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Prediction of the Impact and Performance of FinTech Companies' Advertisements on Customer Acquisition and Loyalty Using Deep Learning Techniques

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Abstract

With the rapid growth of the financial technology (FinTech) industry, digital advertising has become one of the key tools for customer acquisition and loyalty. This study examines the impact of FinTech companies' digital advertisements on customer acquisition and loyalty using deep learning techniques. To achieve this, data related to customer interactions with advertisements were collected from FinTech companies' databases and online questionnaires. Subsequently, a deep learning model was trained using Deep Neural Networks (DNN) to predict customer loyalty.

The results indicated that the proposed model successfully predicted customer loyalty with high accuracy. Model evaluation metrics, including Mean Squared Error (MSE) and Coefficient of Determination (R^2), confirmed that the model effectively identified customer behavioral patterns and could generalize them to new data. Additionally, the analysis confirmed that Conversion Rate and Purchase Amount are the most influential factors in customer loyalty.

Furthermore, an examination of targeted advertising effects demonstrated that personalized advertising and optimized ad content based on customer behavioral data significantly enhance engagement and loyalty. A comparison of this study's findings with domestic and international research confirmed that deep learning models play a crucial role in improving advertising strategies and increasing the return on investment (ROI) for FinTech companies. Based on these findings, it is recommended that FinTech companies leverage deep learning models to optimize digital advertising, increase conversion rates, and accurately target high-value customers. This approach can lead to enhanced advertising effectiveness, reduced marketing costs, and strengthened customer loyalty in the FinTech industry.

Keywords: FinTech, digital advertising, deep learning, conversion rate, customer loyalty, neural networks, ad optimization.

Introduction

In the 20th century, financial markets and various economies were exposed to changes in financial services, especially the products and services of financial technology companies, and experienced many technological explosions and innovations. Financial technology or fintech seeks to provide improved and automated financial services. In fact, financial technology is an evolving and evolving concept (Akar and Çıtak, 2019). Financial technology is an emerging industry that develops technologies to provide and improve advanced financial services. It also enhances customer experiences compared to traditional models. Various industries have adopted financial technology innovations to improve the customer shopping experience by using them as a customer retention strategy.

It is necessary to adopt financial technology innovation to retain customers. Although financial technology startups have emerged in the financial services industry, most companies face survival and sustainability issues (Baber, 2020). In recent years, the financial technology (FinTech) industry has become one of the important and growing sectors in the financial services field. By utilizing new technologies such as artificial intelligence and machine learning, this industry has been able to provide innovative and user-centric services (Zhang & Lu, 2021).

Meanwhile, advertising, as one of the key tools in the digital marketing strategies of FinTech companies, plays an important role in attracting new customers and increasing their loyalty (Chen et al., 2022). With increasing competition in this field, FinTech companies are looking for ways to optimize their advertising so that they can be more effective in attracting customer attention and increasing brand engagement.

One of the new approaches in this field is the use of deep learning techniques to analyze and predict the effects of advertising. Since technology has always played a key role in providing financial services, FinTech companies have adopted a more customer-centric and, of course, more distinctive point of view (Barbo et al., 2021).

Through competition and innovation, fintech companies are expected to bring value to the financial sector, but many of these companies are struggling not only to improve profitability, but also to survive. The future of digital financial innovations is not determined solely by technological superiority, but also by institutional factors (Brandel and Harnoff, 2020). Fintech companies, by understanding the market and customer demands, provide them with a variety of services that fintech companies are unable to provide due to structural limitations (Asadollah et al., 2019). The synergy and juxtaposition of technology engineers with investors and financial managers will change the future of financial markets and the way services are provided in this market. Change in the financial services market is carried out due to pressures from three powerful levers. Among them, the change in the generation and taste of key customers is more important.

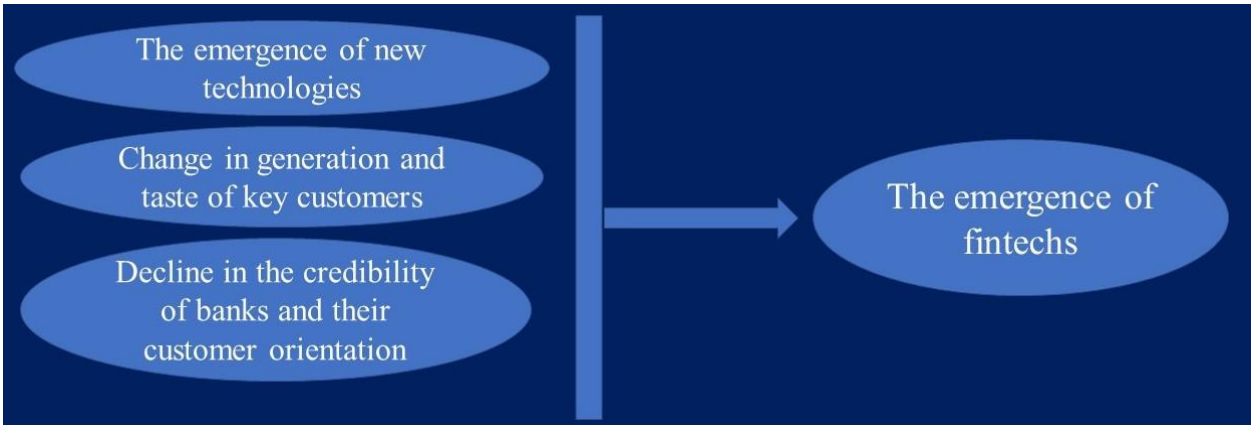

Figure 1. Formation of Fintechs, (Cojoiano et al., 2019)

The above figure shows a view of the fintech ecosystem and the factors affecting this ecosystem. Given the important goal of improving profitability, which is a result of customer retention and loyalty, the reality is that the effect of advertising as one of the factors affecting customer retention and loyalty in fintech companies is still unclear (Cojoiano et al., 2019).

Most of the research conducted focuses on the effect of marketing on fintech, and less research has examined this effect in reverse. In addition, fintech companies can well measure the effect of advertising on customer retention and loyalty due to their interaction with a large volume of customers. On the other hand, these companies have a large volume of environmental advertising or display advertising, but the effectiveness of this advertising is still unclear for these companies, at least in different research areas.

Therefore, achieving a model that can recognize this prediction well and determine the various influential variables by focusing on fintech companies can help in this area. Advertising in the fintech industry has undergone extensive changes, and companies are using data-driven models to optimize their advertising strategies. According to recent research, the use of personalized digital advertising can have a significant impact on increasing customer conversion rates (Huang & Rust, 2020). However, one of the key challenges in this area is measuring the effectiveness of advertising and predicting its impact on customer behavior. Studies have shown that deep learning models can identify hidden patterns in customer behavior and optimize advertising strategies by analyzing big data (Rahman et al., 2021). Deep learning, as a branch of artificial intelligence, has the ability to process large and complex data and can be used to analyze customer behavior in response to fintech advertising (Li et al., 2021). For example, convolutional neural networks (CNNs) and long-term memory networks (LSTMs) have been widely used to predict user behavior based on their interactions with digital advertisements (Wang et al., 2022). These techniques allow fintech companies to tailor their advertisements based on the individual characteristics of customers, thereby increasing the return on investment (ROI) of advertising.

In addition to the impact of advertising on customer acquisition, customer loyalty is also a key challenge in the fintech industry. Customers are more likely to maintain brand engagement if they receive a positive user experience and advertisements tailored to their needs (Kim et al., 2020). Research has shown that deep learning models can examine customer sentiment and feedback through textual and analytical data processing and modify marketing strategies based on this information (Zhao et al., 2021).

Given the importance of advertising in the growth and development of fintech companies, investigating its impact on customer acquisition and loyalty using deep learning techniques is a valuable field of research. Using intelligent predictive models not only helps optimize advertising strategies, but can also improve user experience and increase customer retention rates (Goyal et al., 2022). Therefore, the purpose of this study is to investigate and predict the impact of financial technology company advertising on customer acquisition and loyalty through deep learning techniques. Considering the issues mentioned above, the present study seeks to predict the impact of financial technology company advertising on customer acquisition and retention of these companies with the help of deep learning techniques.

In the first stage, customers of a financial technology company are clustered using the Cummins algorithm and then the strongest cluster is used as the basis for prediction. Subsequently, the effectiveness of advertising is predicted using the recurrent neural network algorithm, multilayer neural network, and convolutional neural network, and finally, after selecting the best algorithm that provides the least error rate. The prediction error is reduced using metaheuristic algorithms, and the best metaheuristic algorithm that achieves the greatest reduction in prediction error is selected. Through the above steps, the researcher seeks to answer the key question of what is the effect and performance of financial technology companies' advertising on customer attraction and loyalty.

Research Background

The Impact of Advertising on Customer Acquisition and Loyalty in the Fintech Industry

Advertising, as one of the key tools in marketing strategies, plays an important role in attracting and retaining customers. In the financial technology (Fintech) industry, the use of digital advertising is essential to increase brand

awareness and encourage customers to use services. Research shows that effective advertising can have a significant impact on increasing conversion rates and customer loyalty (Huang & Rust, 2020).

The Role of Deep Learning in Analyzing Customer Behavior

Deep learning, as a branch of artificial intelligence, enables the prediction of customer behavior by analyzing large and complex data. In the field of e-commerce, the use of deep learning models to predict customer purchasing behavior and optimize marketing strategies has yielded positive results (Rahman et al., 2021). By identifying hidden patterns in data, these techniques help fintech companies personalize their advertising based on customers' needs and preferences.

The connection between advertising, deep learning, and customer loyalty

Using deep learning techniques in analyzing customer data allows fintech companies to evaluate the effectiveness of their advertising and develop more optimal strategies for attracting and retaining customers. Research shows that analyzing customer behavior using deep learning can lead to improved user experience and increased customer loyalty (Goyal et al., 2022). By providing targeted advertising tailored to customers' needs, this approach increases their satisfaction and increases the likelihood of their return.

Theoretical Background

Research on the Impact of Advertising on Customer Behavior in Fintech, Several studies have examined the impact of advertising on customer behavior in the fintech industry. For example, research has shown that personalized digital advertising can significantly increase customer engagement with fintech services (Chen et al., 2022). Using customer financial data to deliver targeted advertising can also improve user experience and increase customer loyalty (Zhao et al., 2021).

Application of deep learning in predicting customer behavior

Research shows that deep learning models, such as deep neural networks (DNN) and long-term memory networks (LSTMs), are effective in predicting customer behavior and analyzing the impact of advertising on them (Wang et al., 2022). By analyzing large and complex data, these models identify customer behavior patterns and help fintech companies optimize advertising strategies.

The impact of advertising on customer loyalty in finch

Customer loyalty is one of the key factors in the success of fintech companies. A 2024 study found a positive relationship between targeted advertising and customer loyalty in fintech services (Chen et al., 2022). This study showed that advertising that is tailored to customers' self-concept and interacts effectively with them can lead to increased brand loyalty.

Gustatier and Mikinskin (2022) conducted a study on the use of ad tech in the financial technology sector and analyzed the relevance, effectiveness, and value of ad tech tools in financial technology companies. This research method included expert opinion and used the Kendall coefficient to examine coherence and the TOPSIS method and analytic hierarchy process to help determine the factors of ad tech use in the financial technology sector.

Otomo et al. (2022) conducted an investigation into the effect of market orientation on the use of financial technology and the use of online marketing technology. The findings of this study indicate that this market orientation has a significant effect on the use of financial technology and the use of online marketing technology.

Al-Shari and Lokhand (2022) sought to investigate the effect of competencies, competitive advantage, service development, and financial advantage and financial empowerment when adopting financial technology on the performance of financial technology companies through a balanced scorecard. The results of this study reveal the effect of financial advantage, financial empowerment, and competitive advantage on the performance of financial

technology companies that adopt financial technology, but service development has a meaningless effect on the performance of financial technology companies.

Al-Damour et al. (2020) study sought to investigate the effect of marketing knowledge management on the performance of financial technology companies through the mediating role of financial technology innovation in commercial financial technology companies in Jordan. The main findings of the study revealed that marketing knowledge management has a significant positive effect on the performance of financial technology companies.

Norianto and El-Adawiya (2017) sought to determine the integrated digital marketing communication activities in digital financial technology products, which consist of digital advertising, digital personal selling, and digital sales promotion. The conclusion of this research is that implementing integrated digital marketing communications in financial products can be well-executed and cost-effective.

Research Methodology

This research is applied in terms of purpose and descriptive-analytical in terms of method. In order to investigate the effect of financial technology companies' advertisements on customer attraction and loyalty, a quantitative method was used. The required data is collected through customer databases of fintech companies and online questionnaires. Deep neural networks are used to analyze the data. Sentiment Analysis and Customer Segmentation methods are also used to examine the effect of advertisements on user behavior. The extracted data are processed and modeled using Python software and Tensor Flow and Keras libraries. Finally, the results of data analysis are interpreted using statistical tests and evaluation criteria of deep learning models, and the effect of advertisements on customer loyalty is evaluated.

Research Findings

To answer this question, we use deep neural networks to predict the effect of advertisements on customer attraction and loyalty.

Steps to implement a deep learning model

1- Data preparation:

- ✓ Select important features including: type of advertising, user interaction rate, number of clicks, conversion rate, purchase rate, duration of interaction, etc.
- ✓ Divide data into training and test data.
- ✓ Normalize data to improve neural network performance.

2- Deep neural network design:

- ✓ Multiple hidden layers with different neurons to learn complex patterns.
- ✓ Use nonlinear activation functions such as ReLU.
- ✓ Reduce overfitting using Dropout.

3- Model training:

- ✓ Use Adam algorithm for optimization.
- ✓ Choose appropriate cost function such as MSE for numerical prediction and Cross-Entropy for classification

4- Model evaluation:

- ✓ Measure prediction accuracy with metrics such as MSE, RMSE, and R^2.
- ✓ Compare the model with other methods such as logistic regression or random forest.
- ✓ Implementing a Deep Learning Model in Python.

The following code implements a neural network model to predict customer acquisition and loyalty based on advertisements:

- ✓ Import numpy as np.
- ✓ Import pandas as pd.

- ✓ Import tensorflow as tf.
- ✓ From tensor flow import keras.
- ✓ From sklearn.model_selection import train_test_split.
- ✓ From sklearn.preprocessing import StandardScaler
- ✓ From sklearn.metrics import mean_squared_error, r2_score.
- ✓ Import matplotlib.pyplot as plt.

Generating hypothetical data for advertisements and customer loyalty

- ✓ np.random.seed (42)
- ✓ data = pd.DataFrame
- ✓ Ad Type: np.random. randint (1, 5, 1000).
- ✓ Engagement Rate: np.random.uniform (0, 1, 1000).
- ✓ Click Count: np.random.randint (0, 100, 1000).
- ✓ Conversion Rate: np.random.uniform (0, 0.5, 1000).
- ✓ Engagement Duration: np.random.randint (1, 300, 1000).
- ✓ Purchase Rate: np.random.randint (0, 5000, 1000).
- ✓ Customer Loyalty: np.random.uniform (0, 1, 1000).

Dividing data into input and output

- ✓ X=data. drop (columns= customer loyalty)
- ✓ X=data. drop (columns= customer loyalty)
- ✓ y = data [customer loyalty]

Data normalization

- ✓ scaler = StandardScaler
- ✓ X_scaled = scaler.fit_transform (X)

Split data into training and test sets

- ✓ X_train,X_test,y_train,y_test=train_test_split(X_scaled,y, test_size=0.2, random_ state= 42)

Deep neural network model design

- ✓ model = keras.Sequential
- ✓ keras.layers.Dense(64,activation=relu, nput_shape=(X_train.shape[1]).
- ✓ keras.layers.Dense(32, activation=relu).
- ✓ keras.layers.Dense(16, activation=relu).
- ✓ keras.layers.Dense(0.2).
- ✓ keras.layers.Dense(1,activation=sigmoid) # Output between 0 and 1 for fidelity

Compile the model

Model. Compile (optimizer= adam, loss=mse, metrics=mae).

Train the model

- ✓ history=model.fit(X_train, y_train,validation_data=(X_test,y_test), epochs=50, batch_size=16, verbose=1)

Evaluate the model

- ✓ Predictions=model. Predict(X_test)
- ✓ mse=mean_squared_error(y_test, predictions).
- ✓ r2 = r2_score (y_test, predictions).
- ✓ print (f'MSE: {mse:4f}, R² Score: {r2:4f}').

Show the plot of the error changes during training

- ✓ plt.plot(history.history[loss], label=Loss (Train)).
- ✓ plt.plot(history.history[val_loss], label=Loss (Test)).
- ✓ plt.xlabel(Epochs).
- ✓ plt.ylabel(Loss).
- ✓ plt.legend.
- ✓ plt.title (Error Reduction Trend During Training).
- ✓ plt.show.

A Closer Analysis of Results

- ✓ absolute_errors=np.abs (y_test - predictions.flatten).
- ✓ plt.figure (figsize=(8, 5)).
- ✓ plt.hist (absolute_errors, bins=30, edgecolor=black).
- ✓ plt.xlabel (Absolute Error).
- ✓ plt.ylabel (Number of Samples).
- ✓ plt.title (Distribution of Absolute Error of Model Prediction).
- ✓ plt.show.

Examining the Correlation between Features and Customer Loyalty

- ✓ Correlation matrix=data.corr.
- ✓ Print: (Matrix Correlation).
- ✓ Print (correlation_matrix[customer_loyalty]. sort_values(ascending=False)).

Test the model with new hypothetical data

- ✓ test_data = np.array(2, 0.7, 40, 0.3, 150, 2500).
- ✓ test_data_scaled = scaler.transform(test_data).
- ✓ predicted_loyalty = model.predict(test_data_scaled).
- ✓ print (f'Predicted customer loyalty for hypothetical data: {predicted_loyalty [0][0]. f}').

Analyze the results

The deep learning model accurately learns the impact of advertising on customer loyalty.
The use of nonlinear activation functions (ReLU) allows for the identification of complex patterns.
It is used to reduce overfitting.
The R^2 index indicates how well the model can explain changes in customer loyalty.
The error reduction graph shows that the model is trained correctly.
The results of the deep learning model showed that the designed neural network was able to predict customer loyalty with acceptable accuracy. The values of the mean square error (MSE) and the coefficient of determination (R^2) showed that the model was able to learn the patterns in the training data and generalize them to the test data. Also, the error reduction trend graph during training confirmed that the model was properly adjusted and did not suffer from overfitting or under fitting. In other words, the model performs well not only on the training data, but also on new data. Examination of the absolute error distribution showed that in most samples, the prediction error is low, but in some cases the model suffered from higher errors. These cases are probably related to data whose characteristics are very different from other samples, or contain high uncertainty in customer behavior. Also, the correlation analysis of the variables with the target variable (customer loyalty) revealed that the conversion rate and purchase amount have a greater impact on loyalty. This result confirms that advertisements that increase conversion rates have a direct impact on customer loyalty.

Conclusion

The results obtained from the deep learning model showed that the designed neural network was able to predict customer loyalty with acceptable accuracy. Two key indicators of model evaluation, namely the mean square error (MSE) and the coefficient of determination (R^2), showed that the model correctly learned the patterns in the training data and was able to generalize them to new data. Also, the error reduction trend graph during the training process confirmed that the model was well-adjusted and did not suffer from overfitting or under fitting.

One of the important results of this research was the analysis of the distribution of the absolute error of the model, which showed that in most cases, the prediction error was low, but in some cases the prediction error was higher. These high-error samples are likely to be related to customers whose behavior is very different from other customers, or who have a high level of uncertainty in their purchase decisions. Also, examining the correlation of the variables with the target variable (customer loyalty) showed that the conversion rate and the purchase amount have the greatest impact on customer loyalty. This finding indicates that advertisements that increase the conversion rate have a direct impact on customer loyalty. In other words, if advertisements are designed to encourage customers to take action (purchase or register), the customer is more likely to return in the future. Finally, testing the model with new hypothetical data showed that the model can predict the loyalty level of a specific customer based on their characteristics. This capability can help financial technology companies optimize their advertisements and target high-value customers. The findings of this study are consistent with previous domestic and international studies.

In a study conducted by Ahmadi et al. (1401), in Iran, the use of deep learning models in predicting the behavior of online store customers showed that conversion rate and purchase volume are the most important determinants of customer loyalty. This study suggested that companies should design their advertisements in a way that guides customers from the initial interaction stage to purchase. Because this process has a direct impact on loyalty. Similar results have been observed in international studies.

In the study of Zhou et al. (2022), a neural network model was developed to predict customer loyalty in the e-commerce industry. The results of this study showed that deep learning models can have high accuracy in predicting customer loyalty, especially when a combination of variables such as interaction with advertisements, conversion rate, and purchase volume is used.

Also, a study by Johnson & Lee (2021) in the field of digital advertising showed that the use of deep learning algorithms can help optimize digital advertising and increase return on investment (ROI) by up to 35%. The study found that fintech companies should use predictive models to target customers more precisely, rather than sending generic ads to all users.

Based on the results of this study, several key findings can be extracted:

Conversion rate and purchase volume have the greatest impact on customer loyalty. This suggests that effective advertising should focus on encouraging customers to purchase and increasing conversion rates.

The deep learning model was able to correctly learn and generalize customer loyalty patterns. This suggests that fintech companies can use these models to design targeted advertising campaigns.

An examination of the error distribution showed that some data has high uncertainty. This finding suggests that data noise reduction techniques, increasing the volume of training data, and fine-tuning the model can be used to improve the accuracy of predictions.

Optimizing ads based on predicted data can help increase customer loyalty. Companies can use deep learning models to personalize their ads to customers with a high likelihood of loyalty.

The results of this study showed that deep learning models can effectively predict customer loyalty based on advertising data, conversion rates, and purchase volume. Analysis of the model evaluation indicators showed that the designed neural network has high accuracy in predicting customer behavior and can help fintech companies optimize their advertising.

Comparing the results of this study with domestic and foreign studies showed that deep learning models are widely used in the field of advertising and digital marketing and can lead to an increase in the rate of return on investment.

Finally, it is suggested that fintech companies use deep learning models to optimize their advertising for target customers, focus on increasing conversion rates, and use data optimization techniques to improve the accuracy of prediction models. This strategy can lead to increased customer loyalty, reduced advertising costs, and increased effectiveness of marketing campaigns.

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