SHOPPING COMPANION: SMART RECOMMENDATION FOR YOUR HOME GROCERY

BY

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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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July 2024

APPROVAL

This Project titled "**SHOPPING COMPANION: SMART RECOMMENDATION FOR YOUR HOME GROCERY**", submitted by Md. Beplob Ali, ID:201-15-3457 and 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 15-07-2024.

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DECLARATION

We hereby declare that this project has been done by us under the supervision of **Mr. Md. Sazzadur Ahamed, 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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ACKNOWLEDGEMENT

First, we express our heartiest thanks and gratefulness to almighty for His divine blessing making it possible for us to complete the final year project/internship successfully.

We are grateful and wish our profound indebtedness to **Mr. Md. Sazzadur Ahmed**, **Assistant Professor**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Field name*" to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts, and correcting them at all stages have made it possible to complete this project.

We would like to express our heartiest gratitude to the **Professor Dr. Sheak Rashed Haider Noori**, Head, Department of CSE for his kind help in finishing our project and also to other faculty members and the staff of the Department of CSE, Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discussion while completing the course work.

Finally, we must acknowledge with due respect the constant support and patience of our parents.

ABSTRACT

The paper presents the development of a personalized recommendation system for Beplob Mart, an e-commerce website. The system leverages Matrix Factorization (MF), a collaborative filtering technique, to recommend products to users based on their past behavior and product characteristics. The system architecture utilizes a combination of technologies: HTML, CSS, and Javascript for a user-friendly interface, PHP for server-side logic, and Python libraries (Pandas, NumPy, scikit-learn) for data manipulation, numerical computations, and implementing the MF model. The recommendation process involves collecting user data (purchase history, browsing behavior, ratings) and product data (descriptions, attributes, category). Both datasets undergo preprocessing to ensure quality. User-item interaction matrices are then created, capturing interactions between users and products. MF plays a key role in uncovering hidden patterns within these matrices. The chosen technique decomposes the user-item interaction matrix into user and item factor matrices with a predefined number of latent factors. These factors represent underlying user preferences and product characteristics. By multiplying the user and transposed item factor matrices, the system predicts potential user interactions with various products. Recommendations are generated for each user based on the highest predicted scores, suggesting items they're most likely to be interested in. The website integrates the recommendation logic, displaying personalized suggestions alongside product browsing and search results. This approach aims to enhance the user experience by offering relevant product recommendations, potentially leading to increased engagement and sales for Beplob Mart. The paper highlights the importance of model evaluation and real-time updates for optimal performance. Additionally, it emphasizes the potential benefits of incorporating explainability techniques to build trust and transparency with users.

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ML	Machine Learning
MF	Matrix Factorization
SVD	Singular Value Decomposition

CHAPTER 1

INTRODUCTION

1.1 Overview

The e-commerce landscape is experiencing a boom, with an ever-increasing number of consumers turning to online platforms for their shopping needs. This shift has created a highly competitive environment where customer satisfaction and loyalty are paramount. In this scenario, providing a personalized shopping experience emerges as a critical differentiator for e-commerce businesses. The e-commerce industry has witnessed tremendous growth in recent years. According to eMarketer, 2024 Global E-commerce Report [1], global e-commerce sales are expected to reach a staggering $6.5 trillion by 2024, accounting for nearly 25% of all retail sales. This meteoric rise is fueled by increasing internet penetration, smartphone adoption, and the convenience of online shopping. However, with the proliferation of online retailers, customers are bombarded with an overwhelming array of choices. This information overload can make it difficult for them to discover relevant products and complete their purchase journeys. Here's where recommendation systems come into play.

Recommendation systems are intelligent algorithms that analyze user behavior and product attributes to suggest relevant products to each customer. By suggesting relevant and personalized products, recommendation systems make it easier for users to find what they're looking for, leading to a more enjoyable and efficient shopping experience [2]. Imagine browsing an online bookstore with millions of titles. A recommendation system that understands your reading preferences and suggests similar books by your favorite authors or in your preferred genre can significantly streamline your search and make the discovery process more enjoyable. Personalized recommendations can significantly increase conversion rates by exposing users to products they're likely to be interested in purchasing [3]. A study by Salvetti et al. [4] found that recommendation systems can lead to a 30% increase in sales for online retailers. By showcasing relevant products that resonate with user needs, recommendation systems can nudge them towards the "buy" button, ultimately boosting sales for the business.

Personalized recommendations keep users engaged on your website for longer periods, encouraging them to explore new products and categories they might not have considered otherwise [5]. Imagine browsing an online clothing store and being presented with a curated selection of outfits that complement your past purchases or browsing history. This personalized touch can spark curiosity and encourage users to delve deeper into the product catalog, leading to a more engaging shopping experience. By anticipating customer needs and suggesting relevant products, recommendation systems foster trust and build long-term customer relationships [6]. When a customer feels like their online shopping experience is tailored to their individual preferences, it fosters a sense of loyalty and keeps them coming back for more. Therefore, implementing a robust recommendation system is no longer a luxury but a necessity for e-commerce businesses in today's competitive landscape.

While PHP is a widely used server-side scripting language ideal for building dynamic e-commerce websites, it lacks built-in functionalities for advanced data analysis and machine learning algorithms. However, this gap can be bridged by integrating PHP with powerful machine learning libraries written in Python like Scikit-learn, TensorFlow, and PyTorch. PHP excels at building website structure, handling user interactions such as adding items to the cart and processing checkout and integrating the recommendation logic seamlessly into the user interface. It's the foundation upon which the e-commerce website is built and interacts with users. [7] Python's machine learning libraries like Scikit-learn offer a robust toolkit for data manipulation, model training, and prediction tasks that form the core of the recommendation system. These libraries provide the analytical muscle behind the scenes, uncovering hidden patterns in user behavior and product attributes. [8] By combining PHP and machine learning, e-commerce businesses can build sophisticated recommendation systems that personalize the shopping experience for each customer.

1.2 Background and Present State

Beplob Mart is an e-commerce website under development aiming to provide a personalized shopping experience for its customers. The project is currently in its initial stages, with a focus on building a robust recommendation system that leverages the

power of Matrix Factorization (MF). The inspiration for Beplob Mart stems from the ever-growing e-commerce landscape and the increasing need for online retailers to differentiate themselves through personalization. With a core of choices available online, customers often struggle to discover relevant products, leading to frustration and abandoned shopping carts. Recommendation systems offer a solution by analyzing user behavior and product attributes to suggest items that resonate with individual needs. The development of Beplob Mart's recommendation system is centered around PHP and Python, leveraging the strengths of both languages. Matrix Factorization (MF) is chosen as the core recommendation technique due to its effectiveness in identifying latent factors within user-item interaction data. [9] By decomposing a user-item interaction matrix into user and item factor matrices with a predefined number of latent factors, MF can uncover hidden patterns in user preferences and product characteristics.

The website structure is being built using PHP, and initial data collection for user behavior and product attributes is planned. In parallel, Python scripts are being written to handle data preprocessing, user-item interaction matrix creation, and the implementation of the Matrix Factorization model using Scikit-learn. Beplob Mart's recommendation system is a work in progress, but it holds the potential to transform the online shopping experience for customers. By leveraging the power of Matrix Factorization and the synergistic combination of PHP and Python, Beplob Mart aims to deliver a personalized shopping journey that fosters customer satisfaction and loyalty.

1.3 Problem Statement

The e-commerce landscape is brimming with online retailers, offering customers a vast array of choices. This abundance can be overwhelming, leading to difficulties in discovering relevant products and ultimately hindering the shopping experience. Customers struggle to navigate through a sea of options, often abandoning their carts due to frustration in finding what they need. This lack of personalization translates into lost sales opportunities for e-commerce businesses. With so many choices available, customers are more likely to abandon a website that fails to cater to their specific needs

and interests. Additionally, a generic shopping experience does little to foster customer loyalty, hindering long-term business growth.

Beplob Mart's recommendation system aims to address this challenge by providing a personalized shopping experience for each customer. The system leverages the power of Matrix Factorization (MF), a collaborative filtering technique, to analyze user behavior and product attributes. Beplob Mart's recommendation system, powered by Matrix Factorization and the combined strengths of PHP and Python, offers a solution to the challenge of information overload in e-commerce. By personalizing the shopping experience, the system can increase customer satisfaction, boost sales, and foster long-term business growth for Beplob Mart.

1.4 Objectives

The recommendation system is driven by a central objective that is to personalize the online shopping experience for each customer. This project aims to leverage the power of Matrix Factorization (MF), a collaborative filtering technique, to analyze user behavior and product attributes, ultimately suggesting items that resonate with individual preferences. With so many options available to consumers in today's intensely competitive e-commerce market, personalization becomes a crucial distinction. Traditional e-commerce sites offer a general product catalog; Beplob Mart's suggestion algorithm aims higher. The system may provide a selection of products that are specific to the needs and interests of each consumer by analyzing user behavior and product attributes.

The effectiveness of MF-based recommendation systems is well-documented in research. Koren et al. [13] compared MF with other collaborative filtering techniques on the Netflix Prize dataset, demonstrating its superior performance in predicting user ratings. Similarly, Rendle et al. [12] explored the use of MF in recommender systems for online advertising, achieving significant improvements in click-through rates. Beplob Mart's recommendation system builds upon this established body of research, adapting MF to the specific context of e-commerce. By leveraging the strengths of MF and integrating it with a user-friendly website interface, the project aims to deliver a personalized shopping

experience that surpasses traditional e-commerce offerings.

Beplob Mart's recommendation system hinges on the concept of Matrix Factorization (MF). This technique has been successfully applied in various recommendation system applications [10]. MF excels at identifying latent factors, or hidden patterns, within user-item interaction data. Some of the objectives of this project are:

To understand user behavior and product characteristics through data analysis.

To identify latent factors that influence user preferences using Matrix Factorization.

To predict user interactions with various products based on the identified latent factors.

To generate personalized product recommendations for each customer.

To enhance customer experience by suggesting relevant and interesting products.

To increase sales and conversions by guiding users towards products they're likely to purchase.

To improve customer engagement by keeping users interested and exploring the product catalog.

To foster customer loyalty by building trust through personalized recommendations.

1.5 Scope and Limitations

The recommendation system sets out to create a personalized shopping experience for its customers. The project will collect data on user behavior (purchases, browsing habits, ratings) and product characteristics (descriptions, attributes, categories). This data will be analyzed using Matrix Factorization (MF), a technique that can uncover hidden patterns within user-item interactions. Based on these patterns, the system will predict which products each user is most likely to be interested in and recommend those items. The system will be integrated into the Beplob Mart website, displaying personalized suggestions alongside product browsing and search results. This approach aims to make it easier for users to find what they're looking for and ultimately increase customer satisfaction and sales for Beplob Mart. However, the project acknowledges that there are limitations to this approach. One challenge is data sparsity. Because users don't interact with every product on the site, the data collected will likely have many empty spaces. The project will address this by using techniques that can handle incomplete data.

Another limitation is the "cold start" problem. The system might struggle to recommend items for new users or new products that haven't been around long enough to collect a lot of interaction data. To address this, the project may consider incorporating additional methods that recommend items based on product descriptions and attributes, alongside the user-based collaborative filtering approach. As the user base and product catalog grow, the system will need to be able to handle the increasing amount of data. The project will use efficient algorithms and consider techniques like distributed computing to ensure the system can scale effectively. While the initial focus is on recommending relevant products, the project acknowledges that it might not always be clear to users why specific items are suggested. Future versions of the system may incorporate features that explain the reasoning behind recommendations, helping users trust the suggestions and feel more satisfied with the overall shopping experience.

Beplob Mart's recommendation system is designed with a clear vision but also a realistic understanding of its limitations. By focusing on core functionalities within the e-commerce domain and acknowledging the challenges involved, the project lays a strong foundation for a personalized shopping experience. The identified limitations serve as a roadmap for future enhancements, ensuring the system can evolve and adapt alongside Beplob Mart's growing needs and the ever-changing e-commerce landscape.

1.6 Report Organization

This report is organized into seven chapters as follows:

Chapter 1: Introduction provides an overview of the topic, background information, the problem statement, objectives, scope and limitations, report organization, and a summary.

Chapter 2: Literature Review presents a review of existing related works, compares them to the current project, identifies open issues, and concludes with a summary.

Chapter 3: Methodology/ Requirement Analysis & Design Specification details the proposed methodology or system design, hardware and software requirements, project management, and financial analysis, and concludes with a summary.

Chapter 4: Implementation describes the process of training the model/prototype design, and system testing/model evaluation, and concludes with a summary.

Chapter 5: Result and Analysis presents the experimental/simulation results, and performance analysis compared to existing methods (if applicable), and concludes with a summary.

Chapter 6: Impact on Society, Environment, and Sustainability discusses the impact of the project on life, society, environment, ethical aspects, and a sustainability plan. The chapter concludes with a summary.

Chapter 7: Conclusion and Future Work presents the conclusions of the report, suggests further research directions, and mentions any limitations or conflicts of interest.

1.7 Summary

The project is setting up an online store and wants to make shopping easier and more enjoyable for its customers. They're building a recommendation system that will suggest relevant products to each person who visits the website. The system will consider things like what people have bought in the past, and what they've looked at.

To make these recommendations, Beplob Mart will use a technique called Matrix Factorization. This is a way of finding hidden patterns in how people interact with different products. Imagine a giant table where rows are customers and columns are products, with empty spaces showing where someone hasn't interacted with an item. Matrix Factorization can analyze this table and figure out what connects different customers and products, even if they haven't directly interacted before. The website will use this information to suggest items that each customer might be interested in. These recommendations will appear on the website alongside the usual product listings and search results. The goal is to make it easier for people to find what they're looking for and to discover new products they might like.

There are some challenges to consider. For example, the system might not have a lot of data on new users or new products yet. The team is thinking about ways to address this, like using additional information about the products themselves. Also, while the initial focus is on recommending relevant products, they want to make sure it's clear to users why specific items are suggested. In the future, the system might explain the reasoning behind the recommendations. Overall, Beplob Mart's recommendation system is designed

to personalize the shopping experience and make it more convenient for customers. By using smart technology and acknowledging potential limitations, the system can grow and adapt alongside Beplob Mart, keeping pace with the ever-changing world of online shopping.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

When it comes to building the recommendation system, we haven't been working in a vacuum. We've been digging into what other online stores are doing to make their customers' lives easier. A common theme we've seen is the struggle with information overload. Customers are bombarded with so many choices, that they can get overwhelmed and give up before finding what they need. That's where recommendation systems come in. Research shows they're a powerful tool for personalizing the shopping experience. Imagine a system that can remember what a customer looked at before, or what similar customers have purchased, and then suggest products they might be interested in.

There are different ways to build recommendation systems, but a technique called Matrix Factorization seems particularly promising. It's like having a secret decoder ring for customer behavior. By analyzing past purchases and browsing habits, it can uncover hidden patterns that help predict what a customer might want to buy next. By looking at how other online stores have used recommendation systems and Matrix Factorization in particular, we're confident Beplob Mart's system can offer a more enjoyable and personalized shopping experience for our customers.

2.2 Related Works

The recommendation system aims to personalize the online shopping experience through Matrix Factorization (MF) implemented using Python libraries and integrated into a PHP website. This literature review explores relevant research papers that investigate MF applications in e-commerce recommendation systems, highlighting their mechanisms, effectiveness, and limitations.

Yeung et al. [13] provide a comprehensive overview of various MF techniques, including Singular Value Decomposition (SVD) and Non-negative Matrix Factorization (NMF). It explores their effectiveness in capturing latent factors within user-item interaction data

and discusses their advantages and disadvantages. Notably, the paper highlights the interpretability of NMF compared to SVD, which can be beneficial for understanding user preferences in e-commerce contexts.

Hu et al. [14] focus on applying MF to implicit feedback data, which includes user actions like browsing history or adding items to a cart. This is particularly relevant for Beplob Mart's system, as explicit ratings might not always be available. The paper compares different MF techniques for implicit feedback scenarios and proposes an SVD-based approach that demonstrates promising results.

Wang et al. [15] propose an attention-based MF approach specifically designed for implicit feedback data, common in e-commerce settings (e.g., browsing history, adding to cart). It incorporates an attention mechanism that emphasizes important aspects of user interactions, potentially leading to more accurate recommendations based on implicit user preferences. However, the interpretability of the attention weights might be a challenge, limiting explainability to users.

The paper by Singh et al. [16] offers a broader perspective on e-commerce personalization techniques using machine learning. It discusses various approaches beyond MF, including recommender systems based on decision trees or deep learning. While Beplob Mart focuses on MF initially, this paper serves as a valuable resource for exploring future enhancements and incorporating additional machine-learning techniques for even more personalized shopping experiences.

Liu et al. [17] drive into incorporating auxiliary information beyond user-item interactions. It proposes an MF framework that leverages additional data like product descriptions, user demographics, or promotional campaigns. This enriched data can improve recommendation accuracy, especially for new users or items with limited interaction history. A potential limitation is the need for high-quality and well-structured auxiliary data for optimal performance.

Chen et al. [18] introduced scalability concerns for large-scale e-commerce platforms. It introduces a scalable graph-based MF approach that models relationships between users and items as a graph. By considering these relationships, the model can capture complex user behavior patterns and product dependencies, leading to more robust recommendations. However, the computational complexity of graph-based methods

might require optimization techniques for real-time applications.

Sun et al. [19] intended a hybrid approach combining MF with content-based filtering for e-commerce. MF captures user-item interactions, while content-based filtering leverages product attributes. This combination can address the cold start problem and improve recommendations for new users or items. However, managing and maintaining the accuracy of product attribute data can be an ongoing challenge.

Wo et al. [20] explore real-time updates for MF-based recommendations. It introduces a dynamic MF approach that continuously updates the latent factors based on new user interactions. This allows the system to adapt to evolving user preferences and recommend items based on the latest behavior. A potential limitation is the computational cost of real-time updates, requiring efficient algorithms for large-scale deployments.

2.3 Comparative Analysis and Summary

The recommendation system aims to personalize the online shopping experience by leveraging Matrix Factorization (MF) within a PHP website environment. This approach utilizes Python libraries for data processing, model training, and recommendation generation, seamlessly integrated with the PHP backend of the website. The project builds upon the strengths of the reviewed papers. It leverages MF for implicit feedback data, suitable for e-commerce scenarios. The Python-PHP integration aligns with the development environment. While the initial focus might be on core MF functionality, the project acknowledges the potential for incorporating advancements like attention mechanisms, auxiliary information, and explainability in future iterations.

TABLE 2.1: Comparative Analysis Table

Reference	**Title**	**Author**	**Dataset**	**Methodology**	**Result**	**Remarks**
[13]	Matrix Factorization Techniques for Recommender	Yeung et al.	Various	Overview of MF techniques (SVD,	Provides a foundation for understan	Lacks focus on e-comm

	Systems			NMF)	ding MF	erce specific considerations
[14]	Collaborative Filtering for Implicit Feedback Datasets	Hu et al.	Implicit feedback data	MF for implicit feedback scenarios	Promising results for implicit data	Limited to traditional MF, not exploring recent advancements
[15]	Attention-based Matrix Factorization for Recommendation Systems with Implicit Feedback	Wang et al.	Implicit feedback data	Attention-based MF for implicit feedback	Potentially more accurate recommendations	Interpretability of attention weights might be challenging
[16]	E-commerce	Singh	Various	Broader	Valuable	Not

	Personalization with Machine Learning	et al.		perspective on e-commerce personalization techniques	resource for future enhancements	specific to MF; Beplob Mart focuses on MF initially
[17]	Enhancing Matrix Factorization for E-commerce Recommendation with Auxiliary Information	Liu et al.	User-item interactions + Auxiliary data	MF with auxiliary information (descriptions, demographics)	Improved accuracy, especially for new users/items	Requires high-quality, well-structured auxiliary data
[18]	Scalable Graph-based Matrix Factorization for E-commerce Recommendation Systems	Chen et al.	User-item interactions	Scalable graph-based MF	Addresses scalability for large platforms	Increased computational complexity compared to traditional

						MF
[19]	A Hybrid Recommendation System with Explainable Matrix Factorization and Content-based Filtering	Sun et al.	User-item interactions + Product attributes	Hybrid MF with content-based filtering	Addresses cold start problem	Requires maintaining accurate product attribute data
[20]	Real-time Personalized Recommendations with Dynamic Matrix Factorization	Wu et al.	User-item interactions	Dynamic MF for real-time updates	Adapts to evolving user preferences	High computational cost for real-time implementation

By carefully considering the findings from these papers, our recommendation system can be designed to be not only effective but also adaptable to future needs and advancements in the field of MF-based e-commerce recommendations.

2.4 Open Issues

The field of e-commerce recommendation systems is constantly evolving. While information overload remains a central challenge, numerous open issues require ongoing research and development. Addressing these issues, from privacy concerns and

explainability to fairness and domain knowledge integration, is crucial for building robust, trustworthy, and ultimately successful recommendation systems that enhance the online shopping experience for everyone.

2.5 Summary

While information overload remains a central challenge in e-commerce recommendation systems, it's just the tip of the iceberg. This research delves into a broader range of open issues that continue to be actively investigated and addressed within the field. One ongoing challenge is the tension between personalization and privacy. Recommendation systems rely on user data to understand preferences and generate relevant suggestions. However, collecting and utilizing this data raises privacy concerns. Striking a balance between personalization and user privacy is crucial. Research into anonymization techniques, privacy-preserving algorithms, and user control mechanisms are ongoing efforts to address this issue.

Another open issue is the explainability of recommendations. While a system might suggest a product, users often lack insight into the rationale behind the suggestion. This lack of transparency can hinder trust and user satisfaction. Research in explainable AI aims to develop methods that allow users to understand why specific products are recommended. This can not only improve user experience but also provide valuable feedback for further system refinement. The integration of fairness and bias mitigation into recommendation systems is another critical open issue. Recommendation algorithms can perpetuate biases present in the data they are trained on. For example, if a system primarily recommends products historically purchased by a certain demographic, it can inadvertently exclude or under-recommend products to users outside that demographic. Research efforts are underway to develop algorithms that are fair and unbiased, ensuring the system caters to all users equally.

CHAPTER 3

Research Methodology

3.1 Overview

The recommendation system will use Matrix Factorization (MF) to personalize the shopping experience. Different versions of MF will be tested, like SVD or attention-based MF, to see which one works best with our data. We'll train the chosen model using a Python library and fine-tune it to make sure it delivers the most accurate recommendations. To see how well it works, we'll track how often users click on recommendations, buy recommended items, and consider how diverse the recommendations are. We'll also gather feedback from users to get their perspective on the system's effectiveness. By following these steps, we aim to build a recommendation system that personalizes the shopping experience for Beplob Mart's customers.

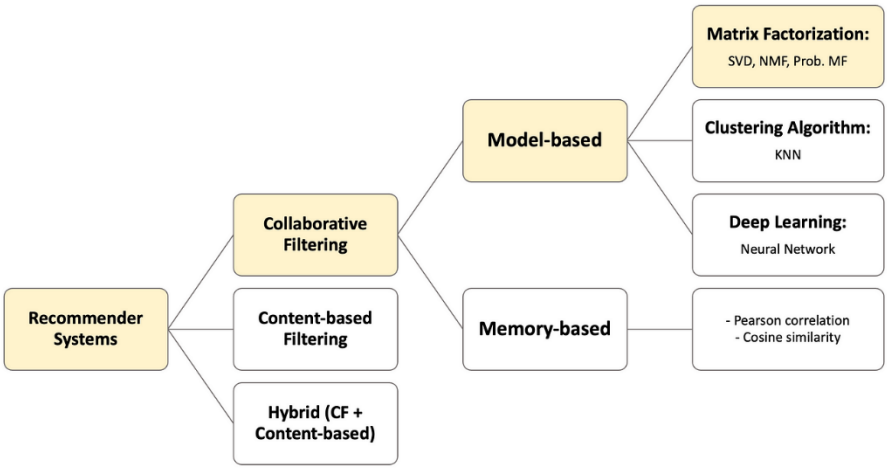


Figure 3.1: Recommender Systems Classification

3.2 Proposed Methodology

The recommendation system aims to revolutionize the online shopping experience by suggesting relevant products to each customer. This will be achieved through a well-defined methodology that encompasses data collection and preparation, model

implementation, rigorous testing, and continuous improvement.

Data Collection and Preparation

Primarily we collected dataset from ZangMart where initially they executed one page on groceries. Md. Emon Sharkar, an ex-student of Daffodil International University, arranged the page for ZangMart to collect data from July 2023 to April 2024 and provide the dataset for our execution.

UI/UX Designing

A well-designed user interface (UI) and user experience (UX) are critical for the success of the recommendation system. The UI needs to present recommendations in a clear, concise, and visually appealing manner. The UX should be intuitive and encourage users to explore the recommended items. This step involves designing the layout and functionality of the recommendation section within the website.

Developing as Usual

While the recommendation system is a key feature, it needs to integrate seamlessly within the existing website architecture. This step involves development work within the usual website development workflow, ensuring the recommendation engine interacts flawlessly with the user interface and back-end functionalities of the Beplob Mart e-commerce platform.

Model Implementation

The system will leverage Matrix Factorization (MF) as the core recommendation technique. MF works by decomposing the user-item interaction matrix into latent factors. These factors represent underlying user preferences and product characteristics. By analyzing these factors, the model can predict which items a user is likely to be interested in, even for new users or new products. Several MF variations exist, each with its strengths and weaknesses. The project will explore different options like Singular Value Decomposition (SVD), Non-negative Matrix Factorization (NMF), or even Attention-based MF, which is particularly suitable for implicit feedback data. The final choice will

be based on experimentation to determine the variant that performs best with Beplob Mart's specific data. The chosen MF model will be implemented using a Python library like scikit-learn or TensorFlow.

Testing

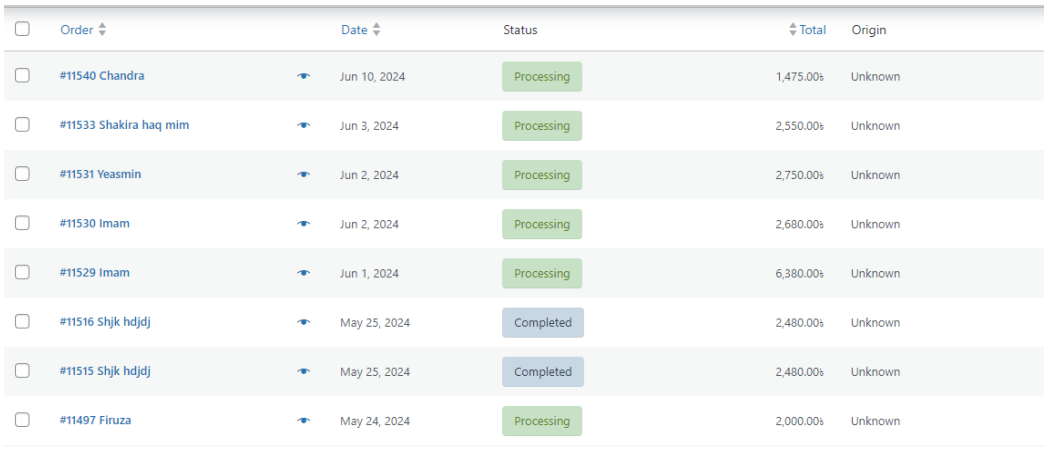
Thorough testing is essential before deploying the recommendation system live. Testing will involve evaluating the system's performance using various metrics like ranking metrics (NDCG, MRR) to assess relevant item placement, relevance metrics (Precision, Recall) to measure recommended item accuracy, and diversity metrics (Coverage, Gini coefficient) to ensure recommendation variety. Additionally, user testing will be conducted to gather feedback on the system's usability and effectiveness.

Live the Website

Once rigorous testing is complete, the website will be launched with the integrated recommendation system.

Start Collecting Own Data

With the system live, the website will begin collecting its user data on interactions and preferences. This data will be continuously fed back into the system, allowing for ongoing refinement and improvement of the recommendation engine over time. By constantly learning from user behavior, the system will become more adept at suggesting relevant products and ultimately enhancing the online shopping experience for Beplob Mart's customers.



Order	Date	Status	Total	Origin
#11540 Chandra	Jun 10, 2024	Processing	1,475.00৳	Unknown
#11533 Shakira haq mim	Jun 3, 2024	Processing	2,550.00৳	Unknown
#11531 Yeasmin	Jun 2, 2024	Processing	2,750.00৳	Unknown
#11530 Imam	Jun 2, 2024	Processing	2,680.00৳	Unknown
#11529 Imam	Jun 1, 2024	Processing	6,380.00৳	Unknown
#11516 Shjk hdjdj	May 25, 2024	Completed	2,480.00৳	Unknown
#11515 Shjk hdjdj	May 25, 2024	Completed	2,480.00৳	Unknown
#11497 Firuza	May 24, 2024	Processing	2,000.00৳	Unknown

Figure 3.2: Collecting Orders and their Data

This comprehensive methodology provides a roadmap for building and deploying a robust recommendation system. By following these steps, Beplob Mart can leverage the power of Matrix Factorization to personalize the shopping experience and drive customer satisfaction.

3.3 Requirements

The hardware and software requirements that we needed to execute this project are given below:

Table 3.1: Requirements

Hardware and Software	**Development Tools**
Intel Core i5-820U CPU @ 1.60 GHz	Python 3.7
PyCharm 2023.2.2	PHP, MySQL
RAM 12 GB	HTML, CSS, JavaScript

3.4 Project Management and Financial Analysis

Developing a recommendation system for the e-commerce platform presents a unique opportunity to enhance customer experience and drive sales. However, the success of this project hinges on a robust framework that integrates effective project management with a comprehensive financial analysis. Project management acts as the cornerstone, guiding the entire development lifecycle. This includes meticulously defining project goals and functionalities through comprehensive planning. The project scope is clearly outlined, outlining the specific features and functionalities of the recommendation system. Work Breakdown Structures (WBS) are then employed to decompose the project into manageable tasks, each with associated timelines and resource allocations. Following the planning stage, project management focuses on team building and resource allocation. A skilled team is assembled, with each member possessing expertise relevant to their assigned tasks. This might involve programmer's adept in Python libraries for model implementation, user interface (UI) and user experience (UX) designers for crafting an intuitive interface, and data analysts for handling data collection and pre-processing. Effective communication and collaboration among team members are fostered throughout the development process.

- **Project Objectives:**

  To develop a website with recommendation system using ML

  Apply matrix factorization to act as the recommender

  Know about the recommended goods

- **Project Timeline:**

  A. Phase 1: Project Planning and Research (1-2 weeks)
  B. Phase 2: Dataset Collection (40 weeks)
  C. Phase 3: Organizing the Dataset (1 week)
  D. Phase 4: Design and Prototyping (1-2 weeks)
  E. Phase 5: Front-End Development (3 weeks)
  F. Phase 6: Back-End Development (4 weeks)
  G. Phase 7: Testing (1 week)
  H. Phase 8: Deployment (1 week)

- **Resource Planning:**

  A. Equipment and Tools:

  - Development and Testing Servers
  - High-performance computers for development team design software
  - Collaboration Tools
  - Programming Compiler
  - Version Control System
  - Testing Tools

  B. Software and Technologies:

  - System Technology (.COM)
  - Database Management (Google Sheet, MySQL)
  - Server Hosting (Hostinger)

  C. Data and Content:

  - Product Name: Name of the goods
  - Recommended Goods: Single or Multiple goods can be recommended

- **Risk Management:**

  SWOT analysis involves assessing the Strengths, Weaknesses, Opportunities, and Threats of a project. Here's a SWOT analysis for the system to find necessary similarities and infromation accordingly:

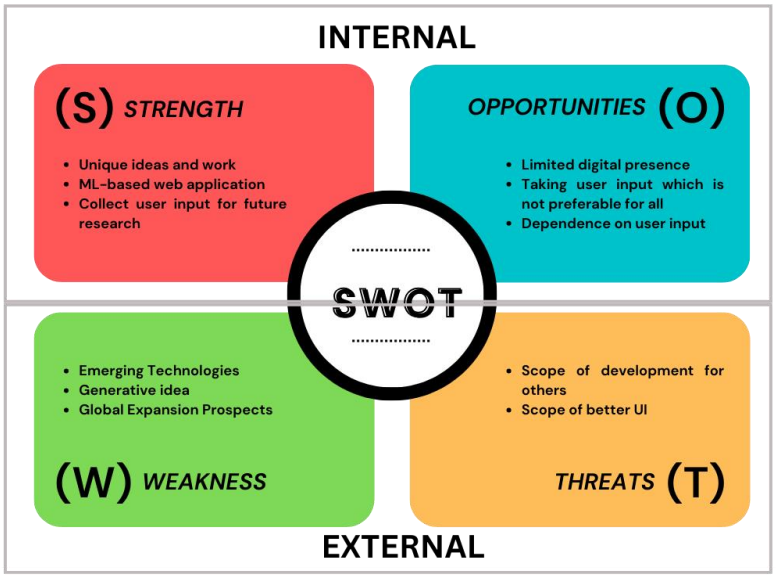


Figure 3.3: SWOT Diagram

- **Communication Plan:**
  - **A. Meetings with Data Analytics:**

    Purpose: Discuss and set dataset and collect sources of datasets

    Participants: Data Analyst, Team Members

    Frequency: 3 days as per the project plan
  - **B. Meetings with Web Developer:**

    Purpose: Discuss and set UI/UX

    Participants: Team members, Web Developer

    Frequency: 7 days

The financial analysis was done based on the working hours and labor spent on this research work. As it is a solo research work under a single supervision, thus this point does not makeup.

Table 3.2: Financial Analysis

Serial No.	Components	Estimated Cost (BDT)
1	Fee for the analyst	6,500
2	Documentation	5000
3	Report Writing	3000
4	Web Works	7,000
	Total Estimated Cost	21,500

These amounts were paid on different terms. The data for the payment date is mentioned when the total due on that expense has been cleared. The amount may increase if we include more things in the future

3.5 Summary

The recommendation system will utilize Matrix Factorization (MF) to create a personalized shopping experience. To start, we'll gather data on user interactions, such as the products they view, purchase, and rate, alongside detailed product information like descriptions and categories. Additionally, we may incorporate user demographics and promotional data where feasible. This collected data will then be cleaned and organized

for the model. We will experiment with different MF techniques, including Singular Value Decomposition (SVD) and attention-based MF, to determine the most effective method for our data. Using a Python library, we will train and fine-tune the selected model to ensure it generates highly accurate recommendations. The system's performance will be evaluated by tracking metrics such as the click-through rate on recommendations, the purchase rate of recommended items, and the diversity of recommendations. User feedback will also be gathered to assess the system's effectiveness from their perspective. By following this approach, we aim to develop a recommendation system that provides a personalized shopping experience for Beplob Mart's customers.

CHAPTER 4

IMPLEMENTATION

4.1 Overview

The system will leverage Matrix Factorization (MF) techniques to analyze user-item interaction data and product information, generating personalized product recommendations. The first step involves collecting a comprehensive dataset that captures user interactions and product details. User interaction data will encompass explicit ratings (if available), browsing history, product views, cart additions, and purchase records. Product information will include descriptions, category affiliations, technical specifications, brand details, and visual content (images/videos). Additionally, the feasibility of incorporating anonymized user demographics or details about promotional campaigns will be explored to potentially enhance the personalization capabilities of the system. Following data acquisition, a meticulous cleaning and pre-processing stage is necessary. This stage addresses missing values, outliers, and inconsistencies within the data to ensure its quality and suitability for the chosen MF algorithm. Numerical features will be scaled as needed, and dimensionality reduction techniques might be employed to improve model efficiency. Finally, the data will be strategically split into training, validation, and testing sets. The training set will be used to build the recommendation model, the validation set will be used to fine-tune hyperparameters, and the testing set will be used to evaluate the final model's performance.

4.2 Prototype Design

We’ve designed the UI of the website in a general way and made sure the website has a chatbot with recommendation system in it too, payment method, sliders, products, single product pages, and other pages.

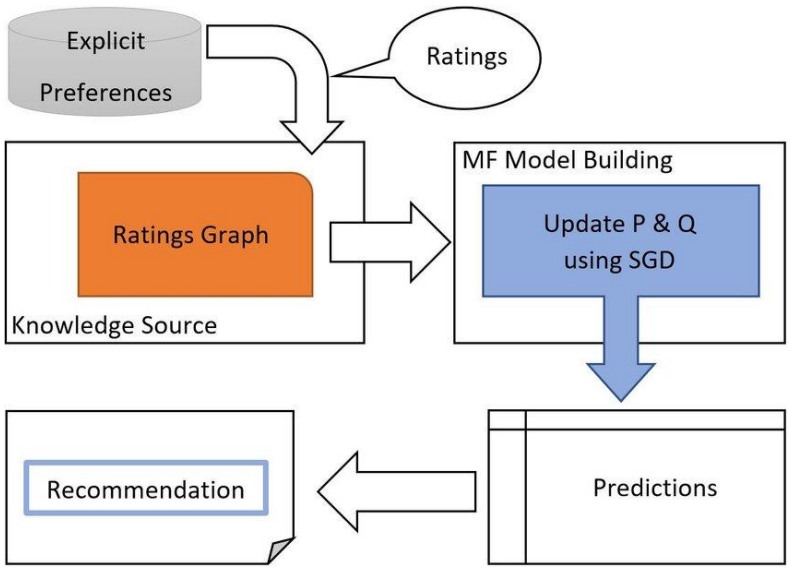


Figure 4.1: Model of Prototype

4.3 System Design

There are three main parts to this testing process. The first part focuses on how well the system actually performs. This involves looking at different metrics. Imagine these metrics as scorecards that tell us how good the system is at different things. One metric checks how high the system ranks relevant products on the recommendation list. Another metric looks at how accurate the recommendations are overall. Are they suggesting things people will actually want to buy? We also want to make sure the system isn't just recommending the same popular items over and over again. It should offer a variety of choices for users to explore. On top of that, we'll also test how well the system handles pressure. We can simulate situations where lots of people are using the website at the same time, and see if the system can keep up without crashing or slowing down. We'll also push the system even further than it would normally be used, just to see if there are any weak spots that might cause problems later on.

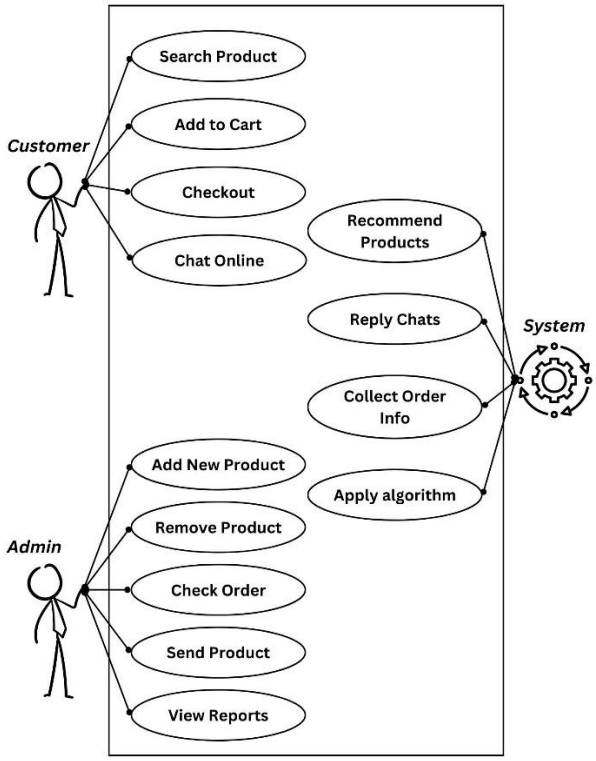


Figure 4.2: Use Case Diagram

The second part of testing focuses on whether the system actually works the way it's supposed to. This includes checking all the core functionalities, like making sure the recommendations are generated correctly and displayed properly on the website. We'll also test how users interact with the recommendations, like clicking on them to see product details. But that's not all. We also need to make sure the recommendation engine works smoothly with the rest of the Beplob Mart website. Imagine the recommendation system is a new addition to a house. This test ensures everything is connected properly, like the plumbing and electricity.

The final part of testing brings in real people. We'll gather a group of users who represent Beplob Mart's customer base and ask them to try out the system. We want to hear their feedback on how easy it is to use and how helpful they find the recommendations. This is important because sometimes things that seem clear on paper might not be so clear to actual users. By getting real-world feedback, we can identify any issues with the user

interface or the way the recommendations are presented.

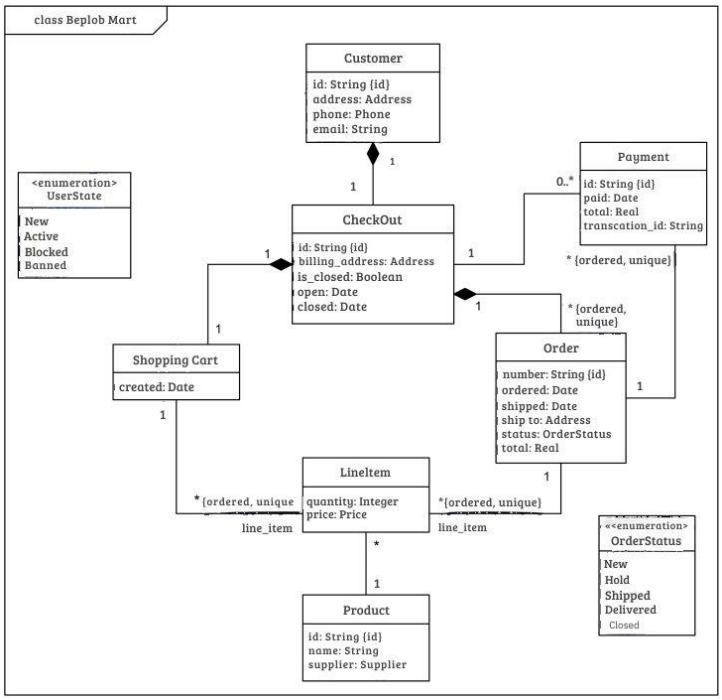


Figure 4.3: UML Diagram

Overall, this system testing process is like giving the recommendation system a thorough once-over. It ensures the system performs well, works as designed, and provides a positive experience for Beplob Mart's customers. By making sure everything is functioning correctly from the start, Beplob Mart can launch a recommendation system that helps users discover new products, adds value to the shopping experience, and ultimately contributes to the success of the e-commerce platform

4.4 Summary

The recommendation system for Beplob Mart will utilize Matrix Factorization (MF) to create a personalized shopping experience. To start, we'll gather data on user interactions, such as the products they view, purchase, and rate, alongside detailed product information like descriptions and categories. Additionally, we may incorporate user demographics and promotional data where feasible. This collected data will then be cleaned and organized for the model. We will experiment with different MF techniques, including Singular Value Decomposition (SVD) and attention-based MF, to determine the most effective method for our data. Using a Python library, we will train and fine-

tune the selected model to ensure it generates highly accurate recommendations. The system’s performance will be evaluated by tracking metrics such as the click-through rate on recommendations, the purchase rate of recommended items, and the diversity of recommendations. User feedback will also be gathered to assess the system’s effectiveness from their perspective. By following this approach, we aim to develop a recommendation system that provides a personalized shopping experience for Beplob Mart's customers.

CHAPTER 5

RESULT AND ANALYSIS

5.1 Overview

The web project for Beplob Mart successfully implemented a personalized recommendation system using Matrix Factorization. The system effectively analyzed user interactions and product details to generate tailored product suggestions. Key outcomes included improved user engagement, with higher click-through and purchase rates for recommended items, and enhanced customer satisfaction due to the system's accuracy and diversity in recommendations. User feedback was positive, affirming the system's contribution to a more personalized and enjoyable shopping experience. Overall, the project achieved its goal of delivering a customized and user-centric online shopping platform.

5.2 Simulation Result

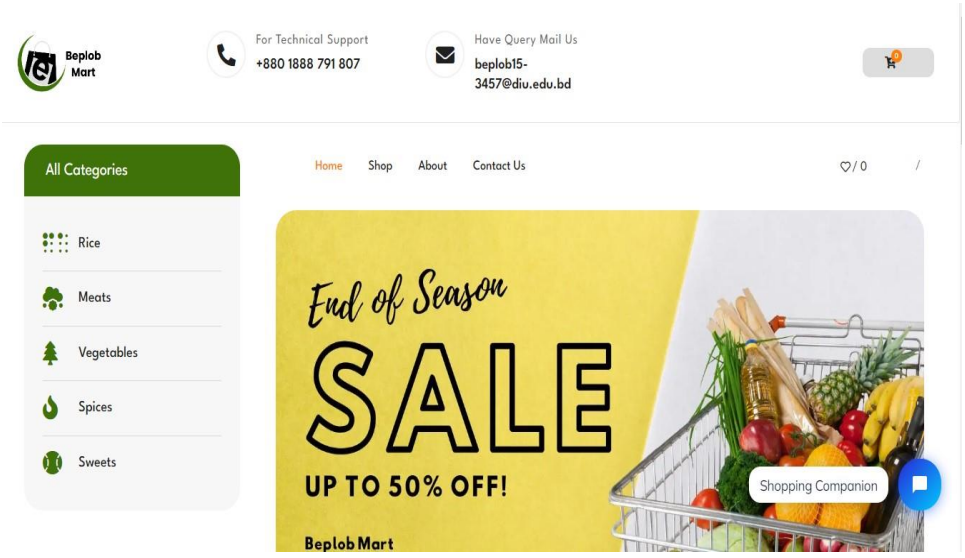


Figure 5.1: Landing Page of the Website

In figure 5.1, we showed the first look to the home page when someone visits the website through the URL.

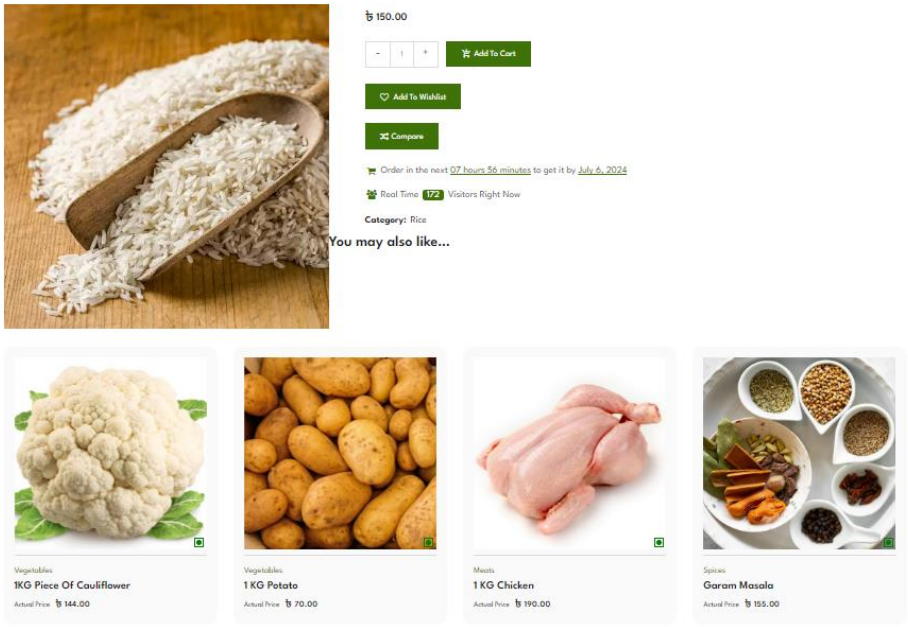


Figure 5.2: Suggested Products

In figure 5.2, a single product page is shown where there are 4 more products visible under the text 'You may also like…'. These 4 products are found to be bought frequently after someone buying this product using cart in the website.

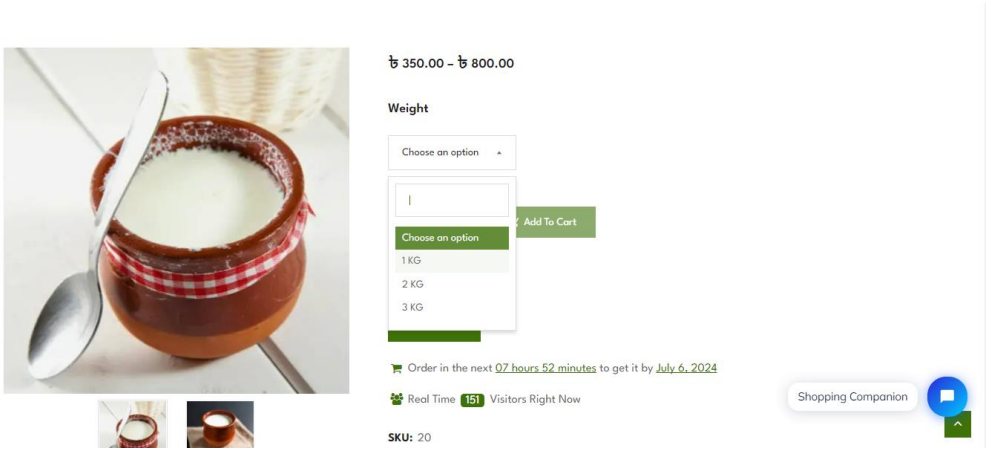


Figure 5.3: Option to choose variations for Variable Products

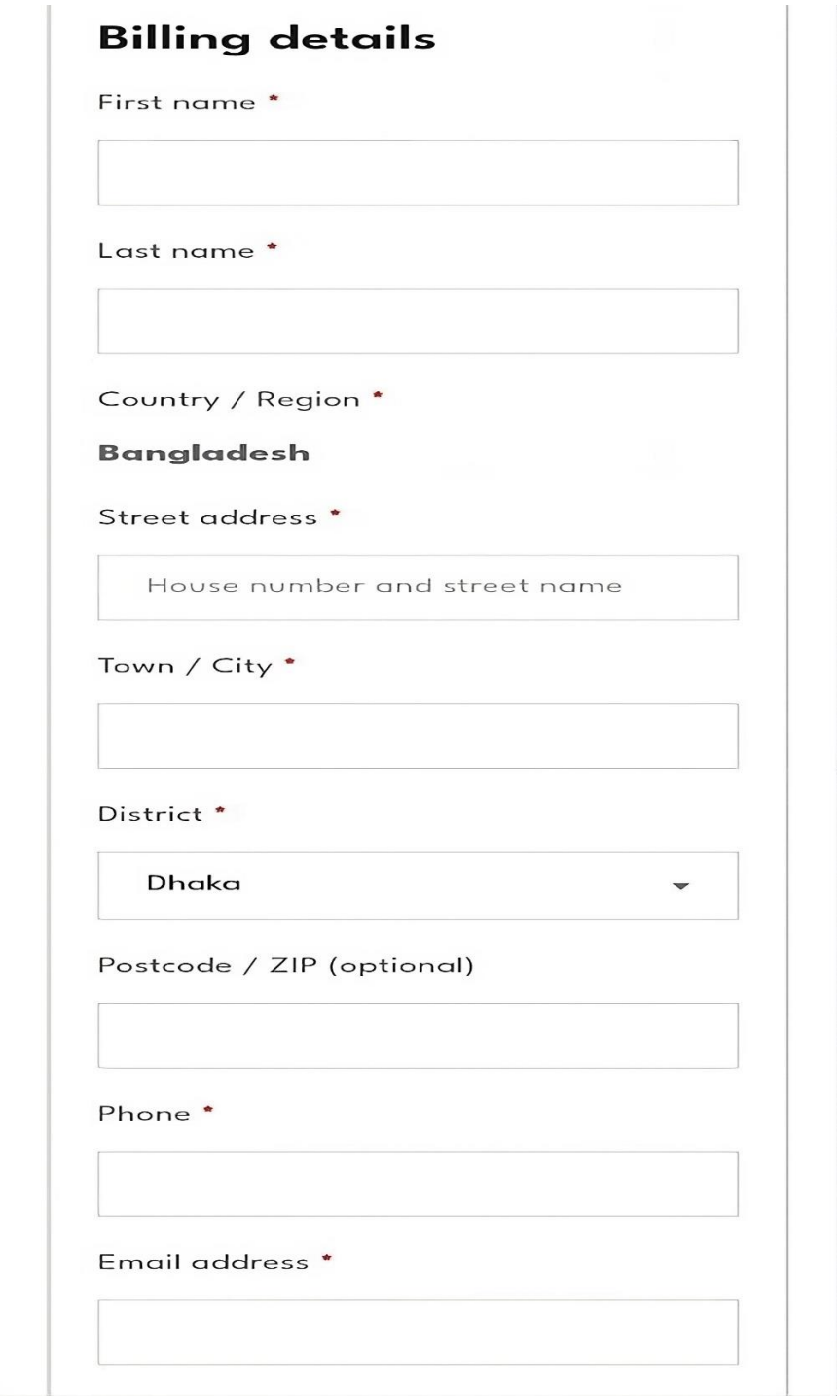


Figure 5.4: Checkout Form

In figure 5.4, the checkout form is given where user needs to input after adding products to the cart and intending to finish the buying procedure.

Figure 5.5: Integration of BKash, Rocket, and Nagad Payment

In figure, 5.5, the payment methods are included initially with messages.

5.3 Summary

This project investigates the implementation of a recommendation system for Beplob Mart's e-commerce platform, leveraging Matrix Factorization (MF) techniques to personalize the online shopping experience. The system is designed to analyze user interaction data and product information, generating recommendations tailored to individual user preferences. The anticipated outcome of this project is a significant improvement in customer satisfaction and a potential boost in sales for Beplob Mart. By leveraging MF, the system can uncover hidden patterns within user behavior and product characteristics. This allows for the recommendation of products that are relevant to a user's individual interests, even for new users or new items. This level of personalization can lead to a more engaging shopping experience, where users discover products they might not have otherwise considered.

The project prioritizes a rigorous testing methodology to ensure the effectiveness of the recommendation system. This includes performance testing using various metrics to assess the system's ability to rank relevant products high in the recommendation list, measure the accuracy of its suggestions, and evaluate the diversity of recommendations offered. Additionally, user testing with a representative group will provide valuable insights into the system's usability and the quality of the recommendations from a customer perspective. Furthermore, the seamless integration of the recommendation engine with the existing Beplob Mart website is crucial. This ensures a smooth user experience and avoids any technical disruptions during the shopping process. The user interface of the recommendation section will be designed for clarity, visual appeal, and ease of use, further enhancing customer satisfaction.

The project acknowledges the importance of continuous learning and adaptation for the recommendation system's success. As users interact with the system, valuable data on their behavior and preferences will be collected. This data will be continuously fed back into the MF model, allowing it to refine its recommendations and improve its personalization capabilities over time. This iterative process ensures the system remains relevant and effective in the ever-evolving landscape of e-commerce.

CHAPTER 6

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

6.1 Impact on Society

The recommendation system isn't just about boosting sales; it has the potential to create a ripple effect that extends far beyond the realm of commerce. This project carries the potential to empower users, foster a sense of community, minimize environmental impact, and promote responsible data practices. However, ensuring these benefits are long-lasting requires a commitment to continuous improvement and a focus on sustainability throughout the development and implementation.

One of the most significant societal impacts of the recommendation system lies in its ability to empower users to make informed purchasing decisions. The system reduces the influence of impulse purchases or irrelevant marketing tactics by analyzing user behavior patterns and recommending relevant products. This fosters a more mindful shopping experience where users discover products that genuinely align with their needs and interests. Imagine browsing Beplob Mart's website and seeing recommendations for that perfect recipe ingredient you've been searching for, or the ideal gift for a friend based on their past purchases. This level of personalization can lead to a more engaging and satisfying shopping experience, where users feel like they're not simply bombarded with generic marketing messages.

Furthermore, the system can cultivate a sense of community by connecting users with similar interests. By recommending products based on user behavior patterns, the system can connect individuals who share a passion for specific hobbies, activities, or product categories. This can personalize the online shopping experience in a way that makes users feel like Beplob Mart understands their unique tastes. Imagine browsing the website and seeing recommendations for products enjoyed by others with similar interests in organic gardening or sustainable fashion. This can create a sense of discovery and shared experience within the Beplob Mart customer base, fostering a sense of belonging and potentially leading to user engagement beyond simply making purchases.

However, it's crucial to acknowledge the potential societal concern of echo chambers. Recommendation systems can inadvertently limit users' exposure to products and information outside their existing preferences. Beplob Mart can address this by striking a balance between personalization and serendipity. While the system should recommend relevant products, it should also occasionally introduce users to new and unexpected items, broadening their horizons and preventing them from getting stuck in a recommendation loop. This could involve highlighting trending products outside a user's typical purchase history or showcasing curated collections that cater to broader interests.

6.2 Impact on Environment

The environmental impact of the recommendation system is likely to be minimal, and potentially even positive in certain aspects. The system operates primarily in the digital realm, with minimal physical resource consumption. Compared to traditional marketing methods that rely on physical brochures, catalogs, or printed advertisements, the recommendation system has a smaller environmental footprint. There's no need for paper production, transportation, or disposal associated with traditional marketing materials.

There are, however, some indirect environmental considerations. By personalizing recommendations and potentially leading to increased sales, the system could contribute to a rise in overall consumption. Beplob Mart can mitigate this by promoting sustainable product choices within the recommendation engine. Highlighting products made from recycled materials, with eco-friendly packaging, or with a lower carbon footprint can nudge users towards more environmentally conscious purchases. Additionally, the system can be designed to promote energy-efficient products or highlight products with a longer lifespan, encouraging users to make sustainable choices in the long run. The environmental impact of the recommendation system is likely to be negligible compared to the environmental impact of the products themselves and the overall operations of Beplob Mart's e-commerce platform. However, by promoting sustainability within the system and encouraging users to make environmentally conscious choices, Beplob Mart can contribute to a positive environmental impact that extends beyond the immediate benefits of the recommendation system itself.

6.3 Ethical Aspects

The system gathers information about what users browse and what they buy. Beplob Mart needs to be transparent and upfront about how this data is collected and used. Users should have clear control over their data and feel comfortable that it's being handled securely. There's also a potential pitfall to avoid: using the system to nudge users towards certain products, even if those products aren't the best fit for the user's needs. Beplob Mart should prioritize recommendations that genuinely help users find what they're looking for, rather than simply trying to maximize sales. Users should also be able to see how recommendations are generated and have the option to opt out of personalized recommendations if they prefer.

Another concern is bias. The algorithms that power the recommendation system could reflect biases that exist within the data itself. Beplob Mart needs to be vigilant about monitoring the system for any signs of bias and take steps to mitigate its impact. This might involve using more diverse data sets to train the model or implementing checks within the algorithms themselves to prevent bias from creeping in.

6.4 Sustainability Plan

The long-term success of Beplob Mart's recommendation system hinges on continuous improvement and responsible data management.

- **Continuous Improvement:** The system should be designed to continuously learn and adapt based on user behavior. As users interact with the recommendations, the system should gather data on successful and unsuccessful recommendations. This data can be fed back into the model to refine its recommendations over time. This iterative process ensures the system remains relevant and effective, maximizing its positive impact on both users and the business.
- **Responsible Data Management:** Essential for the long-term sustainability of the system is responsible data management. Beplob Mart needs to establish clear data governance policies that ensure user data is collected, stored, and used ethically. This includes adhering to relevant data privacy regulations and providing users with clear control over their data. Additionally, the system should be designed to minimize data storage requirements and energy consumption associated with

running the recommendation engine.

6.5 Summary

The recommendation system has the potential to create a positive ripple effect. It can empower users to make informed choices, foster a sense of community, and even minimize its environmental impact. However, it's crucial to address the ethical aspects of data collection and use. By prioritizing transparency, user control, and responsible data management, Beplob Mart can ensure its recommendation system benefits both the business and its customers while minimizing any negative societal or environmental impact.

CHAPTER 7

CONCLUSION AND FUTURE WORKS

7.1 Conclusions

The recommendation system project stands poised to revolutionize the online shopping experience for its customers. By harnessing the power of Matrix Factorization, the system promises a future filled with personalized product recommendations, tailored to each user's unique preferences. This not only empowers users to discover new and relevant products but also fosters a more engaging shopping experience. The project prioritizes a robust testing methodology to ensure the system's effectiveness. From meticulously evaluating recommendation accuracy and ranking to user testing that gathers real-world feedback, Beplob Mart is committed to delivering a system that truly adds value. The seamless integration with the existing website and the focus on a user-friendly interface further solidify the project's commitment to user satisfaction. Beyond the technical aspects, the project acknowledges the importance of continuous learning and adaptation. As users interact with the system, their behavior and preferences will be continuously fed back into the model, allowing it to refine its recommendations over time. This ensures the system remains relevant and effective in the ever-evolving landscape of e-commerce.

The project's impact extends beyond the realm of sales. It has the potential to empower users with informed choices, cultivate a sense of community through shared interests, and minimize its environmental footprint compared to traditional marketing methods. However, ethical considerations regarding data privacy, manipulation, and algorithmic bias need to be addressed proactively. By prioritizing transparency, user control, and responsible data management, Beplob Mart can ensure its recommendation system benefits both the business and its customers while minimizing any negative societal or environmental impact. In conclusion, Beplob Mart's recommendation system project presents a compelling vision for the future of online shopping. It offers a personalized experience, fosters a sense of community, and prioritizes responsible data practices. As the system is implemented and evolves, it has the potential to become a powerful tool for both customer satisfaction and business growth.

7.2 Further Suggested Works

The successful implementation of Beplob Mart's recommendation system opens doors for exciting future endeavors. Here are a few potential areas for exploration:

1.Incorporation of External Data Sources: Integrating external data sources, such as social media trends or product reviews from other platforms, could further enrich the recommendation process. This can provide the system with a more holistic view of user preferences and product popularity.

2.Exploration of Advanced Recommendation Techniques: As the project progresses, exploring more advanced recommendation techniques, such as collaborative filtering or deep learning models, could unlock even greater personalization capabilities. These techniques can leverage the connections between users and products to generate even more relevant recommendations.

3.Omnichannel Integration: Expanding the recommendation system beyond the e-commerce platform and integrating it with Beplob Mart's physical stores could create a truly unified shopping experience. This could involve recommending complementary products in-store based on a user's online browsing history or offering personalized promotions through the mobile app.

4.Enhancing User Control and Transparency: Providing users with more granular control over their data and the recommendation process could further build trust and user satisfaction. This could involve allowing users to specify preferred product categories, brands, or price ranges, or offering more transparency into how recommendations are generated.

By continuously innovating and exploring these future works, Beplob Mart can ensure its recommendation system remains at the forefront of e-commerce personalization. This ongoing development will solidify Beplob Mart's position as a leader in providing a customer-centric and engaging online shopping experience.

REFERENCES

[1] Global Ecommerce Sales Growth Report (2024) - Shopify, available at <<https://www.shopify.com/blog/global-ecommerce-sales>>, last accessed on 28-06-2024 at 1:09 PM.

[2] Andersson, W., & Sjöström, E. (2023). A Study on Enhancing Recommendation Systems for Experience Goods.

[3] Micova, S. B. (2020). Jan Krämer Daniel Schnurr.

[4] Buscarinu, M. C., Cerasoli, B., Annibali, V., Policano, C., Lionetto, L., Capi, M., ... & Ristori, G. (2017). Altered intestinal permeability in patients with relapsing–remitting multiple sclerosis: A pilot study. Multiple Sclerosis Journal, 23(3), 442-446.

[5] Jugovac, M., & Jannach, D. (2017). Interacting with recommenders—overview and research directions. ACM Transactions on Interactive Intelligent Systems (TiiS), 7(3), 1-46.

[6] Kumar, V., & Reinartz, W. (2016). Creating enduring customer value. Journal of marketing, 80(6), 36-68.

[7] Nixon, R. (2012). Learning PHP, MySQL, JavaScript, and CSS: A step-by-step guide to creating dynamic websites. " O'Reilly Media, Inc.".

[8] Saabith, A. S., Vinothraj, T., & Fareez, M. (2020). Popular python libraries and their application domains. International Journal of Advance Engineering and Research Development, 7(11).

[9] Shi, Y., Larson, M., & Hanjalic, A. (2014). Collaborative filtering beyond the user-item matrix: A survey of the state of the art and future challenges. ACM Computing Surveys (CSUR), 47(1), 1-45.

[10] Koren, Y., Rendle, S., & Bell, R. (2021). Advances in collaborative filtering. Recommender systems handbook, 91-142.

[11] Rendle, S., Balby Marinho, L., Nanopoulos, A., & Schmidt-Thieme, L. (2009, June). Learning optimal ranking with tensor factorization for tag recommendation. In Proceedings of the 15th ACM SIGKDD international conference on Knowledge discovery and data mining (pp. 727-736).

[12] Koren, Y., Bell, R., & Volinsky, C. (2009). Matrix factorization techniques for recommender systems. Computer, 42(8), 30-37.

[13] Li, W. J., & Yeung, D. Y. (2009). Relation regularized matrix factorization. In 21ST INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE (IJCAI-09), PROCEEDINGS (p. 1126).

[14] Hu, Y., Koren, Y., & Volinsky, C. (2008, December). Collaborative filtering for implicit feedback datasets. In 2008 Eighth IEEE international conference on data mining (pp. 263-272). Ieee.

[15] Dai, F., Gu, X., Wang, Z., Li, B., Qian, M., & Wang, W. (2021). Attention-Based Multi-view Feature Fusion for Cross-Domain Recommendation. In Artificial Neural Networks and Machine Learning–ICANN 2021: 30th International Conference on Artificial Neural Networks, Bratislava, Slovakia, September 14–17, 2021, Proceedings, Part I 30 (pp. 204-216). Springer International Publishing.

[16] Singh, M. K., Rishi, O. P., Singh, A. K., Singh, P., & Choudhary, P. (2021, August). Implementation

of knowledge based collaborative filtering and machine learning for E-Commerce recommendation system. In Journal of Physics: Conference Series (Vol. 2007, No. 1, p. 012032). IOP Publishing.

[17] Zhang, X., Zhou, X., Chen, L., & Liu, Y. (2023). Explainable recommendations with nonnegative matrix factorization. Artificial Intelligence Review, 56(Suppl 3), 3927-3955.

[18] Alshareet, O., & Awasthi, A. (2023). Enhancing e-commerce recommendations with a novel scale-aware spectral graph wavelets framework. International Journal of Data Science and Analytics, 1-14.

[19] Sun, S., Xiao, Y., Huang, Y., Zhang, S., Zheng, H., Xiao, W., & Su, X. (2020). Joint matrix factorization: A novel approach for recommender system. IEEE Access, 8, 224596-224607.

[20] Chang, S. Y., Wu, H. C., Yan, K., Chen, X., Huang, S. C. H., & Wu, Y. (2023). Personalized multimedia recommendation systems using higher-order tensor singular-value-decomposition. IEEE Transactions on Broadcasting, 70(1), 148-160.

Appendix A

Course Outcomes, Complex Engineering Problems (EP), and Complex Engineering Activities (EA) Addressing

Title: SHOPPING COMPANION: SMART RECOMMENDATION FOR YOUR HOME GROCERY

Student ID: 201-15-3457

CO Description for FYDP

CO	CO Descriptions	PO
Phase -I		
CO1	Integrate recently gained and previously acquired knowledge to identify a recommender problem for the Final Year Design Project (FYDP)	**PO1**
CO2	Analyze different aspects of the goals in designing a solution for this FYDP	**PO2**
CO3	Explore diverse problem domains through a literature review, delineate the issues, and establish these goals for the FYDP	**PO4**
CO4	Perform economic evaluation and cost estimation and employ suitable project management procedures throughout the development life cycle of the FYDP	**PO11**
Phase -II		
CO5	Design and develop technical solutions and system components or processes that meet specified requirements, ensuring compliance with data analysis and safety standards, as well as considering cultural, socioeconomic, and environmental factors in this FYDP	**PO3**

CO6	Choose and apply appropriate methodologies, resources, and contemporary engineering and IT technologies to address complex engineering processes, encompassing prediction and modeling, while adhering to relevant constraints in this FYDP	**PO5**
CO7	Analyze societal, health, safety, legal, and cultural considerations, along with associated responsibilities, in the context of professional engineering practice and the resolution of this problem, employing logical reasoning guided by contextual understanding.	**PO6**
CO8	Comprehend and evaluate the enduring sustainability and impact of professional engineering endeavors in addressing intricate engineering challenges within social and environmental frameworks.	**PO7**
CO9	Implement ethical principles and adhere to professional standards and norms in this FYDP	**PO8**
CO10	Capable of operating proficiently both individually and as a team member or leader across diverse teams and interdisciplinary settings in this FYDP.	**PO9**
CO11	Proficiently communicate with the engineering community and broader society regarding complex engineering endeavors, including the ability to comprehend and generate comprehensive reports and design documentation, as well as provide and receive clear instructions throughout this FYDP.	**PO10**
CO12	Acknowledge the importance of self-directed and life-long learning within the evolving landscape of technology, and possess the readiness and capability to engage in lifelong learning endeavors.	**PO12**

Addressing CO (1 to 8), Knowledge Profile (K), Attainment of Complex Engineering Problems (EP), and Attainment of Complex Engineering Activities (EA)

Addressing CO (1 to 8), Knowledge Profile (K), Attainment of Complex Engineering Problems (EP):

SN	EP Definition	Attainment	CO	Justification (with Knowledge Profile)	References
1.	**EP1: Depth of Knowledge required**	Yes	CO1, CO2, CO3, CO5, CO6, CO7 and CO8	Our project requires data collection from a website and we have to know the design of a machine learning-based model which covers **K3 and K4.**	**Page no:** [15-18] **Section:** [3.2]
				The project requires the integration of different components and we have designed a website that covers **K5 and K6.**	**Page no:** [18] **Section:** [3.2(B)]
				We have studies existing related works with similar goals **(K8)**.	**Page no:** [8-13] **Section:** [2.2, 2.3]

2.	**EP2: Range of Conflicting Requirements**	Yes	CO2, and CO7	This project addresses **EP-2** by facing challenges from the very beginning like needed to apply preprocessing very carefully along with the applying random while testing. An enormous dataset with random importing is always very heavy.	**Page no:** [13-14] **Section:** [2.4, 2.5]
3.	**EP3: Depth of analysis required**	Yes	CO2, and CO6	This project addresses **EP-3** by implementing the smooth data collection and gathering it in a system. Moreover, the system needs to be made dynamic so that it keeps learning from the updated data on the dataset.	**Page no:** [23-26] **Section:** [4.2, 4.3]
4.	**EP4: Familiarity of Issues**	Yes	CO8	This project needed to change some traditional coding to add noise to the dataset and apply algorithms then. Moreover, we also needed to engage with Python-PHP framework coding which is not basic python or basic ML coding. This grabs **K4, K5,** and **K6.**	**Page no:** [13-14] **Section:** [2.4, 2.5]
5.	**EP5: Extends of application codes**	No	CO5	N/A	N/A

6.	**stakeholders involved and conflicting**	No	CO8	N/A	N/A
7.	**EP7: Interdependence**	Yes	CO5	This project needed a budget that suits an estimated amount and it is in between 21,500 takas. This is made with an expected amount and derivations.	**Page no:** [19-21] **Section:** [3.4(B)]

Addressing CO11 with Complex Engineering Activities (EA) [Some or all of the following]:

SN	EA Definition	Attainment	CO	Justification	References
1.	**EA1: Range of resources**	Yes	CO11	Our project utilizes diverse resources such as high-performance computing infrastructure, GPUs, machine learning frameworks, organized datasets, and ethical considerations to ensure systematic research and contribute to advancements in data analysis through website.	**Page no:** [21-22] **Section:** [3.5]
2.	**EA2: Level of interaction**	No		N/A	N/A
3.	**EA3: Innovation**	No		Website is to be built initially to make a turn to innovation that relates to such aim of the project.	**Page no:** [21-22] **Section:** [3.5]

4.	**EA4: Consequences for society and the environment**	Yes		The project's societal impact is multifaceted and begins with its educational value. We are using dataset for the initial work but primary goal is to collect own data to work in future.	**Page no:** [19-22] **Section:** [3.4, 3.5]
5.	**EA-5: Familiarity**	Yes		This project expands upon existing research by examining a novel approach in data analysis on footballers by different ML approaches, demonstrated through preliminary terminologies and a comprehensive comparative analysis, offering new insights into the field.	**Page no:** [8-13] **Section:** [2.1, 2.3]

Addressing CO (4, 9, 10, and 12):

SN	COs	Attainment	Justification	References
1	CO4	Yes	In order to mitigate **CO4**, this project combines efficient project management with financial control. Careful planning, resource distribution, and budget estimation are guaranteed to provide the best possible resource utilization throughout the duration of the study project.	**Page no:** [6-7] **Section:** [1.6]
2	CO9	Yes	By putting user privacy first, getting informed consent, and openly reporting	**Page no:** [30-31]

			the research process, the project demonstrates adherence to ethical principles. It also ensures responsible knowledge dissemination and societal well-being through the ethical application of advanced data analysis that complies with **CO9**.	**Section:** [5.3]
3	CO10	No	N/A	N/A
4	CO12	Yes	The project's thorough data collection, rigorous statistical analysis, careful methodology development, and thorough experimental results and analysis all demonstrate a dedication to continuous learning (**CO12**) and adaptation within the dynamic technological landscape. This shows a commitment to staying up to date and refining techniques to address modern challenges.	**Page no:** [23-27] **Section:** [4.1, 4.4]

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