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E-Mail :
editor.ijasem@gmail.com
editor@ijasem.org

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MAXIMIZING MALL REVENUE PERSONALIZED DIGITAL COUPON ISSUANCE

Guide: B. Roja Sri
Department of CSE (AI&DS),
Eluru College of Engineering and Technology

B. Usha Surya Lakshmi, Ch. Ramya Sudha, B. Tharun, M. Satya Harshith
Department of CSE (AI&DS),
Eluru College of Engineering and Technology

***Abstract*—Maximizing mall revenue through digital coupon issuance involves leveraging targeted marketing and consumer data to drive foot traffic and sales. By offering personalized digital coupons via mobile apps, email, or social media platforms, malls can attract specific customer segments, incentivizing them to visit stores and make purchases. These digital coupons can feature time-sensitive discounts, exclusive deals, or rewards that create a sense of urgency, encouraging immediate action. Integration of analytics helps track coupon redemption patterns and optimize future campaigns. Additionally, collaborating with retailers to issue joint promotions boosts both store and overall mall revenue. It's an efficient strategy for modern retail ecosystems.**

***Index Terms*—Maximizing mall revenue prediction, Deep learning, machine learning, Recurrent Neural Network (RNN), support vector machine (SVM), decision tree (DT), logistic regression (LR).**

I. INTRODUCTION

Maximizing shopping mall revenue is a multifaceted endeavor that requires innovative strategies, technological integration, and a deep understanding of customer behavior. In today's competitive retail environment, malls must go beyond traditional methods to thrive and remain relevant. By leveraging a mix of targeted marketing, enhanced customer experiences, and data-driven decision-making, malls can unlock their full revenue potential.

Collaboration with retailers is essential for mutual success. Malls can partner with tenants to offer joint promotions, exclusive discounts, or bundled deals that benefit both parties. This synergy not only boosts individual store revenue but also contributes to the overall profitability of the mall. Additionally, flexible leasing arrangements, such as pop-up shops or short-term leases, allow smaller or emerging brands to showcase their products, creating a dynamic and ever-changing shopping environment that keeps visitors intrigued.

Sustainability and environmental consciousness are increasingly important to consumers, and malls can capitalize on this trend to enhance their appeal. Incorporating green practices, such as energy-efficient lighting, waste reduction programs, and eco-friendly building designs, demonstrates a commitment to sustainability. Hosting workshops or events related to sustainable living can further engage environment.

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Ultimately, maximizing shopping mall revenue is about creating a holistic, customer-centric ecosystem. By offering memorable experiences, leveraging technology, and fostering strong retailer partnerships, malls can differentiate themselves in the marketplace and secure long-term success. Through innovation and adaptability, they can continue to thrive amidst the ever-evolving retail landscape.

The integration of digital technology is another key driver of revenue growth. Personalized promotions, such as digital coupons and exclusive deals, can be delivered via mobile apps, emails, or social media platforms. These targeted offers incentivize visits and encourage spending Loyalty program.

II. RELATED WORK

Maximizing real-time digital coupon issuance using algorithms like Recurrent Neural Networks (RNN), Support Vector Machines (SVM), and Logistic Regression (LR) has been a topic of significant research in the field of machine learning and eCommerce. These algorithms are employed to enhance the efficiency and personalization of coupon distribution, ultimately driving customer engagement and increasing revenue.

Recurrent Neural Networks (RNN) are particularly effective for analyzing sequential data, such as customer browsing history or purchase patterns. By leveraging RNNs, businesses can predict customer behavior in real-time and issue coupons tailored to individual preferences. For instance, an RNN can analyze clickstream data to identify customers who are likely to abandon their shopping carts and issue targeted discounts to encourage completion of purchases.

Additionally, the use of big data and cloud computing enhances the scalability and responsiveness of these systems. By processing large volumes of customer data in real-time, business. optimize resource allocation, and ultimately drive revenuegrowth.

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Logistic Regression (LR) is a simpler yet powerful algorithm for predicting binary outcomes, such as whether a customer will redeem a coupon or not. LR models can be trained on historical

data, including factors like purchase frequency, average spending, and coupon redemption history. By analyzing these variables, LR can provide probabilities for coupon redemption,

enabling businesses to make informed decisions about coupon issuance.

Research has shown that AI-driven coupon issuance can significantly improve conversion rates and customer retention. Studies have demonstrated that personalized coupons issued based on predictive models lead to higher redemption rates compared to generic offers. Furthermore, the use of machine learning algorithms reduces the burden of manual decision- making, allowing businesses to focus on strategic initiatives.

In conclusion, the application of RNN, SVM, and LR algorithms in real-time digital coupon issuance represents a transformative approach to eCommerce marketing. By leveraging these technologies, businesses can enhance customer engagement, optimize resource allocation, and ultimately drive revenue growth.

for further research into more robust and dynamic prediction

Methodology

This section outlines the systematic approach employed to assess using machine learning techniques. The methodology comprises data preprocessing, model training, evaluation, prediction, and reinforcement learning-based decision-making.

1. Data Collection and Preprocessing The process begins with gathering data from various sources, such as point-of-sale (POS) systems, customer surveys, loyalty programs,. The preprocessing steps involve:

- **Data Cleaning**: Missing values are handled using mean imputation for numerical fields and mode imputation for categorical variables. Outlier detection is performed using the Z-score method:

$$Z = \frac{X - \mu}{\sigma}$$

where X is the observed value, μ is the mean, and σ is the standard deviation of the dataset.

- **Feature Extraction**: - Implementing **Count Vectorization** to convert text-based financial data (such as cryptocurrency news sentiment) into numerical format for analysis. The term frequency (TF) of a word in a document is calculated as:

$$TF(t) = \frac{f_t}{N}$$

where f_t is the number of times term t appears in the document, and N is the total number of terms. - Additional features include moving averages, Relative Strength Index (RSI), and Bollinger Bands.

- **Normalization**: Standardizing numerical data for consistency across models. Min-Max scaling is performed using the formula:

$$x' = \frac{x - \min(x)}{\max(x) - \min(x)}$$

where x is the original value, $\min(x)$ and $\max(x)$ are the minimum and maximum values in the dataset, respectively.

2. Machine Learning Models A combination of supervised learning algorithms is used to maximizing the mall revenue personalized digital coupon issuance" The models include:

a) Support Vector Machine (SVM) SVM is a powerful classification algorithm that finds the optimal hyperplane to separate different classes. The decision boundary is defined as:

$$f(x) = w^T x + b$$

where w is the weight vector, x is the input feature vector, and b is the bias term. The optimization objective is:

$$\min_w \frac{1}{2}||w||^2 \text{ subject to } y_i(w^T x_i + b) \geq 1$$

for all training samples (x_i, y_i), where y_i represents class labels (+1 or -1).

b) Decision Tree Classifier Decision Trees use an entropy-based criterion to split data. Entropy is defined as:

$$H(S) = -\sum p_i \log_2 p_i$$

where p_i is the probability of class i. The model iteratively selects the best split to minimize entropy and improve classification.

The Gini Impurity metric is also considered:

$$Gini = 1 - \sum p_i^2$$

where p_i represents the probability of each class in the node.

c) Logistic Regression Logistic regression predicts risk probability using the sigmoid function:

$$P(y) = \frac{1}{1 + e^{-z}}$$

where $z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n$.

d) Recurrent Neural Network(RNN) Recurrent Neural Networks (RNNs) can be effectively utilized to maximize shopping mall . The output of each neuron is computed as:

$$ht=f(Whht-1+Wxxt+bh)$$

where W is the weight matrix, X is the input vector, b is the bias, and f is the activation function (ReLU or Sigmoid).

e) Voting Classifier (Ensemble Learning) An ensemble method that aggregates predictions from multiple classifiers to improve accuracy. The final prediction is based on majority voting:

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$$P_{final} = \arg\max_{i=1}^{n\Sigma} P_i$$

where P_i is the probability from the i^{th} classifier.

RNNs can analyze sequential customer data, such as shopping patterns, purchase histories, and foot traffic trends. By understanding behavior, the model can predict future actions, like peak shopping times or customers likely to respond to promotions.

y analyzing user interactions and purchase history, RNNs can personalize digital coupon recommendations in real time. For instance, a customer browsing specific items can receive immediate, relevant discounts to encourage purchases.

Analytics play a vital role in optimizing revenue strategies. By harnessing customer data, malls can gain insights into shopping preferences, peak traffic times, and popular stores. These insights enable mall operators to refine marketing campaigns, adjust tenant leasing strategies, and enhance the overall shopping experience. For instance, if data reveals that a particular age group frequents the mall on weekends, promotional efforts can be tailored to maximize engagement during those times.

Research explores the use of machine learning algorithms like RNNs, SVMs, and Logistic Regression to predict customer behavior, optimize promotional campaigns, and personalize offers. Effective tenant mixes, experiential events, and loyalty programs enhance foot traffic and shopping experiences.

III. Results and Discussion

Maximizing mall revenue through personalized digital coupon issuance can yield significant results when implemented effectively, with strategic decisions enhancing customer engagement and operational efficiency. This approach relies on leveraging customer data, machine learning algorithms, and digital platforms to create targeted promotions tailored to individual preferences and behaviors.

Personalized digital coupons foster stronger connections with customers by addressing their specific needs and preferences. For instance, a shopper browsing apparel stores might receive a tailored discount on clothing, increasing the likelihood of purchase. This personalization creates a sense of exclusivity and value, improving overall customer satisfaction and loyalty.

Offering time-sensitive or location-based digital coupons can incentivize customers to visit the mall. For example, limited-time deals pushed to mobile devices can encourage immediate action. This strategy not only boosts foot traffic but also creates opportunities for cross-store purchases as customers explore other outlets during their visit.

Generic coupons often suffer from low redemption rates due to their lack of relevance. Personalized offers, on the other hand, align with customer preferences, significantly increasing the likelihood of redemption. This drives direct revenue growth while optimizing marketing expenditure.

Fig. 1. Architecture

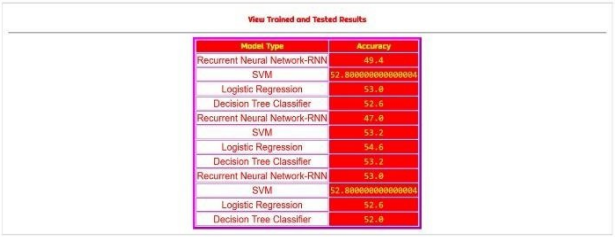

Fig. Fig 2. Accuracy

Personalized digital coupon issuance is a powerful strategy for maximizing mall revenue, benefiting both customers and operators. Enhanced customer engagement, increased foot traffic, higher sales performance, and strengthened retailer partnerships are among the key results achieved. Strategic decisions, including adopting machine learning algorithms, choosing the right platforms, and integrating analytics, ensure the success of coupon campaigns.

VI. Conclusion and Future Work

In future work, Improving shopping mall revenue is a complex yet attainable goal that requires a holistic strategy. As consumer expectations evolve, malls must adapt by embracing innovative, customer-centric approaches and leveraging data-driven decision-making. Personalized marketing campaigns, optimized layouts, diverse tenant mixes, and experiential offerings are key drivers for attracting foot traffic and enhancing customer satisfaction. By integrating cutting-edge technologies such as artificial intelligence and real-time analytics, malls can fine-tune their operations to achieve optimal results. This comprehensive framework provides a roadmap to improving shopping mall revenue by addressing key areas of customer engagement, operational efficiency, and technological integration.

Collaboration with retailers, combined with sustainability and eco-friendly initiatives, ensures long-term community and environmental impact, adding intangible value to the mall ecosystem. Regular monitoring and adjustments ensure that strategies remain effective amidst changing market conditions.

Employ algorithms like linear programming or genetic algorithms for efficient allocation of staff, promotions, and operational resources.Schedule events and campaigns during peak shopping periods to maximize impact.

Improving shopping mall revenue requires a multifaceted approach that blends customer-centric strategies, data-driven decision-making, and technological innovations. By focusing on enhancing customer experiences, personalizing marketing efforts, optimizing tenant mixes, and leveraging analytics, malls can effectively attract foot traffic, boost sales, and build strong retailer partnerships. Embracing digital tools such as real-time coupon issuance and recommendation systems further enables malls to remain competitive in the evolving retail landscape. Sustainability practices and community engagement add long-term value, fostering loyalty and trust. Overall, the key to success lies in adaptability, innovation, and maintaining a customer-focused ecosystem.

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AUTHORS PROFILE

ROJA.B is an Assistant professor in Eluru college of engineering an technology. Her blend of programming expertise, analytical thinking, and innovation makes her a valuable asset in technology and data-driven decision-making. Dedicated to continuous growth, she thrives in addressing complex challenges.

Mail.id:bhagavatularojasri33@gmail.com

USHA SURYA LAKSHMI .B is an AWS Academy Graduate skilled in C, Python, and web development. She excels in deep learning, machine learning, cloud computing, networking. Her blend of programming expertise, analytical thinking, and innovation makes her a valuable asset in technology and data-driven decision-making In the department of cse-artificial intelligence and data science.

Mail.id:ushabudda7@gmail.com

RAMYA SUDHA.Ch is an AWS Academy Graduate skilled in C, Python, and web development. She excels in deep learning, machine learning, cloud computing, networking, and data analytics. Her blend of programming expertise, analytical thinking, and innovation makes her a valuable asset in technology and data-driven decision-making. In the department of cse-artificial intelligence and data science.

Mail.id:ramyasudha1505@gmail.com

THARUN.B is an AWS Academy Graduate skilled in C, Python, and web development. He excels in deep learning, machine learning, cloud computing, networking. With a blend of *5programming expertise, analytical thinking, and innovation, he is a valuable asset in technology and data-driven decision-making. In the department of cse-artificial intelligence and data science.

Mail.id:tharunbuddala8@gmail.com

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SATYA HARSHITH.M is an AWS Academy Graduate skilled in C, Python, and web development. He excels in deep learning, machine learning, cloud computing, networking. With a blend of programming expertise, analytical thinking, and innovation, he is a valuable asset in technology and data-driven decision-making. In the department of cse-artificial intelligence and data science.

Mail.id:harshithmadda@gmail.com