Sentiment Analysis Based Ethereum Blockchain Crowdfunding Decentralized Application

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Abstract - Decentralized **crowdfunding application is used for raising funds in small quantities from large number of people. These funds are for a project that can be of any social cause or an innovative and creative idea. In this paper, we have used Ethereum Blockchain for building this project. We have deployed the smart contract on the Sepolia Testnet. We built the frontend using React.js library where we at first gave the functionality to connect to the Metamask wallet to identify every user uniquely as well as to facilitate the transactions of cryptocurrency. The smart contracts were deployed on the Sepolia Testnet using the Remix IDE. Here we implemented the new feature of governance where once the campaign goal is reached, then the funds will remain on hold and will not be directly transferred to the campaign owner. The voting will be broadcast to all the doners after a certain period where the doners will vote if they find that campaign is legitimate or not based on their own research during the time. Also, we trained a Support Vector classifier (SVC) model based on the dataset from the Kaggle to predict the legitimacy of the campaign based on the title and description of the campaign. The doners can use the model to predict the legitimacy of the campaign. The application will allow the campaign owner to create the campaign on the application. The backer can donate to the campaign and due to governance, the funds remain on hold and once more than 50% backers vote to the decision to transfer the funds, then only the funds will be transfer to the campaign owner. The doners can predict the legitimacy of the campaign through our application which is based on the Support Vector Classifier (SVC) model.**

Keywords **– Crowdfunding; Governance; Support vector classifier; Sepolia Testnet; Metamask; Ethereum Blockchain.**

I. INTRODUCTION

In the digital era, crowdfunding has emerged as a transformative mechanism for raising funds, enabling individuals and organizations to support innovative ideas, social causes, and entrepreneurial ventures. However, traditional crowdfunding platforms face significant challenges, such as limited transparency, lack of accountability, and the potential misuse of funds by campaign owners. These issues undermine the trust of backers, thereby impacting the credibility of the crowdfunding ecosystem. Addressing these concerns necessitates a decentralized approach that ensures both transparency and secure fund management.

This research will implement blockchain technology and sentiment analysis throughout the development of a Sentiment Analysis-Based Ethereum Blockchain Crowdfunding Decentralized Application. The application on the Ethereum blockchain would maintain the trend of the decentralization of crowdfunding towards increases in transparency and trustworthiness. Additionally, through integration with the application of a Support Vector Classifier (SVC) model for sentiment analysis, campaigns can be judged as authentic or not by their title and description, and hence evaluated accordingly. This approach equips funders with information to make prudent decisions and offers a feature called governance that prevents misappropriation of funds.

The purpose of the present study is to introduce an innovative decentralized application that combines blockchain technology with machine learning in an effort to address the long-standing problem currently associated with crowdfunding. Integration of both immutability and security derived from blockchain with predictive capabilities of sentiment analysis will ensure that it is only after validation through backer voting that funds are disbursed. It does this by using a set of smart contracts that have been deployed onto the Ethereum Sepolia Testnet, with a user interface built with React.js. Therefore, within this research framework, the imaginative capacities for predictive tools and a robust governance framework can redefine standards for transparency and accountability within the crowdfunding space.

Fraud in crowdfunding has expanded and is on the increase, with cases ranging from misleading campaigns, backer fraud, to platform manipulation. Our system takes advantage of the transparency and immutability of a blockchain to reduce fraudulent campaigns because all transactions are recorded and cannot be altered. Using the Support Vector Classifier model, we improve early detection and prediction of fraudulent activities, which is the lacking gap in fraud prevention. Smart contracts also add yet another layer of security in that funds are released only after predefined milestones have been achieved. Perceived fraud risks are greatly reduced, which often goes with delays or failure in rewards-based campaigns, accounting for more than 30-40% of the crowdfunded industry's complaints. Immutable transaction records will also prevent backer fraud in the form of fund reversals that affected more than 100 campaigns according to recent studies. In addition, the transparent funding and identity verification reduce backer-creator fraud as it eliminates a possibility of self-contributions. Furthermore, because blockchain is decentralized, it also helps decrease the number of intermediaries depended upon - one of the big issues facing the fast-growing global $5 billion market for crowdfunding wracked by portal-enabled fraud. Building on these considerations, our project establishes trust in this safer, more efficient crowdfunding ecosystem.

The rest of this paper is organized as follows: Section 2 outlines the motivation for this research. Section 3 provides an overview of related work in blockchain-based applications and sentiment analysis. Section 4 discusses the methodology, including the deployment of smart contracts and integration of machine learning models. The results and analysis are detailed in Section 5, followed by the conclusion in Section 6.

II. MOTIVATION

Crowdfunding platforms have mushroomed into a multibillion-dollar industry, with global crowdfunding reaching $13.9 billion in 2021; however, such rapid growth had problems such as fraudulent campaigns, misallocation, and lack of transparency. The European Commission further reported that in 2020, 13% of all crowdfunding campaigns turned out to be a failure or were fraudulent and left thousands of backers empty-handed and not receiving anything as promised. Examples in real life, such as the case with the 2016 Prodege campaign or the Theranos one with its bogus backers or creators of abused funds have, among other things, made trust lack and insecurity some major issues for the traditional crowdfunding platforms. However, most of the sites still rely on intermediaries and traditional payment gateways that are exposed to fraud and hacking. For instance, the largest crowdfunding platform, Kickstarter, has already had cases of over $6 million in fraudulent projects since its invention. Such cases not only harm the reputation of crowdfunding but also deter potential backers from participating owing to the risk of funding scams. Blockchain technology, specifically through Ethereum smart contracts, can address these critical issues by ensuring that funds are only released when clear conditions are met. Blockchain’s transparency, immutability, and decentralized nature make it an ideal solution to mitigate the risks of fraud, provide auditability of funds, and reduce reliance on intermediaries. This research will make use of smart contracts through Ethereum to develop a safe yet transparent crowdfunding platform that tracks real-time funds and keeps the creator answerable to hitting all milestones set for the project. In dealing with the security and transparency shortcomings within the crowdfunding ecosystem, research hopes to infuse back trust into creating equitable fairness and brings efficiency into a secure system both from the side of creators and backers.

III. RELATED WORK

In recent approaches have been proposed towards crowdfunding Decentralized Application. We described some of the approaches as follows.

Shrishti Varshney et al. have used the Goerli faucet as the test net which is now deprecated which makes this project irrelevant. Crowdfunding platform mainly focuses on creating regulatory environment for crowdsourcing and emphasizes the use smart contract which was the main advantage of this project. Again, the transaction in this process takes nearly 15-20 seconds which is one of the advantages. In this we found that deploying on a better test net is mandatory to stay relevant and usable [1].

Praharsh churi et. al. have used the Ethereum blockchain network which is one of the most used networks around the world with large support of community and users as well. This project has one big advantage is that usage of MATIC Cryptocurrency as the user base for this currency is very less and for such kind of projects, addressing the large audience is must. From this project we found that using cryptocurrency with large user base is necessary as it helps to raise the funds easily [2].

Sushanth Kumar reddy kura et. al. have used the Rinkeby test net which is now deprecated which makes this project irrelevant. Also, the use of the ETHER is their main advantage. The lack of governance feature is the major disadvantage of this project which we found that can be implemented using the smart contract and emphasize the use of ETHER crypto to address the large set of doners to promote innovation among the startups [3].

Swarup Chattopadhyay et. al. have not explicitly mentioned governance mechanisms. However, governance could be integrated into the platform through smart contracts, allowing stakeholders to participate in decision-making processes related to fund allocation, project approval, and platform management. Their main advantage is usage of ETHER Cryptocurrency which serves the large set of doners [4].

Prof. Ujwala Gaikwad et. al. have used the polygon network where the smart contract is deployed, which is one of the major advantages of it as it reduces the transaction speed. Donors can track the whereabouts and utilization of their contributions in this project. A major disadvantage of the use of polygon is that it limits the scalability of crowdfunding app. This project helps us to figure out which blockchain network will be the best choice for this project [5].

Firmansyah Ashari et. al. have highlighted the importance of the use of the smart contract and its use to Shorten the submission of campaign and the disbursement of funds and to eliminate dependency on third party. Their project directed us to use smart contracts wisely and in the most effective manner [6].

Syed Abdul Dalim et. al. have used Etherscan API to display the details of transactions performed by users, either fail or success. Also, the use of Rinkeby test net which is now deprecated makes this project irrelevant. All users can view the records of each transaction which can be seen by using Etherscan API. The drawback of the Etherscan API lies in its dependency on a third-party service, potential privacy concerns, limited control over data and functionality, rate limiting, security risks, and possible costs. Instead, direct interaction with Ethereum blockchain is preferred [7].

Singh Rawat et. al. have highlighted the major challenges in the crowdfunding which is the sometimes terrorist groups would try to raise money by passing themselves off as a charity or non-governmental organization (NGO) that helps starving people in Yemen, Lebanon, and other underdeveloped countries and also the same person or fund raiser may introduce the campaign on two different platforms more than once, frequently with the same name and objectives and also having the right idea behind the project is most crucial [8].

IV. METHODOLOGY

A. Wallet Connection

The first point in developing a blockchain-based dApp setting up a secure wallet connection often usually serves as the starting point. The wallet gives the user access to the blockchain, ensuring both secure transactions and interactions with smart contracts, and also opens access to on-chain assets. Based on our application, this will support the smooth-running process of all the stages: from creating a campaign to launching a smart contract and receiving donations.

Tokens represent digital assets on the blockchain, often used for transactions or utility within dApps, while non-fungible tokens (NFTs) are unique assets representing ownership of digital or physical items. Testnet faucets, like Ethereum Sepolia FAUCET BY Google Cloud, provide developers with free tokens like Sepolia ETH to test and deploy smart contracts without incurring real-world costs. These tools are integral to blockchain application development and testing [9].

The following figure shows the integration of a Metamask wallet with the Sepolia testnet and presents its interface, detailed balance, transaction history, and token management abilities. Metamask is an extremely popular cryptocurrency wallet and is essential if one wants to interact with dApps on Ethereum compatible blockchains. In this instance, the wallet contains a balance of 4.546 Sepolia ETH that is a testnet type of token only used for development and testing.

The below figure illustrates the connection between a Metamask wallet and multiple sites, including localhost:3000, where our dApp is under active development. This connection is indispensable for testing and running the crowdfunding application on the Sepolia Testnet, a blockchain network used to simulate real-world scenarios without incurring costs or risks. Fig. 1. Shows the connection of crowdfunding application with the Metamask wallet [10].

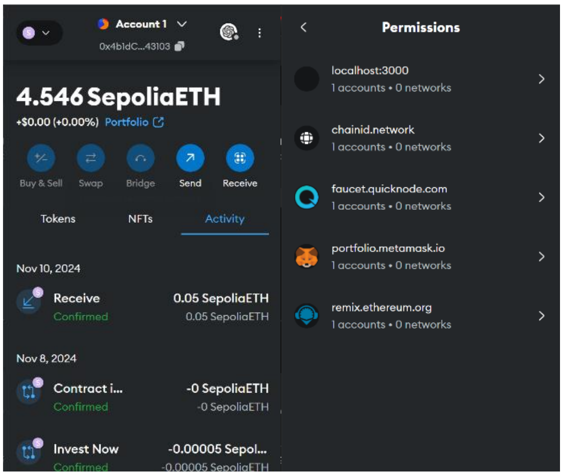

Fig. 1. Metamask connection with the Application

B. Smart contract deployment

Smart contracts are self-executing programs on the blockchain; they implement the rules of the contract automatically, without a central authority or an intermediary. More globally, this is achieved through writing logic in the programming language for Ethereum smart contracts, Solidity. This logic is created using the Remix IDE, which is a web-based integrated development environment specifically designed for Solidity. For instance, in the case of crowdfunding applications, the functionalities include creating a campaign, accepting donations, and withdrawing the funds. Essential features such as access control and state validation would ensure that security and reliability are developed within the smart contract.

Once written, Remix IDE compiles the code to bytecode, ready to run on the EVM. Compilation also occurs to catch syntax errors or to even fix them, as well as optimization warnings. After this, the contract is deployed onto one of Ethereum's test environments, Sepolia Testnet, which enables developers to test applications without spending Ether. Deployment Connect Remix IDE with a wallet on the Sepolia Network configured to Metamask SepoliaETH. The token for the test network is used in this deployment to pay for gas fees.

Upon deployment, the smart contract retrieves an address from the Sepolia blockchain. One can then call functions to create campaigns and send funds to these addresses. All such interactions as well as deployments of the smart contract can be followed and confirmed by blockchain explorers like Sepolia Etherscan. In that manner, campaign data is maintained safely on the blockchain, which can only be achieved by transparency, immutability, and trust in the application.

Creating the smart contract in the Solidity language on the Remix IDE is the next step as all the Test companies will be created according to the campaign smart contract deployed on the Testnet. All the campaigns data will be stored in the blockchain. Fig. 2. Shows the recent transaction on the deployed smart contract with the help of the contract address.

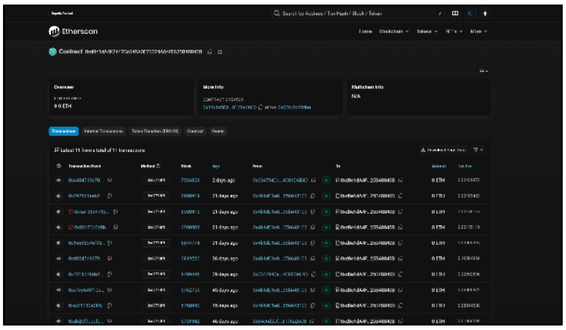

Fig. 2. Recent Contract transactions shown on Etherscan.

C. Creating the components in React Application.

In the React application, several components are built to get an enhanced user experience in the crowdfunding platform. The Button component is used in handling user interactions such as form submissions and navigation. In addition, it also develops the CampaignCard component, where more information than usual may be placed about each of the crowdfunding campaigns, so that users can easily browse and identify those going on. The DashboardCard is for the use dashboard. It produces key statistics and relevant information of a very concise manner. For the campaign in detail view, the CampaignDetails shows extensive information and allows the user to interact with specific actions relating to the campaign. The Header manages the navigation bar so that users may access various sections of the platform easily. The Home component is a landing page with an overview and access to featured campaigns. The ProgressBar component's function uses the Progress component in Ant Design, indicating visually the campaign's fundraising progress. Lastly, the Loader component is applied when, for example, content needs to be fetched or processed before the screen is fully displayed. All these components combined form the base of the application with its dynamic and user-friendly interface. Fig. 3. Shows the forms for taking the input of the campaign details.

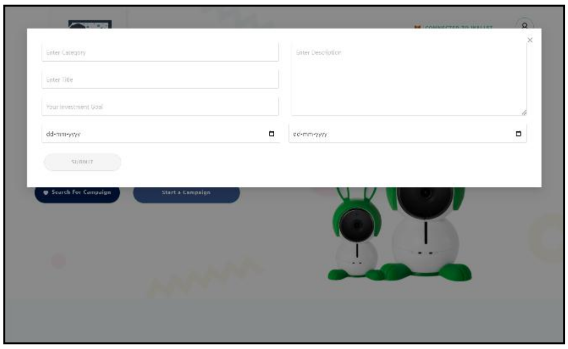

Fig. 3. Form to take input the campaign details.

D. Creating the campaign details page.

The crowdfunding application campaign details page is intended to provide a comprehensive and technical overview of the live campaign, thus supporting user engagement and decision-making. The campaign details page generally includes such vital parts as campaign name, description, start and end dates, and the name of a campaign's creator so that the potential backers would be exposed to enough contextual elements needed for evaluation of the projects. For instance, in terms of status relative to funding the campaign, the value is displayed against the goal, and the amount raised is expressed in value in the cryptocurrency Ethereum (ETH) as well as its equivalent value in a local currency, here, INR. This gives the user a clear indication of the monetary context. As for the levels of user engagement, several actionable buttons are added to the "Sharks". The "Vote" button would enable the users to vote in support of the campaign, the "Transactions" button would make it transparent by opening transaction history for the campaign including donations and funding activity, and the "Other Details" button would give access to or unveil more campaign-specific information like updates about the campaign, progress milestones, or other media relating to the campaign. The page also displays a connected wallet status for the user, thus completing it as an integral part of contributions made through the website. It helps users to easily contribute toward their Favorite digital currency in different forms, which may be ETH.

Additionally, the "Analyze" button offers analytical insights, presenting real-time statistics and performance metrics related to the campaign's funding progress, donor activity, and other relevant data. Overall, this technical layout, as shown in Figure 4, ensures that all critical aspects of the crowdfunding campaign are readily accessible to the user, optimizing transparency, ease of interaction, and informed decision-making for potential backers.

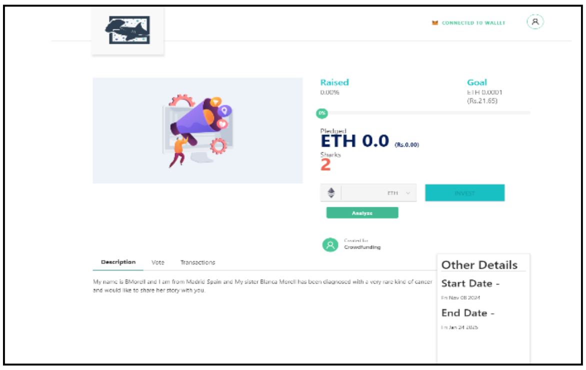

Fig. 4. Campaign page displaying status of campaign

E. Sentiment analysis using support vector classifier.

Developing and training a machine learning model for sentiment analysis to predict the legitimacy of the campaign. The entire Support Vector Classifier model is trained on the text and its sentiments. The campaign title and description are used for doing the sentiment analysis on that specific campaign by combining both and using the TF-IDF.

a) Dataset

There are a total of seven columns in the dataset from the Kaggle and only two are of our interest which are the text and its sentiment. The entire dataset is labelled dataset. Text is the primary textual data, representing user-generated content in natural language. Sentiment is the emotional tone of the text, categorized into three distinct sentiment classes. The dataset's sentiment analysis reveals three distinct categories. Neutral sentiment accounts for 30% of the total entries, indicating a balanced or unbiased emotional tone. Null sentiment represents 27% of the entries, where sentiment information is either unavailable or missing, highlighting gaps in the data. The remaining 44% falls under the other category, which includes positive sentiment and additional classifications not encompassed by the primary categories, representing a broader range of emotional expressions.

b) Support vector classifier model for sentiment analysis

i) The Support Vector Classifier (SVC) is a supervised machine learning algorithm used for classification tasks. It is a specific implementation of the broader Support Vector Machine (SVM) framework. SVC aims to find the best decision boundary (hyperplane) that separates data points of different classes in a feature space, maximizing the margin between them.

ii) Hyperplane: A hyperplane is a decision boundary that separates data points into classes. For a dataset with n features, the hyperplane is an (n−1) dimensional subspace. Mathematically it can be shown as:

$$w \cdot x + b = 0$$

Where:

- w is the weight vector perpendicular to the hyperplane.
- x is the feature vector.
- b is the bias term (offset from the origin).

iii) Margin: The margin is the distance between the hyperplane and the closest data points (support vectors) from either class. The goal of SVC is to maximize this margin, ensuring better generalization of unseen data.

iv) Objective Function: The optimization problem for SVC involves minimizing the following function:

$$\min \frac{1}{2} \mid\mid w \mid\mid 2$$

$$Subject\ to:\quad yi(w \cdot xi + b) \geq 1 \forall i$$

Where:

-yi is the class label (+1 or −1).

-xi is the feature vector of the ith data point.

v) Prediction: Once the SVC is trained, the decision function for a new data point x is given by:

$$f(x) = sign\left(\sum_{n}^{i=1} \alpha yiK(xi, x) + b\right)$$

Where:

- αi are Lagrange multipliers determined during training.
- C is a regularization parameter controlling the trade-off between maximizing the margin and minimizing classification errors.

c) Result classification

The entire classification is done in the categories of the Not Genuine, Potentially Genuine and Genuine based on the description and the title of the campaign. Below figure 5, we can see the model predicting the legitimacy of the campaign.

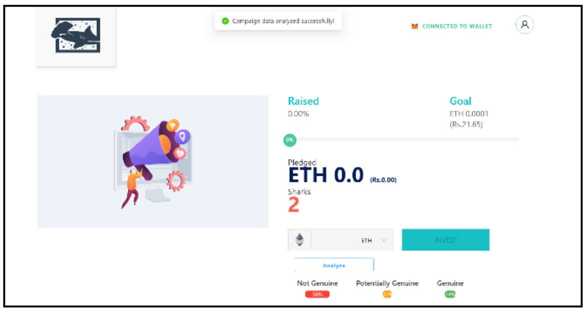

Fig.5. Model Predicts the Legitimacy of the Campaign

F. Governance feature.

The governance feature keeps the funds on hold after the goal of the campaign is met or campaign owner closes the campaign early. The funds will not get disbursed directly to the campaign owner and will wait for the voting of backers of that specific campaign which will be going to decide whether the funds should be disbursed to the campaign owner or not based on the voting percentage of the backers. If the votes are above 50 percent of the total backer's number, then the funds will be immediately disbursed to the owner. The voting period depends on the business logic and can be changed.

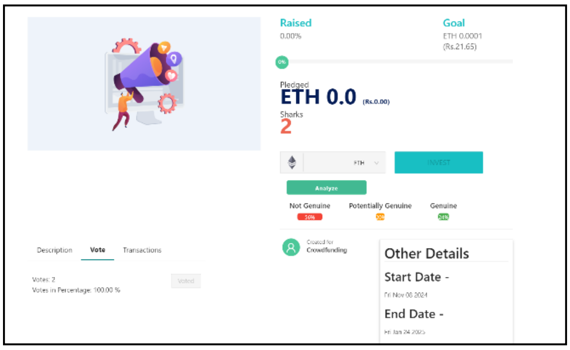

Fig. 6. Governance feature for fund disbursement

V. RESULT AND ANALYSIS

A. Dataset

We used the Sentiment analysis dataset from the Kaggle for training the machine learning model. This dataset provides a robust foundation for experiments in sentiment classification, offering diverse examples spanning various timeframes and contexts.

B. Model Evaluation

We chose the Support Vector Classifier as a machine learning Model. We have used the following measures to evaluate our proposed approach for fake social media profiles detection.

a) Accuracy: Accuracy evaluates the overall efficiency of a categorization model. It is the proportion of accurately predicted occurrences to the total number of examples in the dataset.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

b) Precision: Precision assesses the accuracy of the positive predictions made by the model. It is the ratio of true positive predictions to all positive predictions.

$$Precision = \frac{TP}{TP + FP}$$

c) Recall: The model's ability to properly identify positive cases is measured by recall. It is the proportion of genuine positive predictions to all occurrences of true positive prediction.

$$Recall = \frac{TP}{TP + FN}$$

d) F1-Measure (F1-Score): The F1-measure is an assessment of the model's performance since it is an average of accuracy and recall.

$$F1 - Measure = \frac{2 . Precision . Recall}{Precision + Recall}$$

Following figure 7 shows the performance metrics bar graph.

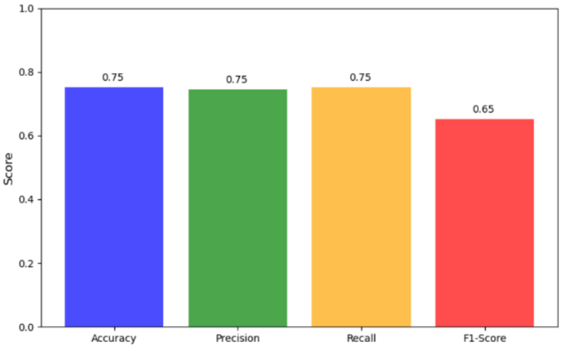

Fig. 7. Model Performance Metrics

The four metrics considered are Accuracy, Precision, Recall, and F1-Score. Accuracy represents the overall correctness of the model's predictions, Precision measures the proportion of positive predictions that are correct, Recall indicates the proportion of true positives that are correctly identified, and F1-Score is the harmonic mean of Precision and Recall, providing a balanced measure of both. The graph shows that the model achieves relatively high accuracy and precision, indicating that most of its predictions are correct and relevant. However, the recall is lower, suggesting that the model might miss some true positive cases. The F1-Score, which balances precision and recall, is also lower than the other metrics, indicating a potential trade-off between these two aspects.

The below figure shows the confusion matrix visualizes the performance of a multi-class classification model. Each cell represents the number of instances that were in a certain class (True Labels) but were predicted to be in a different class (Predicted Labels). We have three classes: Negative, Neutral, and Positive. The diagonal elements represent the correct predictions, where the true label and predicted label match. The off-diagonal elements indicate incorrect predictions. For example, the value in the first row, third column (45) shows that 45 instances belonging to the Negative class were incorrectly predicted as Positive. The confusion matrix can be used to calculate various performance metrics like accuracy, precision, recall, and F1-score for each class and overall. Below Figure 8 shows the confusion matrix for the same.

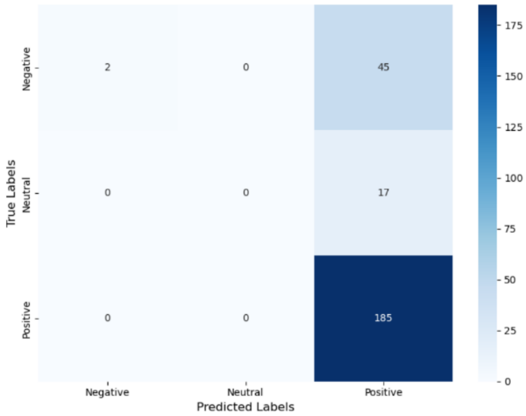

Fig. 8. Confusion Matrix for SVC Model

The table presents the performance evaluation metrics of a multi-class classification model, specifically focusing on three classes: positive, negative, and neutral. The model performs well for the neutral class, with high precision, recall, and F1-score. However, it struggles with the positive and negative classes, especially the negative class, which has very low precision and recall. The overall accuracy is moderate, likely due to the imbalance in class distribution. The weighted average metrics are closer to the neutral class's performance, indicating that the model's overall performance is heavily influenced by the majority class (neutral). Below fig. 9. is the classification report.

Class	Precision	Recall	F1-Score	Accuracy
positive	1	0.04	0.08	0.75
neutral	0.75	1	0.86	0.75
negative	0	0	0	0.75

Fig. 9. Classification Report of the Model

C. Final results

Finally, in the last out crowdfunding platform enables any business or any organization to raise the funds for their project without diluting the equity of their business shares in the market and allow the backers to donate to the campaign. The backers can have insight into the legitimacy of the campaign and predict whether the given campaign is legitimate or not based on the title and description of the campaign.

VI. CONCLUSION

The Sentiment Analysis-Based Ethereum Blockchain Crowdfunding Decentralized Application presents an innovative solution to address the critical issues of transparency, accountability, and trust in crowdfunding platforms. By integrating Ethereum blockchain technology with sentiment analysis using a Support Vector Classifier (SVC) model, the application ensures that funds are only disbursed to campaign owners after rigorous validation through backer voting. This governance mechanism empowers backers, fostering a more democratic and secure funding ecosystem where contributions are protected from misuse. The application demonstrates the potential of combining decentralized technologies and machine learning to enhance user confidence and decision-making. The deployment of smart contracts on the Sepolia Testnet ensures tamper-proof execution of campaign-related processes, while the React.js-based front-end provides an intuitive user experience with seamless wallet integration. The inclusion of the sentiment analysis model, achieving a predictive accuracy of 75.10%, equips backers with additional insights to evaluate campaign legitimacy, further improving the reliability of the platform. This research highlights the transformative role of blockchain and machine learning in building trust-driven systems and sets a foundation for future advancements in decentralized applications. By refining the machine learning model, exploring additional datasets, and expanding governance features, this project has the potential to redefine crowdfunding standards. It serves as a significant step toward fostering innovation and accountability in decentralized ecosystems, ensuring that backers and creators alike can engage with confidence in a transparent and secure environment.

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