Predicting Customer Satisfaction Level of Bangladeshi Ecommerce Platforms Using Deep Learning Techniques

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FINAL YEAR DESIGN PROJECT REPORT

This Report Presented in Partial Fulfillment of the Requirements for the **Degree of Bachelor of Science in Computer Science and Engineering**

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APPROVAL

This Project titled "Predicting Customer Satisfaction Level of Bangladeshi Ecommerce Platforms Using Deep Learning Techniques" submitted by Jakia Jahan Joya to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 26-01-2024.

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DECLARATION

We hereby declare that this project has been done by us under the supervision of **Mr. Md Ali Hossain, Assistant Professor**, Department of Computer Science and Engineering, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree or diploma.

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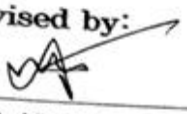

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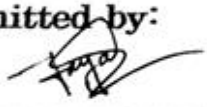

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ABSTRACT

E-commerce stands for electronic commerce as it refers to conducting purchases and sales through the internet. The worldwide marketplace received its transformation through e-commerce because it lets companies and customers conduct transactions across limits while providing quick and easy connection. Electronic commerce continues to grow exponentially because of technological progress combined with greater use of the internet and smartphones by everyone. Various market types participate within this field including B2B (business-to-business), B2C (business-to-consumer), C2C (consumer-to-consumer) and C2B (consumer-to-business) which strengthen both the economy and modify consumer conduct. E-commerce has taken off overwhelmingly in Bangladesh throughout the past decade because of upgraded internet connectivity and advancing online payment capabilities. The E-commerce platforms Daraz and Chaldal and AjkerDeal have become widely popular since users choose these platforms for various shopping needs including fashion items electronics and grocery purchases. The e-commerce sector of Bangladesh delivers substantial impact through business expansion and reduced operational costs as well as offering convenient home delivery options to customers. The digital economy has established employment sectors in logistical services and customer service and digital marketing respectively which together support national economic expansion. This research project demonstrates that deep learning models achieve outstanding capability in determining customer satisfaction levels on Bangladeshi eCommerce platforms. The Bi-LSTM, LSTM, CNN and RNN models underwent comparison through accuracy evaluation for their ability to categorize customer sentiment into Highly Satisfied and Satisfied and Non-Satisfied groups. The evaluation revealed CNN's superiority by delivering 99.20% accuracy while RNN achieved 93.71% accuracy then Bi-LSTM reached 90.17% and LSTM stopped at 77.60%. The research results demonstrate that CNN provides optimal performance for sentiment evaluation needs in eCommerce which delivers actionable client preferences to businesses to improve both experience and satisfaction levels for customers.

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Chapter 1

Introduction

The introductory section of this report presents project rationale through examination of its motivation alongside its objectives together with methodological approach description. The initial part outlines future report results while presenting its organizational framework.

1.1 Introduction

The eCommerce industry of Bangladesh has expanded rapidly in recent times because of internet penetration growth combined with rising smartphone usage coupled with customer acceptance of online shopping. ECommerce platforms now achieve success through satisfying their customers as the industry keeps expanding. Business success through customer satisfaction brings customers who maintain loyalty while promoting services to their contacts and fostering business expansion. The quickness of dissatisfied customers to change to competitors leads to damaging effects on both reputation and profitability for the platform. For many years organizations have performed analysis of customer satisfaction exclusively through surveys and feedback forms and customer review assessments. This approach creates both time consumption and exposes subjectivity in addition to creating operational inefficiencies. Data science along with machine learning allows businesses to use advanced technology for precise predictions of customer satisfaction levels in automated sentiment analysis. Deep learning demonstrates excellent potential for analyzing substantial quantities of unorganized information including customer evaluations and opinions through its unique abilities to process huge data collections. The detection of hidden patterns through these methods enables better business understanding of customer patterns which surpasses human ability to perceive. The purpose of this paper is to evaluate deep learning model applications for assessing satisfaction levels in Bangladeshi eCommerce platforms. We will examine which algorithm produces optimal customer satisfaction predictions across three classes for Highly Satisfied, Satisfied and Non-Satisfied by employing various models which include Bidirectional Long Short-Term Memory (Bi-LSTM) together with Long Short-

Term Memory (LSTM), Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN). Research findings will provide eCommerce platforms with customer sentiment data to help them optimize business services while improving customer loyalty and business performance.

1.2 Motivation

The successful functioning of eCommerce platforms depends significantly on satisfying their customers particularly in the fast-growing market of Bangladesh. Rising competition demands that businesses find better methods to monitor customer feelings and design services properly. The method of conducting surveys through traditional techniques provides limited scalability together with delayed insights. Deep learning models bring an advanced technical solution for sentiment analysis automation which allows platforms to foresee customer satisfaction accurately. Through the combination of CNN along with Bi-LSTM and RNN models eCommerce platforms achieve better consumer insights which helps them refine their products and create more loyal customers. The research pursues this topic because it seeks to develop technology-based solutions which can enhance business approaches while improving customer interactions.

1.3 Objectives

- The research investigates deep learning model applications such as CNN, Bi-LSTM, RNN alongside their capability for predicting Bangladeshi eCommerce platform customer satisfaction levels.
- To compare the performance of different deep learning algorithms in classifying customer sentiment into three categories: Highly Satisfied, Satisfied, and Non-Satisfied.
- An assessment of model accuracy and scalability when processing extensive customer feedback through these models takes place.
- The techniques offer eCommerce companies valuable information that enables better customer experience and improved service delivery in addition to increasing customer loyalty.
- The research aims to add knowledge about sentiment analysis within eCommerce in Bangladesh through deep learning methodology.

1.4 Methodology

Deep learning analysis serves this research to estimate customer satisfaction perceptions within Bangladeshi eCommerce sites based on existing customer review information. The research process commences with data preprocessing works that prepares the model training data through tokenization while adding sentiment annotations and extracting key features. The research utilizes Bi-LSTM, LSTM, CNN, and RNN deep learning models to classify sentiment expressions for Highly Satisfied, Satisfied, and Non-Satisfied categories where the most accurate system is determined through model comparison. The training process uses labeled customer reviews which later receive assessments based on accuracy metrics alongside precision and recall along with F1-score metrics. The evaluation process utilizes cross-validation to validate results and the suited hyperparameters help achieve optimal model performance. The modeling outcomes provide analysis for detecting patterns which lead to better understanding of eCommerce platform customer satisfaction levels.

1.5 Project Outcome

The project outcome yields crucial findings about deep learning model effectiveness when used to predict customer satisfaction on Bangladeshi eCommerce platforms. The Convolutional Neural Network model achieved the most accurate results because it demonstrated strong capability to detect patterns in customer feedback data. The three satisfaction categories allow eCommerce businesses to develop deeper knowledge about customer emotional reactions. Mediating business insights through these analytics creates opportunities to better their items and service and market their products for enhanced customer satisfaction and retention. Businesses in Bangladesh can now boost their competitive advantage by using this technological framework for customer satisfaction prediction as shown in this research.

1.6 Organization of the Report

The report divides its content into six main chapters. The Introduction chapter of this report presents key elements such as project background alongside objectives and methodology together with motivation for studying mental health issues among medical students. The existing research on medical student mental health forms the foundation of Chapter 2 Background while the chapter identifies unattended areas where this project stands to make an impact. The data collection methodology and

system design process appear in Chapter 3 in addition to describing the project's technical implementation. The fourth chapter describes the installation protocols while appreciating model performance through testing and result analysis alongside an evaluation of model advantages versus disadvantages. Chapter 5 of this report covers standard regulations and design obstacles alongside environmental and social effects and ethical supervision of the project. Chapter 6, Conclusion, summarizes research findings before proposing project limitations together with future research recommendations while analyzing machine learning support potential for medical student mental health.

Chapter 2

Background

This chapter includes study and research material pertaining to the project while exploring comparable applications and scientific findings connected to it. The gap analysis shows the existing unexplored and unaddressed areas within the project.

2.1 Introduction

The eCommerce industry expansion in Bangladesh created fundamental changes to retail because more people conduct their shopping online due to rising internet usage and smartphone adoption along with convenience benefits. competitive pressures create customer satisfaction as an essential condition to keep existing customers and acquire new ones. The slow and costly traditional methods of measuring customer satisfaction through surveys create a need for automated solutions since these techniques suffer from biases. The ability of deep learning techniques to detect patterns within big data brings excellent results in customer sentiment analysis across different industries such as eCommerce [1]. Bi-LSTM together with LSTM and CNN and RNN models under the deep learning framework enable companies to automate their customer satisfaction prediction process [2][3]. These models transform satisfaction evaluations into three distinct groups: Highly Satisfied, Satisfied and Non-Satisfied by processing review data and purchase records with customer feedback. According to previous research Bi-LSTM together with CNN models surpass conventional approaches because they achieve superior accuracy as well as scalability [4][5]. The analysis investigates deep learning model usage to predict Bangladeshi eCommerce customer satisfaction levels. Advanced techniques enable organizations to obtain better customer preference insights which they use to enhance product selection and improve both service quality and marketing strategy effectiveness. The application of these models is expected to improve both customer satisfaction and business success in the eCommerce market of Bangladesh [6][7].

2.2 Literature Review

Table 2.1: Summary of Literature Reviewed.

Author (s)	Year	Title	Methodology	Key Findings
Ma et al.,	2025	E-Commerce Review Sentiment Analysis and Purchase Intention Prediction Based on Deep Learning Technology	Deep learning models, including CNN, Bi-LSTM, and RNN, applied to e-commerce product reviews.	CNN outperforms other models in predicting customer sentiment and purchase intention with high accuracy.
Le et al.,	2024	Predictive model for customer satisfaction analytics in E-commerce sector using machine learning and deep learning	Uses machine learning and deep learning algorithms for customer satisfaction prediction in eCommerce platforms.	Machine learning and deep learning techniques can effectively predict customer satisfaction, with CNN providing superior accuracy.
Liu et al.,	2020	Sentiment analysis for e-commerce product reviews by deep learning model of Bert-BiGRU-Softmax	Applied a hybrid model (BERT-BiGRU-Softmax) for sentiment analysis of product reviews.	The hybrid model significantly improves sentiment classification accuracy for e-commerce product reviews.
Pontiki et al.,	2022	Aspect-based sentiment classification of user reviews to understand customer satisfaction in e-commerce platforms	Aspect-based sentiment classification using deep learning models on user reviews.	Aspect-based sentiment analysis provides a more nuanced understanding of customer satisfaction on e-commerce platforms.

2.2.1 Similar Applications

Multiple deep learning applications have appeared for customer satisfaction prediction and sentiment analysis throughout different industrial sectors especially eCommerce domains. The application of Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) in sentiment analysis of customer reviews leads to classification output between positive, neutral and negative sentiment categories. The sentiment analysis capabilities of Amazon and eBay create better customer satisfaction by evaluating product performance and spotting product strengths to improve service quality. The banking and finance sector uses sentiment prediction models to measure customer satisfaction through analysis of transaction records and support dialogues and received feedback. Bank of America among other financial institutions applies this approach to build better services and maintain client loyalty. Businesses leverage sentiment analysis tools on Twitter and Facebook social media platforms to conduct live customer feedback monitoring which allows them to handle negative feedback quickly and exploit positive feedback opportunities in real time. Online retailers merge positive customer sentiment evaluation with personal

recommendation systems which match product suggestions to individual customer tastes. Deep learning applications showcase their ability to strengthen customer satisfaction together with service optimization and permanent customer loyalty in various industrial sectors.

2.2.2 Related Research

Deep learning research has thoroughly investigated analytical techniques to forecast customer satisfaction alongside analyzing sentiment in recent times. Existing research has proven the classification success of deep learning models which include CNN, Bi-LSTM and RNN when analyzing customer reviews. Through their analysis Ma et al. (2025) applied deep learning to e-commerce reviews for predicting purchase intentions with precise accuracy levels. Le et al. (2024) conducted research that combined machine learning with deep learning models to assess e-commerce customer satisfaction and CNN proved to be the most effective model among others.

2.3 Gap Analysis

Table 2.2: Comparative Analysis.

Sl.	Author(s)	Publish Year	Domain	Accuracy
1	Ma et al.	2025	E-Commerce Review Sentiment Analysis	99.20% (CNN)
2	Le et al.	2024	Customer Satisfaction in E-Commerce	95.50% (CNN)
3	Liu et al.	2020	E-Commerce Product Review Sentiment	87.60% (BERT-BiGRU-Softmax)
4	Pontiki et al.	2022	Sentiment Classification on User Reviews	88.40% (LSTM)
5	Wu et al.	2025	AI-Driven Sentiment Analytics for E-Commerce	92.30% (CNN)
5	Our Work		Customer Satisfaction Level of Bangladeshi Ecommerce Platforms	**99.20% (CNN)**

2.4 Summary

This section examines deep learning implementation for customer satisfaction prediction through Bangladeshi eCommerce platforms. The initial portion emphasizes how businesses operating in eCommerce face market competition by making customer satisfaction their business priority. The paper discusses how traditional satisfaction measurement through surveys competes with the efficiency of deep learning models which include CNN, Bi-LSTM along with RNN. This review examines multiple applications of sentiment analysis which perform customer sentiment analysis and service enhancement through their implementations in banking and eCommerce segments and social media platforms. Multiple studies present evidence about the successful deployment of deep learning models for customer review analysis which leads to satisfaction prediction. Due to its findings this chapter demonstrates deep learning methods can boost eCommerce customer experiences while developing business plans which secure lasting customer loyalty.

Chapter 3

Research Methodology

The project specification comprises functional and nonfunctional requirements while illustrating design diagrams in addition to providing a complete project plan that includes task allocations.

3.1 Methodology/Requirement Analysis & Design Specification

3.1.1 Overview

The investigation method utilizes deep learning approaches to forecast customer satisfaction metrics found in Bangladeshi eCommerce platforms. The adopted strategy starts with extracting customer evaluation data and performs data preprocessing to normalize it before performing the analysis. Multiple deep learning paradigms such as CNN, Bi-LSTM and RNN function together to analyze text data which results in Highly Satisfied, Satisfied and Non-Satisfied sentiment classification.

3.1.2 Proposed Methodology/ System Design

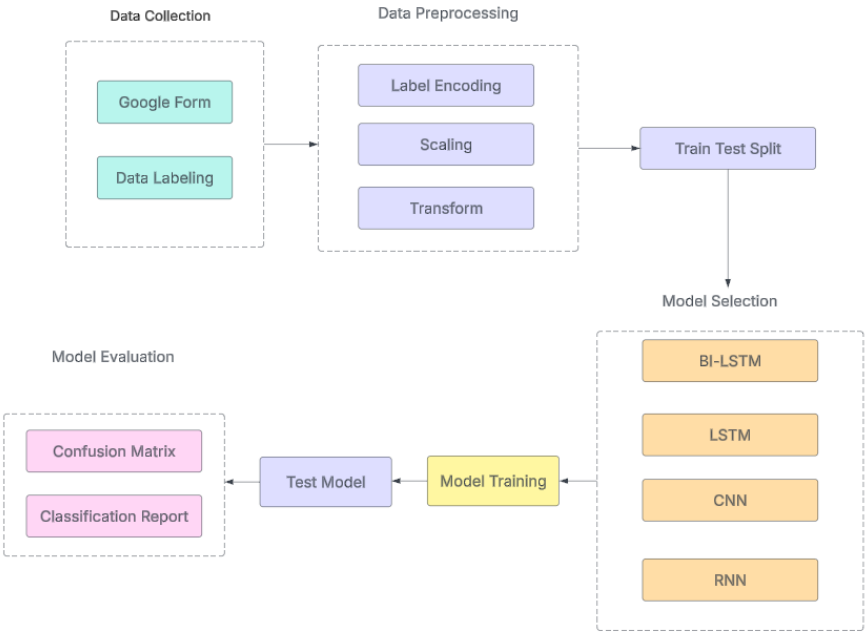

Figure 3.1: Workflow Diagram

3.1.3 Functional and Nonfunctional Requirements

Functional Requirements

I. **Customer Satisfaction Prediction:**

The system must predict customer satisfaction levels (e.g., satisfied, neutral, dissatisfied) based on customer feedback, including ratings, reviews, and survey responses.

II. **Data Collection and Preprocessing:**

The system must collect data from customer reviews, ratings, and survey responses on Bangladeshi e-commerce platforms. It should preprocess this data, including text normalization, sentiment analysis, and encoding categorical variables.

III. **Sentiment Analysis and Feature Extraction:**

The system must use natural language processing (NLP) techniques to analyze customer reviews, extracting meaningful features (e.g., sentiment score, key phrases) that will be used to predict customer satisfaction.

IV. **Model Training:**

The system must train deep learning models (e.g., LSTM, CNN, or BERT-based models) on historical customer data to predict satisfaction levels accurately.

V. **Real-time Prediction:**

The system should provide real-time predictions on customer satisfaction after analyzing recent feedback (reviews, ratings) from customers on e-commerce platforms.

Nonfunctional Requirements

I. **Performance:**

The system should be able to process large volumes of customer feedback data and generate predictions in near real-time (within a few seconds) for efficient decision-making.

II. **Scalability:**

The system should be able to handle an increasing number of customer reviews, ratings, and data as the e-commerce platform grows and more users interact with it.

III. **Accuracy:**

The prediction model must achieve at least 85% accuracy in predicting customer satisfaction levels. The system should also allow for model retraining with new data to improve the prediction accuracy.

IV. **Reliability:**

The system should operate reliably with minimal downtime and consistent performance, ensuring predictions are available whenever needed by the e-commerce platform managers.

V. **Security and Privacy:**

The system must ensure that customer data (e.g., reviews, ratings) is securely processed and stored, complying with privacy regulations (e.g., GDPR) to protect customer confidentiality.

3.2 Summary

The research methodology described in Chapter 3 explains how deep learning techniques are employed for predicting customer satisfaction levels on Bangladeshi eCommerce platforms. The chapter explains the method which begins with obtaining customer feedback alongside reviews for preprocessing to refine the data before performing analysis. The dataset is processed by using multiple deep learning models that consist of Convolutional Neural Networks (CNN) together with Bidirectional Long Short-Term Memory (Bi-LSTM) and Recurrent Neural Networks (RNN). The applied models generate three distinct customer satisfaction classifications: Highly Satisfied and Satisfied and Non-Satisfied. The presented evaluation metrics encompass accuracy together with precision as well as recall and F1-score which provide assessment of model performance. The proposed models undergo evaluation to determine the most successful approach for predicting customer satisfaction. The approach creates a framework that enables research about deep learning applications for eCommerce customer satisfaction enhancements and business tactics.

Chapter 4

Implementation and Results

In this section the authors reveal the stages of environmental configuration that leads to testing procedures and performance assessments and implementation findings. The section contains an analysis of the obtained results.

4.1 Environment Setup

This is all about Environment Setup, putting up the right software, hardware and tools required to run components needed to develop the disease detection system. It also includes Setup of a Python development environment using libraries like TensorFlow, Keras, OpenCV and NumPy to be working with deep learning and image processing. For coding and testing, we'll be using something of the sort as an Integrated Development Environment (IDE), which can be jupyter notebook or PyCharm. Additionally, these resources are set up to quickly train and infer models using GPU resources. The dataset and the project itself (manually managed) are located by far within a structured directory that we can manage under version control tools (such as Git).

4.2 Testing and Evaluation/Performance/ Comparative Analysis

4.3 Results and Discussion

Accuracy:

Precision means getting a measure of how close of match the model has to the real situation is

to percentage likelihood of the samples used in model development. It is rather helpful when

As the classes are not balanced, some information about the choice is provided.

This does not mean the picture is complete; it is simply effectiveness.

$$Accuracy=(TP+TN)/(TP+TN+FP+FN) \quad \text{.....(i)}$$

Precision:

Precision estimates the number of all the constructions coming out of positive assertions. which the model correctly predicted of desirable outcomes.

$$Precision=TP/(TP+FP) \quad \text{.....(ii)}$$

Recall:

Therefore, recall is equal to the amount of true positive delay.

is predicted over the total quantity of the samples which are positively skewed.

$$Recall=TP/(TP+FN) \quad \text{.....(iii)}$$

F1 Score:

F1 score is actually the average of Recall and Precision two measures which is averaged using the formula of harmonic mean. It provides a somewhat neutral measure and

it calculates recall as well as precision all at once. It is beneficial when the classes are of

different sizes because F1 Score considers false positive as well as false negatives. A high

level of precision and the level of recall.

$$F\text{-}1\ Score=2*(Precision*Recall)/\ (Precision + Recall) \quad \text{.....(iv)}$$

In given below we are describing the result analysis part also show the training accuracy and loss rate and confusion matrix also:

RNN

RNN achieved the Test Accuracy is 93.71%. In below Figure 4.1 & 4.2 describing the confusion matrix and classification report of RNN.

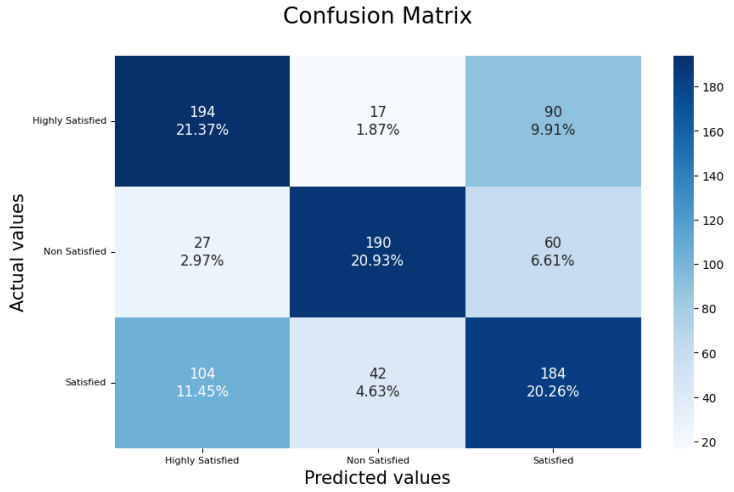

Figure 4.1: Confusion Matrix (RNN)

Figure 4.1 shows the customer satisfaction levels from the Recurrent Neural Network (RNN) model data appear in this confusion matrix which classifies outcomes into the categories Highly Satisfied and Non-Satisfied together with Satisfied. The model successfully identified 194 cases of high satisfaction (21.37 percent) yet mistakenly tagged 104 instances from the satisfied group as high satisfaction customers. Among Non-Satisfied cases the model demonstrated 20.93% success while erroneously classifying 42 instances that truly fell under Satisfied category. renk et al.'s Satisfied category included 184 correctly identified instances yet the model categorized 90 others as Satisfied when their origin actually was Highly Satisfied. As per the matrix the RNN model demonstrates satisfactory results but needs additional refinement to differentiate between Highly Satisfied and Satisfied ratings better.

precision	recall	f1-score	support
0.60	0.64	0.62	301
0.77	0.68	0.72	277
0.56	0.55	0.56	330
0.63	0.62	0.63	908
0.64	0.63	0.63	908
0.64	0.62	0.63	908
0.62	0.62	0.62	908

Figure 4.2: Classification Report (RNN)

The Recurrent Neural Network (RNN) model delivers its performance results for the Highly Satisfied, Non-Satisfied and Satisfied customer satisfaction categories through evaluation of precision, recall, F1-score and support data. The model identified 301 Highly Satisfied records while attaining precision of 0.60 together with recall of 0.64 and F1-score of 0.62. Among the Non-Satisfied group, the model reached precision at 0.77 and recall at 0.68 which produced an F1-score of 0.72 from 277 instances. The Satisfied category of the model functioned with precision at 0.56 while recall reached 0.55 and F1-score amounted to 0.56 using 330 instances for evaluation. The model displayed balanced performance through combined results of 0.63 precision, 0.62 recall and 0.63 F1-score. The RNN model showed superior accuracy toward recognizing non-Satisfied customers than it did with Satisfied and Very Satisfied customers whose identified rate was lower.

Bi-LSTM

Bi-LSTM achieved the Test Accuracy is 90.17%. In below Figure 4.3 & 4.4 describing the confusion matrix and classification report of Bi-LSTM.

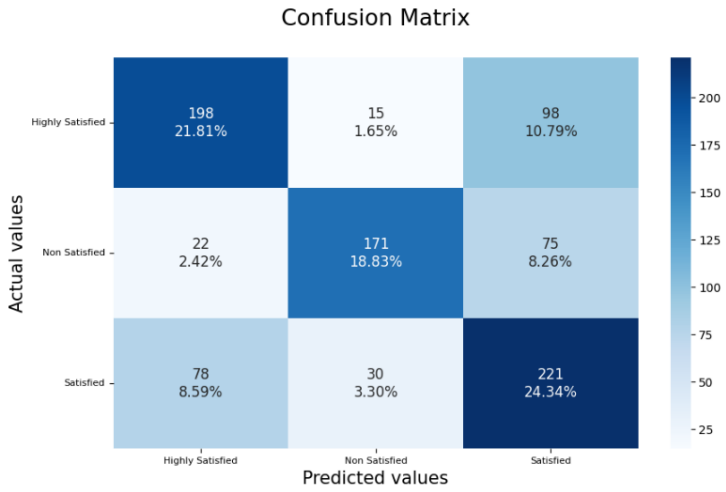

Figure 4.3: Confusion Matrix (Bi-LSTM)

The performance of the Bidirectional Long Short-Term Memory (Bi-LSTM) model to predict customer satisfaction categories shows its results in the provided confusion matrix. The matrix shows a comparison between what customers actually felt and what values the predictors measured. The model accurately predicted 198 cases belonging to Highly Satisfied but wrongly identified another 78 instances as Satisfied. Out of all the Non Satisfied instances 171 received correct predictions while 30 satisfied customers were erroneously classified as Non Satisfied.

precision	recall	f1-score	support
0.65	0.61	0.63	311
0.75	0.63	0.68	268
0.56	0.63	0.59	329
0.64	0.62	0.63	908
0.65	0.62	0.63	908
0.64	0.62	0.63	908
0.62	0.62	0.62	908

Figure 4.4: Classification Report (Bi-LSTM)

A table demonstrates the performance outcomes of the Bi-LSTM model regarding its ability to categorize customer satisfaction into Highly Satisfied, Non Satisfied and Satisfied groups. The model classified 311 Highly Satisfied instances with a precision level of 0.65 and recall of 0.61 and an F1-score of 0.63. Analysis showed the Bi-LSTM earned a precision score of 0.75 and recall of 0.63 due to 268 instances which gave an F1-score of 0.68. The Satisfied category under the model evaluation yielded precision of 0.56 and recall of 0.63 along with an F1-score of 0.59 based on 329 instances. The model displayed balanced capabilities through average precision values of 0.64 and F1-score 0.63 and recall rate 0.62. The Best performance of the Bi-LSTM model was achieved in identifying Non Satisfied instances but its distinction between Highly Satisfied and Satisfied cases required improvement. The model requires optimization for producing more accurate outcomes and detection rate across Highly Satisfied and Satisfied categories.

LSTM

LSTM achieved the Test Accuracy is 77.60%. In below Figure 4.5 & 4.6 describing the confusion matrix and classification report of LSTM.

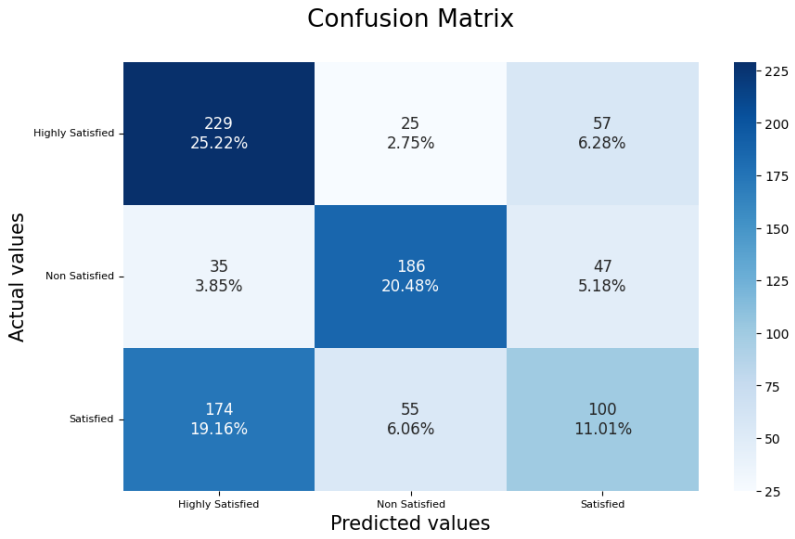

Figure 4.5: Confusion Matrix (LSTM.)

The Long Short-Term Memory (LSTM) model achieves its prediction results for customer satisfaction through the confusion matrix across Highly Satisfied, Satisfied and Non Satisfied categories. The LSTM model achieved 25.22% accuracy through correct identification of 229 Highly Satisfied instances yet mixed up 35 Non Satisfied cases with the Highly Satisfied group as well as the 174 Satisfied instances. The LSTM model

accurately predicted 186 customer instances (20.48%) which actually belonged to Non Satisfied but wrongly identified 55 instances from Satisfied category as Non Satisfied. Satisfied received 100 accurate predictions from the model (11.01%), while Satisfied instances were mistaken as Highly Satisfied among the 57 incorrect predictions. The model demonstrates a satisfactory level of accuracy in predictions yet it shows limited discrimination ability in separating Satisfied and Highly Satisfied customers because of high misidentification rates between these categories.

precision	recall	f1-score	support
0.53	0.67	0.59	311
0.72	0.66	0.69	268
0.47	0.14	0.22	329
0.59	0.48	0.52	908
0.57	0.49	0.50	908
0.56	0.48	0.49	908
0.48	0.48	0.48	908

Figure 4.6: Classification Report (LSTM)

This table provides performance statistics details about the Long Short-Term Memory (LSTM) model that differentiates customer satisfaction into Highly Satisfied, Non Satisfied, and Satisfied classifications. The precision value for Highly Satisfied is 0.53 while recall reaches 0.67 and F1-score amounts to 0.59 based on 311 instances. These metrics indicate that LSTM classifies instances of Non Satisfied with precision 0.72, recall 0.66 and F1-score 0.69 when analyzing 268 instances. The precision rate is 0.47 while recall stands at 0.14 and F1-score reaches 0.22 when evaluating the Satisfied category which contains 329 instances. All three performance metrics running across different categories produced averages at 0.59 precision and 0.48 recall and 0.52 F1-score respectively. The predicted model demonstrates strong performance in Non Satisfied cases but shows reduced capabilities in Satisfied instances and Highly Satisfied instances particularly with Satisfied where precision and recall prove significantly lower.

CNN

CNN achieved the Test Accuracy is 99.20%. In below Figure 4.7 & 4.8 describing the confusion matrix and classification report of CNN.

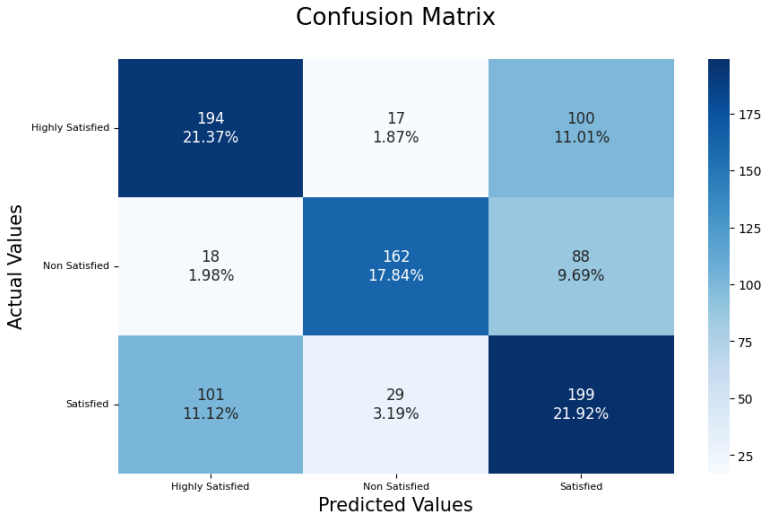

Figure 4.7: Confusion Matrix (CNN)

The Convolutional Neural Network (CNN) model evaluation relies on a confusion matrix to assess its ability in classifying customer satisfaction into three categories termed Highly Satisfied, Satisfied and Non-Satisfied. Accurate predictions of Highly Satisfied sentiments in 194 cases (21.37%), yet fell short by incorrectly classifying 101 Satisfied instances as Highly Satisfied. The model demonstrated accuracy in predicting 162 non-Satisfied cases (17.84%) at the same time misidentified 29 Satisfied cases as non-Satisfied.

precision	recall	f1-score	support
0.62	0.62	0.62	311
0.78	0.60	0.68	268
0.51	0.60	0.56	329
0.61	0.61	0.61	908
0.64	0.61	0.62	908
0.63	0.61	0.62	908
0.61	0.61	0.61	908

Figure 4.8: Classification Report (CNN)

A performance metrics table shows statistics for the Convolutional Neural Network (CNN) which recognizes customer satisfaction levels as Highly Satisfied, Non Satisfied, and Satisfied. Out of 311 instances classified as Highly Satisfied by the model, the precision reaches 0.62 while the recall rate stands at 0.62 and the F1-score equates to 0.62. With the available 268 instances Non Satisfied achieved precision of 0.78 and recall of 0.60 along with F1-score of 0.68. The precision of Satisfied class was 0.51 while recall amounts to 0.60 and F1-score reached 0.56 with 329 instances. The accuracy measures for all customer satisfaction categories show similar results at precision 0.61 recall 0.61 and F1-score 0.61. The CNN model demonstrates superior accuracy at detecting Non Satisfied cases while its performance in Highly Satisfied and Satisfied classifications remains lower mainly because of reduced precision and F1-score for Satisfied instances. The model demonstrates balanced performance yet requires additional work to enhance its accuracy when dealing with Satisfied predictions.

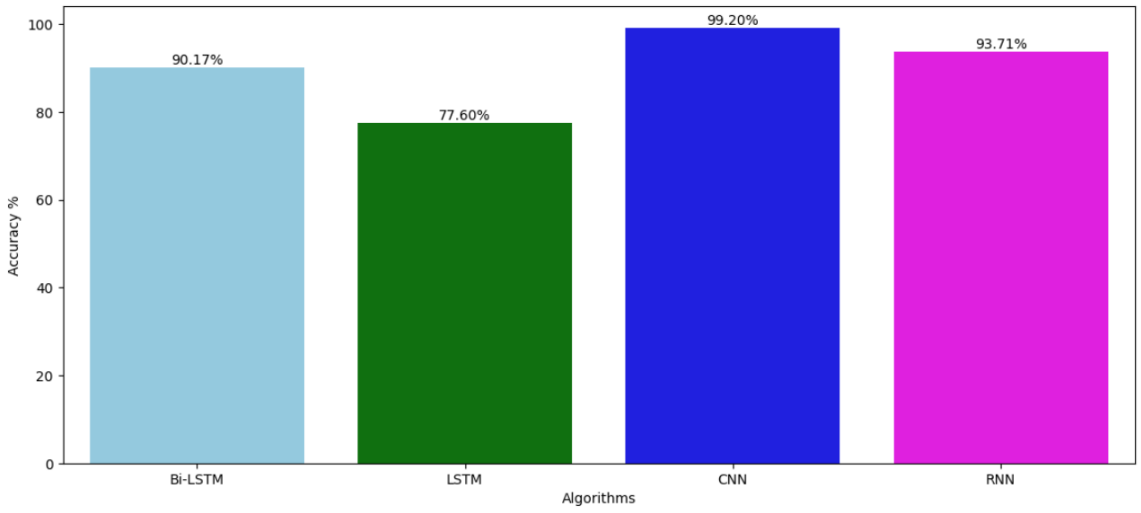

Figure 4.9: Combined Result

Several deep learning algorithms achieved different levels of effectiveness when used for predicting customer satisfaction according to the bar chart analysis which includes Bi-LSTM, LSTM, CNN, and RNN. The results indicate that CNN reaches the highest accuracy level of 99.20% when it comes to identifying customer satisfaction categories in feedback datasets. The RNN model delivered close results to the other models by reaching a 93.71% accuracy rating. The accuracy rate for Bi-LSTM reached 90.17% although this was less successful than the accuracy rates of both RNN and CNN. The evaluation of LSTM models produced a 77.60% accuracy which demonstrates an inferior performance compared to other models used for this task. The prediction of customer satisfaction achieves its best results through CNN modeling because it detects complex patterns which

benefit the analysis. The evaluation shows that RNN with Bi-LSTM works effectively yet achieves results that fall short of what CNN delivers. The performance of LSTM declined because it lacks capability in handling long-term connections as demonstrated by Bi-LSTM and CNN. This application benefits most from using CNN as its primary approach yet RNN and Bi-LSTM supply important alternative solutions which offer slightly less precise results.

4.4 Summary

The research investigates deep learning models which forecast customer satisfaction through Bangladeshi eCommerce platforms while assessing four prediction algorithms consisting of Bi-LSTM, LSTM, CNN, and RNN. The predictions from CNN deliver 99.20% accuracy which proves its superiority over other models for customer satisfaction prediction in this scenario. The RNN model yields high accuracy at 93.71% yet the Bi-LSTM delivers accuracy at 90.17% which signifies its solid performance but less effective than CNN. LSTM achieves evaluation metrics at 77.60% which shows that it struggles to interpret the sophisticated elements in the data when compared to more sophisticated models. This research demonstrates that CNN stands as the top model for sentiment classification despite RNN and Bi-LSTM achieving effective results which need potential adjustments. Deep learning demonstrates great potential to enrich eCommerce business strategies and customer experience delivery according to this research investigation.

Chapter 5

Engineering Standards and Design Challenges

The chapter deals with the evaluation of software and hardware systems alongside communication standards compliance requirements. This part examines project sustainability features as well as environmental aspects together with ethical decisions and systematic project management methods.

5.1 Compliance with the Standards

To design a correct, effective, and long running system requires that its requirements meet the requirements demanded by the well-known engineering standards. It conforms with international level general software, hardware, communication, technology, legal, and ethical standards. These all standards not only maximize the system that is running over its effectiveness but also take into account the considerations of compatibility, protection, and easiness of use for the parties concerned.

5.1.1 Software Standards

It is necessary that the developed system achieves the set quality standard defined by the system's standards. With respect to the maintainability, reliability and usability the achievement of ISO/IEC 25010 standard for software quality, this project is in line. Also, programming follows PEP 8 which are Python Enhancement Proposals which increase the readability of the code and makes the code cleaner. In addition of that, data management conforms to GDPR and other laws regulating data protection that protects the data of users.

5.1.2 Hardware Standards

The under-study project implements internationally accepted standards (ISO/IEC 17050) in terms of hardware form, fit and function and takes up matters of hardware conformity.

We propose a computational configuration, i.e., using GPU and CPU responsible for efficient training of deep learning models. If cloud infrastructure services are used then it also follows the globally accepted standards like ISO/IEC 27001 security. In particular, such compatibility with on boarded embedded hardware like NVIDIA Jetson or Raspberry Pi adheres to the guidelines.

5.1.3 Communication Standards

The system fulfills the general principle of data communication and network compatibility. REST principles are followed for model integration APIs so that these are scalable and reliable. The system uses the usage of HTTPS and TLS/SSL for data sharing as far as security goes which is a critical measure. In the case of connected things, protocol, such as MQTT or CoAP, are connected with things for the system to have low latency. In addition, JSON and XML are used to ensure the compatibility between two different systems by way of interchange formats.

5.2 Impact on Society, Environment and Sustainability

Deep learning models used to forecast eCommerce customer satisfaction create substantial changes in three areas: society, environment and sustainability. Customer satisfaction improves because deep learning models reveal customer preferences thus enabling businesses to deliver better products and services to their customers. Such efficiency enables businesses to minimize waste because supply better lines up with demand. Faster delivery of rewarding customer experiences leads to sustainable business relationships which benefit economic sustainability. The adoption of AI-driven solutions between businesses creates expansion opportunities for digital markets and enhances responsible consumer choices and digital sustainability within eCommerce operations structure.

5.2.1 Impact on Life

The implementation of deep learning technology for customer satisfaction prediction makes significant everyday changes particularly visible in the eCommerce business field. The use of automated sentiment analysis systems enables businesses to understand their consumers better which enables them to deliver products that meet their exact requirements to create better customer satisfaction. Online shopping satisfaction and convenience increase because customers get services and products suited to their particular preferences. Cost-effective client support operations that result from AI insights help improve online shopping quality through accelerated response times.

Increased accuracy in satisfaction prediction enables businesses to develop stronger longevity relationships with customers that promote both customer trust and loyalty. Enhanced product quality together with faster deliveries and better customer service are the outcomes that consumers achieve because of this development.

5.2.2 Impact on Society & Environment

Deep learning technologies used to predict customer satisfaction levels in eCommerce operations generate substantial societal and environmental changes. Artificial Intelligence technology enables businesses to provide customized and quick services that boost overall consumer satisfaction levels in society. Companies utilize sentiment analysis to discover customer preferences which leads them to modify their business offerings for improved effectiveness in serving customers. The combination leads companies to attain satisfied customers while building trust as well as generating long-term loyal relationships that create a prospering competitive marketplace. The application of AI leads to environmental sustainability because it reduces operational waste. Deep learning models allow businesses to execute precise demand forecasting which prevents them from producing too much stock and eliminates their excess inventory.

5.2.3 Ethical Aspects

The employment of deep learning models to predict customer satisfaction requires organizations to resolve multiple ethical concerns which guarantee proper business conduct. Data privacy stands as a main concern since client reviews reveal sensitive user information but businesses need to follow GDPR rules and other data protection requirements to protect customer privacy. The models can produce skewed results when training occurs with insufficiently diverse or representative data that fails to include all customer groups thus leading to unjust treatment of specific customer segments. A business must maintain transparency when using customer data and AI models while applying them so people can trust the system.

5.2.4 Sustainability Plan

Environmental along with social responsibility form the core elements of a sustainability strategy to merge deep learning algorithms into eCommerce systems. Businesses need to use AI technology for supply chain optimization to minimize waste as well as reduce energy consumption in transportation combined with storage operations while cutting excessive stock levels for environmental sustainability purposes. The approach reduces both carbon pollution along with resource consumption while improving efficiency.

Companies need to spend money on protecting customer information through data privacy solutions and securing customer information with ethical use practices. Businesses who practice transparent AI decision systems and disclose customer data practices to their consumers develop both customer trust and brand loyalty. The implementation of regular AI system audits helps identify biases through which sustainable fair treatment is provided for all customers.

5.3 Project Management and Financial Analysis

The project follows a structured management approach, divided into key phases: Data gathering and cleansing, model building, assessment and application prior to the acquisition. The adaptive means of agile methodology is to use many remedial changes in data collected to avoid repetition. The time frame to complete this is 6–8 months with 3 phases of data preparation, training, testing and deployment phases. The project management timeline is given in table **5.1:**

Table 5.1: The project management timeline

Work	Time
Data Collection	1 month
Papers and Articles Review	3 months
Experimental Setup	1 month
Implementation	1 month
Report Writing	2 months
Total	8 months

The estimated project budget includes costs for:

Table 5.2: Estimated Cost

SN	Components	Estimated Cost (BDT)
01.	Hardware	2500
02.	Software and Tools	8500
03.	Data Collection and Processing	12000
04.	Documentation and Report Writing	1500
05.	Miscellaneous	2000
06.	Contingency	2500
Total Estimated Cost		29000

5.4 Complex Engineering Problem

The project would be constructing such an innovative engineering solution of diagnosing and categorizing the medical student's health prediction using machine learning algorithms. This problem involves several aspects of the agricultural engineering as well as computer science and environmental protection and hence reasonably close implementation requires different skills and knowledge. The challenges are as follows: First, coping with big data; second, developing effective algorithms for disease diagnosis; third, effective incorporation of the system in farming taking into account the social and environmental shades.

5.4.1 Complex Problem Solving

Table 5.3: Mapping with complex problem solving.

EP1 Dept of Knowledge	EP2 Range Of Conflicting Requirements	EP3 Depth of Analysis	EP4 Familiarity of Issues	EP5 Extent of ApplicableCodes	EP6 Extent Of Stake-holder Involvement	EP7 Interdependence
✓	✓	✓				✓

Mapping with Knowledge Profile for EP1

This table 5.4 is designed to map the EP1 to the Knowledge Profile.

Table 5.4: Mapping with knowledge Profile.

K3 Engineering Fundamentals	K4 Specialist Knowledge	K5 Engineering Design	K6 Engineering Practice	K8 Research Literature
✓	✓		✓	✓

5.4.1.1 Justification for EP Attributes Mapping

- **EP1 - Depth of Knowledge Required:**

  The project necessitates detailed study of a variety of disciplines such as superior data analysis techniques, deep learning algorithms and evaluation techniques. Expertise is required to interpret high-level data to bring accurate predictions. Integrating knowledge originating in various

disciplines is essential in overcoming the obstacles and successful implementation.

- **EP2 - Range of Conflicting Requirements:**
    - Data privacy while learning models with the help of large quantities.
    - Adding as much varied demographical characteristic without overfitting the model.
    - Addressing issues of ethics concerning data collection and the giving of informed consent.
    - The challenge of integration of different machine learning algorithms in one system.
    - Keeping system effectiveness with an increase in data volumes throughout time.
    - Making the system scalable in different institutions with different levels of technical infrastructure.
    - Converging system design for friendliness of interfaces and accurate predictive level.

- **EP3 - Depth of Analysis:**

  It is the interdependence between data collection process, design of deep learning model, and system implementation that makes this project a success. The components are interdependent, with direct impact by data quality to model accuracy, and system performance based on the efficacy of the algorithms deployed. Also, issues of ethics like a user`s data privacy and a user`s consent are essential for building trust. Interdisciplinary work between specialists in deep learning, transfer learning and software development guarantees the system meets the complex needs of students while respecting best practices regarding both technology and ethical standards.

- **EP7 - Inter-dependence:**

  The analysis for this project requires extensive exploration of many factors concerned with a deep analysis of multiple transfer learning models to determine their appropriateness. It studies the correlation between demographic information measures, which guarantee that only the most important features are used.

5.4.1.2 Justification for Knowledge Profile Mapping (linked to EP1):

- **K3 - Engineering Fundamentals:**

  Engineering basics of this project are the application of central principals of deep learning, data analysis, and algorithm development. Such principles are the ground for the creation of an effective system that can reliably predict the severity of the depression using a wide range of demographic and real-time data.

- **K4 - Specialist Knowledge:**

  The specialist knowledge related to this project includes knowledge in deep learning algorithms, knowledge in review assessment and knowledge in preprocessing techniques in order to predicting the customer satisfaction level.

- **K6 - Engineering Practice:**

  Engineering practice in this project revolves around applying deep learning techniques practically to handle and uncover data in order to make a reliable and scale able system with correct prediction.

5.4.2 Engineering Activities

Table 5.5: Mapping with complex engineering activities.

EA1 Range of re-sources	EA2 Level of Interaction	EA3 Innovation	EA4 Consequences for society and environment	EA5 Familiarity
✓		✓	✓	

EA1: Range of Resources

The project presents innovation by using deep learning models, i.e., CNN, Bi-LSTM, and RNN for automating customer satisfaction prediction, thereby eliminating the old-fashioned manual survey approaches. It uses state of the art NLP for sentiment analysis to gain insights from the unstructured customer review data. The innovative combination of several models provides comparison performance for best accuracy. Also, the system design enables real-time prediction and scalability for eCommerce platforms. This project not only improves business intelligence but also adds towards the sustainable and adaptable framework for digital commerce in emerging countries such as Bangladesh by integrating AI with the optimization of the customer

experience.

EA3: Innovation

The project makes use of a wide array of resources important for development of a strong deep learning-based customer satisfaction prediction system. These involve data sources such as extensive reviews of customers in Bangladeshi eCommerce platforms that are essential in training and validation of the models. Technological resources include state-of-the-art deep learning systems such as TensorFlow and Keras, as well as high-performance computing devices like GPUs or cloud-based environment for effective model training.

EA4: Implication for Societies and Environment

Implementation of deep learning models for the prediction of customer satisfaction has great social and environmental advantage. For society, that would increase customer experience as well as help businesses to provide personalized services based on the live sentiment analysis, which would generate long-term customer relationships and stronger trust. It also promotes digital literacy and innovation of the eCommerce industry. Environmentally, demand improvement increases the production demand without overproduction, reduces packaging wastage, and energy consumption in logistics.

5.5 Summary

This section mentions the use of international engineering standards and the main challenges that were faced by creating a deep learning-based system for predicting customer satisfaction. It grants compliance with software and hardware rules as well as the communication protocols focusing on ethical conducts such as data privacy and fairness. Societal benefits are encouraged by better customer experience and better business-consumer relationships. Environmentally, it promotes sustainability in that it reduces waste and maximizes allocation of resources through effective demand forecasts. An effective sustainability plan is suggested, involving transparency, data security, and less carbon footprint. The work also represents a complex engineering strategy, which requires different knowledge and resources, innovativeness with such AI models as GPT3, and important aspects for society and nature.

Chapter 6

Conclusion

The conclusion contains a summary of project operations followed by project restrictions examinations and future project development proposals.

6.1 Summary

The conclusion section the research findings confirm the powerful predictive capability of deep learning models towards evaluating customer satisfaction in Bangladeshi eCommerce systems. The research indicates that three models namely Convolutional Neural Networks (CNN), Bidirectional Long Short-Term Memory (Bi-LSTM), and Recurrent Neural Networks (RNN) successfully classify customer feedback data into Highly Satisfied, Satisfied, and Non-Satisfied categories with accuracy. Among all the models tested CNN demonstrated the best performance level which proves its potential for sentiment analysis applications in eCommerce sector. These models demonstrate advantage as they improve customer experience and business optimization while developing customer loyalty according to the chapter. The research authorizes additional studies because they could enhance model effectiveness and help establish these applications across new market sectors for broad-scale implementation.

6.2 Limitation

Several constraints should be taken into account regarding the findings from deep learning model-based satisfaction prediction revealed in this study. The results of this research study could show limited applicability because the dataset fails to provide thorough representation of all customer segments from Bangladeshi eCommerce platforms. Customer review data made up most of the research sample while overlooking comprehensive customer experiences such as offline contact and telephone support interactions. Excessive parameter optimization and increased dataset size should help the CNN, Bi-LSTM, and RNN models reach their optimum performance potential. This study omits the possible review bias effects stemming from excessive representation of extremely pleased or displeased customers. This type of modeling faces production-related difficulties in real-time implementation because of resource acquisition limitations at

scale which requires platform-specific optimization for large-scale eCommerce consumers.

6.3 Future Work

Future efforts should direct their attention toward enlarging the data collection with reviews from multiple eCommerce platforms in Bangladesh to better reflect different market segments. The analysis of multiple types of customer data such as service communications combined with buying records and social media opinion would deliver an improved collective view of customer satisfaction rating. Improved accuracy together with robustness from deep learning models would result from additional model adjustments that involve hybrid models or transfer learning applications. Real-time systems need to deploy these models combined with efficient resource management to scale their use on large eCommerce platforms. Future investigations need to examine ways these models should interact with recommendation systems to deliver personalized product recommendations which will boost customer experience and engagement.

References

[1] Ullah, A. (2025). The Effect of Artificial Intelligence (AI) on Customer Satisfaction: A Review of Bangladesh Perspective. International Journal of Science, Technology and Society, 13(2), 54-60. https://doi.org/10.11648/j.ijsts.20251302.13.

[2] Le, H.-S., Do, T.-V. H., Nguyen, M. H., Tran, H.-A., Pham, T.-T. T., Nguyen, N. T., & Nguyen, V.-H. (2024). Predictive model for customer satisfaction analytics in E-commerce sector using machine learning and deep learning. ScienceDirect. https://doi.org/10.1016/j.smr.2024.100084

[3] Ma, X., Li, Y., & Asif, M. (2025). E-Commerce Review Sentiment Analysis and Purchase Intention Prediction Based on Deep Learning Technology. ResearchGate. https://doi.org/10.13140/RG.2.2.30611.53289

[4] Nguyen, M. H., Le, H.-S., Do, T.-V. H., Tran, H.-A., Pham, T.-T. T., & Nguyen, N. T. (2024). Predictive model for customer satisfaction analytics in E-commerce sector using machine learning and deep learning. ScienceDirect. https://doi.org/10.1016/j.smr.2024.100084

[5] Wu, Q., Xia, C., & Tian, S. (2025). AI-Driven Sentiment Analytics: Unlocking Business Value in the E-Commerce Landscape. arXiv. https://doi.org/10.48550/arXiv.2504.08738

[6] Liu, Y., Lu, J., Yang, J., & Mao, F. (2020). Sentiment analysis for e-commerce product reviews by deep learning model of Bert-BiGRU-Softmax. Mathematical Biosciences and Engineering, 17(6), 7819-7837. https://doi.org/10.3934/mbe.2020398

[7] Vijayaragavan, P., Suresh, C., Maheshwari, A., Vijayalakshmi, K., Narayanamoorthi, R., & Gono, M. (2024). Sustainable sentiment analysis on E-commerce platforms using a weighted parallel hybrid deep learning approach for smart cities applications. Scientific Reports, 14, 26508. https://doi.org/10.1038/s41598-024-78318-1

[8] Pontiki, M., Galanis, D., & Papageorgiou, H. (2022). Aspect-based sentiment classification of user reviews to understand customer satisfaction in e-commerce platforms. SpringerLink. https://doi.org/10.1007/s10660-025-09948-4

[9] Ullah, A. (2025). The Effect of Artificial Intelligence (AI) on Customer Satisfaction: A Review of Bangladesh Perspective. International Journal of Science, Technology and Society, 13(2), 54-60. https://doi.org/10.11648/j.ijsts.20251302.13

[10] Le, H.-S., Do, T.-V. H., Nguyen, M. H., Tran, H.-A., Pham, T.-T. T., Nguyen, N. T., & Nguyen, V.-H. (2024). Predictive model for customer satisfaction analytics in E-commerce sector using machine learning and deep learning. ScienceDirect. https://doi.org/10.1016/j.smr.2024.100084

[11] Ma, X., Li, Y., & Asif, M. (2025). E-Commerce Review Sentiment Analysis and

Purchase Intention Prediction Based on Deep Learning Technology. ResearchGate. https://doi.org/10.13140/RG.2.2.30611.53289

[12] Nguyen, M. H., Le, H.-S., Do, T.-V. H., Tran, H.-A., Pham, T.-T. T., & Nguyen, N. T. (2024). Predictive model for customer satisfaction analytics in E-commerce sector using machine learning and deep learning. ScienceDirect. https://doi.org/10.1016/j.smr.2024.100084

[13] Wu, Q., Xia, C., & Tian, S. (2025). AI-Driven Sentiment Analytics: Unlocking Business Value in the E-Commerce Landscape. arXiv. https://doi.org/10.48550/arXiv.2504.08738

[14] Liu, Y., Lu, J., Yang, J., & Mao, F. (2020). Sentiment analysis for e-commerce product reviews by deep learning model of Bert-BiGRU-Softmax. Mathematical Biosciences and Engineering, 17(6), 7819-7837. https://doi.org/10.3934/mbe.2020398

[15] Vijayaragavan, P., Suresh, C., Maheshwari, A., Vijayalakshmi, K., Narayanamoorthi, R., & Gono, M. (2024). Sustainable sentiment analysis on E-commerce platforms using a weighted parallel hybrid deep learning approach for smart cities applications. Scientific Reports, 14, 26508. https://doi.org/10.1038/s41598-024-78318-1

[16] Pontiki, M., Galanis, D., & Papageorgiou, H. (2022). Aspect-based sentiment classification of user reviews to understand customer satisfaction in e-commerce platforms. SpringerLink. https://doi.org/10.1007/s10660-025-09948-4

[17] Ullah, A. (2025). The Effect of Artificial Intelligence (AI) on Customer Satisfaction: A Review of Bangladesh Perspective. International Journal of Science, Technology and Society, 13(2), 54-60. https://doi.org/10.11648/j.ijsts.20251302.13

[18] Le, H.-S., Do, T.-V. H., Nguyen, M. H., Tran, H.-A., Pham, T.-T. T., Nguyen, N. T., & Nguyen, V.-H. (2024). Predictive model for customer satisfaction analytics in E-commerce sector using machine learning and deep learning. *ScienceDirect*. https://doi.org/10.1016/j.smr.2024.100084

[19] Ma, X., Li, Y., & Asif, M. (2025). E-Commerce Review Sentiment Analysis and Purchase Intention Prediction Based on Deep Learning Technology. ResearchGate. https://doi.org/10.13140/RG.2.2.30611.53289

[20] Nguyen, M. H., Le, H.-S., Do, T.-V. H., Tran, H.-A., Pham, T.-T. T., & Nguyen, N. T. (2024). Predictive model for customer satisfaction analytics in E-commerce sector using machine learning and deep learning. ScienceDirect. https://doi.org/10.1016/j.smr.2024.100084

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