ASHESI UNIVERSITY COLLEGE

AN ONLINE STOCK BROKERAGE PLATFORM

FOR AFRICAN MARKETS

APPLIED PROJECT

B.Sc. Computer Science

JANIS RIONGA M'IMIEMBA

2020

ASHESI UNIVERSITY COLLEGE

AN ONLINE STOCK BROKERAGE PLATFORM

FOR AFRICAN MARKETS

APPLIED PROJECT

Applied Project submitted to the Department of Computer Science, Ashesi

University College in partial fulfilment of the requirements for the award of

Bachelor of Science degree in Computer Science.

JANIS RIONGA M'IMIEMBA

2020

DECLARATION

I hereby declare that this Applied Project is the result of my own original work and that no

part of it has been presented for another degree in this university or elsewhere.

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Candidate's Signature:

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Date:

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I hereby declare that preparation and presentation of this Applied Project were supervised

in accordance with the guidelines on supervision of Applied Project laid down by Ashesi

University.

Supervisor's Signature:

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Supervisor's Name:

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Date:

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Abstract

Stock trading is a vibrant industry around the globe. The advent of the internet on the other hand has resulted in the birth of online payment systems and electronic commerce, thus enabling a lot of businesses to carry out transactions online. However, a lot of stockbrokers in African countries are yet to take advantage of these technological developments to enable their clients to buy and sell shares online. This project therefore seeks to facilitate this transition by developing an online brokerage platform that can be easily replicated to meet the needs of online investors in African stock markets and uses the Ghana Stock Exchange as an example in the development process.

This paper explains in detail the development process for the online brokerage platform intended to facilitate online buying and selling of stocks. Key advantages of such a platform include allowing investors to buy and sell shares at any time, and it is time and cost effective as it eliminates the need to go through a stockbroker in order to buy or sell shares. The platform also provides educational material to give investors better insight in their trading activities.

The end product of this project is a web application where users can easily create trading accounts and start the process of buying and selling shares.

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Chapter 1: Introduction

1.1 Aim

The aim of this project is to develop an online brokerage platform that will help capture more potential investors in the stock market by targeting those who would find it convenient to trade online, and thus increase participation in the stock market. The project aims to make it easy for licensed stockbrokers to move to capture this audience by providing a template that they can easily replicate and customize to meet their customer needs. By developing a platform where educational information and means of trading are easily available to investors at their own convenience, the project aims to curb some of the biggest barriers to market participation which are high information cost and transaction costs.

1.2 Background and Significance

The Stock market is a lucrative industry around the globe and offers a place for publicly listed companies to issue and sell shares to the public [8]. Members of the public participating in this trade make profits through dividends paid by companies to their shareholders, and capital gains, which is the difference between the prices at which the investor buys and sells the stocks [6].

The advent of the internet has had a positive impact on industries across the globe, with one major impact being the development and growth of online payment platforms. These have in turn facilitated the growth of ecommerce platforms [5]. Ecommerce involves the buying and selling of information, products and services over the internet [9]. [1] points out that

ecommerce is an essential ingredient for socio-economic development in developing countries. This is because ecommerce enables businesses to reach a wider audience that would have been otherwise limited to their geographical location. Moreover, through ecommerce businesses can make information readily available to customers thus increasing their competitive edge.

The stock market, like other industries around the globe has not been immune to the benefits of these technological advancements. In the US for instance, the increased use of the internet has been linked to increased participation by households in the stock exchange market. This change has been equated to the probability of earning $27000 more in household income or having two more mean years of education [3]. This advancement in stock market participation has been linked to easy availability of information and payment services online, which reduce information and transaction costs [3]. However, despite proof that the internet is an efficient and convenient way for investors to carry out stock trading and access relevant financial information [3], and growing internet penetration in the continent, especially in countries such as Ghana (37.9%), South Africa(56.2%) and Nigeria (27.7%) [10], online brokerage cites are almost nonexistent in the African continent. This means that investors have to call their brokers every time they want to make or inquire about a trade, which creates major inconveniences and costs in terms of time wasted and money used to facilitate the communication. This therefore necessitates the need to develop a platform where investors can easily obtain information and make trading choices at their own convenience.

Moreover, a survey conducted during this research revealed that most individuals do not engage in stock trading due lack of knowledge of the market and the risks involved. Additionally, the few who had traded before with the help of brokers complained of tedious inquiry processes and lack of control over their portfolios. The survey also revealed that 71.4% of the respondents who had ever bought stocks did so through a broker while only 28.6% traded through a brokerage platform. All respondents expressed interest for a brokerage system that would provide them with accurate and up to date information on stocks online, was convenient and easy to use, fast and cost effective. This therefore proves a need for an online stock brokerage platform with these functionalities, which will enable users to actively participate in the stock market and be able to earn extra income as a result.

1.3 Related Work

[2] discusses the roles of stockbrokers which include providing means for buying and selling stocks and providing clients with research information. The authors also point out how in the advent of the internet, information has become easily accessible and online trading platforms are more responsive to this information, thus making them a better trading option than traditional brokerage firms. [7] compares traditional and modern online trading, and points out online trading is less costly, has high speed response, is more transparent and avoids broker indiscretion. This therefore support the need and relevance of online stock trading platforms.

1.4 Existing Solutions

Several applications have been developed by organizations in the past to meet this need to facilitate online trading. Such platforms include the following:

TD Ameritrade: This is one of the largest online brokerage sites, based in the United States. The platform provides various learning materials to aid traders. However, it offers many account types which can be confusing to inexperienced investors [4]. The platform developed in this project sorely focuses on stocks.

E Trade: This platform has easy to use mobile applications. However, it does not provide access to international markets hence traders cannot buy stocks from outside the United States [4]. The platform developed in this project can be easily replicated to meet the needs of traders in different countries.

Merrill: This online brokerage platform offers stocks, options trades and contracts. It has good customer service and consultancy services for users [4].

These platforms are all modelled to meet the needs of users in the US stock market hence there is still a need to create platforms that are replicable to African markets.

1.5 Plan for Requirements Analysis

In order to determine the requirements of the system that will be developed, the following tools will be used to collect relevant data that can be used to determine the right requirements and functionalities of the system.

- Surveys

Surveys will be conducted among potential investors to find out features they would want an online system for stock trading to contain.

- Interviews

Interviews will also be used to get more information on necessary features and areas of concentration in order to ensure the system meets existing market requirements.

- Secondary research

Secondary research will be used to determine things that can be improved in already existing solutions and conditions the platform would need to meet to solve the existing problem.

Chapter 2: Requirements Specification

2.1 Procedure for Requirement Gathering

The requirements for this project were identified by issuing a survey to potential users of the system and conducting an interview with the Stanbic Bank stock brokerage department. The survey was aimed at giving a better understanding of the system users, their understanding of the stock market and features they deemed necessary in a successful brokerage platform. The information obtained from the survey revealed that most users who wanted an online brokerage platform were interested in being able to use a system that was simple and easy to understand, being able to buy and sell online, easily access market information, be guaranteed of making profits, have more payment options, have an easily accessible and easy to open account and being able to invest at a low cost.

The interview with the Stanbic Bank brokerage department revealed that investors must go through a stockbroker or licensed dealer in order to buy stocks in Ghana Stock Exchange. The online brokerage platform would therefore have to be managed by an individual or organization that is licensed as a trader in the stock exchange. It also revealed that the buying and selling of stocks in the Ghana Stock Exchange happens through the trading platform called Capizar, hence any brokerage platform would have to be integrated with the Capizar system for trading to occur.

Figure 2.1 below shows a simple overview of process of buying or selling stocks in the Ghana Stock exchange using existing brokerage systems. In making a buy or sell, investors first carry out extensive research on the stocks then call or visit their brokers to place the order.
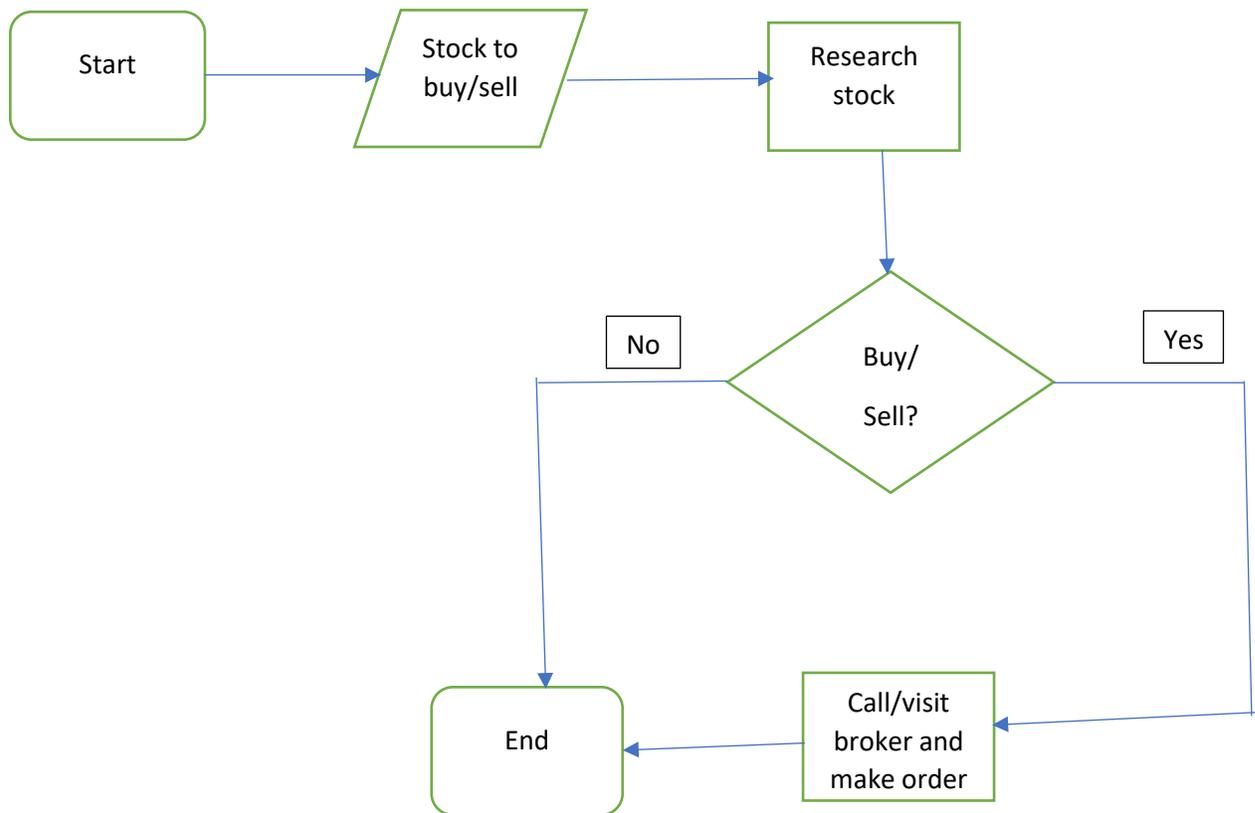

Figure 2.1 Overview of ordering process with existing platforms

2.2 User Classes

The main users of this platform are stock investors interested in investing in stocks listed in African stock markets, and brokerage firms or persons, looking to take their services online.

2.3 Use Case Scenarios

Scenario one: Lilian, an undergraduate student has one thousand cedes saved in her account and would like to grow the savings by investing. However, she has little knowledge of how the stock market works and opening an account with a broker is too expensive for her. Moreover, she would like to have constant update on her stocks and spend less time in making decisions on whether to buy or sell. With good internet access at her school, she searches for online trading platforms and finds one that allows her to create and invest instantly, and provides her with up to date market information, enabling her to make profitable buy and sell decisions. Lilian can grow her one thousand cedes successfully and is happy with her holdings.

Scenario two: SMARTshares is a stock brokerage company listed in the Ghana stock exchange. The company has been looking for ways to gain more clients and discovers that having an online platform reduces cost of acquiring information for their clients thus giving them a competitive advantage. The firm also figures they can use the platform to attract more potential users of their services by targeting internet users in Ghana. The firm finds a replicable online brokerage platform template that they customize to meet the needs of their users and are as a result able to provide more affordable services to their clients and gain new clients, thus increasing their market share.

2.4 Use Case Diagram

The figure 2.2 below shows the use case diagram which shows the expected user interaction with the system to be created.

Figure 2.2 Use case diagram

2.5 Functional Requirements

2.5.1 Front-End

The system should have a graphical user interface that allows users to:

- Create an account

- Login into the account

- See their current holdings and visual data relating to their holdings

- Allow users to make a buy or sell order for stocks

- See all shares available for trading on the broker's site

- Access payment a payment platform to pay for their orders

- See information about shares they hold

2.5.2 Data Mining and Processing

- The system should be able to scrape the web and get market information relating to user's stocks

- The system should be able to process obtained information about stocks and present it to users in visual ways that make it easily understandable and inform their decision making

- The system should be able to get tweets about user stocks and present it to the user, so they get the public sentiment on the companies they hold shares in. This is to help with decision making

2.5.3 Data Storage and Access

- The system should be able to store data about users and their holdings, orders made and information about stocks that can be sold or bought on the site

- The system should be able to retrieve information about a user and verify it during login

- The system should show the broker any orders made on the site in the admin dashboard.

2.5.4 Payment Processing

- The system should allow users to make payment for buy orders, by leading them to a payment processing site where payment will be handled

2.6 Non-Functional Requirements

- The system should be secure

- The system should be user friendly and information on the user interface should be arranged in such a way that it's easily accessible

- Internet is required to access the platform

Chapter 3: Architecture and Design

3.1 System Overview

The aim of creating this trading platform is to enable stock investors to easily access information about stocks and be able to make buy or sell decisions on the stocks they hold without having to contact brokers. This is done by providing a user interface that displays market information and stock performance analysis of held stocks, while also allowing users to make buy or sell orders and make payments where necessary. Figure 3.1 shows the context diagram for the system.
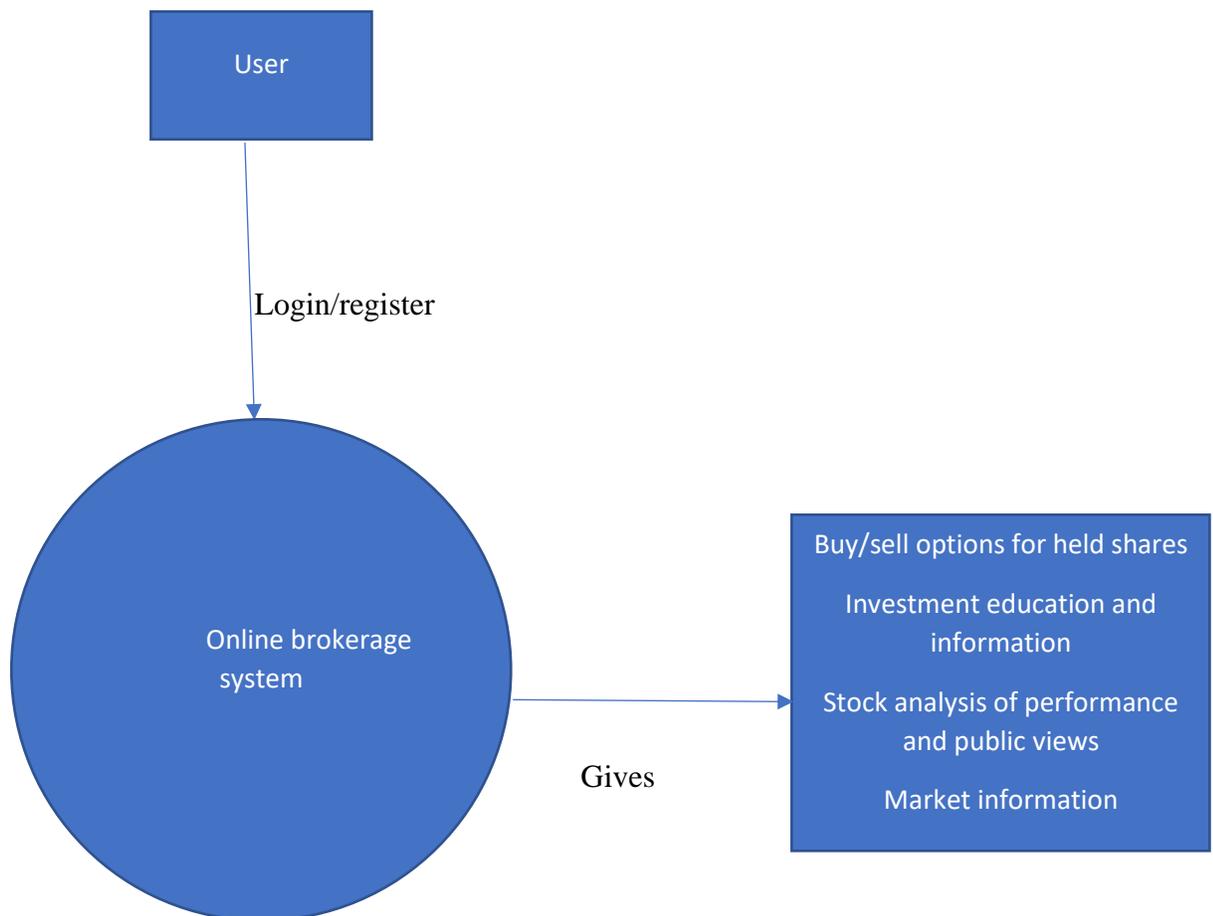
Fig. 3.1 Context diagram

3.2 Software Layer

This layer contains the set of related software that will work together to generate the relevant output for the user. The layers used in the development of this trading platform are:

1. User layer
2. Web scraper
3. Data analysis and presentation
4. Database

3.2.1 User Layer

The user layer is made up of the user interface and will display all necessary information to the user, including market information and analysis of held stocks. The layer will also be used to get necessary information from the user such as login credentials. Through this layer, the user will also be able to place orders to sell or buy stocks. Figure 3.2 below shows the activity diagram for the system.
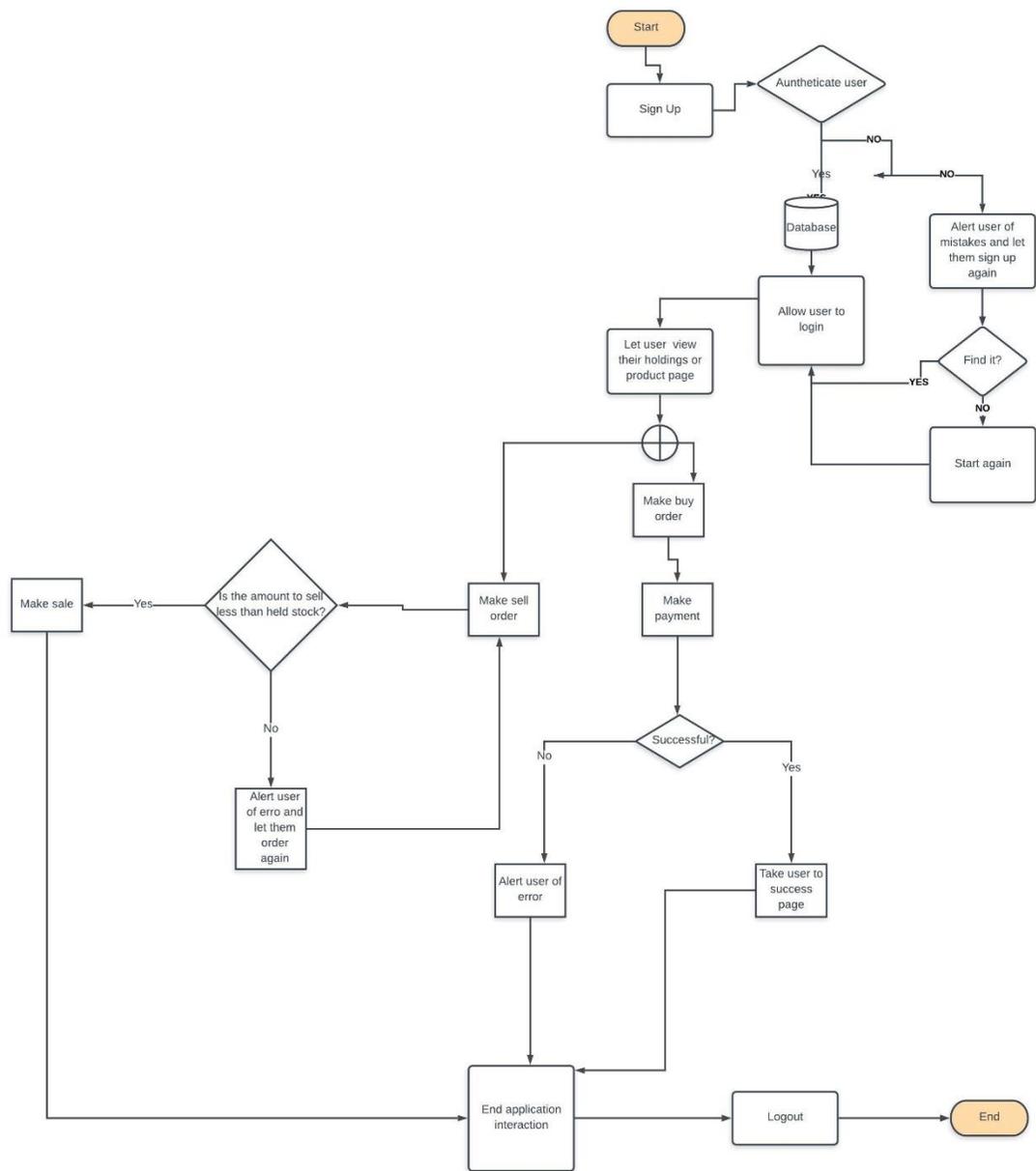
Figure 3.2 Activity Diagram

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3.2.2 Web Scraper

The web scraper will be used to obtain market information and information about stocks from the web.

3.2.3 Data Analysis Model

This layer is where majority of the data processing will take place. This information will then be analyzed and presented to users in a visual way that can help them with decision making.

3.2.4 Database

The database will store information about the user for validation during login, their holdings, and information on all stocks sold on the site. It will also contain information on orders made in the site, both buy and sell orders. Figure 3.3 below shows the database schema.
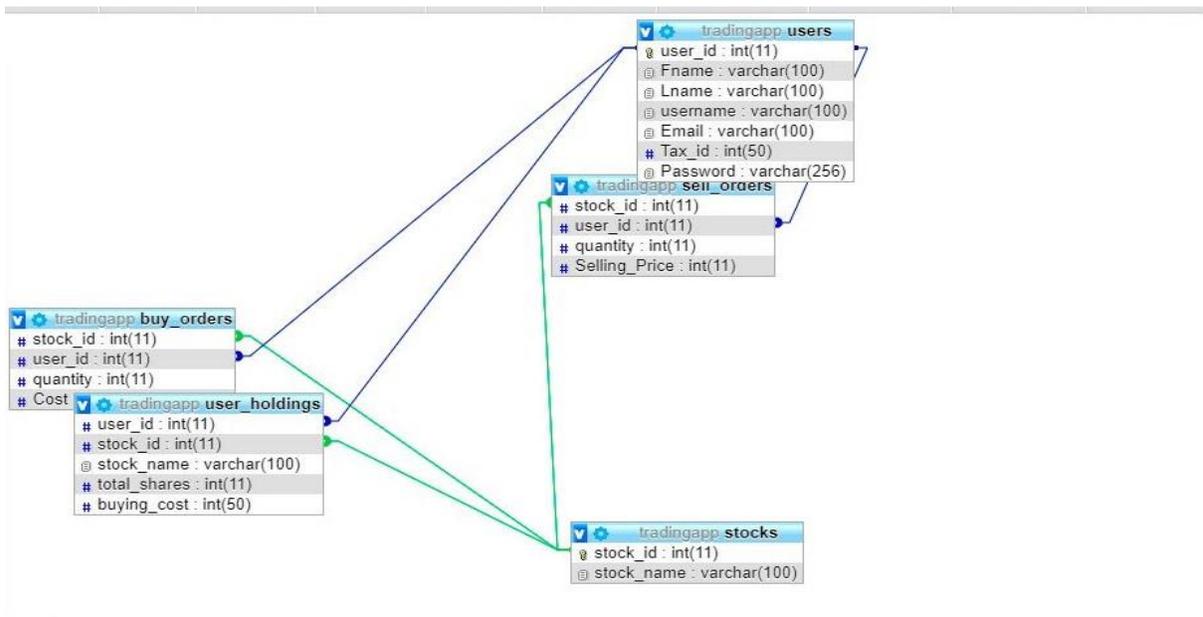

figure 3.3 Online brokerage system database schema

Figure 3.4 below shows the expected software architecture of the system while figure 3.5

shows its layered architecture.

Input	Process	Output

		Give buy/sell advice
User account and password	Validate user account	
		Show market info
Get market info about stocks	Process market information and analyze it	Show analyzed information about stocks
Select whether to buy or sell stocks		Successful buy/sell or show any errors

Fig 3.4 Software architecture

User Interface

| Login | Market info | Buy/sell option | Stock performance |

Data analysis and visualization models

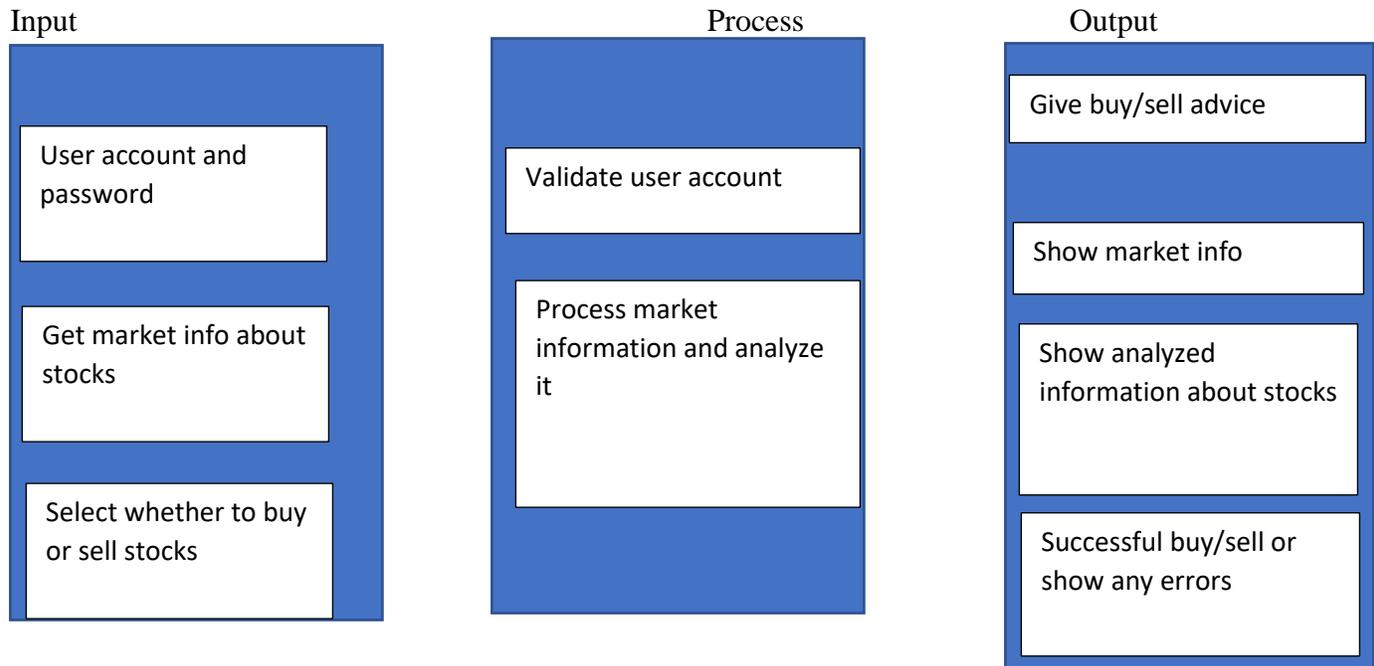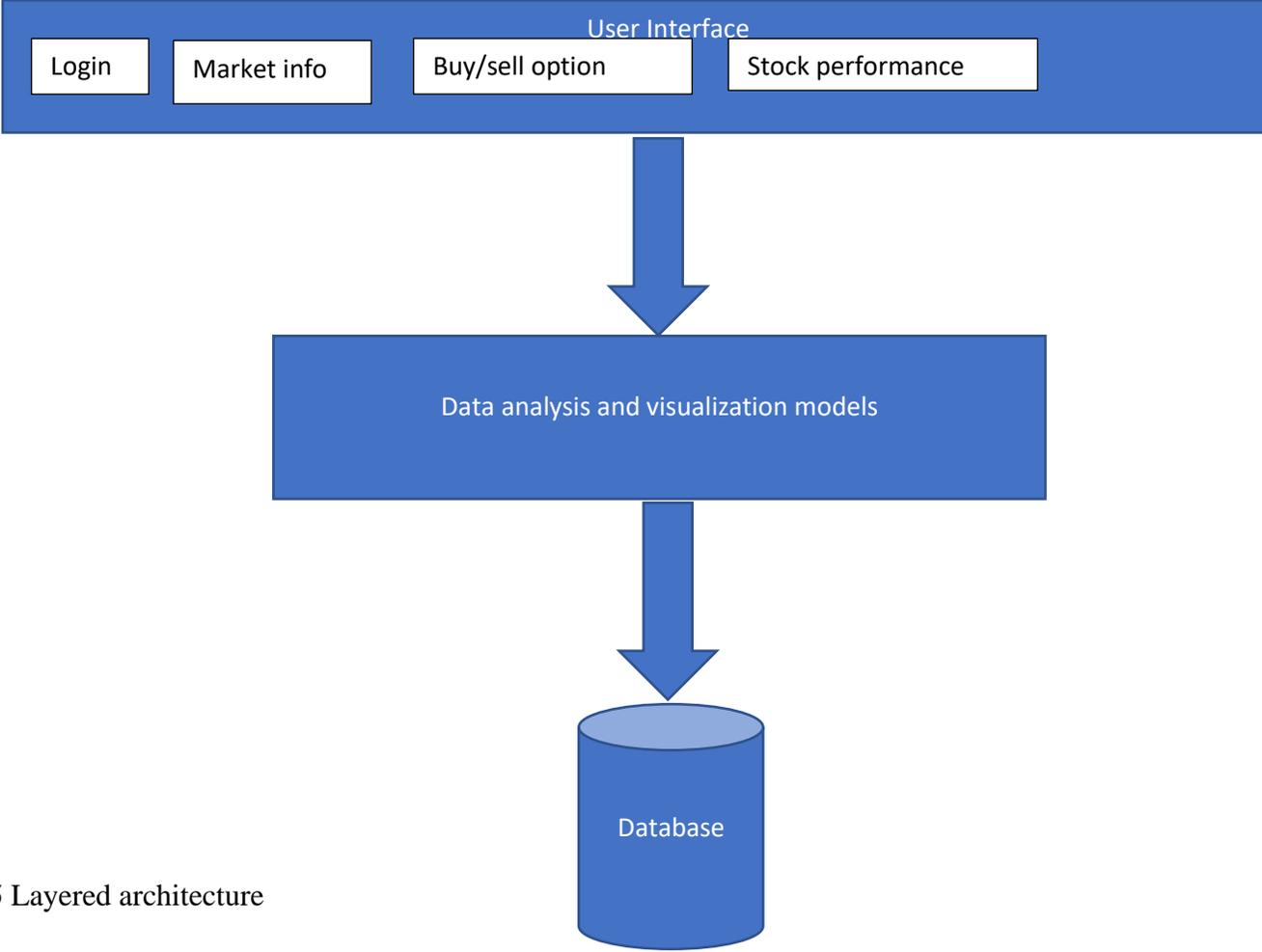Database

Fig 3.5 Layered architecture

Chapter 4: Implementation

4.1 Overview

This section explains in detail the implementation of the various functionalities that constitute the online brokerage platform. The chapter will also explain the various ways these functionalities are expected to work in order to make the application a success.

4.2 Implementation

4.2.1 User Interface

In order to ensure easy accessibility of information to both existing users and others visiting the site, a user interface was implemented. The interface makes use of a navigation bar that shows the different sections of the website, in order to help users, access different pages easily. Clearly marked buttons are also used to help with navigation. Moreover, the colors green and white were used to enhance the site while still maintaining a neutral theme that does not cause distractions for users.

4.2.2 User Registration and Login

In order to access enhanced functionalities of the site such as buying and selling stocks, users must first create an account. The account is created by providing details which include the user's first and last name, an email address, their tax identification number, a username and password. The registration form requires all areas to be filled before processing, and to be of the correct data type. The email address must also meet the criteria for a valid email ID. Additionally, there is a section for confirming the password just to enable the user

to reiterate their password. When the registration form is submitted the system checks to

ensure a similar user does not already exist, and if there is none, the password is hashed, and

details of the user are stored in the database. Upon successful registration, the user is

redirected to a login page where they enter their username and password. The entered details

are then checked against existing user records in the database and if found, a log in session is

created and the user is redirected to their profile page. Figure 4.1 below shows the signup

form developed for this brokerage site.
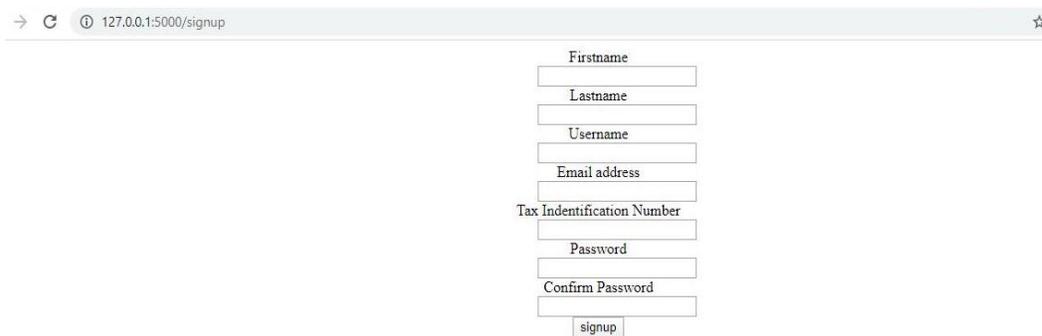
Figure 4.1 signup form

4.2.3 User Profile Page

This page is critical for access to major functionalities in the site such as buying and

selling stocks. The user profile page is only accessible to users who are logged into the

system. The page shows the stocks that are held by a user, and for each of these stocks, a history chart of their performance in the stock market, about two hundred most recent tweets about the company issuing those stocks, and a sentimental analysis of the tweets. This information is aimed at giving users an overview of the performance of the stocks they have traded in and help them in decision making. Each stock row has two buttons which enable users to make either buy or sell orders. In cases where users do not have any holding yet, the product page showing the different available stocks is shown instead. Figure 4.2 below shows a simple example of a user profile page created during the development of this platform. The profile shows shares held by the user, the quantity held, and links to either buy more of the stock, sell or view charts related to the stock. The information is displayed in a table.

Figure 4.2 A simple user profile page

4.2.4 Web Scraping for Twitter Data

  The application also greatly makes use of data mined from twitter to help users with stock analysis. Twitter is used as a source of information because it has a public API which makes it easy to mine data. The functionality implemented in this application makes it possible for users to view analysis of 200 most recent tweets about a company that has issued a stock they hold. This helps users in catching up on news on these companies, and inform their decisions moving forward. The application analyzes the sentiments on the obtained tweets and presents users with a bar chart that helps them understand the public's sentiments about the stocks they hold or companies that issue those stocks. These functionalities are useful as public opinion on companies affects the demand for their stocks and hence it is useful for investors to be on the know. Figure 4.3 below shows a sample sentimental analysis chart created during development, while figure 4.4 shows a string of tweets about the company that were obtained.
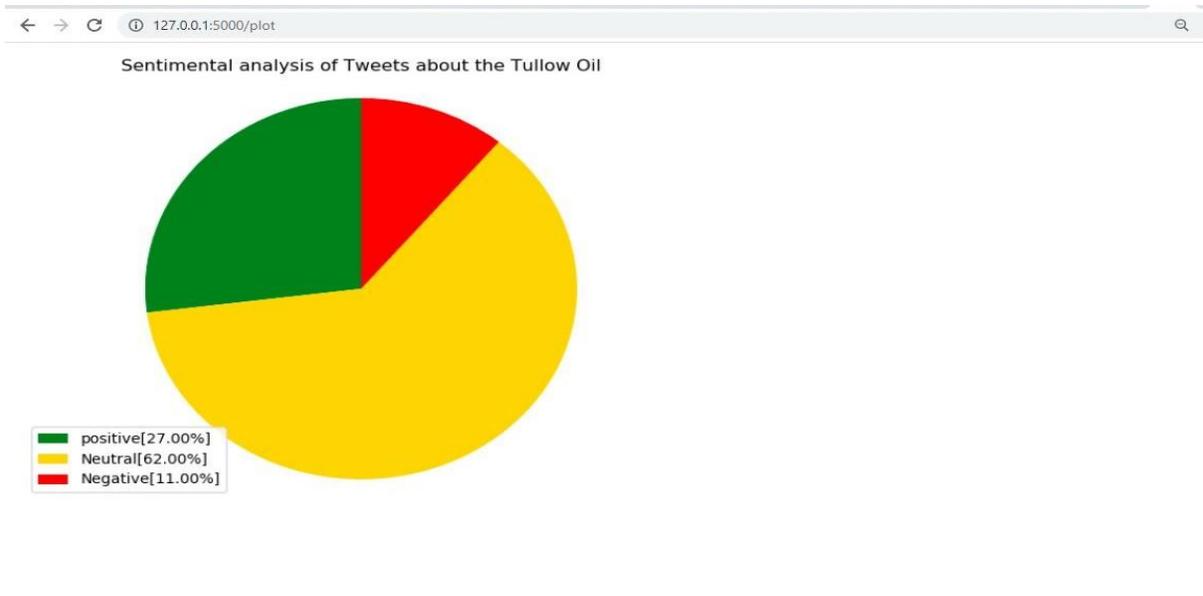
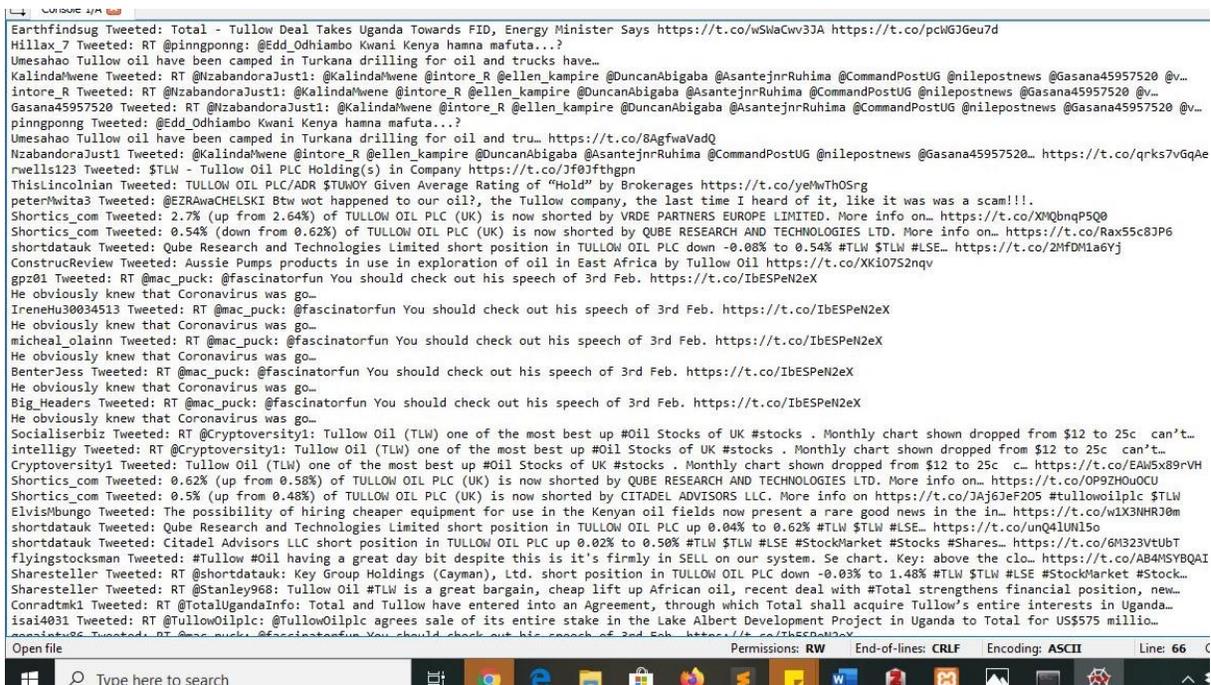Figure 4.3 Sentimental analysis of mined tweets

Figure 4.4 Obtained tweets from twitter mining

4.2.5 Database

A MYSQL database is used to store data needed in the platform. A user table is used to store information about users registered in the platform. The information stored in this table includes the user id which is uniquely assigned by the database when a user account is created, first and last name, a username, email, tax identification number and password. A stocks table is used to store the names and id of all stocks that the site deals in. Another table, the user holdings table is used to store information about stocks held by users. This table takes a user id and stock id as foreign keys and has a column for quantity held. The order processing tables are used to store information about purchase or sale orders that have been made by users.

4.2.6 Order Processing and Payment

The ordering functionality was implemented to enable users to place buy and sell orders for stocks on the site. The buying process begins by following the buy link either in the product page or the user profile page and leads to an order form where users state the quantity of shares to buy and their expected buying price for shares. After filling the necessary details, users are redirected to a payment page where they make payments for their orders. This application uses PayPal as a means of payments, hence users are redirected to the PayPal website for payment. If the payment is successful, users are redirected back to the brokerage platform and land on a success page. The details of the order are then recorded in the buy order table. The user holdings table is also updated to reflect the new holdings. Figure 4.5

below shows the button that redirects users to PayPal, while figure 4.6 shows as the site

redirects to PayPal sandbox account.

Figure 4.5 Payment button to redirect users to PayPal
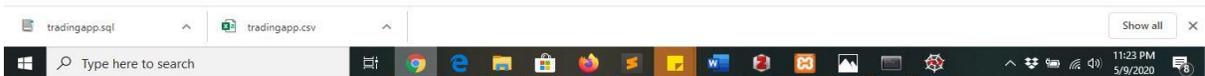

Figure 4.6 Site redirecting to PayPal

Figure 4.7 shows the success page where users are redirected to after successful payment.

Figure 4.7 Page after user successfully makes payment for a stock order

The sale order also begins by clicking the sell button on either the product page or the user profile page. This then leads to a sales form that asks for the quantity to sell and the price at which to sell. The amount to sell is then checked against existing holdings of the stock in the database to ensure users do not sell more stocks than they have in their accounts. If the entered amount is valid, a record for a sale order is created in the database and the user holdings table is also updated to reflect the reduction in holdings.

4.2.7 Logout

This functionality clears a user session when the user clicks the logout button, hence logging them out.

4.3 Implementation Tools

This application is implemented using the Flask, which is a python framework used for web development. The framework contains functionalities that make it easier to develop websites with Python as the back-end language. These functionalities include Jinja templates that make working with HTML easier, faster and efficient. For the front end, the development language used is HML. Bootstrap is also used for styling the site and ensuring the user interface user friendly. WTForms, which is a module for generating forms was used in generating all forms that are used for data collection on the site. This form module also has a validator function that made it easy to validate collected data. The Tweepy API, is a Python API for mining data on Twitter. This API was used in the development of this application for Twitter data mining and analysis. The application also made use of BeautifulSoup which is a python module for web scraping, while the matplotlib and textblob modules were used for chart design and text analysis respectively.

Chapter 5: Testing and Results

5.1 Overview

This chapter gives a detailed account of the results obtained from testing the application.

5.2 Development Testing

5.2.1 Unit Testing

This section describes the tests conducted on the various functionalities separately, the results from the tests and their implications.

5.2.1.1 Testing Registration

Registration testing was done to ensure all necessary areas for creation of user account are filled correctly before submission, and to ensure accounts with duplicate usernames are not created. Testing was done by trying to submit the form with missing fields or fields with invalid information such as an invalid email address. In each case, the correct error was returned, and a user account was not created. Moreover, if a similar user already exists the user got an error message to change the username. Figure 5.1 below shows the error given a user tries to sign up with an already existing username, while figure 5.2 shows the error shown when the email id is invalid, and all fields are not filled.
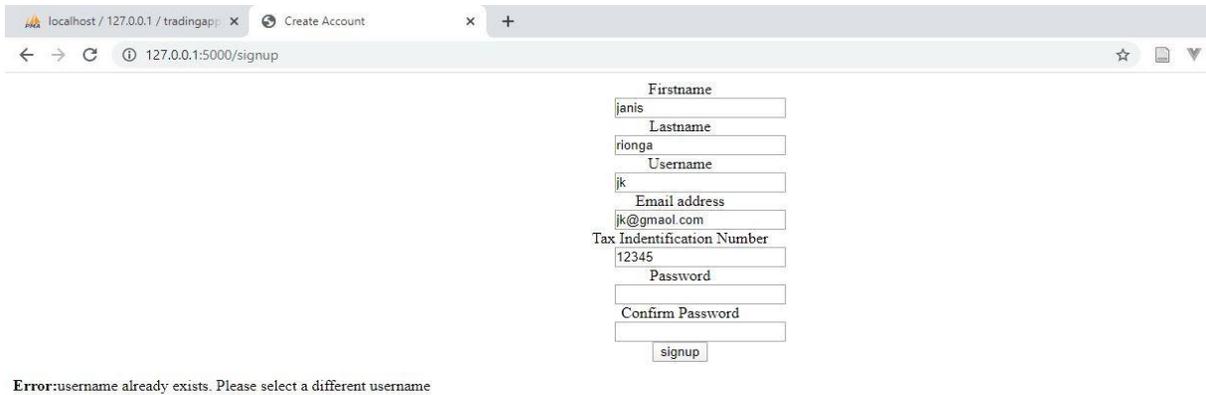
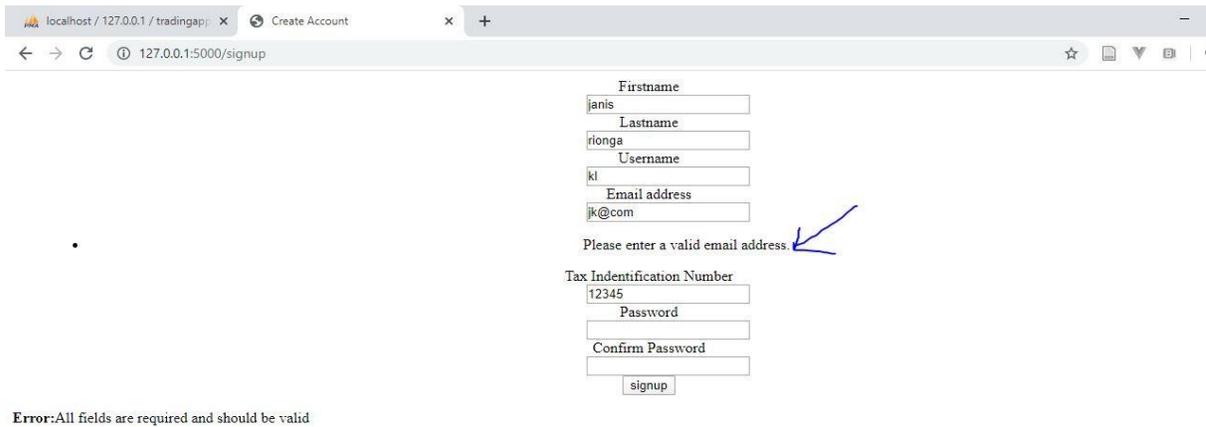Figure 5.1 Testing signup with existing username

Figure 5.2 Testing invalid email ID and unfilled fields

5.2.1.2 Testing Login

This test was conducted to ensure the login page works as expected. This functionality was tested by trying to log in a nonexistent user and a user with the wrong password. In both cases, the system returned an error indicating that the credentials were invalid. However, when an existing user with the correct password was logged in, the system responded accordingly and redirected them to their user profile. Figure 5.3 below shows the results for an invalid login.

Figure 5.3 Testing login with wrong credentials

5.2.1.3 Testing User Profile

This page was tested to ensure that the user's data is displayed correctly as recorded in the database, and that each buy or sell link leads to the right page with the right product id. The system successfully displayed the right information and all links lead to the right pages.

5.2.1.4 Testing Twitter Mining and Data Analysis

These functionalities were tested to ensure they worked as expected. It was observed that the program was able to successfully return tweets about requested keywords and present a chart of the sentimental analysis of the given tweets.

5.2.1.5 Testing Ordering

The buy and sell ordering functionalities were also tested to ensure they worked as expected. It was observed that the appropriate records were either updated or created in the database whenever a sale or buy order was executed, thus proving that the ordering functionality was working as expected.

5.2.1.6 Testing Payment

This functionality was tested to ensure that payment was going through as expected. Dummy accounts were created on PayPal's Sandbox platform which is used for testing integration with PayPal. If payment made on the site was successful, the user would be redirected back to the success page as shown in figure 4.6. This therefore proved that the payment functionality was working as expected.

5.2.1.7 Testing Logout

This functionality was tested by logging a user out and checking if they still had access to features that were supposed to be only visible to logged in users such as the user profile page. The test proved to be a success as users were not able to access these features after logging out.

5.3 System Testing

The system test was conducted to check if the various functionalities worked as an integral system to produce the desired results in the system. The results of the test showed there is clear communication between the components of the system as the desired results were yielded in the test.

Chapter 6: Conclusion and Recommendations

This paper describes in detail the conceptualization process and implementation of an online brokerage platform that can be easily replicated to suit traders in different African stock exchange markets. With such an application, licensed dealers can easily move their operations online and cut down on the timely costs of having to deal with stock traders directly, by availing all the necessary information on the site instead.

So far, the online brokerage platform has the following functionalities implemented:

1. New users can create accounts on the system
2. Existing users can login using valid credentials
3. It can mine tweets about a company issuing stocks and carry out a sentimental analysis of those tweets
4. Allows users to make orders for stocks and pay online using PayPal
5. Saves data about users, their holdings and stocks in the database

The system has the following limitations:

1. The system is reliant on manually input data in some sections such as the traded stocks hence only limited to information manually input into the database.

For future works, the following functionalities can be implemented to improve the brokerage platform:

1. Integration with varying payment companies and banks: The application currently only allows users to make payment for orders via PayPal. However, different users have different preferences and it would be best to integrate the platform with various local payment companies in order to give users who do not use PayPal other valid options.

2. Integration with Stock Exchange Platform: The system currently works independently and only goes as far as order processing. However, for trade to be carried out, it must go through the stock exchange market where the trading occurs. It would therefore be a great improvement to integrate the site with the trading systems of stock exchange markets in order to automate the whole trading process.

3. Generation of Statements of Account: While the current implementation of the brokerage platform allows users to see the performance of their stocks over time, it does not include a functionality to generate statements of accounts for users, which means they would still have to call their broker to get such statements. It would therefore be beneficial to include such a functionality in order to enable users to get statements about their trading within a click of a button instead.

4. The product page should be implemented to show all products specific to the stock exchange the broker is licensed to deal in.

5. The admin dashboard should be implemented to require sign up and login from broker and allow them to provide useful information to users.

In conclusion, this project puts online stock brokerage in the Ghana stock exchange and other African exchange markets just a step away from reality and would go a long way in making work easier for both investors and licensed dealers.

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Appendix

A. Requirement Gathering and Understanding the Problem

A.1 Survey

A.1.1 Survey Questions

Section 1

1. Have you bought stocks or any other financial assets previously?

Section 2 *(Answer this section if your answer for section 1 was yes)*

1. Did you use a stock trading application or broker to carry out your trading?

Section 3 *(answer this section if your answer for section 2 was trading platform)*

1. If trading platform, what's the name of trading platform used?
2. What features did you enjoy when using the platform?
3. What would you want improved in the platform?
4. Would you prefer an automated application that carries out trading on your behalf? Give a reason for your answer
5. Do you think Ghanaian trading platforms or brokers are efficient? Give a reason for your answer

Section 4 *(answer this section if you selected brokers in section 2)*

1. What did you enjoy about working with the broker?

2. What were the challenges of working with the broker?

3. Would you consider using an automated trading platform that carries out trading for you instead of a broker for your trading? Give a reason for your answer

4. Do you think Ghanaian trading platforms or brokers are efficient? Give a reason for your answer

Section 5 *(answer this section if your answer for section 1 was No)*

1. What do you think is the reason you haven't bought stocks or other financial assets yet?

2. If there was a trading platform to make trading easier for you, what features, or actions would you want it to be able to complete?

3. Do you think Ghanaian trading platforms or brokers are efficient? Give a reason for your answer

A.1.2 Insights from Survey

The survey had a total of 44 responses, with respondents being individuals from different backgrounds, ranging from students to working professionals. Some of the responses to the survey are summarized and visualized below:

Have you bought stocks or any other financial assets previously?
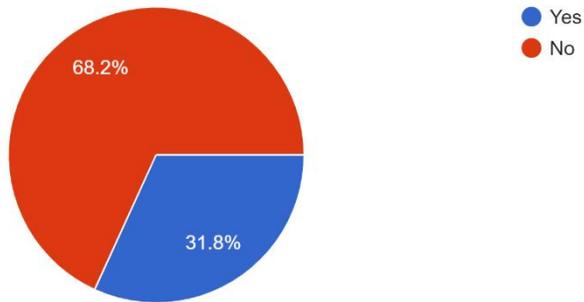44 responses

Figure A1 Summary responses for buying stocks

Did you use a stock trading application or broker to carry out your trading?
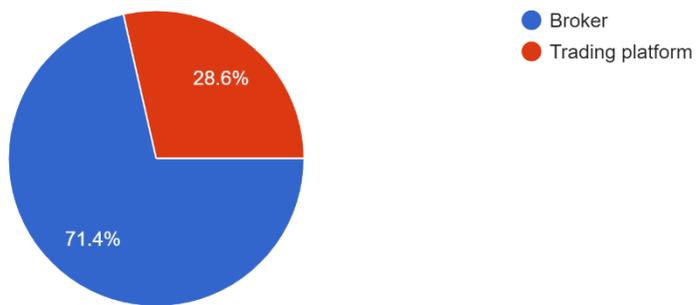14 responses

Figure A2 Summary responses for platform used

Would you consider using an automated trading platform that carries out trading for you instead of a broker for your trading?
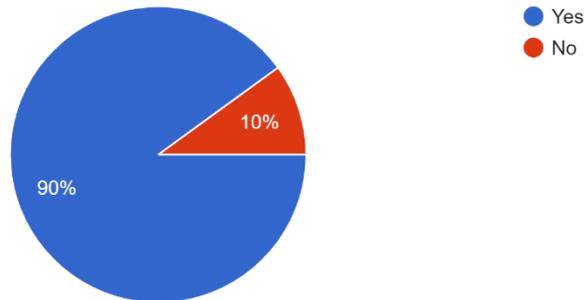10 responses

Figure A3 Summary responses for using automated platform

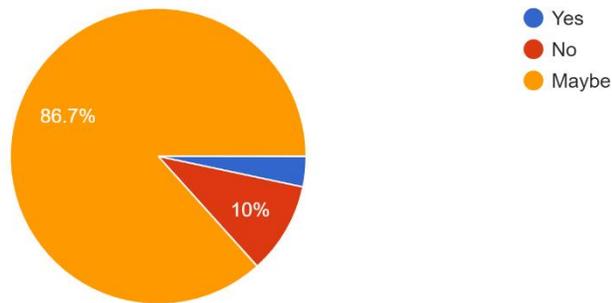Do you think Ghanaian trading platforms or brokers are efficient?
30 responses

Figure A4 Summary responses for efficiency of existing platforms

A.2 Insights from Visit to Stanbic Bank Brokerage Department

1. The Ghana Stock Exchange (GSE) has a trading platform called Capizar.

This system is where all the buying and selling of stocks occurs. All brokers

who are licensed dealers with the GSE have accounts with the GSE which they use to carry out trading

2. Brokers usually have their own systems for client management. These systems are integrated with the Capizar system to facilitate trading

3. Investors must go through a broker in order to buy or sell stocks. They therefore cannot buy or sell directly stocks to the Ghana Stock Exchange on their own accounts.

4. In current broker platforms, clients cannot access their security deposits without going through a broker

5. Stock prices are determined by a lot of factors in the market which vary widely, hence it is difficult to speculate/predict future prices of stocks