UNIVERSITY OF NAIROBI

COLLEGE OF BIOLOGICAL AND PHYSICAL SCIENCES

AN AGENT BASED STOCK PRICE PREDICTION MODEL FOR THE NAIROBI SECURITIES EXCHANGE

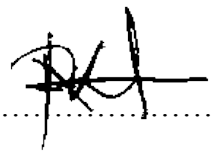
PERMINOUS NDEITHI KAHOME

A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF THE DEGREE OF MASTERS OF SCIENCE IN COMPUTER SCIENCE, IN THE SCHOOL OF COMPUTING AND INFORMATICS, OF THE UNIVERSITY OF NAIROBI.

SEPTEMBER 2014.

DECLARATION

This research project report is my original work and has not been submitted for any academic award in any other university. All the work in this research project is my own except where acknowledged in the text.

SIGNED:……  ……19th September 2014

PERMINOUS NDEITHI KAHOME DATE:

P58/75653/2012

This Research project report has been submitted for examination as a partial fulfillment for the award of the Degree of Masters of Science in Computer Science at University of Nairobi with my Approval as a Supervisor.

SIGNED:…….. ……..

Dr. ELISHA T. OPIYO OMULO DATE:

Senior Lecturer

University of Nairobi

School of Computing & Informatics

DEDICATION

I dedicate this project to my family for their continued support and above all I thank the almighty God for his blessings all through.

ACKNOWLEDGEMENT

I would like to thank my supervisors Dr. Elisha Opiyo for his continued guidance, Prof. Wagacha and Mr. Ogutu for the positive critics during the project period. Special thanks my family for inspiration and support and gratitude to classmates and colleagues. To everyone who contributed to the success of this project I say thank you and God bless you all.

LIST OF ABREVIATIONS:

ANN-Artificial neural network

AOSE-Agent oriented software engineering

ARMA- Auto regression moving average

CMA- Capital Markets Authority

EMH-Efficient market Hypothesis

JADE- Java agent Development

KES- Kenya Shilling

NSE- Nairobi Securities Exchange

PASSI- Process for agent society's specification and implementation

UML- Unified modeling language

DEFINITION OF IMPORTANT TERMS:

Agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet design objectives (Woodridge, 2002).

Bear Market: This is a prolonged period in which share prices of listed companies consistently fall. Bear markets usually occur when the market is in recession and unemployment is high, or when inflation is rising quickly.

Bull Market: This is when share prices of listed companies are persistently rising in value in the market. Bull markets can happen as a result of an economic recovery, an economic boom or investor confidence.

Candlestick Calculations: In the 1600s, the Japanese developed a method of technical analysis to analyze the price of rice contracts. This technique is called candlestick charting.

NSE: Nairobi securities Exchange is a market and commonly known as NSE

Prediction: Forecasting the outcome of events that will happen in the future

Securities Exchange is a market where shares (equities) and bonds (debt instruments) are traded.

Shares: A share is a piece of ownership of a company or an enterprise. Buying a share allows you to become an investor and there by an owner of the company's profit and loss.

Stock broker: A stockbroker is a regulated professional individual, who buys and sells stocks and other securities for both retail and institutional clients, through a stock exchange or over the counter, in return for a fee or commission

Stock Market: A market in which securities are bought and sold.

Stocks: The capital raised by a business or corporation through issue and subscription of shares.

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ABSTRACT

The stock market is a key market in any economy and financial forecast such as stock price prediction is a field receiving much attention both for research studies and commercial applications. Stock market forecasters are keen on developing a successful approach to predict stock prices even more accurately since there is the motivation of gaining massive profits from trading shares by using well defined attractive strategies. This research project develops a stock price prediction model build using JADE based on multi agent architecture in order to harness the power of agents and provide investors with predicted trend of share price by incorporating the various correlated factors like economic, political, company outlook to traditional price over time, demand and supply in order to accurately forecast the stock price trend and thus provide a buying or selling signal to traders. The Trend is determined by incorporating text processing in the agents from live news sources. The model was tested and proved a key tool for stockbrokers, novice traders and investment bankers since its automated and more robust than the traditional methods of price prediction.

Key Words; Agents, Stock Market, Prediction. Stock price. Model. Text processing. JADE.

1.0 CHAPTER ONE: INTRODUCTION

This research project involves an agent-based model for predicting the price movement of a stock. The agents have the ability to scan for news in the internet and analyze the gathered information thus enabling it to predict the trend of the stock prices and provide an output advice informing the traders whether to buy, sell or hold on to a stock.

1.1 Background

For an economy to grow money needs to shift from less productive activities; which means unused money and savings should be invested in productive activities for the economy to grow. The stock market acts as an indicator of any countries economic performance and the Nairobi Securities exchange, having grown over the years to become the fourth largest securities exchange in Africa in trading volumes today is no different. It provides for a platform for companies, governments and individuals to raise both short-term and long-term funds to facilitate the growth of businesses, manpower development, acquisition of real estate, advancement of government projects and critical infrastructure development which in turn provide return on investment to share holders through capital gains of traded shares and dividends.

These stocks are floated in some form of market place in this case the Nairobi Securities Exchange which controls the process of floating the stocks, trading them between the traders. The prices are controlled by external factors and economic laws such as supply and demand, opinions of outcome of real-world events from different people including company outlook, whether it's making profits, internal wrangles, acquisitions, the political climate, relationships with foreign investors and so on.

This research involves the development of a model that uses the agents to collect these dynamics and a controller agent uses known facts to make a decision based on the environment outlook and thus advice the traders respectively.

Investing in the stock market requires vast information on how the market runs. The skills on how to select good stocks, what prices to get them in and when to sell are key. These factors inform what to buy and at what price with the objective of making gains through dividend or price appreciation.

Stock price prediction is one of the most challenging application areas for stock broking firms, investment banks, fund management firms and private investors who do trading in the securities exchange (Jakob, 2012). Recent research (Senthamarai, et al., 2010) shows that many fund management firms have invested heavily in information technology to help them manage their financial portfolios. Over the last three decades increasingly large amounts of historical data have been stored electronically and this volume is expected to increase and grow considerably in the future. Yet despite this immense wealth of data many traders and fund managers have not been able to fully capitalize on their value. This is because information that is inherent in the data for the purpose of investment is not easy to determine.

It's challenging task due to the fact that historical data holds essential memory for predicting future direction but must combined with the many correlated factors like economic, political, social and company outlook that cause uncertainties and in turn affect the prices of a stock. There is a lot of interest in using computational intelligence to try and analyze extensive historical datasets on stock prices and come up with tools to assist this area and act as recommendation systems for traders that inform them of the future stock trend in order to improve profitability of a short or medium time period investment.

1.2 Problem Statement

Financial analysts, stock brokers, individuals and fund managers who trade in the Nairobi Securities Exchange lack accurate models to enable them predict the future price of a stock thus make decision of buy, sell or hold in view of maximizing portfolio's and returns. Its noted by the Capital Markets Authority (2014) that choosing the company shares to invest in is an intricate decision and the current methods in use are; *Fundamental Analysis*; study the company's current management and position in the market and *Technical analysis*; which is purely based on charts to identify price trends the company's stock has and invest accordingly. The current observed trend is that the decision to buy is entirely for the client and sometimes some advice from the stock broker and investment bank. This has led to selection being made based on speculation with no supporting fundamentals to justify the growth of a company's share price and a failure to look at the economic situation, the industry

into which the company is trading in and strong points from the company like current management, market share and sustainability of profits. The use of automated tools is therefore not mentioned in this market.

Also, Most of the traders and investors apart from the large stock brokers and investment banks can't afford the expensive algorithms and software's for prediction nor do they have relevant experience to make relevant, efficient predictions of future stock price. A survey on such a tool like *marketreckon* may be out of reach of small investors with the full version costing price at $4997 which is equivalent to KES 429,742 at the rate of KES86 for $1.

1.3 Objectives:

The goal of this project is to create a recommender system model based on multi Agent architecture that shows stock price trend, taking into account the various external dynamics in the environment that affect price and intern provide an accurate position of whether to buy or sell a stock thus enabling the investor easy decision making in view of maximizing returns.

The objectives of the study include the following:

Research Objectives

i. Assess the impact of using agent in stock price prediction
ii. Assess the agent based stock price prediction system

System objectives

iii. Perform a system analysis process and develop a system requirements Model
iv. Develop an agent based design for the system
v. Construct and test the agent based system using JADE
vi. Use data generated from the system to evaluate stock price predictions.
vii. Provide support for the traders at the NSE on whether stock price is going up or down thus enable them decide to BUY, SELL or HOLD
viii. Provide a Graphical user interface for the User interaction and feedback.

1.4 Research Questions / Hypothesis

- What are the external and environmental factors that affect stock prices?
- How do you classify these factors and their contribution to price change? Is it a negative or a positive effect?
- How do you allocate payloads to agents to represent these identified factors?
- How can we optimize the agent's payloads and their effect on price individually to know the final effects once they are combined?
- How to incorporate the previous day's close price and trend.
- What is the effectiveness of agent-based approach to stock price prediction at the NSE?

1.5 Significance of the Study:

There are numerous techniques that have been adopted in the recent past in the area of stock market forecasting which include and not limited to Neural Network, Data mining, Markov model and traditional methods Time series analysis, fundamental factors and technical analysis which are statistical based. The area with the highest level of accuracy in prediction so far has been the artificial neural network since it has the ability to extract useful information from large sets of data for a properly trained neural network. However, implementing a neural network can be difficult for non-experts. One big obstacle of implementing neural network is formalization of inputs.

As an example, today's planes are fitted with different altimeters; barometric altimeters, radar altimeters and GPS and not to mention the pilots also use visual estimation of altitude. Why do we need to use so many measuring tools? First, any of them can fail and secondly the level of accuracy is improved. Including meteorologists they use many different methods to improve the quality of weather forecasts. Thus the use of a multi agent based method in stock price prediction so as to improve accuracy while resolving the problems with the other methods

The Model developed is a recommender system that informs the various traders about the future stock trend and gives an output of UP, DOWN, VOLATILE as the recommendation which can help the trader improve profitability of a short or medium

time period investment. A Graphical dashboard interface is provided to enhance interaction with the system and easy data interpretation for the traders.

The model will allow a short term to medium term prediction of stock price for specific share along variable time intervals and a graphical representation will be presented to provide ease in result interpretation and visualization of the predicted stock price movement.

1.6 Limitations of the Research

This Research focuses on analyzing how stock market prices are affected by external and environmental factors and how one can use multi agents systems to assists traders and guide them to know which stock is a good buy and sell at any one time

This research is trying to un wrap future events whose outcome is undetermined. With the source of information being what is publicly available about the various stock and the corresponding companies some of which may be purely personal opinion sentiments, miss-reporting by the media and public perception; classifying the result implication of these sentiments will be a challenge.

The Research will also not include all the trading companies In the NSE but a representative sample of the top trading companies as per market capitalization.

1.7 Expected Contributions

My research is expected to contribute to the study in the applications and use of cooperative agents and multi-agent architecture in the financial services sectors of an economy.

The major issues that affect price fluctuations at the NSE will be highlighted.

My research will also provide investors and brokers an affordable advisory modeling platform informing them whether to buy sell or hold on to a share in view of maximizing profits.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction:

This chapter presents the literature review relating to previous work in financial prediction like stock price prediction and also the theory of agents and multi-agent systems.

2.2 The Nairobi Securities Exchange

The Stock market is a public market for trading the company's stocks and derivate at an approved stock price. These are called securities listed on the securities exchange. The NSE is regulated by the capital market authority. The securities exchange allows companies to buy and sell their shares. The price is determined by supply and demand. The price will be high when the demand is high and will decrease incase it's hard to sell the shares. This is called trading and the companies permitted are the 'listed companies'. Generally, investments in the stock market require long time frames, and regular investments to take advantage of market cycles. In the short-term, prices are usually volatile but over a longer period, shares tend to have relatively good returns depending on a company's fundamentals. Gains on any investment of shares are not guaranteed and the possibility of making a loss is equally probable. Changes in price occur. A decline in price below the purchase price will create loss; if the price appreciates above the buying price, you then have an unrealized profit. The loss or gain is realized (actualized) when you sell the shares and collect the money. (Nairobi securities exchange 2014).

The way an exchange works is a two sided auction where traders act as both buyers and sellers. The two sided auction also known as double auction is different from other market places like consumer auction sites where there are multiple separate single- sided auctions. In the exchange markets, there are many potential buyers and sellers of many units of the same good i.e. shares of a company. (Yoav, 2009).

There are many factors that affect the stock prices in the NSE. These include the following:

Politics: The political situation in the country affects the investor confidence and therefore the performance of the stocks. If there a calm political climate, the prices are positively affected but in case of dire political fallout, prices will negatively affected.

Company Outlook: This includes any news that is available about the company. Whether it is making a profit or loss, the management structure, the products they are selling and if they are good and any other news in relation to the general company.

Economic outlook: In the country, how the economy is performing will affect the overall prices of stocks. Debt crisis and slow economic outlook will affect negatively while a bright economy will affect positively.

National Distress: This include terrorism acts, war, coups and any other form of aggression that may cause the country to be under distress will negatively affect stock prices.

Inter Competition: Key competing companies are affected by each other's performance in that if the competitor is doing better, chances are that you're not thus a negative effect. E.g. for sporting company if one team is winning the other is losing.

Government Policy: The policies developed by the government of the day may have a positive or negative effect to a companies' stock price depending if it's in favor with its operations or not.

Natural Factors: Natural occurring events like tsunami's and earthquake may have devastating effects to the country, economy, and people hence lead to changes in prices.

2.3 Why Multi Agents?

The most common method of prediction being currently used is Artificial Neural networks and they have proved successful. This does not mean they are perfect as they have downsides; as Karl (2004) indicates, the black-box-property is the first springs to mind. Relating one single outcome of a network to a specific internal decision (known as the credit assignment problem) is very difficult. Noisy data also

reinforce the negative implications of establishing incorrect causalities, overtraining (or over fitting), which will harm generalization. Finally, a certain degree of knowledge in current subject is required as it is not trivial to assess the relevance of chosen input series.

According to Jakob (2012), it is ideal to use a multi-agent simulation in that it can model complex interactions much more accurately and realistically compared to any static algorithm. Various static algorithms have been common in market prediction for years and some do generally well, these algorithms commonly work by taking a set of historical prices from the market and analyzing them by using different algorithms (running averages, high-low points, candlestick calculations) to produce a very short term prediction on the general rise or fall of the stock prices. But the limitation of these algorithms is that they usually only predict a very short term rise or fall (the next couple of price iterations, be that next few minutes, hours or days in that specific granularity), but don't predict actual price trend over a longer period (over more than a few trading session iterations). Multi-Agent simulation uses the concept of many agents in a system to model various objects that contain interactions (e.g. a financial market). On their own these agents are relatively un-intelligent, governed only by a set of rules of interaction. But with the introduction of many agents into the system, the rules of interaction form much more complex behaviors and patterns that are difficult and in many cases impossible to model using conventional algorithms, as these rules of interaction for each agent are a subset of the algorithms used for static prediction, as mentioned earlier. So what is actually observed in a multi-agent simulation is the result of the interaction of all the various algorithms working together and competing against each other.

2.4 Software Agent Technology

Software agent technology is a relatively new software engineering paradigm, a shift from the structured programming and object oriented programming approach that has been widely used in the traditional software engineering environment. In this new approach, agents are intelligent through reasoning, communication and interactions and they do most of the work. They are modeled in a way that corresponds to how humans understand the world. Agents operate in environments in which they may

have full or partial influence. These environments are usually non-deterministic with the effect that an agent cannot expect the same result each time it performs the same action.

A variety of definitions exist on what an agent is and a more popular definition from Wooldridge and Jennings (1995), an agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet design objectives.

A multi Agent system is one that consists of a number of agents which interact with each other typically by exchanging messages through some computer network infrastructure. They achieve this through their ability to cooperate, coordinate and negotiate with each other.

Some common characteristics of software agents include (Wooldridge & Jennings, 1995)

- **Autonomy** - Agents must be able to operate without direct intervention by humans or other agents.
- **Reactive** - Agents must be able to react to changes in the environment in time for actions to be useful.
- **Pro-activeness** - Agents must be able to take initiative to act in their operating environment.
- **Social ability** - Agents participating in a multi-agent system must be able to communicate with each other in the system.
- **Mobility –** ability to move around network platforms
- **Veracity** – Avoid communicating false information knowingly
- **Benevolence** – conflicting goals. Always try to do what she is asked
- **Rationality** – Acts in order to achieve its goals subject to beliefs.
- **Learning / Adaptation** – can improve performance over time.
- **Personality** – Have distinct personality – behavior, name, and role.

According to Wooldridge (2002), if agent's posses an appropriate balance of these they can be considered intelligent.

The characteristics of multi-agent systems include

- Each agent has incomplete information
- Control is decentralized
- Data is decentralized
- Computation is asynchronous.

2.5 Agent Architectures and Agent Modeling

This section explains how agents are internally modeled and constructed.

Maes defines agent architecture as a particular methodology for building agents. It specifies how the agent can be decomposed into the construction of a set of component modules and how these modules should be made to interact. Architecture encompasses techniques and algorithms that support this methodology.

Kaelbling considers agent architecture to be a specific collection of software (or hardware) modules, typically designated by boxes with arrows indicating the data and control flow among the modules. A more abstract view of architecture is as a general methodology for designing particular, modular decompositions for particular tasks.

2.5.1 Agent Architectures:

There are three main types of agent architectures:

i. Symbolic/logical
ii. Reactive
iii. Hybrid.

Logic-based (Symbolic) architectures draw their foundation from traditional knowledge-based systems techniques in which an environment is symbolically represented and manipulated using reasoning mechanisms. The advantage of this approach is that the human knowledge is symbolic so encoding is easier and they can be constructed to be computationally complete, which makes it easier for humans to understand the logic. The disadvantage is that it's difficult to translate the real world problem into an accurate, adequate symbolic description, and the symbolic representation and manipulation can

take considerable time to execute with results are often available to late to be useful. There are some solutions however to solve some of the merging problems like

- Weaken the logic
- Use symbolic, non-logical representations
- Shift the emphasis of reasoning from run time to design time.

Reactive architectures implement decision making as a direct mapping of situation to action and are based on stimulus – response mechanism triggered by sensor data. Unlike logic based architectures, they do not have any central symbolic model and therefore do not utilize any complex symbolic reasoning. Purely reactive agents make no reference to their history and base their decisions on the present without any reference to the past like a thermostat. The many unresolved problems associated with symbolic AI led to the development of reactive architectures.

Rodney Allen Brooks (Criticism of mainstream AI) - behavior languages. Brooks put forward these three theses.

i. Intelligent behavior can be generated without an explicit representation of the kind of symbolic AI proposes.
ii. Intelligent behavior can be generated without explicit abstract reasoning of the kind that AI proposes
iii. Intelligent is an emergent property of certain complex systems.

Hybrid (layered) architectures allow both reactive and deliberative agent architecture. To enable this flexibility, subsystems arranged as layers of a hierarchy are utilized to accommodate both types of agent behavior. There are two types of control flow within a layered architecture; vertical and horizontal layering. In horizontal layering, the layers are directly connected to the sensory input and action output (see Figure 2), which essentially has each layer acting like an agent. The main advantage of this is the simplicity of design since if the agent needs n different types of behaviors, then the architecture only requires n layers. However, since each layer is in effect an agent, their actions could be inconsistent prompting the need for a mediator

function to control the actions. Another complexity is the large number of possible interactions between horizontal layers–m (where m is the number of actions per layer). Vertical layer architecture eliminates some of these issues as the sensory input and action output are each dealt with by at most one layer each (creating no inconsistent action suggestions). The vertical layered architecture can be subdivided into one-pass and two-pass control architectures. In one-pass architectures, Control flow from the initial layers that gets data from sensors to the final layers that generates action output. In two-pass architectures, data flows up the sequence of layers and control then flows back down as shown below (see figure 2). The main advantage of vertical layered architecture is the interaction between layers is reduced significantly to *m2 (n-1)*. The main disadvantage is that the architecture depends on all layers and is not fault tolerant, so if one layer fails, the entire system fails.

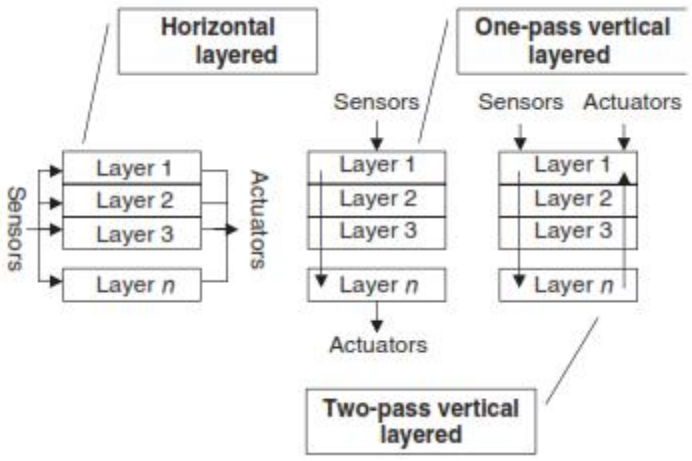

Figure 1: Data control Flows in Layered Architecture

2.5.2 Agent Modeling

Modeling means to capture ideas, relationships, decisions and requirements in a well defined notation that can be applied to many different domains.

Modeling not only means different things to different people but also it can use different aspects of a tool such as UML depending on what you are trying to convey. Modeling languages are used to Specify, Visualize, Construct and document systems. Modeling is a part of the process of constructing multi-agent systems.

The conceptual structures are formulated and decisions related to overall framework are considered. The modeling process however depends on a number of things including the architecture, development framework and application area. You model the agent's basic characteristics, behavior, interactions and decision making.

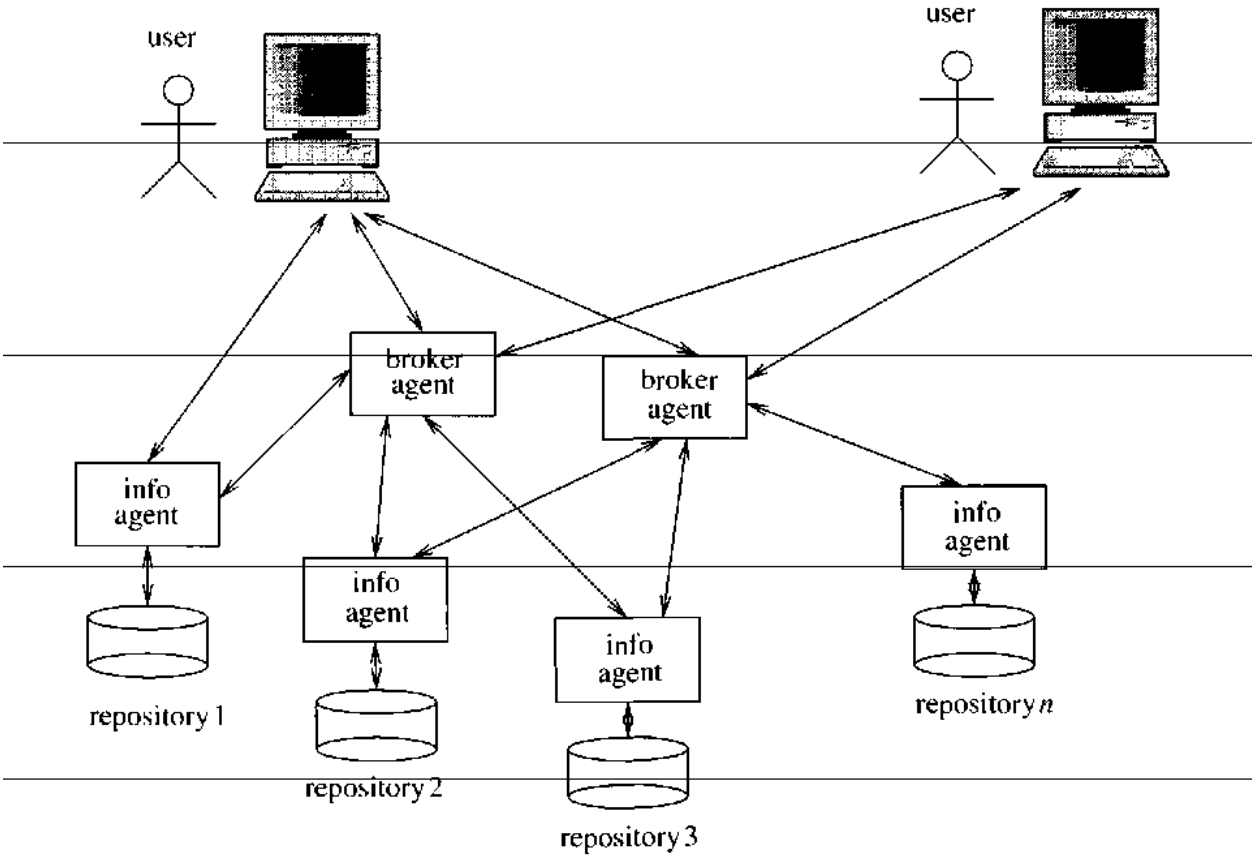

Figure 2 Architecture of a multi-Agent System (Woodridge, 2002)

2.6 Agent Methodologies

A methodology is a body of methods employed by a discipline. A method is a procedure for attaining something. (Paulo Girogini, 2005)

2.6.1 Cases Where Agent Solution Is Appropriate

I. Open, dynamic, uncertain or complex environment
II. Agents are natural metaphors- such as in organizations with distributed functions, intelligent interfaces.
III. Data control or expertise is distributed- such as database systems with different autonomous ownership.
IV. Legacy systems- where interface to old system are important.

2.6.2 Why Agent Oriented Approach?

I. These are limitations with current object oriented modeling approach. (Franco, Andrea, 2004).
II. An object, unlike an agent, is neither autonomous nor proactive
III. OO-applications do not give explicit model of external "environment"; since everything is modeled in terms of objects.
IV. Object based computing promotes a perspective on software's in which components are "functional" or "service oriented" entities.
V. Object based computing leads to global system architecture that is conceived as a static functional decomposition, where interactions between components/ objects are simply an expression of inter-dependencies and where concepts such as society or roles simply do not make any sense.
VI. Object oriented and the agent-oriented perspective on modeling and building a software system are sharply different. Agent based computing represents a brand new software engineering paradigm calling a new discipline of agent oriented software engineering. (AOSE)

2.6.3 Features of Agent Methodology

According to Paulo Girogini (2005); the features include;

I. Provide sufficient abstractions to fully model and support agents and MASs – arguably;
II. Should focus on an organized society of agents playing roles within an environment

III. Support MAS, where agents interact according to protocols determined by the agent roles;

IV. Should be “agent oriented” in that it is geared towards the creation of agent-based software.

2.6.4 An Agent Methodology

Australian AI institute (AAII) agent development methodology

Internal and external models are used. An external model identifies the agents and their interactions. Internal models represent the implementations. The development process is as given below:

I. Identify the relevant agent roles and use these roles to develop agent hierarchies.

II. Identify responsibilities associated with each role, services required or provided by each role and goals related to each service.

III. For every goal work out the plans used to achieve it and the contexts when the plans can be applied.

IV. Formulate the belief structure for the system, which consists of information required for each plan and goal. For example speed(X) means the current speed is X

2.6.5 Agent Oriented Analysis Model

The figure below represents the agent oriented analysis model. (Burmeister, 1996)

Agent Model – Actual Agents

Organizational model – Static relationships between agents

Cooperation model – interaction and cooperation between agents.

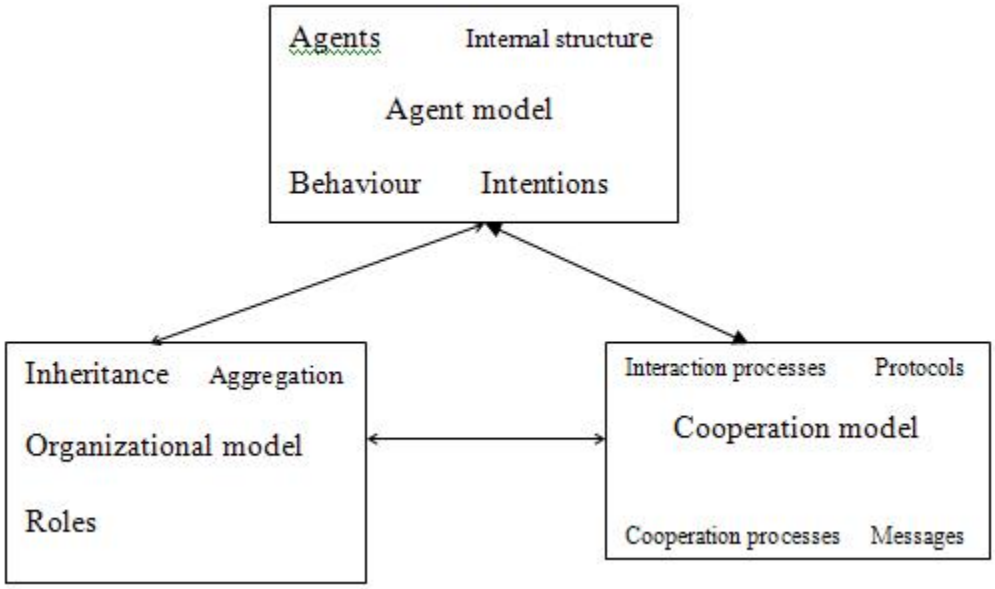

Figure 3: An Agent Analysis Model (Burmeister, 1996)

The figure below represents the influences of object oriented methodology on agent oriented methodology.

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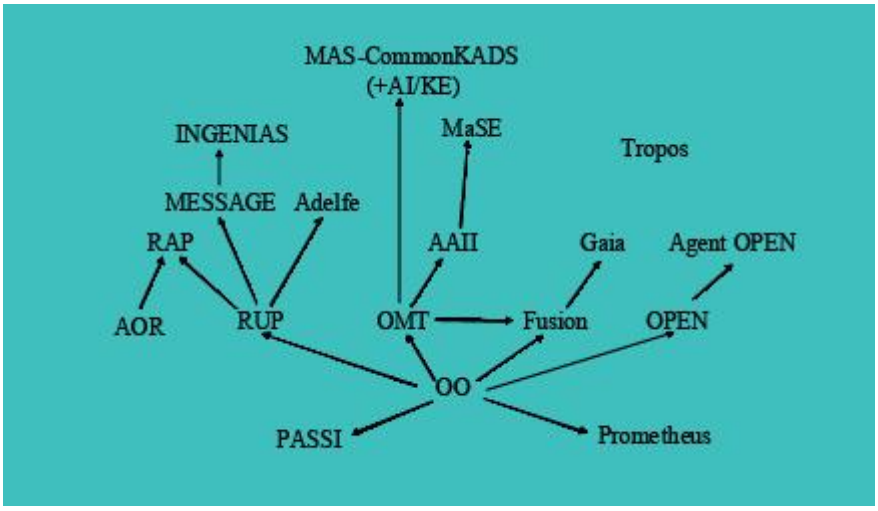


Figure 4: Agent Genealogies (James, 2005)

For this Project, I will use the Passi Methodology (Italy)

2.6.6 The Passi Methodology (Italy)

Process for agent society's specification and implementation (PASSI)

Is a step by step requirement to code methodology for?

Designing and developing multi-agent societies integrating design models and concepts from both object-oriented software engineering and MAS, using unified modeling language (UML) notation.

PASSI evolved out of theoretical studies and experiments in the development of embedded robotics applications.

2.6.7 Why Passi Methodology?

The PASSI methodology brings a particular rich development lifecycle that spans initial requirements through deployment and, in addition emphasizes the social model of agent based systems.

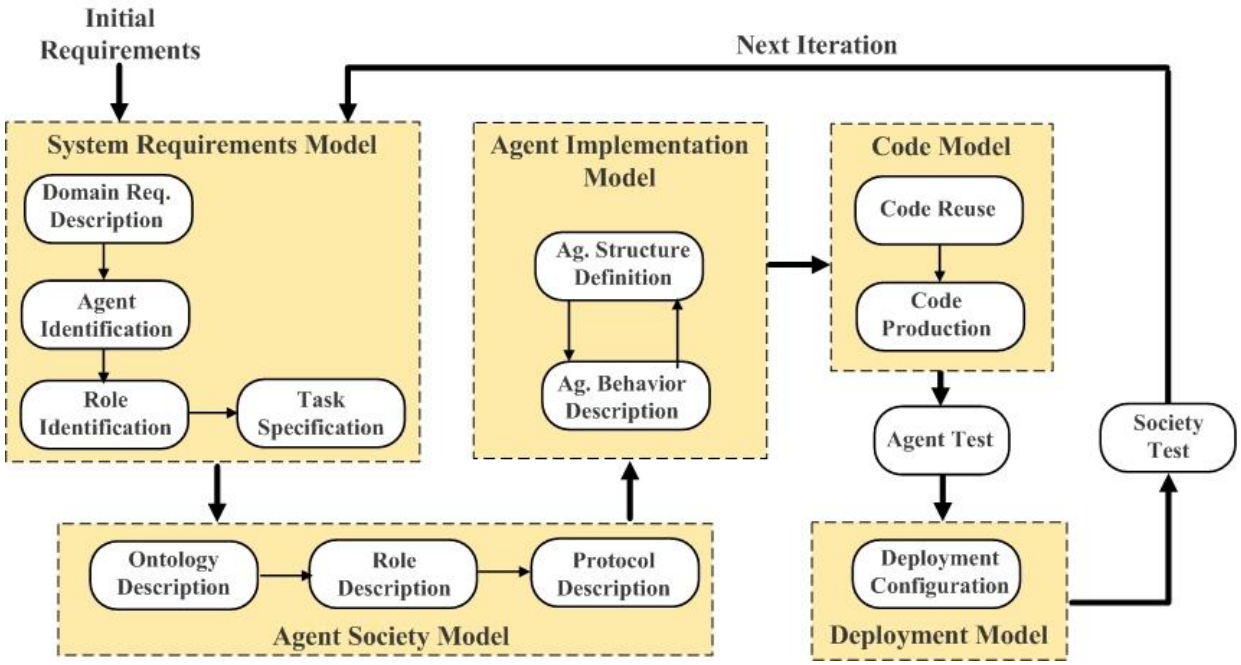


Figure 5: Phases of PASSI Methodology. (Massimo Cossentino (2005))

2.6.8 Systems Requirements Model

This will contain the following activities as described in the PASSI methodology. It is a model of the system requirements in terms of agency and purpose. It is made of four phases;

- Domain requirements description: A functional description of the system using convectional use case diagrams.
- Agent identification: The phase of attribution of responsibilities to agents, represented as stereotyped UML packages.
- Roles identification; A series of sequence diagrams exploring the responsibilities of each agent through role-specific scenarios
- Task Specification: Specification of the capabilities of each agent with activity diagrams.

2.6.9 Agent Society Model

This entails a model of the social interactions and dependencies among the agents involved in the solution. Developing this model involves three phases.

- Ontology specification; Use of class diagrams and OCL constraints to describe the knowledge ascribed to individual agents and their communications.
- Role description: Class diagrams are used to show the roles played by agents, the tasks involved, communication capabilities and inter-agent dependencies.
- Protocol description; Use of sequence diagrams to specify the grammar of each pragmatic communication protocol in terms of speech-act per formatives.

2.6.10 Agent Implementation Model

A classical model of the solution architecture in terms of classes and methods

- Agent structure definition: produce agent overview diagrams showing the internal structure of solution agent classes.
- Agent behavior description: Activity diagrams describing the behavior of individual agents.

2.6.11 Code Model

This stage of the methodology involves

- Code production: write the code to implement the agents
- Code Reuse: Since agents are similar, reuse previously produced code to make implement more agents.

The initial Agent test will occur after this is complete

2.6.12 Deployment Model

This is the final stage in the PASSI methodology and involves deployment and configuration.

A society test will occur after the deployment is successful

The methodology is a lifecycle kind of methodology and if the result agent model is not ideal, the process can be iterated through again to achieve a perfect model.

2.7 Text Processing:

Text processing refers to the discipline of mechanizing the creation or manipulation of electronic text. Text usually refers to all the alphanumeric characters specified on the keyboard of the person performing the mechanization, but in general text here means the abstraction layer that is one layer above the standard character encoding of the target text. The term processing refers to automated (or mechanized) processing, as opposed to the same manipulation done manually. Text processing involves computer commands which invoke content, content changes, and cursor movement, for example to search and replace, format, generate a processed report of the content of, or filter a file or report of a text file.

The project utilizes Regular expressions which are small computer language of their own and should are developed with just as much discipline and care as we apply to writing any computer code. In particular, a complex regular expression is built up in smaller pieces in order to understand how each component of the regular expression works before adding further components.

The text processing of a regular expression is a virtual editing machine, having a primitive programming language that has named registers (identifiers), and named positions in the sequence of characters comprising the text. Using these, the "text processor" can, for example, mark a region of text, and then move it. The text processing of a utility is a filter program, or filter. These two mechanisms comprise text processing.

2.8 Prediction:

Forecasting the outcome of events that will happen in the future is a frequently indulged area for day to day activities. Despite the ubiquity of the forecasts, predicting the outcome of future events is a challenging task for both humans and computers. It requires extremely complex calculations involving reasonable amount of domain knowledge, significant amount of information processing and accurate reasoning, (Janyl, 2012).

Khalid et al, (2013) indicates that recent research interests are intense in areas of future predictions of events/ price movements as the traditional time series has proven difficult and inaccurate which make it challenging and demanding. Researchers, Businessmen and investors who assume that future occurrence depends on present and past data are keen to identify the stock price prediction of movements in stock markets.

One of the pillars of current financial theory is the *Efficient Market Hypothesis* (EMH), which assumes the prices in the financial markets are based on rationale expectations of traders who are trying to maximize their expected utility. As a consequence, past information cannot help predicting the future prices and markets are assumed to be free of internal dynamics of their own. Van den Bergh et al,(n.d) further indicates that in such a setting, mathematical models of price movements in the markets are based on assumptions of homogeneity of traders (e.g. traders are rational), equilibrium analysis and the possession of all relevant information by the traders. Any deviations from these idealized conditions are considered to be exogenous effects or uncertainty (e.g. noise).

Despite the EMH view, it has been suggested that the empirical evidence regarding the price patterns observed in financial markets seem to indicate that the market do have internal dynamics of their own.

Van den Bergh et al, (n.d) further indicates that one promising way of analyzing the internal dynamics of financial markets is the use of agent-based approach. In recent years the agent-based approach to economical and financial analysis has grown into an important research field for developing an understanding of the complex patterns

and phenomena that are observed in the economic system. The agent based approach to the analysis of financial systems models, financial markets as evolutionary systems of competing bounded rational agents. The agents adapt, learn, and evolve in order to remain successful in their competition with other agents.

The EMH is considered as the bridging gap between financial information and the financial markets; it also affirms that the fluctuations in prices are only a result of newly available information and this information is reflected in market prices. In addition to purchasing and selling stocks in the stock market, each share is not only characterized by its price, but also by other variables such as closing price which represents most important variable for predicting the next day price for a specific stock. There is also a relationship with the variables that affect price movements over time like economic factors like political stability, company news, area of operation, currency exchange.

There exist several techniques for stock market price prediction such as

- Technical analysis methods: does not care about the company value only interested in the movement of the market or stock in terms of price.
- Fundamental analysis methods: Involves analyzing the characteristics of a company in order to estimate its value
- Traditional time series prediction methods; in conventional time series analysis instructions and rules are central. A mathematical formula describes the dynamics. One picks a model that is assumed to be applicable for the present task, e.g. the well known Auto Regressive Moving Average (ARMA) model. (Karl 2004)

- Machine learning methods. These are mostly artificial neural networks which have proven most accurate. Neural networks have several advantages. Most important is the ability to learn from data and thus potential to generalize, i.e. produce an acceptable output for previously unseen input data (important in prediction tasks). When displayed to data the network gains experience, learns from regularities in the past and sets its own rules. Data are not described explicitly in mathematical terms. This even holds (to a certain extent) when

> input series contain low-quality or missing data. Another valuable quality is the non-linear nature of a neural network. Potentially a vast amount of problems may be solved. Furthermore no expert system (typically a programmer coding rules in a computer program) is needed which makes the network extremely supple to changes in the environment. One only has to retrain the system. (Karl 2004)

Stock market forecasters focus on developing successful approach to foretell / predict stock prices. Ultimate aim is to earn high profits using well defined trading strategies. The vital idea to successful stock market prediction is achieving best result also minimize the inaccurate forecast of the stock price.

2.9 Related Work: Agent Based Prediction

Modern Finance aims at identifying efficient ways to understand and visualize stock market data into useful information that will aid better investing decisions. Since financial tasks are often stochastic, dynamic, nonlinear, time-varying, flexible , structured and are affected by many economical and political factors; The predictability of stock market return as well as pricing of stock index financial instruments rely on accurate forecasting of the value or price of the stocks to hedge risks or enjoy benefit or arbitrage, therefore being able to accurately forecast stock price has profound implications and significance to researchers and practitioners alike. Subha (2012).

Blake LeBaron, 2005 conducted research on agent based computational models used in finance where the agents represent heterogeneity across a fixed or changing set of strategies. He indicated that financial markets are particularly appealing for agent based methods due to key debates in finance like market efficiency and rationality which are still unresolved, financial time series contains many curious puzzles that are still not well understood, financial markets provide a wealth of pricing and volume data that can be analyzed. He showed several strong connections to relevant experimental results that in some cases operate the same time scales as actual financial markets.

T. Lux et al, (2006) has also done extensive research on agent based models of financial markets and showed how recent models are able to explain some statistical properties also called anomalies of financial data.

Logistic regression (Hosmer &lemeshow 1989; press& Wilson, 1978; studenmund, 1992) and multiple regressions (Menard, 1993, Myers, 1990) are the classical statistical methods that have been widely employed in various studies relating to stock market analysis. Statistics have been applied for predicting the behavior of the stock market for more than half a century with a 54% hit rate which is considered as a satisfying result for stock prediction. To reach better hit rates , other data mining and machine learning methods like neural networks have been applied to stock prediction as they have proved to outperform the classical methods at a 5-20% higher accuracy rates as indicated by Subha (2012) in reference to Ren et al., (2006). However, ways of improving the dynamics and performance of these has been achieved using multi-agents as you capture all the heterogeneity and emerging factors represented by various agents.

2.10 Conceptual Framework

The proposed multi agent system will be able to provide an output that informs the trader/ broker whether to Buy sell or hold on to a share. The conceptual model of the agent will have the following agents and a database. Political Environment Scan agent, Company Environment scan agent, Economic environmental scan agent, Control Agent.

Political Environment Scan Agent: This agent will be able to check and analyze the political climate and update the control agent on the trend and how that will affect prices at the NSE. Its sources will be media, news, declarations etc.

Company Environment Scan Agent: This is the agent that will survey the trend of the company that has issued the stock. Is it making profits, are there internal wrangles, boardroom wars and how they affect stock price and update the control agent.

Economic Environment scan Agent: This Agent will update the control agent on the fundamental changes that can affect stock price changes. Like debt crisis, foreign exchange etc.

National Distress Scan Agent: This Agent will check if there are any national distress facts that may affect stock prices like are we at war, or attack including terrorism.

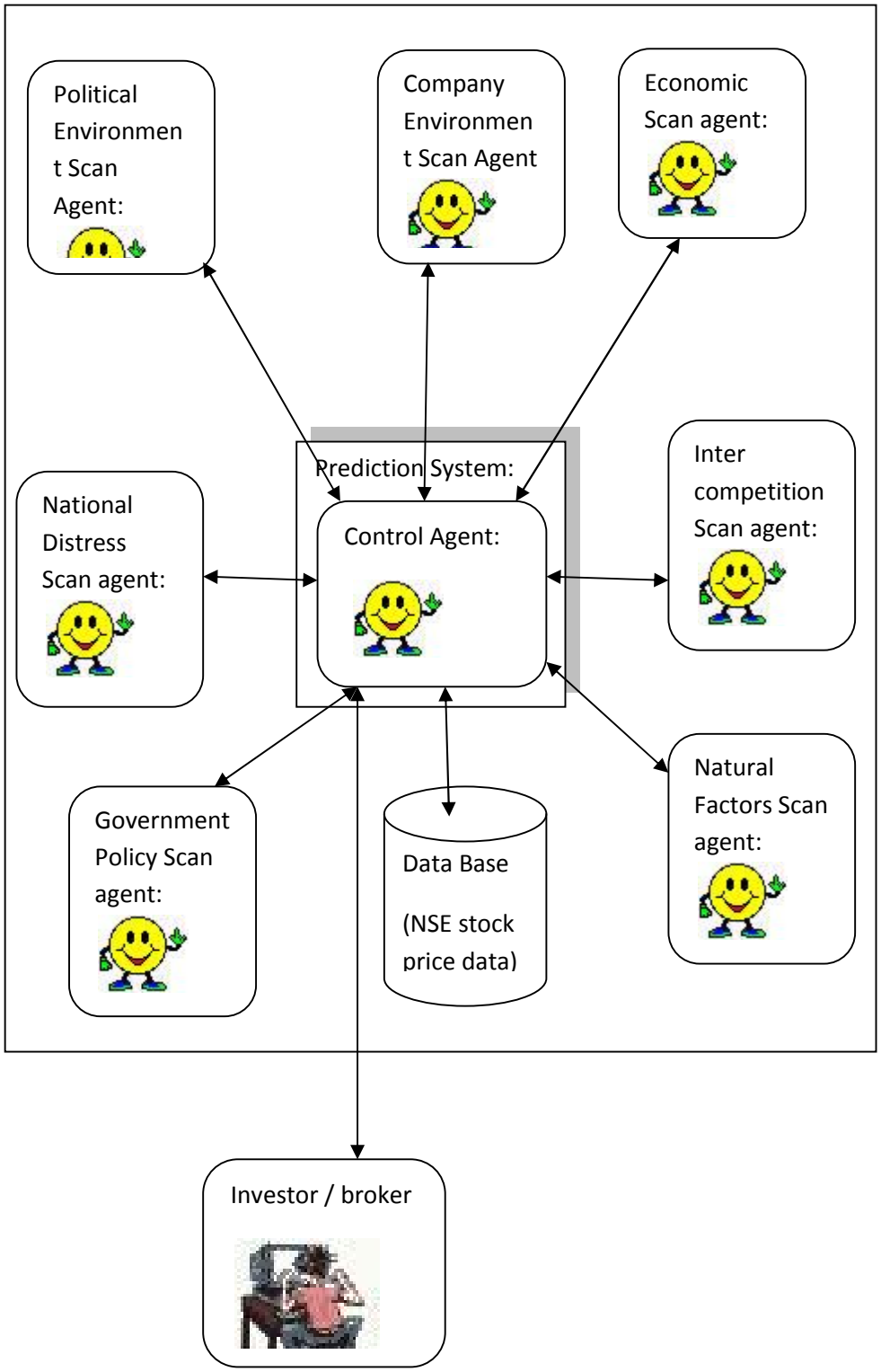
Inter competition Scan Agent: This agent scans our competitors as the company with a listed stock and record effects of their work or products or performance that may affect our stock price

Natural Factors scan agent: This agent check which natural factors are occurring and if they may affect our companies' stock rice like earthquakes, tsunami's and records the effects.

Control Agent: This is the control agent that brings in all the updated factors and checks the database for the stock price, traded volumes and makes a logical conclusion of the trend which is the output of the system.

The database will be holding data from the NSE, including the stock price, highest price, traded volume etc. It will also hold information on the stocks and will be updated by the control agent.

Figure 6: The Conceptual Model



3.0 CHAPTER THREE: METHODOLOGY

3.1 Introduction:

This section seeks to indicate how the objectives will be achieved. The multi-agent methodology that will be used in the system design is represented. It analyzes the developed model functional and non functional requirements.

3.2 Agent Methodology:

There are a variety of methodologies for developing multi-agent systems including the Tropos methodology which is a requirements driven methodology, MAS-CommonKADS is based on commonKADS and object-oriented base methodologies, Passi methodology, Prometheus methodology, Gaia methodology uses the analogy of human based organizations, Adelfe methodology is specialized methodology that emphasizes cooperative agents that self organize and possibly result in emergent systems, Message methodology where analysis and design process is based on the rational unified process, Igneas methodology, Radical Agent Oriented software engineering processes methodology and Multi-Agent systems engineering methodology based on object oriented techniques and uses defined in the unified modeling language.

For this system, PASSI is the methodology to be applied.

3.3 Sources of Data

The study will utilize both primary and secondary data sources as the sources of data. Where a sample is required, a systematic none bias sampling technique will be utilized.

3.3.1 Data Collection

The objective of data collection is to obtain System data. Secondary data from the NSE will also be got at a premium. Also the internet will provide for news related data

3.3.2 Data Analysis

The secondary data will be processed to ensure completeness, detect errors, omissions and classify it. Analysis and sampling technique will be employed to be able to choose which stocks to work with a sample of 15 most active counters.

3.3.3 Questionnaire

I will provide the willing stock brokers and investor participants who will be willing to share their trading strategies in the stock exchange in order to have data for evaluation with the system. Due to the sensitivity and safeguarding of such trade secrets, I will rely on personal networking and recommendations from fellow researchers.

The aim will be to understand how they find the user interface, test whether they can be able to view a forecast; the clarity of output provided and understood and lastly the correctness of such advice.

3.4 System Design

The system will be designed guided by the PASSI methodology. This methodology brings a particular rich development lifecycle that spans initial requirements through deployment and in addition emphasizes the social model of agent based systems.

3.4.1 System Requirements Model

This will contain the following activities as described in the PASSI methodology. The Domain requirements including the functional description of the system using use case diagrams and actual agent identification including their roles and task specification will be done in this stage.

3.4.2 Agent Society Model

This stage will include the modeling of social interactions of the agents and their dependencies' by describing their knowledge and communications that is ontology, also the role description and protocol description by utilizing sequence diagrams.

3.4.3 Agent Implementation Model

Here the agent structure definition including overview diagram and agent behavior description of individual agents.

3.4.4 Agent Code and Deployment Model

This stage involves actual code production and reuse for similar agents. After which deployment and configuration takes place. A society test occurs after deployment is successful.

3.5 Implementation

Implementation of the agent based price prediction system will be done through the use of Java Agent Development Framework (JADE).The framework facilitates the development of complete agent-based applications by means of a runtime environment implementing the life-cycle support features required by agents, the core logic of agents themselves and a rich suite of graphical tools. Its written completely in java and thus it enjoys a huge set of language features and third-party libraries; thus offering a rich set of abstractions and allowing development of Jade-multi-agent systems with relatively minimal expertise in agent theory.

3.5.1 Text Processing

Regular expressions provide a very powerful way to describe general patterns in text. A regular expression consists of a mixture of literal characters, which have their normal meaning, and metacharacters, which have a special meaning. The combination describes a pattern that can be used to find matches amongst text values.

A regular expression may be as simple as a literal word, such as cat, but regular expressions can also be quite complex and express sophisticated ideas, such as [a-z]{3,4}[0-9]{3}, which describes a pattern consisting of either three or four lowercase letters followed by any three digits. These will be developed and implemented in the control agent in order to match negative and positive phrases with actual trend.

3.6 Validation

The model will be validated using live data from the NSE to check whether it's able to capture the intended objectives. Any noted variations will be investigated and corrected to ensure accuracy of the model.

A number of investors and stock brokers will fill an evaluation form provided at the appendix section and inference of the results conducted in order to show whether the research project was successful and any possible future works.

3.7 Documentation

This includes the process of report writing and is a continuous process throughout the project from beginning to the end. All parts of the documentation will be compiled together to come up with a final report for submission and examination. The report will be done using Microsoft office.

CHAPTER 4: ANALYSIS, DESIGN AND IMPLEMENTATION

4.0 Introduction

This system has been developed for stock brokers, investors and traders who trade in the Nairobi Securities Exchange to utilize as a guide to investing by providing prediction into the trend of the stock prices based on analysis of news articles affecting the stocks at a given period in time. There is the use of Multi – Agents methodology to scan for these articles and do an analysis and hence have an all inclusive form of prediction and feedback.

4.1 User Requirements

User requirements specify what users want to achieve from the developed system. These are the problems which the developed system should solve.

I. Provide Graphical User Interface for user interaction.
II. In the GUI provide a Trending dash board Display
III. Input section for Stocks Selection
IV. Secure access to the system
V. Interface to Activity listings
VI. Prediction outcome from system
VII. Administration Menu.

4.2 System Requirements

System requirements (Specifications) include the description of

I. The inputs to the Prediction system which include articles from news website and current stock prices from NSE.
II. The operation and checks performed by the system
III. The output of prediction indicating whether price of a stock is UP or DOWN thus a good BUY, SELL or HOLD option for the stock.

4.3 Analysis Using PASSI Methodology Concepts

PASSI (a process for Agent Societies Specification and Implementation) is a step by step requirement to code methodology for designing and developing multi-agent

societies integrating design models and concepts from both OO software engineering, and artificial intelligence approaches using UML notations.

Since multi-agent systems differ from non-agent ones because agents are meant to be autonomous elements of intelligent functionality. Consequently this requires that the agent based software engineering methods need to encompass standard designs activities and representation as well as models of the agent society. The target environment for this implementation is the widely implemented standard FIPA (foundation for intelligent physical agents) architecture.

In PASSI, an agent is a significant software unit at both the abstract and concrete levels of design. An agent therefore is an instance of an agent class. So it is the software implementation of an autonomous entity capable of going after an objective through its autonomous decisions, actions and social relationships. An agent may undertake several functional roles during its interactions with other agents to achieve its goals. A role is a collection of tasks performed by the agent pursuing a sub goal. A task in turn is defined as a purposeful unit of individual or interactive behavior.

4.3.1 System Requirements Model:

It's a model of the system requirements in terms of agency and purpose. It is compromised of the following phases

4.3.1.1 Domain Description Phase

This is a function description of the system composed of a hierarchical series of use case diagrams. Scenarios of the use case diagrams are explained using the sequence diagrams. We will utilize the scenario described in the problem statement in order to highlight the analysis of the stock price predictor system.

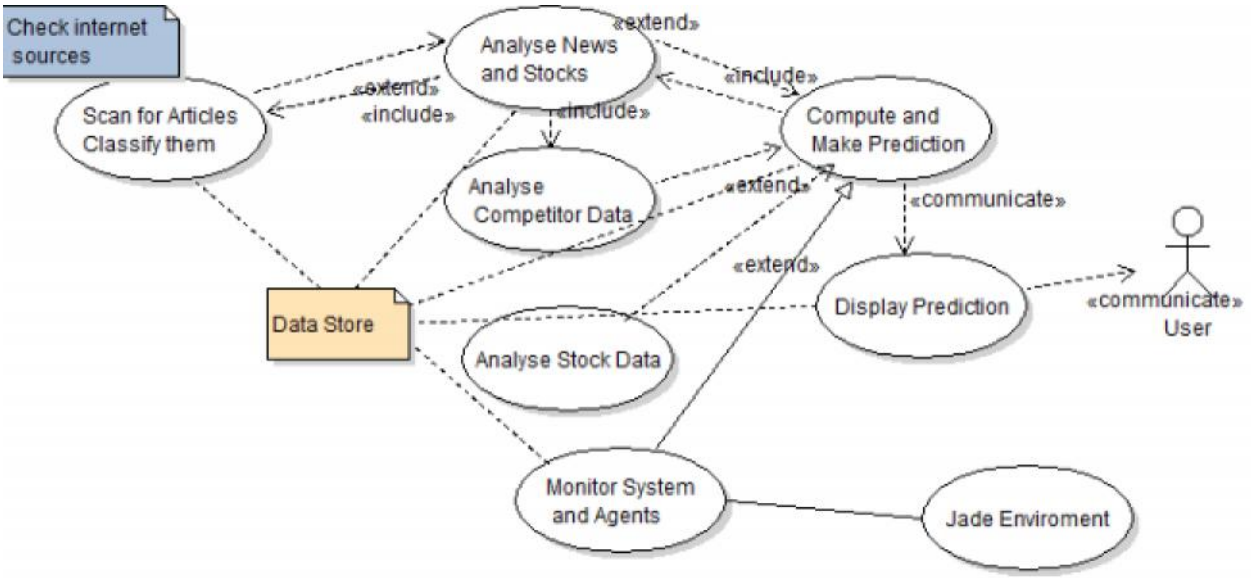


Figure 7: A Domain Requirements Description Diagram

4.3.1.2 Agent Identification Phase

This involves the attribution of responsibilities to agents represented as stereo typed UML packages. In MAS it is more reasonable to locate required behaviors' into units of responsibility from the start and thus this phase. Agent identification starts from the use case diagram above and is packaged as a functional composition from the previous phase.

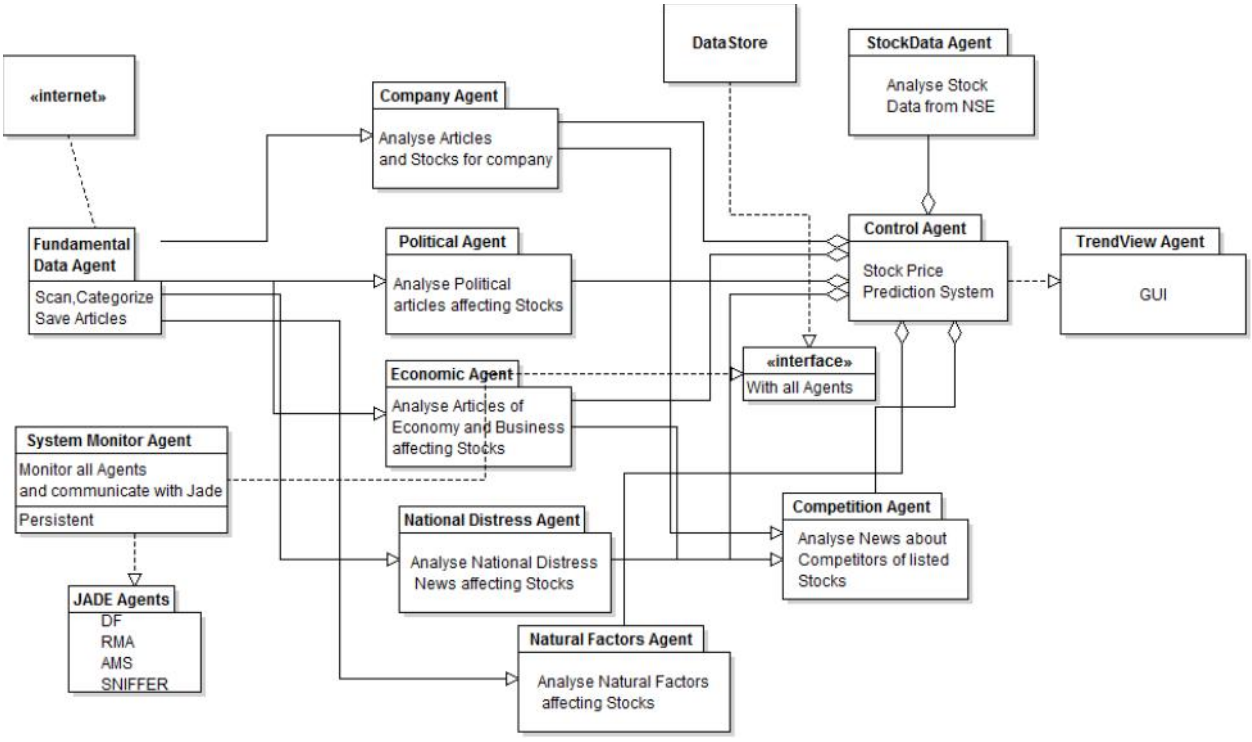


Figure 8: A Block Diagram of the Proposed System Role Identification Phase

This is a series of sequence diagram exploring the responsibilities of each agent through role- specific scenarios. It occurs early into the requirements analysis since we are now dealing with an agent's externally visible behavior than its structure.

It is based on exploring all the possibilities of agent identification diagram involving inter agent communication. A path describes a scenario of interacting agents working to achieve desired behavior.

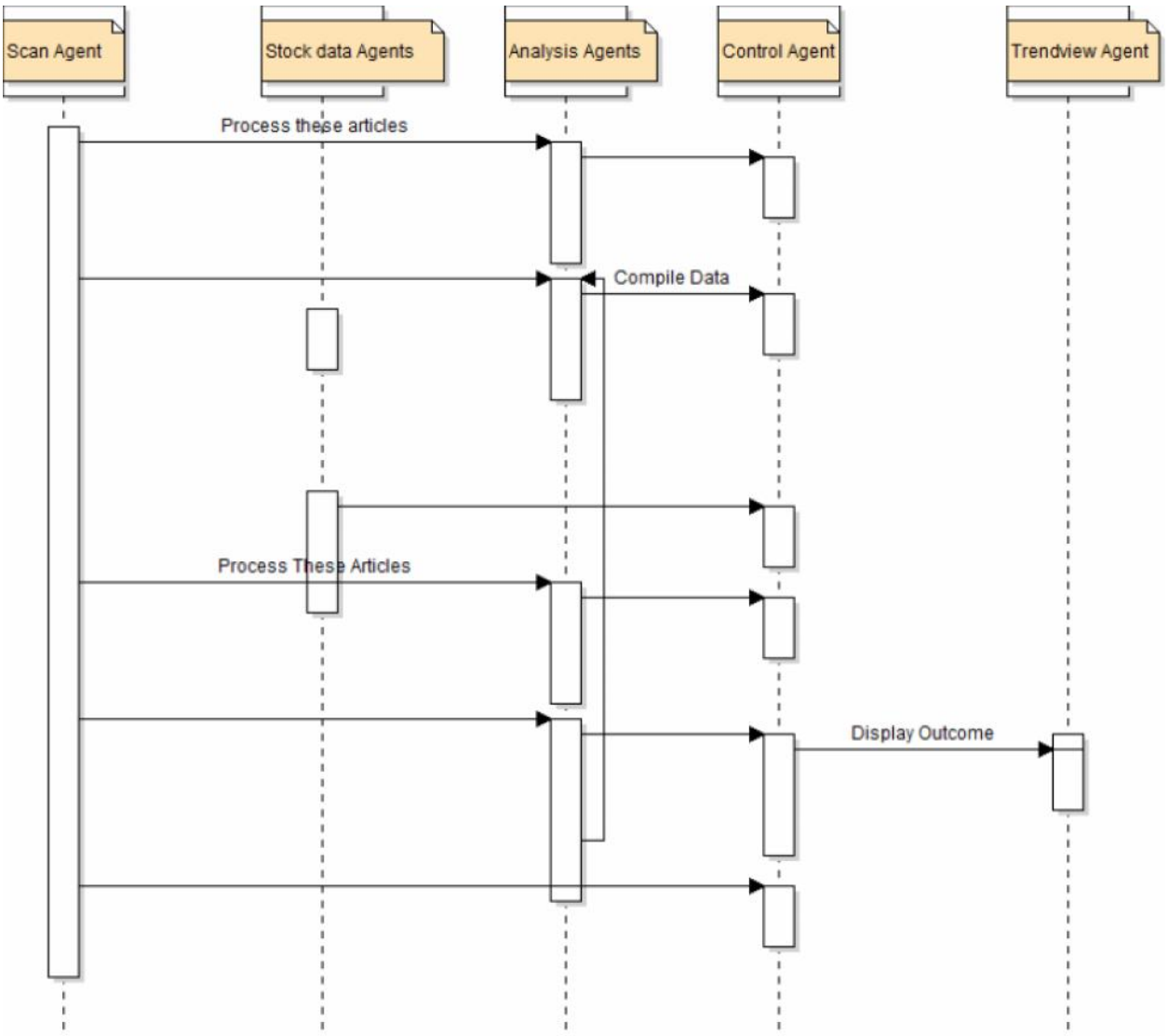


Figure 9: Role Identification Diagram.

4.3.1.2.1 Company Agent

This Agent handles analysis of any news from the specific company that the stock chosen belongs to. This agent reviews the news that belongs to insider category of the company news. These may include things like management news, promotions within the company etc

4.3.1.2.2 Competition Agent

This Agent will handle the news that relates to competition in the business space that the company works in. This is because the well being or demise of a competitor may mean good or bad fortunes for the current company at hand.

4.3.1.2.3 Political Scan Agent

This agent will look at current happening in the political scene and analyses the effects if they are positive which means they have a positive impact on the business whereas heated politics in the national arena is an indication of business slowing down and may affect stock prices.

4.3.1.2.4 National Distress Agent

This agent analyses for issues that cause distress to the country. These include war and terrorism which has adverse effects to stock prices.

4.3.1.2.5 Natural Factors Agent

This Agent analyses for occurrence of natural factors or acts of nature with disastrous effects which include floods, famine, tsunamis, and earthquakes. These have been identified among the factors that affect the stock prices in the money markets.

4.3.1.2.6 Economic Agent

This Agent check for business trends that affect the stock prices and factors which include how the economy in general is performing and also the deals being made. An example would be issuance of a huge tender to the company or a major operations license which would have a positive impact.

4.3.1.2.7 Control Agent

This agent will leverage all factors gained from the other agent and give the final output after summarizing and identifying and gauging all the various factors brought in by the other agents.

4.3.1.2.8 Fundamental Data Agent

This will act as a crawler for all the news items available to it from the various news sources it's connected to. It will keep checking for new updates of the news and update the internal databases. It also informs the control agent of new articles which are forwarded to respective agents for analysis.

4.3.1.2.9 System Monitor Agent

This is the agent responsible for starting and stopping the agents.

4.3.1.2.10 Trend view Agent

This updates the trend board for view by the investor and also presents the GUI.

4.3.1.2.11 JADE system Agents

Jade as a development framework also has its system built agents to perform other functionalities in the environment like the sniffer agent for sniffing agent and also the log Agent for logging agent actions but the main FIPA compliant agents that must be included are:

AMS – Agent Management Service the core agent which keeps track of all JADE programs and agents in the system

DF - Directory Facilitator a yellow page service where agents can publish their services

RMA – Remote Management Agent which handles the GUI interface

4.3.1.3 Task Specification Phase

These are specifications of each agent with activity diagrams. We focus on each agent's behavior in order to conceive of a plan that could fulfill the agents' requirements by delegating its functionalities to a set of tasks.

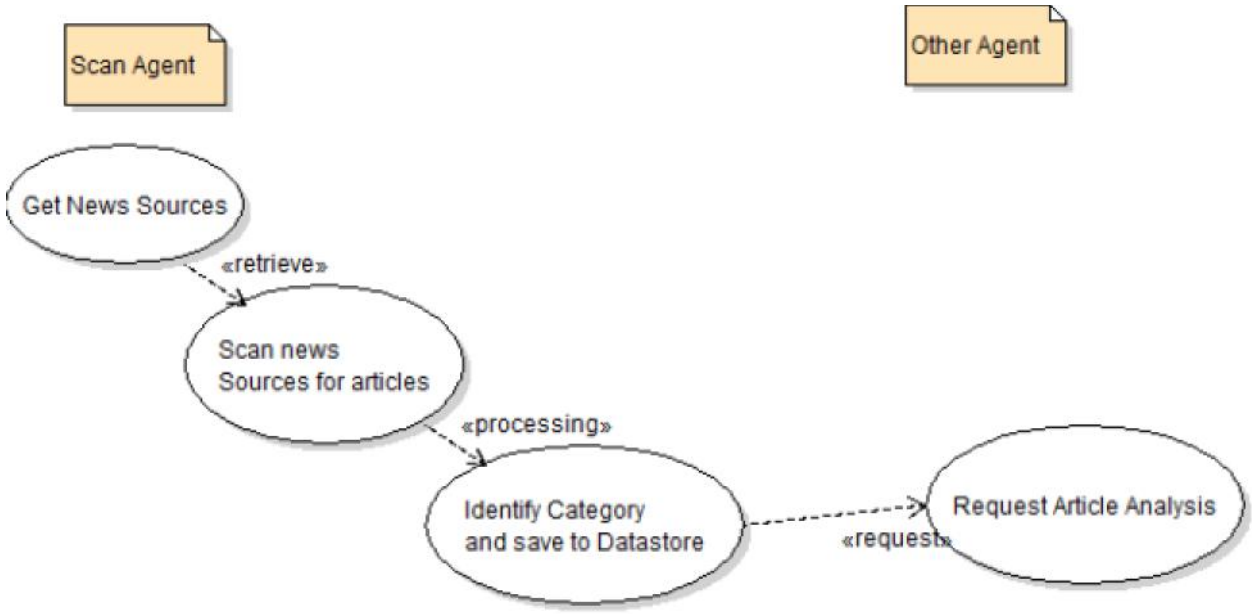


Figure 10: A Task specification Diagram for Fundamental Data Agent

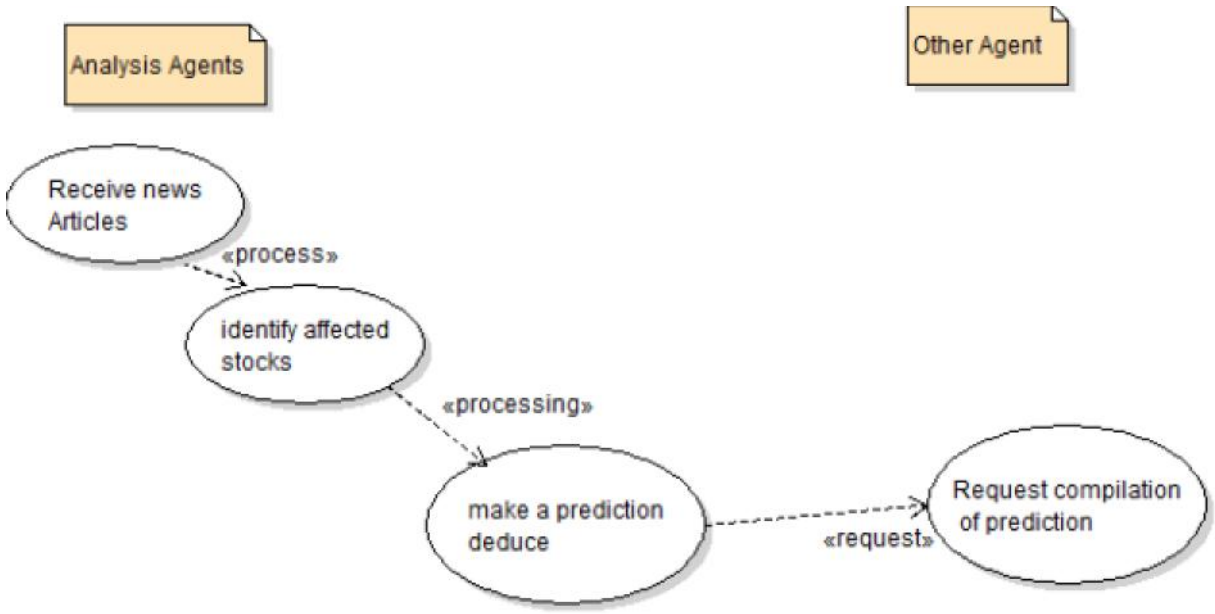


Figure 11: A Task specification diagram for Analysis Agents

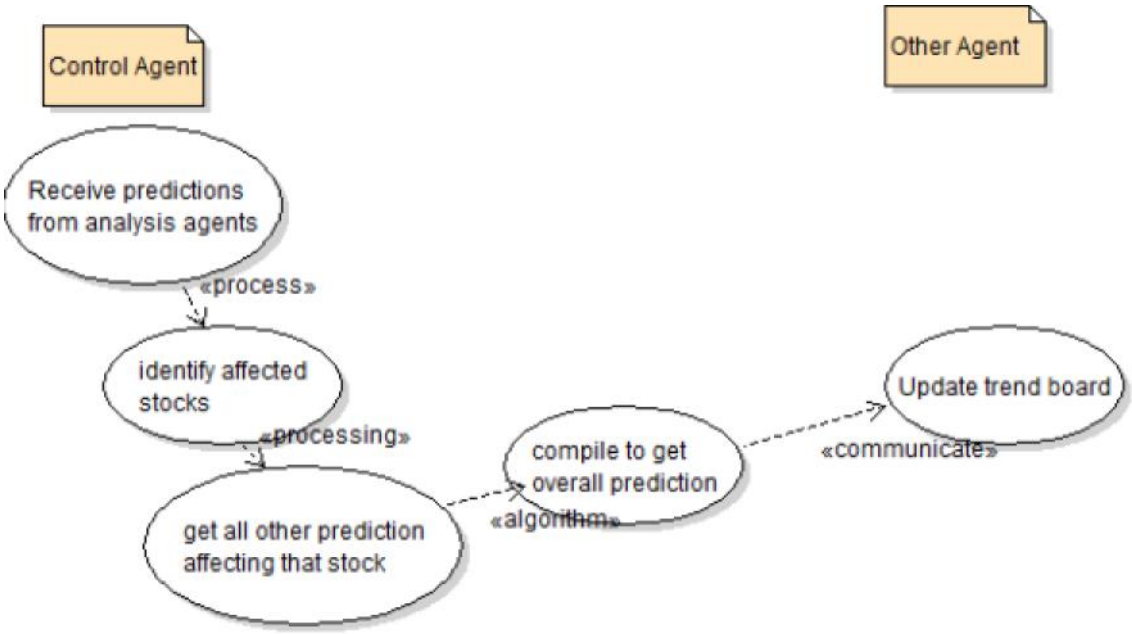


Figure 12: A task Specification Diagram for Control Agent

4.3.2 Agent Society Model:

This includes a model of social interactions and dependencies among the agents involved in the solution. Developing this model involves the following steps

4.3.2.1 Ontology Description Phase

If agents are to communicate in a way that makes sense for them, they must share the same language, vocabularies and protocols. By following FIPA standards, JADE already supports a certain degree of commonality which is evident in the use of FIPA communicative acts and the Coder/Decoder classes which determine the form of messages exchanged between agents. Includes the description of knowledge ascribed to the individual agents and their communication

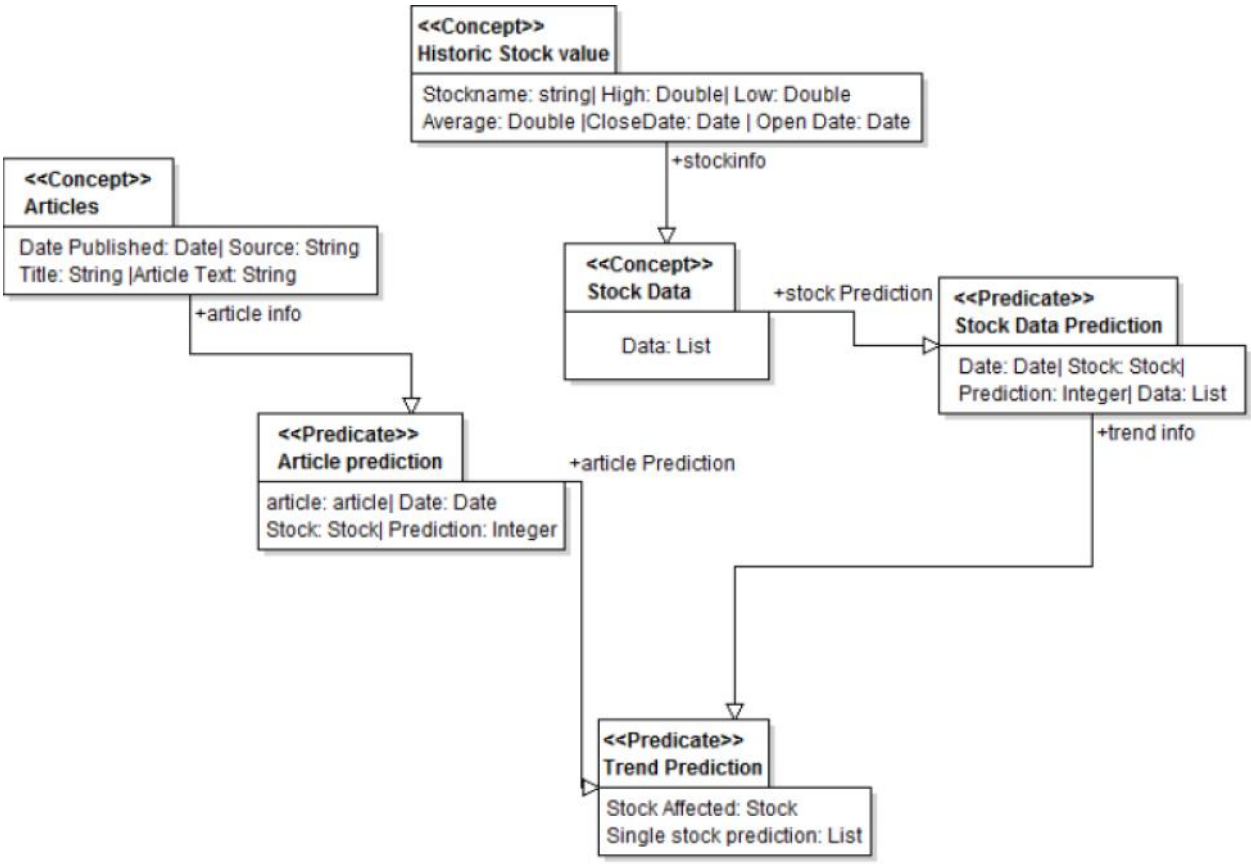


Figure 13: Domain Ontology Diagram

4.3.2.2 Role Description Phase

This phase models the lifecycle of an agent taking into account its roles, the collaboration it needs and the conservations in which it is involved.

4.3.2.3 Protocols Description Phase

As seen in the Ontology description phase and as specified by FIPA architecture, an agent interaction protocol has been used for each communication. Since FIPA has its own protocols which we have followed, no additional protocols were specified.

4.3.3 Agent Implementation Model:

This is a classical model of the solution architecture in terms of classes and methods; the important difference with OO approach is that we have two different levels of abstraction the multi agent level and single agent level. It's achieved as below:

4.3.3.1 Agent Structure Definition Phase

This is influenced and influences the agent behavior description phase as a double level of iteration occurs between them. It's in two views the multi-Agent view we

show the general architecture of the system so to find agents and their tasks; and in the single agents view we show the agents internal structure revealing all attributes and methods of agent class together with its inner tasks, classes.

4.3.3.2 Agent Behavior Description Phase

It's influenced and influences the agent structure definition phase in a double level of iterations.

4.3.4 Code Model

4.3.4.1 Implementation

The model of the solution at the code level is implemented by manually completing the source code and where necessary like where internal structure of models does not change then code Reuse is utilized based on a library of patterns and associated design descriptions. A full structure of the code will be provided with the project in a DVD together with this documentation.

4.3.4.2 Development Tools

The following tools were used in the development of the system.

- Java net beans integrated development environment 8.0 was installed on a 64bit Microsoft windows 7 laptop and libraries of JADE, JSON and all other necessary libraries included.
- Java Runtime environment 1.7 was also installed
- Adobe Dreamweaver was used in web development
- WAMP server 2.5 with Mysql Database was used for both subservice client and Database server

4.3.4.3 Agent Application

The main tool was Java Agent development Environment which as indicated is a library in Java and was incorporated in the IDE.

4.3.4.4 News Source

A locally created and hosted website at http://uhondo.edgesavvy.co.ke/ was used as the news source. Alive news website was also used for RSS feed at

http://www.standardmedia.co.ke/rss/business.php Data was also sourced from the NSE website indication the current live prices.

4.3.4.5 Database

The Database is a MYSQL database hosted in WAMP server that is called Stocks and stores all the data required and generated by the model.

4.3.5 Deployment model

This model is of the distribution of the parts of the system across hardware processing units and their migration between processing units. It involves one step Deployment configuration: This involves a description and setup of the allocation of agents to the available processing units and any constraints on migration and mobility

4.3.6 Testing:

The test of the system was divided into two bits: The Single Agent Test which was devoted to verifying the behavior of each agent regarding the original requirement for the system solved by each agent:

Below is evidence of communication between agents successfully.

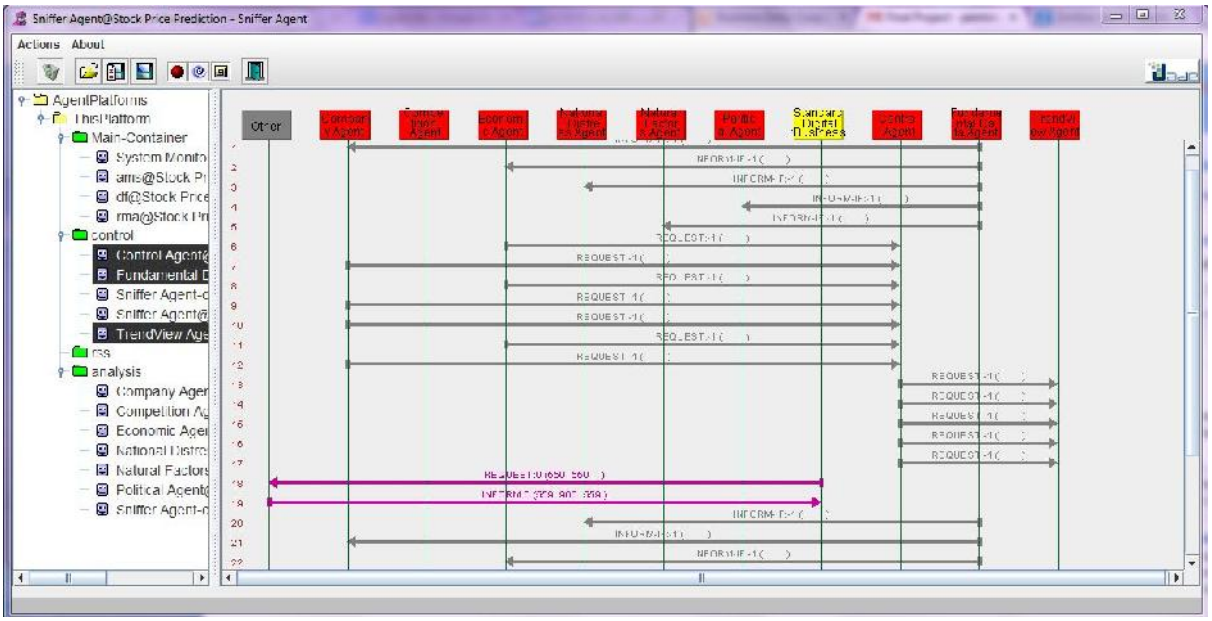


Figure 14: Testing Results showing communication as captured by Sniffer Agent.

Society Test which involved integration verification together with validation of the overall results. A variety of Users were involved in the society test and their comments captured via a User Evaluation Form.

The Agent test is performed on the agents before deployment whereas the society test is carried out on complete system after deployment.

CHAPTER FIVE: SYSTEM EVALUATION AND DISCUSSION OF RESULTS

5.0 Prototype Testing

The system testing was conducted and the following screen shots of running system captured.

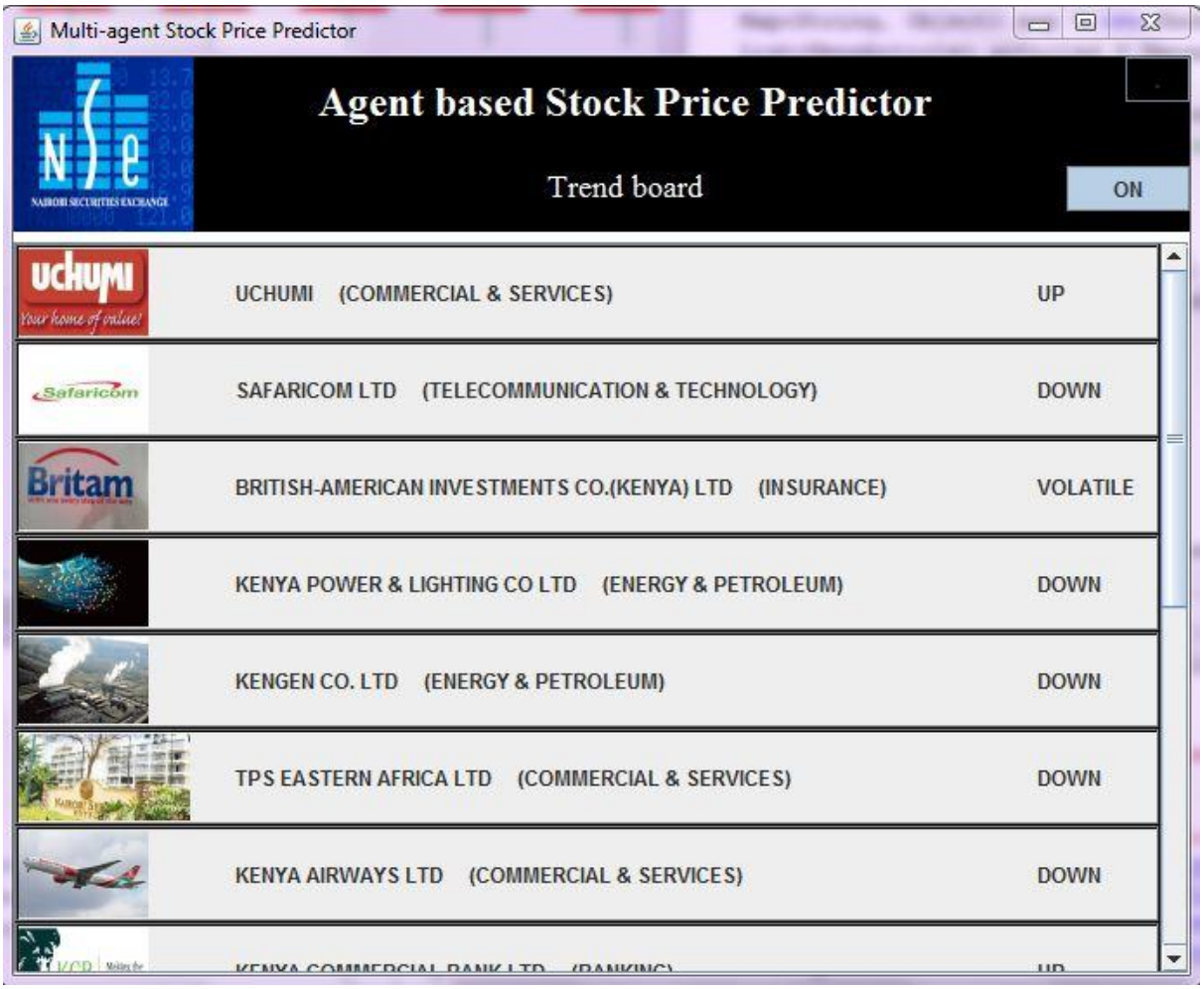


Figure 15: Screen Capture of the Trend Board

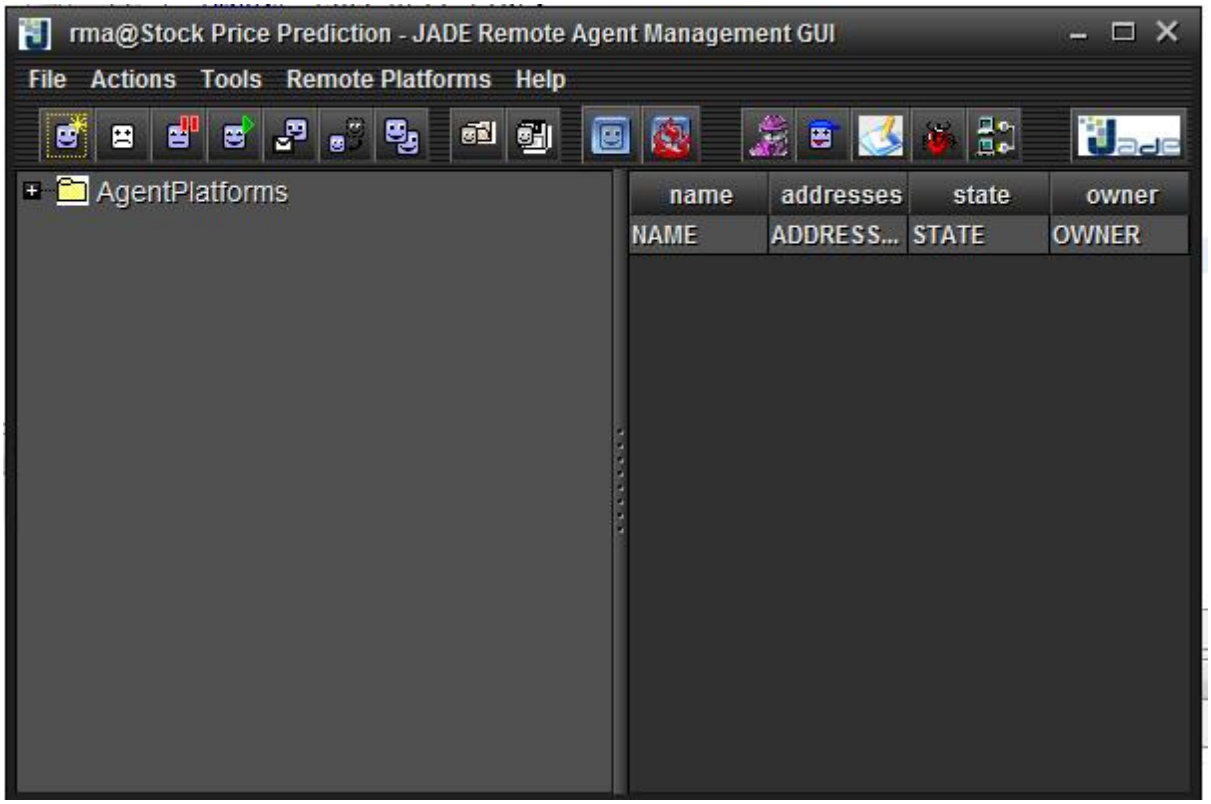


Figure 16: Screen Capture of Remote Agent management GUI

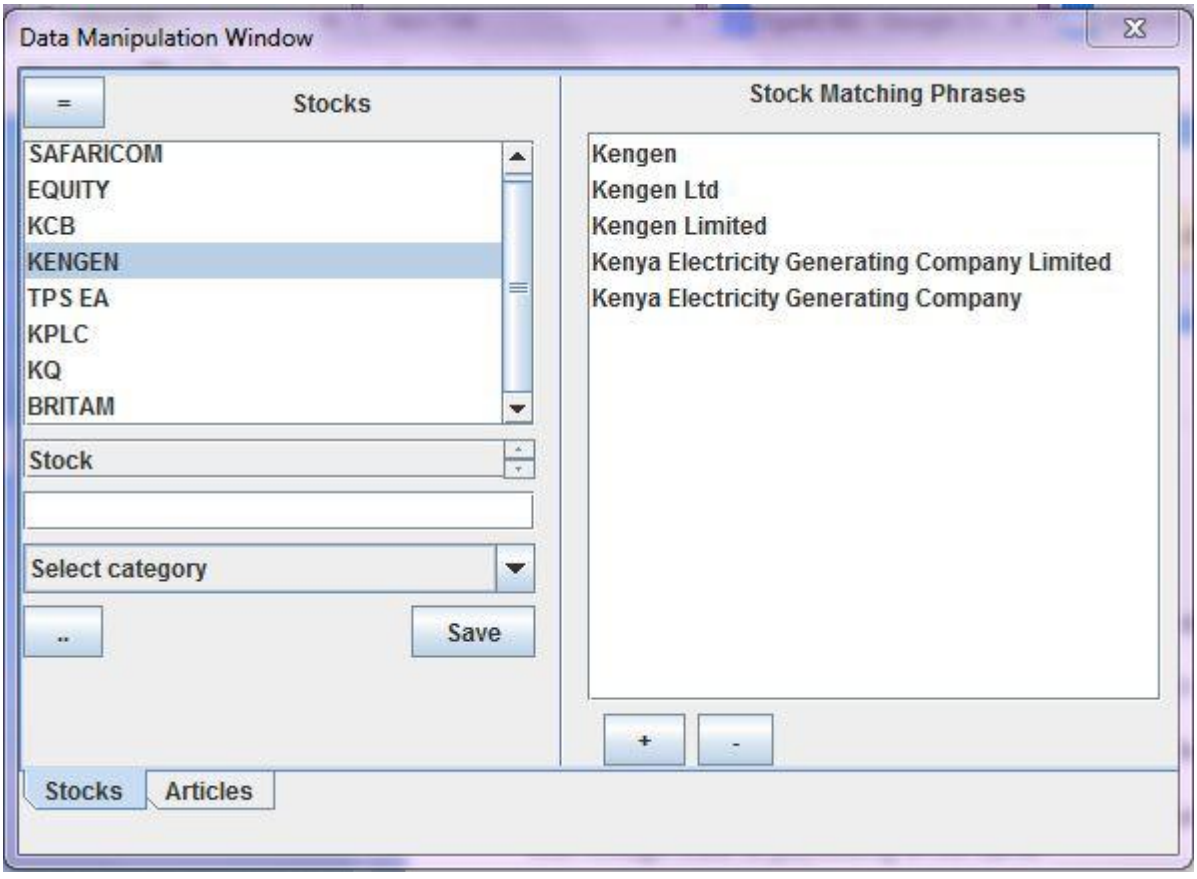


Figure 17: Screen Capture of Data Manipulation Window

5.1 System Evaluation

The System was evaluated through installing it in the user's environments and users tracking the results via dashboards and comparing the results with live happenings at NSE and capturing their evaluation through a user evaluation form.

Users involved in the evaluation include:

- Financial Experts
- Auditors
- Stock traders
- Investment advisor
- Member of Woman's Group finance committee in charge of investment
- Novice Traders

The Users used the evaluation form provided at the appendices to test the system functionalities, usability and accuracy. The following were evaluated from the users.

- Interface Design
- Trend board display
- Ability to identify outcome provided
- News update and whether it is continual process
- General Correctness and accuracy of the prediction in comparison with NSE trend
- Summary and Respondents feedback.

5.2 Discussion of Results:

From the tests conducted by random sample of users, the system can be incorporated into an everyday tool for stock brokers and investors to use to predict the movement of stocks rather than manually reading through all possible news articles and trying to identify the trend on their own.

The System shows efficiency in the use of multi agent's stock price prediction rather than the reliance on technical analysis and fundamental analysis and thus improved profitability and return on investment.

System Usability	**poor**	**Satisfactory**	**good**	**very good**	**excellent**
How is The GUI	0	0	4	2	4
Stock Information Placement	0	1	3	3	3
Ease of use and learning	0	0	3	3	4
User Alerts	0	1	3	4	2
System Functionality	**Strongly Disagree**	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
Automated Article Review	0	0	0	2	8
Automated Prediction	0	0	4	3	3
System Performance	**Very Dissatisfied**	**Dissatisfied**	**Neither**	**Satisfied**	**Very Satisfied**
Level of Satisfaction	1	2	0	4	3
Level of Confidence	0	2	2	2	4
Opportunity for more profits	0	1	1	3	5

All the items tested were above average and the model can be confirmed as accepted by cross function of investors and users. In addition, some users included the following improvement suggestions.

- Include All stocks from the NSE
- Ensure frequent update of articles
- Ensure there is a way to show a comparison with live trade at NSE

CHAPTER SIX: CONCLUSION, RECOMMENDATION AND FURTHER WORK

6.0 Conclusion:

In the study above, multi agents have been used in the stock and financial services sector which is a key area in any economy. Most of Traders and stock Brokers have to read through news articles about the various stocks that are trading in order to identify factors that positively or negatively affect the stock price then they can choose a trading strategy in order to place orders or publish shares to sell.

With the use of the stock price prediction, its evident that the model is a useful tool for stockbrokers and agents and even novice traders who would then need not rely on the traditional methods to be able to identify the trend of prices at the NSE, but also have instant quick update of current trend and with pointer to what caused the trend which then makes it much easier to follow up using their individual trading strategies.

During the Validation, Various stocks predicted had actual prices follow on the trend and any of the involved parties who used the information to make their trading strategy did have an edge and made money or reduced consequent loss for non performing stocks.

The Stock price predictor can therefore be incorporated as an everyday trading tool by all of those stakeholders involved and interested in trading in the NSE.

6.1 Recommendation:

Due to possible litigations and legal hurdles, the Current Model is only registered with one news website source where it sources articles published in the website and further permission on web scraping pages from live news sources needs to be sort to enable the Fundamental agents which is the crawler agent access to multiple articles from multiple news sources and enable better analysis by the other agents. Since the Agents are designed to keep retrieving news articles continuously, the brokers and investors would have a rich pool of prediction information and keep insight into the stock price and easily make more profits, make their work easier and give a return on investment to their clients.

6.2 Further Work:

An area that requires further use of the Agents is to provide actual trading on identified stocks which is possible once the NSE accepts algorithmic trading which is currently not available.

The identification of more phrases and sentiment that enable better prediction trend needs to be done. This collection will keep growing as more articles are reviewed.

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APPENDIX 1:

USER EVALUATION FORM

In this task, you will evaluate software model and indicate whether is fulfills the set objectives which include the following:

- The solution presented shall be able to provide a price prediction indicating the trend of a stock
- The Solution should have a Graphical User interface for ease of interaction with the user
- The Solution should provide correct prediction and advice to the Users
- The outcome is in line with the live happenings at the NSE

NAME: _____

JOB ROLE: _____

EMAIL: _____

EVALUATION DETAILS:

Name of Software: **NSE STOCK PRICE PREDICTION**

In this section you will undertake specific tasks and indicate feedback using the likert scale and any other comment or feedback.

1. How do you rate the solution graphical user interface?
   Poor Satisfactory Good Very Good Excellent

2. How do you rate stock information placement?
   Poor Satisfactory Good Very Good Excellent

3. How do you rate ease of learning and use of the system
   Poor Satisfactory Good Very Good Excellent

4. How do you rate the system user alerts?
   Poor Satisfactory Good Very Good Excellent

5. Does the system automate reviewable articles and news affecting stocks?
   Strongly Disagree Disagree neither Agree nor Disagree Agree Strongly Agree

6. Does the automated prediction of stock price make your role more efficient as an investor in the NSE?
   Strongly Disagree Disagree neither Agree nor Disagree Agree Strongly Agree
7. Indicate your level of satisfaction of the stock placement compared to existing solution?
   Very Dissatisfied Dissatisfied neither Satisfied Very Satisfied

8. Think of your level of confidence on the predicted stock price for a stock of your choosing. Indicate the degree of confidence you have on the trend of the stock price issued by the software and your ability to use it to make a correct investment decision using the following scale:

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
   No Confidence Moderate Confidence Complete Confidence

9. Does the Software solution provide for opportunity to make more profits as opposed to the human trend analysis currently being used?

   Strongly Disagree Disagree Neither Agree Strongly Agree

10. Any Other Comments:
