



TABLE OF CONTENTS

PREFACE	ii
TABLE OF CONTENTS	iii
TABLE OF FIGURES	vi
ABSTRACT	x
INTISARI	xi
CHAPTER I INTRODUCTION	1
1.1 Research Background	1
1.2 Research Problems	3
1.3 Research Scope.....	3
1.4 Research Aims.....	4
1.5 Research Advantage	4
CHAPTER II LITERATURE STUDY	5
2.1 Aspect-Based Sentiment Analysis.....	5
2.1.1 Previous Approaches to ABSA Tasks	5
2.2 Deep Learning for ABSA Tasks.....	6
2.2.1 CNN Approaches for ABSA Tasks	7
2.2.2 RNN Approaches for ABSA Tasks	9
2.3 Word Embeddings	12
2.4 BERT Word Embeddings.....	13
CHAPTER III THEORITICAL FOUNDATION	15
3.1 Sentiment Analysis.....	15
3.2 Aspect-Based Sentiment Analysis.....	15
3.3 Transformer	16
3.3.1 Attention Mechanism.....	17
3.3.2 Feed Forward Layer	19
3.4 BERT	20
3.5 DistilBERT	21
3.6 CNN.....	22
3.6.1 Input Layer.....	22
3.6.2 Convolutional Layer	22
3.6.3 Max-pooling Layer	23
3.6.4 Fully Connected Layer.....	23
3.7 LSTM	23
3.7.1 Input Layer	24
3.7.2 LSTM Layer.....	24
3.7.3 Pooling Layer.....	25
3.7.4 Output Layer	25
3.8 Evaluation.....	25
3.8.1 Confusion Matrix	26
3.8.2 Integration Testing	27
3.8.3 Usability Testing.....	28
CHAPTER IV RESEARCH METHODOLOGY	29
4.1 Description	29
4.2 Data Collection and Feature Engineering.....	30



4.3	Maintaining Stop Words and Punctuation.....	31
4.4	Tokenization	32
4.5	BERT Word Embeddings.....	34
4.5.1	Token Embeddings	35
4.5.2	Segment Embeddings.....	35
4.6	Aspect Term Extraction Model	35
4.6.1	Aspect Term Chunking	36
4.6.2	BERT Token Classifier.....	37
4.6.3	ATE Model Training and Hyperparameters Fine-Tuning	40
4.7	Aspect-Based Sentiment Polarity Classification Model.....	41
4.7.1	Tokenization & Padding	41
4.7.2	Model Training	41
4.7.3	Softmax	42
4.7.4	CNN-based SPC Model	42
4.7.5	BiLSTM-based SPC Model	47
4.7.6	Hybrid-based SPC Model	50
4.8	Application Design and Engineering.....	54
4.8.1	Requirements Specification	55
4.8.2	Functional Requirements	55
4.8.3	Non-Functional Requirements	57
4.9	Software Architecture.....	58
4.9.1	Database	60
4.9.2	Back-end	61
4.9.3	Front-end.....	63
4.10	User Interface and Experience.....	64
4.10.1	General Information.....	65
4.10.2	Single Sentence Analysis Table.....	66
4.10.3	Graph Visualization	66
CHAPTER V IMPLEMENTATION		69
5.1	Hardware and Software Specification for Model Development	69
5.2	Data Preparation	69
5.3	Normalization	69
5.4	Aspect Term Chunking.....	70
5.5	Data Splitting.....	71
5.6	Implementation of The Model.....	72
5.6.1	BERT Token Classifier for ATE	72
5.6.2	SPC Model Implementation.....	72
5.7	Training ATE Model	82
5.8	Training SPC Model.....	84
5.9	Evaluation of The Model.....	87
5.10	Hardware and Software Specifications for Web Application Development...	89
5.11	Backend Implementation.....	89
5.11.1	Database Implementation.....	89
5.11.2	Model Integration Implementation	90
5.11.3	Amazon Product Reviews Scraping Implementation	91
5.11.4	Preprocessing Scraped Data.....	93
5.12	ABSA Prediction for Amazon Product Review Implementation.....	94



CHAPTER VI RESULT AND DISCUSSION	96
6.1 Hyperparameters Fine-Tuning.....	96
6.1.1 BERT/DistilBERT Token Classifier Model Fine-Tuning.....	96
6.1.2 CNN-based Model Training and Fine-Tuning.....	97
6.1.3 BiLSTM-based Model Training and Fine-Tuning.....	99
6.1.4 Single Convolution Unit Hybrid-based Model Training and Fine-Tuning.....	100
6.1.5 Multi Convolution Unit Hybrid-based Model Training and Fine-Tuning.....	101
6.2 Evaluation of The Models	101
6.2.1 Aspect Term Extraction Task	101
6.2.2 Sentiment Polarity Classification Task	104
6.2.3 Summary	113
6.3 Software Evaluation	115
6.3.1 Integration Testing	115
6.3.2 Usability Testing.....	116
CHAPTER VII CONCLUSION AND FUTURE WORKS	119
7.1 Conclusion.....	119
7.2 Future Works	119
REFERENCES.....	121
APPENDIXES	127