Financial and Portfolio Manager Website

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September 2016

Dissertation submitted in partial fulfilment for the degree of
Master of Science in Computing for Financial Markets

Computing Science and Mathematics
University of Stirling

Abstract

This project is about a financial and portfolio manager web page where the users can monitor live stock quotes about different international stocks and currencies and also create their own portfolio in order to track down their performance. The website uses up-to-date equity data from the API of Yahoo [1].

- Problem: As a novice investor I look at different web sites every day to monitor the performance of my shares but the layout, design and functionality of these web pages leave much to be desired. Furthermore, some of these portals offer a free portfolio manager but this feature is very poor in order to be able to make a good track of your portfolio. There are some good ones but they are not thorough as I consider a quite powerful portfolio manager should be.
- Objectives: The main goals of my project are to build a dynamic web site with a functional interface, easy to use and understand for beginner investors to watch real equity data. Secondly, they are able to see a chart about every stock to perform technical analysis in order to take a decision about which stocks to buy. Thirdly, to set up some financial calculators such as a currency calculator to know how much your money is worth in the currency of the security and then be able to know how many shares the investor may buy. And finally, to create a good portfolio management tool in order for the investor to create and track the performance of his own portfolio.
- Methodology: The main challenge to build this web site was that I did not have any knowledge in web development, so that before starting building my website I had to struggle studying the different programing languages that are used to build a dynamic web application. The programs that I utilised were HTML, CSS, JavaScript, JQuery, AJAX, JSON, PHP and MySQL.
- Achievements: I consider I have met my goals, achieving a simple financial web portal with a nice interface and design where the users are able to see the most important stock data over 160 international securities and 13 currencies, and building a quite professional portfolio manager tool.

Attestation

I understand the nature of plagiarism, and I am aware of the University's policy on this.

I certify that this dissertation reports original work by me during my University project except for the following:

- The code discussed in **"Heading 3.1.3 Yahoo's API"** was created by Peter Ponzo and used to display the stock charts from Yahoo Finance. It was taken from [1].
- The pre-made code to display the stock charts was provided for Tradingview [3] for free. It is discussed in **"Heading 4.2 Charts".**
- The code explained in "**Heading 5.9"** about how to set up a Slideshow was taken from w3schools [4].
- The tutorial video "Yahoo Finance API Pt 1 Getting Started" posted by Matthwe Mayers helped me to implement the code to retrieve stock data from Yahoo's API. It is discussed in **"Heading 4.1 Data structure".**

Signature **Date**

Acknowledgements

First of all, I would like to acknowledge my mum for giving me the opportunity to study abroad and funding my expenses during this wonderful year at University of Stirling [5].

Secondly, I want to give many thanks to my supervisor Dr Bruce Graham for helping me to complete this project, giving me good advice and organizing my time.

Furthermore, I have the need to acknowledge Yahoo Finance [6] for leaving developers the chance of fetch and display financial data in their own website and the w3schools.com [7] for being an amazing source to learn how to build dynamic web pages.

Finally, I would like to thank the Student Awards Agency of Scotland (SAAS) [8] for funding me to cover part of my tuition fees.

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1 Introduction

The end product of this project, the International Portfolio Manager (IPM), is a financial and portfolio management web page where the investors may realize four main things.

- First of all, they can watch financial data of stocks that belong to three international Indices (DJIA, FTSE 100 and DAX) and the exchange rates of the major currencies.
- Secondly, they may analyse the price of the stock thanks to a chart provided in every stock page.
- Thirdly, is a financial calculator where among other features the investors can calculate how many shares of a foreign stock they can buy depending on how much they want to invest and what the exchange rate is.
- The last and more important task after selecting the equities and knowing the number of shares they can buy, is to build and manage their own portfolio.

1.1 Background and Context

Nowadays financial markets cannot live without computer programs, both work together to satisfy all the requirements of their clients and give them all kinds of information in real time. However, some decades ago before the arrival of the internet, to access the information that financial markets provided was very hard for a normal citizen. It was limited only to professional workers. The general public had a few options to be able to follow stock quotes and monitor their portfolio, but could not watch them in real time and it was impossible to take control of their investments to manage their portfolios. These options were:

- Newspapers: It was the most popular means of following the stock data, but it has a big disadvantage because the data was printed with one day delayed. It caused investors to waste one day to make a decision.
- Magazines: Most of them were weekly or monthly so the information the investor could read were about news and reports explaining the causes of the movements of the prices rather than displaying information about the stock quotes.
- Financial institutions and brokers: This was probably the best option if an investor wanted to know the performance of her portfolio, but she had to waste time going to her financial institution to ask or call by telephone.

- Financial software: The investors could watch stock quotes in real time and monitor his portfolio, however it was not available for a non-professional because it was very expensive and hard to use for them.
- Television: People could follow the movements of the equities and the most updated news but not to track his portfolio. The drawback is that you could watch only what they were broadcasting and could not search for any kind of information.

However, this panorama changed during the last decades with the boom of the technology, the development of the internet and the set-up of a lot of giant technology companies like for example 'Yahoo' and 'Google'.

Nowadays, an investor can see the real price of a share, its percentage change in the day and more financial data, manage his own portfolio and track its performance all in real time and from home, just with a computer and internet. The applications that allow the investors to be able to do all this are the financial websites like uk.investing.com, mobile applications and financial software like 'Metatrader' [9].

1.2 Scope and Objectives

International Portfolio Manager is a financial website addressed to non-professional investors because it does not require to have a great knowledge about financial markets or finance to use it. The design of this web page was done for them bearing in mind two main concepts: functionality and manageability. It means that, it must be very easy for beginner investors to access the information they are looking for without the need of wasting time looking around the web portal and also to move from one part of the application to another with a simple click in the menu bar or in other links provided.

There are many financial websites that display stock data, some of them in real-time and others with delay. IPM retrieves stock data from the API of Yahoo Finance. I would like to show to my end-users real time stock data, however that is very hard to get due to your need to pay for that. That is why my website displays stock data with 20 minutes delay.

One of the main features of a financial portal is the chance to use a portfolio manager for free. Most of them have a poor portfolio section whereas others offer to its registered users one very completed. Unfortunately, the investors cannot track the performance of their equities in the original currency of the stock, simply they show the total return in the currency of the stock what can lead to confusion to the beginners' investors. That is why IPM will present the investor's return in both local and foreign currency to ease his understanding about financial markets.

1.3 Achievements

As a result of the different objectives I would divide this project in four main parts, three of them to improve tasks of current financial web pages, plus one Calculator section:

- Watch financial stock quotes
- Watch a stock chart for technical analysis.
- International Portfolio Manager.
- Financial calculator.

In the first part the user can select 3 international indices to watch the stock quotes of the equities that belong to them, besides the exchange rate of the 13 major currencies. The aim of this is to take a quick glance at the most current information about them like the last trade price, the change and percentage change in the day. When the customer clicks in the symbol of an equity, the website displays the private page of this equity. It includes more financial data and a chart price to help him analyse the share and make the decision whether invest in this company or not.

The main goal of the International Portfolio Manager section is that the user can create a portfolio of international shares, adding the name of the equity, the number of shares he possesses, the price and the date they were bought at, in order to calculate in real time:

- The current profit and return of the stocks in the currency of the stocks.
- The current profit and return of the equities in the currency of the investor.
- The total value and return of the portfolio after considering the different exchange rates of the equities.

To summary this goal, the investor will be able to know the current value, profit and return of each equity and his portfolio in his own currency using the current exchange rates between his local currency and the currency of the securities. This is something that in most of the websites the investor cannot know.

The last but not less important part of the project is the financial calculator section. There are three kinds of financial calculations the user can do:

- Currency calculator: For my dissertation I am going to work only with three pairs of currencies, EURUSD, EURGBP and GBPUSD. The user can know for example how many USA Dollars £1000 is.
- International Investment: This tells us how many shares of a foreign company the investor may buy and how much is his investment in the currency of the stock de-

pending on his amount to invest in his own currency and the exchange rate between both currencies. It means for instance, how many shares of an America stock like 'Apple' he may buy and in how much his investment is valued in Dollars if he wants to invest £1000, the price of one share is $100 and the interest rate is 1.3193 Dollars per Sterling Pounds. The result is that he can buy 13.93 shares of 'Apple' and his investment was $1,319,30.

- Return predictor: Last one is a return predictor to calculate the future value, profit and return of an investment in different currencies regarding the future interest rate to lock in the trade. For example, if an investor wants to sell his 14 (rounded to the nearest integer) shares of Apple, he must type the price to sell them and the exchange rate that he locks in a future price or the current exchange rate to know if it is profitable or not to sell them with this features.

I had put a lot of effort in the design of the user interface to create an application that can be easily accessed and manageable for all kind of users. I consider this is a one of the strongest point of my project.

To summarise this website offer several functions:

- Watch stock quotes.
- Watch more detailed stock and financial data.
- Watch stock chart to analyse the share price in different periods.
- Use technical analysis in the stock charts.
- Get financial ratios of the stocks.
- A search text field to look for a specific stock.
- Calculate how much money the user has in another currency.
- Calculate number of shares that an investor may buy according to the exchange rates.
- Calculate the value of an investment in a foreign currency.
- Calculate the exchange rate that a trade was done.
- Calculate the value, profit and return of an investment in both local and foreign currency.
- Create and monitor a portfolio.
- Get the performance of stocks in their local currency and also in the currency of the investor.

- Get the total value and return of a portfolio in the investor's currency.

1.4 Overview of Dissertation

Chapter 1 introduced the International Portfolio Manager web site, set up the backgrounds and context, the scope and objectives of this project, besides the achievements reached.

Chapter 2 gives details about what a financial portal is, its main features and a brief explanation about some of the main competitors with their strengths and weaknesses. In addition to a brief introduction to explain what the financial markets are, what portfolio management is and why I decided to develop a financial web site instead other platforms.

Chapter 3 describes the user requirements and the use cases required for the correct functioning of IPM.

Chapter 4 discusses the solution design, explaining how the main components work, how to get the stock data, the different technologies utilised to build this dynamic web site, the design of the database and the web user interface.

Chapter 5 deals with the implementation of all of the elements chosen for the design of the web page.

Chapter 6 focuses on everything related to the testing, evaluation and feedback of the web site for beginner and intermediate investors.

Chapter 7 concludes this dissertation by stating a summary of the achieved work, including self-evaluation and followed by suggestions for future work and improvements for International Portfolio Manager Web site.

At the end of the dissertation are the references and the appendix 1 which includes the questionnaires used to obtain the feedback from the testers.

2 State-of-The-Art

As already introduced, the International Portfolio Manager is a financial and portfolio manager website which focuses on two areas within the Economic and Finance world, financial markets and portfolio management.

In this chapter, I will comment briefly on what they are and how they were introduced in the web development. Moreover, why I decided to realise this dissertation as a web page and not in another kind of software.

2.1 Financial websites

A financial portal is a website that provides a variety of financial data and information about all kinds of financial assets such as equity securities, fixed-incomes, commodities, currencies and indices. It acts as an information hub for clients who individual investors are requiring timely financial news and data to make their investment decisions.

Financial websites are intended to give clients all the finance-related information they need. The portals provide visitors with quotes, charts, articles, analyst recommendations, etc.

Some of the most famous free financial web pages are uk.finance.yahoo.com, google.co.uk/finance, uk.investing.com and in Spain eleconomista.com that allow the users access to a big amount of financial data for free, besides other sections. I will talk about these websites in the **Heading 2.2 Existing financial websites.**

There are a lot of websites to monitor stock quotes, most of them display them in real time such us uk.investing.com although more common is that the websites show them with 20 minutes delay. Some of them, as the one mention previously is very intuitive, easy to use and understand and gives you a lot of current stock information for free. However this is not the general case, from my point of view as an investor most of them have a messy and very poor design, load very slowly and it is difficult to navigate around the website to get the right information you want.

In regard to the portfolio manager, not all the financial web sites have a portfolio manager section, though most of them have it and for free. Personally, I do not like what they offer, because they only show data about the stocks you possess and not how they are performing. So that it is more like a watchlist, rather than a portfolio manager where the investor can monitor the evolution of his stocks in order to know the holding gain and return.

Others just give the return of the stocks in the currency of the share regardless of the exchange rate and what is your currency. For example, if you are a British investor and you

decide to invest £1000 in an American company that operates in the New York Stock Exchange in Dollars, in this kind of websites you can only know the return of the equity in its own currency (Dollar in this example), and not how is your total return in your local currency (Sterling Pounds in this example) according to the exchange rate. In my opinion this is a big mistake, because the exchange rate are very important in international investments. It can make you to have a negative return in spite that the security has a positive return in its own currency.

There are some web sites like uk.finance.yahoo.com which provides a quite powerful portfolio manager for its registered clients because they may add their holdings and track their individual stock performance and the total portfolio value and return at real time in their local currency. Although, Yahoo Finance offers you the final result of your securities and your whole portfolio, I really miss another section where you can know the performance of your equities in their own currency. Therefore, I am going to include in the portfolio manager section of International Portfolio Manager both these topics.

Another negative point for the majority of these websites is that they do not give you the return of your portfolio as a whole, they only focus on the individual price and shares. The even do not tell you what the current return of your securities is. This is the example of the portfolio manager of uk.investing.com. Already mentioned above, they do not bear in mind the exchange rates. Last thing to comment on, is that you cannot make a prediction of your returns playing with the exchange rates. This is something that I do incorporate in my project within the Calculator section.

As an investor I consider that generally these websites provide a poor portfolio manager section that can be improved easily and also be provided for free. That is why I wanted to design a financial and portfolio manager web application, in order that investors with short financial experience feel comfortable and secure investing in international stocks.

2.2 Existing financial websites

There are thousands of financial websites around the world, some are small and local which only focus in its country market and others are big companies that incorporate information about all international markets. They provide to the users many features, quotes, news, reports, portfolio manager and graphics in order to reach the widest audience possible.

Aforementioned in **Heading 1 Introduction** some of them are not easy to understand, hard to navigate between the different menus and sometimes unexpected crashes occur proving how badly these applications have been designed.

2.2.1 Yahoo Finance

uk.finance.yahoo.com is a media property that is part of Yahoo!'s network. It provides financial news, stock quotes, press releases, financial reports, and original programming. It also offers some online tools for personal finance management as a currency calculator and a free portfolio manager.

Yahoo Finance provides the investors with a lot of free stock information, statistics and financial-accounting data. They focus more on providing economic news and financial data for other companies rather than the visualization of this information and data in its website.

In my opinion, the strongest point of Yahoo Finance are its Watchlist and Portfolio sections. In its portfolio manager you can build your own portfolio and track the performance of every stock you have added in your own currency and also the total portfolio value and percentage gain. However, the investor cannot monitor the performance of his shares in the currency that these shares quotes. For my point on view it is very important to know both, how your stocks performed in their local currencies and in the investor's currency, in order to be able to analyze if the decision about to invest in these equities was a good choice or wrong. This is due to for example that an investor could have made a good selection investing in 'Apple' but the Dollar has depreciated a lot causing that the final result is negative in spite of Apple had a positive result.

Figure 4 shows how the investor can monitor the holding value, gain and percentage of his portfolio in his local currency (Sterling Pounds in these example) after having investing in European and American stocks that quotes in Euros and Dollars respectively.

In my portfolio section I am going to include the same features plus to be able to track the performance in the currency of every stock. This is the only negative point I found to Yahoo Finance Portfolio section.

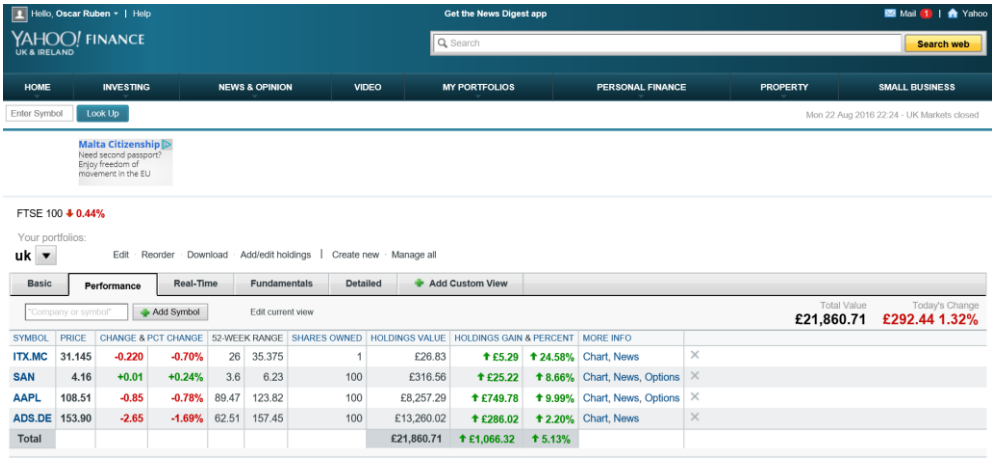

Figure 1. Yahoo's portfolio manager

2.2.2 Google finance

google.co.uk/finance is a financial website launched on March 21, 2006 by Google. The service features businesses and enterprises headlines for many corporations including their financial decisions and major news events. The site also aggregates Google News and Google Blog Search. It lets users see currency information, sector performance for the United States market and a listing of top market movers along with the relevant and important news of the day. It also features charts containing up to 40 years of data for U.S. stocks and real-time ticker updates for stocks, as both NASDAQ and the New York Stock Exchange.

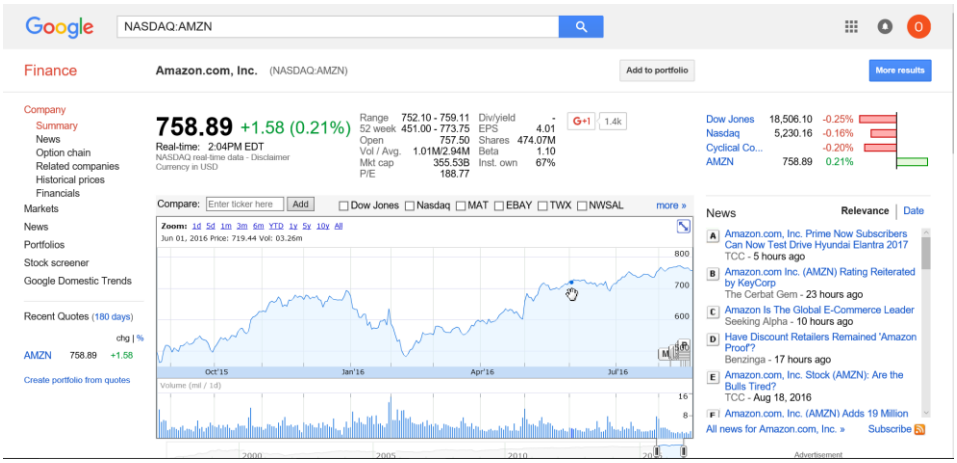

Figure 2. Page style of Amazon.com, INC. in Google Finance

Figure 2 shows how is the design of a page to display the stock quotes of an equity. My opinion is that both the design of this service and the charts are quite poor for being Google the owner of this website. You cannot take a look at the shares of an index as a whole and the information displayed is very limited comparing with other web pages. A positive comment about the chart is that it is related with the news, so that you can see in the chart when they went out and then how was the behavior of the price.

However, its portfolio value is very powerful and like the one of Yahoo Finance gives you the return of your stocks and the portfolio value in your local currency. So that, I reckon they also must show you the return of your stocks in the original currency of the stocks.

2.2.3 Investing

uk.investing.com is a global financial portal that provide news, analysis, streaming quotes and charts, technical data and financial tools about the global financial markets. Real time quotes and technical charts are available on the site for currency pairs, major global indices, stocks, commodities, ETFs, futures, options and bonds from around the globe.

Branded initially as Forexpros.com, the portal launched in 2007 with editions in four languages: English, Spanish, Hebrew and Arabic, offering free data, information, analysis, news and tools over the Forex market for traders.

I consider that Investing has an amazing interface, its navigation bar is very clear, easy to use and navigate from one topic to other. Investors may watch a lot of information about various equities in one simple page. For instance, **Figure 3** reflect how easy we can follow the daily evaluation of German Stocks from the DAX XETRA Index.

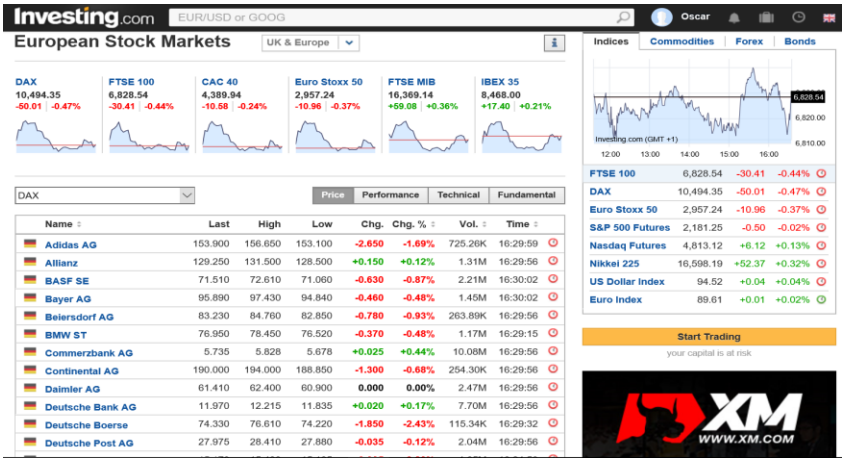

Figure 3. DAX's stocks in investing.com

The mirror for the design and implementation of my program were a mixture among these three portals. I wanted to set up an interface quite practical and manageable that included a lot of data from different stocks as Investing does. Finally, for the portfolio manager section I developed a feature quite similar to that Yahoo Finance or Google Finance already offer but improving the tools aforementioned above in order to enhance the users experience.

2.2.4 Eleconomista

eleconomista.es **(Figure 4)** is one of the most famous financial web pages in my country Spain but from my viewpoint its design is very chaotic, it loads very slowly, is all the time updating so that the page is disappearing and appearing again and again, the graphs are very poor, it does not have a portfolio manager and some sections like reports are at premium.

Figure 4. FTSE 100 page in eleconomista.es

2.3 What are the financial markets?

A financial market is any marketplace that facilitates transactions between buyers and sellers, that is, where investors trade financial securities including equities, bonds, commodities, currencies and derivatives at prices determined by the forces of supply and demand.

There are different kind of financial markets, however I am going to work in my project only with the stock market and foreign exchange market.

- Capital markets: consist of:
  - Stock Markets: It is a financial market that enables investors to buy and sell shares of publicly trades companies from around the world, such as 'Microsoft', 'Tesco' or 'Apple'.
  - Bond markets: A bond is a security in which an investor loans money for a defined period of time at a pre-established rate of interest. They are issued by corporations, states and federal governments.
- Commodities markets: which facilitate the trading of commodities such as gold, silver, wheat and oil.
- Money markets: It is the market for short-term borrowing and lending of securities with a maturity less than one year like deposits, banker's acceptances and commercial papers.
- Derivatives markets: Where investors trade securities that derive its value from its underlying asset. Its value is determined by the market price of the underlying item. This market includes forwards contracts, futures, options, swaps and contracts for differences.

- Foreign exchange markets or FOREX: It is the market where currencies are traded. This one is the most liquid market in the world as cash is the most liquid assets.

2.4 Portfolio management

Portfolio management is the part of finance that focuses on making decisions about investment policy, asset allocation for individual and institutional investors and balancing risk against performance. Portfolio management means to determine opportunities and threats, strengths and weaknesses in the choice of debt securities against equity, domestic securities against international, growth companies against value businesses and many other trade-offs in order to maximize return at a given risk.

Asset allocation is the process that attempt to optimize the risk/return profile of an investor by investing in a mix of assets that have low correlation to each other. The best strategy to have a low correlation is for means of the diversification. It is to spread of risk and return within a mix of different assets. As in this project I am only working with stocks of three international indices and three different currencies, the best option to create a diversified portfolio is to build a basket of securities from different countries with different currencies to provide a broad exposure to all this markets and reduce the risk.

2.5 Other technologies that I could be used

I could have done my dissertation in another platforms rather than a website, for instance a mobile application using Android or iOS or create a financial software with Java. This last option was my first intention but as there already were some past financial dissertations built in this programming language at the end I discarded it. The same situation happened with the mobile apps, that was why I accepted the challenge of my supervisor Dr Bruce Graham to develop a website for my dissertation rather than implement a software, even I did not have any previous knowledge about web design due to I did not take the module ITNP070 Introduction to networking and web scripting.

In year 2012, the student Sami M'chala made his dissertation about a Financial Android Application and Stock Predictor. This free application offers features and tools for chartists to analyse historical prices and predict future stock movements. The application allows the user to input his own holdings to a portfolio manager to monitor them.

Moreover, the student Bandar Kohail made a Stock Portfolio Manager Mobile application for IPhone in the year 2013. His project was to develop a mobile application to track the investment performance of an investor.

In year 2011 the student He Zhang performed his project in a Java program for International Arbitrage to help investors to analyse international arbitrage. In addition, the student Can Li developed another Java Application for Investment Assistant where the user could make some financial calculations to take an investment decision.

3 System requirements

The most important phase of the software development process is the requirements elicitation. The requirements are everything that is required to be developed, it means they are the tasks that the customers can do in the web application. After the specification of the user requirements, the design of the solution on the basis of them and the implementation of the design will be carried out.

The typical user of IPM is a beginner or intermediate investor, though it is a good option even for professionals. IPM has two type of users:

- Unregistered users or visitors: They are the users that have not signed up or logged in yet, even if they are already registered. They have limited access to the web site.
- Registered users, customers or clients: They are the users that are registered in the IPM database and are logged in to be able to access to special section like portfolio manager.

User requirements for this project are the following:

1. Unrequested users may become registered users just by filling in a registration form.
2. All kind of users may watch a variety of stock data about companies belonging to the indices DOW 30, DAX and FTSE 100 and also exchange rates of the major currencies.
3. Search for companies to redirect to their individual page and monitor their performance.
4. Both kinds of users can watch stock charts to accomplish technical analysis.
5. Both types of users can convert the amount of money from one currency into other.
6. Calculate the investment in foreign currency depending on the amount investing in the local currency and the exchange rate.
7. Calculate the number of shares that the investor can buy in a company that quotes in different currency according to the current exchange rate.
8. Calculate the initial investment in a foreign currency according to the exchange rate.
9. Calculate the exchange rate the broker used to perform the trade.

10. Calculate the final investment value according to a price to sell the shares in both foreign and local currencies.
11. Calculate the profit or loss of the trade according to a price to sell the shares in both foreign and local currencies.
12. Calculate the return in percentage according to a price to sell the shares in both foreign and local currencies.
13. Only registered users can create and delete a portfolio of equities.
14. Clients are able to add, edit and delete holdings within a portfolio.
15. Customers can know the current value of their shares and their portfolio in both local and foreign currencies.
16. Investors can track the profit or loss of their stocks and their portfolio in both local and foreign currencies.
17. Clients are able to track the percentage return of their securities and their portfolio in both local and foreign currencies.

3.1 Use cases

Before starting the design of the solution is important to identify the actors of the system and the kinds of tasks that they require to perform. A use case is each task that an actor needs to perform with the help of the system, in order words, a use case documents some behaviour that the actor needs from the system from his point of view. IPM works with 5 actors to develop all of its requirements. These actors are the unrequested user, the customer, Yahoo's API, tradingview and the database. **Figure 5** shows how the actors and the use cases are related one another.

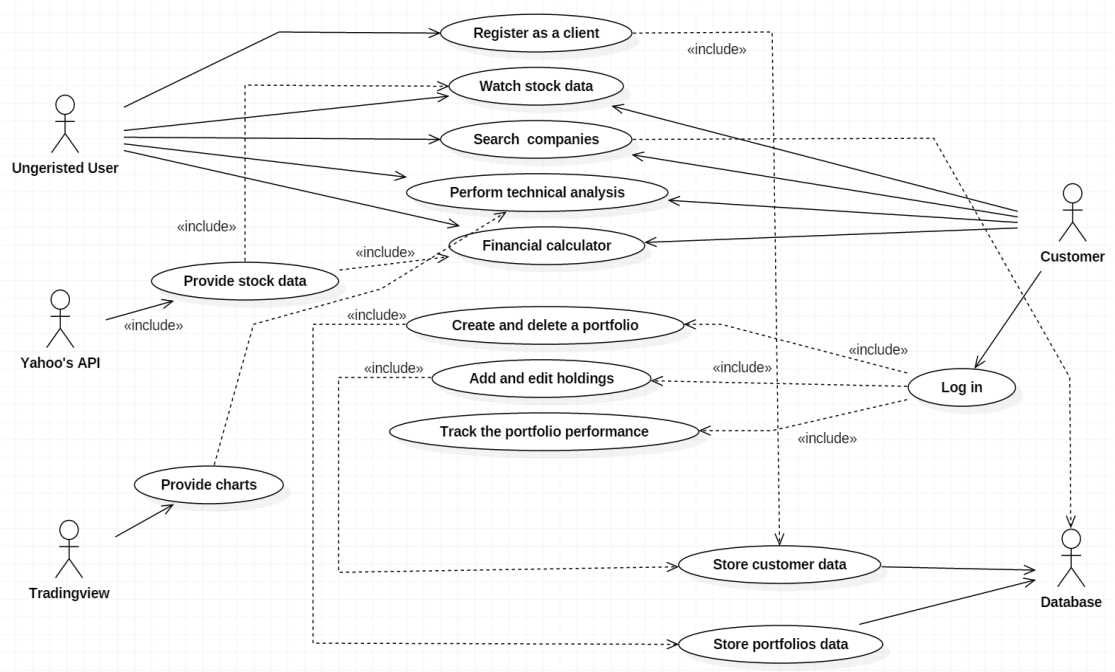

Figure 5. Use cases

3.1.1 Unregistered users

A visitor may create an account by filling in a registration form in order to be able to access to private sections like 'Portfolio Manager' to build and monitor his own portfolio. The user's information is stored in the IPM database. However, the visitor may execute another tasks without the need of being a registered user. He can make a variety of tasks such as search for a company, watch stock data, accomplish technical analysis in the stock chart and perform financial calculations.

3.1.2 Customers

An unregistered user becomes a customer or client once he is registered in IPM and his information is stored in the database. To be able to use the 'Portfolio Manager' he has the precondition that must log in previously if he wants to set up and monitor his own portfolio. All the information about the portfolios that he has created and the holdings that has added to them will be stored in the database.

Furthermore, the client can carry out all the same activities that an unregister user may do like search for a company, watch stock data, accomplish technical analysis and perform financial calculations.

3.1.3 Yahoo's API

IPM retrieves stock data from Yahoo's API using Yahoo Query Language (YQL) [1] to query, filter and display the stock data and exchange rates on the screen. The exchange rates of EURUSD, EURGBP and GBPUSD used in the financial calculator are retrieved from Yahoo's API too. In addition, a chart about 'Apple Inc.' provided for Yahoo is embedded in the homepage. It is carried out in the client-side using JavaScript and jQuery programming languages.

3.1.4 Tradingview

[3] It is an external entity that interact with IPM in the client-side of the web providing the stock charts to the web. This charts are embedded in every individual stock page like for example in the page of 'Apple'. All kind of users may watch them to analyse the evolution of their share price and perform technical analysis to help him making a decision whether to buy a specific share or not.

3.1.5 Database

The database works in the server-side with PHP to store the customer's data after they submitted the registration form. Besides, it stores the portfolios information and holdings of every registered users. Only the information about the portfolios and its holdings can be updated, whereas the customer data stays unchangeable.

4 Design of the system

The design of the solution is the phase of the software development where user requirements, use cases and background research comes together to find the most efficient and well-designed solution.

The solution is a stable web page with a user interface that is easy to navigate, intuitive, functional and a stylish layout. Moreover, it has to be easy to use and understand in order to be practical to move from one point to another and to search for the information that the user is required.

Figure 6. Process design of how to use IPM

First of all, the customer is able to watch the stock prices and percentage change of a group of equities belonging to one of the three indices IPM works. Then he can direct to the individual page of a stock to observe more financial data and the chart of the company. In this section the user may analyse that company in both fields fundamental analysis and technical analysis in order to make a decision whether that company is worth to invest or not. Then, he can use the calculator section to figure out the amount of shares he can buy according to his available cash and the exchange rate between his local currency and the currency of the stock.

After purchasing the equities with his broker, he will be able to add them in his portfolio or create a new one, track the performance of every of them both in local and foreign currency and get the portfolio value and return. **Figure 6** below shows this process since the client watches the stocks until he tracks his portfolio.

4.1 Data structure

All the data that we need to fulfil the requirements of IPM are taken from Yahoo's API using Yahoo Query Language Web Service (YQL) [1] because it is a huge free source application to retrieve data from different webs. Upcoming subheadings explain this process.

4.1.1 Stock data

One of the main goals of this web application is to fetch and display stock data belonging to three different international indices (DOW 30 [10], DAX [11] and FTSE 100 [12]). This sort of information is retrieved from a free source API, in this case from Yahoo using Yahoo Query Language Web Service (YQL).

YQL enables web applications to query, filter, and combine data from different sources across the Internet. To access the YQL Web Service, a web page call HTTP GET, passing the YQL statement as a URL parameter. The YQL Console enables to run YQL statements interactively from your browser. When it processes a query, the YQL Web Service accesses a data source on the Internet, transforms the data, and returns the results in JSON format.

This JSON file has a quote object containing an array with multiples fields or records. Each field is formed for a name/value pair. The fields that are retrieved to display them in the different stock tables are stock symbol, stock name, last trade price, change, percent change, time and date. **Figure 7** illustrates how these fields are displayed in the correspondent tables.

Symbol	Name	Last Price	Change	% Change	Time	Date
ADS.DE	ADIDAS N	146.85	-1.80	-1.44%	4:27pm	9/12/2016
ALV.DE	ALLIANZ SE NA O.N.	135.35	-1.20	-0.88%	4:27pm	9/12/2016
BAS.DE	BASF N	71.20	-1.38	-1.90%	4:27pm	9/12/2016

Figure 7. Output of the records retrieved from Yahoo's API

4.1.2 Financial data

When the visitor accesses to the individual page of a company like for instance 'Apple Inc.' there are three tables with different financial data. The JSON file to get all these records is the same as the one to get the stock data, but the only difference is that the records to be retrieved are different. These records are displayed within three different tables called Statistics, Financial Ratios and Technical data:

- Statistics:

STATISTICS

Previous Close:	**103.13**
Days Range:	**102.53 - 105.14**
Open Price:	**102.65**
Year Range:	**89.47 - 123.82**
Bid:	**105.11**
% Change from Year Low:	**+17.49%**
Ask:	**105.12**
% Change from Year High:	**-15.10%**
Volume:	**29858743**
Ex-Dividend Date:	**8/4/2016**
Market Capitalization:	**566.43B**
Dividend Yield:	**2.16**
Target Price in One Year:	**123.66**
Dividend Pay Date:	**8/11/2016**

Figure 8. Records retrieved for statistics data

- Financial Ratios:

FINANCIAL RATIOS

PERatio:	**12.26**	Book Value:	**23.46**
Price Book:	**4.40**	Short Ratio:	**1.51**
Price Sales:	**2.52**	Earnings Shares:	**8.58**
EBITDA:	**73.96B**		

Figure 9. Records retrieved for financial ratios

- Technical data:

TECHNICAL DATA

Price of 50 Moving Average:	**106.28**	Price of 200 Moving Average:	**101.60**
Percent Change from 50 MA:	**-1.09%**	Percent Change from 200 MA:	**+3.47%**
Units Change from 50 MA:	**-1.15**	Units Change from 200 MA:	**3.53**

Figure 10. Records retrieved for Technical data

4.1.3 Exchange rates

Moreover, IPM needs to retrieve exchange rates for two reasons:

- To show exchange rates among the major currencies in the world like AUS/JPY, EUR/USD, USD/CHF, etc. The records that must be filters are name, rate, time and date.
- To perform the financial calculations that need to be done in the Calculator section. In this section we work only with three currency pairs, EUR/USD, EUR/GBP and GBP/USD.

Name	Rate	Time	Date
EUR/USD	1.1245	7:24pm	9/12/2016
EUR/GBP	0.8435	4:42pm	9/12/2016
EUR/JPY	114.5170	5:30pm	9/12/2016
EUR/AUD	1.4912	6:15pm	9/12/2016
EUR/CHF	1.0931	4:54pm	9/12/2016
GBP/USD	1.3331	5:39pm	9/12/2016

Figure 11. Output of the records retrieved for currencies

4.2 Charts

One of the requirements that a user can make in IPM is to watch a stock chart. The charts are provided by an external company called Tradingview [3]. This company is a financial website that provides free chart widget to another websites, blogs and forums. Chats provides real-time data for free. The charts are embedded in every stock page. The aim of this chart is to help the investor to analyse the past movements of a share price to predict its future evolution. If the investor's forecast is that the price is going to increase he will make the decision to invest, whereas if he considers that the price is going to decrease the best for him will be to stay away for this company.

As if the user were a professional investor, he can perform good analysis of the price due to the chart offers a powerful tool for technical analysis [13]. Some of the tasks the investor can carry out are mentioned below:

- Choose different intervals of time such as 1 minute price movement, 1 hour, 1 day, 1 week, etc.
- Insert lines to mark uptrends or downtrends, supports and resistances, etc.
- Add a huge range of indicators such as Bollinger's Bands or volume.

- Add another company in the chart to compare both of them.
- Select all kind of assets including commodities, currencies, equities, indices and fixed incomes.

Figure 12. Technical analysis in the chart of JPM

4.3 Technical specification

When a web developer has to create a web page he must think what kind of web site he is going to build, considering that depending on that he can set up a static web page or a dynamic web site.

A static or non-dynamic web page do not change neither when the page is loaded by the browser nor when the user click on a button. The user simply views the page and the information on that page, they cannot interact with the page. [14]

Whereas dynamic pages do the opposite, they can change every time they are loaded without the necessity that you have to make those changes. In addition, they can change their content based on what users do, like clicking on some text or an image, providing an interactive user experience.

A dynamic web site is reloaded by the user or by a computer program to change some variable content. The updating information could come from the server or from changes made to that page's DOM by JavaScript [16] .

There are three ways to create dynamic websites: [17]

- Client-side programming or DOM scripting.
- Server-side programming or Database driven web pages.
- Combination of client-side and server-side scripting.

4.3.1 Client-side scripting

Client-side scripting changes interface behaviour within a specific web page in response for example to mouse, keyboard actions or at specific timing events. It basically uses HTML and JavaScript to make the web page change its own content without having to reload or load a new page. Nowadays can be used to load parts of the web automatically with AJAX.

The client-side content takes place on the end users computers and it is run from the browser's users. The source code is transferred from the web server to the user's computers over the internet and run directly in the browser.

Figure 13 explains the process of the client-side programming, where first of all, the user sends a request to the server, then the server processes the request and return information as needed, to finally the data is processed by the client's computer.

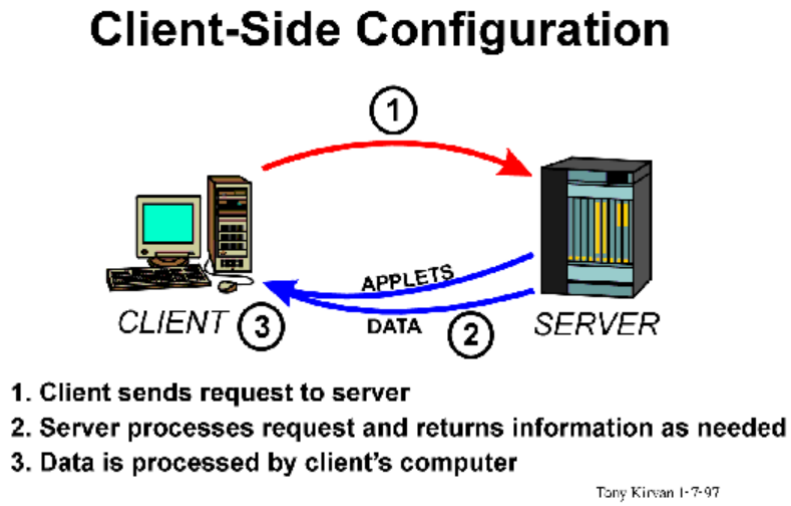

Figure 13. How client-side works [15]

4.3.2 Server-side scripting

Server-side programming runs a scripting language in a web server. A user's request is fulfilled by running a script directly on the web server to generate dynamic HTML pages. This HTML is then sent to the client browser. It is usually used to provide interactive web sites that interact to databases or other data source on the server.

Server-side scripting is used to generate the web content on various web pages, manage users' sessions, treat with HTML forms and control workflow. They are created with the help of server-side programming languages such as PHP, Perl, ASP, ASP.NET, JSP, ColdFusion and others. These server-side languages typically use the Common Gateway Interface (CGI) to produce dynamic web sites.

They are connected to a database to send to and retrieve data to be displayed in a page. **Figure 14** focuses on how the user sends a request that is processed by the web server with the help of PHP code to manipulate the data which is stored in the database. Then the web server sends a page in html that is displayed in the customer's screen. This is done with the programming languages aforementioned above.

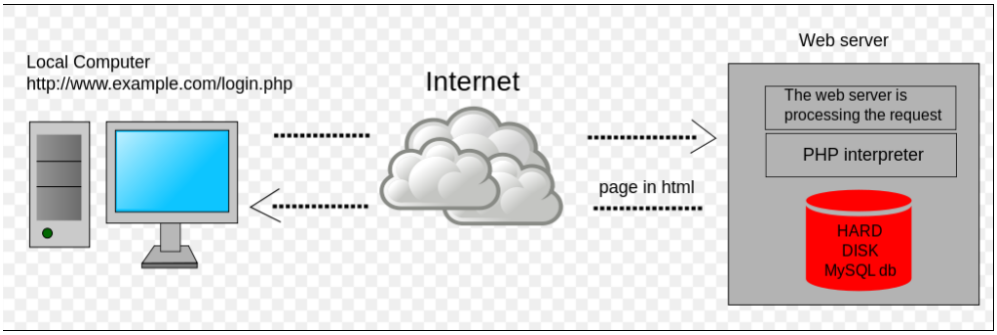

Figure 14. Server-side scripting with PHP and MySQL

4.3.3 Combination of both client-side and server-side scripting

The majority of the web pages that these days run the World Wide Web use a combination of the client-side and the server-side to collectively build a dynamic web page that are called a web application.

AJAX uses a combination of both client-side programming and server-side requests. It is a web application technique for dynamically interchanging content and it sends requests to the server for data in order to do something. The server returns the requested data which then it is processed by a client-side scrip like JavaScript. This technique can reduce server load time because the client does not request the entire webpage to be regenerated by the server's language parser, so that only is transmitted the content that will change.

4.3.4 Summary

For my project I have created a dynamic web site with the combination of both client-side and server-side scripting. JavaScript was the programming language that I used to work on the client-side, whereas for the server-side I coded in PHP to connect to the Database, due to they are the most popular and extended programming languages in their respective fields.

The server-side is important for International Portfolio Manager because it needs to connect to a database in order to save the customer data submitted by the registration form, manage the users' sessions when the user logs in or logs out, create and store the user's portfolios and the information about the equities that have been added to the user's portfolio. It means that I have a web application that sends and retrieve information from a database and inserts that information into the web page, for example, when the user selects one of his port-

folios its holdings will be displayed on the screen. If the information stored in the database changes, the web site connected to the database will also change automatically without human intervention.

With scripts in JavaScript and jQuery, IPM retrieves all the stock data necessary to display them on the tables and update them dynamically. It uses two scripts to get the charts to show them to the visitors. The change and percentage change fields in the stock tables are presented in different colours depending on the evaluation on the price comparing with the closing price of the previous day. Moreover, with code written in JavaScript the users may click a slideshow and manipulate data in the financial calculators.

4.4 Technologies used

A wide range of technologies has been used for the building of this dynamic financial portal. Next subheadings will explain briefly each of them.

4.4.1 HTML

Hyper Text Mark-up Language [18] is the standard mark-up language for creating web pages and web applications. Each HTML document contains a series of connections to other pages called hyperlinks.

HTML was used to create the structure of IPM including the navigation bar, the tables which show the stock data, hyperlinks to move to another pages, create buttons, etc.

4.4.2 CSS

CSS stands for Cascading Style Sheets [19] and describes the style of an HTML document, how HTML elements are displayed on screen. Whereas HTML describes the content of a web site, CSS is used to define styles for the page, including the design of the navigation bar, layout of the content of the pages, design and colours of the tables, the style of the buttons, etc.

4.4.3 JavaScript

JavaScript [20] is the programming language of HTML and the Web which can change HTML content including attributes, elements and CSS style. JavaScript is a high-level dynamic and an object-oriented programming language. Alongside HTML and CSS, it is one of the three core technologies of World Wide Web content production.

JavaScript is an interpreted client-side scripting language that allows a web designer the ability to insert code into their web page. It is commonly placed into a HTML file, and runs directly from the web page.

It was utilised to perform tasks such as:

- To create the code to validate the registration form and log in before the user clicks the 'send' button.
- To validate the inputs that the use must type in the Calculator sections like he cannot write a letter in the input field to type the price of a share.
- Scripts to retrieve the stock data from Yahoo Finance.
- Code to display the charts.
- To perform the mathematical operations in the financial calculators.
- When the log in modal is displayed on screen the user is able to come back to the previous page simply by clicking the part of the screen that is outside of the modal, etc.

4.4.4 jQuery

jQuery [21] is the most popular cross-platform JavaScript library that greatly simplifies the client-side scripting. JQuery's syntax is designed to make easier to navigate a document, select DOM elements, create animations, handle events, and develop AJAX applications with an easy-to-use API that works across a multitude of browsers. To summary jQuery allows the creation of powerful dynamic web pages wrapping many lines of JavaScript code into methods that we can call with a single line of code.

There are several ways to start using jQuery on a web site. The one I use is to include jQuery from a Content Delivery Network (CDN), in my case from Google. jQuery will be loaded from cache when the visitors visit the website, which leads to faster loading time because since many pages use a public CDN the visitor may already have a cache version of the script. **Figure 15** displayed the Google's CDN that I placed within the head tag in a HTML document to be able to use jQuery.

```
<head>
<script
src="https://ajax.googleapis.com/ajax/libs/jquery/1.12.4/jquery.min.js"></script>
</head>
```

Figure 15. JQuery file from the Google's CDN

To get the stock data from the API of Yahoo finance the 'getJSON ()' method was used. It belongs to jQuery and its function is to read the JSON format file that is received and filter the records that are necessary to display in their correspondent part of the page.

4.4.5 JSON

JSON [22] stands for JavaScript Object Notation which is a way to format data, so that it can be transmitted from one place to another, most commonly between a server and a Web application.

JSON is a syntax for storing and exchanging data and a subset of the JavaScript syntax. A JavaScript program can use standard JavaScript functions to convert JSON data into native JavaScript objects. JSON formats data into JavaScript objects and allows for name and value pairs, arrays, strings, and other data types. When this data is read by a JSON parser, it is converted into the appropriate data type in the programming language used for a quick retrieval of data.

Figure 16 was taken from the API of Yahoo Finance that provides a 'json' file with an object called 'quote' that contains an array of many records. Every record is formed by a name property and its value property that present different information about the share to be displayed. Figure 13 shows the records for 'Yahoo Inc.' such as the symbol of the equity 'YHOO', the volume traded in the day '11817100' or the daily change '+0.24' among other data. To summary, Yahoo's API sends back a 'json' file, it is manipulated with the 'getJSON()' method mentioned in the previous jQuery subheading and then with some code we extract from this file only the data we want to display in the web page.


```
"results": {
   "quote": [
    {
     "symbol": "YHOO",
     "AverageDailyVolume": "11817100",
     "Change": "+0.24",
     "DaysLow": "41.94",
     "DaysHigh": "42.61",
     "YearLow": "26.15",
     "YearHigh": "43.29",
     "MarketCapitalization": "40.23B",
     "LastTradePriceOnly": "42.27",
     "DaysRange": "41.94 - 42.61",
     "Name": "Yahoo! Inc.",
     "Symbol": "YHOO",
     "Volume": "6327991",
     "StockExchange": "NMS"
    },
```


Figure 16. Format data of a JSON file taken from Yahoo.

4.4.6 AJAX

AJAX [23] short for Asynchronous JavaScript and XML is a set of web development techniques that uses many web technologies on the client-side to create asynchronous (in the background) web applications. With AJAX, web applications can send data to and retrieve from a server asynchronously without interfering with the display and behaviour of the existing page.

The stock data that IPM needs to display in the web page is extracted from Yahoo's API using an AJAX HTTP GET request. In addition, AJAX was used to implement the live search text field. Its goal is to fetch information from a XML file and to display the name of the companies that matches the search of the visitor.

The difference between classic web pages and the portals which do not use AJAX is that classical ones must reload the whole page if the content change. The difference between a web site that works with AJAX and another that does not operate with AJAX is shown in the next **Figure 14.**

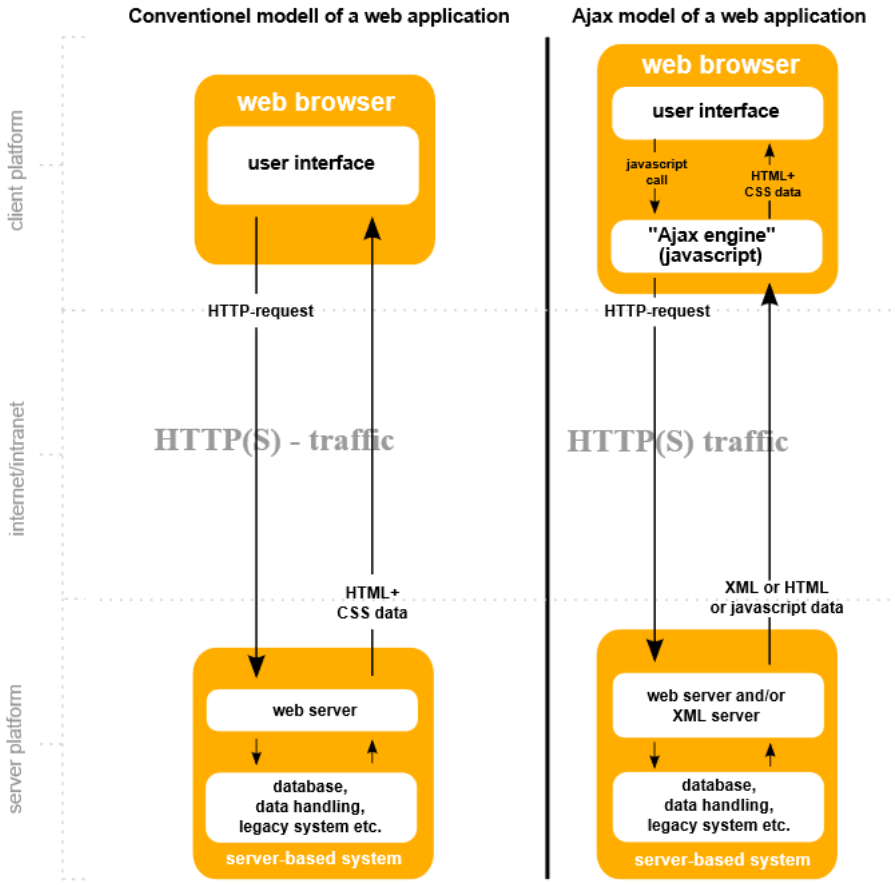

Figure 17. Web application with AJAX vs one without AJAX

4.4.7 PHP

PHP [24] is short for Hypertext Pre-processor, it is a server-side scripting language and a powerful tool for creating dynamic and interactive web pages that effectively work with databases.

PHP scripts are executed on the server and the result is returned to the browser as plain HTML. PHP files have extension '.php' and may contain text, HTML, CSS, JavaScript and PHP code, but also PHP code may be embedded into HTML code. Therefore, for my web site a mixture of both were used, almost all pages are PHP files that contain HTML, CSS and JavaScript code and also there are PHP code within HTML elements.

I had used PHP for different functions such as:

- Generate a dynamic page.
- Collect form data like registration form or add holdings to an existing portfolio.
- Create IPM database and all its tables to keep the data about users and their portfolios.
- Code the footer to insert it at the bottom of all pages.
- Add, delete and modify data in the database.
- Control user-access by means of sign up or log in forms.

4.4.8 MySQL

MySQL is an open-source relational database management system (RDBMS). It is the most popular database system used with PHP, it means that you can connect to and manipulate databases with PHP. PHP combined with MySQL are cross-platforms [25]. It uses standard SQL [26] and compiles on a number of platforms.

There are two ways of using PHP to work with MySQL:

- MySQLi extension:
- PDO (PHP Data Objects)

I decided to access to the IPM database using MySQLi, although PDO can work on 12 different database systems whereas MySQLi only works with MySQL databases. The reason was that MySQLi is faster and has the advantage that offers a procedural API that PDO lacks.

The data in a MySQL database is stored in tables. A tables is a collection of related data and it consists of columns and rows. The tables that IPM needs to operate were created with PHP and their data is stored in a MySQL database. In the next subheading the structure of the database will be discussed.

4.4.9 XML

E**Xt**ensible **M**arkup **L**anguag is a software for storing and sending data. A file to store the name of the companies and their URL within IPM was created in order that the visitors can search for a company and click on its link. After clicking they will be redirected to that URL.

4.5 Database design

The IPM's database together with the Yahoo's API and the charts from Tradingview are considered the most important parts of the design of this web application. All information related to the users like their username, email, password, portfolios and their stocks are permanently recorded in the database.

Figure 18 shows the ER-Diagram formed by 3 entities (Users, Portfolio and Stock), their respective attributes and the relationship between them.

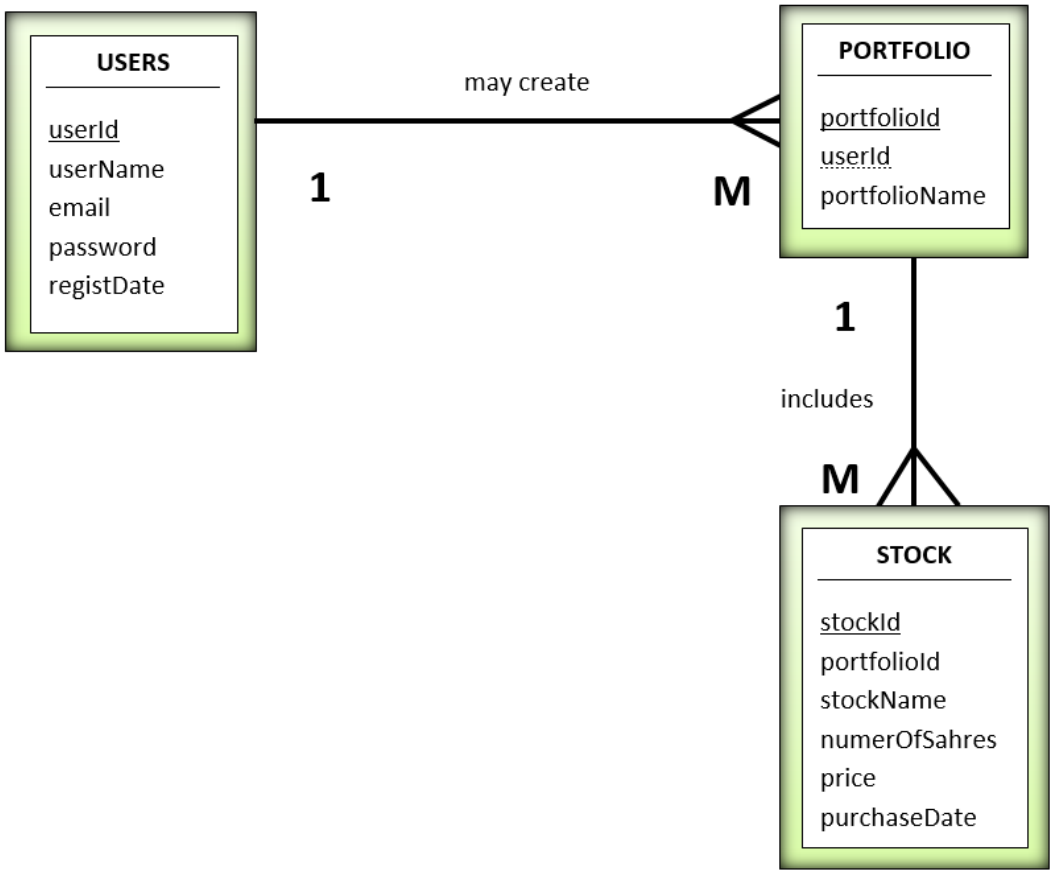

Figure 18. ER-Diagram for the Design of IPM database

4.5.1 Users

The ‘Users’ table stores the information about the clients that previously submitted the registration form. Each user has a unique ID called ‘userId’ which is the primary key. Each row of data represents the inputs that an unregistered user must submit in the registration form to become a customer. These fields are username, email and password.

This information is important because only the users stored in the database are able to access to the portfolio manager, for that the client firstly must log in in his account. This is the table where the system will check if the user is already a register user or not when he attempts to log in. If the username and password match in the same row, the customer will log in. For instance, if the username and password are oscarcito100 and VFLgummers1698 as we can appreciate in **Figure 19** userId=1, the user will be logged in. If not a message will inform him that the data he has typed is wrong.

userId	username	email	password
1	oscarcito100	oscar@gmail.com	VFLgummers1698
2	Ruben	ruben@gmail.com	1234567890
3	Jorge	jorge@gmail.com	1234567890

Figure 19. Example of table Users with real data

4.5.2 Portfolio

The ‘portfolio’ table contains the portfolios that a registered user has created. When he wants to build a new portfolio he must fill in a portfolio form just by giving a name to his new portfolio and it will be stored in the database. All the portfolios hold in the database are identified with a unique portfolio ID. Every portfolio is related to its user by means of the ‘userId’ column, so that this field acts as a foreign key in the ‘portfolio’ table being ‘portfolioId’ its primary key. It makes possible that when a user is logged in, he can see his portfolios in a drop-down list and select the one in which he wants to add, edit or delete holdings.

Portfolios can be deleted from the database when the investor clicks the ‘delete portfolio’ button. As they are related to their stocks, these will be deleted too.

portfolioId	userId	portfolioName
1	1	american stocks
2	1	european stocks
3	2	Germany

Figure 20. Screenshot of Portfolio table

4.5.3 Stock

The ‘stock’ table stores the equities and their features that belong to a portfolio of an existing user. Every equity has its own ID known as ‘stockId’ which also is the primary key of this table. It is related to a specified portfolio due to ‘portfolioId’ acts as a foreign key. Each stock apart from its own name and ID has different fields to give more information about them. This information must be typing for the user when he completes the form to add new stocks. Number of shares that customer has purchased, their price and the date of purchased are the other fields in this table.

After the customer has selected a portfolio in the portfolio section, the stocks related to this portfolio will be displayed on screen beside their own features like price, number of shares, etc. The customer may update the features of the stocks, for instance adding more shares that he has recently purchased and also delete them from the database once he has sold them.

stockId	portfolioId	stockName	numberOfShares	price	purchaseDate
1	1	Apple	100	100	2016-09-15
2	1	Adidas	100	146	2016-09-20
3	2	Sap	50	80.5	2016-09-20

Figure 21. Screenshot of Stock table

4.5.4 Comment

Apart from those related tables discussed previously, IPM’s database includes other table called ‘comment’ that stores the interaction that the users make with the IPM’s administrators, asking for doubts or giving feedback. This table is formed form 4 columns; ‘commentId’ which is the primary key, the name of the sender, his email, and his comment.

4.6 Web user Interface

A web user interface (WUI) is a point of interaction between a computer and humans that includes any number of interactions to transfer data between the user and the computer system. These kinds of interactions are forms, graphics, drawings on the screen, play audio, movements, sounds, access to the keyboard and mouse, etc. A web user interface accepts inputs from the user and provides output by generating web sites which are transmitted via the Internet and visualized by the user using a web browser. Some of the technologies used to implement this interactions are PHP, JavaScript and AJAX. They provide real-time control in a separate program and eliminate the need to refresh a traditional HTML web page.

In conclusion, the goal of my web user interface design is to produce an interaction between the computer and the user which make easy, efficient, and enjoyable her experience navigating around the page.

4.6.1 Navigation bar

A navigation bar is a section of the web user interface intended to aid users in accessing information. The navigation bar includes links to the most important sections of the web site.

The navigation bar of International Portfolio Manager is composed of 8 parts. Each time that one of them is clicked it takes the user to a different section. The only exception for this is the Date subsection due to it only displays the day, date and time of the connection. These subsections are homepage, watchlist, market, calculator, portfolio manager, contact, sign up and sign in, date and search. The first six form the menu of the navigation bar. Coming up next I will discuss all these sections. **Figure 20** shows the navigation bar and its 8 components.

Figure 22. Navigation bar

The main feature of this navigation bar is that it is fixed on the top of the screen. It means that when the visitor move down the content of the page, the navigation bar will be always fixed on the top of the screen. This is one characteristic that a lot of web sites lack and as a user of them I really miss it. In order words, this feature will improve the navigability of IPM with respect to another financial websites that lack of it.

4.6.2 Home

On the bottom-left corner of the navigation bar is situated the logo of the website. It also acts as a hyperlink in the menu bar, so that when it is pressed it takes to the visitor to the Homepage of IPM.

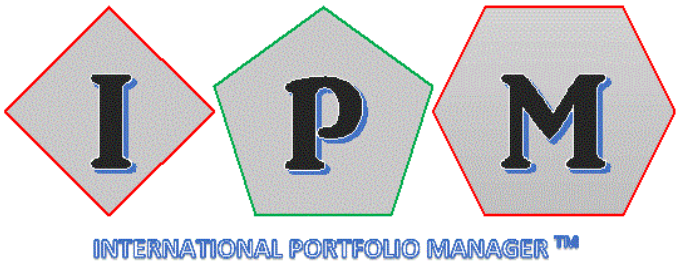

Figure 23. Logo of International Portfolio Manager

4.6.3 Market

Next to the logo hyperlink is the Market menu. When it is clicked the 'Dow 30' page is displayed on the screen by default as we can see at **Figure 22**. Within this page the visitor can see four buttons that link him directly to the other main pages that form the Market section. They are the DOW 30, the DAX, the FTSE 100 and the major currencies page.

When the user is in one of these pages, he can see a table on the centre with information about the stocks that belong to this current Index that has been selected. This table includes the stock symbol, stock name, last price trade, daily change in units, percentage change, time and date information about each of these companies.

In the right side of all these pages we can find the same data-box called 'Market Overview' that includes a small chart about the company 'Apple Inc.' by default and another table with information of different international shares in summary mode. This table includes only the stock name, last price trade and percentage change.

When the visitor clicks the picture of the chart he will be linked to 'Apple .Inc.' page to watch a bigger chart and more data about this American company. The same happens when he presses the button over the name of the company that is displayed on the tables. He will be redirected to this company page within IPM.

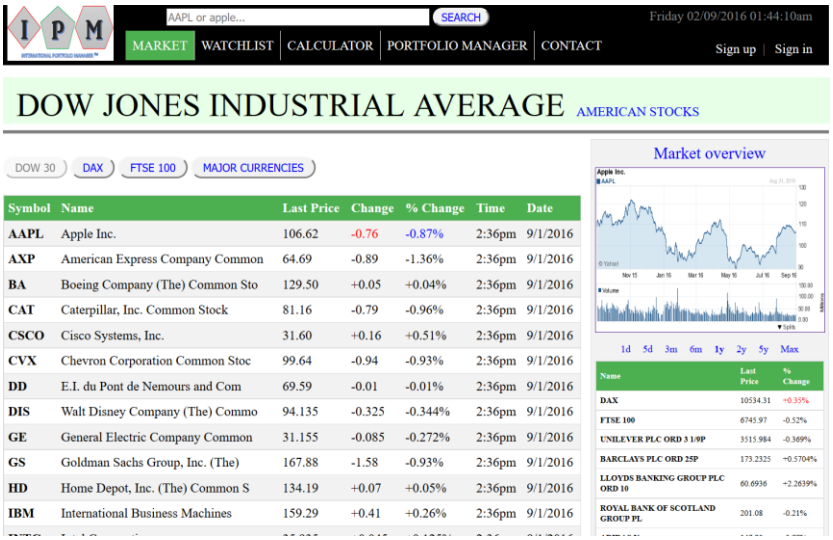

Figure 24. DOW 30 page

The secondary files of the Market menu are the 160 individual stock pages and the 13 currency pairs. These companies belong to the three indices in what IPM works, 30 to the 'DOW 30', 30 to the 'DAX' and 100 to the' FTSE 100'. All these pages have the same structure and style.

At the top of these pages, the stock name, stock symbol and the data related to the last price trade, daily change in unites, daily percentage change, time and date are displayed. Below this data a chart about the stock price of the company is displayed in order that the user can analyse the possible direction of the share, if it is going to increase or decrease. This chart provides a powerful tool for technical analysis. The goal of the technical analysis is to analyse the share price to help the investor to make a decision about whether invest in a company or not or f it is time to close a trade if the possible evolution of the price is not the one he wishes.

Underneath of the graphic, there are three tables that show financial ratios, technical data and statistics data in real-time. The kind of financial ratios the visitor may see are PER ratio, price book, price sales, EBITDA, book value, short ratio and earnings shares, whereas the technical data are 50 Simple Moving Average, its daily percentage change and its daily change in units. Moreover, the same data is available for the 200 Simple Moving Average.

Statistic Data deals with more information about the price of the share such as the previous close, open price of the day, bid and ask price, volume, market capitalization, target price for one year, maximum and minimum of the day and year, percentage change from year low and year high, ex-dividend date, dividend yield and dividend paid date.

4.6.4 Calculator

When the visitor clicks Calculator in the menu bar it displays the calculator section where there are two kinds of financial calculations. First is called ‘Foreign investment and number of shares’. In this one the user can get two kinds of outputs, although first he must select his local currency (his own currency for example Pounds for a British investor) and the foreign currency (the currency of the security for instance Euros for a German Stock). After having chosen the currencies, he must type the amount of money he wish to invest and the price per share in the currency of the equity. When the user pressed the ‘Calculator’ button he would be able to know how much is his investment in the foreign currency (e.g. EUR) and the number of shares of this equity that he can purchase. The value of these outputs depend on the current exchange rates that is provided from Yahoo Finance with some minutes delayed.). For this project we are going to work only with three currencies, Euros (EUR), Sterling Pounds (GBP) and American Dollars (USD).

Also they can use this calculator as a currency convertor in order to know how much a currency is in another currency. For example, in Figure 23 £1000 is $1299.60.

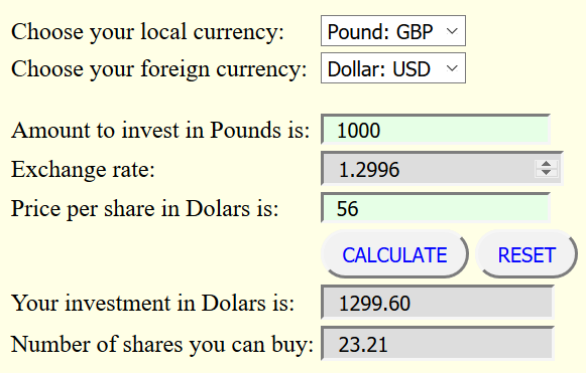

Figure 25. Currency convertor

The second financial calculator is an 'International Return Predictor' where the user making some inputs can get the final investment value, the profit or loss of an investment and the percentage return in the foreign currency (currency of the stock) as we can see in **Figure 24.** However, the strongest feature of this financial tool is that the investor also may get the final investment value, profit or loss and the percentage return in his local currency depending on the future value of the exchange rate between both currencies.

In order to get these data the user first must type 4 inputs which are the amount invested in local currency, the number of shares the investor has bought, their purchase price and their sale price. The next step is that he must click the first 'Calculate' button in order to let him know how much is his investment in the foreign currency and how was the initial exchange rate. Then he must type the future exchange rate in what he has locked in a future exchange rate or the current exchange rate to get an idea of the performance of the stock. Then he must click the second 'Calculate' button that is within the table to get the outputs aforementioned above.

An important point to bear in mind is that in this project we are not going to work with the commissions that the brokers charge to their customers to realise these operations.

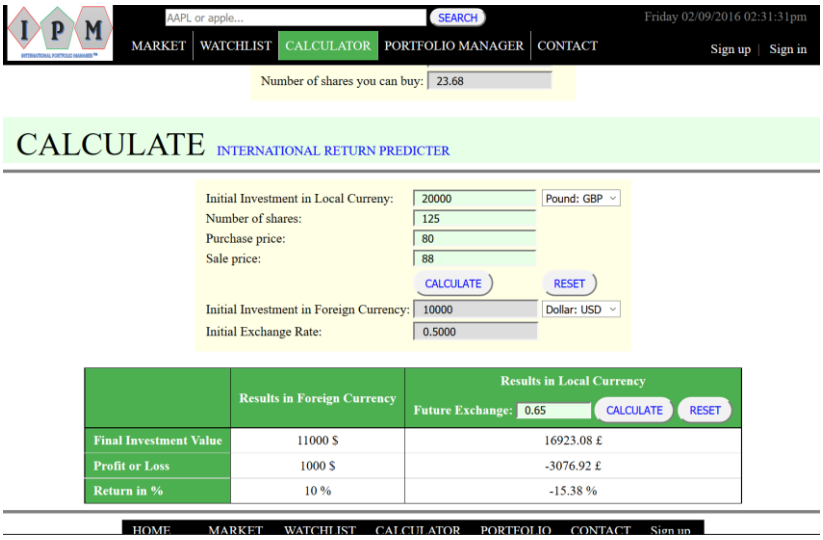

Figure 26. Calculator menu

4.6.5 Portfolio Manager

Portfolio manager offers to the investors the chance to build and track his own portfolio, but only logged in users can access to. It means that when the user is not logged in and he clicks portfolio manager in the menu bar, he will see a page as **Figure 25** illustrates asking him for register or log in to be able to create and monitor his own portfolio.

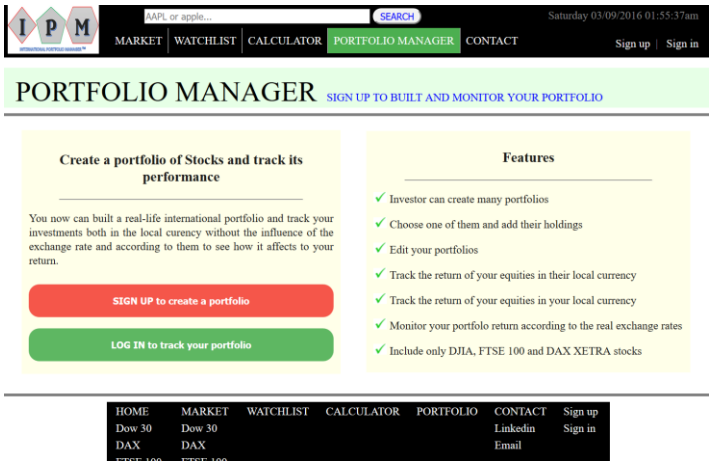

Figure 27. Portfolio menu when user is not logged in

For the other side, when he is already logged in and enter into this section automatically is displayed the information about one of his portfolios by default, besides the list of stocks that form this portfolio and the information about them.

If the investor has more than one portfolio, he can select the one he wish to monitor in the dropdown list. Next to the dropdown is situated a line of four buttons ‘create portfolio’, ‘delete portfolio’, ‘add holdings’ and ‘edit holdings’.

Underneath these buttons there are two tables to monitor the holdings of each portfolio:

- Portfolio composition in foreign currency: In this table the investor can see the current value of his shares, the profit or loss and the return of his stocks in their own currency. Also is shown the percentage distribution of every stock in the total of the portfolio. **Figure 26** shows how the investment in each stock is 25%. This is extra information that other websites like Yahoo finance or Google Finance do not include in their portfolio section.
- Portfolio value in local currency: This table shows the value of every stock at the moment in which they were purchased according to the exchange rate at that specific moment in the currency of the investor. Also the value of every security at the current moment depending on the current exchange rate. Then for difference between both, the investor can get the final profit or loss of each of his stocks and also their return in percentage.

For instance, **Figure 26** shows that the return in Euros in ADIDAS is 5.01%, whereas when we use the exchange rates to know the return of ADIDAS in the local currency of the investor, in this case Sterling Pounds, the final return is 15.14% because the Euro has appreciate with respect to the Pound.

Figure 28. Portfolio layout when user is logged in

4.6.5.1 Create portfolio

When the investor wants to add a new portfolio he must click the 'create portfolio' button in order to be able to do it. It links to a page to fill in a form where he must type the name of his new portfolio and then press the 'create portfolio' button. It is illustrated in **Figure 27**. Once when it is done, the user will be linked to the main portfolio page and the information about this new portfolio will be displayed on the table.

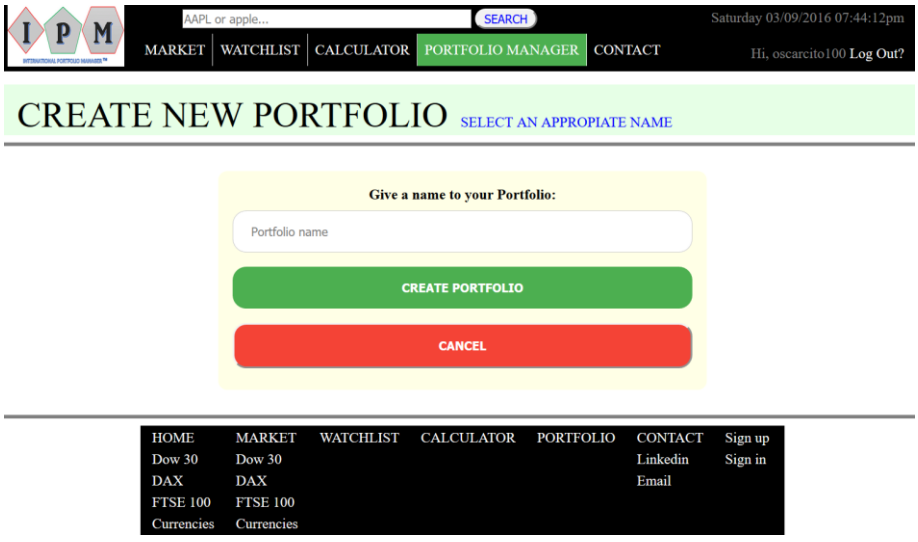

Figure 29. Screenshot create portfolio

4.6.5.2 Delete portfolio

When the user wants to delete an existing portfolio he needs to click the 'delete portfolio' button. Automatically an alert messages as presented at **Figure 28** will pop up to ask him for confirmation if he wishes to delete the current portfolio. To do that he must click 'OK' button in the alert message.

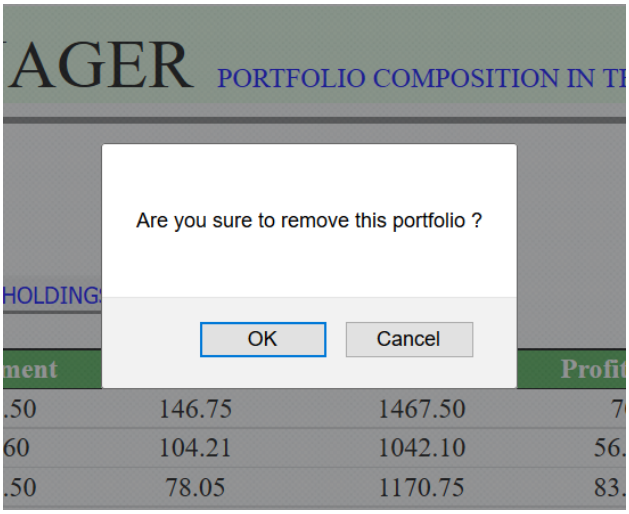

Figure 30. Alert message to confirm delete portfolio

4.6.5.3 Add holdings

In order to add a new share into the portfolio, the investor must click the 'add holdings' button. It will open a page to complete a form and to look for the name or symbol of the company. Then he must type the date of purchase, the number of shares purchased and their price. Once all this data is typed, he must click 'add holding' button to get the data adding to the current portfolio. It can be seen in the next **Figure 29**.

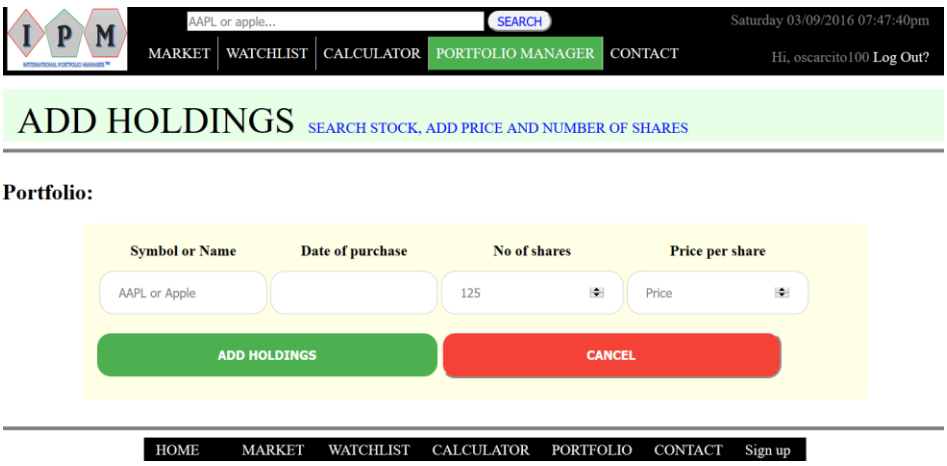

Figure 31. Screenshot of add holdings

4.6.5.4 Edit holdings

After clicking the 'edit holdings' button, the visitor is able to edit the already existing stocks. For doing this, all the stocks that belong to the current portfolio will appear with the available fields that he can modify such us date of purchase, number of shares and price per share. Also there is a delete option in case he wish to delete the stock. To confirm the update he must press the 'save holdings' button.

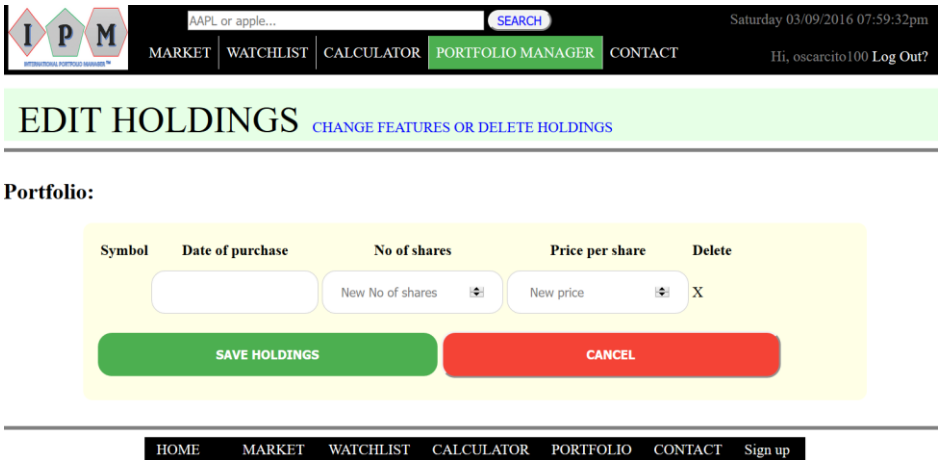

Figure 32. Screenshot of edit holdings

4.6.6 Contact

The users may contact to the administrator of IPM through Contact section. The name of the user, his email and a text area must be typed in order the data can be sent to the database.

4.6.7 Live search field

At the top centre of the navigation bar is situated a live search text field. The user is able to input a company name or symbol and the options available will appear below the text field. When he selects the company it takes him directly to the individual page of this company in order to see the different stock data and the chart previously commented in **"Heading 4.6.3 Market"**.

4.6.8 Sign up / sign in

The sign up and sign in buttons are situated on the bottom-right of the navigation bar. They are available in all the pages of the web site. If the visitor wants to access to a private section he must click over the world 'sign up'. Whereas he will click over 'sign in' if he is already a registered user. Both links will be highlighted in red colour when the user place the mouse over them.

4.6.8.1 Sign up

After clicking ‘sign up’ link, the registration form will be displayed. A screenshot about the registration form is presented in **Figure 31**. In order to create an account in IPM the user must type a valid username, email, password and confirmation password. All these inputs are marked as mandatory fields. To be officially a registered user he must click the ‘create account’ button, the system will check that there is no other user with the same username or email. If one of them already exists, an alert message will be popped up to inform him to change them. Moreover, this page includes a link for an already registered users.

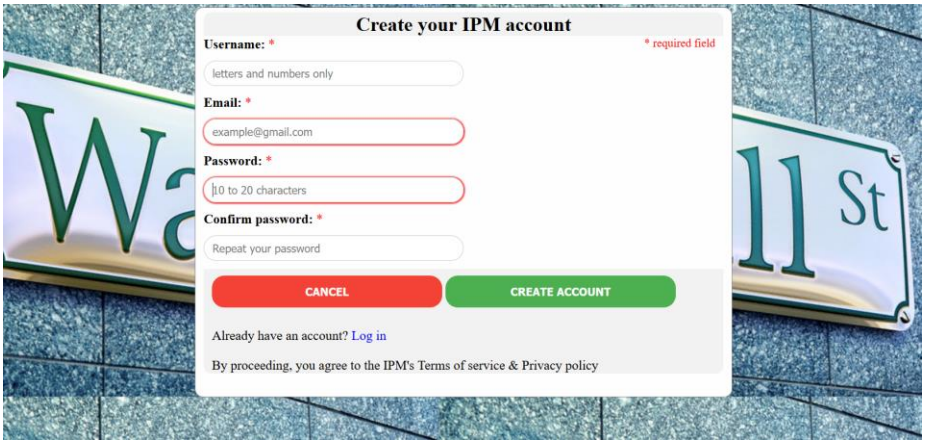

Figure 33. Registration form

4.6.8.2 Log in

When the investor is already an existing user, in order to use the private sections he only needs to log in. To log in, first he has to click the ‘log in’ link and a modal window will be displayed where he must type his username and password as illustrated in **Figure 32**.

If he forget his password he is able to recuperate it by clinking ‘retrieve password’. In addition, if he is not a registered user yet, he needs to click ‘Register now here’ to be redirected to the registration form.

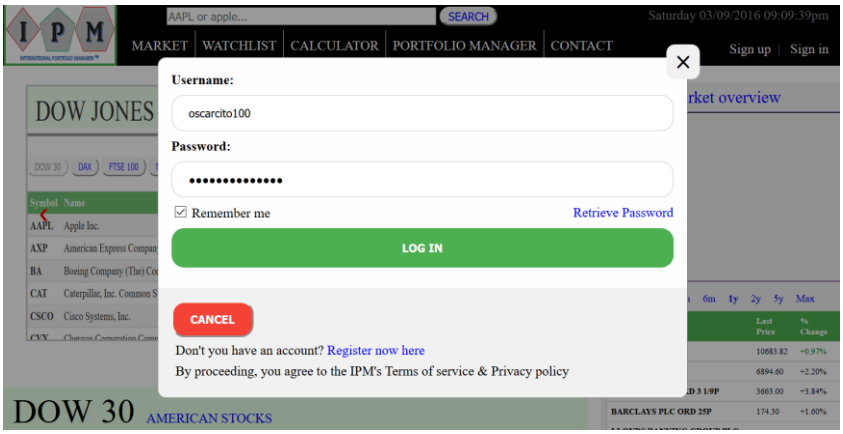

Figure 34. Modal to log in

The visitor will know that he is already connected and then he may use private sections such as the portfolio manager when on the bottom-right corner of the navigation bar appear his username and 'log out?' link instead to sign up / sign in. In the **Figure 33** on the bottom-right corner we can see that the user 'oscarcito100' is logged in.

Figure 35. User is logged in

4.6.8.3 Log out

Once he is connected and he wants to disconnect his session, he only has to click the 'log out' link. After that, at the bottom-right corner of the navigation bar will appear again the links to sign up and sign in.

4.6.9 Footer

At the bottom of all pages there is a Footer section where the users have a quick link to other sections of the web application, such as DOW 30, portfolio, sign up, my personal email account etc.

5 Implementation

The following subheadings will walk through the different functions IPM offers, from fetching stock data to all necessary validations that the user requires for a smooth user experience.

5.1 Data structure

5.1.1 Stock data

To retrieve the data from Yahoo's API is necessary to construct a valid URL which I divided it in four variables:

- BASE_URL: It is the base URI for YQL to get the data.
- yql_query: This query selects the stock data for the companies we select in the statement from 'yahoo.finance.quotes' within Yahoo's API.
- yql_query_str: To make a call to the YQL Web service, we must create a URL encoded query string with 'encodeURI ()' function. This function appends the BASE_URI and the 'yql_query'.
- query_str_final: We append the previous 'yql_query_str' with the response in JSON format.

The URL to call to YQL is made within an HTML script tag and the returned JSON responds is parsed with jQuery. To be able to use jQuery I used the Google's CDN that was already commented in **Figure 15**. The method '$.getJSON()' was utilised to be able to use the records within the JSON file received from Yahoo's API to extract the data we want to display in the web page using an AJAX HTTP GET request.

The return JSON response includes a 'quotes' object which at the same time includes an array with multiples records. These records are the data we can retrieve for the companies selected. Each security is retrieved individually within a switch statement because every stock symbol includes a hyperlink to the individual stock page when the user clicks over the symbol.

For instance, as can be seen in **Figure 34**, the company name, symbol, last trade price, change, change in percentage, time and date are the filters to display in the table called 'stockTable'. This name is the 'id' name of the main table that show the stock data of DOW 30. This code shows the base URI with the appended query string and JSON format for the YQL Web service, besides how to retrieve the data with '$.getJSON()' method.

The same process for the other two markets, FTSE 100 and DAX just changing the symbol of the companies in the yql_query. The four market pages DOW 30, FTSE 100, DAX and Currencies have exactly the same style and layout in all their components because they share the same CSS file called 'marketMenu.css.

```
<script>
var BASE_URL = 'https://query.yahooapis.com/v1/public/yql?q=';
var yql_query = 'select * from yahoo.finance.quotes where symbol in ("AAPL","AXP","BA","CAT","CSCO","CVX","DD","DIS","GE","GS","H
var yql_query_str = encodeURI(BASE_URL + yql_query);
var query_str_final = yql_query_str + "&format=json&diagnostics=true&env=store%3A%2F%2Fdatatables.org%2Falltableswithkeys&callbac
$(document).ready(function(){
    $.getJSON(query_str_final, function(data){
        var stockQuotes = data.query.results.quote;
        for(var i = 0; i < stockQuotes.length; i++){
            var stockData = stockQuotes[i];
            switch(i){
                case 0:
                $("#stockTable").append("<tr><td><b><a href='../quotes/dow30/apple.php'</a>" + stockData.Symbol + "</b></td><td>"
                stockData.Change + "</td><td id='percentChange'>" + stockData.PercentChange + "</td><td>" + stockData.LastTradeTi
                break;
```

Figure 36. Code to retrieve the stock data from Yahoo's API

5.1.2 Financial data

Four JavaScript files were created to fetch all the financial data from Yahoo's API, one per market because every market quotes in a different currency, so that they are the same except in that each of them has its own currency symbols. These files are embedded in a script element in their respective stocks, in order not to repeat this code again and again. The process to get them was the same as explained in the previous **subchapter 5.1.1 'Stock data'**. It means that the same URL was used to get the data using YQL.

The difference lies just in the kind of records that the web browser needs to retrieve to display them in their correspondent tables, but the rest of the process is exactly the same. For example, now the data that must be fetched from the response JSON format are market capitalization, price book or the 200 moving average price among others instead of last trade price, percentage change, etc.

To style these tables I coded a CSS file called 'stocks.css' that is embedded in every stock page, in order that the 160 stock pages have the same design. When the page of the company that the user has selected is open, all this data is loaded automatically calling the function 'start ()' within this JavaScript file.

```
function start(){
    getData();
}
function getData(){
var yql_query_str = encodeURI(BASE_URL+yql_query);
var query_str_final = yql_query_str + "&format=json&diagnostics=true&env=store%3A%2F%2Fdatatable
// header data
var symbol, name, lastTradePriceOnly, change, percentChange, lastTradeDate, lastTradeTime;
// statistics table
var volume, bid, ask, yearRange, daysRange, marketCapitalization, previousClose, dividendYield,
// ratios table
var bookValue, earningsShare, ebitda, priceBook, shortRatio, peRatio, priceSales;
// technical table
var fiftydayMovingAverage, twoHundreddayMovingAverage, changeFromTwoHundreddayMovingAverage, per
$(document).ready(function(){
    $.getJSON(query_str_final, function(data){
        var stockQuotes = data.query.results.quote;
        symbol = stockQuotes.Symbol;
        volume = stockQuotes.Volume;
        bookValue = stockQuotes.BookValue;
```

Figure 37. Code to retrieve the financial data embedded in every stock page

5.1.3 Exchange rates

The exchange rates are retrieved using the same structure explained previously, however, now the table from where get the exchange rates in 'Yahoo's API' is 'yahoo.finance.xchange' as presented in the second variable 'yql_query' in **Figure 36**. In this case, the JSON file has an object called 'rate' containing an array of exchange rates with records such as Name, Rate or Time.

```
var BASE_URL = 'https://query.yahooapis.com/v1/public/yql?q=';
var yql_query = 'select * from yahoo.finance.xchange where pair in ("EURUSD","EURGBP","EURJPY","EURAUD","EURCHF","GBPUSD","GBPJPY","GBPCHF","GBPAUD","AUDUSD",
var yql_query_str = encodeURI(BASE_URL + yql_query);
var query_str_final = yql_query_str + "&format=json&diagnostics=true&env=store%3A%2F%2Fdatatables.org%2Falltableswithkeys&callback=";
$(document).ready(function(){
    $.getJSON(query_str_final, function(data){
        var currency = data.query.results.rate;
        for(var i = 0; i < currency.length; i++){
            var currencyData = currency[i];
            $("#stockTable").append("<tr><td><b>" + currencyData.Name + "</b></td><td>" + currencyData.Rate + "</td><td>" + currencyData.Time + "</td><td>" +
            currencyData.Date + "</td></tr>");
        };
    });
});
```

Figure 38. Code to fetch exchange rate from Yahoo's API

5.2 Change colour in change and percentage change

To ease the way the user can interpret if a share is going up or down during the day in comparison with the previous day, the change in units and the change in percentage was coded in order that if the price is greater than the day before it displays the result in green, if it is less the colour will be red and if the current price is the same at the closing price of the previous day the result will be shown in blue colour.

This code is used in all the tables that show stock data like 'DOW 30', 'DAX', 'FTSE 100' and also in the header of the individual stock pages.

```
// set green, red or blue color according the change
        var changeColor = document.getElementById("change");
            changeColor.innerHTML = change;
            if(change > 0){
            changeColor.style.color = "green";
            }
            if(change < 0){
            changeColor.style.color = "red";
            }
            if(change == 0){
            changeColor.style.color = "blue";
            }
```

Figure 39. Code to change colour of change and percent change fields

5.3 Graphics/charts

IPM includes a powerful stock chart provided for Tradingview. A graphic appears in every individual stock page and in every currency page to show the visitor the share price of that company within a chart. It was implemented using two scripts, one that allow to get the chart from Tradingview and the second that simply specify the features of the chart. **Figure 38** presents both codes and the characteristics I choose for my web site as for example 700 pixels width and 450 pixels height.

```
<script type="text/javascript" src="https://d33t3vvu2t2yu5.cloudfront.net/tv.js"></script>
<script>
new TradingView.widget({
  "width": 700,
  "height": 450,
  "symbol": "NASDAQ:AAPL",
  "interval": "D",
  "timezone": "Etc/UTC",
  "theme": "White",
  "style": "1",
  "locale": "en",
  "toolbar_bg": "#f1f3f6",
  "enable_publishing": false,
  "allow_symbol_change": true,
  "hideideas": true,
  "show_popup_button": true,
  "popup_width": "1000",
  "popup_height": "650"
});
</script>
```

Figure 40. Code to display the charts on screen

5.4 Financial calculations

5.4.1 Amount to invest in foreign currency and number of shares to buy

When the investor has decided in which international company invests his savings, he does not know how many shares he is able to purchase because of these securities quotes in a different currency than the investor has. Fortunately, IPM possess a financial calculator to help him. In order that the system can perform the operations necessaries to get the number of shares to buy, it needs to know:

- Which are the local and foreign currencies.
- The amount to invest in his own currency
- The price of the stock.
- The current exchange rate between both currencies

The investor has to select in the dropdown lists his local currency and the foreign currency, then type the amount to invest in his currency and the price of the stock, whereas the exchange rate is provided for 'Yahoo'. The program automatically perform these operations after he clicked the 'calculate' button. Below in **Figure 39** are presented the code for the calculations and validations.

```
function calculateInvestment(){
    var amountToInvest = document.getElementById("amountToInvest").value;
    var exchangeRate = document.getElementById("exchangeRate").value;
    var investment = (amountToInvest * exchangeRate);
    document.getElementById("valueToInvestInForeignCurrency").value = investment.toFixed(2);
    var pricePerShare = document.getElementById("pricePerShare").value;
    var numberOfShares = (investment / pricePerShare);
    document.getElementById("numberOfShares").value = numberOfShares.toFixed(2);
    try{ // to manage the errors
        if(amountToInvest == "") throw "You need to type the amount to invest in local currency";
        if(pricePerShare == "") throw "You need to type the price of a share";
        if(isNaN(amountToInvest)) throw "Amount to invest is not a number. Please type a positive number";
        if(isNaN(pricePerShare)) throw "Price per share is not a number. Please type a positive number";
        amountToInvest = Number(amountToInvest);
        pricePerShare = Number(pricePerShare);
        if(amountToInvest <= 0) throw "You have typed a negative amount or zero to invest. Please type a positive number";
        if(pricePerShare <= 0) throw "You have typed a negative price or zero. Please type a positive number";
        if(amountToInvest < pricePerShare) throw "Amount to invest must be greater than the price per share"
    }
    catch(err){
        alert(err);
    }
};
```

Figure 41. Code to validate inputs in the first financial calculator

5.4.2 Initial investment in foreign currency and initial exchange rate

When an investor open a trading operation he knows the amount he invests in his local currency, the number of shares he purchased and their price, but its broker never tell him neither what was the investment in the foreign currency nor the exchange rate in what the operation was performed. So that, after typing these data in their correspondent fields and clicking the 'calculate button' he will know his initial investment in foreign currency and the exchange rate in which the trade was performed.

```
function calculateReturnPredictor(){
    var numberOfShares = document.getElementById("numberOfSharesBought").value;
    var purchasePrice = document.getElementById("purchasePrice").value;
    var initialInvestmentForeign = (numberOfShares * purchasePrice);
    document.getElementById("initialInvestmentForeign").value = initialInvestmentForeign;
    var initialInvestmentLocal = document.getElementById("initialInvestmentLocal").value;
    var initialExchangeRate = (initialInvestmentForeign / initialInvestmentLocal);
        document.getElementById("initialExchangeRate").value = initialExchangeRate.toFixed(4);
```

Figure 42. Code to get investment in foreign currency and initial exchange rate

5.4.3 Results in foreign and local currency

On the basis of the data provided in the previous calculations, by typing the price he wishes to sell his stocks or he has already sold them and the current exchange rate, the investor may compare the return of the investment in the currency of the stock and in his currency and therefore forecasting the future return.

```
    var salePrice = document.getElementById("salePrice").value;
// to get final investment value
    var finalValueForeign = (salePrice * numberOfShares);
//to get  foreign profit
    var inicialValueForeign =document.getElementById("initialInvestmentForeign").value;
    var profitForeign = (finalValueForeign - inicialValueForeign);
//to get  foreign return
    var returnForeign = ((finalValueForeign - inicialValueForeign) / inicialValueForeign) * 100;
    document.getElementById("returnForeign").innerHTML = returnForeign + " %";
// final investment value in local currency
    var initialValueLocal = document.getElementById("initialInvestmentLocal").value;
    var initialExchangeRate = document.getElementById("initialExchangeRate").value;
    var futureExchangeRate = document.getElementById("futureExchangeRatePrice").value;
    var finalValueLocal = (finalValueForeign * (1 / futureExchangeRate));
//to get  local profit
    var profitLocal = (finalValueLocal - initialValueLocal);
//to get local return
    var returnLocal = (profitLocal / initialValueLocal) * 100;
```

Figure 43. Code to get the results in foreign and local currency

5.4.4 Input validations

All the inputs belonging to the Calculator Menu have their own data validations when the user clicks the 'calculate' button. Data validation is very important to avoid wrong data, for instance the purchase price cannot be a letter or a negative number. It can be only a positive number.

```
try{
    if(initialInvestmentLocal == "") throw "You need to type the amount of your initial investment in local currency";
    if(numberOfShares == "") throw "You need to type how many shares you bought";
    if(purchasePrice == "") throw "You need to type the average price you bought your shares";
    if(salePrice == "") throw "You need to type the average price you sold your shares";
    if(futureExchangeRate == "") throw "You need to type the Future Exchange Rate Price in the next table. You need it to close out your trade";
    if(isNaN(initialInvestmentLocal)) throw "Initial investment is not a number. Please type a positive number";
    if(isNaN(numberOfShares)) throw "Number of shares is not a number. Please type a positive number";
    if(isNaN(purchasePrice)) throw "Price you bought your stock is not a number. Please type a positive number";
    if(isNaN(salePrice)) throw "Price you sold your stock is not a number. Please type a positive number";
    if(isNaN(futureExchangeRate)) throw "Future exchange rate is not a number. Please type a correct number";
    initialInvestmentLocal = Number(initialInvestmentLocal);
    numberOfShares = Number(numberOfShares);
    purchasePrice = Number(purchasePrice);
    salePrice = Number(salePrice);
    futureExchangeRate = Number(futureExchangeRate);
    if(initialInvestmentLocal < 0) throw "You have typed a negative initial investment. Please type a positive number";
    if(numberOfShares < 0) throw "You have typed a negative number of shares. Please type a positive number";
    if(purchasePrice < 0) throw "You have typed a negative purchase price. Please type a positive number";
    if(salePrice < 0) throw "You have typed a negative sale price. Please type a positive number";
    if(futureExchangeRate < 0) throw "You have typed a negative future exchange rate. Please type a positive number";
}
catch(err){
    alert(err);
}
```

Figure 44. Code to validate the input fields in return predictor calculator

5.5 Sign up

To register as an IPM's user, the client must fill in a registration form that includes four inputs. These are username with attribute type='text', email with type ='email' so that this field only accept to write text as an email structure. The third and fourth input are 'password' type where the user must type the same password in both fields between 10 and 20 characters. This form is written in an HTML document that when the user clicks 'create account' button the registration form is submitted to the file 'users.php'. This file has code to validate its information and if all of that is correct will be stored on the database. Also before submitting the registration form, the function 'validateRegisterForm ()' is called to validate the information in the client-side.

All the inputs are required using the attribute 'required' in them. Furthermore, at the top-right corner of the registration form there is a text in red colour that inform to the user that all the inputs are required. Within every input field there is a clue or example about what the customer must type in them. It was done with the attribute 'placeholder'.

To submit the registration form the 'Create Account' button must be clicked. Once it happens the server checks in the database concretely in the table 'users' that the username or email that the user typed are not taken as shown in **Figure 43.** If they already exist an alert messages is popped-up to inform him that the username or email already exist, so he needs to choose another one. However, if their username or email are still available in the database, he will be added as a new user.

In order to the user data saves in the database correctly, there are a function called 'test_input ($data)' that check if the data is correct, strip unnecessary characters like extra space, tab or new lines from the user input data and remove backslashes from the user input to escape code.

```php
function signUp(){ // check that the username that the user type is not taken
    global $userRegisterName;
    global $connection;
    global $email;
    $queryUserRegisterName = "SELECT username FROM users WHERE username='$userRegisterName'";// the username written is
    $resultQueryUserRegisterName = mysqli_query($connection, $queryUserRegisterName);
    $rowQueryUserRegisterName = mysqli_num_rows($resultQueryUserRegisterName); // to check for all the rows

    $queryEmail = "SELECT email FROM users WHERE email = '$email'"; // email written is not contain in the column email
    $resultEmail = mysqli_query($connection, $queryEmail);
    $rowQueryEmail = mysqli_num_rows($resultEmail); // to check all the rows
    if($rowQueryUserRegisterName == 0 || $rowQueryEmail == 0){ // if there are any row
        newUser();
    } else{
        echo "Sorry! ". $userRegisterName . " or " . $email . "already exists. Please select another username or email";
    }
}
```

Figure 45. Code in PHP to check if username or email already exists in the database

5.5.1 Data validation

As a well design and professional website, the data that the user type in the registration form must be validated before and after he clicks 'Create account' button. The process of validation before clicking the button is carried out in the client-side with JavaScript, in order that any data that does not fit with the conditions required cannot be sent. Another method of validation that IPM uses is in the server-side with PHP to validate again the data when it was sent after clicking 'Create account' button. Every input field has a specified conditions that must fulfil in order that their data can be submitted and stored in the database and finally the user becomes a new user.

For instance, **Figure 44** show alert messages when the password and confirm password were written with less than 10 and more than 20 characters. Whereas **Figure 45** sends an alert message if confirm password is different than password written to warn the user that they must be the same. Moreover, all the input fields are required, it means that if one of them is empty a message will appear and the input field will be surrounded with a border red colour.

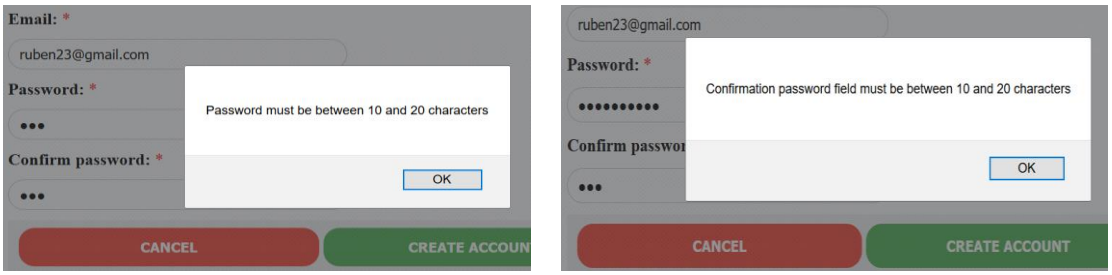

Figure 46. Alert message password or confirmation have not the correct characters

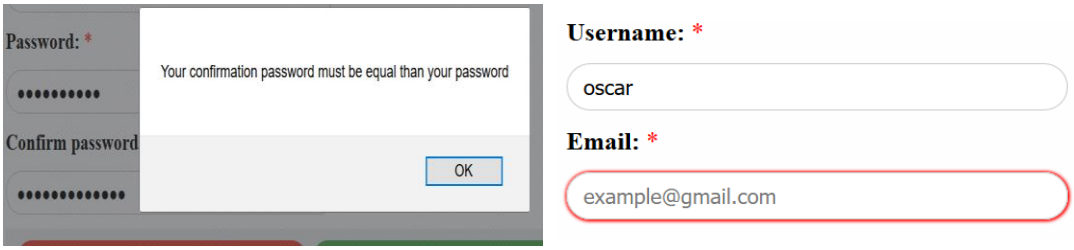

Figure 47. Alert message and style message is an input is empty

5.6 Sign in

The modal window for log in by default is not display on the screen because the element that contains the modal has a style property 'display: none;'. It will be shown when the user clicks the text 'sign in' on the bottom-right corner of the navigation bar due to it calls to display the modal.

The visitor can cancel the log in modal just by clicking with the mouse outside of the modal window. The two inputs that the user must type mandatorily are username and password and have the same features that their inputs in the registration form.

```
// Get the modal for sign in
var signInModal = document.getElementById('signInModal');
// When the user clicks anywhere outside of the modal, close it
 window.onclick = function(event) {
    if (event.target == signInModal) {
        signInModal.style.display = "none";
    }
}
```

Figure 48. Code to close the modal window when user clicks outside of it

When the user clicks the 'log in' button, a query in the database is launched to check if the user is already registered. He will be logged in if there is a match between the username and the password in the same row within the table 'users'. The code for that is shown in **Figure 47**. It is impossible that two users have the same username because this field is unique.

```
function getLogIn(){
    if($_SERVER["REQUEST_METHOD"] == "POST"){ //to check the form has been submitted
        $userRegisterName = test_input($_POST["username"]);
        $password = test_input($_POST["password"]);
        global $connection;
        if(!empty($_POST["username"])){
            $query = "SELECT * FROM users WHERE username = '$userRegisterName' AND password = '$password'";
            $result = mysqli_query($connection, $query);
            $countRows = mysqli_fetch_array($result);
            if(!empty($countRows["username"]) AND !empty($countRows["password"])){
                $_SESSION["username"] = $countRows['username'];
                header("location: ../portfolio/portfolioUserRegister.php");
            } else{
                echo "Sorry! You have entered a wrong Username or Password. Please try again!";
            }
        } else {
            echo "You must type your username";
        }
    }
}
```

Figure 49. Code in PHP to check if the user is already registered

5.6.1 Validate log in

The validations for the log in form are exactly the same as for the registration form because the two inputs have the same features that those in the sign up form. The validations of the client side is coded in the file 'validateLogIn.js' that is called when the user clicks the 'log in' button. This file has an extra validation which consist on username and password must match with one row that already exist in the database, if not he will not be able to connect and will receive a message tell him that username or password are wrong as evince in **Figure 48**.

Sorry! You have entered a wrong Username or Password. Please try again!

Figure 50. Alert message when input data in the log in modal is wrong

5.7 Log out

When the user is connected, the 'Log out' text will be displayed in the navigation bar instead 'Log in'. He simply has to click this text to log out and will be redirected to the home page.

```php
<?php
  session_start();
  session_destroy();
  header("Location: ../home/home.php");
?>
```

Figure 51. Code to execute log out link

5.8 Search for a company

The text field where user has to type in order to look for a company includes an 'onkeyup' attribute. Each time that the user type a letter in the text field, it calls for a JavaScript function called 'searchTextField.js' which at the same time calls for a 'php' file that implements the code to load a 'xml' file and retrieve the name of the company and its url when the letters match the name of the company.

5.9 Slideshow

The aim of the slideshow is that the visitor can get fast information and see examples about what he can do in another sections of IPM. It is situated at the top-centre in the Home page inside a border in grey colour because it is the first thing the users appreciates when they enter into the web site. The slideshow is composed for three records, first is the market, second the calculator ant third the portfolio section. Each record is formed by a picture, a text and the number of the record that is active.

To move from one record to the other, the user has two options,

- First, he may click the symbols situated on the right or on the left to move to the next one or the previous one respectively.
- Second, click the dot buttons situated at the bottom of the slideshow.

All dot buttons were setting up with an attribute that on click calls for a function called 'currentSlide (n)' and the symbols greater than and less than call for the function named 'plusSlides (n)'. At the same time that they are called, both of them call the function 'showSlides (n)' to handle these events on click and display the correct record. This code is displayed in the **Figure 50** below.

```
<script>
var slideIndex = 1;
showSlides(slideIndex);
function plusSlides(n){
    showSlides(slideIndex += n);
}
function currentSlide(n) {
  showSlides(slideIndex = n);
}
function showSlides(n){
    var i;
    var slides = document.getElementsByClassName("homeSlides");
    var dots = document.getElementsByClassName("dotSlides");
    if(n > slides.length){
        slideIndex = 1
    }
    if(n < 1){
        slideIndex = slides.length
    }
    for(i = 0; i < slides.length; i++){
      slides[i].style.display = "none";
    }
    for (i = 0; i < dots.length; i++) {
        dots[i].className = dots[i].className.replace(" activeDotSlide", "");
    }
    slides[slideIndex-1].style.display = "block";
    dots[slideIndex-1].className += " activeDotSlide";
}
</script>
```

Figure 52. Code to move to the next and to the previous slideshow

5.10 Portfolio

5.10.1 Create portfolio

When the customer creates a new portfolio the form is submitted to the database and the portfolio name will be stored in the 'portfolio' table. This portfolio will be assigned with a unique ID related to the 'userId'. **Figure 51** below is the SQL code within a PHP file to set up this table in the IPM database. Also **Figure 52** shows the statement to insert the data in the table.

```
$portfolioTable = "CREATE TABLE portfolio (
portfolioId INT(10) UNSIGNED AUTO_INCREMENT,
userId INT (6) UNSIGNED NOT NULL,
portfolioName VARCHAR(30) NOT NULL,
PRIMARY KEY (portfolioId),
CONSTRAINT portfolio_ibfk_1 FOREIGN KEY (userId) REFERENCES users (userId) ON DELETE CASCADE ON UPDATE CASCADE
)";
```

Figure 53. SQL code to create portfolio table

```
$insertPortfolioName = "INSERT INTO portfolio (userId, portfolioName)
                        VALUES (" . $_SESSION["userid"] . ",'$portfolioName')";
```

Figure 54. Statement to insert portfolio name into the portfolio table

5.10.2 Delete portfolio

If the customer wants to delete a portfolio, he just has to press the 'delete' button and the portfolio will be deleted from the table portfolio with the code presented below in the **Figure 53**. In addition, all the stocks included in the deleted portfolio will be deleted too.

```php
if(isset($_GET['deletePortfolioButton'])){
    $deleteQuery = "DELETE FROM portfolio WHERE portfolioName='.$row['portfoilioName'].'";
    mysqli_query($connection, $deleteQuery);
    header("Location: portfolioUserRegister.php");
}
```

Figure 55. Code to delete a portfolio when customer clicks 'delete' button

5.10.3 Add holdings

To add a new holding in a specific portfolio, the customer has to complete a form and after clicking the 'add holding' button it will be submitted to the database. The information he has to provide are the name of the stock, number of shares, their price and the date he has purchased them. If the input validations are right the data will be stored in the 'stock' table.

```php
// sql to create table
$stockTable = "CREATE TABLE stock (
stockId INT(100) UNSIGNED AUTO_INCREMENT,
portfolioId INT(10) UNSIGNED NOT NULL,
stockName VARCHAR(30) NOT NULL,
numberOfShares INT(10) NOT NULL,
price FLOAT(2) NOT NULL,
purchaseDate DATE NOT NULL,
PRIMARY KEY (stockId),
CONSTRAINT stock_ibfk_1 FOREIGN KEY (portfolioId) REFERENCES portfolio (portfolioId) ON DELETE CASCADE ON UPDATE CASCADE
)";
```

Figure 56. SQL code to create 'stock' table

```php
$insertHolding = "INSERT INTO stock (stockName,numberOfShares,price,purchaseDate)
                  VALUES ('$addHoldingsName','$addHoldingsNoShares','$addHoldingsPrice','$addHoldingsDate')";
```

Figure 57. Statement to insert the holdings in the 'stock' table

5.10.4 Edit holdings

If the client made a mistake with the data provided, has to add more shares or has to delete one stock this is the page to update their stocks. The 'stock' table in the database will be updated whit the action that the investor has performed in the form.

```php
$updateHolding = "UPDATE stock
                  SET numberOfShares = '$addHoldingsNoShares', price = '$addHoldingsPrice', purchaseDate = '$addHoldingsDate'
                  WHERE stockId=$row['stockId']";
```

Figure 58. Statement to update the holdings included in 'stock' table

5.11 Contact Form

If the user has the need to contact to the administrator of IPM a form must be filled in typing his name, his email and finally his comment. The three inputs must not be empty in order that when the visitor click the 'submit' button the information can be sent and stored in the database. It is stored in the comment table that previously was created.

commentId	contactName	contactEmail	comment
1	oscar	oscar@gmail.com	This is a nice web
2	Jorge	jorge@g.com	Horrible web!

Figure 59. Screenshot of the comments sored in the 'comment' table

5.12 Footer

For the footer a PHP file named ‘footer’ was created and inserted at the end of every main page within a div element. This file also includes a CSS file with its style.

This file is formed for a table with links to some of the main sections of IPM such us DOW 30, FTSE 100, DAX, portfolio, sign up or sign in. It also includes the author’s LinkedIn profile. They act as a hyperlinks to make easier and faster the navigation around the web site when the visitor is on the button of the page. So that, when the user click them, he will redirected to that selected page.

6 Evaluation

6.1 Testing

Testing is a crucial elements in the web development because ensures that the implementation matches the requirements. So that, in this section will be tested if the system meets the requirements specification.

6.1.1 Functional testing

Functional testing is a process belonging to the black-box testing that bases its tests on the requirements specification and check that each component does what they are required to do by the design phase. Functions are tested by typing the inputs and examining the outputs.

6.1.1.1 Data structure

Data that should be retrieved from Yahoo's API appear perfectly in their position where they should be placed. **Figure 7**, **8, 9 and 10** illustrates that. From my point of view the data is easy to interpret and appear quickly on the screen. With a simple click in the buttons the user can redirect to another market and pressing over the stock symbol within the tables he will be moved to that specific stock page.

There is a problem with the data that must be gotten and displayed in the homepage as a summary of every stock market. The code written is exactly the same that the one coded in the market menu, the only difference is that now was used only four companies as a summary table. However, the data is not display in the tables, just works the currency table.

It was planned that the change and percentage change columns of every stock that composes a table showed their output in different colours according to the evolution of the stock in that current moment in comparison with the closing price the previous day. However, it is only displayed in the first stock and sometimes in the wrong colour. For instance, if the stocks are going up in comparison with the last trade price of the previous day it should displayed the percentage change and change fields in green, but it only works for the first stock and sometimes it does it in blue or red not in green.

Symbol	Name	Last Price	Change	% Change	Time	Date
ABF.L	ASSOCIATED BRITISH FOODS PLC OR	2701.00	+5.00	+0.28%	1:42pm	9/21/2016
ADM.L	ADMIRAL GROUP PLC ORD 0.1P	2080.00	+0.00	+0.00%	1:41pm	9/21/2016
AHT.L	ASHTEAD GROUP PLC ORD 10P	1193.00	-23.00	-1.89%	1:42pm	9/21/2016

Figure 60. Change and percent change do not displayed the correct colours

6.1.1.2 Chart

The stock chart is big enough to appreciate the evolution if the share price, to make a good technical analysis and fit well with the size of the window.

6.1.1.3 Calculator

This sections was tested typing in the inputs and examining the outputs as soon as one calculation was done. To check if the results are correct I made the operations by hand. Some of them were found wrong but after figured out the mistakes in the code all of them show the expected outcome.

Once the investor has chosen his local currency (GBP) and the foreign currency to invest (USD) the exchange rate between them will appear in the exchange rate field. Then he has to type the amount to invest in his local currency (£20,000) and the price of the stock ($80). After clicking 'calculate' button the amount to invest in dollars $25,998.00 and the number of shares that the investor could buy will be 324.98 that rounded to the nearest integer will be 325 shares. These outputs depends on the current exchange rate, for this example was 1.2999 pounds per dollar.

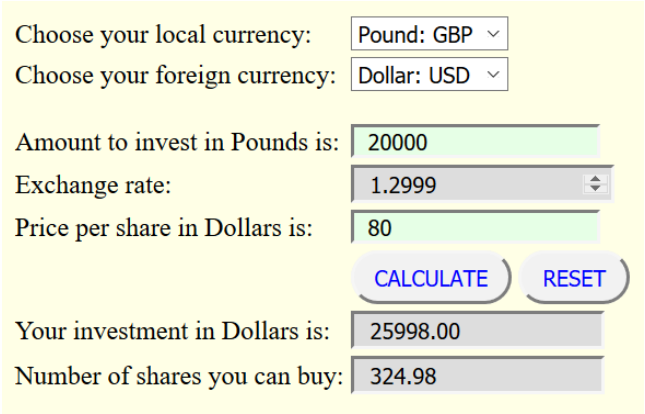

Figure 61. Example showing the outputs of one financial calculator

These inputs include many data validations to check that the user types the correct type of data. All these validations works perfectly. They were discussed in **"Heading 5.4 financial calculations".**

Figure 59 illustrates how an investor may predict the return of an investment depending for example in the current price of the equity (£ 88) and the exchange rate (0.65). He is able to know that in spite of having a positive return in the stock (10%) he would have a loss of $ 3,076.92 (- 15.38%) due to the depreciation of the pound (the currency of the stock).

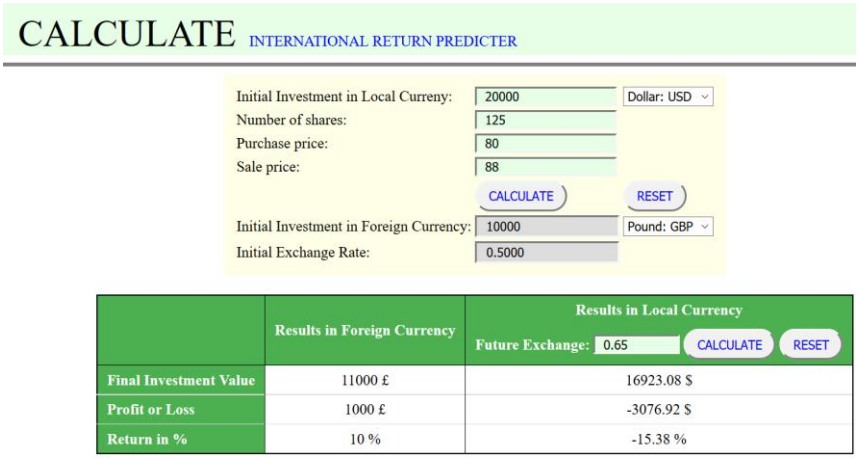

Figure 62. Testing international return predictor

One weakness of the 'International return predictor' is that when the user clicks the first 'calculate' button, the system ask him in an alert message to insert the future exchange rate situated in the 'Results' table. This table already has his own 'calculate' button but both perform the same calculations due to they share the same function called 'calculateReturnPredictor()'. The improvement that will be done is that the first calculate' button only will work for the first form and the second one only for the 'Results' table.

6.1.1.4 Registration form

All the data validation of the registration form works as expected. If the user do not type one field, the email does not have the correct structure, password and conformation password are less than 10 characters or more than 20, and if the confirmation password is not the same as the password an alert message warning him about his mistake will be displayed on screen.

After completing all the inputs and clicking 'create account' button the register form will be submitted and the data stored in the database. However, when a new user attempts to register with a username or email that already exist in the database, the system does not detected it. The code to warn the user that the username or email typed already are taken does not work.

6.1.1.5 Log in

If the visitor clicks 'log in' button with an empty field, the web browser will displayed an alert message telling him that he must type both fields username and password before submitting. If the username or password fields do not match with any data available in the' users' table within the database, a message inform him that he has entered a wrong username or password will be shown. Therefore this section works well.

6.1.1.6 Portfolio

When the investor wants to monitor her portfolio first must log in. Then, her portfolios will appear in the drop-down list and after choosing one, its stocks and features should be displayed in two different tables. The code to show the portfolios' name is done but they do not appear on the drop-down list, and then if we are not able to select a portfolio, its stocks cannot be displayed neither.

The code for deleting a portfolio is done too, but as cannot be possible to select a portfolio, the delete portfolio does not work neither.

The form to add new stocks is not working because of the query to insert the data in the 'stocks' table is incorrect. An error message is received warning us about that. Once it is fixed, the data would be stored in the database and then display on screen. The same problem happens with the form to edit the holdings. It is a process in what one code does not work the next step cannot be carried out.

6.1.1.7 Contact form

The data is stored in the database according to expected. Besides, the validations works properly not let the data to be sent if the fields are empty.

6.1.1.8 Live search field

This feature works as it was planned. When the user types a letter, the results that match with that letter appear under the search text field and when he clicks on that name, it redirects him to that company page within IPM. Due to time constraint just the American stocks can be searched. Sometimes the desired links cannot be clicked due to there are other elements that overlap them.

6.1.1.9 Watchlist

A watchlist section was planned to carry it out. However due to my reduced knowledge about web developer I have not had time to do it. In this section the registered users should be able to add a list of stocks to track them. The goal of this feature is that the user should assign them a price requirement and when the share price reaches that point, the system would send him an automatically an alert message to let him know that.

6.1.1.10 Encrypt password

When a website stored information about customers it is very important that nobody can neither access to their data nor using their account. To avoid that hackers can get and see the

passwords of users when they log in, the encryption of the password must be coded. There are many ways to do it such as with md5() or hash('sha256)'. Unfortunately, IPM does not include encrypted password but it is one of the improvements to be performed in the future.

6.1.2 Non-functional testing

Non-functional testing is related to any sort of test that does not involve any coding. It includes the navigation between the elements in the menu bar, the hyperlinks between the tables and the individual stocks when a user clicks on them, the layout of the different sections, a quick and correct response when a user press a button or a link, the interaction between a variety of elements within a page, etc.

One of my objectives were to develop a well-design web application with a clear layout, easy to use and understand, ease to navigate around, interactive and friendly to make a positive user's experience.

Testing was carried out in three different browsers, Microsoft Edge, Mozilla Firefox Developer Edition and Mozilla Firefox. The style of the web portal works generally well in the two firsts whereas in Mozilla Firefox some elements overlap the fixed navigation bar when the page is scrolled down. Some examples of those overlapped elements are the charts, the slideshow and the aside section in the homepage.

A common bug of all browsers is that the elements overlap one another when the user resize the window. Despite of those minor errors, I consider the goals about style and design were achieved. Those bugs will be resolved after the dissertation as a future work due to the lack of time to fix them.

6.2 User testing

This sections is where the testing is executed by final users. Aforementioned in the introduction this web site has been designed and implemented for users with small knowledge about financial markets or beginners investors, but even professional investors could find some sections in the website very interested.

A questionnaire was designed to identify whether the web site has a clear and friendly interface, is easy to navigate around, financial calculators are intuitive in their use and the portfolio section is useful and easy to track portfolios. It was done to analyse what necessary improvements must be done to get a user friendly web application. Additional information regarding whether they would use this we page to make their financial decisions and monitor their portfolio and also any comment they wish to make are included in the questionnaire. They are attached in the **Appendix 1.**

The results of the questionnaires reveal that the web portal is easy to use and navigate, the information about the stocks is appropriate, the charts are good for using analysis technical, financial calculations are able to help investors to make an investment decision, portfolio has a good structure and useful data even it does not work. Finally they will use the website to monitor their portfolio and see stock quotes.

In the comments, apart from saying that the web site is well presented and the layout is good, they make some comments about future improvements such as finish the portfolio section, fix the issues with the elements overlap on screen, create an independent currency convertor, etc.

7 Conclusion

7.1 Summary

IPM reached almost all the goals set at the beginning of this project and all the requirements were implemented but they are not enough to launch the website on the market. Still some works is necessary to get a powerful financial web application.

Due to time constraint, further research was needed and limitation of knowledge, not always the best solution could be implemented, portfolio section does not work properly despite the code is written and secondary system requirements like setting up of cookies and encrypting of password has not been embedded for better user's experience and safety. Therefore those improvements must be released in a future work.

7.2 Evaluation

This project was developed to provide to the investors a web site to observe and evaluate stock data, to perform technical analysis for decision making whether or not to invest in a company. Additionally, IPM includes some financial calculators and a portfolio manager for registered users to create and track their portfolios.

The evaluation can be divided in following four main parts:

- Watch stock data:

  Stock, financial and currency data are retrieve perfectly from Yahoo and well-displayed in their correspondent tables. Further search was needed to implement this code, for example a deep study of YQL was carried out.

- Technical analysis:

  Firstly, a quiet simple chart provided from Yahoo was implemented. However it had some drawbacks because of it did not give real time data, it was a picture that showed the last price trade and therefore could not be manipulated, technical analysis could not be perform, change of company to see other share could not be done, etc. At the end, another kind of chart was found and implemented. This new tool provides a powerful chart for technical analysis due to the investor can see real time price, manipulate the graph, insert lines for uptrends and downtrends, set up supports and resistances, change the stock within the chart and add indicators among other features. In my opinion, this amazing tool is one of the strong points of IPM.

- Financial calculators:

  For the implementation of the financial calculators a long code in JavaScript was needed in order to manipulate all the inputs and carry out the calculations necessaries for the outputs. All of them fulfil the user requirements.

- Portfolio manager:

  This section should have been the most powerful feature of my project. A big number of code in PHP and the creation of a database in MySQL was performed to be able to implement this sections, however the time constraint was not enough to end it up. Aforementioned in **heading 6.1.1.6 Portfolio** its implementation is done but some statements are not correctly done because the data is not display in the drop-down list to select the portfolio and then their stocks neither.

7.3 Future Work

This is the first attempt for the author to create a thorough web application. It is just the beginning for an unfinished financial portal. As far I concern some improvements are needed for a better performance of the project. This website could be set up on the internet in order to help investors with their financial operations. Suggestions for future improvements of the web page are listed below:

- The 'Portfolio' should be completed.
- Validations for the portfolio inputs must be done.
- Set up password encrypt using 'md5()' or 'hash('sha256')'.
- Set up 'cookies' to identify users
- The elements should be fixed to overlap others on the screen.
- For user's facilitation issues should be taken into account such as to resize the window, due to some of the elements overlap others.
- Increase the number of equities that can be searched in the live search field.
- A 'Watclist' section could be added. Already explain in **heading 6.1.1.8 Watchlist.**
- Information about the backgrounds of IPM plus contact data must be added to 'Contact' section.
- A 'News' section could be added to display economic news retrieved from Yahoo, CBS or another news website by means of their 'rss' feeds.

- A ‘Report’ section should be included in order to post financial reports and technical analysis about a variety of stocks.
- An automatic timer could be added to the slideshow, in order to changes its records every 4 seconds.
- Insert different taps in the aside table. Each tap will include data about a different market, instead of having all together as it is currently.
- Left next to the charts a vertical navigation bar will be embedded to display links to the individual companies’ page in order to have a quick access to another stocks.
- Improvement of Currency convertor by setting it up in a new page and include more currency pairs.
- Create a file ‘header.php’ formed by all the code written for the navigation bar and replace it in all the files.
- Pie charts could be added to illustrate the distribution of the stocks, and the distribution of the portfolio in currencies.
- Line charts could be added to display the evolution of the portfolio’s return.

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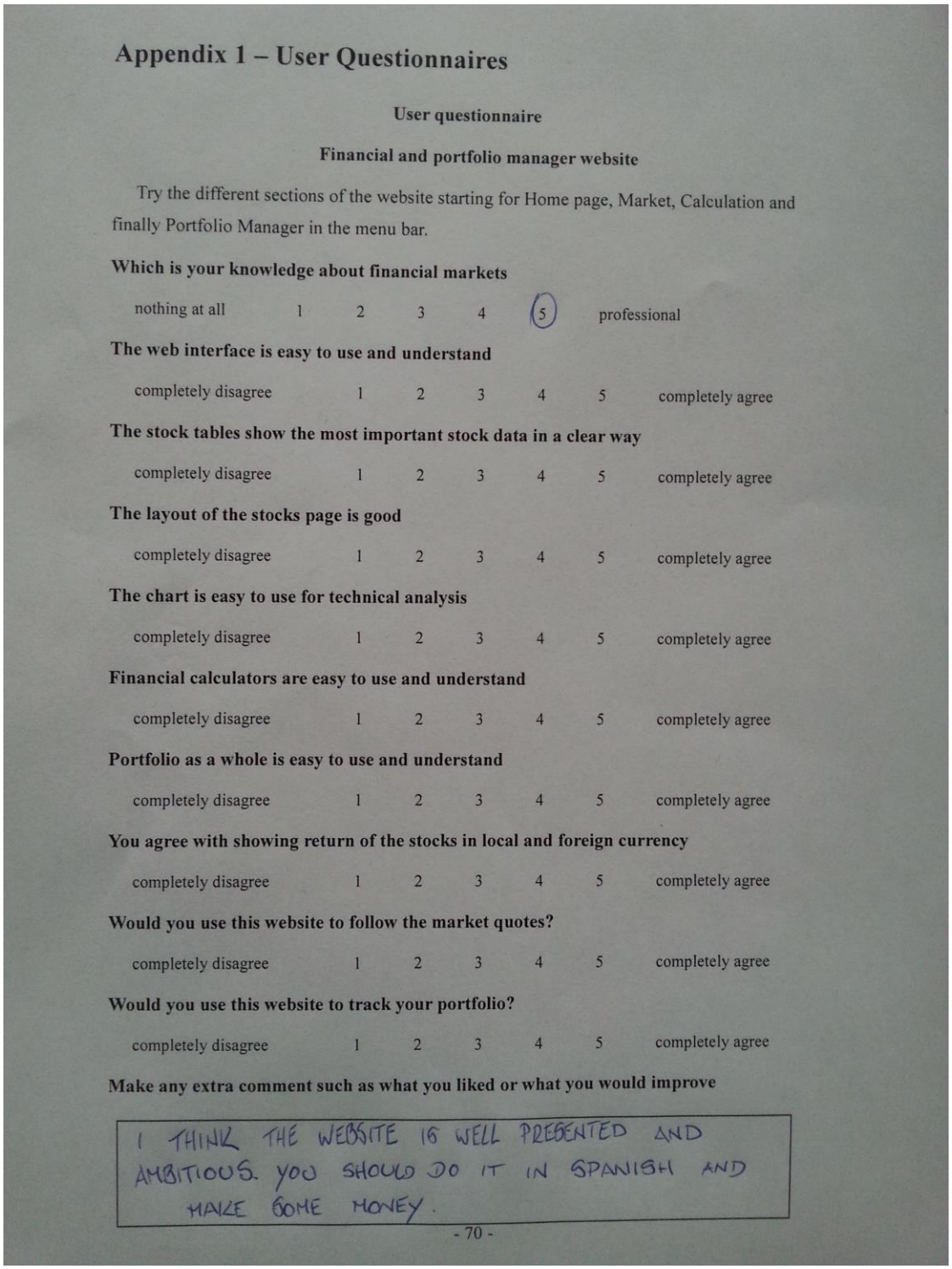
Appendix 1 – User Questionnaires



Appendix 1 – User Questionnaires

User questionnaire

Financial and portfolio manager website

Try the different sections of the website starting for Home page, Market, Calculation and finally Portfolio Manager in the menu bar.

Which is your knowledge about financial markets

nothing at all 1 2 3 4 (5) professional

The web interface is easy to use and understand

completely disagree 1 2 3 4 5 completely agree

The stock tables show the most important stock data in a clear way

completely disagree 1 2 3 4 5 completely agree

The layout of the stocks page is good

completely disagree 1 2 3 4 5 completely agree

The chart is easy to use for technical analysis

completely disagree 1 2 3 4 5 completely agree

Financial calculators are easy to use and understand

completely disagree 1 2 3 4 5 completely agree

Portfolio as a whole is easy to use and understand

completely disagree 1 2 3 4 5 completely agree

You agree with showing return of the stocks in local and foreign currency

completely disagree 1 2 3 4 5 completely agree

Would you use this website to follow the market quotes?

completely disagree 1 2 3 4 5 completely agree

Would you use this website to track your portfolio?

completely disagree 1 2 3 4 5 completely agree

Make any extra comment such as what you liked or what you would improve

I THINK THE WEBSITE IS WELL PRESENTED AND AMBITIOUS. YOU SHOULD DO IT IN SPANISH AND MAKE SOME MONEY.

- 70 -

User questionnaire

Financial and portfolio manager website

Try the different sections of the website starting for Home page, Market, Calculation and finally Portfolio Manager in the menu bar.

Which is your knowledge about financial markets

nothing at all 1 2 (3) 4 5 professional

The web interface is easy to use and understand

completely disagree 1 2 3 (4) 5 completely agree

The stock tables show the most important stock data in a clear way

completely disagree 1 2 3 (4) 5 completely agree

The layout of the stocks page is good

completely disagree 1 2 3 (4) 5 completely agree

The chart is easy to use for technical analysis

completely disagree 1 2 (3) 4 5 completely agree

Financial calculators are easy to use and understand

completely disagree 1 2 (3) 4 5 completely agree

Portfolio as a whole is easy to use and understand

completely disagree 1 2 (3) 4 5 completely agree

You agree with showing return of the stocks in local and foreign currency

completely disagree 1 2 3 4 (5) completely agree

Would you use this website to follow the market quotes?

completely disagree 1 2 (3) 4 5 completely agree

Would you use this website to track your portfolio?

completely disagree 1 2 3 (4) 5 completely agree

Make any extra comment such as what you liked or what you would improve

Currency converter is confused, it should be independent
the layout is good
Fix overlaps issues