

**VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF
TECHNOLOGY**
(An Autonomous Institute Affiliated to University of Mumbai)
Department of Computer Engineering



Project Report on

**FinCalls - Earnings Calls Analyzer and Annual
Public Financial Reports Chatbot**

Submitted in partial fulfillment of the requirements of the
degree

**BACHELOR OF ENGINEERING IN COMPUTER
ENGINEERING**

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**VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF
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CERTIFICATE

This is to certify that the Mini Project entitled “**FinCalls - Earnings Calls Analyzer and Annual Public Financial Reports Chatbot**” is a bonafide work of **Tasmiya Khan (30), Purtee Mahajan (39), Ketaki Nalawade (44), Srushti Satish Sambare (54)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of “**Bachelor of Engineering**” in “**Computer Engineering**” .

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Mini Project Approval

This Mini Project entitled “**FinCalls - Earnings Calls Analyzer and Annual Public Financial Reports Chatbot**” by **Tasmiya Khan (30), Purtee Mahajan (39), Ketaki Nalawade (44), Srushti Satish Sambare (54)** is approved for the degree of **Bachelor of Engineering in Computer Engineering**.

Examiners

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Date:

Place:

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Earnings calls are hosted by companies to discuss their financial conditions, providing stakeholders with insights into quarterly results, operational highlights, future guidance, and an opportunity for a Q&A session with analysts and investors. The information can be overwhelming for some investors. Calls lasting for a long duration can cause information overload. There occurs a high probability of disclosure bias. Also, even if the transcript is available, it is a time consuming task to study and analyze it. Using Fincalls - Earnings Calls Analyzer, we try to solve the above problems by generating the transcript using Assembly AI, summarizing it using BART (a large-sized model fine-tuned on CNN Daily Mail) and performing timeline analysis using flask,PyPDF2,spaCy,Matplotlib and termcolor.

Company public reports, such as annual reports, quarterly reports, and other regulatory filings, provide information regarding a company's financial health, performance, and strategic initiatives. Users can either upload the report from the device or just search and upload from the website itself, multiple financial reports and chat with them. The chatbot is efficient, to not only answer the straight-forward extractive questions, but various reasoning questions too. This is done using Google's PaLM2 LLM and Custom search API.FAQs are generated as the pdf is uploaded and data visualization is also created as per the prompt given to the chatbot.

Thus, using the Fincalls - Earnings Calls Analyzer and the Public reports chatbot, businesses can make impactful decisions, engage stakeholders with transparency, and gain a competitive advantage in responding swiftly to market dynamics leading to an unstoppable growth!

Chapter 1: Introduction

1.1 Introduction

Earnings calls play an important role in boosting the investments in the company by conducting economic communication. Earnings conference calls follow the quarterly release of a firm's earnings, and have increased in popularity in recent years, mainly because of their ease of accessibility through modern communication mediums (e.g., applications like EarningsCast, interactive investor-relation websites)[2][3]. The purpose of these calls is to tell the market about the firm's future strategy and tactics, as well as to comment on the previous quarter's revenue streams and costs[2][3].

Technical and financial analysis of the company along with the fundamental analysis of the economy is to be taken into account while investing in the capital market[4].A variety of factors influence investors' perceptions of various investing options[4].Data visualization and interpretation are becoming increasingly crucial in today's commercial world[5].Timeline based analysis gives a lot of insights about the companies activities in the past,present and future.Various companies have annual public financial reports which need to be analyzed.

Therefore, developing an analyzer for these earning calls and a chatbot for the annual public financial reports in which users can upload multiple annual reports and ask questions about the reports ,give prompts for data visualization and comparative analysis has become crucial in order to help the investors to make profitable decisions.

1.2 Motivation

Access to reliable and timely information is essential in the dynamic world of finance and investing. Earnings calls are a goldmine of complete data that investors, analysts, and decision-makers may use to make knowledgeable decisions. These conversations provide access to the inner workings of businesses and a window into their financial situation, business plans, and potential outcomes.

The requirement to effectively collect, analyze, and evaluate the content of earning calls is a problem in this flood of data, though. Earning calls may last for hours and are filled with technical terms, subtle terminology, and inconsistent audio quality. These calls can be difficult and time-consuming to listen to, transcribe, and understand. Also, the transcript generation is only performed in English majorly so transcription in multiple languages was challenging. Performing comparative analysis of the annual public financial reports of the companies quickly and through visualization was crucial. Integrating transcription, transcript summarization, timeline analysis for earning calls analysis and chatbot for annual public financial reports all at one place was another problem which was important to be addressed.

These problems served as our inspiration for starting the "FinCalls - Earnings Calls Analyzer and Annual Public Financial Reports Chatbot" project. We understood how much this process might be streamlined by using cutting-edge technologies. Our goal was to completely transform the way earning calls and annual public financial reports are analyzed.

1.3 Problem Definition

FinCalls - Earnings Calls Analyzer and Annual Public Financial Reports Chatbot aims to provide the facilities of transcript generation, transcript summarization, timeline based analysis of the corporate earning calls and a chatbot to find answers to questions from multiple annual public financial reports, create data visualization and comparative analysis of reports all at one single platform for the investors to leverage its power and make informed decisions.

1.4 Existing Systems

The existing systems for earning calls analyzer are :

- 1) Decode Investing : It is an AI-powered tool that simplifies the process of searching, analyzing, and reviewing earnings call transcripts. It serves as an indispensable assistant for stock market analysts and investors, providing them with valuable insights directly from earnings calls.
- 2) StockGPT : It is an AI search tool for transcripts dating back to Q2 2011. It can answer questions related to Tesla's earnings call and provide specific quarter and year associated with the transcript. However, it may produce inaccurate or incomplete answers. It cannot predict the future or provide financial advice.
- 3) EarningsDigest.Ai : It is an AI based tool that transforms earnings calls into concise AI-powered summaries. Save hours reading lengthy earnings call transcript, summary of highlights, guidance, strategic insights, and sentimental analysis.
- 4) AlphaResearch : It helps investors extract information from unstructured texts, filings, earnings call transcripts, and much more to help with investing decisions and analysis of stocks and companies financial information and more.
- 5) Listen411: Podcast Transcription Summarization by Listen411 offers lightning-fast transcription services, converting 1-hour audio files into text in just 1 minute. With a pay-as-you-go model at \$0.06 per minute, users can easily transcribe files by simply uploading them in various formats such as AAC, MP3, or WAV.
- 6) Frex : It is an AI tool focused on effortless financial analysis. It allows users to retrieve precise information from SEC filings using AI, eliminating the need for manual data crunching. The tool offers real-time access to knowledge-based information available up to September 2021.

The existing systems for chatbot are :

ChatPDF : It is a free, online tool that can assist you with any PDF-reading task. By uploading your PDF file to the platform, you'll receive an AI-generated summary and potential questions you could ask, to help you learn more from your document.

1.5 Lacuna of the existing systems

There's a risk of producing inaccurate or incomplete answers, which can undermine the reliability of the information provided. The AI-powered summaries may not always capture the nuances or key details of the earnings calls accurately, potentially leading to oversimplified or misleading insights. It may not forecast future trends or provide financial advice, limiting its utility for investors looking for forward-looking insights.

ChatPDF did not offer the capability to input company names and years to retrieve annual public financial reports from various sources across the internet. It also lacked the functionality to download and upload multiple annual public financial reports in PDF format. Moreover, it was unable to answer questions related to comparative analysis or generate responses in tabular format and graphs. Additionally, it did not provide answers to open-ended or future scope-based questions.

Moreover , the biggest lacuna of all the existing systems is that they don't have the features of analyzing the earning calls and annual public financial reports at one single platform.

1.6 Relevance of the Project

Our project entitled “FinCalls - Earnings Calls Analyzer and Annual Public Financial Reports Chatbot” is a one stop solution for the investors as it combines the analysis of earning calls through transcript generation , transcript summarization and timeline based analysis along with the comparative analysis and data visualization of multiple annual public financial reports via chatbot at one single platform. Our FinCalls has a very friendly UI and gives accurate and useful results. This can be used by investors in real time to make informed decision before investing in any company which may help them make profit and avoid losses. Overall, our web app can be a very useful tool in the finance sector.

Chapter 2: Literature Survey

A. Brief Overview of Literature Survey

The literature survey conducted for FinCalls - Earnings Calls Analyzer and Annual Public Financial Reports Chatbot likely encompasses a broad range of sources related to natural language processing (NLP), sentiment analysis, financial reporting, and machine learning. Here's a concise overview:

NLP Techniques: The survey would explore various NLP methodologies, such as named entity recognition, topic modeling, and sentiment analysis. It would likely delve into recent advancements and state-of-the-art approaches in processing and understanding textual data.

Financial Text Analysis: Research in financial text analysis would be crucial, covering studies on parsing and interpreting financial documents like earnings calls transcripts and annual reports. This would involve understanding the linguistic nuances and specific terminologies prevalent in financial discourse.

Sentiment Analysis: A significant portion of the survey would focus on sentiment analysis techniques tailored for financial text. This includes exploring lexicon-based approaches, machine learning algorithms for sentiment classification, and sentiment aggregation methods.

Machine Learning in Finance: Given the application domain, the survey would likely include literature on machine learning models applied to financial data analysis. This might encompass predictive modeling, anomaly detection, and classification tasks relevant to financial text processing.

Chatbot Design and User Experience: Beyond the technical aspects, the survey might also cover research on conversational agents and chatbot design principles. This includes studies on user interaction, dialogue management, and user experience considerations specific to financial applications.

Ethical and Regulatory Considerations: The survey may touch upon ethical and regulatory considerations in deploying AI-based systems in financial contexts. This includes compliance with data privacy regulations, bias mitigation techniques, and transparency in algorithmic decision-making.

B. Related Works

2.1 Research Papers Referred

Paper 1 : [6] Volatility Forecasting via Text Audio Fusion with Graph Convolutional Networks for Earnings Calls | Year : 2020

a. Abstract of the research paper

Natural language processing has recently made stock movement forecasting and volatility forecasting advances, leading to improved financial forecasting. Transcripts of companies' earnings calls are well studied for risk modeling, offering unique investment insight into stock performance. However, vocal cues in the speech of company executives present an underexplored rich source of natural language data for estimating financial risk. Additionally, most existing approaches ignore the correlations between stocks. Building on existing work, we introduce a neural model for stock volatility prediction that accounts for stock interdependence via graph convolutions while fusing verbal, vocal, and financial features in a semi-supervised multi-task risk forecasting formulation. Our proposed model, VolTAGE, outperforms existing methods demonstrating the effectiveness of multimodal learning for volatility prediction.

b. Inference drawn

Incorporating vocal cues from company executives during earnings calls, along with textual and financial features, can significantly improve stock volatility prediction. The VolTAGE model, which utilizes a combination of neural components including graph convolutional networks, multi-utterance attention mechanisms, and semi-supervised multi-task risk forecasting, outperforms existing methods by effectively capturing cross-modal signals and inter-stock correlations. This multi-modal approach demonstrates the utility of integrating verbal-vocal coherence with graph-based features for more accurate volatility forecasting following earnings calls.

Paper 2 : [8]Transformer-based Models for Long Document Summarisation in Financial Domain | Year : 2022

a. Abstract of the research paper

Summarisation of long financial documents is a challenging task due to the lack of large-scale datasets and the need for domain knowledge experts to create human-written summaries. Traditional summarisation approaches that generate a summary based on the content cannot produce summaries comparable to human-written ones and thus are rarely used in practice. In this work, we use the Longformer-Encoder-Decoder (LED) model to handle long financial reports. We describe our experiments and participating systems in the financial narrative summarisation shared task. Multi-stage fine-tuning helps the model generalize better on niche domains and avoids the problem of catastrophic forgetting. We further investigate the effect of the staged fine-tuning approach on the FNS dataset. Our systems achieved promising results in terms of ROUGE scores on the validation dataset.

b. Inference drawn

The Longformer-Encoder-Decoder (LED) model shows promise in handling long financial documents for summarisation tasks. The researchers found that using LED as a pre-trained language model and formulating the task as extractive summarisation led to improved performance compared to other state-of-the-art systems in the financial narrative summarisation shared task. Additionally, the study highlighted that multi-stage fine-tuning did not significantly impact the performance of the LED-based systems, suggesting that the model's inherent capabilities were effective in summarizing financial reports.

Paper 3 : [9] Automating the Extraction of Financial Data – KTH Bachelor Thesis Report | Year : 2022

a. Abstract of the research paper

It is hard for retail investors and data providing companies to obtain financial data of European companies. The work of extracting financial data of European companies is most likely done manually, which is a time-consuming process. This would explain why European companies' data is supplied slower than American companies. This thesis attempts to see if it is possible to automatise the process of extracting financial data of European companies by creating two proof of concept systems. One focuses on collecting financial reports of European companies using a web scraper and directly scraping the reports from the source. The other system extracts financial data from the reports using AmazonWeb Services(AWS), specifically the text extraction tool called Textract. The system that collects financial reports from companies could not be automated and did not meet the expectations set by the company that commissioned the thesis. The system that extracts financial data from companies was promising as all data points of interest could be extracted. The second system was deemed promising however since it is reliant on a system that supplies it with reports, it cannot be implemented. The work conducted shows that automating the process of extracting financial data from European companies is not (yet) possible. Extracting the data from reports is possible however collecting the report is the bottleneck which is not possible. It would have been better to manually collect financial reports instead of using a web scraper in this thesis. This was a bottleneck which could be solved in future projects.

b. Inference drawn

The system that collects financial reports using a web scraper did not achieve the desired results, the system that extracts financial data from the reports worked perfectly with 100% accuracy. The system that collects financial reports needs improvement, but there is potential for it to be useful with adjustments. It suggests that a more efficient web scraper, potentially controlled by an AI model, could be developed to navigate to the correct investor relations pages and collect financial reports. Additionally, the use of Machine Learning models to classify financial reports from other PDF files could improve the accuracy of collecting financial reports.

Paper 4 : [10] Survey Paper On Youtube Transcript Summarizer | Year : 2023

a. Abstract of the research paper

The goal of this project is to construct a chrome extension that will send a request to a backend REST API, conduct NLP, and return a summary version of a YouTube transcript to improve the surfing experience without distracting from it. This procedure combines both transcript production and text summarizing. To generate the transcript, first convert the video to audio using the PyTube package, which extracts audio in mp3 format. A toolkit called hugging sound is used for text creation from audio. Spacy, an NLP library, is used for text summarizing. Moreover, an API based on Flask is being developed to allow users to communicate with the backend, as well as a Chrome extension to give a user-friendly browsing experience.

b. Inference drawn

A YouTube Transcript Summarizer project has been developed to improve the user experience of watching YouTube videos. The project involves using a Chrome extension to send requests to a backend REST API, conduct Natural Language Processing (NLP), and provide a condensed summary of a YouTube video's transcript. This project aims to save users time by extracting relevant information from videos without the need to watch the entire content. The system uses NLP modules, libraries like SpaCy and transformers like PyTube and Hugging Sound for text summarization. The architecture includes processes for transcript creation, text summarization, backend connection, and Chrome extension creation. The project benefits users by providing summarized text without the need to watch the entire video, helping them identify important information and avoid irrelevant content.

Paper 5 : [11] Financial Knowledge Graph Based Financial Report Query System | Year : 2021

a. Abstract of the research paper

Annual Financial Reports are the core in the Banking Sector to publish its financial statistics. Extracting useful information from these complex and lengthy reports involves manual process to resolve the financial queries, resulting in delays and ambiguity in investment decisions. One of the major reasons is the lack of any standardization in the format and vocabulary used in the reports. An automated system for resolution of intelligent financial queries is therefore difficult to design. Several works have been proposed to overcome these problems using Information Extraction; however, they do not address the semantic interoperability of the reports across different institutions. This work proposed an automated querying engine to answer the financial queries using Ontology based Information Extraction. For Semantic modeling of financial reports, a Financial Knowledge Graph, assisted by Financial Ontology, has been proposed. The nodes are populated with entities, while links are populated with relationships using Information Extraction applied on annual reports. Two benefits have been provided by this system to stakeholders through automation: decision making through queries and generation of custom financial stories. The work can further be extended to other domains including healthcare and academia where physical reports are used for communication.

b. Inference drawn

It discusses the challenges faced by stakeholders in extracting financial information from company reports and the proposed solution of integrating information extraction with the semantic web to create a Financial Knowledge Graph. It outlines the methodology for extracting information from annual reports, developing an ontology, and creating a knowledge graph. It also discusses the process of querying the knowledge graph to provide answers to user queries related to financial information. The document emphasizes the importance of automating the extraction of financial data to make it more accessible and useful for stakeholders.

Paper 6 : [7]A Pattern Recognition approach to automated XBRL extraction Year : 2012

a. Abstract of the research paper

Using example-based Pattern Recognition methods and combining years of developing both EDGAR filings and natural language processing software, BCL Technologies has developed SmartXBRL©, a simplified and automated way to create a compliant XBRL document. In this paper we describe the methods adopted to identify and extract the face financial tables, Document and Entity Information (DEI), Parenthetical, and financial Notes from a 10-Q financial document.

b. Inference drawn

It describes the development of SmartXBRL© by BCL Technologies, which is an automated system for creating compliant XBRL documents by extracting financial information from 10-Q financial documents. The system focuses on identifying and extracting Document and Entity Information (DEI), financial tables (Income Statement, Cash Flow, Balance Sheet, and Stockholders' Equity), parenthetical information, and financial notes from the 10-Q documents. The methods used include pattern matching algorithms and keyword-based searches. The accuracy of the system in identifying and extracting these elements is evaluated using precision and recall measurements. The study concludes by discussing future work to improve the accuracy of extracting parenthetical tables and financial notes, as well as extending the extraction methods to other financial documents like 10K, 6K, and 8K.

2.2 Comparison with the existing system

	USP1	USP2	USP3
needle.ai	Comparison with past transcripts	Sentiment Analysis	Clip and convert financial results to word files
seekingalpha	Provides only the transcripts	Stock and news related services	

Table 2.4.1. Existing systems

Chapter 3: Requirement Gathering for the Proposed System

3.1 Introduction to requirement gathering

The success of any software project hinges on its ability to meet the needs and expectations of its users. Therefore, a comprehensive requirement gathering process serves as the foundation upon which the entire project is built. For "FinCalls - Earnings Calls Analyzer and Annual Public Financial Reports Chatbot," this process is crucial in understanding the intricate demands of investors and stakeholders within the finance sector.

Identifying Stakeholders: The first step in requirement gathering is identifying the stakeholders who will be impacted by the project. In the case of FinCalls, stakeholders may include investors, financial analysts, fund managers, and regulatory bodies. Understanding their roles, responsibilities, and expectations is essential for crafting a solution that addresses their needs.

Gathering User Requirements: Next, it's imperative to gather user requirements through various means such as interviews, surveys, and workshops. This involves understanding the specific features, functionalities, and user experience expectations of the target audience. For FinCalls, this may include the ability to generate accurate transcripts, visualize financial data effectively, and provide real-time insights through the chatbot interface.

Analyzing Existing Solutions: Conducting a thorough analysis of existing solutions and market trends helps in identifying gaps and opportunities for innovation. By understanding the strengths and weaknesses of competitor products, FinCalls can differentiate itself by offering unique features and functionalities that cater to unmet user needs.

Defining Functional and Non-functional Requirements: Functional requirements specify what the system should do, while non-functional requirements define how it should perform. For FinCalls, functional requirements may include transcript generation, comparative analysis, and chatbot integration, while non-functional requirements may encompass scalability, reliability, and security.

Prioritizing Requirements: Not all requirements are created equal, and prioritizing them helps in allocating resources effectively. By categorizing requirements as must-have, should-have, and nice-to-have, the development team can focus on delivering essential features first while keeping room for future enhancements.

Documenting Requirements: Documenting requirements in a clear and concise manner ensures alignment among stakeholders and serves as a reference throughout the project lifecycle. Requirement documents for FinCalls may include use cases, user stories, wireframes, and system specifications.

Iterative Approach: Requirement gathering is not a one-time activity but an iterative process that evolves as the project progresses. Regular communication and collaboration with stakeholders help in validating and refining requirements based on changing needs and priorities.

3.2 Functional Requirements

Functional requirements of Earnings Call Analyzer:

Transcript Generation:

- It should be able to generate accurate transcripts of earnings calls from audio recordings.
- It should generate the transcript quickly.

Transcript Summarization:

- It should provide summarization of earnings call transcripts to highlight the words searched on the search bar.
- Summarization should condense lengthy transcripts into concise summaries without losing important information.

Timeline-based Analysis:

- It should allow users to view the results on specific periods of interest such as past, present and future through the timeline.
- The content of the timeline analysis should be accurate and the response time required for its generation should be very less.

Functional requirements of Chatbot :

Search bar :

- The chatbot should be able to search the annual public financial reports from all over the internet based on the company name and year entered on the search bar.
- Users should be able to download the annual public financial reports and upload it for processing.

Frequently Asked Questions(FAQ) generation :

- After uploading the financial report , FAQs based on the annual public financial report should be generated.

Comparative Analysis :

- Users should have the ability to compare the financial performance of multiple companies based on their annual public financial reports.
- Comparative analysis should include metrics such as revenue, profit margins, earnings per share, and other key financial indicators.
- It should give sensible answers to open ended questions.

Data Visualization:

- The chatbot should offer interactive data visualization to present financial data in graphs.
- Visualization should enable users to identify trends, patterns, and anomalies in the data quickly and intuitively.

3.3 Non-Functional Requirements

Performance:

- The system should be responsive and provide quick access to information, with minimal latency in generating transcripts, summarizations, and analysis results.
- The system should be able to handle a large volume of user requests simultaneously, especially during peak usage times.
- Response times for chatbot interactions and data visualization should be within acceptable limits, even under heavy load.

Scalability:

- The system should be designed to scale horizontally and vertically to accommodate increasing user demand and data processing requirements.

Reliability:

- The system should be highly reliable, with minimal downtime and maximum uptime to ensure continuous availability for users.

Usability:

- The user interface should be intuitive, user-friendly, and visually appealing, with clear navigation paths and informative feedback messages.
- Accessibility features should be implemented to ensure that the system is usable by individuals with disabilities, complying with relevant accessibility standards and guidelines.

Compatibility:

- The system should be compatible with a wide range of devices, web browsers, and operating systems to ensure seamless access for users across different platforms.

Maintainability:

- The system should be designed with modular components and well-documented code to facilitate easy maintenance, troubleshooting, and future enhancements.

3.4.Hardware, Software , Technology and tools utilized

1. Frontend: The frontend will be done using React.js - a JavaScript Frontend Framework which will provide a user interface for our project.
and streamlit for chatbot interface.

2. Backend:

- a. Transcript Generation: We used Assembly AI for transcribing the earning call received which is in the form of audio.
- b. Transcript Summarization:
 - i. Tech stack: Language: Python
 - ii. Libraries: ReportLab: for PDF generation
transformers: for tokenization and utilizing pre-trained Facebook's BART (Bidirectional and Auto-Regressive Transformers model), a large-sized model fine-tuned on CNN Daily Mail
re: for regular expressions

`os`: for file handling

c. Timeline Based Analysis:

- i. Flask: A lightweight Python web framework for building web applications.
- ii. PyPDF2: A Python library for reading and manipulating PDF files.
- iii. spaCy: An open-source natural language processing library in Python.
- iv. Matplotlib: A plotting library for creating static, animated, and interactive visualizations in Python.
- v. termcolor: A Python library for ANSI color formatting.

d. Search and get Annual Public Financial Reports from all over the web:

- i. Requests: The Requests library is used for making HTTP requests to the Google Custom Search API to retrieve search results.
- ii. Urllib: The Urllib library is used for parsing the PDF URLs obtained from the search results.
- iii. Google Custom Search API: This API is utilized for searching PDFs based on the provided query, company name, and year. It returns JSON responses containing search results.

e. Chat with multiple Annual Public Financial Reports

- i. PyPDF2: PyPDF2 library is used for extracting text from PDF documents.
- ii. langchain: The LangChain library seems to be a custom library for NLP (Natural Language Processing) tasks. It includes modules for text splitting, embeddings, language models, vector stores, conversational retrieval chains, and memory management. Specific components used include:
 1. RecursiveCharacterTextSplitter: Used for splitting text into chunks.
 2. GooglePalmEmbeddings: Used for generating embeddings of text chunks.
 3. GooglePalm: A language model (LLM) used for generating responses to user queries.

4. FAISS: A library for efficient similarity search and clustering of dense vectors. Used for creating vector stores from text chunks.
 5. ConversationalRetrievalChain: Used for managing conversational context and generating responses based on user queries.
 6. ConversationBufferMemory: Used for maintaining conversation history.
- iii. OS: The OS module is used for environment variables and file operations.

3.5 Constraints

1. Accuracy of External Services: The accuracy of transcription by AssemblyAI and search results from Google Custom Search might not be perfect. This can lead to errors in downstream analysis.
2. Limited Scope of NER and Summarization: NER and summarization techniques might not capture all nuances of financial language or complex sentence structures. This could lead to incomplete or inaccurate summaries.
3. Scalability of Database: Storing large volumes of transcript data in chunks within MongoDB could pose scalability challenges for very high usage scenarios.
4. Dealing with Annual Public Financial Reports: Our chatbot only takes input annual reports of 200mb per file.

Chapter 4: Proposed Design

4.1 Block diagram of the system

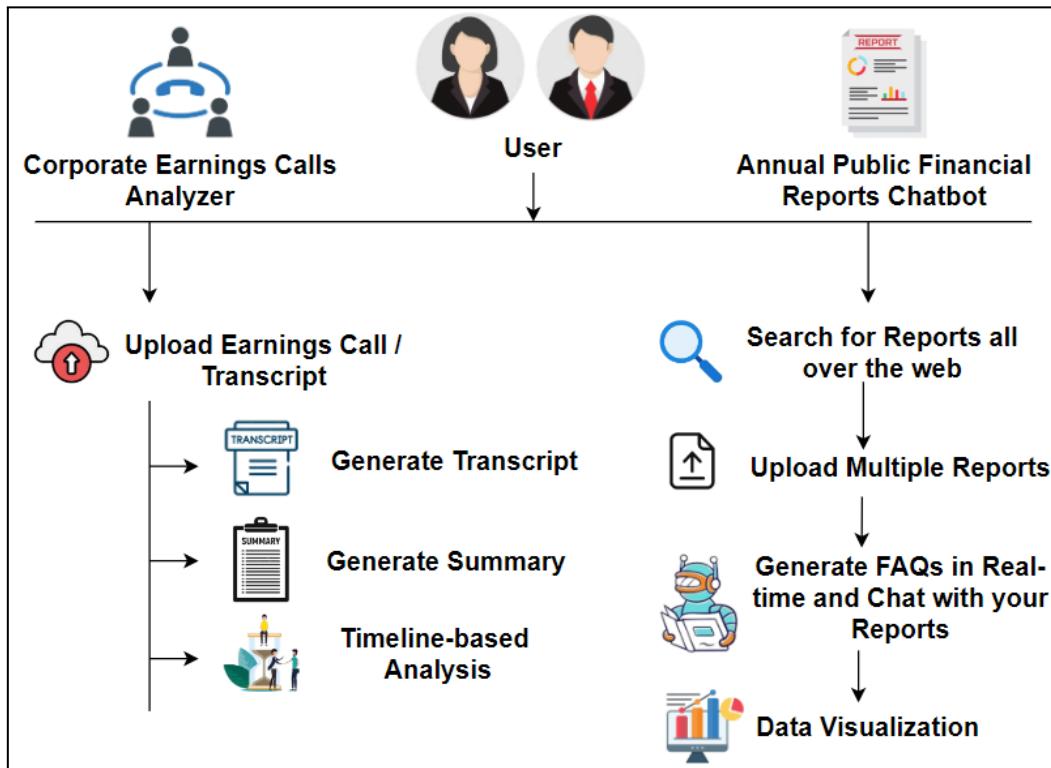


Fig 4.1.1. Block diagram of system

The following diagram, 4.1.1, describes the components of our system. It consists of two major modules. First, if the user has a corporate earnings call in audio format or has a transcript of the call, he can upload it. This call will be processed and saved in the database in text format. After a successful upload, the user can generate a transcript of the call. He can also generate a summary of that call. The last internal module is timeline-based analysis, which will divide the chunk of transcript into three chunks, which will be past, present, and future, based on the grammatical structure of each sentence and give an overview of it by means of a graph.

The other module is our chatbot, which takes input from the annual public financial report. If the user has a report with him, he can upload it to our chatbot. If he doesn't, then he can search for the report for that specific company all over the web and then download and upload it. After uploading, real-time FAQs are generated based on four specific categories. The user can give any prompt and get an accurate response from the chatbot. Our chatbot is not only capable of answering straight-forward questions but also open-ended questions related to risk, etc.

4.2 Modular design of the system

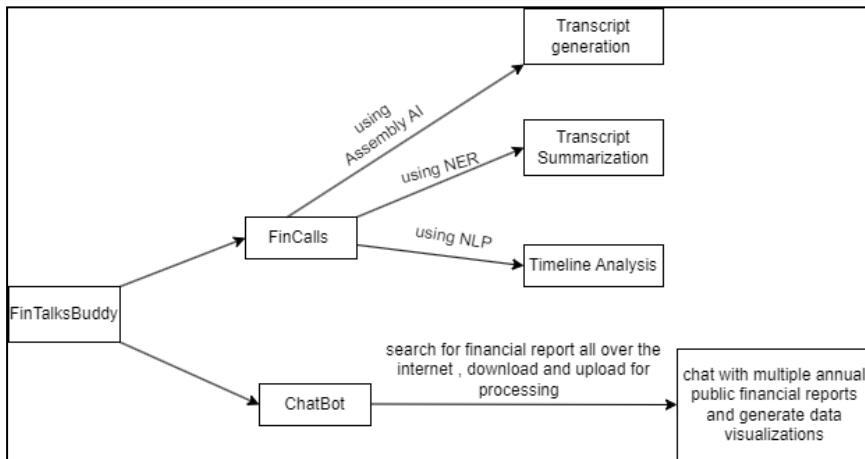


Fig 4.2.1. Modular design of system

4.3 Detailed Design

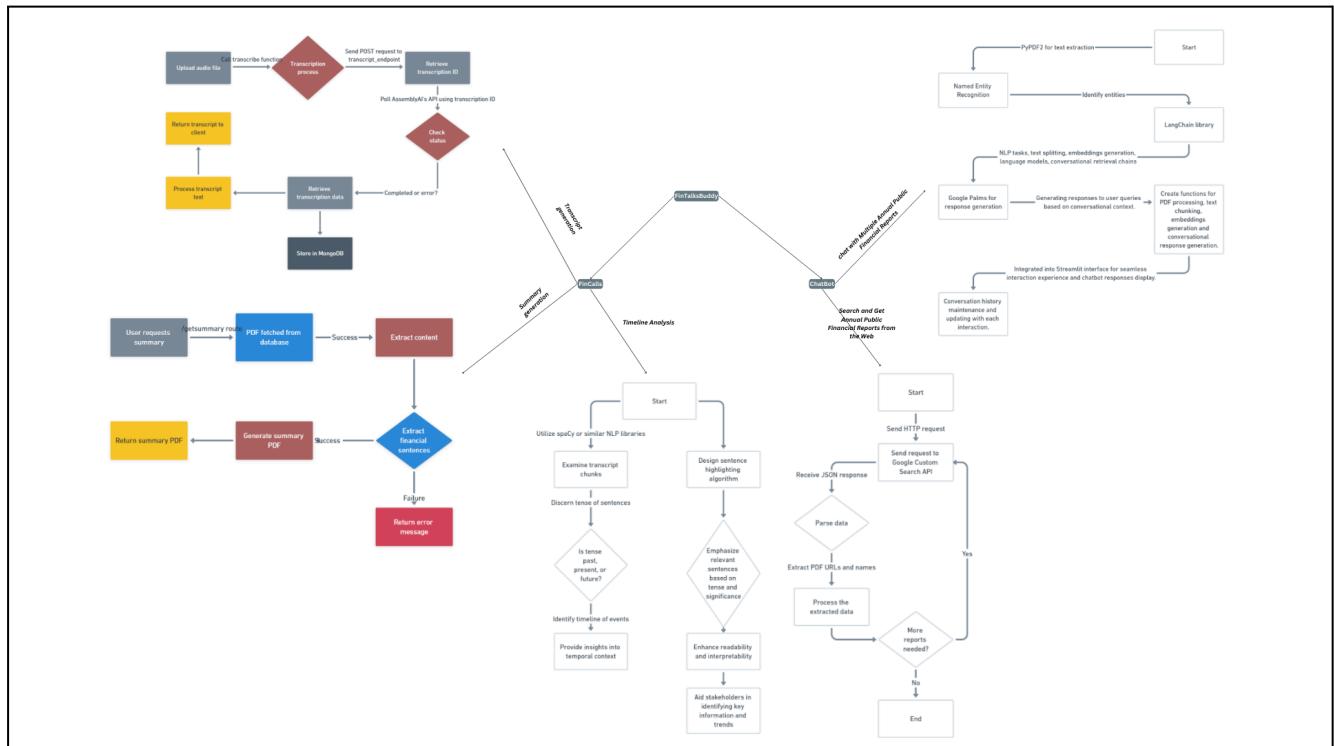


Fig 4.3.1. Modular design of system

4.4 Project Scheduling & Tracking using Timeline / Gantt Chart

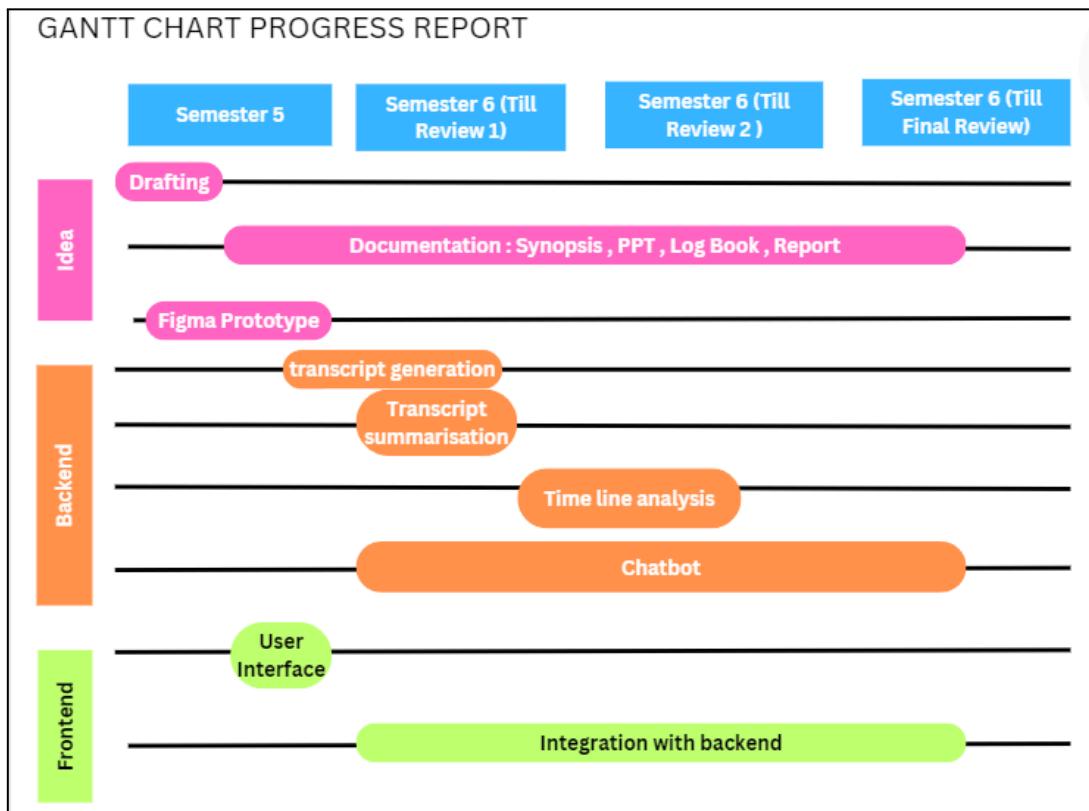


Fig 4.4.1.Gantt chart of system/Tracking using Timeline

Chapter 5: Implementation of the Proposed System

5.1. Methodology employed for development

A. Dealing with Corporate Earnings Calls:

1. Transcript Generation:

- Allow users to upload either an audio clip or a transcript of the earnings call.
- Utilize AssemblyAI for transcribing audio files of earnings calls if an audio clip is uploaded.
- If a transcript is uploaded directly, skip the transcription process and proceed to further analysis.
- Import the API key for AssemblyAI and use it to send POST requests for transcription if an audio clip is uploaded.
- Implement a polling mechanism to check the transcription status until completion.

- Retrieve the transcribed text data from AssemblyAI or directly from the uploaded transcript file.
- Store the transcript data in a MongoDB database, saving it as chunks.

2. Transcript Summarization:

- Fetch the transcript chunks from the MongoDB database.
- Install necessary libraries such as transformers and ReportLab.
- Load pre-trained NER model and tokenizer using transformers library.
- Process the transcript chunks and apply NER techniques to identify and extract relevant entities.
- Develop logic to summarize the transcript based on the extracted entities.
- Generate a concise summary PDF using the extracted entities and summarized insights.

3. Timeline-Based Analysis:

- Fetch the transcript chunks from the MongoDB database.
- Set up the development environment by installing Flask, PyPDF2, spaCy, Matplotlib, and termcolor.
- Implement functions for PDF processing, tense analysis, sentence highlighting, and plotting.
- Create HTML templates for user interface using HTML, CSS, and Jinja templating.
- Develop Flask application to handle user interactions and display analysis results.
- Conduct testing and validation to ensure accurate tense analysis and visualization

B. Dealing with Annual Public Financial Reports:

1. Chat with Multiple Annual Public Financial Reports (using NER and Google Palms):

- Utilize PyPDF2 for text extraction from PDF documents.
- Apply NER techniques to identify entities such as financial metrics, company names, and dates.
- Implement LangChain library for NLP tasks including text splitting, embeddings, language models, and conversational retrieval chains.
- Utilize Google Palms for generating responses to user queries based on the conversational context.

- Develop functions for PDF processing, text chunking, embeddings generation, and conversational response generation.
- Create a Streamlit interface for user interaction and display of chatbot responses.
- Maintain conversation history and update it with each interaction for reference.

2. Search and Get Annual Public Financial Reports:

- Utilize the Requests and Urllib libraries for making HTTP requests and parsing PDF URLs.
- Implement Streamlit user interface for input and search results.
- Capture user input for company name and year using Streamlit components.
- Send requests to Google Custom Search API to retrieve PDF URLs based on user input.
- Parse the API response to extract PDF names and URLs.
- Display the extracted PDF names and URLs in the Streamlit sidebar for user interaction.

5.2 Algorithms and flowcharts for the respective modules developed

1. Transcript Generation:

→ Transcription Algorithm: Utilize AssemblyAI's transcription algorithm to convert audio files into text transcripts. This algorithm utilizes machine learning models trained on large datasets of audio recordings to accurately transcribe spoken words into written text.

2. Transcript Summarization :

→ NER Algorithm: Apply Named Entity Recognition (NER) algorithms such as spaCy's NER model to identify and extract relevant entities from the transcript chunks. This algorithm identifies entities such as financial metrics, company names, dates, and other key information mentioned in the transcript.

3. Timeline-Based Analysis:

- Tense Analysis Algorithm: Conduct tense analysis using spaCy or similar NLP libraries to analyze the tense of sentences in the transcript chunks. This algorithm identifies the timeline of events mentioned in the earnings call, such as past, present, and future actions or developments.
- Sentence Highlighting Algorithm: Implement algorithms to highlight sentences in the transcript chunks based on their tense and relevance to specific events or trends. This algorithm enhances the readability and interpretability of the transcript analysis results.

4. Search and Get Annual Public Financial Reports from the Web:

- Google Custom Search API Algorithm: Utilize the Google Custom Search API to search for annual public financial reports based on the provided query, company name, and year. This algorithm sends HTTP requests to the API endpoint, retrieves JSON responses containing search results, and parses the results to extract PDF URLs and names.

5. Chat with Multiple Annual Public Financial Reports:

- PDF Processing Algorithm: Implement algorithms using PyPDF2 to extract text from PDF documents uploaded by users. These algorithms parse PDF files, extract text content, and preprocess the text for further analysis.
- Named Entity Recognition (NER) Algorithm: Utilize NER algorithms such as spaCy's NER model to identify and extract relevant entities from the extracted text of financial reports. This algorithm identifies entities such as financial metrics, company names, dates, and other key information mentioned in the reports.
- Google Palms Algorithm: Utilize Google Palms for generating responses to user queries based on the extracted entities from financial reports. This language model (LLM) processes user input, retrieves relevant information from the financial reports, and generates responses tailored to the user's queries.
- Conversational Retrieval Chain Algorithm: Use LangChain's Conversational Retrieval Chain module to manage conversational context and generate responses based on user queries. This algorithm maintains conversation history, processes user input, integrates Google Palms responses, and generates coherent responses for a natural conversational experience.

Flowcharts:

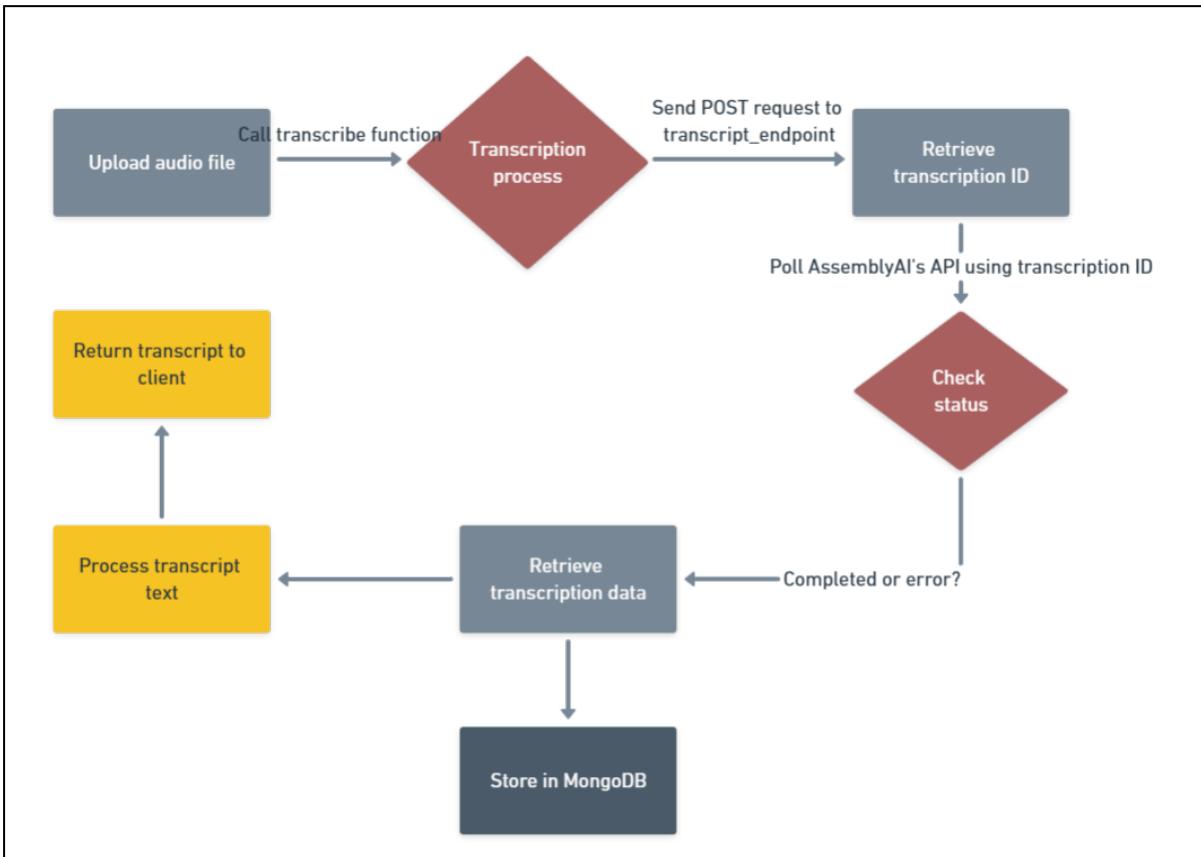


Fig 5.2.1. Flowchart of Transcript generation

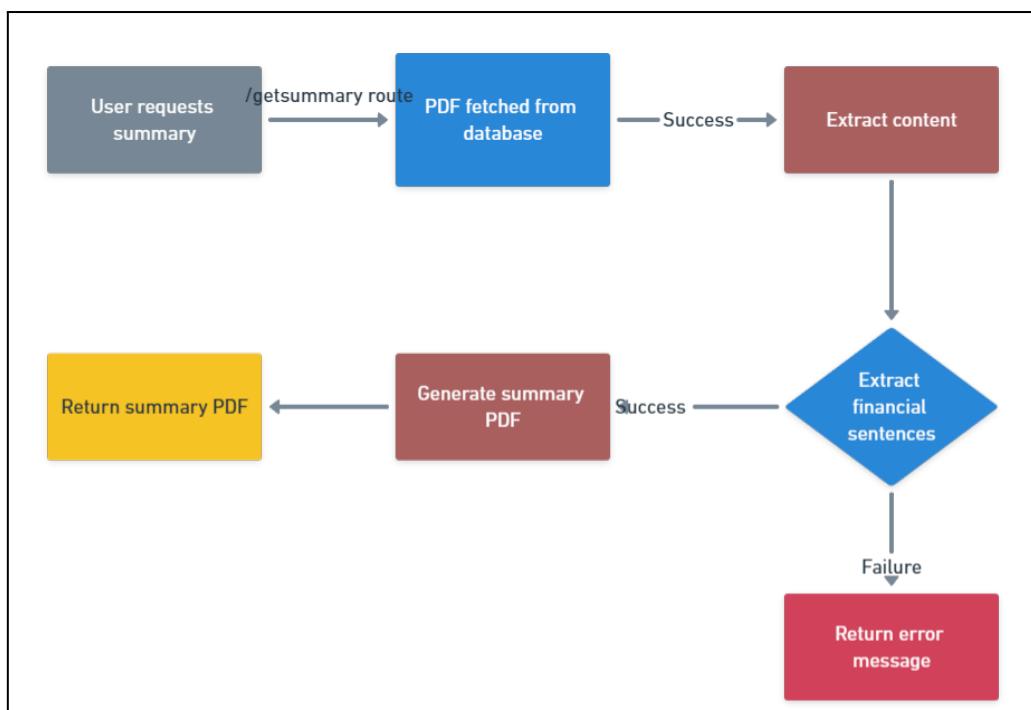


Fig 5.2.2. Flowchart of Summary generation

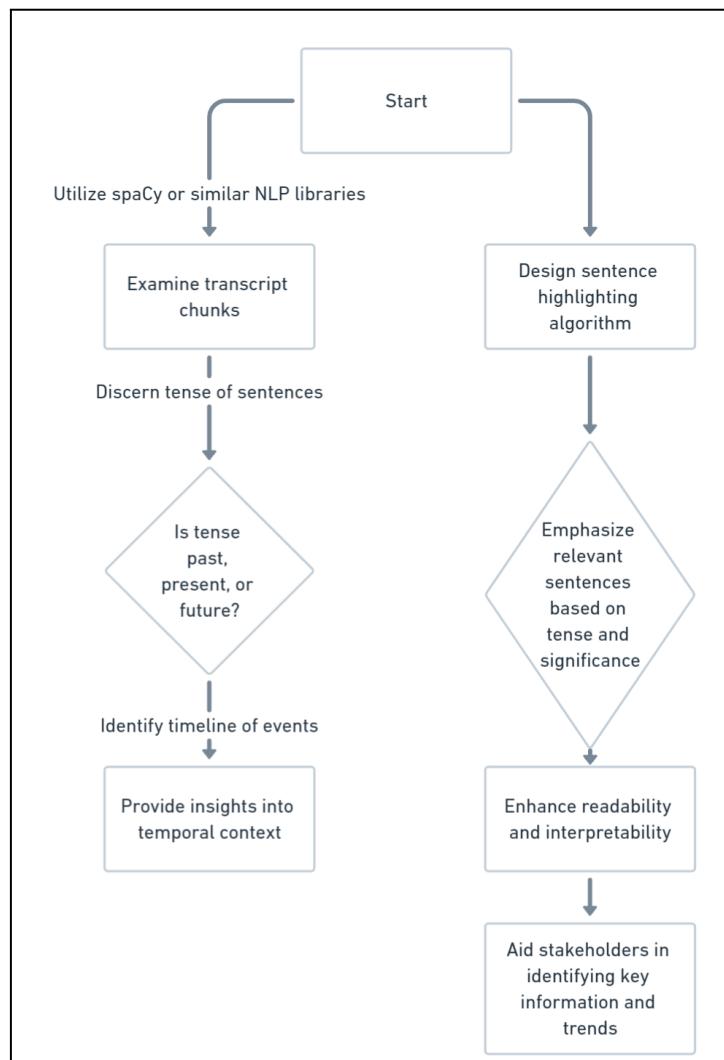


Fig 5.2.3. Flowchart of Timeline Analysis

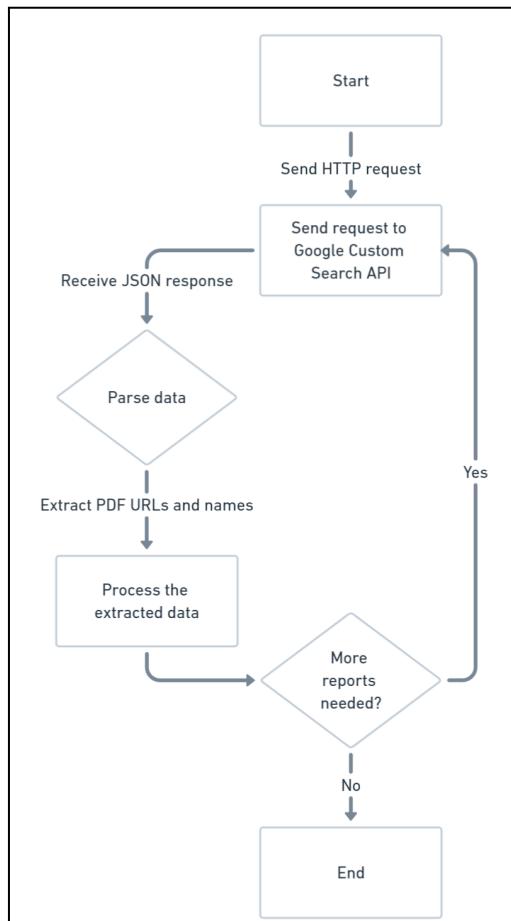


Fig 5.2.4. Flowchart of Search and Get Annual Public Financial Reports from the Web

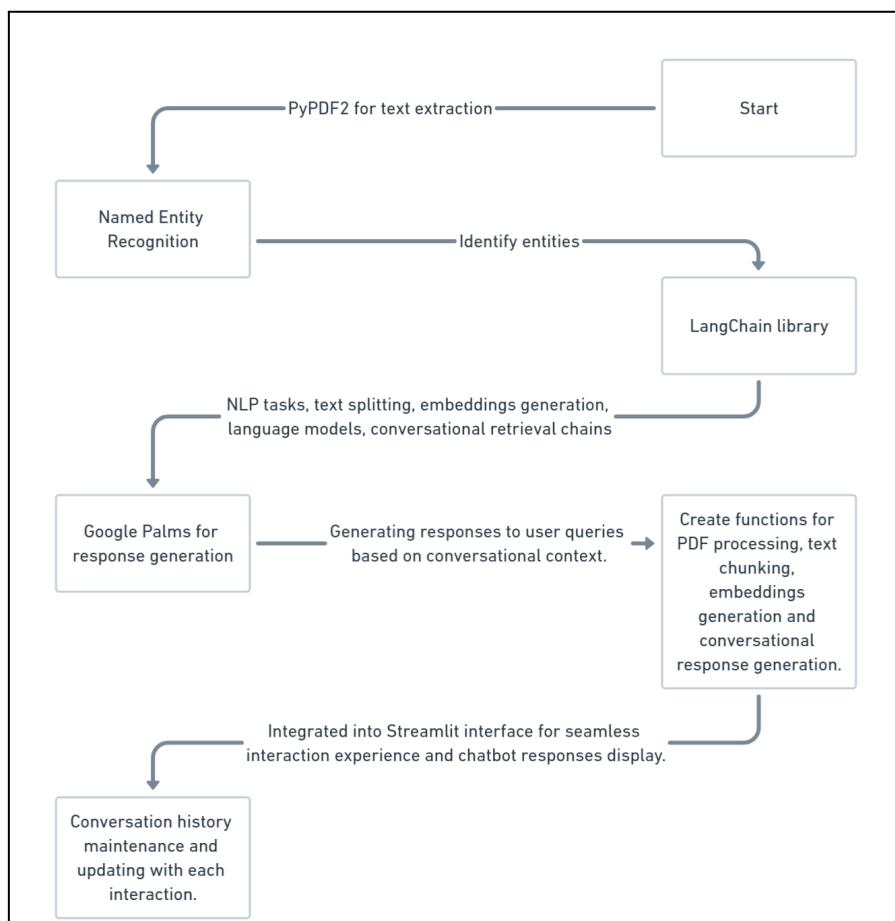


Fig 5.2.5. Flowchart of chat with Multiple Annual Public Financial Reports

5.3 Datasets source and utilization

1. Annual Reports and Financial Reports:

- Source: Annual reports and financial reports can be sourced directly from the companies' websites, regulatory filings (such as SEC filings in the US), financial databases, or financial news websites.
- Utilization: These reports provide comprehensive information about a company's financial health, performance, and strategic initiatives. They can be used for analysis, trend identification, and comparison across different time periods and companies. NLP techniques can be applied to extract key information such as financial metrics, business strategies, and risk factors.

2. Transcripts of Earnings Calls in PDF Form:

- Source: Transcripts of earnings calls in PDF form can be obtained from financial databases, investor relations sections of company websites, financial news websites, or specialized platforms that aggregate earnings call transcripts.
- Utilization: These transcripts provide insights into a company's quarterly results, operational highlights, future guidance, and management discussions. NLP techniques can be applied to extract key information, perform sentiment analysis, identify trends, and summarize the content for easier interpretation and analysis.

3. Earnings Calls in Audio Form:

- Source: Earnings calls in audio form can be obtained from the same sources as PDF transcripts, as many companies provide both formats for their earnings calls. They can also be sourced from platforms that specialize in hosting and distributing audio recordings of earnings calls.
- Utilization: While audio recordings provide the spoken content of earnings calls, they require transcription before NLP techniques can be applied. Once transcribed, the text data can be utilized similarly to PDF transcripts for analysis, summarization, and sentiment analysis.

Chapter 6: Testing of the Proposed System

6.1. Introduction to testing

Testing is a crucial aspect of software development that ensures the quality, reliability, and functionality of the developed system. In the context of our project, testing plays a vital role in verifying the accuracy and effectiveness of each module and feature, ultimately contributing to the overall success of Fincalls - Corporate Earnings Calls Analyzer and Annual Public Financial Reports Chatbot. The testing phase involves systematically evaluating various components and functionalities to identify and rectify any defects or inconsistencies, thereby ensuring that the final product meets the requirements and expectations of the users.

6.2. Types of tests Considered

- **Unit Testing:** Unit testing involves testing individual components or units of code in isolation to ensure they function correctly. In our project, unit tests are conducted for each function or method within the modules, verifying their functionality and identifying any errors or bugs.
- **Integration Testing:** Integration testing evaluates the interaction between different modules or components to ensure they work seamlessly together. This type of testing ensures that data flows correctly between modules and that integration points function as expected.
- **System Testing:** System testing evaluates the entire system as a whole to ensure it meets the specified requirements and functions correctly in the intended environment. This comprehensive testing approach assesses the system's functionality, performance, security, and usability.
- **Acceptance Testing:** Acceptance testing involves verifying whether the system meets the acceptance criteria and satisfies the requirements of the stakeholders. This testing phase typically involves end-users or stakeholders testing the system in a real-world scenario to validate its suitability for deployment.

6.3 Various test case scenarios considered

- Transcript Generation: Test cases are designed to verify the accuracy of the transcript generation process, ensuring that audio files are transcribed correctly and that the resulting transcripts accurately reflect the content of the earnings calls.
- Summarization: Test cases for summarization focus on evaluating the effectiveness of the summarization algorithms in generating concise and informative summaries of the earnings calls and financial reports.
- Chatbot Functionality: Test cases are designed to assess the performance of the chatbot in responding to user queries and providing relevant information from the transcripts and financial reports. This includes testing the accuracy of entity recognition and response generation.
- Search and Get Annual Public Financial Reports from the Web: Validate the system's ability to accurately retrieve and present annual financial reports based on user-provided company name and year inputs, ensuring error-free performance and appropriate handling of invalid queries.

6.4. Inference drawn from the test cases

Through thorough testing, we aim to identify and address any issues or discrepancies within the system, ensuring that it meets the required quality standards and performs optimally. By analyzing the results of the test cases, we can gain valuable insights into the system's strengths and weaknesses, allowing us to make necessary improvements and enhancements to deliver a robust and reliable solution to our users. Additionally, testing helps build confidence in the system's functionality and ensures a seamless user experience, ultimately contributing to the success and adoption of Fincalls in the market.

Chapter 7: Results and Discussion

7.1. Screenshots of User Interface (UI) for the respective module

A. Fincalls:

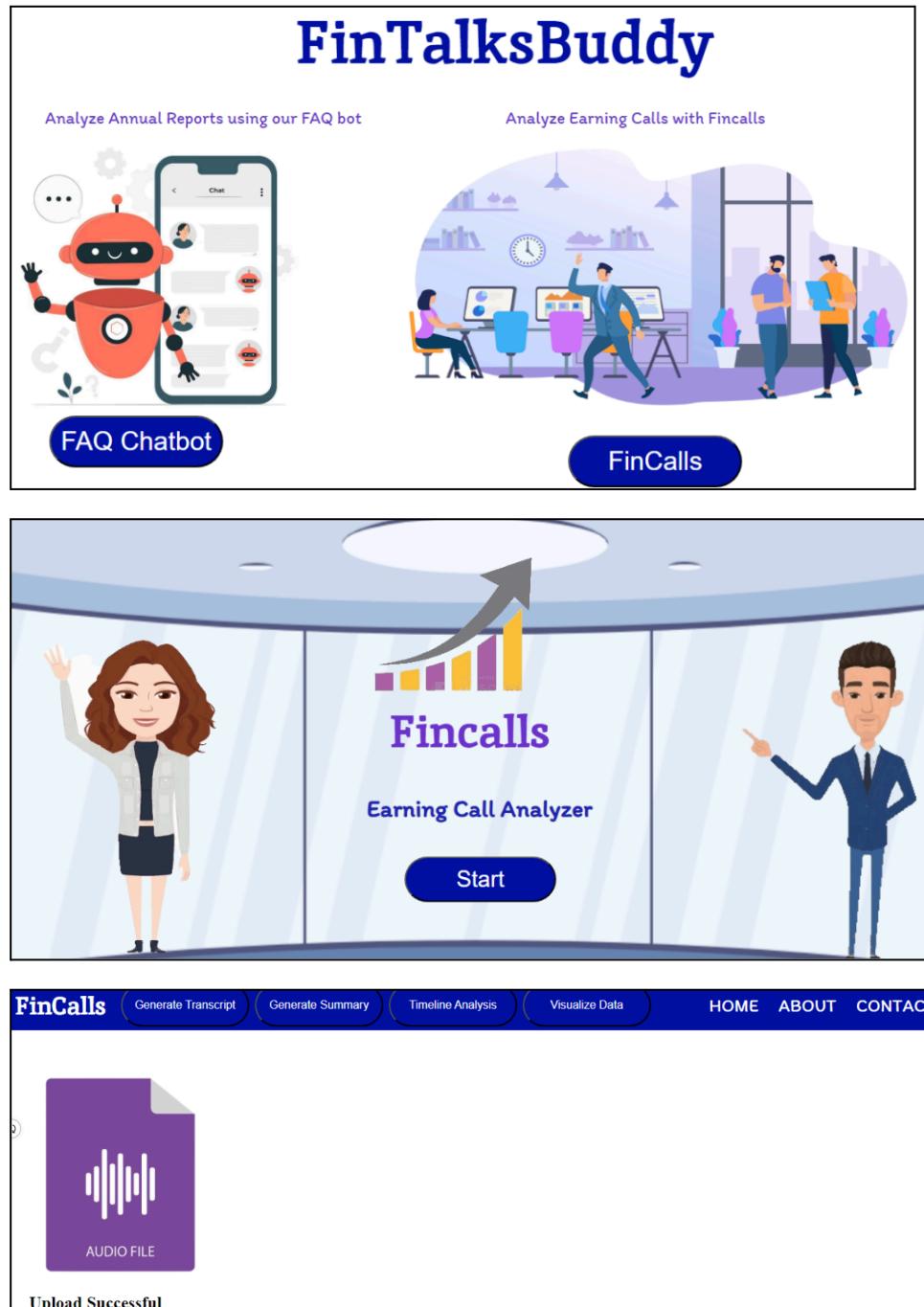


Fig 7.1.1. User successfully uploaded the earnings call

The screenshot shows the FinCalls platform interface. At the top, there are four buttons: 'Generate Transcript', 'Generate Summary', 'Timeline Analysis', and 'Visualize Data'. To the right of these are 'HOME', 'ABOUT', and 'CONTACT' links. The main content area displays a transcript for 'Meta Platforms, Inc. (META) Fourth Quarter 2023 Results Conference Call February 1st, 2024'. The transcript starts with a greeting from Ken Dorell, Director, Investor Relations, followed by a summary of the call's purpose and a note about forward-looking statements.

Fig 7.1.2. Transcript generated

This screenshot shows the 'Transcript Summary' section of the FinCalls interface. It features a large heading 'Transcript Summary' above a summary paragraph. The paragraph discusses the company's performance, including revenue growth, new product launches like Threads and Ray-Ban Meta smart glasses, and the introduction of AI-powered features like Reality Labs and Reels. It highlights the company's commitment to AI and its future potential.

Fig 7.1.3. Transcript summary generated

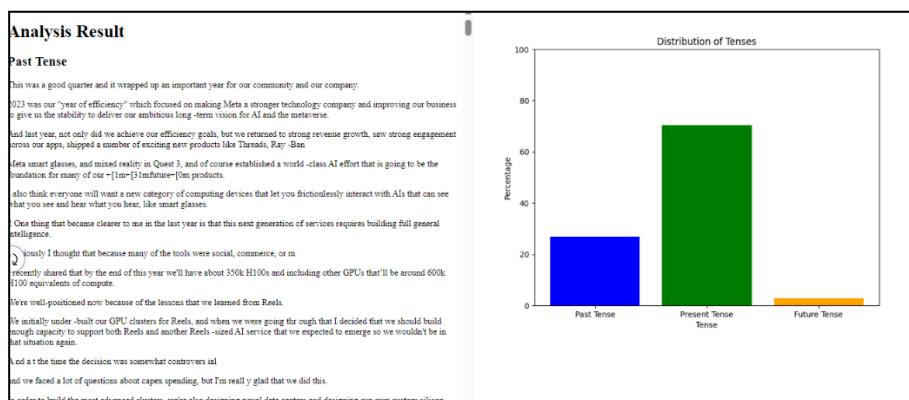


Fig 7.1.4. Timeline Analysis generated

B. Chatbot:

The screenshot shows the 'Chat with Annual Public Reports' interface. On the left, there is a 'Settings' sidebar with sections for 'Upload and Process PDFs' (including a file upload area and a 'Browse files' button), 'Enter Company Name', 'Enter Year', and a 'Search' field. On the right, there is a main chat window with a header 'Ask a Question from the PDF Files' and a 'Get Response' button. The overall layout is clean and modern, designed for user interaction with financial documents.

Fig 7.1.5. ChatBot Page

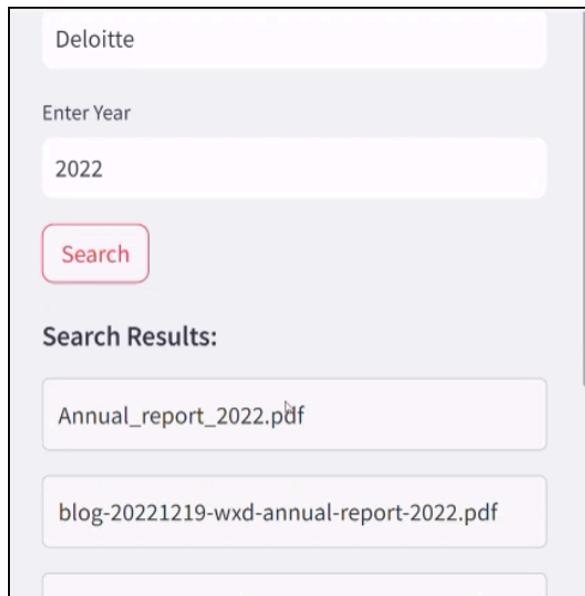


Fig 7.1.6.Search and Get Annual Public Financial Reports from the Web

The screenshot shows a "Settings" page. On the left, there's a section for "Upload and Process PDFs" with a "Drag and drop files here" area containing two files: "Accenture-Fiscal-2022-Annual-R..." (0.9MB) and "accenture-fiscal-2021-annual-re..." (7.8MB). A "Process PDFs" button is below. On the right, under "Here some FAQ's", there's a section titled "Financial Performance" with a question about total revenues and net profits for the year. The answer states that total revenues increased by 22% in U.S. dollars and 26% in local currency compared to fiscal 2021. It also mentions strong growth across all geographic markets, industry groups, and types of work.

Fig 7.1.7.FAQs generated



Fig 7.1.8. Tabular output with graphs generated

Human: Please tell the risk factors associated with the company.

A: - Business Risks

- Volatile, negative or uncertain economic and political conditions
- Demand for our services and solutions
- Competition
- Our ability to attract and retain key employees
- Our ability to manage our global operations and effectively integrate acquisitions and joint ventures
- Our ability to protect our intellectual property rights
- Our ability to manage the risks of our global operations and strategy
- Our ability to comply with applicable laws and regulations
- Financial Risks
 - Our leverage
 - Our ability to generate cash flows from operations
 - Our ability to raise additional capital
 - Our debt service obligations
 - Our exposure to foreign currency exchange rate fluctuations
 - Our ability to maintain adequate insurance coverage

Fig 7.1.9. Open ended questions also answered accurately

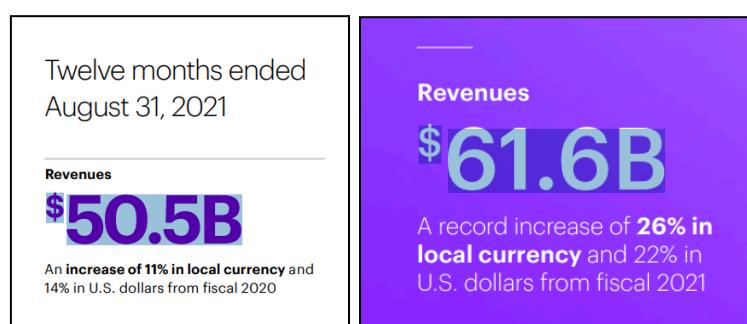
7.2. Performance Evaluation measures

Chatbot results:

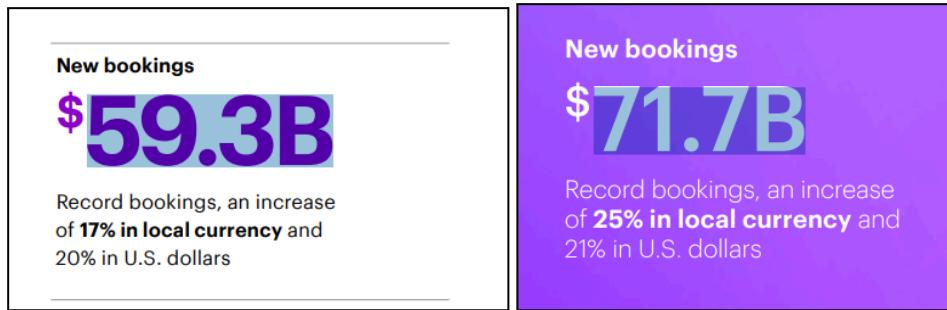


Fig 7.2.1. Chatbot results

Revenues-



New Bookings -



The time taken for various tasks is as follows:

- ❖ Transcript Generation:
 - ➔ Processing time for an earnings call of 48 minutes: 3-4 minutes
 - ➔ Retrieval time from the database: 2 seconds
- ❖ Summary Generation:
 - ➔ Approximately 2 minutes
- ❖ Timeline Analysis:
 - ➔ Approximately 2-3 minutes
- ❖ Chatbot (Transcript Processing):
 - ➔ Processing time for each uploaded PDF: Approximately 1 minute

7.3. Input Parameters / Features considered

1. Fincalls:
 - a. The input to the Fincalls will be audio files which will be of type: .MP3, mpeg and wav.
 - b. The transcript can be uploaded in pdf or text format also.
2. Chatbot
 - a. Input to the chatbot is the annual report which will be in .pdf format.
 - b. Input can be a single pdf or it can also be multiple PDF documents.

7.4. Graphical and statistical output



Fig 7.4.1. Graphical and Statistical Output

7.5. Inference drawn

The Fincalls project offers valuable insights and efficiencies in analyzing corporate financial data. By automating transcript generation, summarization, timeline analysis, and providing a chatbot interface, it significantly reduces manual effort and time consumption in processing earnings calls and financial reports. This enhanced efficiency translates into improved decision-making for stakeholders, who gain quick access to summarized insights and interactive tools for data interpretation. The project's ability to handle various data sources, including audio recordings and transcripts, along with its scalability and reliability, ensures accessibility and accuracy in financial analysis. Furthermore, Fincalls lays the groundwork for future advancements, such as predictive analytics and sentiment analysis, to further enrich decision-making capabilities and broaden the scope of financial analysis tools. Overall, Fincalls serves as a pivotal platform in navigating the complexities of corporate financial analysis, empowering stakeholders with actionable insights and facilitating more informed investment strategies.

Chapter 8: Conclusion

8.1 Limitations

The project exhibits several limitations that may impact its efficacy and reliability. Dependency on data quality, particularly the accuracy and completeness of transcripts and financial reports, poses a significant challenge. Additionally, variations in language, accents, and audio quality may affect the accuracy of speech-to-text transcription. Entity recognition techniques, such as Named Entity Recognition (NER), may encounter difficulties in identifying financial metrics, company names, and dates accurately, especially in documents with complex structures or languages. The system's coverage of financial data may also be limited by the availability of publicly accessible documents, impacting the comprehensiveness of analyses. Furthermore, processing time and resource requirements may increase with larger datasets, potentially affecting scalability and performance. Regulatory and privacy considerations surrounding the use of publicly available financial data and transcripts necessitate careful compliance to mitigate legal risks. Addressing these limitations through ongoing refinement and optimization is crucial to enhancing the system's effectiveness and reliability for users.

8.2 Conclusion

Fincalls - Corporate Earnings Calls Analyzer and Annual Public Financial Reports Chatbot offers a comprehensive solution for analyzing corporate financial data and accessing annual public financial reports. Utilizing services such as Assembly AI for transcript generation, pre-trained NER models for summarization, and Google Custom Search API for report retrieval, the project enables seamless data analysis and decision support. Tense analysis and sentence highlighting algorithms enhance the interpretability of earnings call transcripts, while NLP techniques facilitate entity recognition and conversational response generation. Despite its comprehensive approach, the project faces limitations related to data quality, entity recognition accuracy, and scalability. Continuous refinement is necessary to improve the system's effectiveness and reliability over time, ultimately empowering users with actionable insights for informed decision-making.

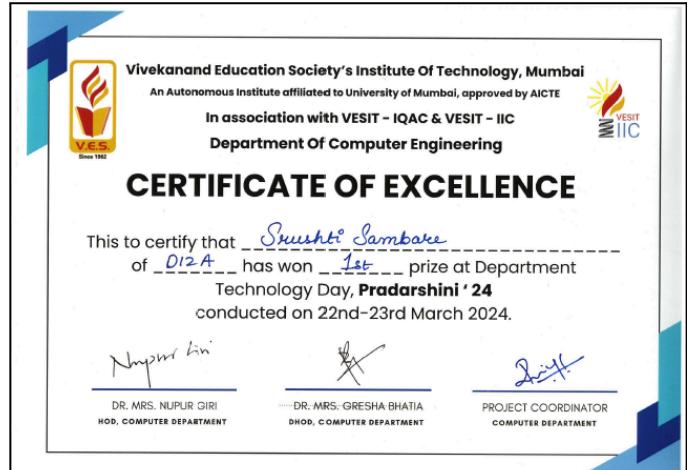
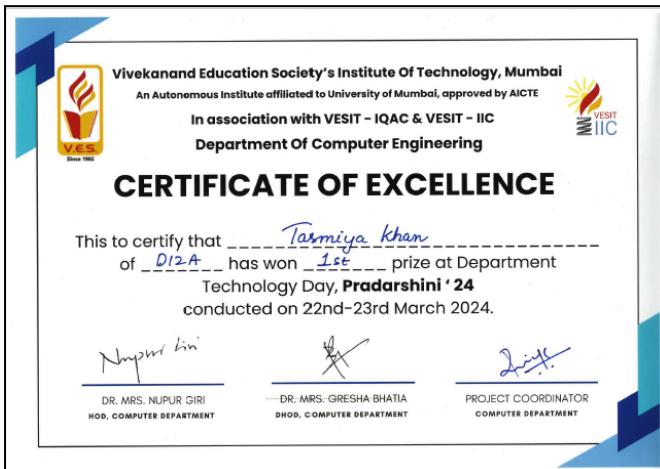
8.3 Future Scope

The future scope of Fincalls - Corporate Earnings Calls Analyzer and Annual Public Financial Reports Chatbot is promising, with opportunities for further enhancements and expansion. Potential avenues for development include the integration of predictive analytics capabilities to forecast future company performance, sentiment analysis to gauge market perceptions, and risk assessment and management functionalities to identify and mitigate investment risks. Additionally, the incorporation of advanced algorithms for data visualization and interpretation could provide users with richer insights into financial trends and patterns. Furthermore, ongoing advancements in natural language processing and machine learning techniques offer the potential for refining entity recognition accuracy and enhancing conversational response generation. Moreover, expanding the scope of the project to include regulatory compliance monitoring and industry benchmarking functionalities could further enhance its value proposition for users. Continuous iteration and refinement will be key to unlocking the full potential of Fincalls and ensuring its relevance and effectiveness in an ever-evolving financial landscape.

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Eesha Inamdar*1, Varada Kalaskar*2, Vaidehi Zade*3
*1.2.3 Dept. Of Elec. And Telecommunication Pune Institute Of Computer Technology.
DOI : <https://www.doi.org/10.56726/IRJMETS37432>
Volume:05/Issue:04/April-2023 Impact Factor- 7.868
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Award certificate for project competition



Project Review Sheet

Review 1 :

(07)														
Industry / Inhouse:		Project Evaluation Sheet 2023-24												
Research / Innovation:														
Title of Project (Group no): <u>Financial Analysis Earnings Call Analyzer</u>														
Group Members: <u>Ketaki D. Nalawade (44)</u> , <u>Srushti Sambare (54)</u> , <u>Tasmiya Khan (30)</u> , <u>Purteek Mahajan (39)</u>														
Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environment Friendly	Ethics	Team work	Presentation Skills	Applied Engg & Mgmt principles	Life - long learning	Professional Skills	Innovative Approach	Total Marks
(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage 1	4	4	5	3	4	2	2	2	3	3	3	5	5	47
Comments: <u>Good work Integrate all modules.</u>														
<u>Dr. Sugata Kedkar</u> Name & Signature Reviewer1														
Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environment Friendly	Ethics	Team work	Presentation Skills	Applied Engg & Mgmt principles	Life - long learning	Professional Skills	Innovative Approach	Total Marks
(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage 1	4	4	4	3	4	2	2	2	3	3	3	5	5	46
Comments:														
Date: 10th February, 2024														
<u>Manisha Methur</u> <u>13/2/24</u> Name & Signature Reviewer2														

Review 2 :

Inhouse/ Industry _ Innovation/Research:												Class: D12 A/B/C			
Project Evaluation Sheet 2023 - 24												Group No.: 7			
Sustainable Goal:															
Title of Project: <u>Fin calls:- Corporate Earnings Call Analyzer</u>															
Group Members: <u>Ketaki D. Nalawade</u> , <u>Purteek Mahajan</u> , <u>Tasmiya Khan</u> , <u>Srushti Sambare</u>															
Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environment Friendly	Ethics	Team work	Presentation Skills	Applied Engg&Mgmt principles	Life - long learning	Professional Skills	Innovative Approach	Research Paper	Total Marks
(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(3)	(5)	(50)	
4	4	5	2	5	2	2	2	2	3	3	3	3	3	45	
Comments:															
<u>Dr. Sugata Kedkar</u> Name & Signature Reviewer1															
Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environment Friendly	Ethics	Team work	Presentation Skills	Applied Engg & Mgmt principles	Life - long learning	Professional Skills	Innovative Approach	Research Paper	Total Marks
(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(3)	(5)	(50)	
4	4	5	2	5	2	2	2	2	3	3	3	3	3	45	
Comments: <u>Good work.</u>															
Date: 9th March, 2024															
<u>Manisha Methur</u> <u>13/3/24</u> Name & Signature Reviewer 2															