



TABLE OF CONTENTS

APPROVAL PAGE	i
PLAGIARISM STATEMENT.....	ii
FOREWORD.....	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
ABSTRACT	1
INTRODUCTION.....	2
1.1. Research Background.....	2
1.2. Research Problem	4
1.3. Research Scope.....	4
1.4. Research Objective	5
1.5. Research Benefits	5
LITERATURE REVIEW	6
THEORETICAL BASIS	13
3.1. Natural Language Processing (NLP).....	13
3.2. Information Retrieval (IR)	13
3.3. Question Answering System.....	14
3.4. Similarity Search.....	15
3.5. Vector Store	16
3.6. Large Language Model (LLM)	16
3.7. Prompt	16
3.8. BLEU Evaluation	17
RESEARCH METHODOLOGY	18
4.1. Research Description	18
4.1.1. Query.....	18
4.1.2. Proprietary Data	19
4.1.3. Dataset Preprocessing.....	19
4.1.4. Data Splitting.....	21
4.1.5. Dataset and Query Embedding.....	21
4.1.6. Vector Store	22
4.1.7. Prompt Template	23



4.1.8. Answer Generation with LLM.....	23
4.2. Additional Libraries	24
4.3. Basic Generative QA System	24
4.4. BLEU Evaluation.....	24
4.5. Performance Evaluation.....	25
IMPLEMENTATION	27
5.1. Implementation Environment.....	27
5.2. Data Collection	27
5.3. Dataset Preprocessing.....	28
5.3.1. Data Cleaning.....	28
5.3.2. Data Sorting and Compiling	29
5.3.3. Text Cleaning	30
5.3.4. Data Saving.....	31
5.4. Vectorization	32
5.5. Context Augmentation.....	32
5.6. LLM and RAG Chain Establishment	33
5.7. Basic Generative QA System	34
5.8. BLEU Evaluation.....	35
RESULTS AND DISCUSSION	41
6.1. Data Collection Result	41
6.2. Data Preprocessing Result.....	41
6.3. BLEU Evaluation Result	41
6.4. Performance Evaluation.....	42
6.5. Discussion.....	37
6.6. Limitations.....	39
CONCLUSION AND SUGGESTION	41
7.1. Conclusion	41
7.2. Future Works	41
REFERENCE LIST	42



LIST OF TABLES

Table 2.1 Average accuracy and parameters count of all Flan-T5 checkpoints in MMLU benchmark test by Papers With Code (n.d.)	8
Table 2.2 Large Language Model Comparison Table by Mandvikar (2023)	9
Table 2.3 Question Answering Research Comparison	10
Table 3.1 Answer extraction method, benefits, and disadvantages of every QA approach by Otten (2023).....	14
Table 4.1 Drug review sample.....	19
Table 4.2 Data compiling illustration.....	20
Table 6.1 Acquired BLEU evaluation score by the selected large language models.	41
Table 6.2 The generated question and answer by the examined large language models on a specific query.....	42
Table 6.3 Processing time taken to generate questions and answers out of every row in the sample.....	42
Table 6.4 List of test questions and answer keys.....	43
Table 6.5 Answers to the test questions generated by the proposed RAG QA system and the baseline QA system using all 3 evaluated large language models	35



LIST OF FIGURES

Figure 2.1 The Structure of a basic generative QA system	8
Figure 3.1 General architecture of QA system by Mutabazi, et al. (2021)	14
Figure 3.2 Vector stores by LangChain (n.d.)	16
Figure 4.1 The workflow of the proposed RAG QA system.....	18
Figure 4.2 Illustration of a dataset split by rows.....	21
Figure 4.3 Illustration of an embedding model converting a sentence into their numerical form.....	22
Figure 4.4 An example of a prompt template used in a RAG QA system.....	23
Figure 5.1 Manually importing the dataset from Google Drive	27
Figure 5.2 Data cleaning.....	28
Figure 5.3 Data sorting and compiling.....	29
Figure 5.4 Text cleaning	30
Figure 5.5 The first 5 rows of the preprocessed dataset	31
Figure 5.6 Saving the preprocessed dataset.....	31
Figure 5.7 Dataset vectorization	32
Figure 5.8 Context augmentation using a prompt template	33
Figure 5.9 Loading the selected LLM and establishing the RAG chain	33
Figure 5.10 Baseline generative QA system.....	34
Figure 5.11 Libraries used for conducting the BLEU evaluation.....	35
Figure 5.12 Loading the dataset for BLEU evaluation.....	36
Figure 5.13 creating the text2text-generation pipeline for all assessed models.....	36
Figure 5.14 Declaring the helper class and defining unpack_result function.....	37
Figure 5.15 Cutting extensive strings and giving prompts for question generation .	37
Figure 5.16 Generating and unpacking the questions	38



Figure 5.17 Generating and unpacking the answers to the generated questions 38

Figure 5.18 Merging the generated questions and answers 39

Figure 5.19 Loading the BLEU metrics and perform the evaluation..... 39