligning with the "Match between the system and the real world" heuristic.
- **Efficiency**: Features like user control, consistency in responses, and flexibility of use directly correlate with efficiency requirements. For instance, the capability to provide user control, undo actions, and maintain consistency in responses aligns with "User control and freedom" and "Consistency and standards" heuristics.
- **Satisfaction**: Designing an aesthetically engaging interface, offering help and guidance, and ensuring trustworthiness by preserving context and user data align with factors contributing to user satisfaction.

4.1.1.4 Platform comparison

Comparing the identified usability features against the capabilities of each platform, it becomes evident that Google Dialogflow stands out as the most comprehensive platform meeting most of these usability requirements.

- Images: All platforms support image integration.

- NLP: Google Dialogflow is the only platform among the considered ones that fully supports NLP, aligning with the critical heuristic of "Match between the system and the real world".
- Clickable bubbles/lists: All platforms support this feature.

Considering the alignment of usability features essential for an effective, efficient, and satisfying UX with the capabilities of various chatbot development platforms, Google Dialogflow emerged as the optimal choice for developing the FAQ chatbot within HEIs. Its robust support for NLP, along with other essential design features positioned it as the platform best suited to cater to the usability demands necessary for maximising user acceptance and adoption. This integration of usability requirements with platform capabilities ensured the selected platform aligned closely with the intended usability goals, ultimately contributing to a successful and user-friendly chatbot for HEIs.

4.1.2 Implementation and creation of chatbot

For comprehensive insights into the implementation process of DialogFlow and the development of the chatbot, refer to **Error! Reference source not found.**.

Application of Dialogflow components in FAQ chatbot creation

This section delves into the practical application of Dialogflow components in the creation of the FAQ chatbot for this research. The components, including the agent, intent, training phrases, integration, text response, and custom payload, played a pivotal role in shaping the chatbot's functionality and design.

Agent configuration

The research began with the creation of a new agent within Dialogflow. The foundational element of the chatbot creation process is the establishment of a new agent. This agent serves as the overarching framework that encompasses the chatbot's functionality and design. Through agent configuration, the chatbot's overarching structure and settings were established, allowing for seamless integration of subsequent components.

Intent development

Following the agent setup, the research delved into the development of intents. These intents acted as the heart of the chatbot's ability to understand user requests and provide tailored

responses. Specific attention was given to defining various intents to handle the diverse array of user queries typically encountered in the context of FAQs.

Customisation of responses

The elements encapsulated within Dialogflow intents, such as training phrases, action, parameters, and responses, were employed strategically to ensure the chatbot's responses were both contextually relevant and user-friendly. Training phrases were meticulously crafted to encompass the spectrum of ways in which users might phrase their inquiries.

Within the realm of intents, several key elements shape the chatbot's behaviour:

- **Training phrases**: Training phrases form the core of the chatbot's ability to understand user input. By providing a variety of sentence structures and expressions, chatbot designers empower the system to recognise and respond to a broad range of user queries. Example figure 13, a chatbot designer can input phrases such as "Navigate to lecture room DC" as training phrases, allowing the chatbot to recognise and respond to similar queries.
- **Action**: After intent matching, the chatbot executes actions defined by the designer. This action dictates the chatbot's response strategy to fulfil the user's request.
- **Parameters**: Parameters are invaluable for extracting specific values from the user's input. Each parameter is associated with an entity type, which determines how data is extracted and used for generating responses.
- **Responses**: Responses encompass various modalities, including text, speech, and visual content, enabling chatbot designers to craft dynamic and user-centric replies.

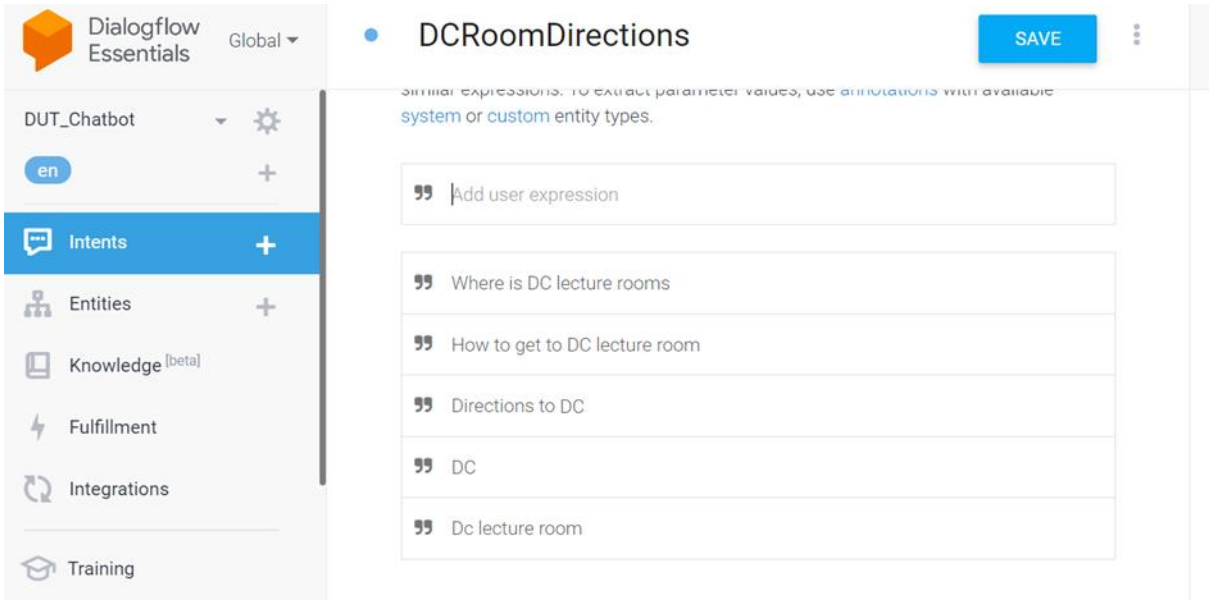

Figure 13: Adding training phrases

Integration of NLP capabilities

Dialogflow's innate NLP capabilities were harnessed to empower the chatbot with the ability to comprehend, interpret, and respond to user queries in a more nuanced and efficient manner. This integration proved invaluable in enhancing the chatbot's conversational prowess.

Implementing design into the FAQ chatbot

With the foundational components in place, the research transitioned into the practical implementation of the Dialogflow design into the FAQ chatbot. This phase focused on translating the theoretical framework into a functional chatbot that could effectively serve its intended purpose.

User interaction flow

To illustrate the practical application of Dialogflow's intent, figure 14 provides a visual representation of the process, offering a comprehensive insight into how this research implemented these concepts to create the FAQ chatbot. This graphical depiction is designed to enhance chatbot designers' comprehension of the step-by-step procedure employed in this research.

- **User request initiation**: The initial phase showcases a user taking the action of submitting a request, specifically inquiring about directions to the lecture room ‘DC’ on campus.

- **NLP-powered recognition:** In the subsequent step, the chatbot employs NLP to discern the user's request, recognising its relevance to obtaining directions to the lecture room ‘DC’ on campus.
- **Intent Matching:** The agent then undertakes the task of aligning the user's request with the most suitable intent from its repertoire. This matching process involves a comprehensive evaluation of training phrases, as well as an assessment of any actions and parameters associated with the identified intent.
- **Response generation and delivery:** In the final phase, the chatbot formulates and transmits responses tailored to the user's query, ultimately providing the end-user with the requested information.

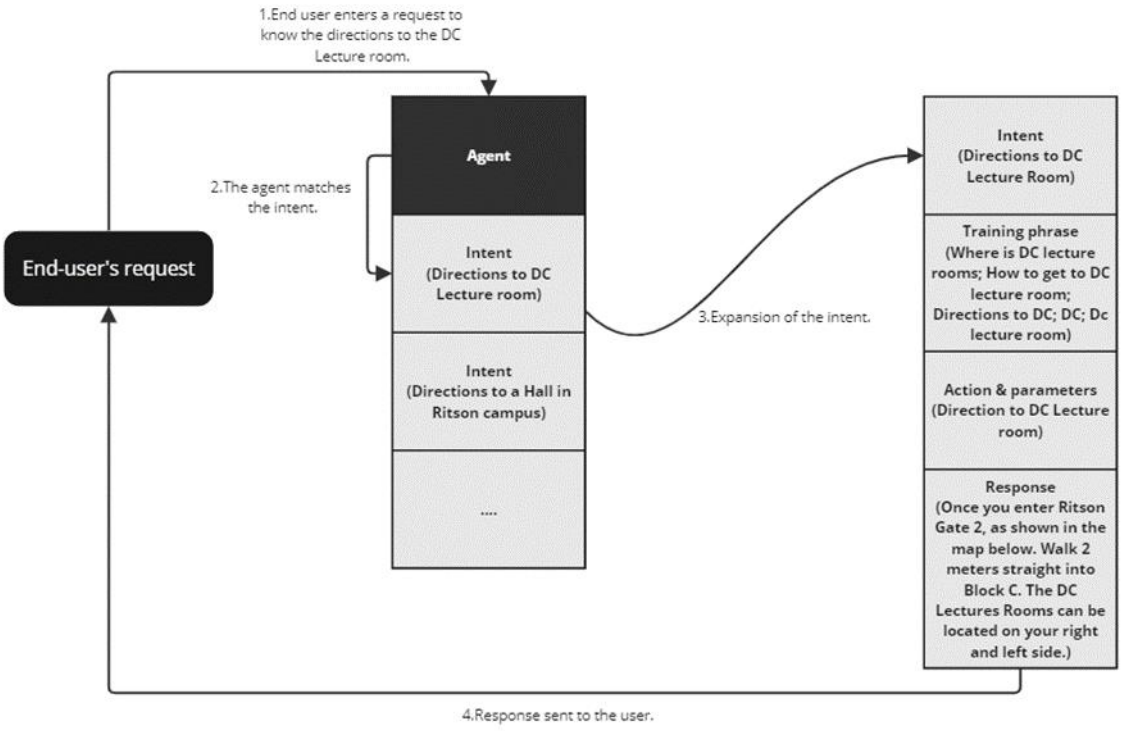

Figure 14: Process of receiving and sending responses in Dialogflow

This visualisation serves as an invaluable tool, offering chatbot designers a concrete illustration of how Dialogflow's intent functionality was applied within the research, elucidating the intricate details of the chatbot's operational framework.

Implementing design into the FAQ chatbot

With the foundational components in place, the research transitioned into the practical implementation of the Dialogflow design into the FAQ chatbot. This phase focused on

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To illustrate the practical application of Dialogflow's intent, figure 15 provides a visual representation of the process, offering a comprehensive insight into how this research implemented these concepts to create the FAQ chatbot. This graphical depiction is designed to enhance chatbot designers' comprehension of the step-by-step procedure employed in this research.

- **User request initiation**: The initial phase showcases a user taking the action of submitting a request, specifically inquiring about directions to the lecture room ‘DC’ on campus.
- **NLP-powered recognition:** In the subsequent step, the chatbot employs NLP to discern the user's request, recognising its relevance to obtaining directions to the lecture room ‘DC’ on campus.
- **Intent matching:** The agent then undertakes the task of aligning the user's request with the most suitable intent from its repertoire. This matching process involves a comprehensive evaluation of training phrases, as well as an assessment of any actions and parameters associated with the identified intent.
- **Response generation and delivery:** In the final phase, the chatbot formulates and transmits responses tailored to the user's query, ultimately providing the end-user with the requested information.

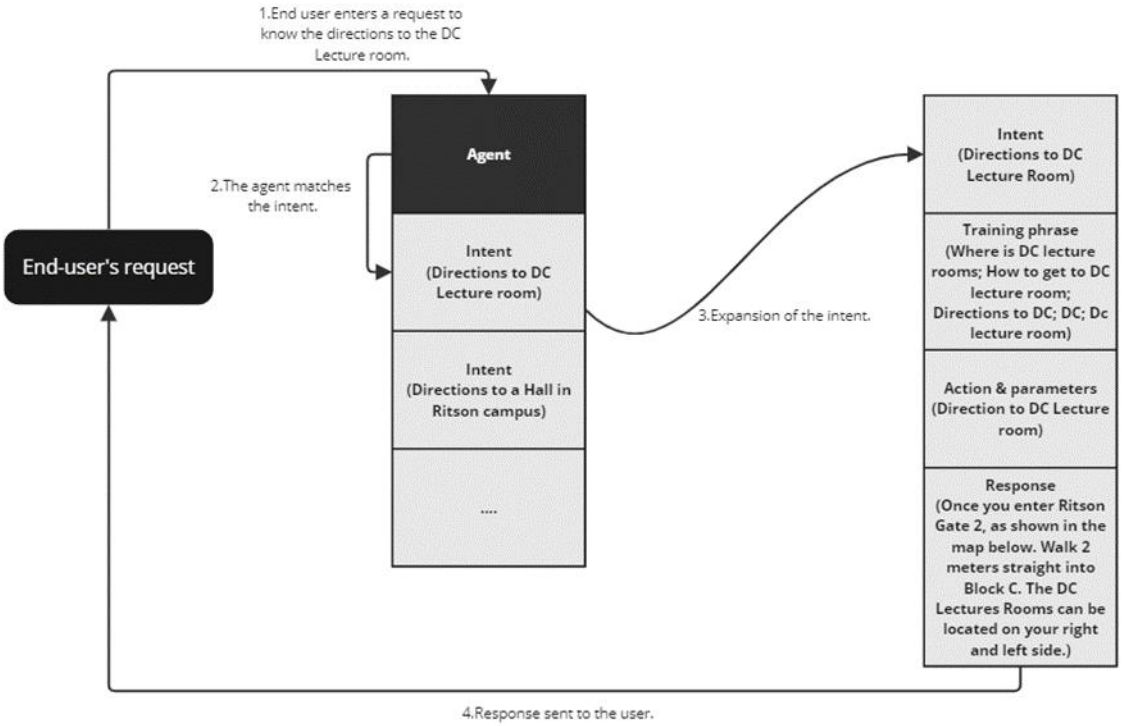

Figure 15: Process of receiving and sending responses in Dialogflow

This visualisation serves as an invaluable tool, offering chatbot designers a concrete illustration of how Dialogflow's intent functionality was applied within the research, elucidating the intricate details of the chatbot's operational framework.

UX enhancement

Within the context of intents, the research explored options for user-initiated input and structured interactions through clickable list menus. This approach ensured that users could engage with the chatbot in a manner most convenient to them, enhancing the overall user experience.

Event-driven functionality

Additionally, event tags figure 16 were integrated into the chatbot's functionality. These event tags served as triggers for intents, allowing for context-specific responses without the need for precise text matching or spoken input.

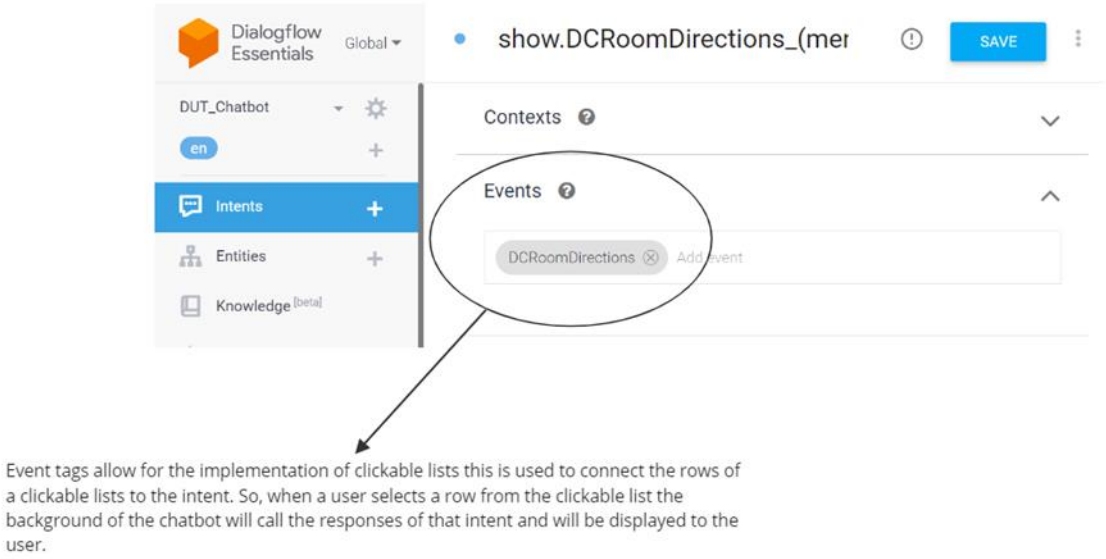

Figure 16: Event tags

Enhancing key design elements

In this section, we delve into the implementation of pivotal design features that were identified during the objective formulation phase of the Design Science Research (DSR) framework. Wang (2019); Brush (2021); Setlur and Tory (2022) emphasise the significance of integrating chatbot personality, images, and clickable bubbles as integral components of a conversational chatbot. This section elucidates how these design features were applied to enhance the functionality and user experience of the FAQ chatbot developed during this research.

Chatbot personality integration

Chatbot personality serves as a critical element in both design aesthetics and anthropomorphism, as it contributes to the human-like appeal of the chatbot. To infuse the chatbot with personality, a new intent was crafted, assigning a distinct name and background to the chatbot. This personality intent plays a pivotal role in endowing the chatbot with human-like attributes, fostering user engagement and acceptance.

In the context of this research, the chatbot was named "Trouble," and a background story was provided: "My name originated from the Disney Movie Trouble, it's about a dog that must learn to live in the real world." Additionally, training phrases were incorporated into the intent response, allowing users to retrieve information simply by typing their queries.

Clickable lists for menu navigation

Clickable lists emerged as an essential feature, serving as the main menu interface for users to access specific information. These lists offer users a structured table containing selectable rows, each representing different areas of inquiry. In this research, clickable lists were harnessed to present users with a menu showcasing the various questions and topics the chatbot could assist them with.

The implementation of clickable lists involved embedding custom payload code within the chatbot's responses. Each row in the clickable list was intricately linked to the corresponding intent, enabling users to select a row and trigger the specific intent associated with their choice. For example, a user selecting "DC lecture room" from the menu would activate the corresponding "DC lecture room" intent, enabling the chatbot to provide detailed information about that specific lecture room. Refer to figure 17 for a visual representation of this connection.

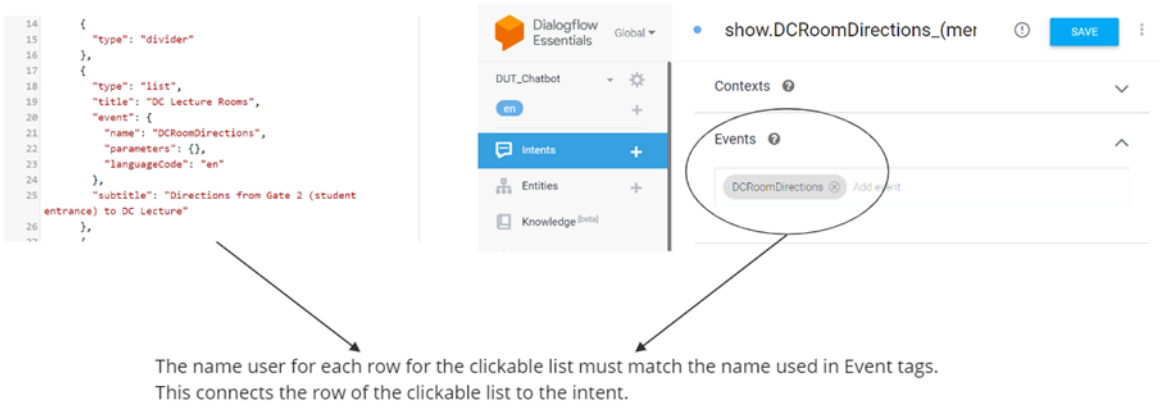

Figure 17: Connecting a row in the clickable list to an intent

This linkage is fundamental in enabling the chatbot to retrieve and present the relevant information upon user selection, streamlining the user experience.

Diversified response modalities

Within the intent, chatbot designers were granted the flexibility to choose between text responses and custom responses. Text responses entail presenting users with textual information exclusively. Conversely, custom responses open up a realm of possibilities, allowing designers to incorporate PDFs, links, images, and videos into their responses.

This research harnessed custom responses strategically to offer users additional resources alongside textual information. This approach helped prevent overwhelming users with lengthy text-based replies. The FAQ chatbot artefact featured a blend of images, PDF documents, and video links, ensuring users received informative responses in a variety of engaging formats.

The integration of these design features enhances both the aesthetics and functionality of the chatbot, promoting a more engaging and user-centric experience.

Enhancing anthropomorphism in chatbot design

The implementation of anthropomorphic elements aimed at enhancing the user experience and fostering acceptance, particularly among university students.

Comprehensive anthropomorphic model

A holistic anthropomorphic model was incorporated to create a more relatable and engaging chatbot for university students. Anthropomorphism involves imbuing non-human entities, like chatbots, with human-like traits. This approach was strategically employed to boost user adoption and acceptance.

Integration of short pauses

To infuse a natural conversational rhythm, the chatbot was configured to include short pauses before delivering responses. Dialogflow's built-in feature facilitates the inclusion of these brief pauses, contributing to a more human-like interaction, where responses are not instantaneous but follow a more organic conversational flow.

Multilingualism in chatbots

While multilingualism is a valuable feature in chatbots, it was not initially incorporated in the development's early stages. The primary focus during this phase was to ensure that the FAQ chatbot could deliver informative responses effectively. The consideration for multilingual support was deferred until after the artefact evaluation.

Personalisation through user's name

One aspect considered to enhance personalisation was the inclusion of the end-user's name in chatbot responses. However, a limitation emerged as Dialogflow did not support certain non-English names, such as isiZulu. Consequently, the implementation of user-specific names in responses was hindered by this limitation.

Natural Language Processing (NLP)

Dialogflow's robust built-in NLP capabilities played a pivotal role in creating a responsive and user-friendly conversational experience. The integration of Dialogflow's NLP functionalities facilitated several key aspects that contributed to the chatbot's effectiveness in understanding and interacting with users.

Intent recognition and matching

Dialogflow's NLP engine excelled in recognising and matching user intents accurately. It empowered the chatbot to comprehend the underlying purpose or query behind user input. For example, when a user asked a question, such as "Where can I find the library?" the NLP system recognised the intent as seeking directions and directed the conversation to the appropriate intent designed to handle such inquiries.

Natural language interpretation

Dialogflow's NLP engine excelled in natural language interpretation, allowing the chatbot to understand user inputs expressed in various ways. Users could phrase their questions using different sentence structures, synonyms, or even colloquial language, and the chatbot could still interpret and respond effectively. This flexibility enhanced the chatbot's ability to cater to diverse communication styles. The NLP functionalities of Dialogflow included synonym recognition, which was particularly valuable in ensuring accurate understanding of user queries. Users often employ synonyms or alternative phrasings to express the same intent. Dialogflow's NLP engine adeptly identified these variations, ensuring that users received relevant responses regardless of the specific wording used.

Language expansion and learning

Dialogflow's NLP capabilities extended beyond a static vocabulary. The system continuously learned and adapted to expand its understanding of language. It recognised new phrases, expressions, and user inputs over time, allowing the chatbot to evolve and become increasingly proficient in comprehending user queries, even if they employed novel or unconventional language. These NLP capabilities facilitated precise intent recognition, contextual understanding, natural language interpretation, synonym recognition, and ongoing language expansion, collectively contributing to an enhanced user experience and the chatbot's effectiveness in addressing user queries and requests.

Usability heuristic and UX design

The incorporation of usability heuristics and UX design principles played a pivotal role in ensuring that the chatbot not only functioned effectively but also provided an optimal user experience.

Usability heuristics for chatbot development

The integration of usability heuristics into the design and development of the FAQ chatbot was a crucial step in ensuring that the chatbot not only provided accurate information but also offered a user-friendly and satisfying experience. Here is how each of the usability heuristics was applied:

- **User control and freedom:** The chatbot allowed users to make mistakes and provided options to undo actions without extensive dialogue. For example, if a user entered an incorrect query, the chatbot would politely correct the user and suggest a more appropriate query, allowing the user to continue the conversation seamlessly.
- **Consistency and standards:** Chatbot responses were designed to be simple, informative, and free from ambiguity. Standard language and terminology were used to ensure that users were not confused by words, opinions, or actions. This consistency created a sense of familiarity and reliability in the chatbot's responses.
- **Helping users recognise, diagnose, and recover from errors:** Clear and concise responses were provided to help users identify and resolve any issues or errors in their queries. The chatbot guided users towards constructive solutions, reducing frustration and ensuring a positive UX.
- **Help and guidance:** The chatbot was designed to guide users in retrieving information and searching effectively. Actions and options were made visible when appropriate, ensuring that users could easily navigate through the chatbot's capabilities and access the information they needed.
- **Flexibility and efficiency of use:** The chatbot was seamlessly integrated into the university's website, ensuring easy accessibility for users. This integration allowed users to interact with the chatbot without the need for additional installations or complex procedures, promoting efficiency and convenience.
- **Aesthetic, minimalist, and engaging design:** Chatbot dialogues were designed to be concise and relevant. Short interactions were encouraged, and clickable lists were

provided for users to quickly access information. This design approach ensured that users could engage with the chatbot effortlessly and find answers efficiently.

- **Good error messages:** Error messages generated by the chatbot were carefully crafted to be helpful and informative. Instead of simply stating an error, the chatbot provided guidance on how users could correct their queries or take appropriate actions, reducing user frustration.
- **Trustworthiness:** The chatbot avoided requesting personal information from users, ensuring that user privacy and trust were maintained throughout the interaction. This approach was particularly important in the context of an educational institution, where data security and privacy are paramount.
- **Maintaining conversation topic**: NLP techniques were employed to keep the chatbot's responses relevant to the ongoing conversation. NLP allowed the chatbot to understand and respond contextually to user queries, ensuring that the chatbot's responses remained on-topic and valuable.

By integrating these usability heuristics into the design and development of the FAQ chatbot, the research project aimed to create a user-centric and effective tool for students and staff at the university. The chatbot not only provided answers but also ensured that users had a positive and efficient interaction, ultimately enhancing the overall UX.

4.1.3 Results and insights

This section discusses the results and insights of the semi-structured interviews conducted. Specific themes and subthemes that emerged from the data are discussed, providing valuable insights into the chatbot's performance and user expectations. The data gathered from the semi-structured interviews can be found in this Google One Drive link.

First year student

The thematic analysis of semi-structured interviews conducted with ten first-year students at the Durban Ritson campus aimed to understand their experiences and interactions with the FAQ chatbot. This section presents the key themes and subthemes identified from the interviews, offering insights into the usability and functionality of the chatbot from the students' perspective. The results from the semi-structured interviews conducted with first-year students provide valuable insights into their experiences with the FAQ chatbot. The analysis identified

several key themes and subthemes, which are summarized in Table 19. To view the full responses received from the participants, it can be found in Google drive link.

Table 19: Main themes and subthemes identified from the semi-structured interview

Themes	Description	Subthemes
1. Navigation around the Ritson campus.	Providing the user with directions to certain areas in the campus such as lecture rooms, libraries, and the cafeteria.	• Direction libraries close to Ritson campus. • Location of lecture rooms. • Locating the finance department. • Finding the café.
2. Additional information.	This makes up the information that is not seen as mandatory support provision, but information that can assist students in performing other tasks like links to the FAI social media platforms.	• Social media links. • South African jokes.
3. Help desks.	Providing students with information that are normally asked at the campuses help desks.	• Interpreters. • Finance queries.
4. Support Information.	Information that assists students in carrying out certain actions.	• Library times. • Applying for finance and NSFAS. • General support. • Student parking disk forms.

Navigation around the Ritson Campus

The theme of navigation emerged as a critical aspect of the chatbot's functionality. First-year students, unfamiliar with the campus layout, found the chatbot's guidance on locating various facilities extremely beneficial. The subthemes within this category included directions to libraries, lecture rooms, the finance department, and dining areas. Students emphasized the importance of clear and accurate directions in helping them acclimate to the new environment.

Sample Responses

> *"Map to get to the ML and Steve libraries. Opening times of libraries."*
>
> Participant 4.

“The topics that can be added to the chatbox could be maybe adding maps and directions to go to the other libraries because most of our time is spent there.”

Participant 9.

Additional Information

This theme encompasses the supplementary information provided by the chatbot that, while not mandatory, enhanced the overall student experience. The subthemes included links to the faculty's social media platforms and local humor, such as South African jokes. These elements made the interaction with the chatbot more engaging and enjoyable for the students.

Sample Responses

“Add Dut social media links/ pages and link to Dut web site.”

Participant 3.

“Besides using language to make the chatbox unique, since you got jokes maybe add some South African jokes will be able to reach students better.”

Participant 3.

Help Desks

The help desks theme captured the chatbot's role in providing answers to frequently asked questions that students typically seek at campus help desks. This included information on interpreters and finance-related queries. The chatbot effectively streamlined the process of obtaining these answers, saving time and reducing the need for direct interaction with administrative staff.

Sample Responses

“Contact details of a sign language interpreter. How to go about getting in touch with a sign language interpreter in dut campus.“

Participant 5.

“Finance is a main issue I have problems with. “

Participant 10.

Support Information

Support information was a prominent theme, highlighting the chatbot's assistance in helping students carry out specific actions. This included information on library operating hours, applying for financial aid such as NSFAS, general support services, and obtaining student parking disk forms. The students valued this information for its practicality and relevance to their daily needs.

Sample Responses

> *"Applying for NSFAS. Finance is a main issue I have problems with."*
>
> Participant 10.

> *"Support for issues with finance."*
>
> Participant 7.

Discussion

The thematic analysis of the semi-structured interviews with first-year students revealed that the FAQ chatbot was effective in addressing their informational needs. The identified themes and subthemes provided a comprehensive understanding of how the chatbot enhanced the student experience. The navigation assistance, supplementary information, help desk support, and essential support information were all crucial in helping students navigate their first year at the Durban Ritson campus.

Administrative staff members

The semi-structured interviews with five administrative staff members at the Durban Ritson campus provided in-depth insights into their experiences and perceptions regarding the FAQ chatbot. The thematic analysis revealed several key themes and subthemes, which are summarized in Table 20. To view the full responses received from the participants, it can be found in Google drive link.

Table 20:Main themes and subthemes identified from the semi-structured interview

Themes	Description	Subthemes

1.Navigation around Ritson campus.	Providing the user with directions to certain areas in the campus such the faculty office, the different departments in Ritson, and the directions to certain blocks in Ritson.	- Directions to faculty office, departments, labs. - Blocks in Ritson campus.
2.Financial Aid	Assisting regarding financial queries and the relevant contact details for the fees department.	- Contact details of finance department. - Finance queries.
3.Registration codes	Students are presented with error codes that indicates the reason for incomplete registration.	- Registration codes.
4.Handbooks	Handbooks that detail each departmental requirements and subjects along with its respective fees. This provides students with detail insight into their subjects.	- Various handbooks for departments and fees.
5.Support information	Additional assistance required by students to help in accessing DUTs platforms, queries on student housing, and official forms required by students.	-Official forms required by students. -Student housing queries. - Access to academic records and email.

Navigation around the Ritson Campus

Navigation assistance was highlighted as a crucial feature of the chatbot. The administrative staff emphasized the importance of providing accurate and clear directions to help students locate essential facilities on campus. This included directions to the faculty office, various departments, laboratories, and specific blocks within the Ritson campus.

Sample Responses

“Most of the students come to the offices asking for the faculty because of them think things are done at the offices then the faculty. So it better to know where the block and which level it is one or two. Like departments, faculty.

Questions students ask is where is the faculty of accounting and informatics, along with where are certain department. Its nice to have because most students gets confused. And where is IT student labs?”

Participant 1.

“Students often ask where is the faculty office. And more about the Departments would be nice.”

Participant 4.

Financial Aid

The theme of financial aid centered on the chatbot’s ability to assist students with their financial queries and direct them to the appropriate contacts within the finance department. This support is vital for students seeking information about tuition fees, payment options, and financial assistance.

Sample Responses

“Payment of fees for students, who needs to clear them they always direct their queries to us when they need to direct it to finance. They ask us to unblock to be able to register.“

Participant 5.

“The questions we usually get would be about finance, financial aid, and faculty office they don’t know the difference.”

Participant 2.

Registration Codes

The chatbot’s function in helping students understand registration error codes was another key theme. This feature aids students in resolving issues related to incomplete registration by explaining the error codes and suggesting possible solutions.

Sample Responses

"Online normally tells them when they are trying to register, they don't know the codes because now we are using the codes. Like finance tells them it says RA, but it does say financial reason, but I think they don't read or they don't understand, so they come to us and say unblock or I can't register online and every time when we check we find that it's a finance block. So we have to direct them to finance. I think especially for first years because they don't understand the codes we need maybe if you can create something you know that can explain the codes to them."

Participant 5.

Handbooks

Providing access to departmental handbooks was identified as an important feature. These handbooks detail the requirements and subjects for each department, along with the associated fees, giving students comprehensive information about their courses.

Sample Responses

"Cause its necessary for students and am self-cause I would normally go and see it. It should be a general handbook and a fee one. Because it has everything for DUT, departments as well as the fees for every other subject that is offered by DUT. One more thing I think for international students, if you can add something for international students what you can do I think, add a handbook for international students it has everything that a student can need. So if on this app you can put international students handbook it has the numbers and everything. Because the handbook has everything."

Participant 1.

"Finance handbook is what students normally use to know the amount for a module."

Participant 5.

Support Information

Support information encompasses additional assistance provided by the chatbot, including access to DUT platforms, student housing queries, and official forms. This theme highlights the chatbot's role in addressing a wide range of student needs beyond academic support.

Sample Responses

"Student forms these are any forms the students need. There are forms that the students use like students one that allow them to add a module. But be careful of those forms because sometimes students use the incorrect form and we have to then correct the student."

Participant 2.

"Students normally ask about student housing. You got everything covered, as most first years need help with housing and financial aid."

Participant 3.

Discussion

The thematic analysis of the semi-structured interviews with administrative staff members revealed several key areas where the FAQ chatbot effectively supported students at the Durban Ritson campus. Navigation assistance, financial aid information, registration support, access to handbooks, and additional support services were identified as crucial functionalities that enhance the student experience. The feedback from administrative staff underscores the importance of a comprehensive and user-friendly chatbot that can address a wide range of student needs. The insights gained from this analysis can guided further improvements to the FAQ chatbot, ensuring it continues to meet the evolving requirements of both students and administrative staff.

4.1.4 Overall usability assessment

The evaluation process revealed that the chatbot demonstrated promising usability, as indicated by students' successful completion of tasks and positive feedback in the questionnaires. The chatbot effectively addressed common queries related to campus navigation, departmental information, and support services. Students generally found it helpful in providing directions, answering questions, and offering support information.

4.1.4.1 User satisfaction and feedback

The questionnaire-based feedback indicated a generally positive user satisfaction level with the chatbot's performance. Students reported that the chatbot's responses were friendly, helpful, and easy to understand. However, some suggestions for improvement were also noted, particularly in enhancing error messages and rephrasing questions to improve clarity.

4.1.4.2 Identified themes and subthemes

During the evaluation process, thematic analysis was used to identify several themes and subthemes emerged, highlighting specific areas for improvement and enhancement. The themes and direct responses from participants are detailed below.

1. Navigation Assistance

Students emphasized the importance of the chatbot providing clear directions to various campus locations. Participants frequently mentioned difficulties in navigating the campus and suggested improvements:

- **Directions to Faculty Offices and Departments**:
    - "Students often ask where the faculty office is and how to distinguish between it and the departments. It's crucial to include these directions in the chatbot" (Participant 2, Admin).
    - "Providing directions to IT labs and other departments is needed. Students get confused between different blocks and offices" (Participant 1, Admin).
- **Directions to Libraries**:
    - "Adding maps and directions to libraries would be very helpful. We spend a lot of time there, and it's important to know where they are" (Participant 9, Student).
    - "The chatbot should show library opening and closing times to assist students better" (Participant 4, Student).
- **Locating the Finance Department and Café**:
    - "Finding the finance office and café is often a challenge. Including these in the chatbot could greatly help first-year students" (Participant 6, Student).

2. Financial Aid Support

The need for comprehensive financial aid support was a recurring theme:

- **Contact Details and Financial Queries**:

- "Students frequently ask about finance-related issues and need contact details for the finance department. The chatbot should address these queries effectively" (Participant 5, Admin).
- "We often get questions about financial aid and fee payments, which could be resolved through the chatbot" (Participant 2, Admin).

3. Handbooks and Support Information

Participants highlighted the importance of including various handbooks and support information:

- **Handbooks**:
  - "The chatbot should provide access to departmental handbooks and fee details. This would reduce the number of inquiries we receive" (Participant 1, Admin).
  - "Including a handbook for international students with all necessary information would be beneficial" (Participant 5, Admin).
- **Official Forms and Student Housing**:
  - "First-year students often struggle with finding the right forms. The chatbot could assist by providing these forms directly" (Participant 2, Admin).
  - "Providing information about student housing would make the chatbot more comprehensive" (Participant 3, Student).
- **Access to Academic Records and Email**:
  - "Students often need guidance on accessing their academic records and resetting email passwords. Incorporating these features would be very useful" (Participant 2, Admin).

4. Accessibility Enhancement

Suggestions were made to increase the chatbot's visibility and accessibility on campus:

- **Physical Screens and Signage**:
  - "Having physical screens around campus to access the chatbot would increase its usage, especially for students without data" (Participant 3, Student).

- "Installing directional signage to guide students to the chatbot would be helpful" (Participant 5, Student).

5. Responses and Interaction

Feedback on the chatbot's responses was generally positive, with suggestions for improvement:

- **Friendly and Informative Responses**:
    - "The chatbot's responses are friendly and clear, but improvements are needed in error messages and question rephrasing" (Participant 1, Admin).
    - "It's important that the chatbot's responses remain helpful and not robotic, with clearer instructions" (Participant 2, Admin).

6. Administrative Staff Perspectives

The semi-structured interviews with administrative staff provided additional insights:

- **Impact on Workload**:
    - "The chatbot is seen as a valuable tool for reducing routine inquiries, allowing staff to focus on more complex tasks" (Participant 5, Admin).
    - "Staff noted that while the chatbot helps with basic queries, there's a need for improvement in response accuracy and relevancy" (Participant 1, Admin).

These direct narratives underscore the key themes identified during the evaluation, highlighting areas for improvement and enhancement in the chatbot's design and functionality.

4.1.5 Conclusion and improvements

Building upon the valuable insights gained from the chatbot's evaluation, this section elucidates the iterative process of implementing feedback garnered during the demonstration phase and outlines the pivotal role it played in refining the chatbot's usability and effectiveness. The implementation of multilingualism to the FAQ and chatbot knowledge connectors within the chatbot framework was a strategic response to the pressing need to enhance its capabilities, aligning with the valuable feedback received during the demonstration phase.

4.1.5.1 Feedback-driven implementation

The decision to implement knowledge connectors was fundamentally rooted in user feedback. The call for improved navigation assistance, better financial aid support, access to

comprehensive support information, enhanced responses, and reduced workload for administrative staff directly informed the development of these connectors. In essence, knowledge connectors represent a direct response to user needs and expectations, shaping the chatbot into a more powerful and user-centric tool. The subsequent sections will delve into the practical aspects of utilising knowledge connectors and their seamless integration into the chatbot's architecture.

4.1.5.2 Student Attitudes and Acceptance Towards the FAQ Chatbot

Based on the results, there is clear evidence of a positive attitude and acceptance among student participants towards the use of an FAQ chatbot designed for university administration support. The data reveals that participants consistently identified and appreciated the chatbot's potential to address various campus-related challenges.

For instance, the recurring mentions of how the chatbot could assist with navigation around the campus, such as finding lecture rooms, libraries, and the finance department, indicate that students recognize the practical value of the chatbot in easing their daily activities. Participant 9 highlighted the importance of having directions to libraries, indicating that the chatbot would save them time and reduce the frustration of getting lost. Similarly, Participant 6 pointed out the need for guidance on locating lecture rooms and finding food, which shows an understanding of how the chatbot could enhance their campus experience.

The inclusion of additional features like social media links, South African jokes, and help desk information further reflects students' positive attitude toward the chatbot. These suggestions not only illustrate the students' engagement with the concept but also demonstrate their willingness to interact with the chatbot if it offers relevant and culturally resonant content. Participant 3's suggestion of adding South African jokes to make the chatbot more relatable indicates an acceptance of the chatbot as part of their university life, while Participant 9's appreciation of the DUT logo in the chatbot suggests that students feel a connection to the institution through this tool.

Overall, the analysis shows that students are not only open to using the FAQ chatbot but also view it as a valuable resource that can significantly improve their university experience. Their active participation in suggesting enhancements and expressing what they need from the chatbot underscores their positive attitude and acceptance of this technological solution.

4.1.5.3 Practical implementation: step-by-step guide

This Google One Drive link provides a comprehensive guide to implementing knowledge connectors, delineating the steps taken in creating and managing these critical components. This practical guide aims to empower chatbot developers and administrators with the knowledge and tools necessary to harness the full potential of knowledge connectors for the benefit of both students and administrative staff.

4.2 Questionnaire design

4.2.1 Benefits of using quantitative methods for data collection in an FAQ chatbot for university students

In the context of Design Science Research (DSR), the implementation of quantitative methods for data collection is integral to developing an FAQ chatbot that effectively meets the needs of university students. This research adopts a DSR approach to systematically design, develop, and evaluate the chatbot. Quantitative data collection plays a crucial role within this framework by providing empirical evidence to guide the iterative design process, ensuring the chatbot is both functional and user-centric. The collection of quantitative data, such as the adoption of using a questionnaire to evaluate the FAQ chatbot, enables refinement of the chatbot, ensuring that it accurately addresses the most common administrative concerns. This approach aligns with DSR's emphasis on creating practical, evidence-based solutions, thus enhancing the chatbot's usability and overall effectiveness in improving administrative support for students.

4.2.2 Design and implementation of the questionnaire for FAQ chatbot evaluation

The development and execution of the questionnaire in this study were significantly influenced by the research paper "Developing a comprehensive evaluation questionnaire for university FAQ administration chatbots" by Essop, Singh and Wing (2023). By aligning with the framework and recommendations proposed in this research, the questionnaire was designed to comprehensively assess the various elements of the chatbot, ensuring robust evaluation outcomes. The structure, content, and guidelines laid out in the questionnaire provided a solid framework for assessing key constructs such as user acceptance, satisfaction, usability, and effectiveness. Overall, the utilisation of this research played a crucial role in shaping the questionnaire development process, contributing to the overall success and effectiveness of the study’s evaluation methodology.

4.2.3 Analysis of questionnaire questions in alignment with the usability framework

Analysing the questionnaire against a usability framework allows for a clear understanding of how each question pertains to specific usability features. The alignment ensures a systematic evaluation of the chatbot's usability within the context of an HEI. The questionnaire for a FAQ chatbot within the HEI context has been structured to align with key usability framework areas, focusing on effectiveness, efficiency, and satisfaction. Each question in the questionnaire corresponds to a specific usability feature, as outlined in Appendix C: Usability framework analysis of chatbot evaluation questions within higher education institution context. The questions have been meticulously crafted to target specific usability aspects, ensuring a comprehensive evaluation of the chatbot's performance and UX. This comprehensive approach – aligning – the questionnaire with the usability framework – facilitates a systematic evaluation of the chatbot's usability. It ensures an overall assessment of its effectiveness in delivering information, efficiency in user interactions, and ability to enhance user satisfaction within the HEI context.

4.3 Conclusion

In conclusion, the development and evaluation of an FAQ chatbot within the university support service context involved a comprehensive approach to ensure effectiveness and usability. The initial phase focused on developing the chatbot, incorporating various components to enhance its functionality and UX. By selecting a chatbot platform based on a usability framework, integrating Dialogflow components for NLP, and implementing design principles such as clickable lists for menu navigation and enhanced anthropomorphism, the chatbot was designed to provide intuitive and engaging interactions for users.

Subsequently, the analysis phase involved feedback-driven implementation, where user feedback gathered during the demonstration phase informed iterative improvements to the chatbot. This approach ensured that the chatbot continuously evolved to meet user needs and expectations, resulting in enhanced usability and effectiveness over time. Adoption of multilingualism and integration of knowledge connectors further enriched the chatbot's capabilities, catering to diverse user demographics and providing comprehensive support information.

Lastly, the design and development of the questionnaire for evaluating the chatbot's effectiveness played a crucial role in assessing user acceptance, satisfaction, and usability. Drawing from established frameworks and guidelines, the questionnaire was meticulously

crafted to align with key usability features and ensure a systematic evaluation of the chatbot's performance. By leveraging quantitative methods and integrating user feedback, the questionnaire provided valuable insights into enhancing the chatbot's effectiveness and usability within the HEI context.

Overall, this study highlights the importance of a user-centred approach in developing and evaluating FAQ chatbots for university support services. By focusing on usability, effectiveness, and continuous improvement, chatbots can serve as valuable tools for enhancing the student experience and streamlining administrative processes within HEIs.

Chapter 5: Results

Chapter 5 provides a comprehensive overview of the pre-validation process for the questionnaire, including the evaluation of reliability and validity, data cleaning and analysis, and measurement model assessment. Additionally, it delves into the final evaluation of the FAQ chatbot using the questionnaire, encompassing the evaluation method and results, demographic analysis, and exploratory analysis. Furthermore, it highlights the adoption of the evaluation questionnaire design by Essop, Singh and Wing (2023) and its contribution to the body of knowledge, implications, and outcomes.

5.1 Pre-validation for the questionnaire

The pre-validation process encompassed the assessment of both reliability and validity, ensuring the robustness and accuracy of the data collected for the evaluation of the FAQ chatbot.

5.1.1 Questionnaire Items Adaptation and References

The majority of the questionnaire items in this research example were adapted from established published studies (Table 21). Given that these studies were primarily conducted in different contexts, some modifications were made to better fit the local setting. This included restructuring sentences and incorporating terminology that is more familiar and relevant to the target audience.

Table 21: Questionnaire Items and References

Question Number	Question	Reference
1	Was the chatbot's initial greeting and introduction clear and informative for someone new to university services?	Gonda *et al.* (2018)
2	Did the chatbot effectively explain its scope and purpose in assisting with university-related queries?	Gnewuch, Morana and Maedche (2017)
3	Was the chatbot's purpose in providing university-related information evident in its interactions?	Følstad and Brandtzæg (2017)
4	Did the chatbot's interactions make you feel like it had human-like and friendly qualities in its responses?	Følstad *et al.* (2019)

5	Were the chatbot's responses perceived as intelligent and knowledgeable about university-related topics?	Lu *et al.* (2024)
6	Did the chatbot's personality and interaction style feel realistic and engaging within the context of university services?	Hilton, Linsey and Goodman (2015)
7	How helpful were the images or visual aids used by the chatbot in conveying university-related information?	Tran, Pallant and Johnson (2021)
8	Did the clickable menu/navigation options assist in finding relevant university information effectively?	Jain *et al.* (2018)
9	Were the topics covered by the chatbot well-integrated and relevant to university services and student needs?	Følstad and Brandtzæg (2017)
10	How well did the chatbot manage errors or mistakes in assisting with university-related inquiries?	Kovacevic *et al.* (2024)
11	Were the topics covered by the chatbot directly relevant and useful in a university context?	Følstad and Brandtzæg (2017)
12	Did you find the chatbot easy to navigate while seeking university-related information?	Jain *et al.* (2018)
13	How helpful were the chatbot's responses in addressing your university-related queries?	Gnewuch, Morana and Maedche (2017)
14	Was there a consistent flow and understanding in the chatbot's interactions related to university services?	Følstad *et al.* (2019)
15	How well did the chatbot understand your university-related queries and needs?	Liu *et al.* (2020)
16	Would you consider using this chatbot more frequently for university-related inquiries in the future?	Følstad *et al.* (2019)
17	Did using the chatbot leave you feeling more at ease or confident about accessing university services?	Gonzalez-Bonorino and Lauría (2022)

5.2 Final evaluation of the FAQ chatbot with the questionnaire

The final evaluation of the FAQ chatbot is conducted utilising the comprehensive questionnaire developed earlier, providing a detailed analysis of user feedback and satisfaction levels.

5.2.1 Evaluation method and results

In the pursuit of discerning relationships and patterns within the data to enhance the development and refinement of the FAQ chatbot, this study employed a structural model assessment. This model was utilised to assess the significance of various key design aspects aimed at increasing the acceptance and usage of the FAQ chatbot in a university context. The statistical methodology applied was PLS-SEM, which was used to evaluate the FAQ chatbot to uncover potential relationships and patterns within the data that could inform the development and refinement of the FAQ chatbot. This section is divided into two segments: Demographic considerations and exploratory analysis which focuses on the broader aim of uncovering relationships and patterns in the data, without including hypothesis testing.

5.2.2 Demographic analysis

The demographic analysis for the sample size of 132 participants is available in Appendix D: Demographics for the exploratory analysis. This analysis provides a detailed overview of the characteristics of the study sample, including demographic variables such as age, gender, education level, and any other relevant demographic information collected during the data collection process.

A slight majority of participants (52%) have prior experience with chatbots, suggesting a balanced mix of familiarity and new exposure. Linguistically, while 75.8% of participants speak isiZulu as their home language, an overwhelming 96.2% prefer the chatbot to be in English, indicating a strong preference for English in formal or technical settings. Gender distribution is nearly even, with 47% male and 52.3% female participants, ensuring a balanced perspective across responses. Academically, a significant concentration (66.7%) of participants are from the Department of Information Technology, reflecting a technical background that may influence their interaction with the chatbot. The vast majority (84.1%) accessed the questionnaire via smartphones, underscoring the importance of mobile-friendly interfaces. Additionally, most participants are recent high school graduates, with 51.5% having completed Grade 12 in 2020 or 2021, indicating a young demographic. Nearly all participants (99.2%)

reported no disabilities, suggesting a largely homogeneous group in terms of physical and sensory abilities.

5.2.3 Structural Model Evaluation and Robustness Assessment

Upon receiving the dataset for analysis data cleaning procedures were implemented to ensure the integrity and reliability of the collected information. This process included the removal of duplicate entries and incomplete questionnaires to ensure that only complete and unique responses were included in the subsequent analyses. The number of questionnaires returned was 170 but after cleaning the data the sample size was reduced to 132 participants. The evaluation of the measurement model, attention was directed towards the assessment of the structural model.

5.2.3.1 Path coefficients

The path coefficients represent the strength and direction of the relationships between constructs in the structural model. Table 22 presents the path coefficients for each hypothesised relationship in the structural model.

Table 22: Path coefficients

Path coefficients - Mean, STDEV, T values, p values					
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Antro -> UX	0.142	0.147	0.107	1.330	0.183
DF -> UX	0.393	0.382	0.107	3.690	0.000
NLP -> UX	-0.003	-0.001	0.078	0.033	0.974
U -> UX	0.347	0.351	0.089	3.906	0.000
UI -> UX	0.061	0.065	0.070	0.878	0.380

Antro → UX (0.142, p = 0.183): The path coefficient from Antro to UX, though positive, failed to reach statistical significance (p = 0.183). This result suggests a modest effect of Antro, the anthropomorphism factor, on UX with the FAQ chatbot.

DF → UX (0.393, p < 0.001): the path coefficient between FAQ DF and UX yielded a highly significant and positive relationship (p < 0.001), indicating a robust influence of DF on UX. This finding underscores the pivotal role of well-designed FAQ structures in shaping user perceptions and satisfaction with the FAQ chatbot. The substantial P value suggests that optimising DF elements can significantly enhance the overall UX and acceptance of the chatbot.

NLP → UX (-0.003, p = 0.974): Surprisingly, the path coefficient from NLP to UX was non-significant (p = 0.974), indicating minimal impact. Despite NLP's fundamental role in enabling conversational interactions, its direct influence on UX in this context appears negligible.

U → UX (0.347, p < 0.001): The path coefficient from U to UX yielded a highly significant and positive relationship (p < 0.001), indicative of the substantial impact of usability principles on UX. This finding underscores the crucial role of adhering to usability heuristics in shaping user perceptions and satisfaction with the FAQ chatbot interface. This suggests that prioritising usability considerations can significantly enhance overall UX and acceptance.

UI → UX (0.061, p = 0.380): Despite the positive direction of the path coefficient from UI to UX, the relationship was non-significant (p = 0.380), suggesting a minimal effect. While intuitive and engaging user interactions are essential for a satisfactory UX, the current findings imply that UI elements alone may not significantly influence overall UX.

These insights into the path coefficients elucidate the intricate dynamics shaping user acceptance and satisfaction with the FAQ chatbot. By dissecting the influence of individual design aspects on UX, this analysis provides valuable guidance for refining and optimising the chatbot interface to better meet user needs and expectations.

5.2.3.2 Bootstrapping

Bootstrapping is a resampling technique commonly used in SEM to assess the robustness of model estimates, particularly path coefficients and their associated standard errors. In this study, bootstrapping with 5000 resamples was performed to assess the stability and reliability of the structural model estimates. The bootstrap analysis was conducted to validate the path coefficients obtained from the structural model assessment. Figure 18 shows the results of the bootstrap analysis which provides insight into the stability and robustness of the structural model.

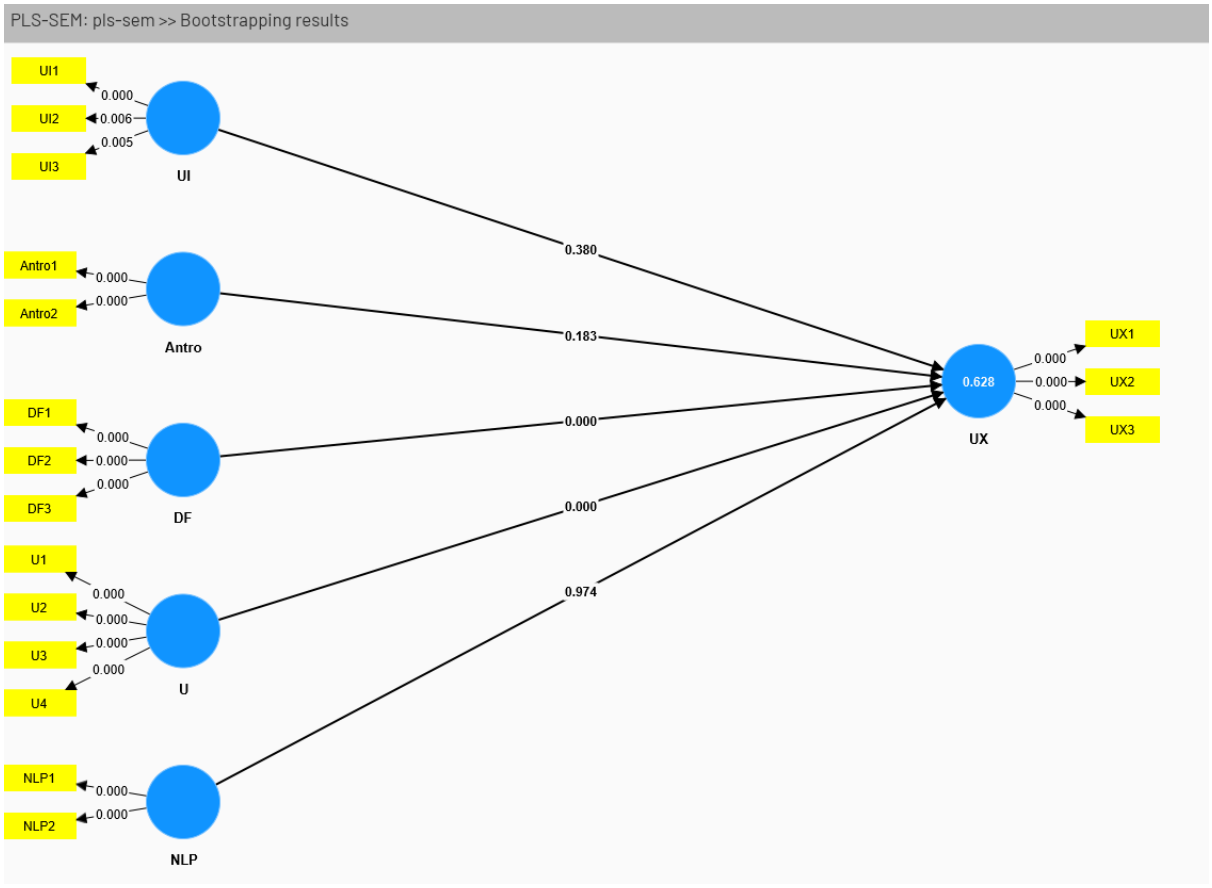

Figure 18: PLS-SEM – Bootstrapping results

UI to UX (0.380): The path coefficient from UI to UX yielded a positive relationship of 0.380. However, the bootstrapped confidence intervals for this path included zero, indicating that the relationship may not be statistically significant.

ANTRO to UX (0.183): The path coefficient from ANTRO to UX showed a positive relationship of 0.183. However, the bootstrapped confidence intervals included zero, suggesting a lack of statistical significance.

DF to UX (0.000): The path coefficient from DF to UX yielded a relationship of 0.000, indicating no discernible effect of DF on UX. The bootstrapped confidence intervals included zero, suggesting a lack of statistical significance.

U to UX (0.000): The path coefficient from U to UX showed no significant relationship (0.000). However, the bootstrapped confidence intervals encompassed zero, indicating a lack of statistical significance.

NLP to UX (0.974): The path coefficient from NLP to UX exhibited a strong positive relationship of 0.974. However, the bootstrapped confidence intervals included zero, indicating potential variability in the relationship.

Overall, the bootstrap analysis offers valuable insights into the stability and reliability of the estimated path coefficients in the structural model. Interestingly, like the path coefficients, the results for usability and design features remained consistent even when subjected to bootstrap analysis. While some relationships exhibited potential associations, their statistical significance was not consistently supported by the bootstrap results. This highlights the need for cautious interpretation and further validation of the structural model findings, emphasising the importance of iterative testing and refinement in understanding the dynamics of UX with the FAQ chatbot.

In conclusion, the integration of path coefficients and bootstrap results offers a comprehensive understanding of the factors influencing the UX of the FAQ chatbot. While certain design aspects, such as design features and usability, demonstrate significant associations with UX, others, like anthropomorphism, UI, and NLP, may require further refinement to enhance their effectiveness. The variability observed in the bootstrap results underscores the importance of cautious interpretation and the need for ongoing validation of the structural model findings. Moving forward, researchers and developers should prioritise iterative testing and refinement of design elements to ensure the continued improvement and effectiveness of the chatbot in meeting user needs and expectations.

5.2.3.3 Rationale for Structural Model Approach and Exclusion of Factor Analysis

The study did not elect to use Confirmatory Factor Analysis (CFA) or Exploratory Factor Analysis (EFA) because these techniques are primarily used for validating the measurement model by assessing the underlying factor structure of observed variables. In this study, the focus was on evaluating the relationships between predefined constructs within a structural model, rather than exploring or confirming the factor structure of a set of observed variables. CFA and EFA are typically employed to test or explore the dimensionality of constructs. In contrast, this study focused on understanding the impact of design elements on the user experience (UX) with the FAQ chatbot, making the structural model approach more appropriate. The use of SEM, which incorporates path analysis, allowed for a comprehensive examination of these relationships, making CFA and EFA unnecessary for the study's aims.

5.3 Conclusion

The development and evaluation of the FAQ chatbot within the university support service context involved a systematic approach aimed at enhancing its usability, effectiveness, and overall UX. This chapter provided a comprehensive overview of the methodology employed, including the pre-validation of the questionnaire, data cleaning and analysis, and the final evaluation of the FAQ chatbot with the questionnaire. Through descriptive statistics, reliability, and validity analyses, as well as structural equation modelling, the study aimed to uncover insights into the factors influencing user acceptance and satisfaction with the FAQ chatbot.

The pre-validation process involved assessing the reliability and validity of the questionnaire through descriptive statistics, ensuring its usability and effectiveness in gathering relevant data. Subsequent data cleaning procedures, including handling missing data, removing duplicates, standardising data formats, and coding categorical variables, were crucial in preparing the dataset for analysis. The adoption of PLS-SEM facilitated a comprehensive evaluation of the measurement model, including reliability assessment through Cronbach's alpha and composite reliability, and validity assessment through convergent and discriminant validity analyses.

The final evaluation of the FAQ chatbot revealed significant associations between certain design aspects, such as design features and usability, and UX. However, the influence of other factors, such as anthropomorphism, user interface, and NLP, was less pronounced and may require further refinement. The bootstrap analysis provided valuable insights into the stability and reliability of the estimated path coefficients, highlighting the need for cautious interpretation and ongoing validation of the structural model findings.

In conclusion, the chapter's findings underscore the importance of iterative testing and refinement in understanding the dynamics of UX with the FAQ chatbot. Moving forward, researchers and developers should prioritise continuous improvement efforts to ensure the chatbot effectively meets user needs and expectations in the university support service context.

Chapter 6: Conclusion, Limitations, and Future Research

6.1 Introduction

This chapter revisits the research objectives outlined in Chapter 1, focusing on the development and evaluation of the FAQ chatbot in HEIs. It aims to demonstrate how these objectives were effectively achieved during this study. Furthermore, the chapter seeks to address any encountered limitations, provide recommendations for future research, and highlight the contribution of this study to the advancement of chatbot technology and its diverse applications within HEIs.

6.2 Summary of the dissertation

This research study delved into the dynamics of how a FAQ chatbot can offer valuable service support to first-year university students. Drawing from existing studies, it has become evident that many chatbots are characterised by simplicity, often resulting in user frustration and limitations in executing specific tasks.

The study aimed to address the challenges surrounding the usability and acceptance of a university administration support FAQ chatbot among first-year students within the context of support service provision. The initial problem identified in existing chatbots was their simplistic nature, leading to user frustration. The objectives were strategically designed to determine relevant FAQs, establish usability design features, develop a usability framework, evaluate suitable development tools, and construct an effective FAQ chatbot.

Substantially, the study successfully achieved its objectives. Systematic compilation and integration of FAQs related to university administrative support services were effectively incorporated into the chatbot. Crucial usability design features were identified and systematically integrated, culminating in the development of a comprehensive usability framework. The evaluation of development tools led to the selection and adoption of Google Dialogflow for the construction of the chatbot. The resultant FAQ chatbot efficiently addressed the support needs of first-year students within the university context.

The usability framework devised in this research served as a comprehensive guide that significantly contributed to both the design and evaluation phases of the FAQ chatbot. Through incorporation of essential elements such as NLP, usability heuristics, anthropomorphism, UX design guidelines, and UI acceptance features, the framework facilitated a holistic approach to enhancing chatbot usability. Its systematic integration into the development process contributed

to the observed improvements in the chatbot's acceptance and usability among first-year students.

The employed research methodology, DSR, proved effective in achieving the study's objectives by providing a systematic framework for identifying and incorporating usability and key design features into the FAQ chatbot's development process. This approach facilitated the utilisation of semi-structured interviews, thematic analysis, and questionnaire-based evaluations to gather both qualitative and quantitative data, resulting in comprehensive insights into the chatbot's usability, accuracy, and UX. Rather than formulating hypotheses and conducting hypothesis testing, the study shifted its focus towards the practical application of these design areas. Consequently, the FAQ chatbot was meticulously developed using Google Dialogflow, aiming to assist students with FAQs and campus navigation. To gain invaluable insights into the chatbot's usability and accuracy, semi-structured interviews were conducted with first-year students at the FAI and administrative staff members. Thematic analysis was employed to gain feedback and refine the FAQ chatbot, ensuring it maximises benefits for its users.

Subsequently, a comprehensive questionnaire was developed to evaluate various facets of the FAQ chatbot, including its UI, usability, and conversational capabilities. Unlike previous studies, which often measured specific aspects in isolation, this questionnaire embraces a holistic approach, by incorporating elements of UI, UX, NLP, anthropomorphism, key design features, and usability. Testing with 14 participants was conducted to ascertain the reliability and validity of the questionnaire. It achieved a Cronbach alpha and composite reliability score of above 0.7, signifying robust internal consistency within the questionnaire. Convergent and discriminant validity measures were meticulously applied to ensure the questionnaire's relevance.

The questionnaire served as the instrument for evaluating the performance of each key design area. The sample size was 132 first-year students at the Ritson campus of DUT. Data analysis was conducted using PLS-SEM via SmartPLS version 4. The results showed that usability heuristics and design features exerted significant influence on students' UX and heightened their acceptance of the FAQ chatbot.

In essence, this exploratory analysis has offered valuable insights into the pivotal role of the FAQ chatbot in fostering acceptance and adoption among first-year students. It has resulted in the creation of a practical heuristic tool, namely, a FAQ chatbot specifically designed to meet the support needs of first-year students within a university environment.

6.3 Achieving the research question

This study was guided by the following research question.

6.3.1 Research Question:

How can a framework be developed to enhance the usability of a university administration support FAQ chatbot, thereby improving its acceptance and usage among first-year students?

The research objectives and how they were accomplished are presented below.

6.3.1.1 Research Objective 1: To determine the FAQs in the context of university administrative support services

The primary objective of this study was to compile a comprehensive list of frequently asked questions pertinent to university administrative support services. This foundational step was crucial for ensuring that the FAQ chatbot effectively addressed the queries commonly encountered by students within the administrative domain. The achievement of this objective involved a multifaceted approach, including a thorough review of relevant literature and conducting semi-structured interviews with first-year FAI students and administrative staff members.

Chapter 3 (section 3.3) and 4 (section 4.1) provide detailed insights into the methodology employed to fulfil this objective. Through thematic analysis of the results obtained from the semi-structured interviews, the content was refined and further defined, contributing to the development of the FAQ chatbot. The outcomes of the semi-structured interviews, along with their analysis, are presented comprehensively in this Google One Drive link, shedding light on the diverse perspectives gathered from both students and administrative staff members.

6.3.1.2 Research Objective 2: To establish a set of usability key design features for a FAQ chatbot

This objective involved defining and outlining specific usability key design features crucial for enhancing the functionality and effectiveness of the FAQ chatbot. It contributed to understanding the elements necessary to optimise UX and engagement. The identified key usability design features included usability heuristics, UX design principles, NLP techniques, personas, anthropomorphism, and UI considerations. These key components are thoroughly discussed in the literature review (Chapter 2, sections 2.3 to section 2.8), providing valuable

insights into their significance and impact on the development and effectiveness of the FAQ chatbot.

6.3.1.3 Research Objective 3: To develop a usability framework that can be used as a reference for the design and evaluation of the FAQ chatbot

Developing a usability framework was essential to guide the design and evaluation processes. This framework served as a reference point, ensuring the chatbot aligned with established usability standards, fostering a user-centric approach throughout the development and evaluation stages. The usability framework is extensively discussed in the literature review (Chapter 2, section 2.8), while its practical implementation in the design and development of the chatbot is detailed in Chapter 4 (section 4.1.1).

6.3.1.4 Research Objective 4: To evaluate development tools and platforms and choose those most suitable for FAQ chatbot university administrative support services

This objective focused on the evaluation and selection of appropriate development tools and platforms necessary for creating the FAQ chatbot tailored to university administrative support services. It emphasised the importance of choosing tools that align with the specific requirements of the chatbot's functionality and usability. This involved a thorough evaluation process to ensure that the chosen tools aligned with the specific functional and usability requirements of the chatbot. The selection of chatbot platforms, including a comprehensive review and the rationale behind choosing Google Dialogflow as the most favourable option, is discussed in detail in Chapter 4 (section 4.1).

6.3.1.5 Research Objective 5: To develop a FAQ chatbot in the context of university support service provision and evaluate the FAQ chatbot

This objective involved the actual development of the FAQ chatbot based on the determined FAQs and usability design features. Additionally, it included evaluating the developed chatbot to assess its functionality, usability, and effectiveness in improving user acceptance and usage among first-year students seeking support services within the university context. Subsequently, the developed chatbot underwent rigorous evaluation to assess its functionality, usability, and effectiveness in enhancing user acceptance and usage, particularly among first-year students seeking support services at the university.

For the evaluation of the FAQ chatbot which can be found in Chapter 5 (section 5.1 and section 5.2), a tailored questionnaire focusing specifically on FAQ chatbots was utilised. Reliability

and validity tests were conducted using Smart-PLS to ensure the robustness of the questionnaire. Additionally, an exploratory analysis using PLS-SEM was conducted to identify the factors influencing the UX of the FAQ chatbot. The evaluation revealed significant associations between certain design aspects, such as design features and usability, with UX. However, other factors such as anthropomorphism, user interface, and NLP may require further refinement to enhance their effectiveness in improving UX. This comprehensive evaluation approach provides valuable insights for refining and optimising the FAQ chatbot to better meet the needs and expectations of university students seeking support services.

After extensive investigation and analysis, this study has effectively addressed the central research question: **" How can a framework be developed to enhance the usability of a university administration support FAQ chatbot, thereby improving its acceptance and usage among first-year students?"** Through the accomplishment of the research objectives as outlined in this chapter, including the determination of FAQs, establishment of usability design features, development of a usability framework, evaluation of development tools and platforms, and the subsequent development and evaluation of the FAQ chatbot, significant progress has been made towards achieving this overarching aim. By employing diverse research methodologies, frameworks, and evaluation techniques, valuable insights have been gleaned regarding the development and enhancement of FAQ chatbots in university support service contexts. The culmination of these efforts has laid a robust foundation for future advances in chatbot usability and efficacy, thereby enhancing the overall UX and acceptance among university students seeking administrative support services.

6.4 Contributions of the research

- **Chatbot artefact:** The development of the FAQ chatbot stands as a tangible outcome, serving as a practical solution catering to the specific needs of first-year students seeking support services within the university. This artefact serves as a benchmark and practical reference for future developments in enhancing chatbot utility.
- **Usability framework (contribution to theory):** The devised usability framework provides a comprehensive and adaptable guide tailored for chatbot development. Its formulation contributes significantly to theoretical advancements in improving chatbot usability and fostering user acceptance. This framework not only aids in the

development of user-friendly chatbots but also contributes to the broader theoretical understanding of usability in the context of chatbot design.

- **Questionnaire:** Development of a comprehensive questionnaire stands as a notable contribution to this study's methodology and outcomes. Unlike prior research, which often focused on isolated aspects, this questionnaire embodies a holistic evaluation approach. It encompassed a wide spectrum of assessment elements, integrating UI, UX, NLP, anthropomorphism, key design features, and usability factors.

6.5 Answering the research question

The central research question of this study was: How can a framework be developed to enhance the usability of a university administration support FAQ chatbot, thereby improving its acceptance and usage among first-year students?

To address this question, the study adopted a systematic approach across five key research objectives. Initially, a comprehensive list of FAQs relevant to university administrative support was compiled through literature review and semi-structured interviews, ensuring that the chatbot addressed pertinent student queries. Next, essential usability design features were defined, incorporating usability heuristics, UX design principles, NLP techniques, and UI considerations. This was followed by the development of a usability framework, which guided the chatbot's design and evaluation to meet established standards and user-centric principles. The study also evaluated various development tools and platforms, selecting Google Dialogflow based on alignment with functional and usability requirements. Finally, the chatbot was developed and evaluated using a tailored questionnaire and PLS-SEM, revealing significant associations between design features and user experience, while highlighting areas for further refinement.

These findings align with similar research efforts in chatbot usability and design. For instance, the work of Lindqvist (2019) emphasized the importance of integrating usability principles and user feedback in chatbot development to enhance user satisfaction and effectiveness. Gonda *et al.* (2018) demonstrated that effective FAQ chatbots benefit from a well-structured design framework and rigorous evaluation methods to improve user interactions and acceptance. Hussain, Ameri Sianaki and Ababneh (2019) highlighted the critical role of NLP and UI considerations in shaping user experiences, aligning with the study's findings on the influence of these factors. Additionally, Božić (2023) illustrated how a structured approach to chatbot design and evaluation can significantly impact user engagement and usability. These

publications reinforce the study's approach and findings, showcasing the alignment between the developed framework and established research in chatbot usability and design.

6.6 Achievement of the aim

The aim of this study, was to develop a framework that enhances the usability of a university administration support FAQ chatbot to improve acceptance and usage among first-year students. This aim was successfully achieved through the comprehensive fulfillment of the research objectives and the subsequent development and evaluation of the FAQ chatbot.

By systematically determining FAQs, establishing key usability design features, developing a usability framework, evaluating development tools, and ultimately creating and assessing the FAQ chatbot, this study effectively addressed the aim of enhancing the usability of the chatbot. Through rigorous methodology and analysis, the framework devised provides valuable insights and practical guidance for improving user acceptance and usage of FAQ chatbots within university administrative support services, particularly among first-year students.

6.6 Limitations

Despite the encountered limitations, particularly the challenge of incorporating personalised responses due to language constraints within Google Dialogflow, there are promising opportunities for future research and improvement in this area. As advancements continue to be made in NLP, and with increasing focus on South African indigenous languages, the possibilities for enhancing the effectiveness of chatbots, particularly in accommodating diverse linguistic contexts, are substantial.

6.7 Future research

This research has successfully identified key design areas influencing the UX, acceptance, and usage in FAQ chatbots. The findings from the PLS-SEM highlighted the need for implementing ML in chatbot development. The integration of ML and large language models (LLM) supports NLP that can enhance responsiveness in providing users with more tailored responses. Consequently, future researchers are encouraged to incorporate ML and LLM techniques in chatbot development, aiming to significantly improve both NLP functionality and anthropomorphism in FAQ chatbots.

Recent contributions in the field, such as advancements in chatbot technologies like ChatGPT and other publications post-2022, have demonstrated progress in enhancing chatbot capabilities. Technologies like ChatGPT may contribute to improving chatbot interactions,

providing insights and advances that complement the findings of this research without conflicting with its outcomes. These recent contributions serve to enrich the field and complement the understanding of chatbot usability, potentially aligning with the identified areas for improvement.

Future studies can explore innovative approaches to address language limitations in chatbot development, such as integrating multilingual support or leveraging advanced NLP techniques tailored to specific languages. Additionally, research efforts can focus on developing and refining NLP models specifically trained on South African indigenous languages, thereby enabling chatbots to better understand and respond to queries in these languages.

By addressing these language-related challenges and further exploring the potential of NLP technologies, future research endeavours have the potential to significantly enhance the functionality and inclusivity of chatbots, particularly in diverse linguistic settings such as South Africa. This underscores the importance of continued research and innovation in the field of chatbot development to overcome existing limitations and unlock new possibilities for improving UXs and engagement.

6.8 Conclusion

This study embarked on a journey to develop and evaluate a FAQ chatbot tailored to university administrative support services, aiming to enhance its usability and effectiveness among first-year students. Guided by a structured methodology and research objectives, each stage of the study contributed to a deeper understanding of chatbot development and usability frameworks.

Chapter 1 laid out the foundation for exploration of the topic, providing an overview of the contextual background, articulating the problem statement, defining the aim, objectives, and articulating the research questions. By framing the study within the context of universities in the 4IR, the chapter established the significance of the research topic and outlined its intended contributions to the academic and practitioner communities. Additionally, the chapter provided an overview of the research design, highlighting the planned approach for addressing the identified problem and achieving the set objectives.

Chapter 2 provided a thorough review of literature, laying the groundwork for identifying key usability design features crucial for optimising the chatbot's functionality and effectiveness. These features, including usability heuristics, UX design principles, NLP techniques, personas,

anthropomorphism, and UI considerations, were extensively discussed and analysed, providing valuable insights into their significance and impact on the chatbot's development and usability.

Chapter 3 presented the research methodology employed in the study, focusing on DSR methods. The chapter explained the rationale behind choosing DSR as the primary research approach and delineated the systematic process involved in the development and evaluation of the FAQ chatbot within the university support service context. Through a combination of semi-structured interviews and quantitative questionnaires, the study aimed to gather qualitative and quantitative data to inform the design and assessment of the chatbot's usability and efficacy. Ethical considerations, sampling strategies, and data analysis techniques are also discussed, providing insight into the methodological rigour underpinning the research.

Chapter 4 focused on the development of a usability framework to guide the design and development of the FAQ chatbot. Drawing from the literature review, this framework ensured alignment with established usability standards, fostering a user-centric approach throughout the development and evaluation stages. The research objective to determine FAQs in the context of university administrative support services was addressed through semi-structured interviews and thematic analysis. This process yielded a comprehensive list of FAQs, which formed the foundation for the chatbot's content and further refinement. The evaluation of development tools and platforms, as outlined in Chapter 4, was crucial for selecting the most suitable options for creating the FAQ chatbot. Through a comprehensive review and evaluation process, Google Dialogflow emerged as the most favourable platform, aligning with the specific functional and usability requirements of the chatbot.

Finally, Chapter 5 encompassed the evaluation of the FAQ chatbot, and the use of advanced analysis techniques such as Smart-PLS and PLS-SEM. The evaluation provided valuable insights into the chatbot's functionality, usability, and effectiveness. The final evaluation of the FAQ chatbot revealed significant associations between certain design aspects, such as design features and usability, and UX. However, the influence of other factors, such as anthropomorphism, user interface, and NLP, was less pronounced and may require further refinement.

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Appendices

Appendix A: Implementation of Dialogflow and the creation of the chatbot

Google Dialogflow review

Design aspects and the requirements of potential users are essential to keep in mind when selecting a platform. Chatbot designers are encouraged to use Google Dialogflow as it enables a high degree of customizability, supports NLP, and allows for integration with external services using REST API (Pérez-Soler *et al.* 2019). According to Sharma (2020), Dialogflow enables chatbot designers to apply changes to the chatbot while integrated with multiple platforms. Features of Dialogflow allow facilitating extensive documentation of handling errors, thereby helping chatbot designers to pick up errors and offering easy integration into messaging platforms. Lubow (2019) adds that Google Dialogflow provides users with 24/7 interaction and a well-designed chatbot that feels more like a human than a robot that replies with accurate responses in real-time. Under those circumstances, Israr and Aakula (2018); Santoso *et al.* (2018); Pérez-Soler *et al.* (2019); Singh, Ramasubramanian and Shivam (2019) are in favour of adopting Google Dialogflow as it is a popular platform used for developing efficient chatbots. Evidently, Google Dialogflow has assisted previous studies in creating beneficial chatbots. Hence, this research also applied the use of Google Dialogflow for the development of the FAQ chatbot.

Appendix B: Questionnaire

Table 23: Questionnaire

Question number	Question
1	Was the chatbot's initial greeting and introduction clear and informative for someone new to university services?
2	Did the chatbot effectively explain its scope and purpose in assisting with university-related queries?
3	Was the chatbot's purpose in providing university-related information evident in its interactions?
4	Did the chatbot's interactions make you feel like it had human-like and friendly qualities in its responses?
5	Were the chatbot's responses perceived as intelligent and knowledgeable about university-related topics?
6	Did the chatbot's personality and interaction style feel realistic and engaging within the context of university services?
7	How helpful were the images or visual aids used by the chatbot in conveying university-related information?
8	Did the clickable menu/navigation options assist in finding relevant university information effectively?
9	Were the topics covered by the chatbot well-integrated and relevant to university services and student needs?
10	How well did the chatbot manage errors or mistakes in assisting with university-related inquiries?
11	Were the topics covered by the chatbot directly relevant and useful in a university context?
12	Did you find the chatbot easy to navigate while seeking university-related information?
13	How helpful were the chatbot's responses in addressing your university-related queries?

14	Was there a consistent flow and understanding in the chatbot's interactions related to university services?
15	How well did the chatbot understand your university-related queries and needs?
16	Would you consider using this chatbot more frequently for university-related inquiries in the future?
17	Did using the chatbot leave you feeling more at ease or confident about accessing university services?

Appendix C: Usability framework analysis of chatbot evaluation questions within higher education institution context

Table 24: Usability Framework Analysis of Chatbot Evaluation Questions within Higher Education Institution Context

Usability framework	Key design area	Question theme	Question number	Question
Effectiveness	UI	Chatbot Introduction	1	Was the chatbot's initial greeting and introduction clear and informative for someone new to university services?
Effectiveness		Purpose Explanation	2	Did the chatbot effectively explain its scope and purpose in assisting with university-related queries?
Effectiveness		Indication of Purpose	3	Was the chatbot's purpose in providing university-related information evident in its interactions?
Satisfaction	Anthropomorphism	Humanlikeness Perception	4	Did the chatbot's interactions make you feel like it had human-like and friendly qualities in its responses?
Efficiency		Perceived Intelligence	5	Were the chatbot's responses perceived as intelligent and knowledgeable about university-related topics?
Satisfaction	Design features	Realistic Personality	6	Did the chatbot's personality and interaction style feel realistic and engaging within the context of university services?
Satisfaction		Use of Visual Aids	7	How helpful were the images or visual aids used by the chatbot in conveying university-related information?

Satisfaction		Helpfulness of Clickable Menu	8	Did the clickable menu/navigation options assist in finding relevant university information effectively?
Satisfaction	Usability	Integration of Topics	9	Were the topics covered by the chatbot well-integrated and relevant to university services and student needs?
Efficiency		Error Handling	10	How well did the chatbot manage errors or mistakes in assisting with university-related inquiries?
Efficiency		Navigation Ease	11	Did you find the chatbot easy to navigate while seeking university-related information?
Efficiency		Relevance of Topics	12	Were the topics covered by the chatbot directly relevant and useful in a university context?
Efficiency	Natural Language Processing (NLP)	Helpfulness of Responses	13	How helpful were the chatbot's responses in addressing your university-related queries?
Efficiency		Consistency in Interactions	14	Was there a consistent flow and understanding in the chatbot's interactions related to university services?
Effectiveness	UX	Understanding User Queries	15	How well did the chatbot understand your university-related queries and needs?
Satisfaction		Desire for Continued Use	16	Would you consider using this chatbot more frequently for university-related inquiries in the future?

Satisfaction		Post-Interaction Feelings	17	Did using the chatbot leave you feeling more at ease or confident about accessing university services?

Effectiveness:

- **Chatbot introduction (Question 1):** Assesses the effectiveness of the chatbot's initial greeting and introduction in providing clear and informative information for individuals new to university services.
- **Purpose explanation (Question 2):** Evaluates whether the chatbot effectively articulates its scope and purpose in assisting with university-related queries, ensuring clarity for users.
- **Indication of purpose (Question 3):** Focuses on determining if the chatbot's interactions clearly demonstrate its intent in providing university-related information, ensuring users understand its purpose.
- **Understanding user queries (Question 15):** Evaluates how well the chatbot comprehends users' university-related queries and needs, contributing to user satisfaction and effectiveness in providing appropriate responses.

Efficiency:

- **Perceived intelligence (Question 5):** Evaluates users' perception of the chatbot's responses as intelligent and knowledgeable about university-related topics, addressing efficiency in providing informative answers.
- **Error handling (Question 10):** Assesses the chatbot's efficiency in managing errors or mistakes during interactions related to university inquiries, ensuring smooth user experiences.
- **Navigation ease (Question 11):** Focuses on users' ease of navigating the chatbot while seeking university-related information, contributing to efficiency in interaction design.
- **Relevance of topics (Question 12):** Evaluates the relevance and usefulness of the topics covered by the chatbot in a university context, ensuring efficiency in providing pertinent information.

- **Helpfulness of responses (Question 13):** Assesses the efficiency of the chatbot's responses in addressing users' university-related queries, ensuring helpful and relevant information.
- **Consistency in interactions (Question 14):** Determines if the chatbot maintains a consistent flow and understanding in interactions related to university services, contributing to efficient user engagement.

Satisfaction:

- **Humanlikeness perception (Question 4):** Evaluates users' perception of the chatbot's human-like and friendly qualities in its responses, addressing satisfaction in user interaction.
- **Realistic personality (Question 6):** Assesses users' perception of the chatbot's personality and interaction style as realistic and engaging within the context of university services, contributing to user satisfaction.
- **Use of visual aids (Question 7):** Evaluates the helpfulness of images or visual aids used by the chatbot in conveying university-related information, impacting user satisfaction.
- **Helpfulness of clickable menu (Question 8):** Assesses the assistance provided by clickable menu/navigation options in finding relevant university information effectively, contributing to user satisfaction.
- **Integration of topics (Question 9):** Determines if the topics covered by the chatbot are well-integrated and relevant to university services and student needs, addressing satisfaction in information coherence.
- **Desire for continued use (Question 16):** Explores users' inclination towards using the chatbot more frequently for university-related inquiries in the future, indicating satisfaction and trust in the system.
- **Post-interaction feelings (Question 17):** Assesses whether using the chatbot leaves users feeling more at ease or confident about accessing university services, contributing to overall user satisfaction and trust in the system.

Appendix D: Demographics for the exploratory analysis

Table 25:Demographics for the exploratory analysis

Questions/categories	**Participants n = 132**
Participants who have used a chatbot before	
Yes	69
No	63
The participants home language	
English	21
isiZulu	100
Afrikaans	0
Xhosa	8
Venda	0
Sign Language	0
Southern Sotho	0
Tswana	0
Northern Sotho	1
Tsonga	0
Swati	2
Ndebele	0
Languages participants prefer the chatbot to be in	
English	127
isiZulu	5
Afrikaans	0
Xhosa	0
Venda	0
Southern Sotho	0
Tswana	0
Northern Sotho	0
Tsonga	0
Swati	0
Ndebele	0

Gender	
Male	62
Female	69
Other	1
Departments of each participant	
Department of Auditing and taxation	7
Department of Finance and information management	2
Department of Financial accounting	25
Department of information and corporate management	3
Department of information systems	4
Department of information technology	88
Department of Management Accounting	3
Device the participant used to access the questionnaire	
Smart phone	111
Tablet	3
Desktop computer	9
Notebook	9
The year the participant completed Grade 12	
2021	34
2020	33
2019	25
2018	14
2017	9
2016	6
2015	3
2014	4
2013	1
2012	1
2011	0
2010	0
2009	0

2008	0
2007	1
2006	0
2005	0
2004	0
2003	0
2002	0
2001	0
2000	1
Disabilities	
Yes	0
No	131
N/A	1

Appendix E: Link to chatbot

Link to chatbot: https://link-chatbot.tiiny.site

Appendix F: Editing certificate

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EDITING CERTIFICATE

Re: **LUTHFIYA ESSOP**
Master's dissertation: **ENHANCING THE USABILITY OF A UNIVERSITY STUDENT SUPPORT SERVICES FAQ CHATBOT**

I confirm that I have edited this dissertation and the references for clarity, language and layout. I returned the document to the author with track changes so correct implementation of the changes and clarifications requested in the text and references is the responsibility of the author. The intellectual content of the document is the responsibility of the author. I am a freelance editor specialising in proofreading and editing academic documents. My original tertiary degree which I obtained at the University of Cape Town was a B.A. with English as a major and I went on to complete an H.D.E. (P.G.) Sec. with English as my teaching subject. I was a part-time lecturer in the Department of Homoeopathy at the Durban University of Technology for 13 years and supervised many master's degree dissertations during that period.

Dr Richard Steele
29 March 2024
per email

Appendix G: Ethical clearance used for semi-structured interviews

First-year students

Appendix B

LETTER OF INFORMATION

Dear: Participant

Title of the Research Study: Key design acceptance factors for development of an anthropomorphic chatbot to support first-year university students.

Principal Investigator/s/researcher: Luthfiya Essop, BTech: Information Technology.

Co-Investigator/s/supervisor/s: Supervisor: Dr J W Wing (PhD: IT), Co-supervisor: Dr A Singh (PhD: IT)

Brief Introduction and Purpose of the Study: Chatbots are more than what meets the eye, it can be improved as it interacts with the user, or it can just provide the user with a set of options. The type of chatbots aids in tailor-making chatbots to suit the needs of an organization or educational sector. The purpose of this research is to design and develop a chatbot that can help students on campus in getting around more effectively with on-time reliable responses.

Outline of the Procedures: Participants for this research would be selected using the simple random sampling, this allows each participant to have an equal chance of being selected. Each participant will be allocated 15 minutes to interact with a prototype chatbot. This interaction will give the participant an insight and feel of how a chatbot works and which aspects could be improved. The participant will then undergo a semi-structure interview, the questions that will be based on open-ended questions to identify the acceptance factors needed to improve the prototype.

Risks or Discomforts to the Participant: There is minimal risk that this study poses to the participant.

Benefits: The potential outcomes of this research would benefit the participants as returning students next year, if they require on campus assistance.

Reason/s why the Participant May Be Withdrawn from the Study: There will be no adverse consequences for the participant should they choose to withdraw.

Remuneration: Participants that will be participating will not receive any monetary or other types of remuneration, as this is completely voluntary.

Costs of the Study: The participant is not expected to cover any costs.

Confidentiality: Confidentiality of participant will be maintained. No identification names or further particulars of individual will be required. The semi-structured interviews will be completely anonymous.

Research-related Injury: Should any unforeseeable injury or adverse reaction occur the participant will be taken to the clinic on Ritson campus, and there will be no compensation allocated to be participant.

Persons to Contact in the Event of Any Problems or Queries:

Please contact the researcher on 083 776 1089 or email address: 21615442@dut4life.ac.za, my supervisor Dr J W Wing email address: jwing@dut.ac.za or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the DVC: Research, Innovation and Engagement Prof S Moyo on 031 373 2577 or moyos@dut.ac.za.

General:

Potential participants must be assured that participation is voluntary and the approximate number of participants to be included should be disclosed. A copy of the information letter should be issued to participants. The information letter and consent form must be translated and provided in the primary spoken language of the research population e.g. isiZulu.

Administrative staff members

Appendix B

LETTER OF INFORMATION

Dear: Participant

Title of the Research Study: Development and Evaluation of a usability enhanced FAQ chatbot for first year student support services in a university.

Principal Investigator/s/researcher: Luthfiya Essop, BTech: Information Technology.

Co-Investigator/s/supervisor/s: Supervisor: Dr J W Wing (PhD: IT), Co-supervisor: Dr A Singh (PhD: IT)

Brief Introduction and Purpose of the Study: Chatbots are more than what meets the eye, it can be improved as it interacts with the user, or it can just provide the user with a set of options. The type of chatbots aids in tailor-making chatbots to suit the needs of an organization or educational sector. The purposeof this research is to design and develop a chatbot that can help students on campus in getting around more effectively with on-time reliable responses.

Outline of the Procedures: Participants for this research would be selected using the simple random sampling, this allows each participant to have an equal chance of being selected. Each participant will be allocated 15 minutes to interact with a prototype chatbot. This interaction will give the participant an insight and feel of how a chatbot works and which aspects could be improved. The participant will then undergo a semi-structure interview, the questions that will be based on open-ended questions to identify the acceptance factors needed to improve the prototype.

Risks or Discomforts to the Participant: There is minimal risk that this study poses to the participant.

Benefits: The potential outcomes of this research would benefit the participants as returning students nextyear, if they require on campus assistance.

Reason/s why the Participant May Be Withdrawn from the Study: There will be no adverse consequences for the participant should they choose to withdraw.

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Costs of the Study: The participant is not expected to cover any costs.

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Appendix H: Gate keeper's letter

Faculty Research Office
Durban University of Technology
Date March 18, 2021

Student Luthfiya Essop
Student Number: 21615442
Degree: MASTER OF INFO & COMMUNICATIONS TECHNOLOGY
Email: 21615442@dut4life.ac.za
Supervisor:
Supervisor email:

Dear Mr Kendra

ETHICAL APPROVAL: LEVEL 2

I am pleased to inform you that the Faculty Research Ethics Committee (FREC) following feedback from two reviewers, has granted preliminary permission for you to conduct your research 'Key design acceptance factors for development of an anthropomorphic chatbot to support first- year university students.',

When ethics approval is granted:
You are required to present the letter at your research site(s) for permission to gather data. Please also note that your research instruments must be accompanied by the letter of information and the letter of consent for each participant, as per your research proposal.

This ethics clearance is valid from the date of provisional approval on this letter for one year A student must apply for recertification 3 months before the date of this expiry.

Recertification is required every year until after corrections are made, after examination, and the thesis is submitted to the Faculty Registrar.

A summary of your key research findings must be submitted to the FRC on completion of your studies.

Kindest regards.

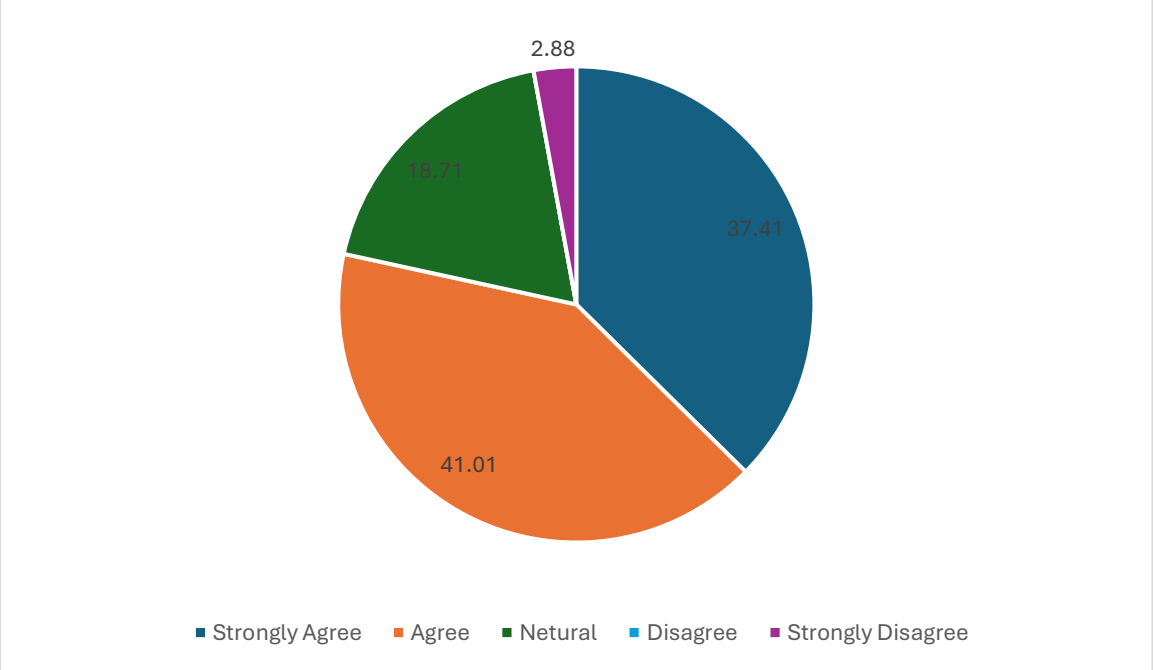
Yours sincerely

Dr Mogiveny Rajkoomar
FREC Chair
Faculty of Accounting and Informatics
Durban University of Technology

Appendix I: Visual presentation of each questions performance

1.Was the chatbot's initial greeting and introduction clear and informative for someone new to university services?

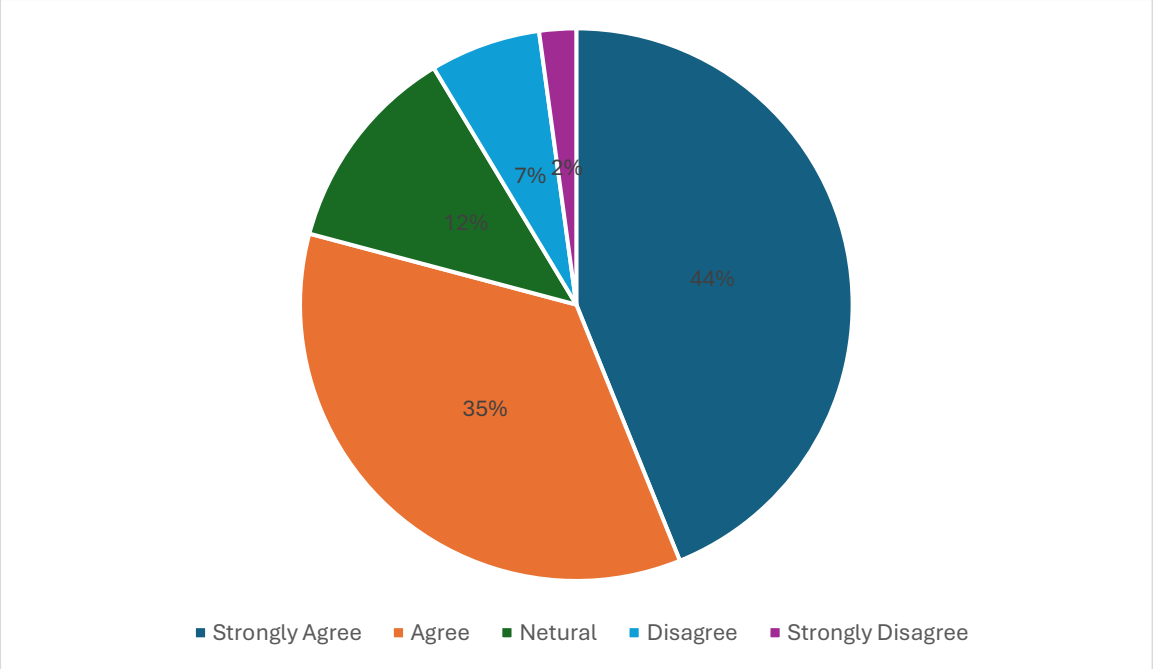
Importance: Ensures that new users receive a welcoming and clear introduction, setting a positive tone and providing essential guidance on using the chatbot.



Most users (37.41% strongly agreed, 41.01% agreed) felt that the chatbot's initial greeting was clear and informative, which is crucial for creating a positive first impression and effectively guiding new users. The small percentages of neutral (18.71%) or negative responses suggest room for improvement in clarity or detail.

2.Did the chatbot effectively explain its scope and purpose in assisting with university-related queries?

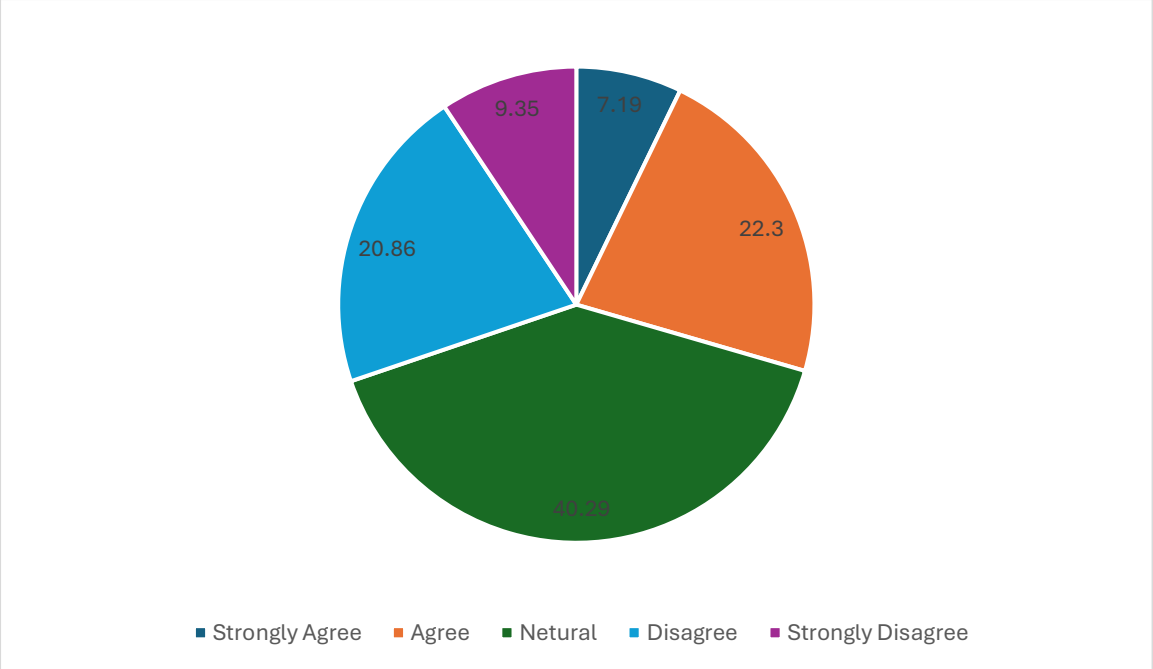
Importance: Clarifies the chatbot's functions and capabilities, helping users understand how it can address their specific needs related to university services.



With 43.88% strongly agreeing and 35.25% agreeing, most users felt the chatbot successfully communicated its scope and purpose. However, the 12.23% neutral and 8.63% who disagreed or strongly disagreed indicate that some users may still find the explanations lacking or unclear.

3.Was the chatbot's purpose in providing university-related information evident in its interactions?

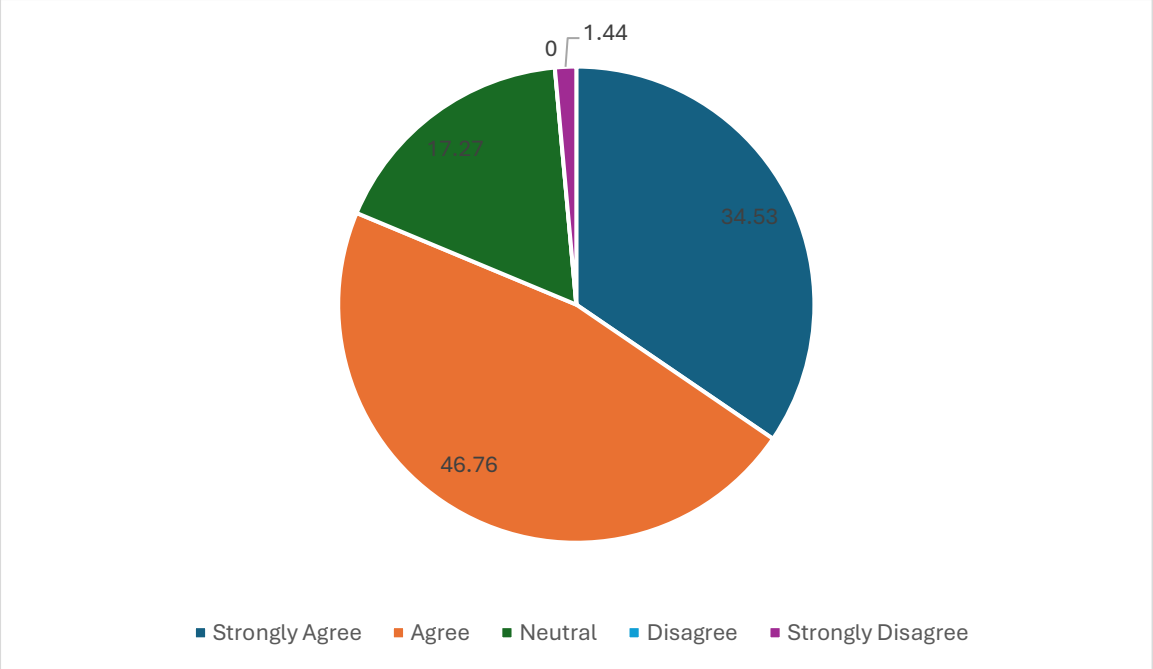
Importance: Assesses whether the chatbot consistently communicates its role and relevance in supporting users with university-related information throughout the interaction.



Only 29.49% strongly agreed and 22.3% agreed that the chatbot's purpose was clear, with a significant 40.29% neutral and 30.21% disagreeing or strongly disagreeing. This suggests that the chatbot may need to better communicate its role and purpose throughout interactions.

4.Did the chatbot's interactions make you feel like it had human-like and friendly qualities in its responses?

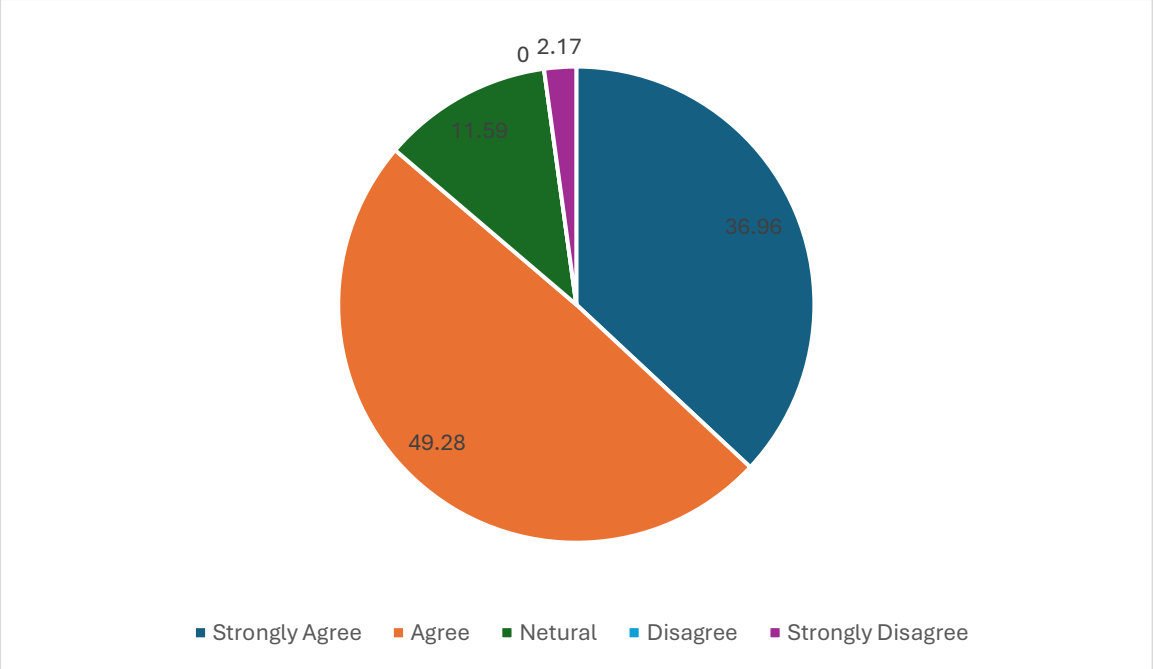
Importance: Evaluates the chatbot's ability to engage users with a personable and approachable demeanor, enhancing user satisfaction and comfort.



A substantial 34.53% strongly agreed and 46.76% agreed that the chatbot felt human-like and friendly. This suggests that the chatbot's personable demeanor is appreciated, though the 17.27% neutral and minimal negative responses indicate that further improvements in this area could enhance user engagement.

5.Were the chatbot's responses perceived as intelligent and knowledgeable about university-related topics?

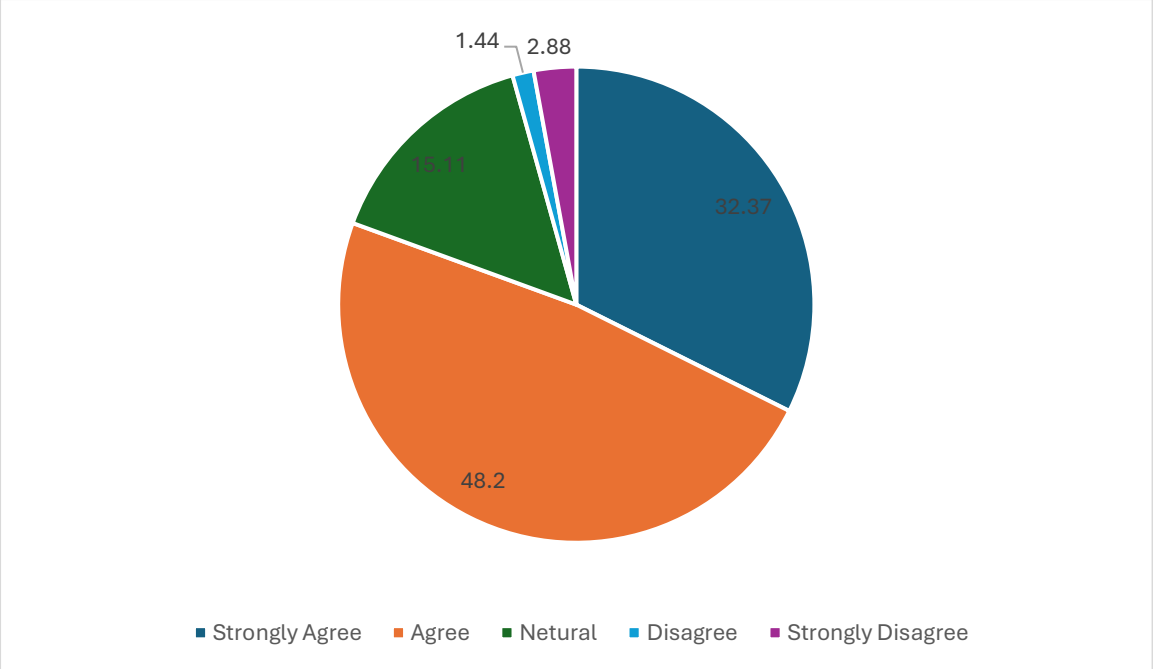
Importance: Ensures the chatbot provides accurate and insightful information, reinforcing its credibility and usefulness in addressing user queries.



With 36.96% strongly agreeing and 49.28% agreeing, users generally perceived the chatbot as intelligent and knowledgeable. The 11.59% neutral and 2.17% negative responses suggest that some users may still have concerns about the accuracy or depth of the information provided.

6.Did the chatbot's personality and interaction style feel realistic and engaging within the context of university services?

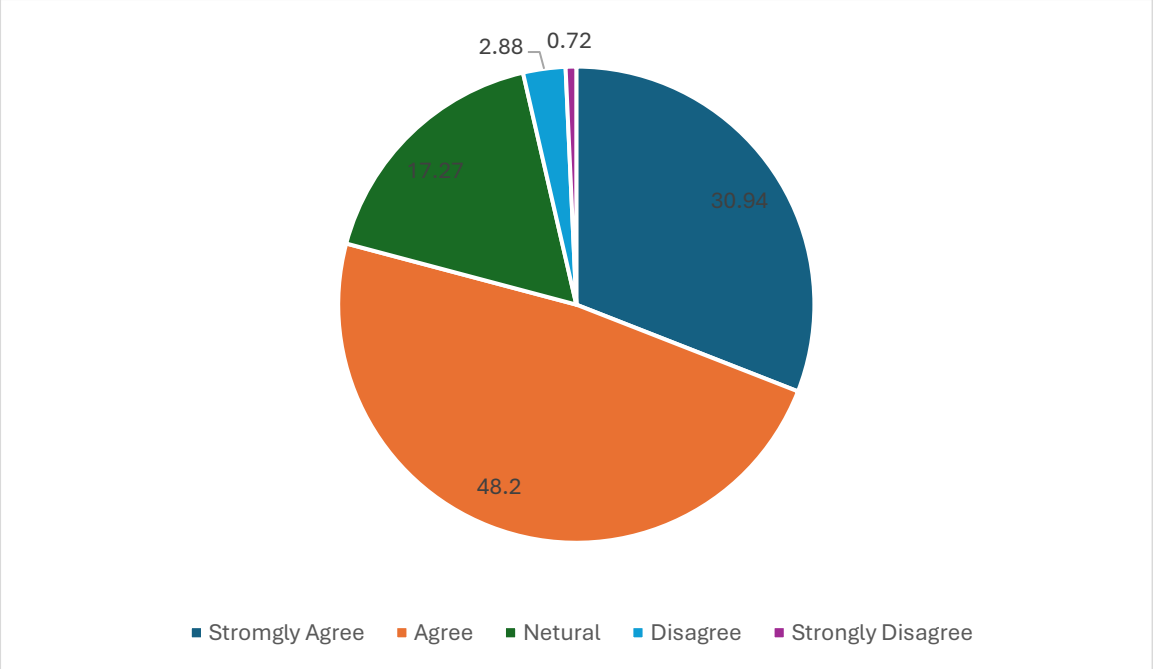
Importance: Examines if the chatbot's persona aligns with user expectations for a university context, making interactions feel natural and engaging.



Most users (32.37% strongly agreed and 48.2% agreed) found the chatbot's personality and interaction style engaging and realistic. However, the 15.11% neutral and small percentages of negative responses indicate that there might be opportunities to further refine its persona.

7.How helpful were the images or visual aids used by the chatbot in conveying university-related information?

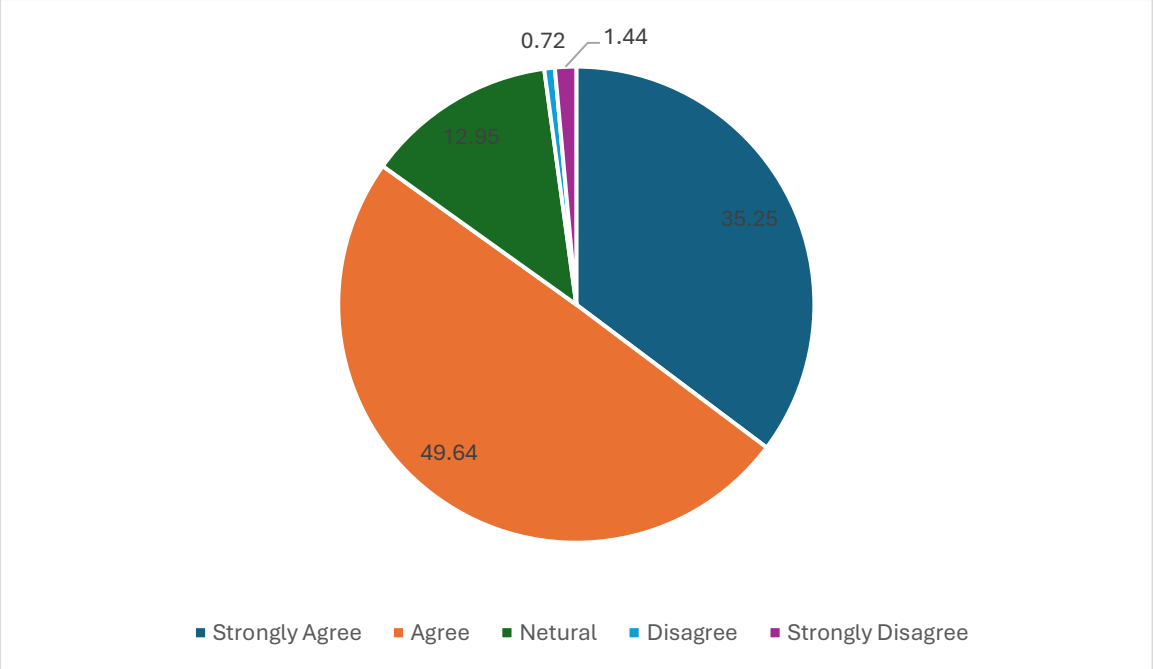
Importance: Assesses the effectiveness of visual aids in enhancing user understanding and retention of information related to university services.



With 30.94% strongly agreeing and 48.2% agreeing, most users found the visual aids helpful. The 17.27% neutral and minor negative responses suggest that while useful, there could be room for improvement in the integration or quality of visual aids.

8.Did the clickable menu/navigation options assist in finding relevant university information effectively?

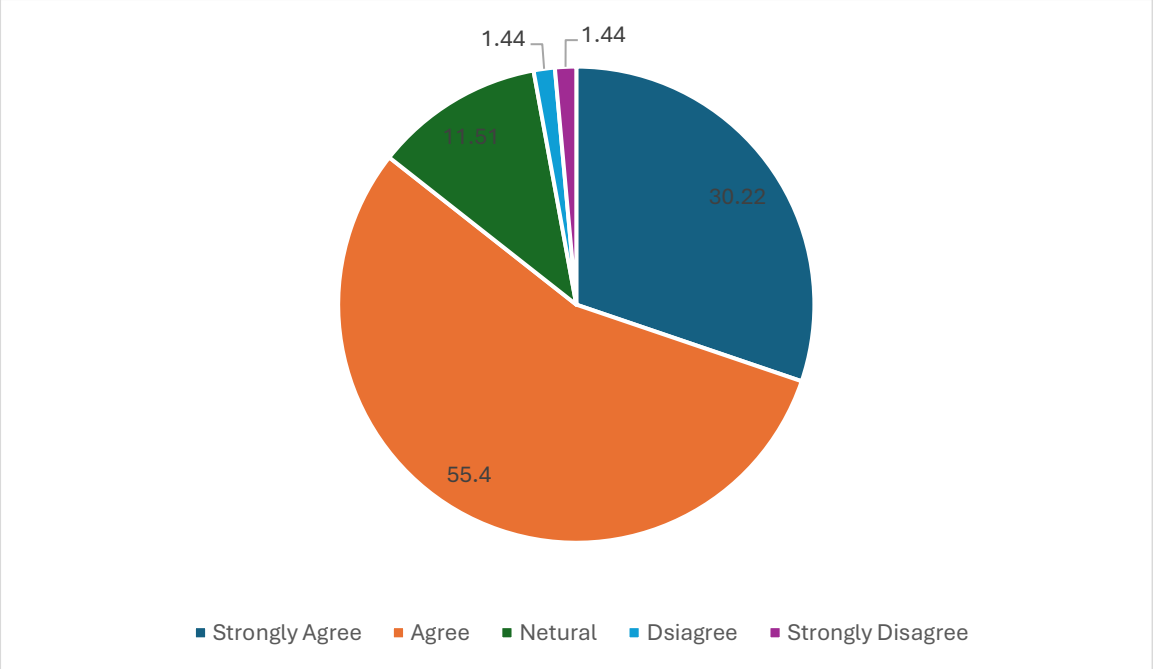
Importance: Determines the ease of navigating the chatbot and locating necessary information, improving overall user experience.



A high percentage (35.25% strongly agreed and 49.64% agreed) felt that the navigation options were effective. The 12.95% neutral and minor negative feedback suggest that while the navigation is generally effective, there could be areas for enhancement.

9.Were the topics covered by the chatbot well-integrated and relevant to university services and student needs?

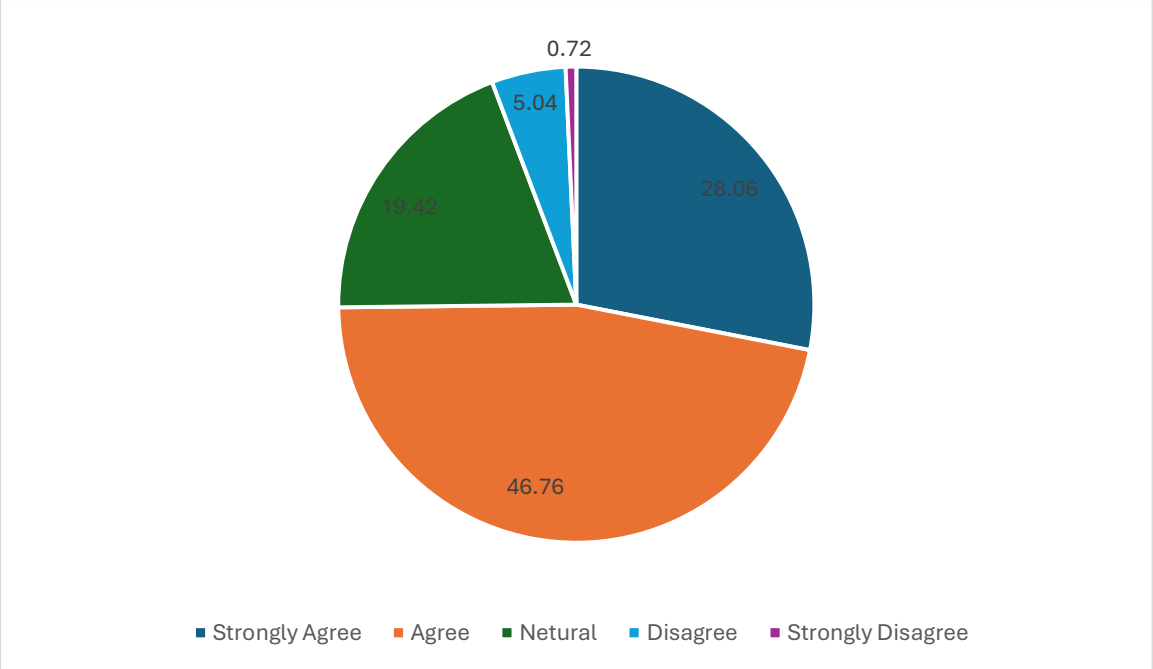
Importance: Ensures that the chatbot addresses pertinent topics and integrates information cohesively, making it a valuable resource for students.



The majority (30.22% strongly agreed and 55.4% agreed) felt the topics were well-integrated and relevant. The 11.51% neutral and minor negative responses suggest that the chatbot generally addresses relevant topics, though there may be some gaps or integration issues.

10.How well did the chatbot manage errors or mistakes in assisting with university-related inquiries?

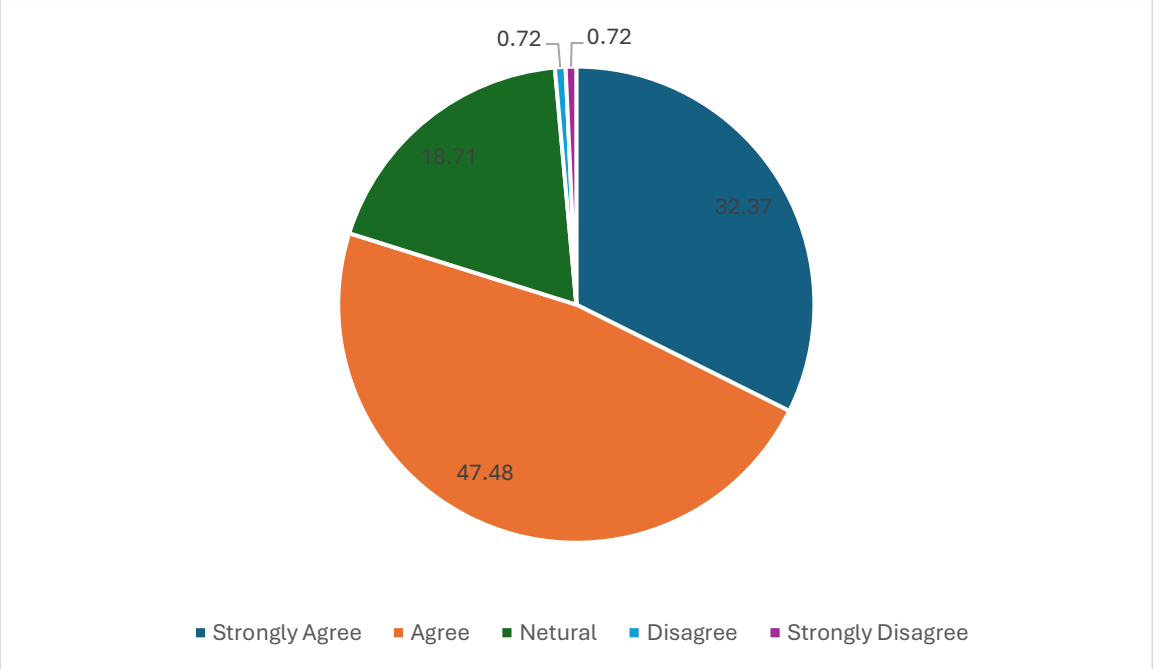
Importance: Evaluates the chatbot's capability to handle and recover from errors, ensuring a smooth and efficient user experience.



Positive feedback (28.06% strongly agreed and 46.76% agreed) indicates that the chatbot manages errors relatively well. However, the 19.42% neutral and 5.76% negative responses highlight the need for further improvements in error handling.

11.Were the topics covered by the chatbot directly relevant and useful in a university context?

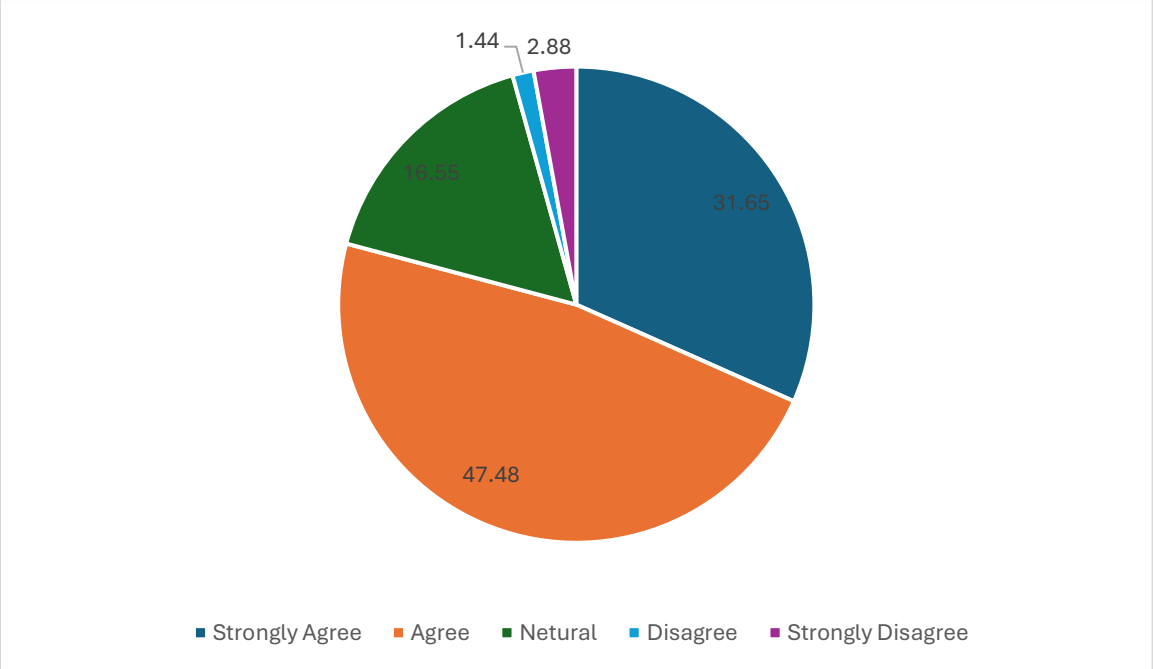
Importance: Ensures the chatbot's content is pertinent and beneficial to users, addressing their specific needs related to university services.



With 32.37% strongly agreeing and 47.48% agreeing, most users found the topics relevant and useful. The 18.71% neutral and small negative responses suggest there is overall satisfaction, but some users might find certain topics less applicable.

12.Did you find the chatbot easy to navigate while seeking university-related information?

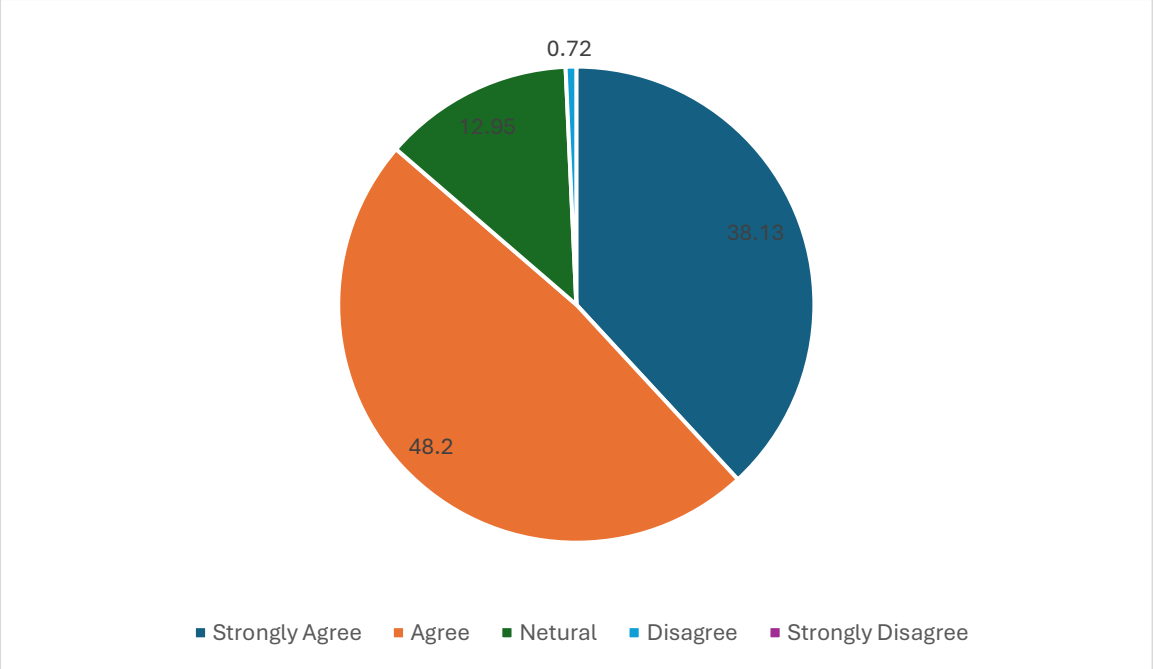
Importance: Assesses the overall user-friendliness and accessibility of the chatbot, ensuring that users can efficiently find the information they need.



High user satisfaction (31.65% strongly agreed and 47.48% agreed) suggests that the chatbot is generally easy to navigate. The 16.55% neutral and minor negative responses indicate there could be areas for improvement in the navigation experience.

13.How helpful were the chatbot's responses in addressing your university-related queries?

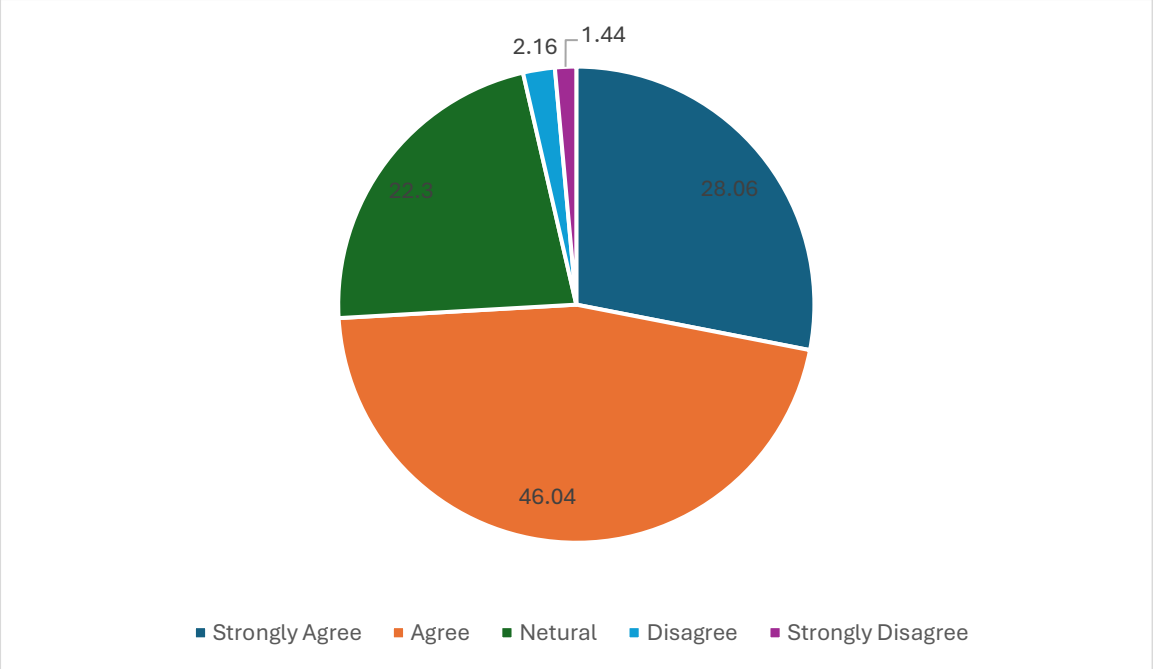
Importance: Measures the effectiveness of the chatbot's responses in resolving user inquiries, directly impacting user satisfaction.



A significant 38.13% strongly agreed and 48.2% agreed that the responses were helpful. The 12.95% neutral and minimal negative feedback suggest that the chatbot is generally effective, though some responses might need enhancement.

14.Was there a consistent flow and understanding in the chatbot's interactions related to university services?

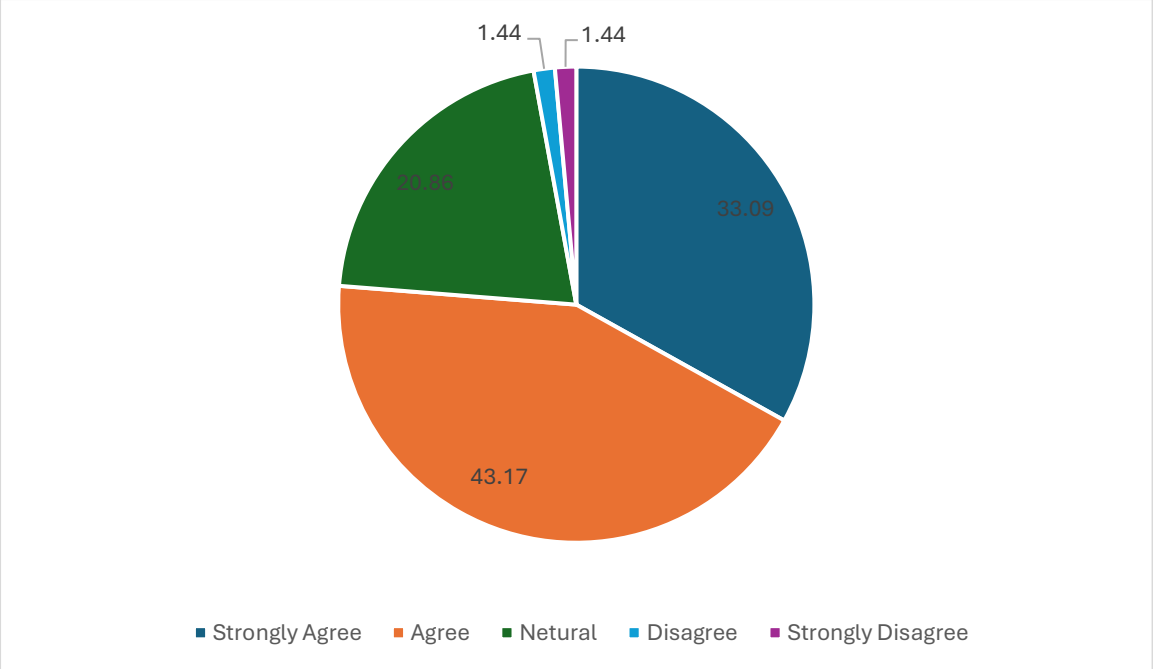
Importance: Evaluates the coherence and logical progression of interactions, ensuring users receive a smooth and comprehensible experience.



With 28.06% strongly agreeing and 46.04% agreeing, most users experienced a consistent flow. The 22.3% neutral and small negative responses highlight that improving interaction consistency could further enhance user experience.

15.How well did the chatbot understand your university-related queries and needs?

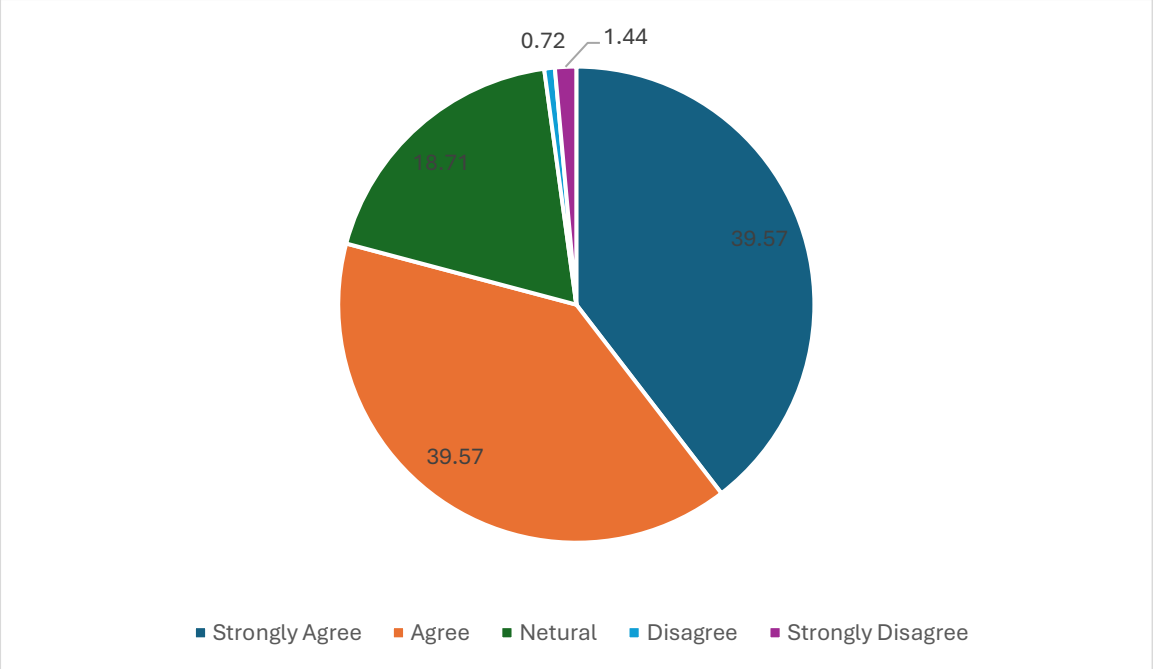
Importance: Assesses the chatbot's ability to accurately interpret and address user queries, ensuring relevant and useful responses.



The majority (33.09% strongly agreed and 43.17% agreed) felt the chatbot understood their queries well. The 20.86% neutral and minor negative feedback suggest that while understanding is generally good, there may be instances where the chatbot struggles with specific queries.

16.Would you consider using this chatbot more frequently for university-related inquiries in the future?

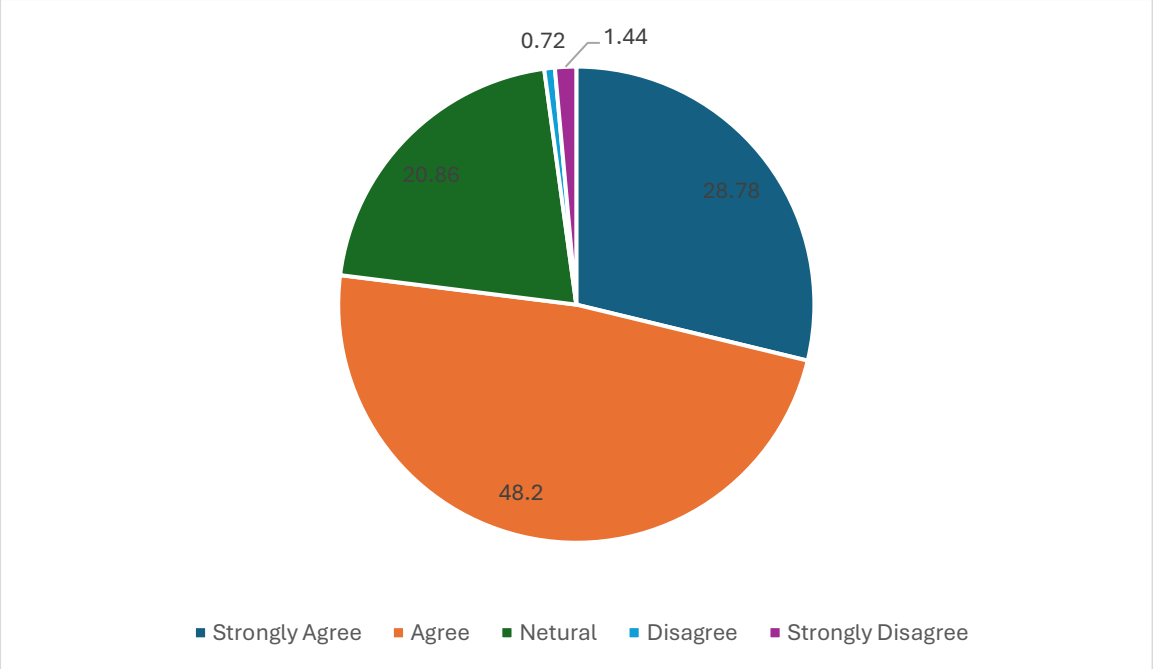
Importance: Gauges user satisfaction and the likelihood of continued use, reflecting the chatbot's overall effectiveness and value.



Positive responses (39.57% strongly agreed and 39.57% agreed) reflect that users are likely to continue using the chatbot, indicating its overall effectiveness and value. The 18.71% neutral and minimal negative responses suggest that continued improvements could further boost user retention.

17.Did using the chatbot leave you feeling more at ease or confident about accessing university services?

Importance: Measures the chatbot's impact on user confidence and comfort in accessing university services, highlighting its effectiveness in support.



With 28.78% strongly agreeing and 48.2% agreeing, the chatbot positively impacts user confidence and comfort. The 20.86% neutral and minimal negative responses suggest that while generally effective, further enhancements could increase user confidence further.