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Research Paper

Smart Notification Optimization System for E-Commerce Applications

K.Pavani[1], Shaik Fayaz [2]

#1 Assistant Professor & Head of Department of MCA, SRK Institute of Technology, Vijayawada.

#2 Student in the Department of MCA, SRK Institute of Technology, Vijayawada.

Abstract

With the rapid growth of online shopping platforms, communication between businesses and customers has become increasingly important. Notifications play a significant role in informing customers about discounts, offers, order updates, and personalized recommendations. However, many e-commerce platforms send large numbers of notifications without considering whether the information is relevant to the user. As a result, customers often experience notification fatigue, ignore messages, or disable notifications completely.

The E-Commerce Smart Notification System is developed to address this challenge by providing a more intelligent and personalized notification mechanism. The system analyzes user behavior such as browsing activity, purchase history, product interests, and interaction frequency to determine the relevance of a notification before sending it. Instead of broadcasting the same message to all users, the system identifies which users are most likely to benefit from a specific notification.

The application is developed using the Flask framework in Python, which provides a lightweight and efficient backend environment. User activity data is stored and processed using a relational database. A notification scoring algorithm evaluates customer engagement and assigns a relevance score to each notification event. When the score exceeds a predefined threshold, the system triggers an SMS notification through the Twilio API.

The proposed solution helps reduce unnecessary notifications, improves customer engagement, and increases the likelihood of user interaction. By delivering timely and personalized communication, the system enhances customer satisfaction while helping businesses achieve better marketing performance. The architecture is designed to be scalable and can be extended in the future using machine learning models for advanced recommendation and prediction capabilities.

Keywords: E-Commerce, Flask, Twilio, Notification System, Personalization, Customer Engagement, SMS Alerts, User Behavior Analysis..

1.INTRODUCTION

The digital commerce business has changed how consumers shop. Users want individualized experiences, fast communication, and relevant

recommendations when using online platforms. E-commerce enterprises employ notification systems to send promotional offers, product updates, order confirmations, and seasonal discounts to match these expectations.

Although notifications are important, overcommunication often backfires. Many people receive dozens of ads per week, most of which are irrelevant. Customers eventually ignore these communications, diminishing notification campaign efficacy. Businesses face a problem because notification saturation might obscure crucial information.

This issue is addressed by the E-Commerce Smart Notification System. The technology prioritizes sending people notifications depending on their interests and behaviors. The system decides whether to send or omit notifications based on user behavior and relevancy.

The suggested notification system emphasizes personalization over mass messages. User activities like product views, search history, purchase frequency, and category preferences are assessed. The system uses these characteristics to find the best communication opportunities.

Flask, a lightweight Python web framework, simplifies backend development and API interaction. The SMS gateway Twilio sends notifications straight to users. Flask with Twilio create a dependable, scalable, and efficient platform for individualized customer communication.

2.LITERATURE SURVEY

[1] Resnick, P. and Varian, H. R. (1997) – Recommender Systems

Resnick and Varian introduced the concept of recommender systems as intelligent tools designed to assist users in discovering relevant information from large collections of data. The authors discussed the importance of personalization in filtering information overload and highlighted collaborative filtering as a key recommendation technique. Their work established the foundation for modern recommendation systems by emphasizing the role of user preferences and behavior in generating meaningful recommendations.

[2] Ricci, F., Rokach, L., and Shapira, B. (2015) – Introduction to Recommender Systems Handbook

This work provides a comprehensive overview of recommender system technologies and methodologies. The authors classified recommendation approaches into content-based filtering, collaborative filtering, and hybrid methods. The handbook discusses evaluation metrics, system architectures, and practical applications across various domains. It serves as an essential reference for understanding the theoretical and practical aspects of recommendation systems and their impact on improving user experiences.

[3] He, X., Deng, K., Wang, X., Li, Y., Zhang, Y., and Wang, M. (2020) – LightGCN: Simplifying and Powering Graph Convolution Network for Recommendation

The authors proposed LightGCN, a simplified Graph Convolutional Network model specifically designed for recommendation tasks. Unlike traditional GCN-based models, LightGCN removes unnecessary feature transformations and nonlinear activation functions, resulting in improved efficiency and recommendation accuracy. Experimental results demonstrated that LightGCN outperforms several state-of-the-art recommendation algorithms by effectively capturing user-item interaction patterns through graph-based learning techniques.

[4] Twilio Inc. – Twilio Messaging API Documentation

The Twilio Messaging API provides a cloud-based communication platform that enables applications to send and receive messages through various communication channels. The documentation explains API integration, message delivery mechanisms, authentication procedures, and scalability features. In recommendation systems, Twilio can be utilized to deliver personalized recommendations, alerts, and notifications directly to users, thereby enhancing user engagement and improving the overall effectiveness of the recommendation platform

3. METHODOLOGY

a) Proposed Work:

The E-Commerce Smart Notification System provides intelligent and tailored notification management. The system analyses user activity to evaluate whether a notification is relevant before sending it to all users.

Customer activity data is collected by the system:

• History browsing

• Records of purchases

• Added wishlist items

• Product category preferences

• Frequency of user interaction

Using these actions, a notification scoring system evaluates relevancy. Twilio SMS API notifications are sent if the calculated score exceeds a threshold. The notice is skipped otherwise..

c) Modules:

User Management Module

The User Management Module handles user registration, authentication, and profile management.

Functions

User Registration

User Login

Password Validation

Profile Management

Implementation Details

When a new user registers, the system validates the provided information and stores it securely in the database. Existing users can log in using their credentials to access personalized services.

This module serves as the entry point for all customer interactions.

User Activity Tracking Module

The User Activity Tracking Module is responsible for monitoring customer interactions within the e-commerce platform.

Activities Recorded

Product Searches

Product Views

Wishlist Additions

Cart Activities

Product Purchases

Implementation Details

Whenever a user performs an action, the system records the event along with its timestamp. These records are stored in the activity database and later used for behavioral analysis.

The collected information forms the foundation for generating personalized notifications.

Behavior Analysis Module

The Behavior Analysis Module evaluates customer activities and identifies patterns that indicate product preferences and interests.

Functions

Analyze Browsing Behavior

Analyze Purchase History

Identify Preferred Categories

Calculate User Engagement

Implementation Details

The module processes historical activity data and determines which products or categories are most relevant to the customer.

This analysis helps the system avoid sending irrelevant notifications.

Notification Scoring Module

The Notification Scoring Module is the core component of the application.

Purpose

To determine the relevance of a notification before delivery.

Parameters Considered

Number of Product Views

Wishlist Activities

Purchase Frequency

Recent User Activity

Product Category Preference

Implementation Details

Each activity contributes to a notification score. The system assigns weights to different actions and calculates a final relevance score.

For example:

Product View = 10 Points

Wishlist Addition = 20 Points

Product Purchase = 30 Points

The final score is used by the Decision Engine to determine whether a notification should be delivered.

Decision Engine Module

The Decision Engine evaluates the notification score and makes the final delivery decision.

Decision Logic

If:

Notification Score > Threshold Then:

Send Notification Else:

Skip Notification

Implementation Details

This module helps reduce notification spam by filtering out low-value notifications. Only notifications that satisfy predefined criteria are forwarded to the delivery service.

Twilio Integration Module

The Twilio Integration Module is responsible for sending SMS notifications.

Functions

Establish Connection with Twilio API

Generate SMS Content

Send SMS Notifications

Track Delivery Status

Implementation Details

The Twilio API is integrated using Python libraries. Once a notification is approved by the Decision Engine, the SMS message is generated and sent to the user's registered mobile number.

This module ensures **reliable and real-time communication.**

Notification Logging Module

The Notification Logging Module maintains a history of all notification activities.

Information Stored

Notification ID

User ID

Message Content

Delivery Status

Timestamp

Implementation Details

Every notification event is recorded for auditing, analytics, and reporting purposes.

These logs help administrators evaluate notification effectiveness and system performance.

Admin Dashboard Module

The Admin Dashboard provides management and monitoring capabilities.

Features

View Registered Users

Monitor Notifications

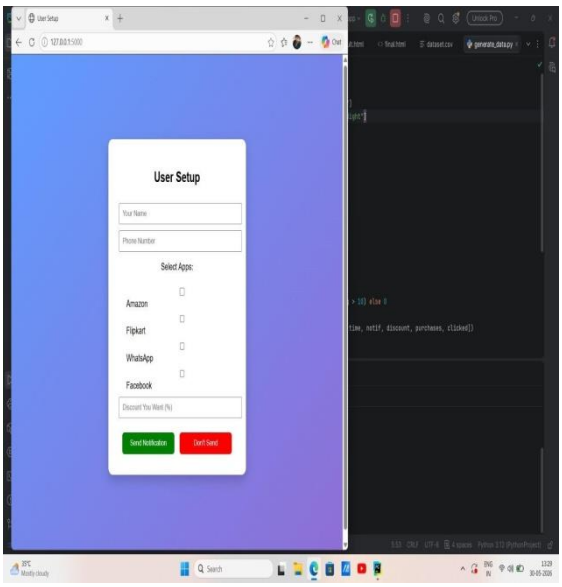
Analyze User Engagement

Generate Reports

Manage Notification Rules

Implementation Details

The dashboard presents summarized information through tables and reports, enabling administrators to make informed decisions regarding notification strategies.



4. EXPERIMENTAL RESULTS

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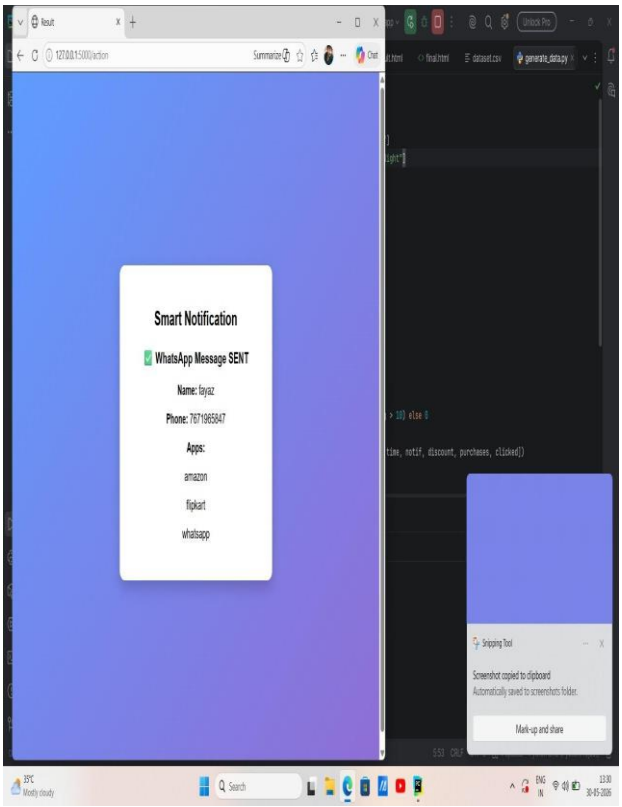
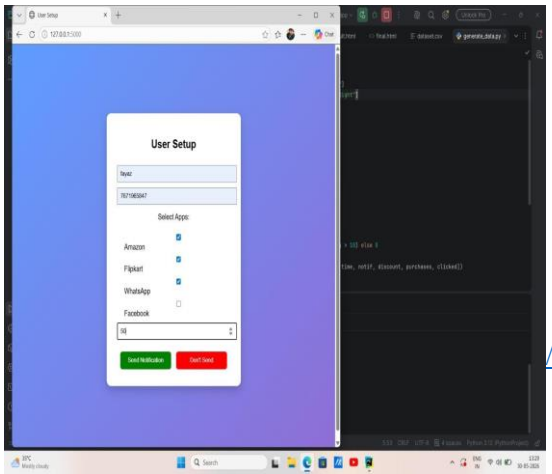
Fig 1:Resutls





5. CONCLUSION

The E-Commerce Smart Notification System was developed with the objective of improving customer engagement through personalized and intelligent notification delivery. Traditional e-commerce platforms often rely on bulk notification strategies, which frequently result in notification fatigue, low engagement rates, and poor user experience. To address these challenges, the proposed system introduces a behavior-driven notification mechanism that analyzes customer activities before delivering messages.

The system successfully collects and processes user interactions such as product browsing, wishlist additions, purchase history, and engagement patterns. Based on this information, a notification scoring algorithm evaluates the relevance of each notification. The Decision Engine then determines whether a notification should be sent or ignored, ensuring that users receive only meaningful and personalized communication.

The implementation of Flask as the backend framework provided a flexible and scalable environment for application development, while Twilio API enabled reliable and real-time SMS notification delivery. The integration of these technologies resulted in a system capable of improving communication efficiency and enhancing customer satisfaction.

Comprehensive testing was conducted to validate the functionality, performance, reliability, and security of the application. The results demonstrated that the system accurately tracks user activities, calculates notification relevance scores, filters unnecessary notifications, and successfully delivers SMS alerts to intended users. The testing phase confirmed that all modules operate according to the specified requirements.

The project successfully achieved its objectives by reducing unnecessary notifications, increasing personalization, and improving user engagement. The proposed solution provides a practical and efficient approach to customer communication in modern e-commerce platforms. It demonstrates how user behavior analysis can be utilized to create a more intelligent notification system that benefits both businesses and customers.

Overall, the E-Commerce Smart Notification System represents a significant improvement over traditional notification methods by focusing on relevance, personalization, and customer satisfaction. The system establishes a strong foundation for future advancements in intelligent communication and customer relationship management

6.FUTURE SCOPE

Although the current system performs effectively, several enhancements can be implemented in the future to further improve its capabilities and performance.

Machine Learning-Based Prediction

The notification scoring mechanism can be enhanced using machine learning algorithms that automatically learn customer preferences and predict user interests with greater accuracy.

Artificial Intelligence Integration

AI-powered recommendation engines can be incorporated to generate highly personalized product suggestions and notification content.

Push Notification Support

In addition to SMS communication, the system can be extended to support mobile push notifications for Android and iOS applications.

Email Notification Integration

Future versions can integrate email services to provide multi-channel communication and increase customer reach.

Real-Time Analytics Dashboard

An advanced analytics dashboard can be developed to provide detailed insights into user behavior, notification performance, engagement rates, and conversion metrics.

Customer Segmentation

Users can be categorized into different groups based on demographics, purchase behavior, and interests to improve notification targeting.

Cloud Deployment

The system can be deployed on cloud platforms such as AWS, Microsoft Azure, or Google Cloud to improve scalability, availability, and performance.

Multilingual Notification Support

Notifications can be delivered in multiple languages based on user preferences, making the platform accessible to a broader audience.

Advanced Security Features

Additional security measures such as multi-factor authentication, data encryption, and secure API gateways can be implemented to strengthen system protection.

Recommendation System Integration

A recommendation engine can be incorporated to automatically suggest products, offers, and discounts based on customer behavior and purchase history

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Author Profiles

Mrs. K.Pavani is working as an Assistant and Head of Department of MCA, in SRK Institute of technology in Vijayawada. She completed her MCA and M.Tech in Computer Science. She has 10 years of teaching experience in SRK Institute of technology, Enikepadu, Vijayawada, NTR District. Her areas of interest include AI and ML, etc.

Mr. Shaik Fayaz is an MCA Student in the Department of Computer Application at SRK Institute Of Technology, Enikepadu, Vijayawada, NTR District. He has Completed Degree in B.Sc.(computers) from vikas Degree College vissannapeta. His area of interest Cloud Computing and Machine Learning.