



CENG 407

Innovative System Design and Development I

2024-2025 Fall

e-TurFinSAS: Entity Based Turkish Financial Sentiment Analysis System

Team 20

Software Requirements Specification

Names of members:

- | | |
|-------------------------|---------------------------|
| • Mert Şerafettin Kargı | Student Number: 202011061 |
| • Ahmet Gökay ÜRKMEZ | Student Number: 202011057 |
| • Baha ÖÇALAN | Student Number: 202011056 |
| • Ahmet Eren YAĞLI | Student Number: 202011038 |
| • Taner Onur UYAR | Student Number: 202011014 |

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1. INTRODUCTION

1.1. Purpose

The purpose of this project is to conduct entity-based sentiment analysis of social media posts (tweets) about the top 100 companies listed on the Borsa Istanbul (BIST100), which have the highest market value and trading volume. By analysing these posts, the project aims to classify sentiments as positive, negative, or neutral, with the following objectives:

- Supporting investors in their decision-making processes.
- Better predicting market trends.
- Enabling companies to evaluate their social media image.
- Developing early warning mechanisms for financial crises or unexpected events.
- Providing a new data source for testing behavioural finance theories.

1.2. Scope of Project

This project aims to deeply analyse the relationship between social media sentiment and financial market dynamics in Turkey. It focuses on the 100 companies with the highest market value and trading volume traded on Borsa Istanbul (BIST100). Within the scope of the project, Turkish tweets shared on the Twitter/X platform regarding these companies will be collected and an asset-based sentiment analysis will be performed on these tweets. As a result of the analysis, it is aimed to obtain concrete findings regarding the impact of the perception formed in social media on financial markets and investor behavior by determining the positive, negative or neutral sentiments of the posts. In order for the project to achieve these goals, advanced Natural Language Processing (NLP) and Machine Learning (ML) techniques will be used, considering the unique challenges of Turkish.

In order to address the complex language features of Turkish, such as its agglutinative structure and morphological richness, pre-trained models such as BERT will be utilized, and these models will be customized specifically for Turkish. In addition, a powerful preprocessing process will be developed to clean elements such as noise (slang, abbreviations, emojis) commonly seen in tweets and to standardize the texts. Within the scope of the project, the scope of the model will be expanded to correctly understand the terms and jargons frequently used in financial texts.

The performance of the sentiment analysis model will be evaluated using well-known metrics such as accuracy, F1 score, precision, recall, and AUC-ROC curve. The findings from this project will be usable in various fields. For example, it will provide a clearer picture of public perception towards companies to help investors make more informed decisions. Companies will be able to evaluate their social media image and brand perception with this data and develop improvement strategies. In addition, this project will create a new data source that will contribute to behavioural finance studies to examine the impact of emotional reactions on financial decisions.

However, the project also aims to contribute to the development of decision support systems. In order to create early warning mechanisms, especially for financial crises or unexpected events, the data obtained from sentiment analysis will be integrated with traditional financial indicators. In this way, more effective methods for predicting market trends and volatility can be developed. In general, this project aims to provide valuable tools and insights for investors, analysts and companies by combining social media analytics with financial market research.

1.3. Glossary

Term	Definition
BIST100	Collecting Turkish-language tweets about BIST100 companies from the Twitter/X platform.
Sentiment Analysis	Developing an entity-based sentiment analysis model tailored to the morphological richness of the Turkish language and financial texts.
Natural Language Processing (NLP)	A subfield of artificial intelligence focused on enabling computers to understand and process human language.
Machine Learning (ML)	A field of artificial intelligence that enables computers to learn from data without explicit programming.
Entity-Based Sentiment Analysis	A method of analysing sentiments specifically associated with an entity (e.g., a company).
Twitter/X	A social media platform where users share short text-based posts for communication.
F1 Score	A metric that balances precision and recall measuring a model's performance.
Pre-trained Model	A machine learning model that has been trained on a large dataset and can be finetuned for a specific task.
Morphological Richness	The ability of languages like Turkish to form derivatives of words through the addition of suffixes, creating complexity in language processing.

2. OVERALL DESCRIPTION

2.1. Product Perspective

This project utilizes advanced NLP and ML techniques to perform **entity-based sentiment analysis** on tweets about the top 100 companies listed on Borsa Istanbul (BIST100). By classifying tweets as positive, negative, or neutral, the system provides actionable insights into social media sentiment surrounding these companies.

Designed as a **decision-support tool**, it aids investors and market analysts in predicting trends and making data-driven decisions. Companies can also evaluate their public perception to refine strategies. Additionally, the system supports early warning mechanisms for detecting potential risks, ensuring timely and informed actions.

Tailored to the Turkish financial ecosystem, this product leverages big data analytics to enhance market analysis and strategic planning.

2.1.1. Software Methodology

We decided to use the agile methodology while doing our project. Agile methodology is a flexible and collaborative approach used in software development and project management. In short, agility is a paradigm shift in the usual way of working. The word agile has passed into Turkish as "çeviklik". The concept of agile, which is the ability to adapt quickly to changing conditions; Although it is defined as method, methodology, method or project management in most sources, it is a way of thinking contrary to these. At the core of this methodology are the principles that individuals and interactions are more valuable than processes, a working product is more important than comprehensive documentation, customer collaboration is more important than contract negotiations and adapting to change is more valuable than following a plan. Agile aims to deliver projects faster, increase customer satisfaction, and adapt quickly to changing requirements through small, manageable work cycles (e.g., sprints). Although it was initially developed for software development, today it is widely used in different sectors such as marketing, finance and manufacturing. Adopting a continuous improvement and value-oriented approach, Agile enables teams to work more efficiently and effectively.

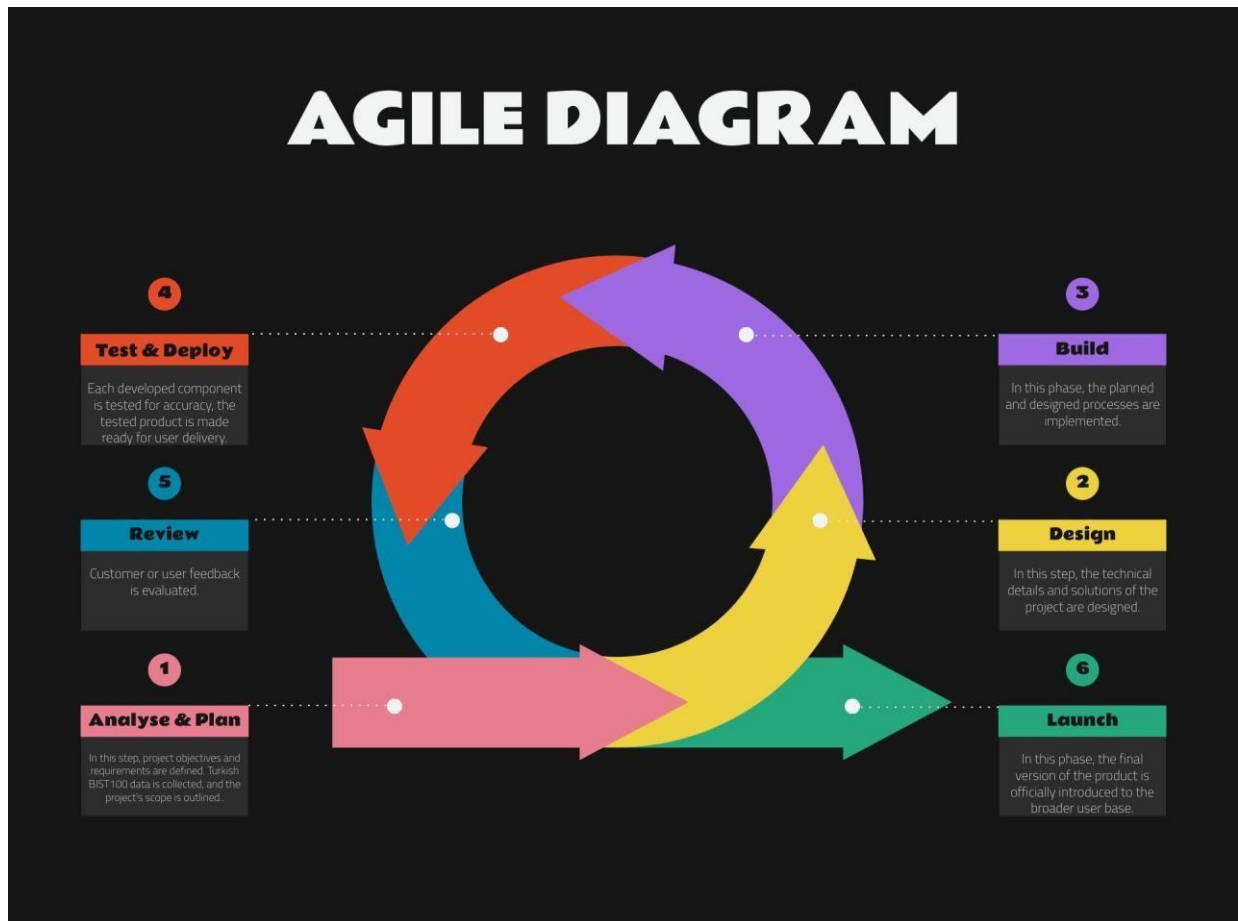


Figure 1. Agile Diagram

- In the **Analysis & Planning** phase, it is decided which data will be collected, from where, and under which topics. Along with task distribution for the team, deficiencies and requirements are identified, and a timeline is created.
- In the **Design** phase, decisions are made regarding which technologies and methods will be used for the project. Since a Turkish NLP model will be created at this stage, care is taken to select methods that are effective for Turkish, and answers are sought to the question of how these methods and the literature can be contributed to.
- In the **Build** phase, the project is implemented by following the previous two phases as closely as possible. This phase includes the NLP model, UI, backend, and all other remaining project components.

- In the **Test & Deploy** phase, all components of the final version of the project are tested, and it is prepared for release.
- In the **Review** phase, the final version of the project is shared with stakeholders and optionally with potential users, and feedback is collected. Stakeholders make new decisions regarding the project's shortcomings and additional requests, marking the end of the cycle for the next iteration. After this step, the project can either be published or move into a new agile cycle, with all steps repeated.
- In the **Launch** phase, the final version of the completed project is published. After the launch, maintenance and updates are carried out regularly.

2.2. User Characteristic

2.2.1. Participants

- Participants must have a professional or academic interest in financial markets or Natural Language Processing (NLP).
- Participants must be proficient in Turkish language, as the analysed data and simulation outputs will be in Turkish.
- Participants must have a basic understanding of sentiment analysis concepts and methodologies.
- Participants must be familiar with the Borsa Istanbul (BIST100) or financial data interpretation.

3. REQUIREMENTS SPECIFICATION

3.1. External Interface Requirements

3.1.1. User Interfaces

The user interface will be available for:

- Android devices with **Android 7.0 (Nougat)** or higher. [1]
- iOS devices with **iOS 12.0** or later. [2]

The interface will be simple and lightweight, designed primarily for querying sentiment analysis results regarding BIST100 companies.

3.1.2. Hardware Interfaces

There are no specific hardware interface requirements. The application can run on any modern smartphone that meets the minimum OS requirements.

Minimum hardware specifications:

- **Android:** At least 1 GB RAM and 50 MB of free storage. [1]
- **iOS:** At least 1 GB RAM and 50 MB of free storage. [2]

Network connectivity is required to access backend services.

3.1.3. Software Interfaces

The application does not depend on any external software interfaces or libraries installed on the user's device.

3.1.4. Communication Interfaces

The application requires an active internet connection to communicate with backend cloud services.

- Communication will be over secure HTTPS protocols.
- The app will send user queries to the backend API and receive processed sentiment analysis results.

3.2. Functional Requirements

3.2.1. Login/Register Use Case

Use Case:

- Login
- Register
- Login as Admin
- Exit

Diagram:

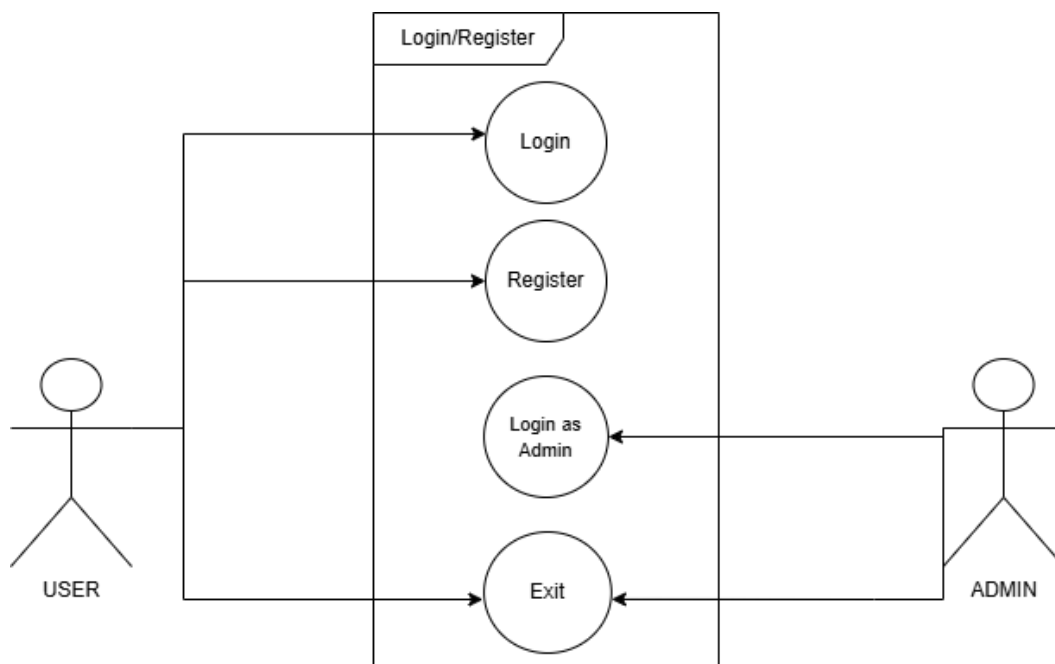


Figure 2. Login/Register Use Case Diagram

Brief Description:

The **Login/Register** use case diagram illustrates the core functionalities for system entry and exit processes for two types of users: **Participants** and **Admins**. Both user roles can exit the system, but their other actions differ:

- **Participants** can initiate the system without logging in.
- **Admins** are required to log in using their credentials, specifically a username and password.

Step-by-Step Description:

Participant Access:

- The Participant is allowed to start the system without the need for login credentials.
- They can proceed directly to use functions that do not require authentication.

Admin Login Process:

- The admin must log in using a valid Admin username and password.
- If the provided password is invalid for the given username, the system will prompt the admin to re-enter their credentials until successful login.

Exiting the System:

- Both Participants and Admins have the option to exit the system at any point by selecting the "Exit" function.

3.2.2. Admin Use Case

Use Case:

- Update data
- Change data frequency
- Change data
- Change NLP method

Diagram:

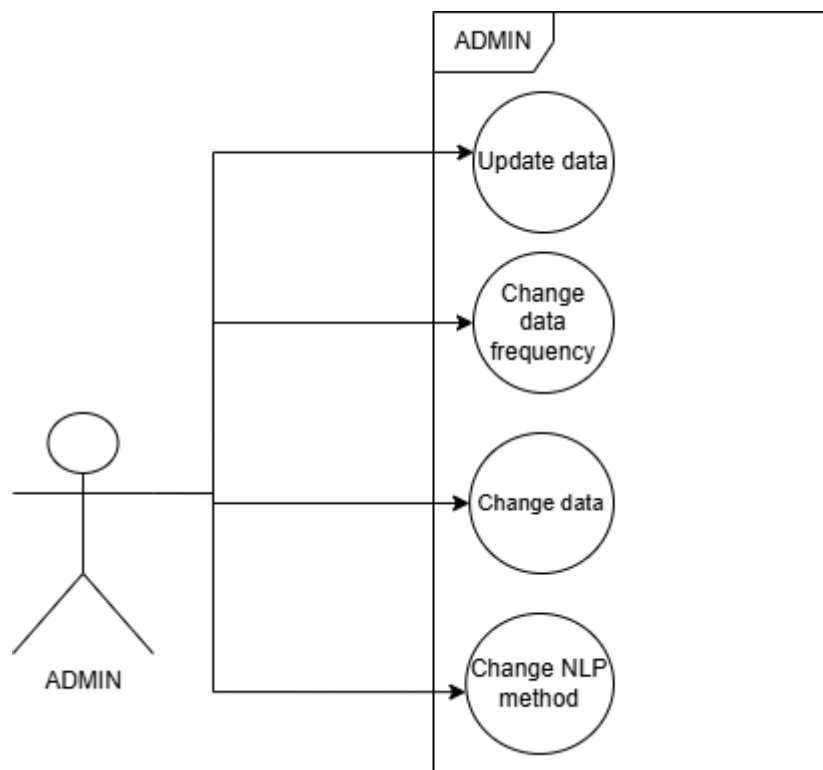


Figure 3. Admin Use Case Diagram

Brief Description:

The use case diagram illustrates the functionalities available to an **Admin** in the system, focusing on data management and system configuration. The admin role is pivotal, as it oversees modifying data sources, updating processing methods, and adjusting system settings for optimal performance.

Step-by-Step Description:

Admin Login Requirement:

- Only Admins can access these functionalities. They must log in to ensure secure operations.
- The system verifies the admin's credentials before granting access.

Update Data:

- Admins can trigger updates to the data repository.
- This functionality ensures the most recent data (e.g., tweets or financial texts) is available for analysis.

Change Data Frequency:

- Admins can modify how often the system fetches and processes new data.
- This could involve scheduling updates daily, weekly, or in real time, depending on user requirements.

Change Data:

- This allows Admins to replace or alter data sources.
- For instance, changing the data provider or transitioning from historical data to live data streams.

Change NLP Method:

- Admins can switch or upgrade the Natural Language Processing (NLP) technique used in sentiment analysis.
- For example, transitioning from a pre-trained model to a custom-built model tailored for Turkish financial texts

3.2.3. Main Page Use Case

Use Case:

- View BIST100 Analysis
- Compare analysis of 2 BIST100 companies
- Add BIST100 companies to favourites
- Display details of stock market shares

Diagram:

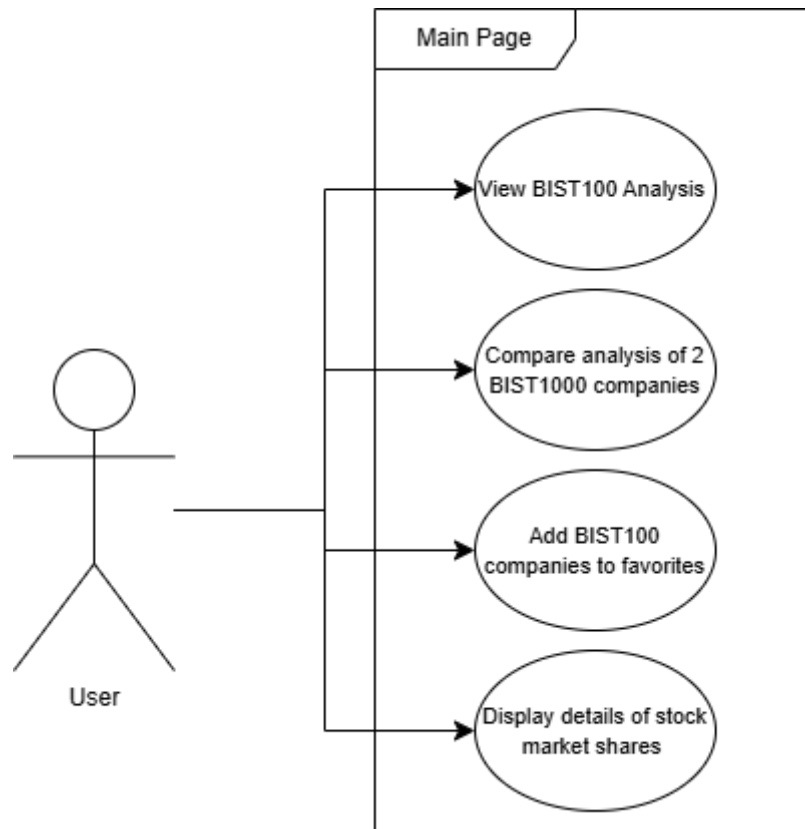


Figure 4. Main Page Use Case Diagram

Brief Description:

The **Main Page** use case diagram illustrates the core functionalities for system options of BIST100 companies.

Step-by-Step Description:

View Companies Analysis:

- The feature that welcomes users.
- Thanks to that feature users can view all analyses of BIST100 companies and their share price prediction without any effort after the sign in.
- Share price prediction is displayed according to the user's term choice, short - medium - long.

Comparing 2 stock market shares:

- Users can compare shares' prices and analysis via that feature
- Also help users understand the difference between shares through graphics etc.

Add any of the BIST100 company to favourites:

- Users can add BIST100 companies they are interested in to their favourites and access them quickly.

Display of a BIST100 stock share:

- Users redirect to the details page that include news, short - medium - long term analysis etc. about the share.

3.2.4. Notification Use Case

Use Case:

- Set Notification Preferences
- Receive Notification Preferences
- Sent Notification
- Read Notification

Diagram:

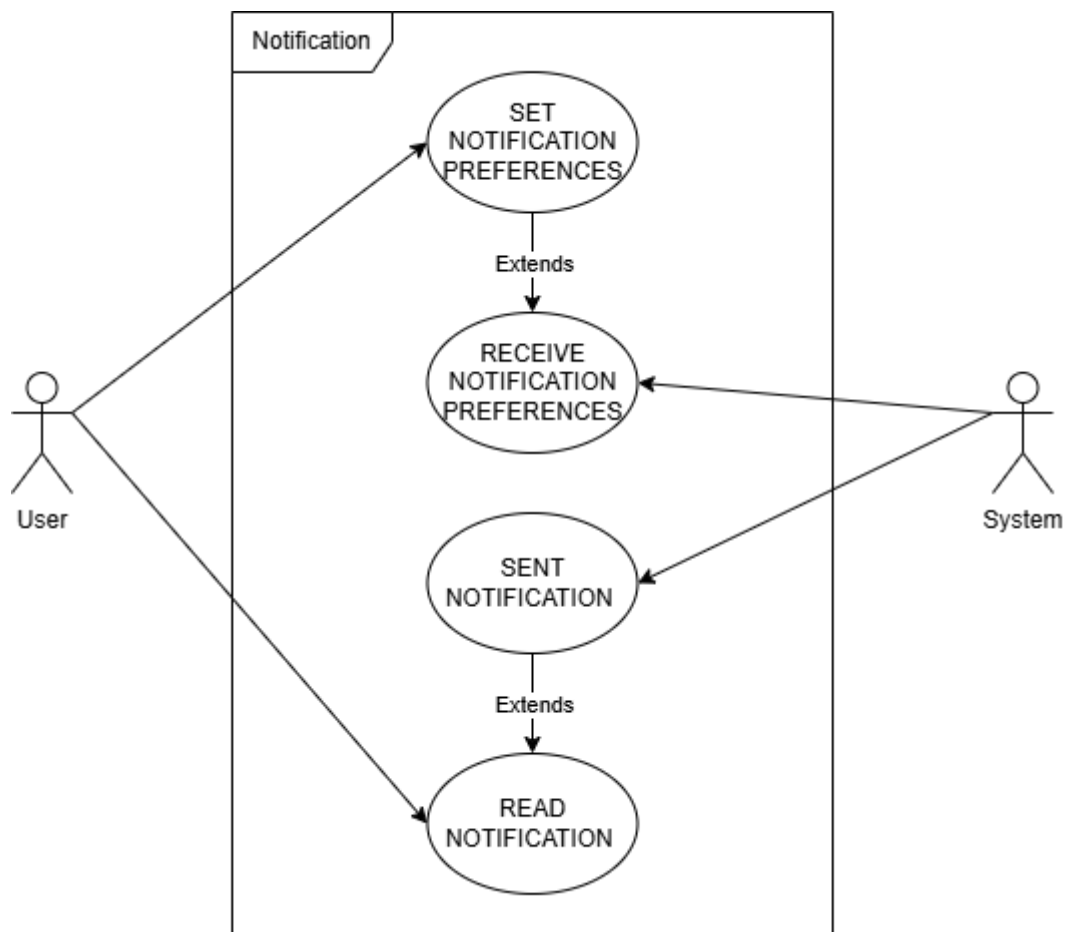


Figure 5. Notification Use Case Diagram

Brief Description:

The Notification System use case diagram illustrates the main methods of sending notifications to the user, through the user's notification preferences.

Step-by-Step Description:

Set Notification Preferences:

- The feature that users can select notification preference.
- Users can select notification content and shipping type.
- Users can change preferences and turn off notifications any time.

Receive Notification Preferences:

- System can access each user's notification preference data.
- System receives each user's selected notification content and shipping type.

Sent Notification:

- The system groups notifications according to their types and each user is sent notifications from the types they have selected.
- The system sends user-selected notifications using the user-selected notification shipping type.

Read Notification:

- Users can read the notifications via the sending method the user prefers.

3.2.5. Display Details of Stock Market Shares Use Case

Use Case:

- Market Statistics
- Performance History
- Real Time Stock Details
- View News and Analysis about Stock

Diagram:

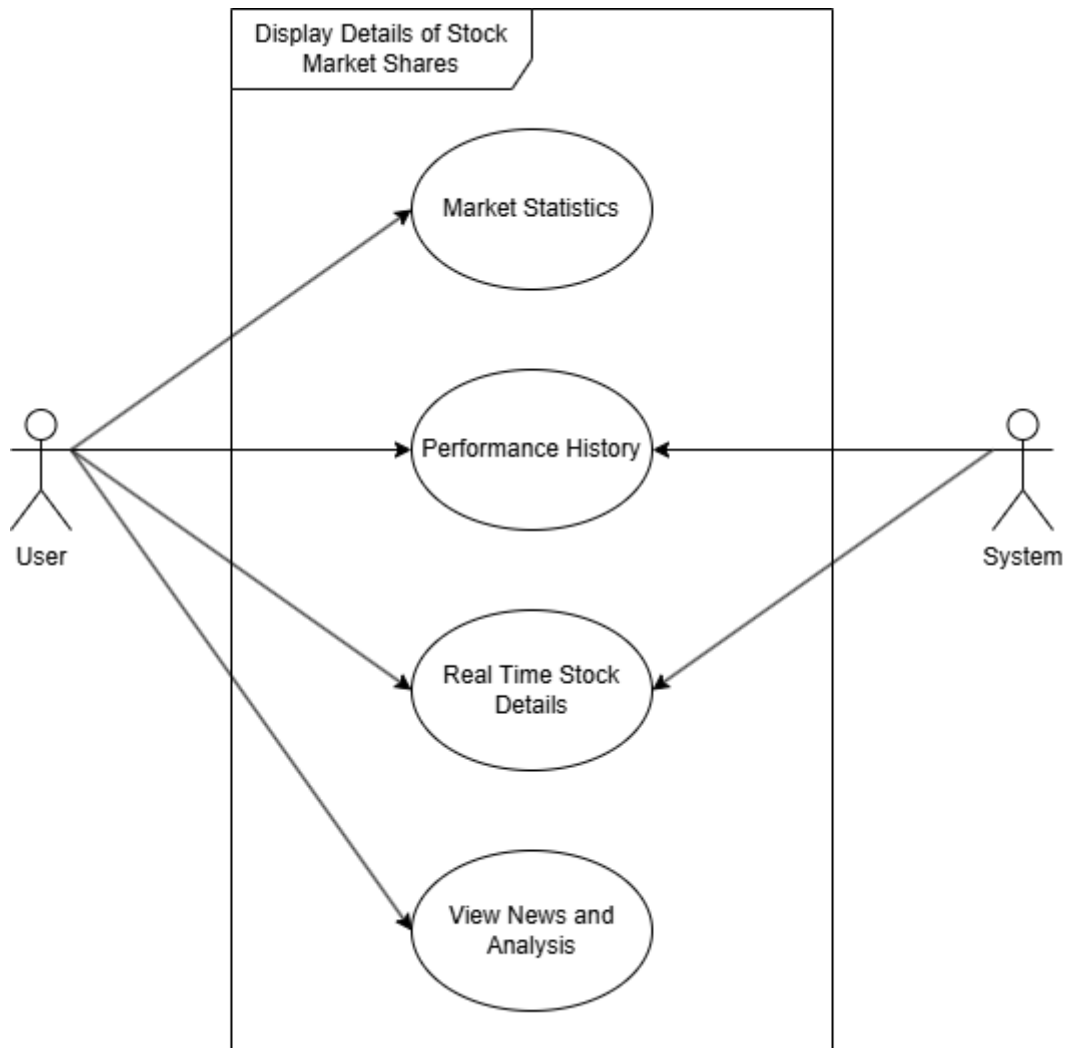


Figure 6. Display Details of Stock Market Shares Use Case Diagram

Brief Description:

The Display Details of Stock Market Shares use case diagram illustrates the ability of users to view variety of details about stock market shares for companies listed on BIST100

Step-by-Step Description:

View Statistics:

- The user select company or a sector from BIST100.
- The user can see market capitalization, trading volume and other metrics to evaluate the current financial situation of the company or sector.

Performance History:

- The system displays trends in certain time periods decided by the user.
- Users can select a certain time period and access historical stock price data.

Real Time Stock Details:

- The system gives live updates about stock price and other metrics.
- Users can view real time data in stock performance and use it to make decisions.

View News and Analysis about Stock:

- The user can see news and read analysis about the stock or sector they choose.
- This feature allows users to keep up with new updates in stocks and sectors.

3.3. Performance Requirement

Since the analysis model runs on one computer, and the results will reach the user by application, it does not require good performance hardware. An Android or iOS device such as today's world devices will be good enough, more details on the below.

3.4. Software System Attributes

3.4.1. Portability

- The mobile app is designed to run on both Android 7.0+ and iOS 12.0+.
- The results which pre-trained model produces reach through backend, cloud platform. It's independent.

3.4.2. Performance

- The model API endpoints must provide an average response time of <1 second under load.
- The application must be designed with efficient, optimized algorithms to keep fluency.

3.4.3. Usability

- Company-specific sentiment analysis.
- Error messages (e.g., “Network Unavailable”) must provide actionable guidance to the user.

3.4.4. Adaptability

- The system is designed to integrate new features, such as expanded sentiment categories or support for additional languages (e.g., English), without major architectural changes.

3.4.5. Scalability

- Backend services must dynamically scale to support 5x the current user load during market events.

3.4.6. Security

- All data exchanged between the mobile app and backend must be encrypted using TLS 1.2 or higher.
- Sentiment analysis results and user queries must be anonymized and stored in compliance with Turkish data protection laws (KVKK).

3.5. Safety Requirements

3.5.1. Data Integrity

- Tweets fetched for analysis must not be altered during processing to ensure sentiment results are trustworthy.

3.5.2. User Safety

- Users should be warned against over-reliance on sentiment trends, emphasizing that the tool complements, not replaces, professional financial analysis.

3.5.3. System Reliability

- Backup servers must replicate critical data every hour to minimize loss in case of failure.

3.5.4. Ethical Considerations

- The system must prevent misuse of sentiment analysis (e.g., for manipulating stock markets) by flagging abnormal patterns in social media data.

4. REFERENCES

- For drawing Use Case Diagrams (Figure 2-6): <https://app.diagrams.net/>
- For drawing Agile Diagram (Figure 1.): <https://wepik.com/>
- [1] Google Play App Requirements: <https://support.google.com/googleplay/android-developer/answer/11926878?hl=en>
- [2] Apple iOS App Store Requirements: <https://developer.apple.com/news/upcoming-requirements/>
- Use Case Explanation: <https://www.techtarget.com/searchsoftwarequality/definition/use-case>
- Functional & Non-Functional Requirements Explanation: <https://www.jamasoftware.com/requirements-management-guide/writing-requirements/functional-requirements-examples-and-templates>
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