

National College of Ireland  
MSc Web Technologies  
2010/2011

Oliver Reilly  
X10208534  
X10208534@student.ncirl.ie

## The Investment Industry and Social Media

Supervisor Dr Dietmar Janetzko



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I hereby certify that this material, which I now submit for assessment of the programme of study leading to the award of Master of Science in Web Technologies is entirely my own work and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work

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Date

Student Number 10208534

## ABSTRACT

This thesis describes the design, implementation, testing and user evaluation of InvestClub an investment portfolio management application that incorporates and harnesses the power of social media. The application allows people to create and share investment portfolios with other people. People can choose to follow other investor portfolios meaning that changes in a lead portfolio will be replicated in follower portfolios. Lead portfolios benefit by receiving a commission from follower portfolios while followers benefit from not having to actively manage their portfolios.

To tap the potential of social media the application allows investors to create prediction markets to help them make better investment decisions by harnessing the wisdom of investors that are tracking them. In addition, investors can interact with their followers through the creation of information threads and comments.

Finally there are the added benefits of complete transparency of transactions, stock price movement charts, performance analysis, stock screening and information feeds from the sources such as Twitter, Yahoo Finance, etc.

The application will undergo usability testing by a number of people and the results will be documented. The business model behind the application will also be assessed by industry experts. Suggestions for improving the application will also be documented.

## ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr Dietmar Janetzko, for his guidance, ideas, feedback and time over the last year

I would also like to thank all those who helped with the evaluation of my thesis and for the valuable feedback that they provided me with

I'd also like to thank my manager and colleagues in the Irish Stock Exchange who have been very supportive of me throughout the duration of the course

Finally I want to express my gratitude to my wife and children for their help, patience and encouragement over the duration of the thesis and course. Many weekend plans had to be put on hold because of my workload, hopefully I can make up for lost time!

Thank You All,

Oliver

## DEFINITIONS

**Mutual Fund** A pool of money belonging to many investors that is managed and invested professionally on their behalf. Most funds have a defined investment strategy and charge management fees. An example is a pension fund.

**Hedge Fund** These are similar to mutual funds in that they manage a pool of money belonging to many investors. They differ in that they can invest in more diverse and riskier assets and are not as regulated. They usually make higher returns than mutual funds but charge higher fees.

**Social Media** The use of online platforms to simulate real world communication in a real-time manner.

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## 1. INTRODUCTION

InvestClub is a web based investment portfolio management application that allows people to create and share investment portfolios with other people. In addition, the application taps the potential of social media through the use of a prediction market mechanism and associated online social commentary. This allows investors to draw upon the wisdom of fellow investors to assess investment strategy and opportunities.

People can create their own investment portfolio or they can choose to follow other investor portfolios meaning that changes in a lead portfolio will be replicated in follower portfolios. Lead portfolios benefit by receiving a commission from follower portfolios while followers benefit from not having to actively manage their portfolios.

There is also the added benefit of complete transparency of transactions and real time performance analysis. The application will also incorporate financial and stock feeds from information sources such as Twitter, Yahoo Finance, etc.

### 1.1 SCENARIO

Warren works as a research analyst at a leading investment bank and specialises in new and emerging pharmaceutical companies. He graduated from college with a PhD in Chemistry but with limited opportunities for PhD graduates in the science sector, he started looking at other industries for opportunities. He really enjoys working as a research analyst in the financial sector as he gets to meet with lots of new and exciting science ventures assessing their research and drafting reports on trends within the sector. Having recently inherited some money from a deceased uncle, he decides to put some of his specialist knowledge to use and decides to invest in the stock market. A friend tells him about the crowdsourced website InvestClub and he likes the idea of potential followers tracking his investments due to his specialist knowledge. He creates a profile on the website, invests his money in 5 up and coming pharmaceutical companies, creates a commentary on his investment strategy and then sits back waiting for his portfolio to increase in value and investors to start following his portfolio. After 3 months, his portfolio is up 20%. After 6 months, he has 25

people following his portfolio, each paying him a commission for the privilege of his investment knowledge

After 8 months, Warren's portfolio has increased 28%. He is now a frequent commentator on the website and comments on his portfolio on a regular basis. Warren thinks that it might be good to diversify his portfolio a little. He has been looking at 2 stocks in particular. One is a high risk, high return Silicon Valley computing start-up and the other is a lower risk German car component company. He decides to seek advice from some of his followers and after posting some commentary on the pros and cons of each stock, he creates a couple of prediction markets to assess what people think of each stock's investment opportunity. His followers vote that investing in the German car component company is a 'Strong Buy' whereas the Silicon Valley start-up is a 'Sell'. This reinforces Warren's assessment of both companies and so he decides to invest in the German company.

After 1 year, Warren's investments and those following him are up 26%. His investment in the German manufacturing company is up 8% whilst a similar investment in the Silicon Valley start-up would be down 22%. In addition, Warren has also earned commission from each of his 38 followers.

Warren's followers are very happy with the portfolio return and with Warren's regular commentary and analysis. Not only is the whole process completely transparent but they have real-time performance analysis and they have just the right amount of control of their investment. They can switch portfolio at any time and can discuss investment strategies with Warren or other investors on the website. It is a real case of crowdsourced investing and collaboration.

## 1.2 RESEARCH QUESTION

Given the rapid increase in popularity of social media over the last decade, this thesis seeks to explore some of the issues with incorporating social media into the investment industry. Research suggests that harnessing the wisdom of crowds can under certain conditions lead to better decision making when assessing uncertain outcomes (Surowiecki, 2005). This thesis develops a business model that incorporates social media into the investment industry, with the aim of answering the question:

*“Can harnessing the wisdom of crowds assist investment managers in making better investment decisions?”*

## 1.3 RESEARCH OBJECTIVES

The objectives of this thesis are:

- To provide a comprehensive literature and background review of the subject areas that impact on the InvestClub business model. This includes Web 2.0, Wisdom of Crowds, Information Cascades and Prediction Markets.
- To provide a comprehensive description of the application's design, architecture, user evaluation, areas for improvement and further research.
- To develop a fully functional web based portfolio management application that allows people to create and share investment portfolios with other people and to share knowledge through social commentary and prediction markets.

- Use the prototype application to assess if tapping the wisdom of crowds could lead investment managers to make better investment decisions.

#### 1.4 AREA OF CONTRIBUTION

The proposed area of contribution of this thesis is in the use of prediction markets and social media to allow investment managers make better investment decisions. Research suggests that crowds can, under certain conditions, make better decisions than experts (Surowiecki, 2005). By allowing investment managers to tap the knowledge within a crowd through the use a prediction market, they should be able to make better investment decisions that benefit not only their investment but those within their social media context i.e. their portfolio followers. The prediction market mechanism allows information from the crowd to be aggregated into meaningful data which the investment manager can use to reach a decision. The prediction market mechanism also helps create the conditions which, as the research suggests, lead to better decisions being made (Surowiecki, 2005).

#### 1.5 THESIS OUTLINE

This thesis will follow the following structure:

- **Literature Review:** This chapter discusses the subject of social media and the wisdom of crowds. It also looks in detail at some topics specific to these areas such as information cascades and prediction markets.
- **Research Background:** This chapter looks at a number of business models where social media and the investment industry have been integrated. It also examines some existing web based portfolio management systems and describes their current functionality. Based on the literature review and the research background, this chapter will also detail how they have influenced the InvestClub business model.
- **Architecture and Implementation:** This chapter starts with a set of detailed requirements of the application. It then outlines a high level overview of the

application's architecture before going on to describe some of the technologies used within the application and how they were implemented. After showing some screenshots of how the requirements were implemented, it finishes with an overview of the testing that was done on the application.

- **Evaluation** This chapter discusses how the application and the concepts behind the application were evaluated. It describes the objectives behind the evaluation, the method of evaluation and the reasons for choosing the method of evaluation.
- **Results** This chapter discusses the results of the evaluation and some of the conclusions that can be drawn from the results. It also discusses the viability of the application and some limitations of the concepts behind the application. It also outlines some recommendations for improving and diversifying the application.
- **Conclusion** This chapter outlines the conclusions to be drawn from the design, development, implementation and evaluation of the InvestClub application. It also outlines future areas for research in relation to the investment industry and social media.



## 2. LITERATURE REVIEW

### 2.1 INTRODUCTION

This chapter looks at some relevant literature on the concepts behind the InvestClub application. It starts off with a general overview of social media or web2.0 as it is sometimes called. Companies that effectively use social media can benefit from many opportunities such as better product research, new product development or tapping the 'wisdom of the crowd' to make better decisions (Li & Bernoff, 2008). The concept of wisdom of crowds is central to the InvestClub application and this chapter discusses what the wisdom of crowds means, the conditions needed to harness the wisdom of crowds and why crowds can make better decisions than deliberating groups of people. It also discusses the benefits of combining wisdom to make better predictions. By tapping the wisdom of crowds, InvestClub will help investors make better decisions about their trading activities. This chapter also looks at the topic of information cascades and how it leads individuals to ignore their own information in favour of the group's perceived better information. InvestClub aims to avoid information cascades in its decision making process as information cascades mean that all the information available isn't being elicited effectively from the group. One way of eliciting the information effectively is to use prediction markets. This chapter concludes with an overview of prediction markets and how they work.

### 2.2 WEB 2.0 - SOCIAL MEDIA AND COLLABORATION

O'Reilly and Battelle are credited as the first people to coin the phrase Web2.0 from an O'Reilly Media conference in 2004. During the conference they discussed why some companies had survived after the initial dot com bubble burst. Among the main reasons cited was the companies that survived embraced the network as a platform architecture i.e. rather than just providing a software as a service, they offered a platform whose value was created by the community of users using it. The software facilitated the community's interaction. Web 2.0 was all about harnessing collective intelligence by managing, understanding, and responding to massive amounts of user-generated data in real time. (O'Reilly and Battelle, 2005)

5 years later they followed up on their original paper with some updated observations about Web 2.0 to take account of the rise in smart phone technology. With more users and sensors (GPS,

motion, cameras) supplying data to applications and platforms, the opportunities for the web are growing exponentially. They sum this up with a nice quotation: “1990–2004 was the match being struck, 2005–2009 was the fuse, and 2010 will be the explosion” (O’Reilly and Battelle, 2009)

So how do companies go about harnessing collective intelligence and just what are these opportunities for companies that do harness it?

---

## 2.2.1 HARNESSING COLLECTIVE INTELLIGENCE

Li & Bernoff describe the rise in social media as a movement that can't be tamed. They call it the 'Groundswell' and they define it as: “A social trend in which people use technologies to get the things they need from each other, rather than from traditional institutions like corporations” (Li & Bernoff, 2008)

The list of technologies used includes blogs, podcasts, social networks, wikis, review sites, etc. For a business to tap the potential of social media, Li & Bernoff outline a 4-step planning process for building a social media strategy (Li & Bernoff, 2008). They call it the POST method and it stands for:

**People** This step assesses what the company's customers are ready for? It aims to assess how customers will engage, based on how they currently use social media. If the customers don't currently use social networks, then having a social networking strategy would be a waste of resources.

**Objectives** What are the goals for using social media? Possible goals might be marketing, research, customer support or collaboration.

**Strategy** This assesses how customer relationships would change with a social media plan? Would customers become more engaged with the company, would they spread the word about the company, etc. Knowing how the customer interaction would change would also allow a company to put procedures in place to measure how effective any social media plan is achieving its objectives.

**Technology** What technologies should be used? Possible technologies include blogs, wikis, social networks, etc. All the previous steps should be decided upon before this step is considered.

Once a company has a social media strategy in place to harness collective intelligence, a number of opportunities become available to them such as boosting revenue through new sales channels, developing new products in response to customer feedback or providing better customer support by making their business more transparent and accessible (Li & Bernoff 2008 ) Another opportunity, and one that this thesis will focus on, is tapping the “Wisdom of Crowds”

## 2.3 WISDOM OF CROWDS

In his book, “The Wisdom of Crowds Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations”, Surowiecki outlines how information held by groups can be aggregated in a way that often leads to better decisions than any individual within the group could have made. He argues that under certain conditions, the individual predictions of groups of people, once aggregated together, will be more accurate than the predictions of the individuals within the group or even experts outside the group. He supports his theory with many case studies that back up his theory (Surowiecki, 2005)

One such case study relates to a U.S. submarine that disappeared in the North Atlantic in 1968. After carrying out a fruitless 20-mile radius search of where the last radio contact with the submarine was made, a naval officer, John Craven, proposed a new plan of action. Rather than consulting with 3 or 4 submarine and ocean current experts, he assembled a large number of experts with diverse skill sets including mathematicians, salvage men, submarine and ocean current experts. He then proposed to them a number of different scenarios for the fate of the missing submarine. Rather than getting the group to deliberate each scenario, he asked them to assign a probability of occurrence to each scenario. At the end of the exercise, the team had made predictions on events such as the speed of the submarine, direction, steepness of descent, etc. Craven believed that aggregating the information together he'd end up with a good estimate of where the submarine might be. In effect, he was seeking to harness the collective wisdom of the group. The outcome of the exercise was a location that no-one in the group had predicted, but when the submarine was located, it was a mere 220 yards from the group's estimate. Surowiecki says the astonishing thing about the story is that *“even though no one knew why the submarine sank, how fast it was travelling or how steeply it sank, the group as a whole knew them all”* (Surowiecki, 2005)

He states that certain conditions need to exist for a crowd to have wisdom. When these conditions do not exist, the crowd is not wise as in the case of a mob or a stock market bubble. The 4 conditions required for groups to be wise are

|                      |  |
|----------------------|--|
| Diversity of Opinion | Each person should have private information even if it's just an eccentric interpretation of the known facts |
| Independence         | People's opinions aren't determined by the opinions of those around them                                     |
| Decentralization     | People are able to specialize and draw on local knowledge  |
| Aggregation          | Some mechanism exists for turning private judgments into a collective decision                               |

Table 2.1 Conditions required for groups to be wise (Surowiecki, 2005)

When a group meets these conditions, Surowiecki believes that the group's judgement is likely to be accurate. He states that each person's guess contains both information and error. Asking a large group of diverse, independent people to make an estimate of an outcome's probability and then taking the average of those answers means that the errors made in the individual estimates get cancelled out. In other words, taking away the error just leaves the information. He qualifies this statement with the assumption that the group is somewhat smart, i.e. that there is some information in their individual answers (Surowiecki, 2005).

This point is also made by Sunstein when he describes such groups as being statistical groups. Again, Sunstein says that when *the relevant conditions are met, the average or 'statistical answer' is often the best answer*. He also backs up his argument with another real world 'wisdom of crowds' example where the world chess champion, Gary Kasparov, played the world in a game of chess over the internet. Four chess experts were asked to suggest moves but the 'World' team voted on their preferred move with the majority vote winning. Despite Kasparov's ability, it took 4 months for him to finally win the game after which he declared it the greatest game in the history of chess (Sunstein, 2006).

Surowiecki mentions that with most things the average of a group is less than the best in the group however with decision making this is not the case. With decision making, the average answer is often equal to that of the smartest person (Surowiecki, 2005). Sunstein explains that the accuracy of such group decisions lies in the Condorcet Jury Theorem which states that *“the probability of a correct answer by a majority of the group increases toward 100% as the size of the group increases so long as two conditions are met*

*- majority rule is used*

*- each person is more likely than not to be correct”*

(Sunstein, 2006)

He gives an example where given a three person group where each person has a 67% probability of being right, then the probability of the majority vote being the correct answer is 74% (Sunstein, 2006). As the group size increases, so too does the probability.

When comparing the conditions for the wisdom of crowds against Condorcet's assumptions, Sunstein noticed some similarities. Condorcet, he points out, assumed that

- People would be unaffected by whether their votes would be decisive
- People would not be affected by one another's votes
- The probability that one group member would be right would be statistically unrelated to the probability that another group member would be right

(Sunstein, 2006)

The first two points relate closely to the Independence and Decentralisation conditions while the third point is closely related to the Independence, Diversity of Opinion and Decentralisation conditions outlined above. Condorcet theory, Sunstein points out, states that the group must be well informed so that their answers will contain information. This is what Surowiecki referred to above when stating that, for the group to be smart there must be some information in the individual answers. The more expert the group, the better the result.

---

## 2 3 1 COMBINING FORECASTS

Armstrong outlines some evidence to support the aggregation of opinions stating that over a series of thirty comparisons, statistical groups of experts had on average 12.5% fewer errors than individual experts on forecasting tasks involving such diverse issues as cattle and chicken prices,

real and nominal GNP, survival of patients, and housing starts. Statistical groups of experts significantly outperformed individual experts in predicting the annual earnings of firms, and changes in the U.S. economy (Armstrong, 2001)

Armstrong also outlines the case for aggregating individual predictions. He states that making predictions is important in every aspect of life whether it's people making predictions about suitable occupations, companies making predictions about new products or the government making predictions about the economy. He argues that different forecasts contain different but valid information because maybe different methods or datasets were used. By combining forecasts, more information is captured and errors from faulty assumptions, bias, or mistakes in data are reduced (Armstrong, 2001)

Under certain conditions, he states that forecasting errors can be reduced by sometimes more than 20%. These conditions occur in the following situations:

- when there is uncertainty as to the selection of the most accurate forecasting method
- when there is uncertainty associated with the forecasting situation
- when there is a high cost for large forecast errors

(Armstrong, 2001)

His key principles for combining forecasts are to use:

- different methods or data or both
- forecasts from at least five methods when possible
- formal procedures for combining
- equal weights when facing high uncertainty
- trimmed means
- weights based on evidence of prior accuracy
- weights based on track records, if the evidence is strong
- weights based on good domain knowledge

(Armstrong, 2001)

Sunstein asks the question that if statistical groups perform so well, then would groups of people who deliberate decisions perform equally as well (Sunstein, 2006) One would imagine that deliberation of a decision with other people would lead to a better outcome and indeed it often does Sunstein outlines three situations where deliberation often creates a better outcome (Sunstein, 2006)

- Groups as Equivalent to Their Best Members

In this situation, the group contains one or more experts and the others are non-experts This works well in situations where there is a definite answer and the experts are able to convince the non-experts that their answer is correct If group members listen to the opinion of the expert, the group will do at least as well as the expert would have done on his own

- Aggregation

In this situation, there are no experts in the group but each member has some information to offer In this situation, deliberation can aggregate the information leading to possibly the group being an expert even though none of the group's members are

- Synergy and Learning

Cooper & Kagel state that, in this situation, deliberation of information and viewing it from different perspectives, leads to a situation where the synergy of the group fosters innovation and creativity Often the outcome from innovative deliberation can be much better than the mere aggregation of the information within the group (Cooper & Kagel, 2005)

However Sunstein sounds four warnings when looking at the process of deliberation (Sunstein, 2006)

1. Heath and Gonzales state that group members become more confident about their decisions after speaking with one another. People feel more confident about their decisions once they have been corroborated by others within the group. This can lead to the group as a whole being very confident about their decision even if it is the wrong decision. This is a scenario referred to as groupthink (Heath and Gonzales, 1997).
2. Deliberation can promote uniformity by decreasing the range of views within groups. Sunstein talks about an experiment where groups of either 'liberal' or 'conservative' voters were asked to debate a mixture of 8 liberal and conservative issues. Before debating, each member was asked to state their opinion. After deliberation, they were asked again to state their opinion. In every case, the conservatives became more conservative and the liberals became more liberal. The group debate had polarised their opinion thereby ruling out the options in the middle. There was no diversity within the group after deliberation (Sunstein, 2006).
3. They do not elicit the information that their members have. Sunstein discusses a paper by Gigone and Hastie where they refer to the "common knowledge effect" where groups tend to be more influenced by common shared information than information held by just a few members (unless those members are experts). They say that unique information held by a just few members is often either ignored or not shared at all. Sharing common knowledge leads to poor decisions when there is unique knowledge within the group that is not being used (Gigone and Hastie, 1997).
4. They are subject to information cascades.

## 2.4 INFORMATION CASCADES

Bikhchandani, Hirshleifer and Welch define an information cascade as "An information cascade occurs when it is optimal for an individual, having observed the actions of those ahead of him, to follow the behaviour of the preceding individual without regard to his own information" (Bikhchandani, Hirshleifer and Welch, 1992).

They state that an information cascade will occur when a person perceives the best decision is to follow the behaviour of others preceding him rather than his own information. The person



assumes that the previous people have information that is stronger than his own information and therefore decides to trust their decision rather than his own instincts (Bikhchandani, Hirshleifer and Welch, 1992)

Easley & Kleinberg give an example of choosing a restaurant. Based on a person's own research they intend to choose Restaurant A but find that when they get there it is empty whilst the adjacent Restaurant B is full. If the person believes the diners have similar tastes and that they have access to similar restaurant information then it is rational for the person to choose to eat in restaurant B despite their initial intentions. When the first diners went to Restaurant B, they conveyed information to later diners about what they knew. A cascade occurs when people abandon their own information in favour of what other people have decided before them. They argue that, in a social context, information cascades may be responsible for many of the fads and fashion that occur in technology, political movements, book sales and even popular restaurants (Easley & Kleinberg, 2010)

Information cascades can be easy to simulate. In 1996 Andersen and Holt published a paper outlining how to conduct a classroom exercise, using just 2 urns and 2 sets of differently coloured marbles and a small incentive to encourage the students' participation. The students, in sequence, publically made predictions about an unknown event based on some private information and information inferred from previous student predictions. They found that an information cascade occurred if the initial predictions coincided, the later students went along with the consensus even if it was in conflict with their own personal information (Andersen and Holt, 1996)

While information cascades can easily form, they can also be easily broken. Easley and Kleinberg point out 3 observations about cascades

- *Cascades can be wrong – if earlier decisions in a cascade are wrong, it's likely that all subsequent decisions will be wrong*
- *Cascades can be based on very little information – this occurs because people ignore their private information when making a decision based on what previous people have decided*
- *Cascades are fragile – because it takes only a little information to create a cascade, all it takes is for a couple of people, with strong private contrary information, to break the cascade*

They outline a simple experiment like the one above but describe what happens when, in a class of 100, students 50 and 51 cheat by showing the results of their draw. With this new information, the subsequent students deviate from the cascade to state their prediction based on the new

information that has come to fore. Easley and Kleinberg argue that the students knew that each of the first 49 guesses had very little information supporting the decisions (Easley and Kleinberg, 2010). Bikhchandani et al argue that because participants know that they are in a cascade, they know that the cascade is based on little information. They state that several situations can break the cascade such as the release of new public information or the arrival of strongly informed individuals (Bikhchandani et al, 1998). Ziegelmeyer & Bracht however, argue that as an information cascade increases in size, it will be more difficult to break the cascade (Ziegelmeyer & Bracht, 2009).

## 2.5 PREDICTION MARKETS

To help avoid information cascades and the other problems associated with group deliberation, prediction markets are an ideal mechanism for harnessing the information within a crowd. Chen and Pennock define a prediction market as a decision making mechanism that “offers contracts whose future payoff is tied to outcomes of an event of particular interest and attracts participants to trade the contract” (Chen and Pennock, 2010).

The current price of the contract then represents the probability, according to the group, of that event occurring. They give an example of a contract for the occurrence of avian flu in the US before March 31, 2011. If it occurs, the contract will pay \$1 otherwise it pays \$0. If a person is 75% sure that that event will happen he will pay up to 75 cent for the contract. People who buy low and sell high are rewarded for their belief in their opinions whereas people buying high but selling low are punished for doubting the market’s prediction (Chen and Pennock, 2010).

Prediction markets differ from opinion polls where people state their preference for an outcome. They differ in that they allow participants to indicate their conviction in their decision. If they firmly believe in an outcome, they are willing to pay more for the contract. As a result, the information captured in the price more accurately reflects the information of the group of participants.

Many studies (Chen, Chu et al, 2005; Graefe, 2011) have shown that prediction markets are more accurate than other forecasting methods such as opinion polls or expert opinion. In fact, Surowiecki discusses the case of a political election prediction market called the IOWA Exchange Market (IEM) which he states that between 1988 and 2000, the election-eve prices on the IEM were accurate to within 1% to 4% of the actual result (Surowiecki, 2005). These results were more

accurate than any opinion poll. Given their accuracy and relative ease of implementation, it is not surprising that, in the last few years, there has been a lot of interest in the area as a corporate forecasting tool. Zitzewitz and Wolfers state that from 2006-2009, Google conducted the largest corporate experiment in prediction markets to predict everything from new markets to new product launches (Zitzewitz and Wolfers, 2009). Kamp & Koen state that prediction markets have outperformed official company sales forecasts within Hewlett Packard 6 out of 8 times (Kamp & Koen, 2009) while Pennock et al. state that the Hollywood Stock Exchange was more accurate than the predictions of five experts in the prediction of the 2000 Oscar winners (Pennock, et al., 2000).

In describing prediction markets, Luckner outlines some key features required for prediction markets to function well (Luckner, 2008). He states these as being

- Contracts

By contracts he means statements i.e. the statement of the contract should be clear and unambiguous. People buying the contract should know what exactly they are buying.

- Trading Mechanism

This is concerned with how buyers and sellers interact, the most common mechanism being the continuous double auction where every trade consists of a buyer who wants to buy and a seller who wants to sell at a certain price.

- Incentives

There should be an incentive to encourage people to take part in the prediction. Without incentives, there might only be a few participants in the market. Although having lots of participants is obviously of benefit, Kamp & Koen state that the literature seems divided about the impact of the number of participants (Kamp & Koen, 2009).

- Diversity of information

Prediction markets will only work if traders with relevant information take part in the market. However, he states that the traders don't need to be experts and diversity is important.

## 2.6 CONCLUSION

This chapter looked at current research and literature on the concepts behind the InvestClub application. It gave a general overview of social media or web2.0 and how companies that effectively use social media can benefit from many opportunities. One such opportunity is tapping the 'wisdom of the crowd' to make better decisions. This chapter discussed what the wisdom of crowds means, the conditions needed to harness the wisdom of crowds and why crowds can make better decisions than deliberating groups of people. The chapter also looked at the benefits of combining forecasts to make better predictions and it outlined some of the problems with group deliberation and information cascades and how they can lead to poor decisions being made. Finally the chapter concluded with a discussion on prediction markets and how they can be used effectively to harness the wisdom of the crowd.

At its core, InvestClub aims, using a social media platform, to create a service that allows investors make better decisions based on information elicited from the crowd. The literature review influenced the functionality of the application most obviously in its use of a prediction market mechanism as a method of eliciting information from the group to make better investment decisions. The 4 conditions required for groups to be wise also influenced the design of the application in the way that prediction voting is independent and anonymous; there is a central aggregation of the voting information and finally that the voting group is more informed through the use of StockTalks on relevant predictions. Additionally the literature on combining forecasts recommended using weighting based on expertise or track record for aggregating results. As a result, a weighting algorithm is used in the InvestClub prediction market framework to give those with a greater track record of accurate predictions a greater say in the outcome of a prediction.

### 3. RESEARCH BACKGROUND

#### 3.1 INTRODUCTION

This chapter discusses a number of innovative ways that the investment industry has incorporated social media into their current business models. It then focuses on the specific area of web based portfolio management applications and examines the features of a number of market leading systems. The analysis of these business models and portfolio management applications will allow a list of features and requirements that incorporate social media and portfolio management for the InvestClub to be compiled.

According to Salmon, for the 5 years up to 2008, approximately 75% of mutual funds underperformed the S&P 500 (Salmon, 2008). This is backed up by John Bogle, founder of the Vanguard Group (one of the largest investment management companies in the world) when he states most investors seem unaware that that mutual funds' average annual return from 1984 to 2002 was 9.3%, compared to 12.2% for the S&P 500 (Bogle, 2011). While some investors, such as Warren Buffet, consistently beat the market, Bogle's statement highlights that the vast majority of investment managers underperform when it comes to investing. When one takes into account the lack of transparency within the investment management industry and the high administration fees, it is obvious that it is an industry in need of some much needed change and innovation. To date, the internet has had a major impact on the airline, entertainment, advertising and many other industries however the investment industry has remained relatively untouched. With the public outraged at the recent financial and banking scandals and given the rise in popularity of social media, the time for redefining traditional investment industry business models may be here. Social media may do to the investment industry what the internet did to the music industry.

#### 3.2 INVESTING AND SOCIAL MEDIA: 6 BUSINESS MODELS

In his book "TradeStream Your Way to Profits: Building a Killer Portfolio in the Age of Social Media", Millar discusses how social media can be used to allow investors implement strategies that allow them beat the market. He describes eight different business models

and provides some examples of companies that are successfully using these models (Millar, 2010) Six of the most relevant models are

|                      |                        |
|----------------------|------------------------|
| Blog Bigwigs         | Rumour Mills           |
| Present Day Gurus    | Crowds                 |
| Undiscovered Experts | Co-Lateral information |

Table 3 1 Investing and Social Media 6 Business Models (Millar, 2010)

### 3 2 1 BLOG BIGWIGS

Using this model, users can benefit from the expert advice and analysis for free or very low cost through financial blogging websites. Financial bloggers are rivalling investment analysts and journalists in their ability to research, analyse and comment on a vast array of different stocks and industries. In fact the financial blogging world has an advantage in that they write about thousands of stocks/industries whereas the leading investment research house usually concentrate on a much smaller set of stocks/industries. Two websites that are disrupting the traditional investment analysis industry are

- Stocktwits - a Twitter based communications platform for the investment community to share investment ideas (<http://stocktwits.com>)
- Seeking Alpha – a leading website for stock market analysis and debate with contributions from over 5000 analysts (<http://seekingalpha.com/>)

In order to reassure users of the quality of the articles posted and that there is no conflict of interest, both websites have rigid editorial conditions and guidelines attached to everything published <sup>1</sup>

[1] <http://stocktwits.com/rules> and [http://seekingalpha.com/page/editorial\\_principles](http://seekingalpha.com/page/editorial_principles)

This model is very good for identifying new investment opportunities but, apart from the two websites mentioned above, there is a lack of transparency in the analysis as it may not be clear if the author is promoting a stock for his own benefit in the hope that his analysis drives up the price. However, with regards to the InvestClub application, this model is useful for identifying new investment opportunities as the application's target market, small private investors, would be unlikely to pay the high fees to access research from an investment research company. Therefore this model and the websites mentioned above would be useful when used in conjunction with InvestClub as a way of identifying new investment opportunities.

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### 3.2.2 PRESENT DAY GURUS

This model outlines how investors can use social media to follow the long-term investment strategies of successful investors such as Warren Buffet. Tighter regulation of the hedge fund industry has led to the requirement that portfolio managers are required to disclose large movements in their portfolio holdings. By copying these movements, investors are able to build portfolios that resemble leading hedge funds. Martin and Puthenpurackal found that, even after factoring in the time delay of these regulatory disclosures, if a person mimicked the investments from 1976 to 2006 they would have made significant returns. Not only has this strategy the benefit of mimicking a top investor like Buffet, but it's also allows one to track the investments of other leading investors (Martin and Puthenpurackal, 2005).

A website that uses this strategy is

Alphaclone – this is a portfolio management platform that allows investors to invest in stock strategies derived from the holdings of top managers at the time their stock movements are disclosed (<http://alphaclone.com/>)

Since tracking what the top investors are doing has a proven successful track record, this model would be of great benefit to InvestClub users. By following the disclosed stock movements in successful hedge funds, investors can very likely make a good return on their investment. If this became their investment strategy, they could also attract followers who

like the reduced risk of following a leading hedge fund's stock movements but who don't have the time or the skill to track those movements. The more followers attracted means the more commission income the lead portfolio manager earns from those followers.

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### 3.2.3 UNDISCOVERED EXPERTS

This model discusses how to find the next Warren Buffett! It describes how people currently manage virtual and real portfolios through open platforms often with brilliant performances. Through social media, these people are discussing their investment strategies and their analysis. By mimicking their investments, others can make significant profits also. Millar claims that these communities must meet three criteria to assess who the experts are. They must have

- Relatively open membership – this encourages the creation of a solid, engaged community
- A ranking system – this allows investors to decide who the best are performing portfolios based on whatever criteria they decide
- Transparency – investors are encouraged to blog and write about their investment strategies as well as engaging with fellow investors who may be tracking them

A good example of such a community is Covestor (<http://covestor.com/>). This site has over 150 professional and individual sector expert investment managers all investing their own money in their chosen portfolios using multiple investment strategies. An investor can track any of the portfolios on the website. Portfolios can be filtered and ranked by risk, region, industry etc. to identify suitable candidates to track. The portfolios are fully transparent with viewable track records. Finally, all their managers are encouraged to provide an active commentary about their strategy and analysis.

Another example of an expert community is the website SumZero (<http://www.sumzero.com>). This site requires its members to share certain pieces of information, such as an investment idea, in exchange for access to the opinions of the site's other members. The attraction for joining is that membership to this community is quite exclusive and so it is very good for building networks and for getting good feedback on investment ideas and analysis.



In both cases, these communities are good for sharing and evaluating ideas compared to sites like Yahoo! Finance which can be quite noisy in terms of people's comments. This sharing of ideas and strategies will be central to the InvestClub application. Investment managers will be given the ability to promote their strategies and their ideas to all those who are interested in following them.

The model is also beneficial in that it can give you access to very good investment managers who may be sharing their knowledge in a private capacity i.e. investing is their day job and their hobby. The ability to rank managers in terms of performance and track record is also a key benefit to this model and is something that the InvestClub application needs to have if people are to decide who to follow.

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### 3.2.4 RUMOUR MILLS

This model is about developing a strategy to find the relevant information inside rumours and news. Rumours on the internet are everywhere! Weiss says that investment professionals do watch message boards closely and profit from them. He believes that Internet message boards can make stock prices move higher or lower (Weiss, 2000).

Millar argues that there is an information cascade risk associated with rumours in that people may make decisions based on rumours that may be in conflict with their personal views (Millar, 2010). The power of 100 message posters all supporting a rumour may force the investor to ignore his personal information.

One example of a website using this strategy is WhisperNumber (<http://www.whispernumber.com/>). This website collects earnings expectations (whisper numbers) from the investment public anonymously in order to fill a void between what the company says and what the markets expect. According to their website, two academic studies have verified that their data is more accurate than analyst predictions.

Given the amount of activity on message boards and platforms like Twitter, this model is of limited benefit in making investment decisions as it is difficult to filter out the noise to

actually find the truth in a rumour. The previously mentioned model 'Blog Bigwigs' would be a better model to adopt as it filters out a lot of the noise and the investor has more confidence in the person creating the news due to the editorial criteria applied on reputable websites like SeekingAlpha.

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### 3.2.5 CROWDS

This model looks at how prediction markets and changes in sentiment can be used to tap the 'wisdom of crowds' to find the next good stock or industry to invest in. It also looks at how crowd collaboration can be used to uncover new investment ideas. As discussed in chapter 2, using prediction markets to harness the wisdom of the crowd could be very effective in determining what stocks to invest in.

One website using prediction markets to do this is Piqqem (<http://piqqem.com>). It asks users to predict how a stock's share price will perform in the next 90 days and how strongly they believe their prediction. By tracking this data over time, the website is able to provide key sentiment data, i.e. what the public thinks will happen, in the following areas:

- 1 Price Specific
- 2 Price Directional
- 3 Demographic
- 4 Relative (Stock vs Stock)
- 5 Time Based

This information is extremely useful to investors in determining their investment strategies.

Another excellent website is Wikinvest ([www.wikinvest.com](http://www.wikinvest.com)). This site operates like the well-known Wikipedia site in that people collaborate to build a wiki of knowledge and research on companies, concepts, commodities, funds & indices, global markets and financial education topics. For each company listed, the wiki provides information such as Business Overview, Trends & Forces, Competition, Related Wiki articles, Quotes and News.

Like the 'Undiscovered Experts' model discussed above, this model is central to the InvestClub. As the previous chapter discussed, tapping the wisdom of a crowd can lead to better decisions being made and using prediction markets is a good way of aggregating the wisdom within the crowd. InvestClub will be using a prediction market similar to Piqqem.com but it won't track sentiment the way that Piqqem.com does due to resource constraints. Tracking sentiment is very useful in assessing how the crowd's opinion of a stock changes over time and is something that future releases of InvestClub should consider. In addition, the collation of information on stocks and portfolios as the Wikinvest.com does would be another useful feature to add to the InvestClub application. Users could create a wiki for researching other stocks or even other portfolios and should be considered for future releases of InvestClub.

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### 3.2.6 CO-LATERAL INFORMATION

This model describes how relevant information on stocks may exist in unlikely sources. The customer product reviews on websites like Amazon or the 'Like' statistic on Facebook are useful for research to gauge the public's opinion on a company or product. Industry specific websites can also be useful in getting more informed opinions.

Another source of information on general trends is Google Domestic Trends ([http://www.google.com/finance/domestic\\_trends](http://www.google.com/finance/domestic_trends)) which shows Google search traffic across 27 specific sectors of the economy such as Cars, Air Travel, Luxury Goods, etc. Changes in the search volume for a sector can provide useful information for that sector. e.g. if a recession is ending, searches for mortgage information might rise. This can be an early indicator of a stock's future price movement.

While this model is very interesting in that it uses the crowd's opinions and search trends to seek new opportunities, the model is quite limited in that it is more useful for researching consumer companies rather than non-consumer companies e.g. biochemical companies. No one writes an Amazon review for a product used by the pharmaceutical industry and there would be limited Google searches for it. However, in the case of a company making a key ingredient for the leading diabetes medication, this model would not highlight that the company could be a major investment opportunity given the increase in diabetes in the world. This model therefore would be of limited use to the InvestClub application.

In addition to these six models, Tapscott & Williams propose a model of crowdsourced financial services regulation (Tapscott & Williams, 2010). Under this model, they suggest opening up financial models for scrutiny by the public at large. They argue that regulators are under staffed and lack the resources to effectively manage such a complex intertwined industry. With increased transparency and a platform to facilitate collaboration between regulatory bodies and a community of financial experts such as academics, retired analysts, etc., they argue that such a model would go a long way towards restoring the public's faith in the banking industry and keeping the complexity of the industry in check.

### 3.3 PORTFOLIO MANAGEMENT APPLICATIONS

There are many free portfolio management applications available online for businesses or individuals. Some are web based while some need to be downloaded and run from a user's desktop. They all differ in their functionality but most allow users to create portfolios, buy, sell stocks, monitor and chart performance, have almost real-time pricing, view relevant news and research for a stock, etc. However, compared to non-free systems, their functionality is limited. In particular, they may be missing functionality like real-time prices for stocks and indices, advanced screening and filtering, advanced reporting and rebalancing functionality. Since the InvestClub application is a free web-based application, the functionality of free web-based portfolio management applications has been analysed.

Five popular free web-based portfolio management applications are:

- MyPortfolios on Yahoo Finance (<http://finance.yahoo.com/>)
- Portfolio Monkey (<https://www.portfoliomonkey.com/>)
- Portfolios on Google finance (<http://www.google.com/finance>)
- Portfolio on Morningstar (<http://portfolio.morningstar.com>)
- Portfolio Manager on MSN ([http://moneycentral.msn.com/stock\\_portfolio](http://moneycentral.msn.com/stock_portfolio))

Listed below are the key features that all the applications share. Most of this functionality will be required for the InvestClub application to allow investors to manage their portfolios effectively.

| Feature              | Description   |
|----------------------|---|
| Create Portfolio     | Does the application allow the creation of personal portfolios?             |
| Buy/Sell Stock       | Does the application allow the purchase/sale of stocks?                     |
| Monitor Stock/Alerts | Does the application allow the monitoring of stocks or create price alerts? |

|   |  |
|---|--|
| Stock Performance                                 | Does the application allow the analysis of stock performance?  |
| Index comparison                                  | Does the application allow the comparison of the portfolio performance against benchmark indices e.g. ISEQ 20? |
| Portfolio comparison                              | Does the application allow the comparison of the portfolio performance against other portfolios?               |
| Stock Filtering                                   | Does the application allow filtering of stocks based on certain criteria e.g. P/E ratio?                       |
| Stock News  | Does the application display relevant news for individual stocks?  |
| Stock Social Media (Twitter, News websites, etc.) | Does the application display relevant social media for individual stocks?                                      |
| Charting  | Does the application provide charts?   |
| Real Time Prices                                  | Does the application use real-time pricing?  |
| Historical Analysis                               | Does the application have historical pricing?  |
| Blogging/Commentary                               | Does the application allow blogging/commentary to others?  |
| Tracking Other Portfolio                          | Does the application allow tracking of other portfolios?   |
| Research  | Does the application allow investors to research stocks?   |
| Recommendations                                   | Does the application provide stock recommendations?  |
| Multi Sign On Options                             | Does the application allow users to sign in using their Google/Facebook login?                                 |
| Unique Selling Point                              | What feature makes the application stand out from competitors?   |

Table 3.2 Portfolio Management Features Summary

| Feature  | Yahoo Finance | Portfolio Monkey | Google Finance | Morningstar | MSN |
|--|---------------|------------------|----------------|-------------|-----|
| Create Portfolio                                     | Y             | Y                | Y              | Y           | Y   |
| Buy/Sell Stock                                       | Y             | Y                | Y              | Y           | Y   |
| Monitor Stock/Alerts                                 | Y             | Y                | Y              | Y           | N   |
| Stock Performance                                    | Y             | Y                | Y              | Y           | Y   |
| Index comparison                                     | Y             | Y                | Y              | Y           | N   |
| Portfolio comparison                                 | Y             | Y                | N              | N           | N   |
| Stock Filtering                                      | N             | N                | Y              | Y           | N   |
| Stock News   | Y             | Y                | Y              | Y           | Y   |
| Stock Social Media<br>(Twitter, News websites, etc.) | Y             | N                | N              | N           | N   |
| Charting   | Y             | Y                | Y              | Y           | Y   |
| Real Time Prices                                     | Y             | N                | N              | N           | N   |
| Historical Analysis                                  | Y             | N                | Y              | Y           | Y   |
| Blogging/Commentary                                  | Y             | N                | N              | Y           | N   |

|                       |                                  |                 |                 |                          |                     |
|-----------------------|----------------------------------|-----------------|-----------------|--------------------------|---------------------|
| Track Portfolios      | N                                | Y               | N               | N                        | N                   |
| Research              | Y                                | Y               | Y               | Y                        | N                   |
| Recommendations       | N                                | Y               | N               | Y                        | N                   |
| Multi Sign On Options | Y                                | N               | N               | N                        | N                   |
| Unique Selling point  | Comprehensiveness of information | Recommendations | Stock Screening | Portfolio Analysis Tools | Nice User Interface |

Table 3.3 Portfolio Management Tools Comparison

### 3.4 CONCLUSION

This chapter looked at how the investment industry has incorporated social media into their current business models. It looked at a number of business models and determined that the most useful models were tracking the disclosed movements of successful hedge funds; mimicking investment managers who share their investments strategies on real or virtual trading platforms and finally using the crowd to help make better decisions through the use of prediction markets and wikis. The chapter then did a feature comparison between 5 leading portfolio management applications looking at what the key functionality that these applications implement and what each of the unique selling points are. The analysis of these business models and portfolio management applications will allow a list of features and requirements that incorporate social media and portfolio management for the InvestClub to be compiled.



## 4. ARCHITECTURE AND IMPLEMENTATION

This chapter outlines the criteria used to determine how the InvestClub requirements were drawn up and describes in detail what the set of requirements are. It then discusses the architecture and technology that the application uses. Finally, it describes how the requirements were tested and implemented and discusses some of the decisions behind the implementation.

### 4.1 DETERMINING REQUIREMENTS

Chapter 3 discussed some different investment industry business models that currently use social media and looked at some websites that implement those business models. In addition, the functionality of various web-based portfolio management applications was outlined. Based on this research a set of features and functionality was drawn up and assessed for inclusion in the InvestClub application. Each feature is assessed for inclusion using the following criteria:

Development Time: As measured in days

Requirement Level: 1 => Required

2 => Important to have

3 => Nice to have.

Innovativeness => 1 => 0 to 2 websites has the feature

2 => 3 or 4 websites have the feature

3 => More than 4 websites have the feature

In terms of determining the requirements for InvestClub

- All Requirement Level 1 functionality was implemented.
- For Requirement Level 2 functionality, the innovativeness score and the Development Time was assessed to determine if the feature was included. An innovativeness score of

1 or 2 was deemed a requirement if the Development Time was less than 5 days. Greater than 5 days or an innovativeness score of 3 meant that the functionality would be deferred to be included in future releases of the application.

- No Requirement Level 3 functionality was included in the requirements for InvestClub but they could be included in future releases.

This full set of features and their assessment markings is listed in Appendix 1.

## 4.2 APPLICATION SCOPE

Given the complex legal requirements surrounding the management of investment portfolios and issues with having real time pricing and execution of trades, it was decided to develop InvestClub as a virtual portfolio management game with each person being allocated €100,000 upon registration. This allowed the scope of the application to be set so the use of social media within the application could be assessed.

## 4.3 REQUIREMENTS ANALYSIS

After ordering the list of features to implement, the following requirements were defined for each feature:

### 4.3.1 MIMIC PORTFOLIOS - FOLLOW PORTFOLIO

- Any portfolio should be able to view and follow any other portfolio in the system apart from their own portfolio.
- The maximum amount that can be invested in the lead portfolio is equal to their current euro balance minus the relevant commission fee.
- Upon following a portfolio, the same instruments with the same weighting as the lead portfolio are purchased
- Upon following a portfolio, the Euro position of the follower portfolio is updated with the amount invested.
- Shares will be rounded down where the number of share to be bought is not even. This would ensure that there are sufficient funds available to complete the order.
- On the MyPortfolio screen, the follower portfolio should be able to
  - View a Summary of Lead Portfolio's current performance
  - View a Summary of Lead Portfolio's predictions
  - View a Summary of Lead Portfolio's StockTalks
  - Unfollow a Lead Portfolio's
  - Follow a Lead Portfolio's i.e. invest more in the portfolio
  - Vote on the Lead Portfolio's Predictions
  - Vote on the Lead Portfolio's StockTalks

### 4.3.2 MIMIC PORTFOLIOS - FOLLOW SECOND PORTFOLIO

- Even if a portfolio is tracking another portfolio, they should be able to view and follow any other portfolio in the system apart from their own portfolio if they have funds available. Following a second portfolio should not affect their holding in other tracked portfolios.

- Following a second portfolio has the same requirements as the “Follow Portfolio” Feature above

---

#### 4 3 3 MIMIC PORTFOLIOS - UNFOLLOW PORTFOLIO

- Portfolios should be able to unfollow any portfolio that they currently follow
- Portfolios should not be able to unfollow any portfolio that they currently don't follow
- The maximum amount that can be unfollowed in the lead portfolio is equal to their current value of the holding in that Lead Portfolio
- Upon unfollowing a portfolio, all the instruments being tracked are sold
- Upon unfollowing a portfolio, the Euro position of the follower portfolio is updated with proceeds from the sale of the instruments minus the relevant commission
- On the MyPortfolio screen, if there is still a holding in the Lead Portfolio, the follower portfolio should be able to
  - View a Summary of Lead Portfolio's current performance
  - View a Summary of Lead Portfolio's predictions
  - View a Summary of Lead Portfolio's StockTalks
  - Unfollow a Lead Portfolio's
  - Follow a Lead Portfolio's i.e. invest more in the portfolio
  - Vote on the Lead Portfolio's Predictions
  - Vote on the Lead Portfolio's StockTalks
- If there is still no holding remaining in the Lead Portfolio, the follower portfolio will not have any of these options available

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#### 4 3 4 UNFOLLOW SECOND PORTFOLIO

- Even if a portfolio is tracking another portfolio, they should be able to view and unfollow any portfolio that they currently follow with affecting the holdings in their other tracked portfolios
- Unfollowing a second portfolio has the same requirements as the “Unfollow Portfolio” Feature above

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#### 4 3 5 BUY/SELL STOCK – LEAD PORTFOLIO

- The features are the same as those for the Buy/Sell Stock feature
- For follower portfolios, the Buy/Sell triggers a rebalance of their portfolio
- For follower portfolios, the amount of their portfolio that is tracking the lead portfolio is rebalanced so that the weighting of each stock in the lead portfolio is the same as that in the follower portfolio. This means that the purchase/sale of a stock in the lead portfolio will be reflected in the follower portfolio
- During the rebalance, for a purchase transaction shares will be rounded down where the number of shares to be bought is not even. This would ensure that there are sufficient funds available to complete the order
- Due to rounding in rebalancing transactions, follower portfolios instrument weighting may not match exactly those of the lead portfolio

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#### 4 3 6 BUY/SELL – STOCK (ALREADY OWNED THROUGH LEAD PORTFOLIO)

- The features are the same as those for the Buy/Sell Stock feature
- The commission fees will be less as it is executed through an individual trade rather than as a result of a transaction
- The stock will appear separately in the holdings list to identify it as one that is not held as a result of following another portfolio
- The stock can be sold without affecting the holding associated with the lead portfolio
- The stock in the lead portfolio can only be sold by either unfollowing the lead portfolio or if the lead portfolio decided to sell the stock

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#### 4 3 7 BUY STOCK

- Any portfolio should be able to view and buy any stock in the system
- The maximum amount that can be invested in the stock is equal to their current euro balance minus the relevant commission fee
- Upon purchasing a stock, a trade to buy the stock is created and the Euro position is updated with the amount invested
- Shares will be rounded down where the number of shares to be bought is not even This would ensure that there are sufficient funds available to complete the order
- On the MyPortfolio screen, the portfolio should be able to
  - View a Summary of Portfolio's current performance including the new holding
  - View a Summary the purchase transaction
- The business rules applied are
  - You cannot purchase more that you have available in Cash (minus the commission)
  - You cannot purchase a negative amount of shares

---

#### 4 3 8 SELL STOCK

- Any portfolio should be able to view and sell any stock that they currently own apart from those that they own as a result of following a lead portfolio
- The maximum amount of stock that can be sold is equal to their current holding value minus the relevant commission fee
- Upon selling a stock, a trade to sell the stock is created and the Euro position is updated with the amount invested
- On the MyPortfolio screen, the portfolio should be able to
  - View a Summary of Portfolio's current performance excluding the holding that was sold
  - View a Summary the sale transaction
- The business rules applied are
  - You cannot sell more than you own
  - You cannot sell a negative amount of shares

---

#### 4 3 9 PREDICTION RESULTS

- On the Prediction screen in the My Portfolio section there should be three views available
  - Current Open Predictions
  - Previous Predictions that need a result update
  - Previous Predictions
- When a prediction is created, the prediction name & expiry date is mandatory
- The prediction result can only be updated on expired predictions
- Upon updating the prediction result, each portfolio that voted in the prediction gets their perception score updated. The perception score is the sum of all the voting points that the portfolio has participated in
- The scoring mechanism is points based with scored as follows
  - Correct answer      10 points
  - 1 answer out        3 points
  - 2 answers out       0 points
  - 4 answers out       -3 points
- Each vote is updated with the relevant points
- The weighted result of each prediction uses the formula  
$$\text{Average of all (prediction vote * confidence * portfolio perception score / total number of votes)}$$
- Portfolio must have participated in more than 2 votes to be included in overall figures
- A detailed vote is available for each prediction showing the final result, average confidence number of votes cast per outcome

---

#### 4 3 10 VOTING

- If a user is following a portfolio, they should be able to vote on any predictions for that portfolio
- If a user is following a portfolio, they should be able to view any previous votes that they made

- If a user is following a portfolio, they should be able to amend any votes that they made where the vote has not yet expired
- Users are only allowed create one vote per prediction although they can amend that vote up till the prediction expires
- When creating a vote, the confidence and vote result fields are mandatory

---

#### 4 3 11 CREATE PORTFOLIO

- When a user registers as a new portfolio they will need to input the following information
  - Name
  - Description
  - Portfolio profile
  - *Portfolio manager profile*
- When a portfolio is created, a €100,000 Euro trade is created by default This represents the portfolio's opening balance

---

#### 4 3 12 SECURITY

- The application should force login for the following
  - Buy/Sell instruments
  - Follow/Unfollow portfolio
  - My Portfolio Views
  - View details of current portfolios
  - Create a prediction
  - Vote on a prediction
  - Create a StockTalk
  - Comment on a StockTalk
- Without logging in, the following items should be free to view
  - Instrument Views
  - Portfolio views

---

#### 4 3 13 INSTRUMENT MENU



- There will be different views available under the portfolio details menu option including
  - Best performing – this view will rank, from best to worst, the performances of the instruments over the last month
  - Price change – this view will rank, from best to worst, the performances of the instruments over the last day
  - Most Popular – this view will rank, from best to worst, the most popular instruments held by all portfolios

---

#### 4 3 14 PORTFOLIO MENU

- There will be different views available under the portfolio details menu option including
  - Best performing – this view will rank, from best to worst, the performances of the portfolios over the last month
  - Price change – this view will rank, from best to worst, the performances of the portfolios over the last day

---

#### 4 3 15 MY PORTFOLIO MENU

- There will be different views available under the portfolio details menu option including
  - Current Holdings – this view will all the current instrument holdings in the portfolio, the current price and the change in price since the previous day
  - Transactions – this view shows all the transactions that have taken place since the portfolio's inception
  - Predictions – this view shows all the predictions that the portfolio has created
  - Stock Talks – this view shows all the Stock Talks that the portfolio has created
  - Following Portfolios – this view shows all portfolios that the investor is tracking
  - Follower Portfolios – this view shows all the portfolios that are tracking the investor

---

#### 4 3 16 VIEW INSTRUMENT DETAIL

- The system will allow users to view details of any Instrument
- The Instrument detail will include a
  - Chart of the previous months performance
  - Details of the instruments current price
  - Feeds to Twitter, Reuters and Yahoo finance
  - An option to Buy/Sell the instrument
- When the user clicks Buy/Sell they will be brought to the Buy/Sell Instrument screen

---

#### 4 3 17 VIEW PORTFOLIO DETAIL

- The system will allow users to view details of any Portfolio
- The Portfolio detail will include a
  - Chart of the previous months performance
  - Details of the portfolio's risk profile
  - Current Value of the Portfolio
  - Number of instruments within the portfolio
  - Number of predictions that the portfolio has created
  - Information about the portfolio manager
  - An option to follow/unfollow the portfolio
- When the user clicks Follow/Unfollow they will be brought to the Follow/Unfollow portfolio screen

---

#### 4 3 18 STOCK TALK

- The system will allow portfolios managers create discussion threads, called StockTalks
- Each StockTalk should have a title, an instrument, a portfolio ID and optionally a description
- Portfolio Managers must be able to view a summary table of all StockTalks opened by them  
The list should be ordered with the most recent appearing first
- The total of all comments for each Stocktalk should be displayed in the summary grid

- Updating or Deleting StockTalks is restricted to the Stocktalk's owner
- Portfolio Managers must be able to comment on all StockTalks that they own
- Title and Instrument are mandatory fields

---

#### 4 3 19 COMMENTS

- The system will allow portfolios managers create comments on StockTalks that they own
- The system will allow portfolios managers create comments on StockTalks that belong to portfolios that they are following
- Each StockTalk should have a comment date, a portfolio ID and a StockTalk Id
- Portfolio Managers must be able to view a summary table of all comments on a StockTalk that's visible to them The list should be ordered with the most recent appearing first
- The total of all comments for each Stocktalk should be displayed in the summary grid
- Updating or Deleting Comments should be restricted to the Comment's owner
- Comment Text is a mandatory field

---

#### 4 3 20 PREDICTIONS

- The system will allow portfolios managers create a Prediction with an instrument, a description and an expiry date
- Three summary tables of predictions should be displayed
  - Predictions that have not expired
  - Predictions that have expired and need the Prediction owned to enter a result
  - Predictions that have expired and have been updated with a result
- Each summary table should show the number of votes cast and the latest aggregated prediction result

## 4 4 ARCHITECTURAL DECISIONS

The architecture behind the InvestClub application is based on two patterns N-tier and Model-View-Controller (MVC)

### 4 4 1 N-TIER ARCHITECTURE

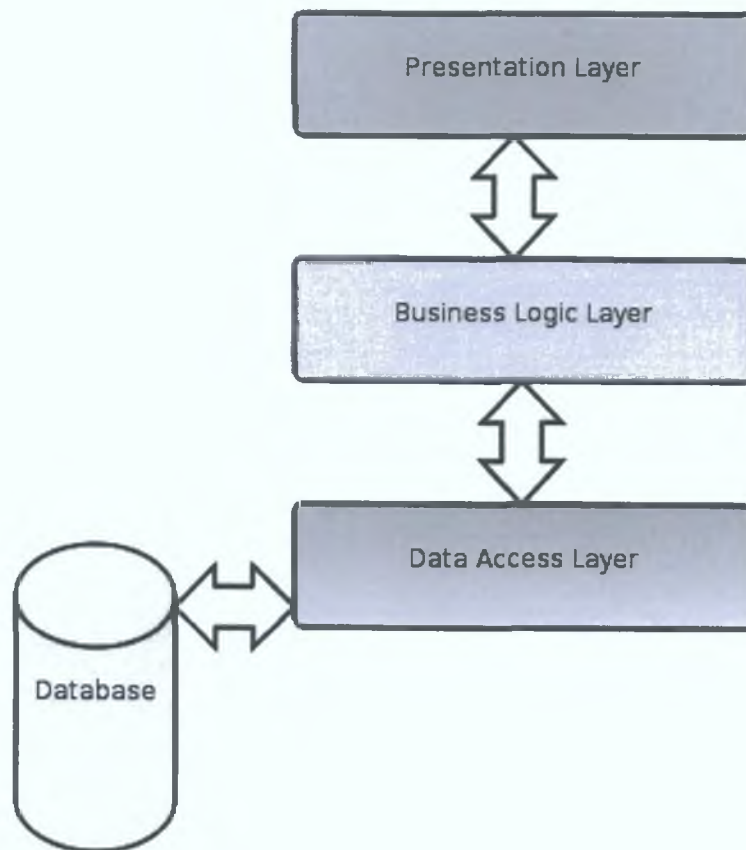
An N-tier application uses client-server architecture and is concerned with keeping the presentation, application/business logic and data management in separate logical layers. It consists of

- A Presentation Layer, the topmost layer, which displays information to the user
- A Data Layer, which stores and retrieves the system's data by executing Create, Retrieve, Update and Delete (CRUD) operations
- A Business Logic Layer, the middle layer, controls the systems functionalities, serving as the bridge between the two other layers

The benefits of N-tier application architecture include

- Allows for the development of flexible and reusable applications
- Creates independence between layers and avoids the mixing functionality between different layers
- Allows for the encapsulation of implementation details for each layer
- Allows different teams to work independently on different aspects of an application development
- Allows for new layers to be added or removed without affecting the entire application, assuming the layers have been implemented correctly

As an example, an application may have a presentation layer that displays information to the user via a web browser and receives information from the business layer. For a new mobile application, a new separate presentation layer could be created to take input from the same business layer without affecting the existing presentation layer. In addition the implementation process for the mobile presentation layer could be completely different from that of the web browser



presentation layer.

Figure 4.1: N-tier architecture

InvestClub is split into 4 layers:

- Presentation Layer
- Business Layer
- Data Access Layer
- Infrastructure Layer

## Presentation Layer

This is the topmost layer of the application. It displays information to users via HTML views. It also receives requests from the browser and determines what action to take on the business layer by calling services. It receives information back from the services (Business layer) in the form of models which it then passes to the HTML template.

The Presentation Layer uses the MVC design pattern to interact between the user interface and the business layer. MVC is discussed in section 4.4.2.

## Business Layer

All the InvestClub domain entities were implemented as services that are accessed from the presentation layer. This is where all the validation and business rules logic resides. Once a service has completed all its validation and checks, the relevant data is packaged into associated view models. These models use data annotations to apply attribute validation on the properties as well as entire objects.

Validation was implemented in the Business layer within the view models. Attaching the validation to the models ensured that when passing the model back down to the presentation layer, a simple check on the model state could be done to determine if the validation passed. This approach kept the controllers in the presentation layer very light.

To implement the validation in the models, the following built-in data annotations for simple validation were used:

- `StringLengthAttribute`
- `RangeAttribute`
- `RequiredAttribute`
- `RegularExpressionAttribute`

In terms of client-side validation, two JavaScript files (`MicrosoftMvcValidation.js` and `MicrosoftMvcAjax.js`) load at runtime and auto-generate JavaScript validation based on the data annotation validation declared in the models.

## Data Access Layer

The Data Access Layer, or DAL, in the InvestClub application contains the database, the ORM entities and custom repository objects. It deals entirely with CRUD requests from the Business layer. The Presentation and Common layers have no knowledge of it.

Repository classes were used to handle all data access to the database. Each repository class contains CRUD (Create, Read, Update, Delete) methods to run against the ORM tool used. Each repository class uses a dependency injection pattern in order to make unit testing of the business layer faster and more complete.

Request (passing down) and Response (passing back up) DTOs were used between all the layers. A DTO is a design pattern used to transfer data between different layers of an application. The difference between them and other objects is that they do not have any behaviour associated with them, they just contain getters and setters for their own data. Due to their lack of behaviour, they are very lightweight and therefore efficient when passing data between layers. Additionally, they ensure that only data you want entering your data layer (database) will get in and they reduce the overhead of having additional unwanted data be passed between layers.

### Infrastructure Layer

The infrastructure layer contains functionality that is used by all layers of the application. Logging is used in the application for debugging and error handling purposes across all the layers. For InvestClub, the Log4Net logging framework was used as it is very configurable, being able to write to log files and database tables by just amending the configuration file. The infrastructure layer is referenced by all the other layers and calls to the logging functionality are made through an interface. Using an interface means that the logging tool can be changed if needed as long as the new logging tool implements the same interface.

---

## 4.4.2 DEPENDENCY INJECTION AND INVERSION OF CONTROL

The dependency injection pattern is used in all the classes in InvestClub. Using dependency injection means all the high-level classes have no dependencies on lower-level classes, e.g. the business layer has no dependency on the data access layer. Dependency injection is implemented by abstracting the functionality and properties of a class to an interface. By creating an interface of a low-level class, it can then be injected into a high-level class that depends on it. Injection can happen in the constructor of the class or in specific getter/setter methods.

The advantages of using dependency injection are:

- Low-level objects can be replaced by different objects without breaking the application once they implement the interface that the high-level objects are expecting. This means we could replace one logger with another without having to amend dependant objects.
- It makes systems very testable since the dependencies on lower objects can be replaced by mock/fake implementations (e.g. using Rhino Mocks) meaning that unit testing can focus on the object being tested and any errors raised are as a result of a bug in that particular object and not in a lower-level dependency.

The responsibility for managing dependency injection by creating concrete classes is often handled by an Inversion of Control container. The advantage of using an IOC container is the classes in the a system are much cleaner as they don't have to create their dependencies themselves but rather that get their dependencies passed in through their constructors (using dependency injection) courtesy of the IOC container. Implementations of classes can also be easily changed through a configuration file. There are a number of IOC frameworks available all of which have similar functionality. For InvestClub, the Unity framework from Microsoft was used as there is good support documentation available and because of its compatibility with the applications technology stack.

---

#### 4.4.3 MVC

Model-View-Controller is an architectural pattern that separates 'Domain logic' from the 'User interface'. This separation of concerns allows for separate development and testing of each section. A widely used application of the MVC pattern is in web applications, where the view consists of HTML, the controller receives get/posts and the model performs business rules logic and sends output back to the view via some form of template engine.

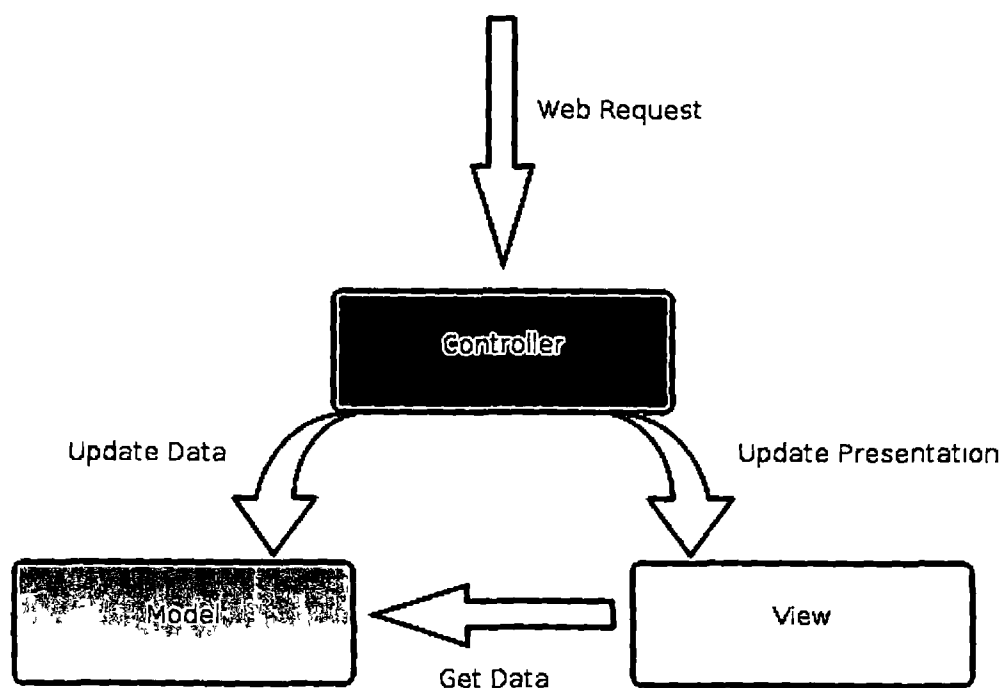




Figure 4 2 MVC architecture model

### Model

This area deals with all the business rules and logic of the application, in other words it manages all the behaviour and data of the application. It interacts with both the View and Controller. It generally responds to requests from the view about its current state, and responds to requests from the controller to change state.

### View

The view will generally render the model into a user interface. It is what is presented to the user. There could be multiple views displayed to the user depending on the outcome/state of the model.

### Controller

The controller receives requests (typically from the view) and determines where to send the request, i.e. what section of the model to send it to. The model would typically perform some actions and return the response to the controller which will then decide what view to send the information to.

The InvestClub application uses the Microsoft .Net MVC framework. The framework comes with a lot of built-in functionality such as Html helpers that allow for the easy management of model states. In addition it provides the ability to auto generate the skeleton of CRUD based controllers and associated views allowing for rapid development of prototypes.

---

### 4 4 4 REST

The application is designed in a way that it adheres to the RESTful architectural style. REST or Representational State Transfer was defined by Roy Fielding in his doctoral dissertation "Architectural Styles and the Design of Network-based Software Architectures" in 2000 (Fielding, 2000). REST defines a set of architectural principles by which web services are designed. There are 4 basic principles:

- All communication uses the standard HTTP methods i.e. POST, GET, PUT and DELETE

- Communication is stateless. This facilitates scalability.
- URLs should be intuitive and based on rules e.g. [www.investclub.com/instrument/id](http://www.investclub.com/instrument/id)
- Transfer data using standard formats e.g. XML, JSON or text.

Using a RESTful architectural style means that complex applications can be broken down into much simpler resources and it's easier to extend the application without breaking existing functionality. The statelessness of the communication also has a performance boost as web service requested can be cached.

## 4.4 TECHNOLOGICAL DECISIONS

### 4.4.1 BASE TECHNOLOGIES

The Business and Database tiers of the application were build using C# and for the web based front end, a mixture of JQuery, Ajax , ASP.NET, XHTML and C# was used. The technologies were chosen for the following reasons:

- C# & ASP.Net were chosen because of the author's familiarity with the languages and their widespread use for building enterprise applications.
- JQuery & AJAX were chosen for elements of the presentation layer due to their widespread popularity for building Rich Internet Applications and because they are supported by the Visual Studio development platform. These technologies allow for a much better user experience by using such features as modal screens and seamless rendering of data i.e. no server postbacks.
- Both languages are well documented and supported.

The application was built as a standard web application rather than a cloud based application because of hardware and software constraints on the developer's laptop. Initial investigations into developing the application to be hosted on the Windows Azure cloud platform showed that it needs IIS (Internet Information Services) to be installed locally. It was not possible to install IIS on the developer's machine due to operating system (Windows XP) incompatibility. However the n-

tiered nature of the application means that migrating the application to the Azure platform would be a relatively straightforward task

---

#### 4.4.2 DATABASE TECHNOLOGIES

The database server chosen was Microsoft SQL Server 2008 due to its easy integration with Visual Studio, developer familiarity, ease of use and performance. To overcome object-relational impedance mismatch an object relational mapper was used. Object-relational impedance mismatch occurs when entities in a relational database are mapped to their equivalent domain objects. The impedance mismatch occurs for a number of reasons:

- Objects in the domain do not map directly to database entities e.g. the Transactions table in the database might be represented as 2 separate classes in the domain
- Datatypes might differ between the two systems e.g. char versus string

In addition, data retrieved from the database can be converted directly to domain objects without having to parse a dataset. Other advantages of ORMs are that they can cut down on development time since database procedures do not need to be written and code for creating traditional SQL command objects is now done automatically by the ORM. Most ORMs have similar functionality so for InvestClub, the Microsoft developed EntityMap framework was used because of its compatibility with SQL Server and Visual Studio.

To filter the data in the database, LINQ was used. LINQ (Language Integrated Query) is a Microsoft .NET library that allows queries to be built and executed in the C# code rather than on the database. It has the advantage of making code more testable since all code resides within the application rather than having some code on SQL Server. While using LINQ was beneficial for most queries, once the queries became more complicated with multiple joins or grouping, the performance became much slower. The most likely reason for the performance degradation is that, when using LINQ, the queries need to be compiled on SQL Server before executing. As a result, LINQ was not used for complicated queries and precompiled views of database tables were used instead. LINQ is then used to retrieve results from the database views without any impact on performance.

---

#### 4.4.3 DEVELOPMENT PLATFORM

The whole application was developed using Visual Studio 2010. This is the most popular platform on which to develop C# based applications and comes with good debugging tools, intellisense, documentation, AJAX support, a built in web server and lots of other useful features.

---

#### 4 4 4 CSS THEME

As the author is not skilled in GUI design, a design template from the website [www.themeforrest.net](http://www.themeforrest.net) was used to give the application a modern look and feel. The theme chosen also came with some useful built-in features such as modal windows and a grid that could be dynamically filtered.

## 4.5 PROTOTYPE

Using the above technologies and frameworks, a prototype portfolio management application was built that implemented all the requirements discussed above. Below are screenshots of some of the key features of the InvestClub application.

### 4.5.1 HOME SCREEN

Figure 4.3 shows the homepage screen when a user launches the website. All the main parts of the application are navigated to through the dropdown menu at the top of the screen. Login functionality appears on the top right corner. Some investing-related information is available through links at the bottom of the page.



Figure 4.3 Home Screen

## 4.5.2 MYPORFOLIO SCREEN

Figure 4.4 shows the MyPortfolio screen which is displayed by default when the user logs in. The top of the screen shows the users current investment and cash value. The main part of the screen displays a table of their current holdings and a list of functionality relevant to their portfolio. Clicking any of these functions uses AJAX to render a new partial view to the grid.

The screenshot shows a web browser window with the URL localhost:2961/MyPortfolio. The page has a dark header with a 'Menu' dropdown and 'Login' and 'New User' links. Below the header, the 'My Portfolio' section displays three metrics: Portfolio Name (LeadPF), Portfolio Value (€99990.00), and Cash Balance (€99600.00). A sidebar on the left contains a list of navigation options: My Portfolio (selected), Transaction History, Predictions, Voting, Stock Talk, Following, and Followers. The main content area is titled 'All Instruments' and features a search bar and a 'Show 10 entries' dropdown. Below this is a table with the following data:

| Stock Name                           | Sector                             | Current Value | Shares Held | Action                    |
|--------------------------------------|------------------------------------|---------------|-------------|---------------------------|
| KINGSPAN GROUP PLC - Ordinary Shares | Construction & Property Investment | 390.00        | 50          | Buy Sell More Information |

At the bottom of the table, it says 'Showing 1 to 1 of 1 entries' and includes navigation buttons: First, Previous, Next, and Last.

Figure 4.4: MyPortfolio Screen

### 4.5.3 PREDICTIONS

Figures 4.5, 4.6 and 4.7 show functionality related to Predictions. Clicking the Predictions button renders a view that shows 3 tables of predictions. There is also an option to create a new prediction. Viewing prediction results gives a detailed breakdown of the vote on each prediction outcome. The 3 tables of predictions are:

- Predictions that the users created and are still open.
- Predictions that the users created and have expired but need to have the final result updated. Updating the result forces the system to update the perceptiveness score of all those who voted in the prediction.
- Predictions that the users created and have expired and no further action is required.

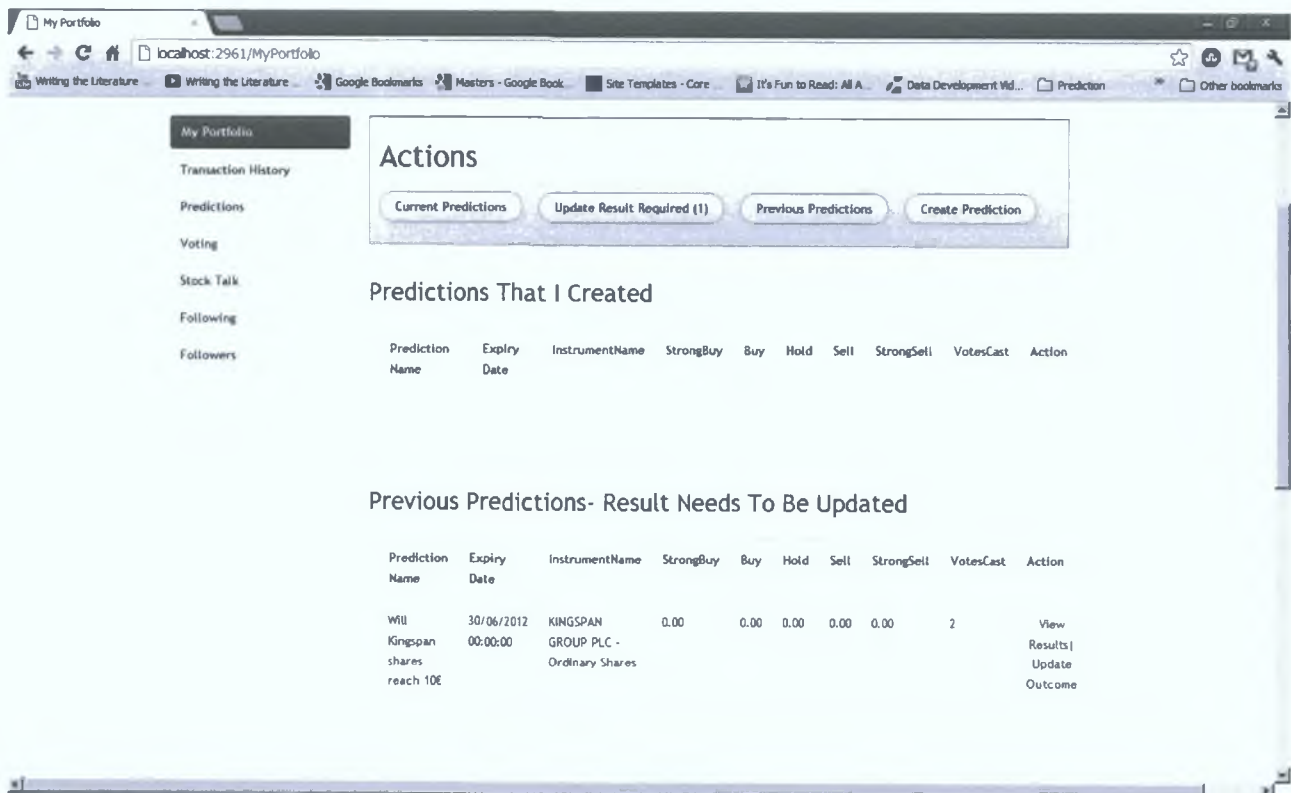


Figure 4.5: Prediction Screen View

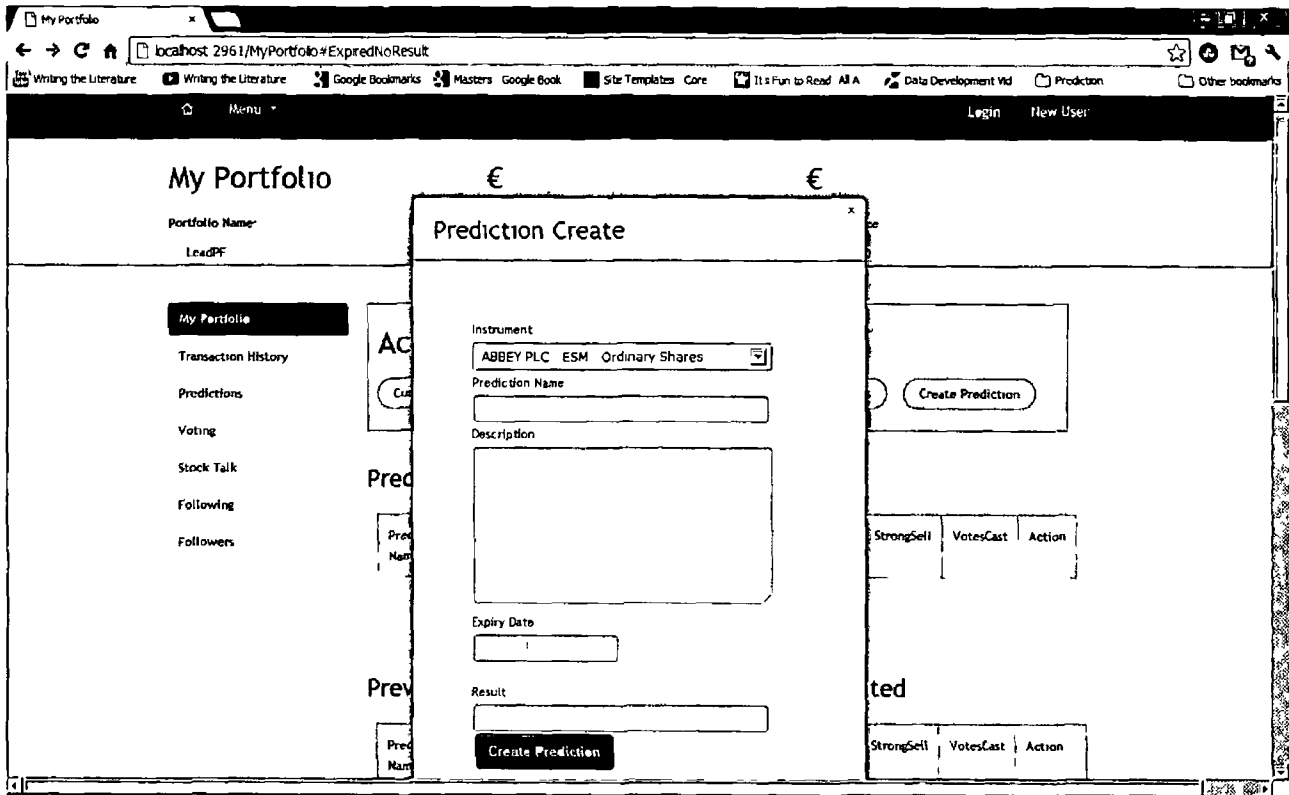


Figure 4 6 Prediction Screen Create



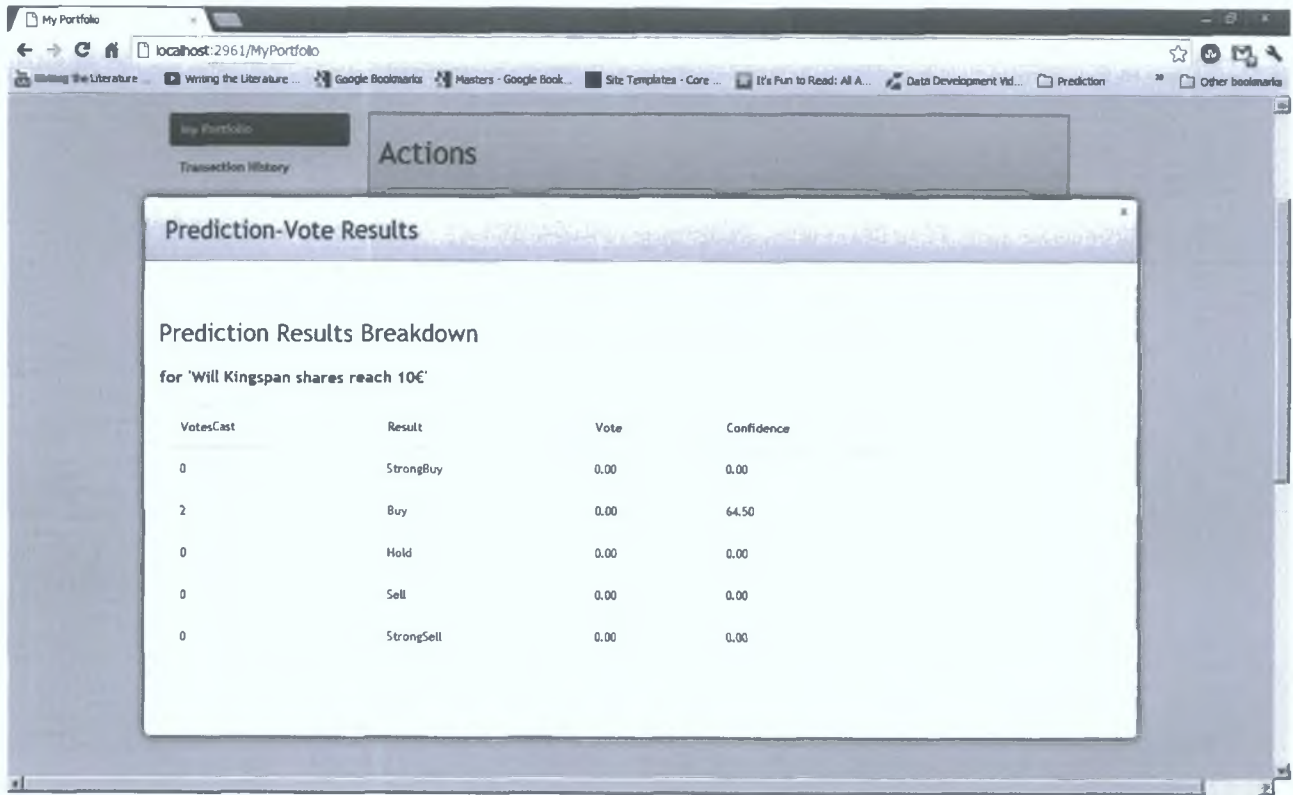


Figure 4 7: Prediction Screen Results

## 4 5 4 VOTING

Figure 4 8 shows functionality related to Voting When a user decides to vote on a prediction, a modal screen is displayed asking for their vote and, using the slider control, how confident they are in their vote The results of this vote are then aggregated and displayed back to the person who created the prediction

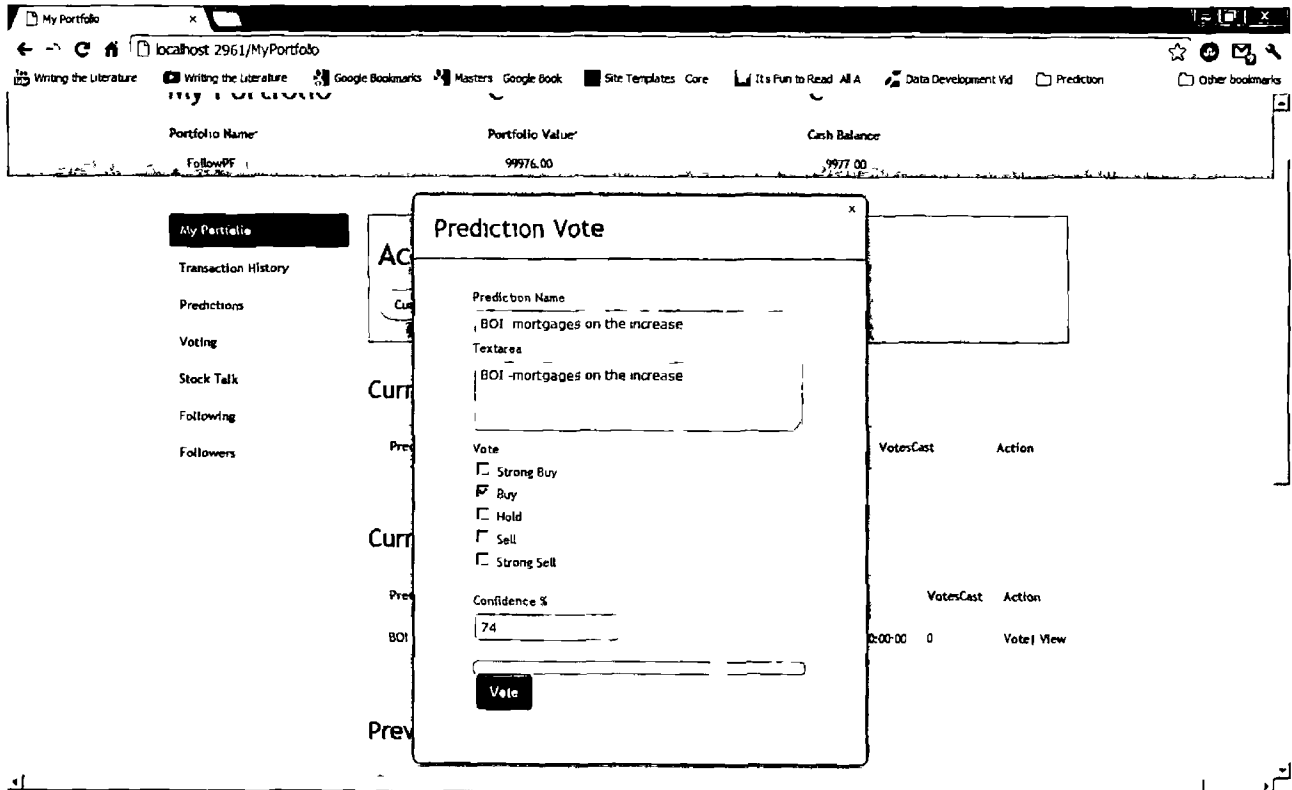


Figure 4 8 Voting Screen

#### 4.5.5 STOCKTALKS

Figures 4.9 and 4.10 show functionality related to Stocktalks. Clicking the Stocktalks button renders a view that shows a table of Stocktalks created by the user. There is also an option to create a new Stocktalk. Figure 4.10 shows how the use of a modal screen creates a better user experience.

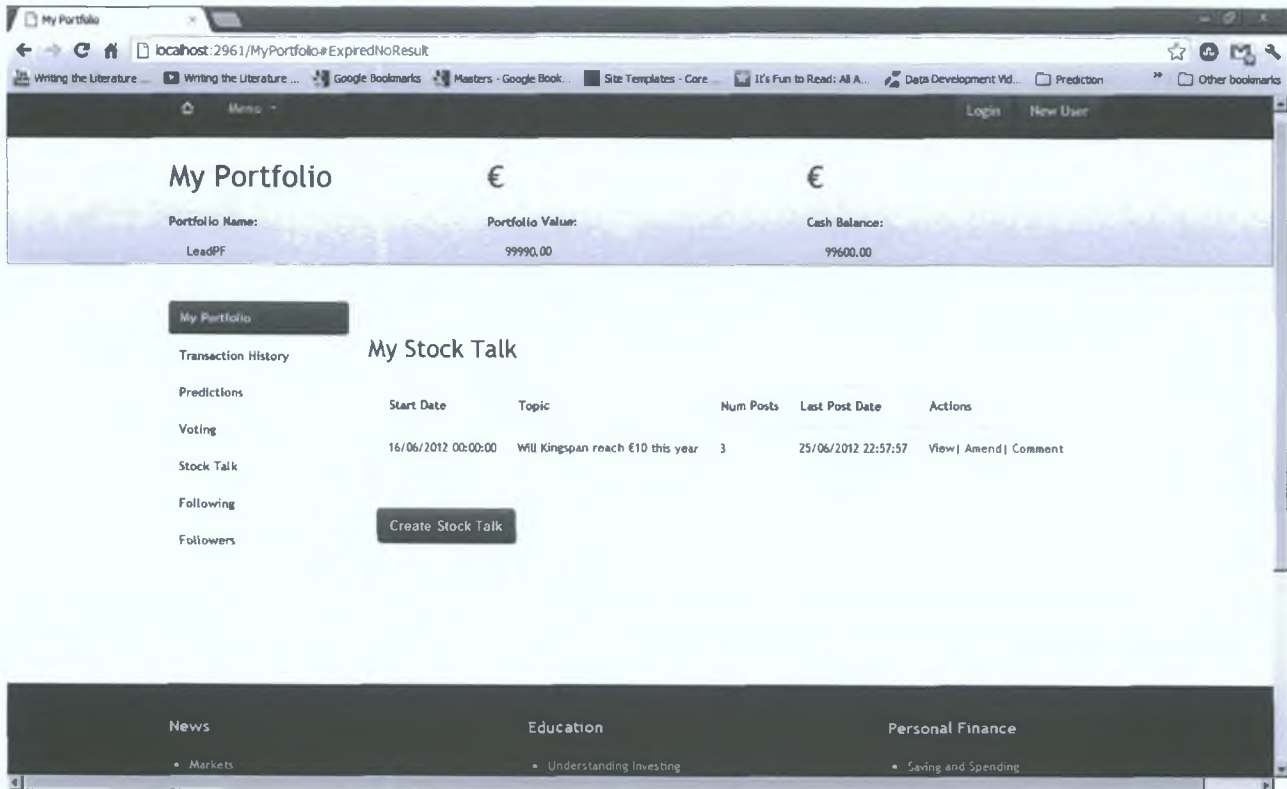


Figure 4.9: StalkTalk Screen

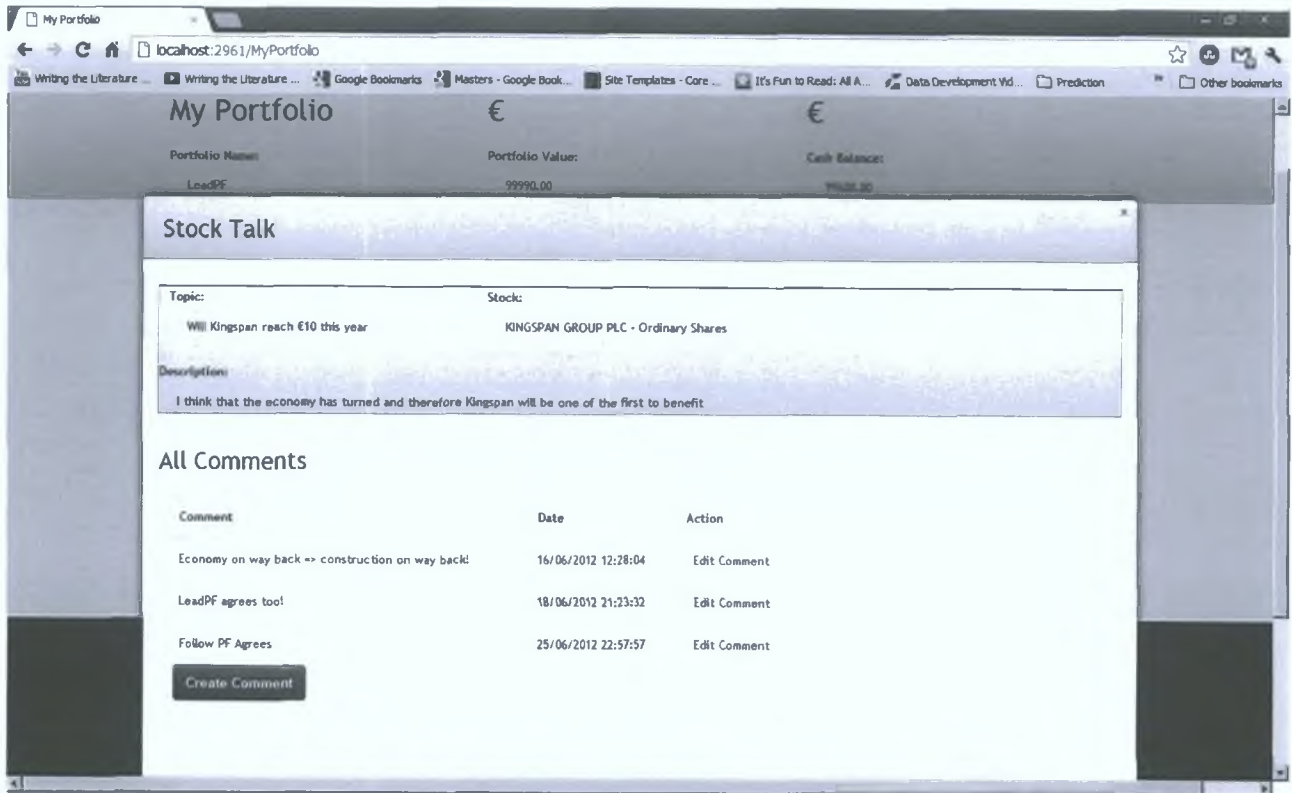


Figure 4.10: StalkTalk Create Screen

## 4 5 6 INSTRUMENTS

Figures 4 11 and 4 12 show functionality related to Instruments. Selecting 'Stocks' from the main dropdown menu renders the default view shown in figure 4 11. The main part of the screen displays a table of the current stocks in the system and a list of views relevant to those stocks. Clicking any of the views options uses AJAX to render a new view to the main table as is shown in figure 4 12.

The screenshot displays the 'All Instruments' view. On the left, a sidebar contains a dropdown menu with 'All' selected, and four options: 'Daily Price Change', 'Weekly Price Change', 'Monthly Price Change', and 'Most Popular'. The main content area is titled 'All Instruments' and features a 'Show 10 entries' dropdown and a search box. Below this is a table with the following data:

| Instrument Name                           | Sector                             | Market | ISIN          | Sedol    | Action                       |
|---|------------------------------------|--------|---------------|----------|------------------------------|
| ABBEEY PLC<br>ESM Ordinary Shares         | Construction & Property Investment | IEX    | IE0000020408  | 0002040  | Buy Sell<br>More Information |
| AER LINGUS GROUP PLC<br>Ordinary Shares   | Transportation                     | IEX    | IE00B1CAMPN86 | B1CAMPN8 | Buy Sell<br>More Information |
| ALLIED IRISH BANKS PLC<br>Ordinary Shares | Financial Services                 | IEX    | IE0000197834  | 4020684  | Buy Sell<br>More Information |
| AMINEX PLC<br>Ordinary Shares             | Energy & Exploration               | IEX    | IE0003073255  | 0307325  | Buy Sell<br>More Information |
| ARYZTA AG<br>Registered Shares            | Food & Drink                       | IEX    | CH0043238366  | B19VJ74  | Buy Sell<br>More Information |

Figure 4 11 Instruments View Screen

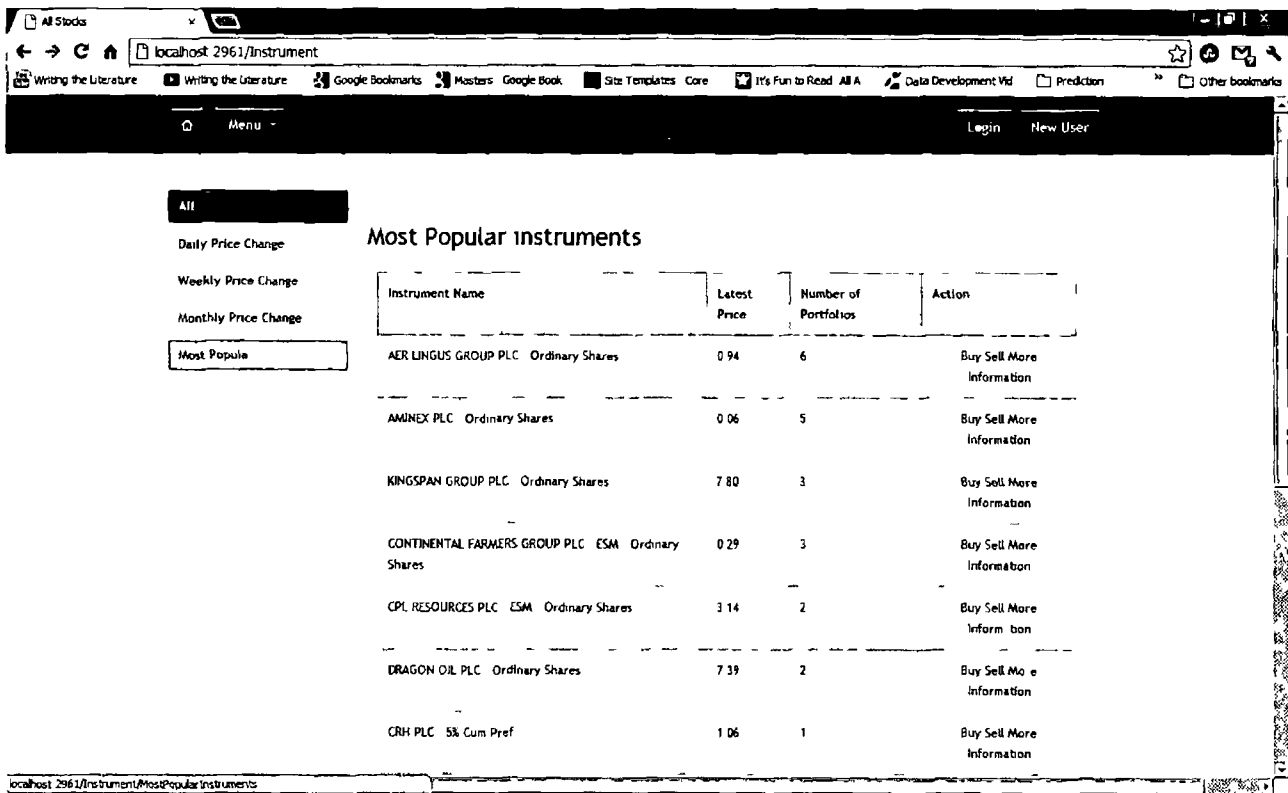


Figure 4.12 Instruments View – Most Popular

## 4 5 7 INSTRUMENT DETAILS

Figure 4 13 shows the screen displayed when a user clicks an instrument for more details. The screen displays a chart of recent price movement, some relevant news items and the option to buy shares in the stock.

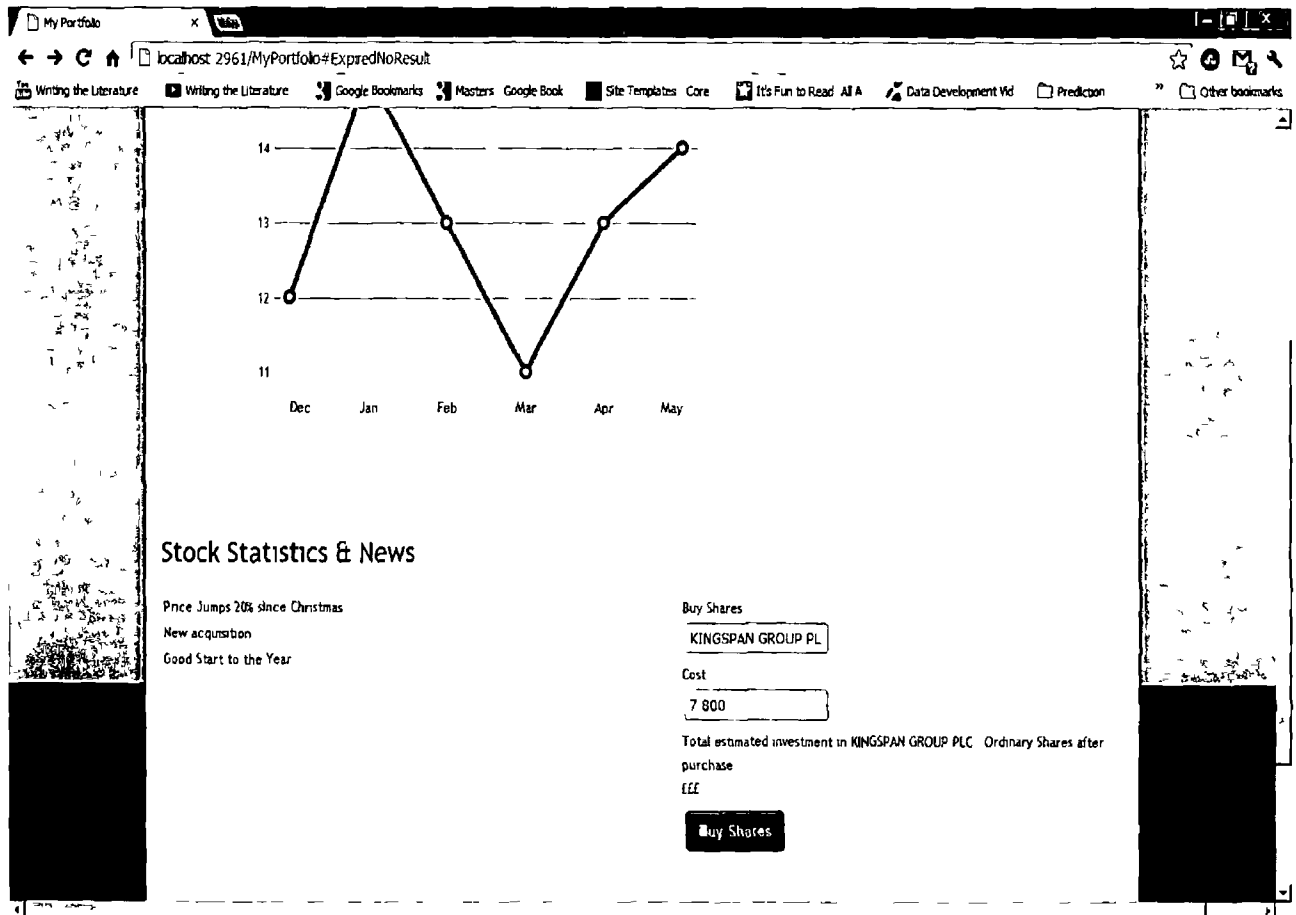


Figure 4 13 Instruments Buy Screen

## 4 5 8 PORTFOLIOS

Figures 4 14 and 4 15 show functionality related to Portfolios. Selecting 'Portfolios' from the main dropdown menu renders the default view shown in figure 4 14. The main part of the screen displays a table of the current portfolios, their performance in the system and a list of views relevant to those stocks. Clicking any of the views options uses AJAX to render a new view to the main table as is shown in figure 4 15.

The screenshot shows a web browser window with the address bar displaying 'localhost:2961/Portfolios'. The page title is 'All Portfolios'. On the left side, there is a navigation menu with options: 'All Portfolios', '30 Day Performance', '365 Day Performance', 'Performance Since Inception', and 'Most Followers'. The main content area features a table with the following data:

| Portfolio Name | Inception Date      | Current Value | Daily Change% | Action                        |
|----------------|---------------------|---------------|---------------|-------------------------------|
| BrianPF        | 01/01/0001 00:00:00 | 100000.00     | 0.00          | Follow<br>UnFollow<br>Details |
| FollowPF       | 01/01/0001 00:00:00 | 99976.00      | 0.00          | Follow<br>UnFollow<br>Details |
| Johnie J       | 01/01/0001 00:00:00 | 100000.00     | 0.00          | Follow<br>UnFollow<br>Details |
| KenPF          | 01/01/0001 00:00:00 | 100175.00     | 0.00          | Follow<br>UnFollow<br>Details |
| LeadPF         | 01/01/0001 00:00:00 | 99990.00      | 0.00          | Follow<br>UnFollow<br>Details |
| Main PF        | 01/01/0001 00:00:00 | 100000.00     | 0.00          | Follow<br>UnFollow<br>Details |



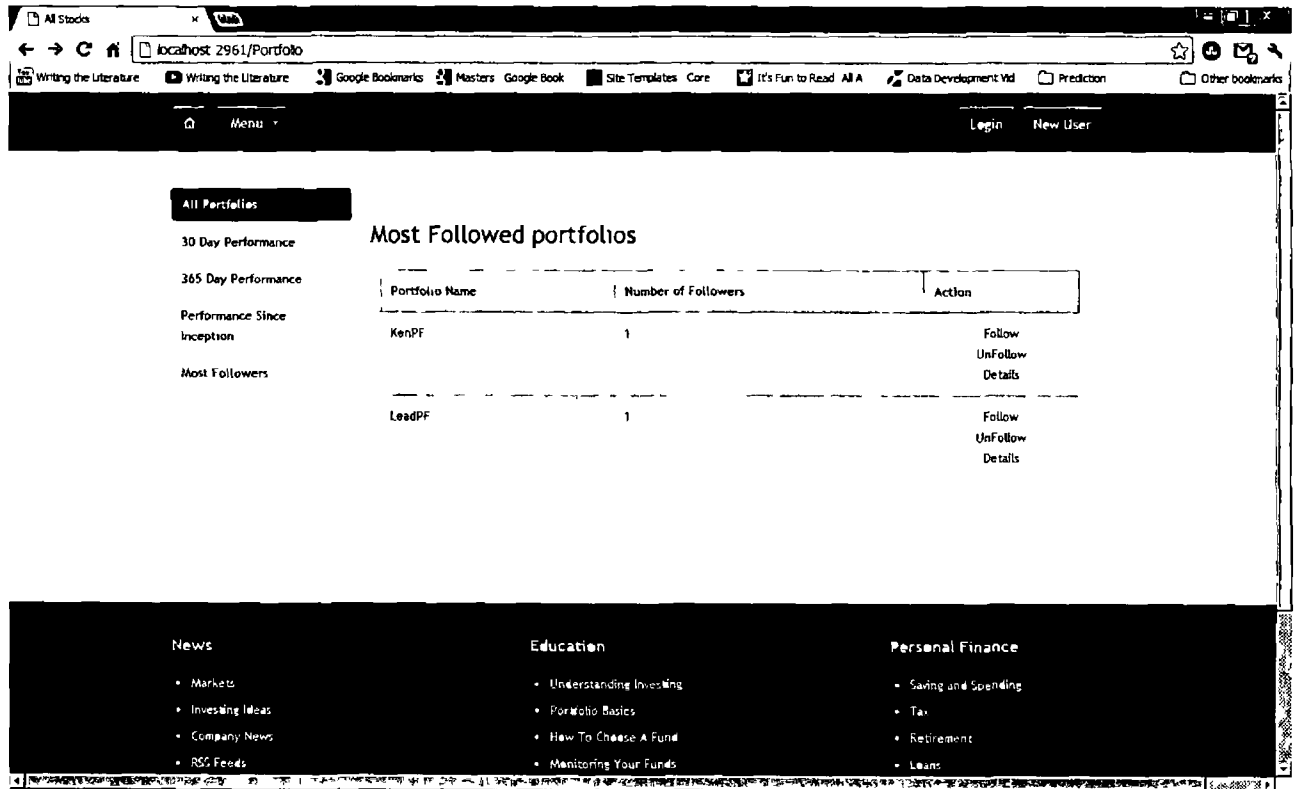


Figure 4 15 Portfolios View – Most Popular

#### 4.5.9 FOLLOW/UNFOLLOW PORTFOLIO

Figure 4.16 shows functionality related to Following a Portfolio. The user is presented with a modal screen showing their current holding in the portfolio, what the holding is worth, how much is available to invest and how much commission they will be charged.

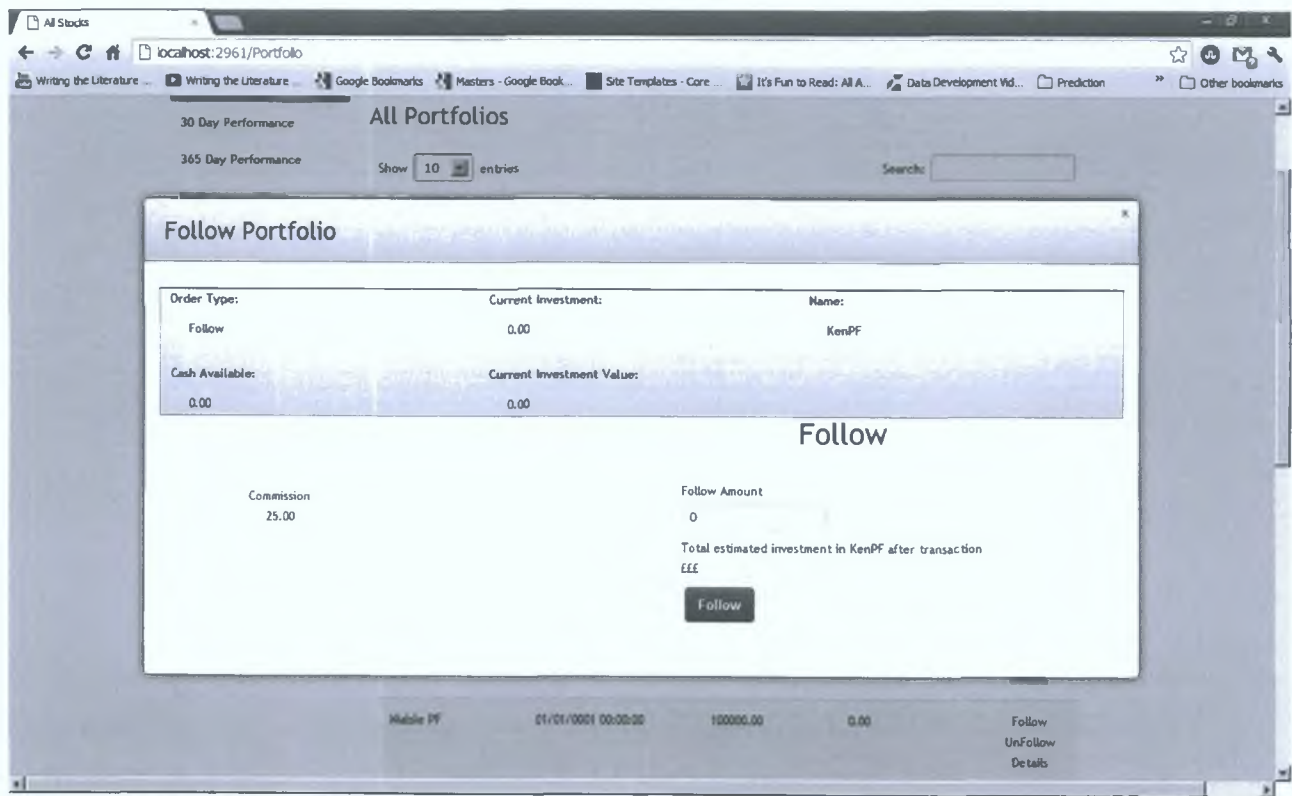


Figure 4.16: Portfolios Follow/Unfollow Screen

## 4.6 IMPLEMENTATION DETAILS

This section presents the implementation details of the relatively complex logic used to determine a prediction outcome. The overall score for each prediction outcome is determined as follows:

Each vote is amended by the perceptiveness score of the user. A user's perceptiveness score gives an insight into how good they are predicting outcomes. Each time they predict correctly, their score goes up. Predict wrong, and their score goes down. A slightly wrong prediction is penalised less than a severely wrong prediction e.g. if the result was 'strong buy' a user who predicted 'buy' is deducted 2 points but a user who predicted 'strong sell' is deducted 10 points. A similar system, used by the site Stackoverflow.com, determines who experts are when answering technology related questions<sup>1</sup>.

Once the user's expertise is assessed, the votes are averaged using a weighted average algorithm. Using a weighted average means that a person who has voted 10 times gets a greater weighting than a person who has voted just 2 times. There are lots of other algorithms that could be used such as the Elo ranking system<sup>2</sup> used in chess competitions but the weighted average benefits from being accurate, simple to compute and easy to explain.

[1] <http://meta.stackoverflow.com/questions/7237/how-does-reputation-work>

[2] [http://en.wikipedia.org/wiki/Elo\\_rating\\_system](http://en.wikipedia.org/wiki/Elo_rating_system)

## 4.7 TESTING

Proper testing is essential for the success of any IT system. In order to ensure that the system meets all its requirements a number different test stages exist to ensure the application is fully tested. A detailed test plan and scripts should be created for each test stage and iteration of the application to allow for testing of new functionality.

For InvestClub, the following test stages were relevant for delivering a successful application

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### 4.7.1 UNIT TESTS

This is the process of testing the underlying correctness of each individual part or unit in the application. The tests are usually quite technical and specific, focusing on particular isolated activities or functions.

Unit testing for InvestClub was carried out mainly on the Business Layer as this is the layer that contains most of the business rules and logic of the application. Unit tests were carried out on the following:

- Saving new valid and invalid domain object records to the database
- Updating valid and invalid domain object records to the database
- Fetching valid and invalid domain object records to the database
- Valid/invalid model states

To assist unit testing, a mock test framework was used. A mock test framework is used to test modules in an application that have dependencies on other modules (e.g. the business layer object having a dependency on a database layer object) in the system or external applications e.g. a database. Mock frameworks rely on the Dependency Injection design pattern to supply mock objects that implement the interface being injected to create a mock (concrete) class in the code

being tested. These classes can be configured in many ways e.g. a dataset can be setup in the test to simulate a dataset being returned from a database.

There are a number of advantages to using a mocking framework:

- It allows parts of the system to be tested in isolation from its dependencies. Therefore if a test fails, the developer is sure that the error is isolated to the piece of code being tested.
- It allows for faster running of unit tests since the application doesn't have to interact with external systems e.g. database, fileserver.
- It allows parts of the application to be tested even when its dependencies have not yet been developed or implemented.

There is a number of mocking frameworks available all with similar functionality and for InvestClub the Rhino Mocks framework was used since it is widely used with good support documentation and examples.

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#### 4.7.2 SYSTEM/INTEGRATION TESTS

This is the process of carrying out integrated, end-to-end testing of the individual use-cases to ensure technical viability of the overall application. For InvestClub, a detailed test plan was created that tested all the functionality and business rules defined in the requirements gathering.

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#### 4.7.3 USER ACCEPTANCE TESTS

This is the process of testing the application against the underlying business requirements to verify the system is functioning as expected and in accordance with the agreed project scope. Early UAT would be essential as it would allow issues with usability, functionality, business rules etc. to be captured and fixed in the development lifecycle. No user acceptance testing was carried out on the InvestClub system as there were no users available to test the application. However a set of usability tests were carried out by independent users and this testing is discussed in detail in chapter 5 and 6.

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#### 4.7.4 IMPLEMENTATION TESTS

This is the process of testing the implementation procedures to ensure the final solution can exist as a production, operational solution. This approach aims to ensure that any operational issues can be addressed prior to go-live.

Since the InvestClub application was only developed as a prototype on the developer's laptop, no implementation testing was required. If implementation testing was required, a replica of the production environment (IIS on Windows server with separate SQL server) with InvestClub installed would have to be created. Independent testers could then carry out some testing to ensure the application was working as expected.

#### 4.8 CONCLUSION

This chapter outlined the criteria used to determine how the InvestClub requirements were drawn up and described in detail what the set of requirements were. It then described how N-Tier architecture was used to implement the requirements discussing what each layer in the application was responsible for. It also discussed how MVC was used to implement the application's UI using the principles of a RESTful architecture. Using screenshots of the prototype, it was shown how the requirements were implemented. It also discussed some of the technologies used in the application such as the EntityMap ORM and the Unity IoC framework and how some of the more complex application logic was implemented. Finally it discussed how the requirements were tested using unit and system testing and a mock testing framework.

## 5. EVALUATION

This chapter discusses how the InvestClub application and the concepts behind the application were evaluated. It describes the rationale that led to the evaluation methods chosen, presents how a focus group and usability testing were used to gather results to evaluate the application, and discusses the results of the evaluation.

### 5.1 METHOD

Two methods of evaluation, a focus group and usability testing, were used to evaluate the InvestClub application and the concepts behind the application. These methods were chosen because the complexity of the application required giving a demonstration of how the application worked and explaining the concepts behind the application. To have a large group of people testing and using the application would mean that a set of videos or documentation on how to use the application would have to be drawn up. Also, the use of an expert focus group was preferred because the business domain is quite specialised with industry knowledge being key to understanding and evaluating it.

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#### 5.1.1 FOCUS GROUP

To evaluate the viability of InvestClub as a commercial application and to evaluate some of the concepts behind the application, a focus group was conducted with investment industry experts. The focus group consisted of a 30 minute presentation covering topics such as the problems with the current investment industry, the concept of the wisdom of crowds, prediction markets, social media strategies currently being used by the industry and the functionality of the InvestClub application. The presentation was then followed with a short demonstration of the application's key features. The group then took part in a 30 minute discussion around the concepts covered in the presentation as well as the viability of the application. Finally, a questionnaire consisting of 7 questions was given to each focus group member in order to get additional individual feedback on the application and the concepts behind it. A copy of the questionnaire can be found in Appendix 2.

The objectives of the focus group were

- To assess the viability of using the wisdom of crowds concept to help make better investment decisions rather than just relying on experts
- To assess how useful social media could assist investment decision making and if so what the most effective strategy is. Most of the strategies outlined in chapter 3.2 are used to some extent in InvestClub. Assessing the usefulness of these strategies could influence future releases of the application.
- To assess the commercial viability of InvestClub
- To gather ideas for improving the application
- To gather ideas for using the concepts within the application for addressing issues with other industries e.g. the betting industry

The focus group participants consisted of 7 staff from the Irish Stock Exchange including

- Head of Information Technology
- Head of Market Development
- Senior Manager of Traded Market Services
- Senior Manager of Trading Technologies
- 2 Traded Market Data Executives
- 1 IT Development Support Analyst

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## 5.1.2 USABILITY TESTING

To evaluate the usability of the application, usability testing was conducted with a group of 3 people. The users were from different backgrounds including a teacher, a computer network engineer and an office administrator. Each test session lasted 10 – 15 minutes and was composed of a short introduction, the execution of a number of specific tasks and a post-test interview to assess overall satisfaction with the website. Different metrics were measured such as tasks completed, errors recorded, comments (positive & negative) made and number of steps taken to



complete tasks. In addition post-test interviews were conducted to determine overall satisfaction with the system and any recommendations.

The following tasks were set for the testers:

- Buy a stock.
- Follow a portfolio.
- View current performance.
- Vote on a prediction.
- Comment on a Stocktalk.

The objectives of the usability testing were:

- To gather data to help determine the usability of the application under the quality components identified by Nielson (Nielsen, 2003)
  - Learnability: How easy is it for users to carry out specific tasks e.g. creating trades, voting, etc.
  - Efficiency: How quickly can users carry out specific tasks once they are familiar with the website?
  - Memorability: how well can users can carry out specific tasks after a period of not using the application.
  - Errors: how many errors did a user make when doing specific tasks? How are the errors handled?
  - Satisfaction: Did the user enjoy using the application?
- To determine if there are any flaws in the design or navigation of the application.
- To determine ways in which the application could be improved
- To determine what works well within the application.

## 5.2 CONCLUSION

Usability testing and a focus group were used to evaluate the InvestClub application and the concepts behind the application. The usability testing was very good at evaluating the functionality within the application and assessing if it was fit for purpose. The focus group was very useful for

evaluating the idea of using social media strategies to make better investment decisions and for assessing the commercial viability of the application.

## 6. EVALUATION RESULTS

This chapter discusses the results from the usability testing and the focus group evaluation of the InvestClub. Both sets of evaluations are discussed separately as they each assess different aspects of the application.

### 6.1 USABILITY TESTING

#### 6.1.1 USABILITY TESTING QUESTIONS

A mixture of quantitative and qualitative data was used to assess the usability of the InvestClub application. The quantitative data was gathered using the following questions:

1. How many tasks were completed successfully?
2. How many errors were recorded in the completion of each task?
3. How many steps did it take to complete each task?

From a qualitative angle, Nielsen, identified 5 components that combine to assess how easy user interfaces are to use (Nielsen, 2003). These components are:

- **Learnability:** This measures how easy it is for users to carry out specific tasks the first time they use the website.
- **Efficiency:** This measures how quickly a user can perform a task once they are familiar with the website.
- **Memorability:** measures how well a user can perform tasks after a period of not using the website.
- **Errors:** Measures how many errors a user makes when performing a task and how easy it is to recover from them.
- **Satisfaction:** Measures the website design and how happy the user was using the website.

Based on Nielson's quality components, the following questions were asked at post-test debriefing to help determine the website's usability

#### Learnability

- How easy or complex was it to perform the assigned tasks?

#### Efficiency (Based on the quantitative data gathered)

- How many tasks were completed successfully?
- How many steps did it take to perform the assigned tasks?

#### Memorability

- How easy was it to buy a stock on subsequent login
- How easy was it to vote on a prediction on subsequent login

#### Errors

- What problems did they encounter whilst performing a task?
- If the user ran into a problem, were they able to overcome it. If so, how?

#### Satisfaction

- Did the site meet the user's expectations?
- Did the users ask any questions about the website's functionality or design?
- Would they use the website once live?

6 1 2 USABILITY TESTING RESULTS

6 1 2 1 QUANTITATIVE DATA

| <u>Task</u>              | <u>How many testers completed the task</u> | <u>Errors</u> | <u>Steps to Task Completion</u>            |
|--------------------------|--|---------------|--|
| Buy a stock              | 3  | 0             | 10<br>(should be 6 - 12 steps for 3 tests) |
| Follow a portfolio       | 3  | 0             | 11<br>(should be 6-12 steps for 3 tests)   |
| View current performance | 3  | 0             | 4<br>(should be 3 - 6 steps for 3 tests)   |
| Vote on a prediction     | 3  | 0             | 12<br>(should be 9 - 12 steps for 3 test)  |
| Comment on a Stocktalk   | 3  | 0             | 11<br>(should be 9 - 12 steps for 3 test)  |

Table 6 1 Summary of Usability Test Quantitative Data

- Task Completion Information

All testers were successfully able to complete all tasks with very little assistance from the moderator. This would confirm the overall feedback that the website is easy to use and instructions are clear. The testers did say though that the website needed some demonstration videos to show how the application worked and what its purpose is.

- **Errors Recorded**

All testers were successfully able to complete all tasks without any errors being recorded in the log files or displayed on screen.

- **Number of steps taken to complete tasks**

All testers were successfully able to complete all tasks within a tolerable number of steps as measured by the number of mouse/return key clicks. Some users took longer than others as they paid more attention to the instructions on the screen.

## 6.1.2.2 QUALITATIVE DATA

### **Learnability**

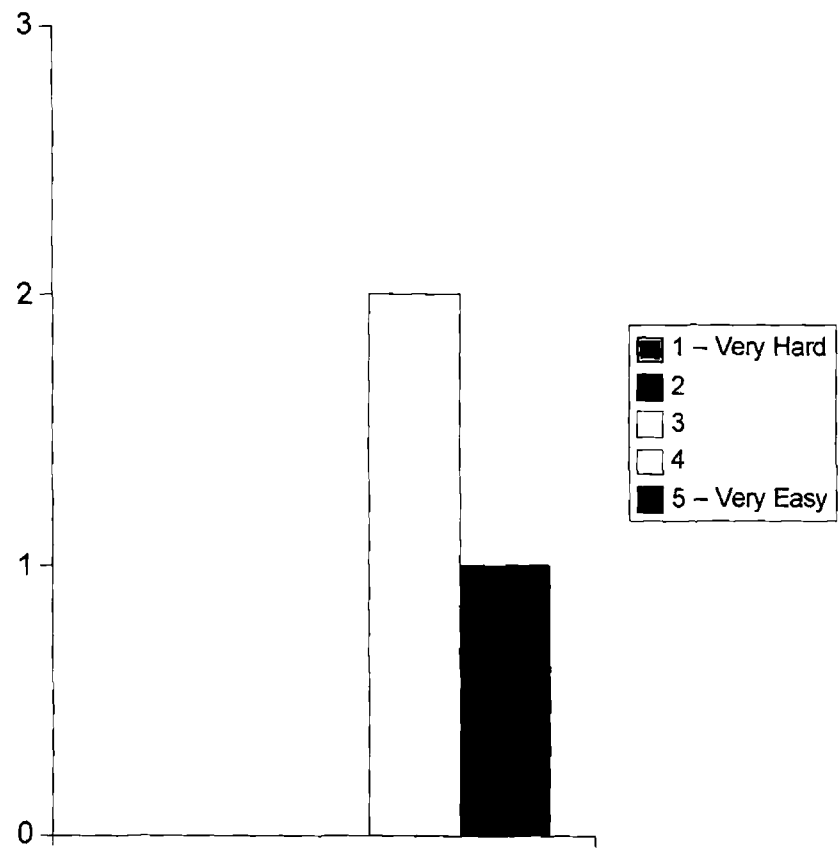


Figure 6 1 How i  
 Figure 17 How easy was it to complete the tasks?

During the post-test interview testers were asked to give a rating on how easy they felt it was to complete their tasks. On a scale of 1 -5 (1 for very hard and 5 for very easy) all testers gave a mark of 4 or higher.

Figure 18 How clear are the instructions and the layout of the website?

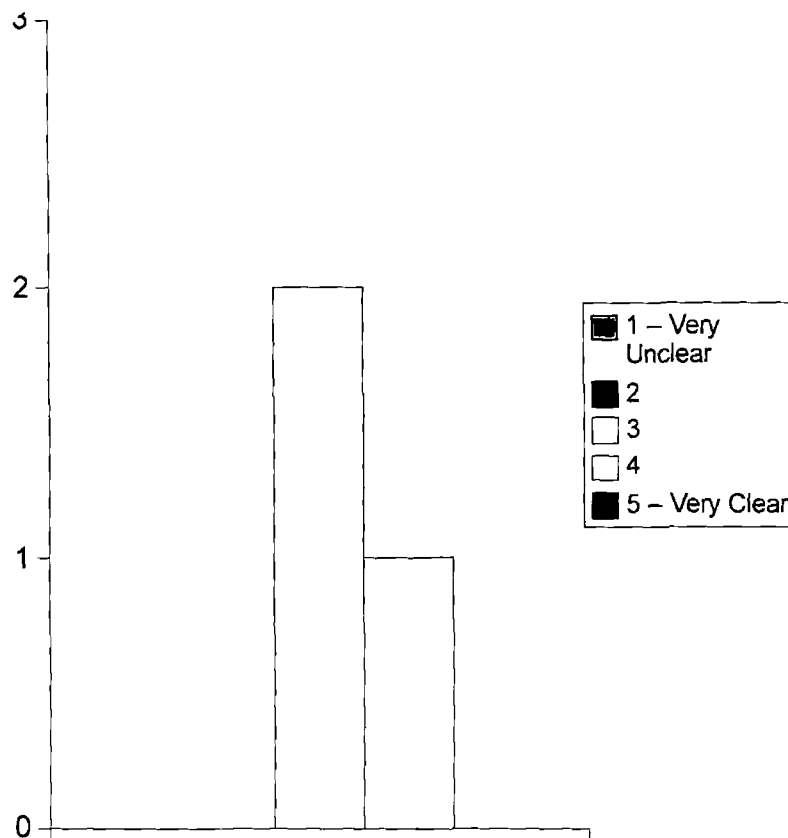


Figure 6 2 How clear are the instructions and the layout of the website?

Testers were also asked to give a rating on how clear the instructions and the layout of the website were. On a scale of 1-5 (1 for very unclear and 5 for very clear) 1 tester gave a mark of 4 and 2 testers gave a mark of 3. When questioned further, the testers who gave a mark of 3 said that the terminology was quite technical ("Portfolio Follow" & "Predictions") and that some video presentations about how to use the website would be essential.

### Efficiency

Based on the quantitative data gathered above, all tasks were successfully completed in an acceptable timeframe and with an acceptable number of steps.

### Memorability

Upon subsequent login, all users were able to complete the tasks without any assistance from the moderator in an acceptable timeframe and with an acceptable number of steps.

**Errors:**

Based on the quantitative data gathered above, all tasks were successfully completed without any errors being raised or logged in the log files.

**Satisfaction:**

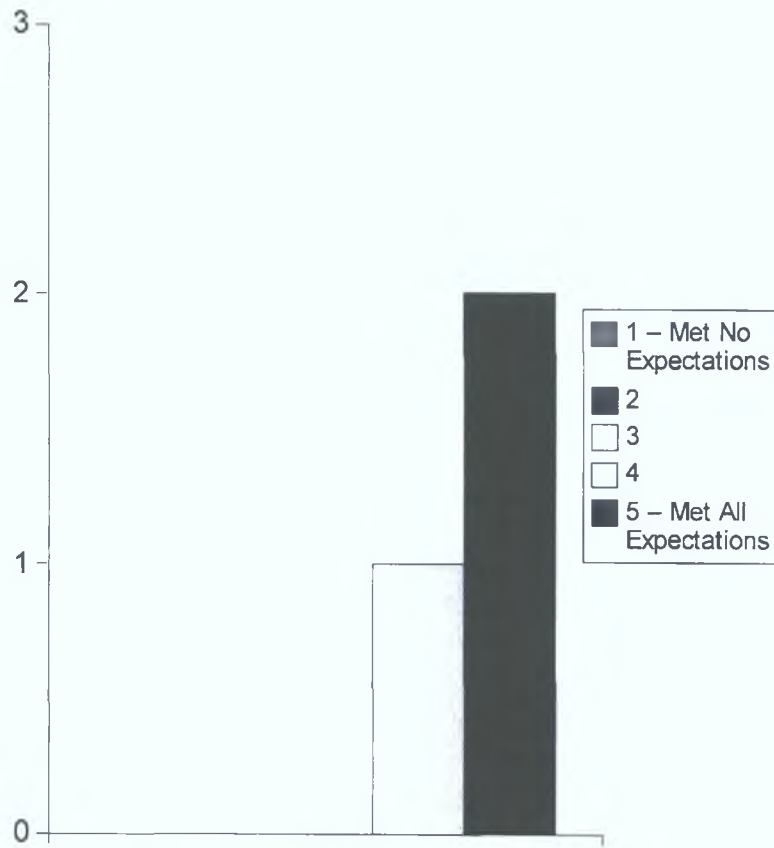


Figure 19: Did the website meet your expectations?

Figure 6.3: Did the website meet your expectations:

During the pre-test introduction, the concept behind InvestClub was explained to the testers. During the post test interview testers were asked if the website met their expectations based on the pre-test description of the website concept. On a scale of 1 -5 (1 met no expectations and 5 for met all expectations) all testers gave a mark of 4 or higher. However, none of the testers said they would use the website once live as they felt inexperienced when it came to investing in stocks and would probably leave the management to their money to a professional e.g. bank or pension fund.

Finally the testers were asked to identify 2 things that they liked and 2 they disliked about the website and also if they had any suggestions for improving the website.



The results are outlined in the table below

| <u>Liked Most</u>    | <u>Liked Least</u>     | <u>Suggestions</u>   |
|----------------------|------------------------|--|
| Simplicity of design | Technical instructions | Try use different chart tool   |
| Functionality        | Lack of images         | More information on portfolio managers e.g track record, photo, number of predictions created, etc |
| Ease of use          | No demonstration video | More images  |
| Hope page image      | Better use of charts   | Demonstration Video  |
| Fluid flow of pages  | More portfolio profile |  |

Table 6 2 InvestClub - Likes and Dislikes

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### 6 1 3 USABILITY TESTING ANALYSIS

The quantitative and qualitative data gathered during usability testing can be analysed with regard to the objectives set out at the start of the chapter

For the objective of determining any flaws in the design of the application, the users found no flaws. They were able to complete all the tasks efficiently and without error. They also felt they had the required information and tools available in the application to help them complete the tasks.

For the objective of determining ways in which the application could be improved, the users

identified a small number of issues with the application that are all areas that can be improved. They mentioned that the application and task instructions were quite technical and also that there was very little training resources on the website. Incorporating more video and podcasts could address both these issues. They also said charts could be better used and that the lead portfolios need to have a greater profile such as a photo, track record information, previous prediction information, etc.

For the objective of determining what works well within the application, the users all said that they liked the fluid flow of the application and the simplicity of its design. They found the application easy to use and that there was lots of useful information and functionality in the application to help them make decisions.

Finally for determining the usability of the application using Nielson's quality components, the data gathered shows that the application is easy to learn, efficient and memorable. All tasks were successfully completed within a minimum timeframe and number of steps. No errors occurred during the completion of tasks and overall the users were very impressed with the application and it met their expectations fully.

## 6.2 FOCUS GROUP

A mixture of data from the focus group discussion and the follow up questionnaire was used to assess the viability of the InvestClub application and the concepts behind the application.

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### 6.2.1 FOCUS GROUP DISCUSSION

The focus group was given a presentation about the research behind the application including concepts such as the wisdom of crowds, prediction markets and investment industry social media strategies. They were then given a full demo of the application and shown how the research concepts were implemented. Finally a 30 minute discussion was held about the viability of the application and the concepts behind it. The focus group discussed a lot of topics but the main points raised were:

## **Trust in the Lead Portfolio**

For the application to work, trust in the lead portfolio manager would be key. People would need assurance that the lead portfolio didn't have a hidden agenda e.g. trying to manipulate the price of certain stocks for his own personal gain. To build trust, the group suggested that having a comprehensive portfolio profile would be of great benefit.

Regarding trust, the moderator suggested that it is in the lead portfolio's interest to be transparent in his activities as otherwise he risks losing followers and gaining a bad reputation within the community. The group's suggestion of having a comprehensive portfolio profile would definitely boost trust. Another way of building trust could be to allow follower portfolios to have a stake in rating lead portfolios through a recommendations function much like the way people rate hotels on TripAdvisor.com.

## **Liquidity**

One person commented that for the application to work, it would need a lot of transaction liquidity i.e. there needs to be lots of activity on the application to maintain a person's interest. Activity could be in the form of comments, new trades, new users, predictions, etc.

Liquidity is very important for the application to thrive, Twitter without all its user activity wouldn't survive. A comprehensive marketing plan would need to be developed to increase awareness about the application and hopefully encourage active participation by users on the platform.

## **Fees**

The group wondered how the application would generate income. The moderator stated that the InvestClub would generate income by taking a small transaction fee of every trade processed. The group then wondered if the InvestClub fees along with the fees for following a lead portfolio would make it more expensive than traditional mutual funds. The moderator responded by saying that Investclub may be more expensive than a traditional mutual fund but when compared to hedge funds it would be much cheaper. The application aims to allow users to make the large profits that hedge funds make but at a fraction of the cost.

## **Legal Issues**

The group stated that the legal issues and regulation would be two big hurdles to overcome if the application was to launch. The moderator agreed stating that the application, for the purpose of the thesis, was developed as a game in order to keep legal issues and regulation out of scope.

### **Prediction Mechanism - Minimum Participants Required**

One member in the group asked would a minimum number of people be required for the prediction market result to be valid. The moderator stated that it would be better if lots of people took part in prediction votes as it captures more diversity of opinion and hence more information. However, as Surowiecki points out, only 20-30 users participated in Hewlett Packard's prediction market but the results outperformed the company's traditional forecasts 75% of the time (Surowiecki, 2005).

### **Trade Disclosure**

Within the system, if a lead portfolio buys or sells a stock, the amount of the trade is visible to follower investors. One member of the group wondered if this was a wise strategy as it may influence other portfolios in their investment decision. This is something that needs further investigation as ultimately it may lead to making some aspects of the application less transparent.

### **Investment Trends**

One of the group commented that the people are becoming much more aware of the poor performance of pension funds and that there is a move towards more do-it-yourself investing. The person mentioned one investment broker, <http://www.interactivebrokers.com>, which has acknowledged this trend by offering customers much more input into how their money is invested.

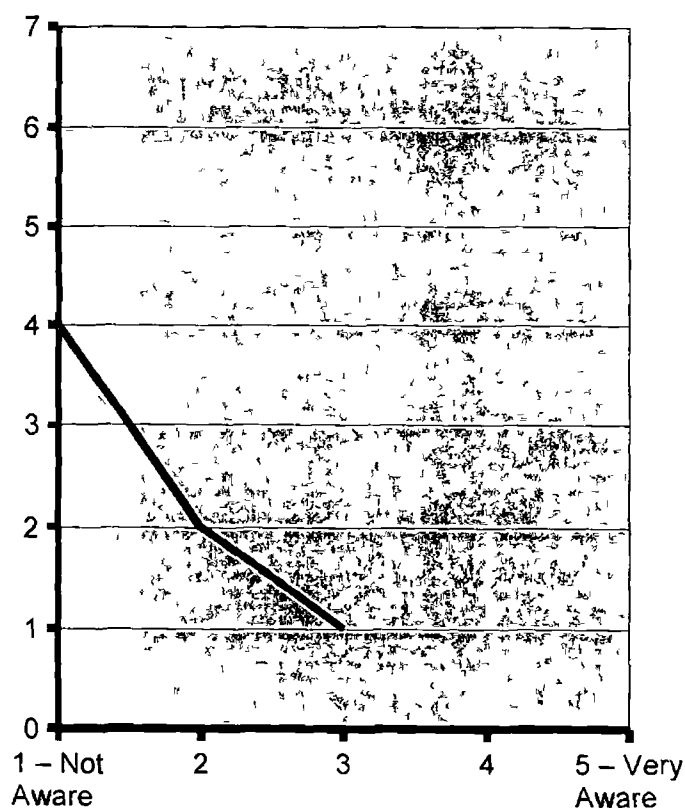
### **Wisdom of Crowds**

The moderator asked the group for their opinion of tapping the wisdom of the crowd. The group generally agreed that there was potential in the concept for the investment industry but that transparency was key i.e. people creating prediction market contracts need to be transparent with their voters. One person did comment that the use of prediction markets to tap the wisdom of experts might have helped prevent the economic collapse of the Irish economy by creating a forum where experts could have, back in 2006, expressed their objective opinion, free from the influence of the media or other detractors, of the 'soft or hard landing' of the Irish economy.

## 6 2 2 QUESTIONNAIRE FEEDBACK

After the presentation, the focus group was given a questionnaire to assess their opinions on different aspects of the application and the concepts behind the application (for a copy of the questionnaire see Appendix 2) The answers to the questionnaire could influence the functionality to be implemented in the application or even other ways in which the technology and concepts could be used The questions in the questionnaire were based on some of the topics and examples covered in the presentation

**Q1 The following websites were used as examples in the presentation SeekingAlpha, Covestor com, Wikinvest, Alphaclone, Piqqem, Intrade and SumZero To what extent were you aware of any of the websites before the presentation?**



#### Figure 6.4 Awareness of social media & investments industry websites?

This question measured how aware the group was of the investment website examples mentioned in the presentation. It shows that most of the group had no awareness of the websites mentioned in the presentation. This highlights that social media is still in the early stages of disrupting the industry but given the rise in popularity of social media platforms like Twitter in a relatively short space of time, an innovative idea like InvestClub, with the right marketing and business plan, could have a similar growth rate within the investment community.

**Q2 To what extent do you believe that the harnessing the wisdom of the crowd could be useful in developing an investment strategy?**

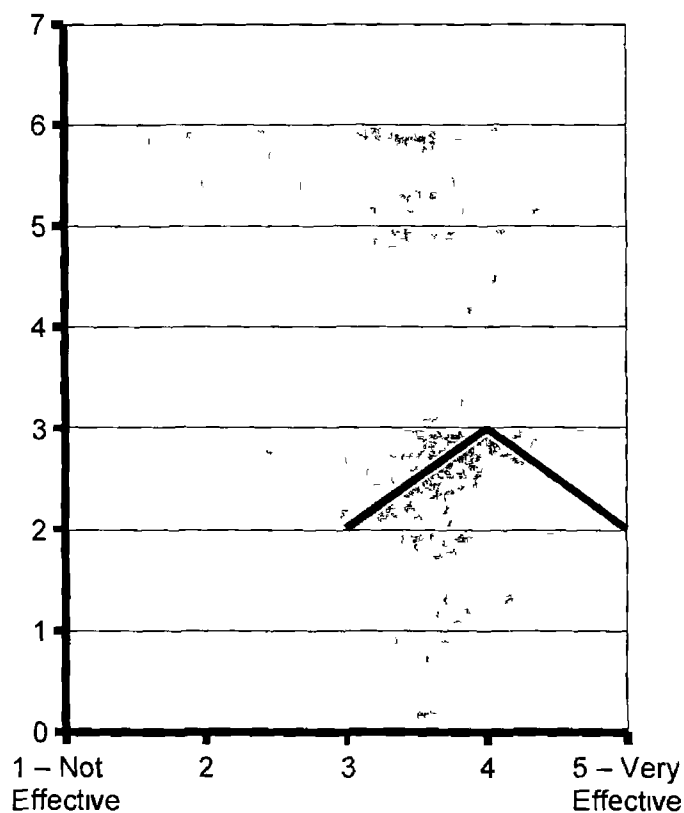


Figure 21 Can harnessing the wisdom of crowds and assist investments strategy?

Figure 6 5 Can harnessing the wisdom of crowds and assist investments strategy?

Question 2 & 3 & 4 assess how useful the group believes that social media can assist investment decision making and if so what the most effective strategy is. Question 2 looks using the wisdom of crowds to help make investment decisions. It shows that the group believes that using the wisdom of crowds could be very effective in making investment decisions. However 2 respondents were undecided. This could be due to the concerns raised in the focus group discussion around the need for transparency and trust in the crowd when the crowd's wisdom is used to make a decision.

Question 3 is split into 5 parts, each part looking the different social media strategy covered in the presentation and assessing how useful each of the strategies could be. Many of the strategies assessed are used to some extent in InvestClub. The group's answers to this question could influence the next release of the application especially if they were unanimous in their support of a particular strategy.

Q3 a) How effective is using social media for research in finding new investment opportunities  
e.g SeekingAlpha

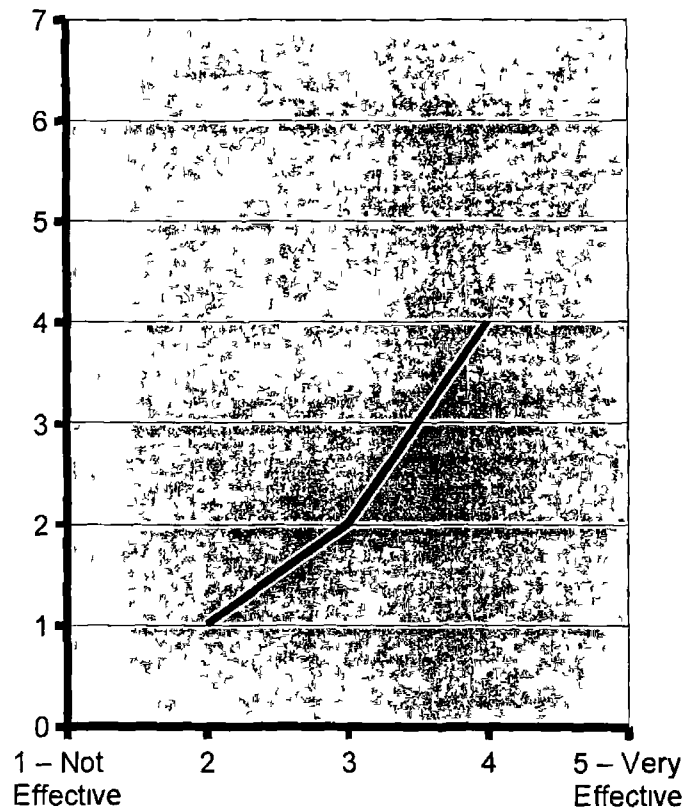


Figure 22 Using social media for research in finding new investment opportunities

Figure 6 6 Using social media for research in finding new investment opportunities

The responses to this question show that the group have mixed opinions on using social media to find new investment opportunities. While the majority of the group believe it is an effective strategy, some of the group mentioned that trust in social media is a concern i.e. people could use social media to promote stocks for their own benefit. The need for transparency and trust in InvestClub was mentioned in the group discussion and it would be an essential feature if investors are to engage with each other on the platform.



3b) How effective is using social media for tracking the disclosed investments of large hedge fund investors e.g Alphaclone

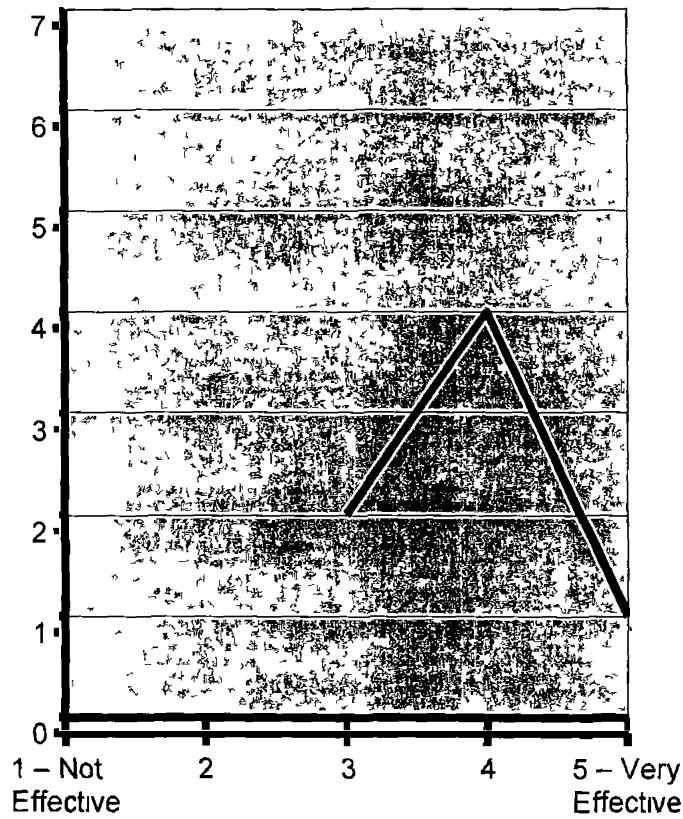


Figure 23 Using social media for tracking hedge fund disclosures

Figure 6 7 Using s

The responses to this question show that the group in general believe that using social media to track the disclosed investments of large hedge fund investors is an effective strategy. While InvestClub doesn't directly use this strategy, some of the individual portfolio managers could use it as an investment strategy.

3c) How effective is using social media for tracking the investments of virtual or real investment portfolios e.g. Covestor

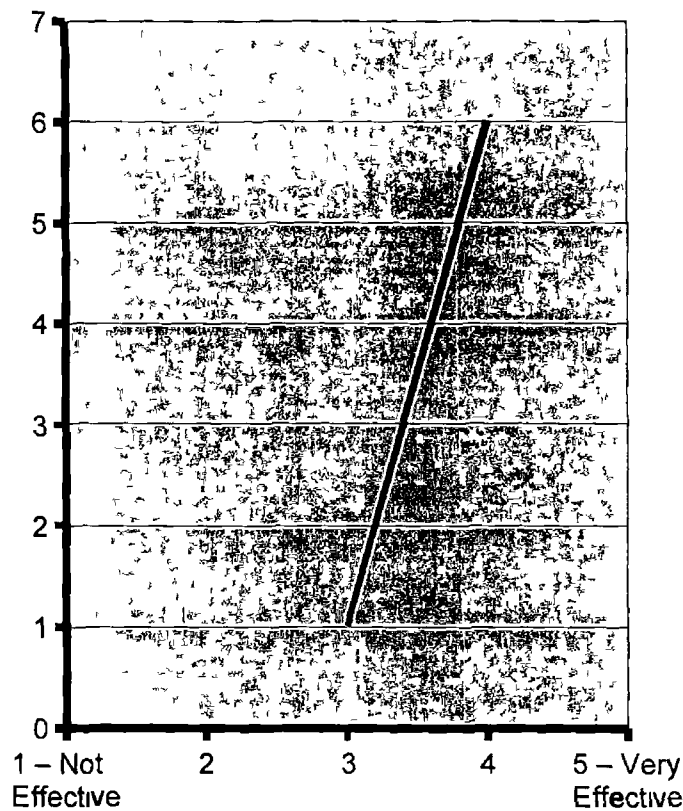


Figure 24 Using social media for tracking virtual or real investment portfolios

Figure 6 8 Using s

The responses to this question show that the group in general believe that using social media to track virtual or real investment portfolios is an effective strategy. This strategy is core to the InvestClub application so it is encouraging that the group thought this strategy was effective. Getting strong performing investment managers, with proven track records and consistently good investment returns, to sign up as lead portfolios would be key to ensuring that this strategy is effective in the long term. This should be considered as part of the business plan for launching the application.

3d) How effective is using social media for researching new investment ideas e.g Wikinvest

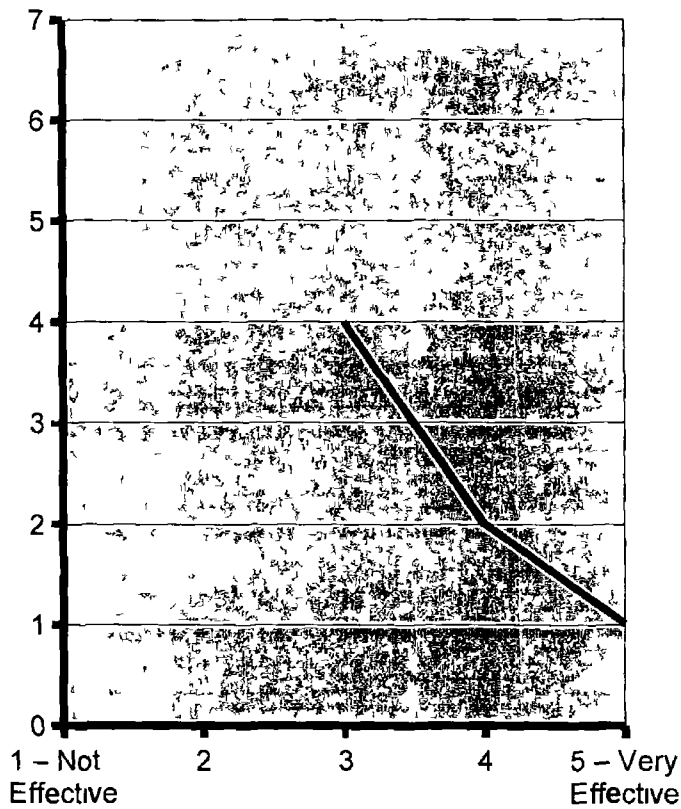


Figure 25 Using social media for researching new investment ideas

Figure 6.9 Us

The responses to this question show that the group are quite undecided in the effectiveness of using social media for research although the responses do suggest that it is useful. This strategy is not used in InvestClub as all the information on stocks comes from official sources or links to other news sites such as Yahoo finance. The responses to this question suggest that there would be little benefit in implementing this strategy in InvestClub.

3e) How effective is using social media for predicting market sentiment e.g Piqqem, InTrade

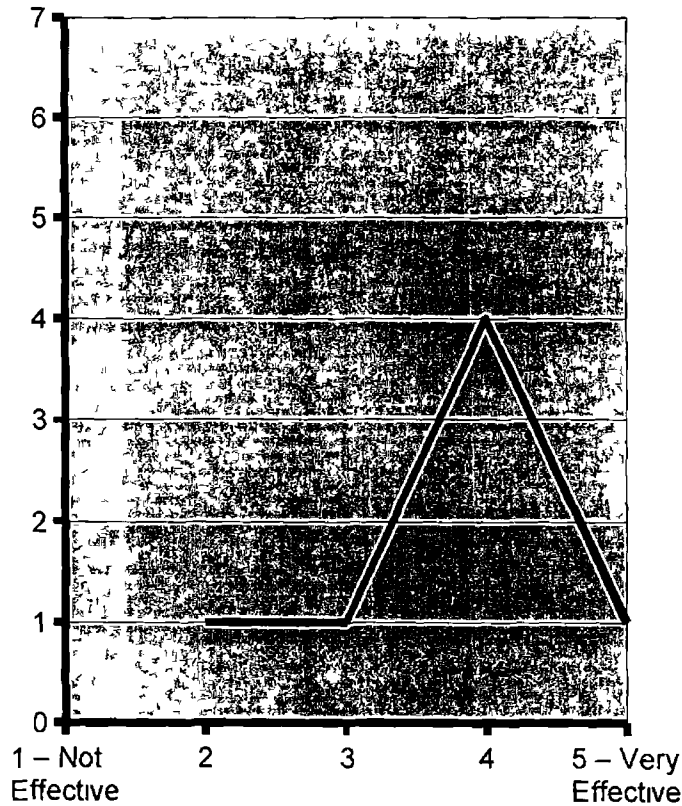


Figure 26 Using social media for predicting market sentiment

Figure 6 10 Using social media for predicting market sentiment

The responses to this question show that the group in general believe that using social media to predict market sentiment is an effective strategy. This strategy is also core to the InvestClub application so ensuring it works well is essential. One respondent didn't think it was an effective strategy, again this could relate to lack of trust in the crowds decision. Ensuring the perceptiveness algorithm is accurate should help generate better predictions as will ensuring lots of relevant commentary and interaction to educate the voters.

4 Do you think that profitable investors would be prepared to share their investment strategy in return for a commission from other investors?

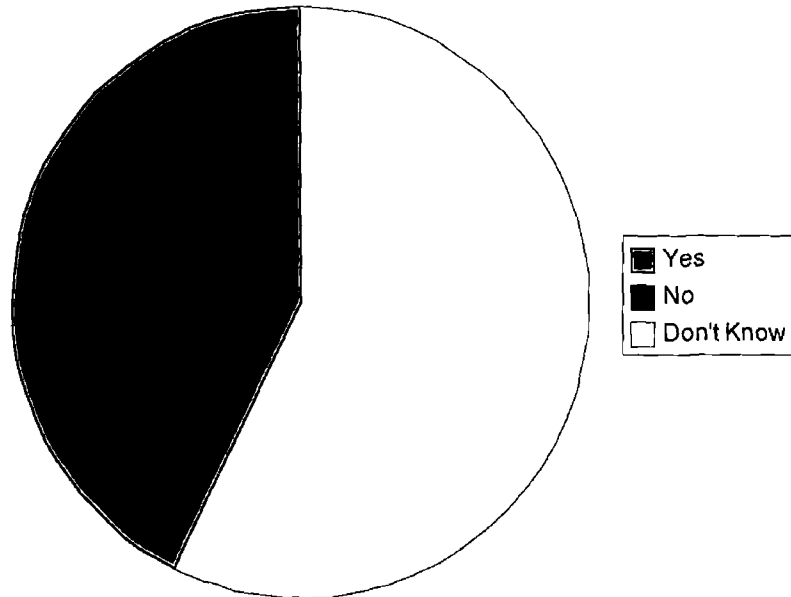


Figure 27 Would profitable investors be prepared to share their investment strategy?

Figure 6 11 Would profitable investors be prepared to share their investment strategy?

This question aimed to assess if successful portfolio managers would be willing to share their strategies. While 4 respondents didn't know if they would, 3 respondents said they would share and 0 respondents said that they wouldn't. This is good indicator that the application would work because if lead investors are not willing to share their strategies then they would never sign up to the application. One respondent noted that professional investors using any kind of sophisticated, proprietary quantitative analysis in their investment strategies would be unlikely to sign up but that they may sign up to run their own private portfolios.

5 As a concept, do you think that InvestClub is commercially viable?

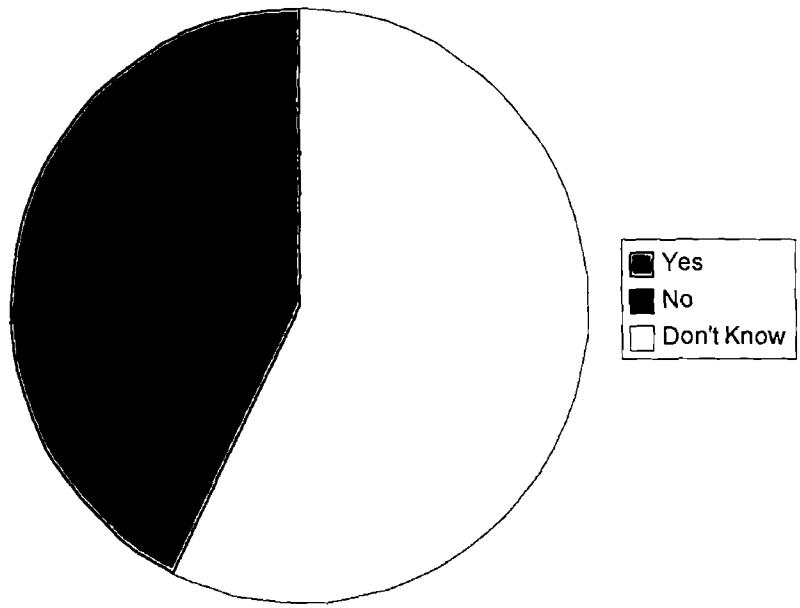


Figure 28 Is InvestClub commercially viable

Figure 6 12 Is Investclub commercially viable

This question aimed to assess if the InvestClub application is commercially viable. While 4 respondents didn't know, 3 respondents said it was and 0 respondents said it wasn't viable. One respondent noted it was a very interesting area and likely to evolve further given investor empowerment driven by the financial crisis and disillusionment with the performance and costs of the traditional active fund managers. However, he also noted that as with most start-ups, commercial viability would depend on a mix of good timing and luck. The 4 respondents that didn't know if it was commercially viable didn't specify why but it may be to do with legal and regulation concerns. Overall the responses are a good indicator that the application would be commercially viable.

## **6 Can you identify 2 obstacles, if any, to overcome if InvestClub went live?**

This question sought to assess how the application could be improved/amended to make it commercially viable. Most responses mentioned the legal and regulation aspects of the application. One respondent stated that regulation was needed to protect customers as trust is a critical requirement for buy in.

Building critical mass and maintaining interest were other obstacles to overcome. One respondent stated that investors will not wish to be first to sign up and that building an environment and conditions that enable the crowd to behave such as the system requires would also be difficult. Another respondent suggested that bringing the concept to someone like Rory Gillen at <http://gillenmarkets.com/> (or similar) could provide an alternative partnership based kick start with an established client base?

Trust and reputation of the website was also mentioned as an obstacle. One respondent stated that getting InvestClub recognised as bone-fide would be difficult without a proven track record or association with an existing trusted brand.

Misuse of the system was another hurdle with one respondent asking what was to stop people deriving an investment strategy from InvestClub but avoiding spending money on InvestClub e.g. by doing their trading outside the system thus reducing InvestClub's income. This is an issue that would need to be addressed in the business plan.

## **7 What other opportunities exist where the concepts behind InvestClub (prediction markets & wisdom of crowds) could be used e.g. the betting industry?**

This question sought suggestions on how the technology and concepts could be used in other domains. The responses were very interesting and included a number of diverse ideas. These included:

Using the wisdom of crowd and prediction market concepts to improve the quality of decision making or to come up with more creative solutions for local councils, community and social issues.

Using prediction markets in agricultural co-ops to help set the market price of commodities like grain and milk.

Using prediction markets within companies to leverage all relevant knowledge in terms of innovation and business development.

Using the concept as a research tool, independent of the trading platform. If it was possible to source quality audiences and process their opinions the results could be provided as backup data to relevant parties.

Football betting – The wisdom of crowds could be a substitute for the pub/betting shop both of which are in decline.

Using the wisdom of crowds concept in communities for solving domestic DIY problems.

Using prediction markets to assist students in choosing college courses based on the predictions of individuals within various sectors on the future of those sectors e.g. demand for workforce etc.

### 6.3 CONCLUSION

The results from usability testing showed that the testers thought the website was very good and met their expectations. They found the application to be very simple to use, had lots of useful functionality and tools for making their decisions and had a modern, fresh look and feel. They identified a number of relatively small issues such as the lack of training tools and the need for more information on portfolio profiles. They also suggested using different graphs or a different graphing tool for analysing performance.



The results from the focus group discussion and questionnaire showed that the group thought that the application had commercial potential but that there were some significant hurdles with transparency, trust and legal issues to overcome if it was to be considered commercially viable. However, if these obstacles were overcome, the questionnaire results showed that they did believe in the use of social media to help make better investment decisions and they were very confident that both prediction markets and tracking other investor portfolio strategies were very useful ways of using social media to make better investment decisions. Finally the group came up with a number of suggestions for alternative uses for the concepts behind the application such as sports betting, pricing of agricultural produce and suggesting what college courses for students to choose based on predictions of future employment opportunities.

## 7. CONCLUSIONS AND FUTURE RESEARCH

### 7.1 CONCLUSIONS

The aim of this thesis was to develop a web based application, called InvestClub, that incorporated social media into the investment industry, with the aim of answering the research question “Can harnessing the wisdom of crowds assist investment managers in making better investment decisions?” To answer this question 4 objectives were set and these objectives have been fully met. This chapter discusses the lessons learned both from a research point of view and also from evaluation of the InvestClub application.

A literature review was carried out on how social media could be used to help make better decisions. The review focused on the concept of 'wisdom of crowds' whereby under certain conditions groups of people can make better decisions than individuals (Surowiecki, 2005). It looked at the conditions needed (Diversity of Opinion, Independence, Decentralization and Aggregation) to harness the wisdom of crowds and the benefits of combining predictions from different sources. It also outlined why deliberation within a group can also lead to poor decisions and looked at the risks of information cascades forming when individuals ignore their private information in favour of the group's decision. Finally it looked at concept of prediction markets which are a very effective way of aggregating wisdom within a crowd to make better decisions.

The background research looked at how the investment industry currently uses social media focusing on 6 different business models that make use of social media. It concluded that using prediction markets, mimicking the trade of investors on virtual/real trading platforms and tracking the disclosed trades of successful hedge funds were the most relevant business models for the development of the InvestClub application. The research then looked at 5 popular investment portfolio management systems and detailed the features that each have. These features were then used in determining the requirements of the InvestClub application.

Based on the literature and background research, a comprehensive set of features for an investment portfolio management system was drawn up. The features incorporated social media, prediction markets, the ability to mimic the trading of other investors and all the expected functionality of an investment portfolio management such as performance analysis, charts, etc. Not all the features could be implemented so each feature was assessed for inclusion by looking at its development effort, level of requirement and degree of innovativeness. The application was

developed as a web based application and was designed in a way that it adheres to the RESTful architectural style. It was build using an n-tier architectural design with an MVC based user interface on a SQL Server 2008 database. This design allows for scalability and flexibility and would make migrating the application to the cloud much easier. Before evaluation, the application was tested using both unit and system testing.

Finally the application was evaluated using 2 methods of evaluation. Usability testing was carried out to evaluate the application's design and functionality. To evaluate the application's commercial viability and potential alternative uses of the technology, a focus group discussion and follow-up questionnaire with industry experts was carried out. The results of the usability testing showed that the website was easy to use and had lots useful functionality and tools for making investment decisions. However, it also highlighted that the application would benefit from some training tools and more information on portfolio profiles. The results from the focus group discussion and questionnaire showed that the application had commercial potential but that there were some significant hurdles with transparency, trust and legal issues to overcome if it was to be considered commercially viable. It also showed that prediction markets and tracking other investor portfolio strategies were very useful ways of using social media to make better investment decisions. It also highlighted a number of alternative uses for the concepts behind the application such as sports betting, pricing of agricultural produce and suggesting what college courses for students to choose based on predictions of future employment opportunities.

## 7.2 FUTURE RESEARCH

Research for the future of the InvestClub application should focus on the suggestions for improvement that arose from the evaluation. In particular, developing the application to be commercially ready would mean having to overcome the transparency, trust and legal issues identified by the focus group. Implementing a trust rating or a recommendation system for portfolios could address the trust and transparency issues. Legal issues would need in-depth research to identify how the application would need to be amended to comply with financial regulation with attention focused on custodianship of investors' money while it's invested and whether the application needs an investment broker license. On a more practical level, training materials, real time pricing and real time execution of trades would need to be incorporated into the application. On a technical level, migrating the application to a cloud environment would be essential to provide scalability and reliability. Also developing mobile versions of the application would be of great benefit especially when trying to increase number of people using the application as a lot of social media use is conducted on mobile devices.

From a theoretical viewpoint, there is a lot of scope for future research. The focus group made some good suggestions for using the technology and concepts in other domains such as sports betting or determining where future employment opportunities may lie to help students choose the most appropriate college courses. Each of these suggestions would be very interesting research areas. The evaluation also suggested that the technology could have been used by the government to predict the hard or soft landing of the Irish economy in 2008. Researching how the government could make use of prediction markets for forecasting economic trends would be very beneficial. The background research also suggested the creation of a crowd sourced regulation platform to assist central banks in regulating the industry and this too would be worth researching. Finally research could focus on the issues of developing the application as a learning tool rather than a commercial application. It could be used by investment managers to learn about new investment strategies or sectors by following the strategies of others.

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## APPENDICES

### APPENDIX 1 INVESTCLUB REQUIREMENT & FEATURE ANALYSIS

| Portfolio Management Functionality                | Development Time | Requirement Level | Innovativeness | Include in InvestClub |
|---|------------------|-------------------|----------------|-----------------------|
| Create Portfolio                                  | 1                | 1                 | 3              | Y                     |
| Buy/Sell Stock                                    | 2                | 1                 | 3              | Y                     |
| Monitor Stock/Alerts                              | 2                | 3                 | 2              | N                     |
| Stock Performance                                 | 4                | 1                 | 3              | Y                     |
| Index comparison                                  | 2                | 3                 | 4              | N                     |
| Portfolio comparison                              | 3                | 2                 | 1              | Y                     |
| Stock Filtering                                   | 3                | 2                 | 1              | Y                     |
| Stock News  | 2                | 2                 | 3              | Y                     |
| Stock Social Media (Twitter, News websites, etc ) | 2                | 2                 | 1              | Y                     |

|                              |   |   |   |   |
|------------------------------|---|---|---|---|
| Charting                     | 3 | 2 | 3 | N |
| Real Time Prices             | 3 | 3 | 1 | N |
| Historical Analysis          | 2 | 2 | 2 | Y |
| Blogging/Commentary          | 2 | 1 | 1 | Y |
| Track Portfolios             | 3 | 2 | 1 | Y |
| Research                     | 5 | 3 | 2 | N |
| Recommendations              | 5 | 3 | 2 | N |
| Multi Sign On Options        | 2 | 3 | 1 | N |
| <b>Social Media Features</b> |   |   |   |   |
| Social Commentary            | 2 | 1 | 1 | Y |
| Mimic Portfolios             | 5 | 1 | 1 | Y |
| Prediction Market            | 4 | 1 | 1 | Y |
| Investment Wiki              | 6 | 3 | 1 | N |
| Prediction Market Sentiment  | 3 | 3 | 1 | N |



APPENDIX 2 FOCUS GROUP QUESTIONNAIRE

**The Investment Industry and Social Media - Focus Group Questionnaire**

- 1 The following websites were used as examples in the presentation SeekingAlpha, Covestor com, Wikinvest, AlphaClone, Piqqem, Intrade and SumZero

To what extent were you aware of any of the websites before the presentation?

| Not Aware             |                       |                                  | Very Aware            |                       |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| 1                     | 2                     | 3                                | 4                     | 5                     |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- 2 To what extent do you believe that the harnessing the wisdom of the crowd could be useful in developing an investment strategy?

| Not Useful            |                       |                                  | Very Useful           |                       |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| 1                     | 2                     | 3                                | 4                     | 5                     |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- 3 Please rate how useful each of the following 5 strategies would be as a research tool?

- Using social media for research in finding new investment opportunities e.g SeekingAlpha,

| Not Useful            |                       |                                  | Very Useful           |                       |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| 1                     | 2                     | 3                                | 4                     | 5                     |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- Using social media for tracking the disclosed investments of large hedge fund investors e.g. AlphaClone

| Not Useful            |                       |                                  | Very Useful           |                       |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| 1                     | 2                     | 3                                | 4                     | 5                     |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- Using social media for tracking the investments of virtual or real investment portfolios e.g. Covestor

| Not Useful            |                       |                                  | Very Useful           |                       |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| 1                     | 2                     | 3                                | 4                     | 5                     |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- Using social media for researching new investment ideas e.g. Wikinvest

| Not Useful            |                       |                                  | Very Useful           |                       |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| 1                     | 2                     | 3                                | 4                     | 5                     |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- Using social media for predicting market sentiment e.g. Piqqem, InTrade

| Not Useful            |                       |                                  | Very Useful           |                       |
|-----------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| 1                     | 2                     | 3                                | 4                     | 5                     |
| <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |

4 Do you think that profitable investors would be prepared to share their investment strategy in return for a commission from other investors?

- Yes
- No
- Don't Know

5 As a concept, do you think that Invest Club is commercially viable?

- Yes
- No
- Don't Know

6 Can you identify 2 obstacles, if any, to overcome if Invest Club went live?

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7 What other opportunities exist where the concepts behind Invest Club (prediction markets & wisdom of crowds) could be used e.g. the betting industry?

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