Mining Implicit Knowledge to Predict Political Risk by Providing Novel Framework with Using Bayesian Network

Siavash Asadi Ghajarloo

Abstract—Nowadays predicting political risk level of country has become a critical issue for investors who intend to achieve accurate information concerning stability of the business environments. Since, most of the times investors are layman and nonprofessional IT personnel; this paper aims to propose a framework named GECR in order to help nonexpert persons to discover political risk stability across time based on the political news and events.

To achieve this goal, the Bayesian Networks approach was utilized for 186 political news of Pakistan as sample dataset. Bayesian Networks as an artificial intelligence approach has been employed in presented framework, since this is a powerful technique that can be applied to model uncertain domains. The results showed that our framework along with Bayesian Networks as decision support tool, predicted the political risk level with a high degree of accuracy.

Keywords—Bayesian Networks, Data mining, GECR framework, Predicting political risk.

I. INTRODUCTION AND BACKGROUND

NUMEROUS financial and economic decisions depend on political stability of the business environment. This dependency encourages investors to search out strategies for predicting political risk level within a foreign country or emerging market [1].

A. Challenges of the political risk prediction

Country risk analysis can be described using three significant components: political risks, economic risks and financial risk [2]. In fact country risk ratings are significant macroeconomic indicators as they summarise the understandings of socio economic agent about economic and political stability [13]. The empirical results showed that the country risk indicators are correlated with each other. One of the sophisticated risk indicators under concept of country risk is *political risk*. This can determine how investors, banks as well as multinational corporations will behave in the future. Political risk variables are also used to discover future market behavior in specific business environment [3].

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There are various ways of predicting economic risk as well as political risk by using Artificial Intelligence techniques such as neural network [4]-[5] and Bayesian Network [6]-[7]. But most of the conducted studies are a bit difficult in terms of understanding and employing by investors who are mostly nonexpert people. Investors normally have good business idea in one hand and money in the other hand. This is actually difficult and time consuming for them if they want to learn AI techniques and try to apply them in their decision making algorithm for making any investment. What we are trying to show in this research is just providing a framework in between business idea and decision to be made by investors, using AI technique for the purpose of making accurate investment decisions.

B. Solution of research problem

In this paper we introduce a framework by which an investor can gain accurate knowledge about future market behaviour based on the prior understanding of the political events and situations. Constructed framework can be fed easily by investors with political news for the specific time period. Proposed framework in this paper aids nonprofessional investors to forecast political risk without knowing complex approaches. The output of the framework visualizes the fluctuations of the risk level across time. In fact this framework has been constructed to simplify all processes of making investment from gathering data for investigation of business environment to analysis of the future behavior of market. There are so many challenges for nonexperts who intend to use existing ways of predicting political risk within a country which can be considered as follows:

1. It is difficult for investors to investigate all political news and documents to find phrases and key words that imply political instability since it is so time consuming to read huge number of political news and decide whether the location is safe to invest or not ?

2. Most of the times modeling country risk involve some degree of uncertainty, so there should be a solution to help investors to make better and accurate decision under uncertain domain.

3. Modeling country risk level across time is a vital requirement for those who intend to invest in a foreign environment. By this ability they would be able to observe the fluctuations of political situations across time.

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This ability enables them to decide whether political risk is going to be raised or not.

In order to solve these issues we are going to propose a framework in this research for nonexpert who would like to invest in a foreign country. This framework concentrated on the political issues which may affect business activities. Presented framework in this research named GECR since for a layman as investor four activities are required when he/she decides to investigate political situations and safety of the specific location in which he/she is going to do investment. These activities are:

1. Gathering political news: political documents and articles for the specific period of the time will be gathered in this stage for the purpose of judging from them to conclude whether this place is safe and stable enough in terms of political issues or not?

2. Extracting useful information: important information is extracted from collected dataset in previous level by using data extraction techniques. This information may help investors to see if selected location for investing is safe enough or not?

3. Constructing a model: based on the information extracted from political dataset, a model will be constructed for helping us to make decision under uncertainty. For this reason we employ Bayesian Network which enables us to combine expert opinion in this framework in order to have more accurate prediction of political risk within a country.

4. Risk prediction: after extracting information from dataset and constructing political risk model using Bayesian Network, now political risk level can be viewed across time. At this level our framework visualizes the political risk fluctuations across time based on the input data. So, nonexpert people as investors can see the political instabilities through specific duration of time to decide whether to invest in selected location or not.

These processes are four main steps of proposed solution in this research. In fact, we are making the task of predicting political risk level for nonprofessional investors as simple as possible. For this reason presented framework in this study named GECR, since this combines four major steps as Gathering data, Extracting information, Constructing political risk model and Risk prediction.

The country risk concept can be categorized under different categories. One of the most popular classifying for country risk is categorizing it under economic, political and financial risks [9]. Country risk analysis also can be described using five measures as: economic, political, financial, country credit rating and composite risk [10].

The country risk elements are correlated with each other. These elements have been modeled in various studies in different ways. Some of them use data-driven model that scores the level of risk in a specific country by ranking the riskiness of specific country from one to five, as country risk increases the distribution of rating migrates down [2]. There are also several artificial intelligence techniques that have been employed to help forecasting economic or financial variables of country risk. Neural network solutions have been successfully applied for macroeconomic forecasting [4]. It has also been used prosperously to forecast inflation as an economic risk factor [8]. Neural networks have been extensively studied and successfully applied in finance [11] and economic forecasting [12].

The other technique that has been studied for political and economic forecasting is Bayesian Networks. Bayesian Networks and its related machine learning algorithm can be employed for economic and political forecasting based on the pattern recognition algorithms [14]-[15]. In this research we used Bayesian Network instead of neural network for political risk prediction since it has some advantages over other AI techniques such as ability to combine expert opinion and excremental data [14]. Bayesian Networks can be graphically represented when modeling uncertain events by expert and nonexpert people [6]. Thus, the problem in this research has been modeled and visualized by using Bayesian network to present political risk situation in graphical manner. By this way, investors can observe the main factors which may affect political risk conditions.

In this research we are going to use Bayesian Networks with data mining technique for extracting information from political news and we put all these steps as a framework. We have also developed a prototype to visualize the framework and test sample dataset to get result for predicting political risk level across time. This prototype has been developed using Microsoft visual studio.net by using Microsoft SQL express as database.

II. METHODOLOGY

As it is mentioned above, this research endeavors to provide a solution in a form of framework for nonexpert people who are willing to invest in risky business environments. Prototype which is developed based on the GECR framework enables investors to see political news content, extracting useful information from them and applying this information for making business decisions by just following simple steps. In this section all steps of GECR framework will be explained and illustrated clearly.

A. Gathering Data

The outcome of this research is supposed to aid investors to discover political situations of specific location in which they are going to invest. For this reason, investors normally use the political news to find out the political stability of the selected business environment. Since this research is going to show and test GECR framework, a dataset of Pakistan have been used which contains political news articles. This dataset contains 186 political news articles which are all in format of text files. So, GECR framework will utilize this dataset to extract information and help investors to know about political stability of the Pakistan as a sample business environment for the purpose of investment. GECR framework utilizes Pakistan political news to elicit important key words from content of text files. These key words may carry important meaning in terms of political issues and events. Later on, these key words will be engaged to show political stability across time.

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Figure 1 shows the process of gathering data and passing them to the data mining engine to extract meaningful key words that might be helpful to discover political stability.
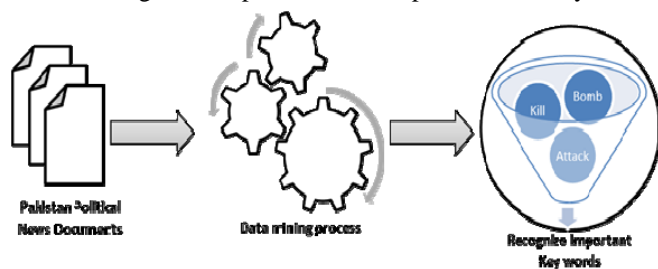

Fig. 1 Gathering data and preparing them for information extraction

B. Information Extraction

After collecting political news from different websites and news resources, it is time to extract information from them. Extracting information in this study is divided into three main steps which are explained below.

i. Extracting key words

Information in this research is considered as important and most frequent key words which are appeared in all through Pakistan dataset. Since we are dealing with key words in our dataset we need a strategy to extract key words from political news content. Proposed strategy for eliciting important key words from dataset is illustrated in figure 2.
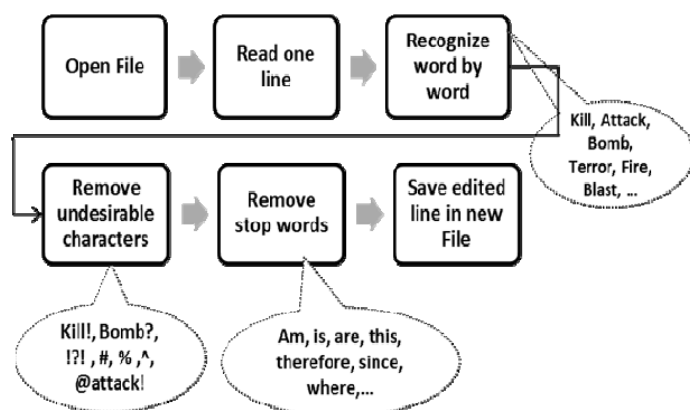

Fig. 2 Key word extraction process

Since in this research we have focused on political news, so the content of the text files should be investigated to find out whether Pakistan is safe in terms of political events and issues or not? We focused on the key words of the Pakistan dataset by splitting each key word in each text file. As it is illustrated in figure 2, the processes for extracting key words are divided into six steps. These steps are implemented in the developed prototype so investors can easily run these steps as simple as some clicks through graphical user interface. Underlying processes are: first is opening the text file. Second is reading on line from opened file. Third is splitting key words in line. Forth is removing undesirable characters which might be followed after or before of each key word. This process is done to make all key words in one format without any preceding or suffix characters. Fifth is removing stop words;

in every corpus there might be so many words which are repeated frequently whereas they don't carry important meaning in terms of our purpose which is dealing with key words that are recognized meaningful for political issues. In this research we have combined some list of stop words to make the prototype more accurate. These lists would be easily found in internet websites. Sixth is saving edited line after cleaning noisy data from selected line. In this step we save the cleaned up line in separate file so, these files will be utilized in next steps of GECR framework All tables and figures you insert in your document are only to help you gauge the size of your paper, for the convenience of the referees, and to make it easy for you to distribute preprints.

ii. Date extraction

As it is mentioned earlier, the users of GECR framework need to observe the political risk fluctuations across time. For this reason we need to extract date from content of each file as political news. In order to achieve this goal Microsoft regular expression has been employed in this framework. Based on our understanding from nature of Pakistan dataset which is political news of Pakistan, in each file there is one line in which date of publishing article is cited. Microsoft regular expression enables us to define patterns of text. So, according to the predefined patterns we can search inside text files, once we found any match this can be considered as date of publishing selected article. Thus, after extraction each date from each article we would be able to search key words which are observed in specific date. Figure 3 shows the processes above clearly.
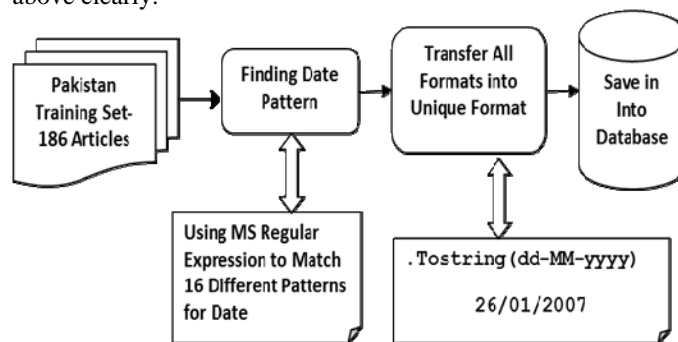

Fig. 3 Extracting date for dataset

In this research political news are saved from different resources so, after extracting date from articles we transform all dates in one single date format. Thus, these dates can be stored in database since they are all converted into one unique format. This will enable us later, to search and go through database in terms of dates and key words.

iii. Ranking key words

As it is mentioned previously, we are dealing with political news articles with key words in their content which carry important meaning for us. Since, we have removed undesirable characters and stop words from content of news articles; we can rank key words all through dataset in order to find most frequent key words in Pakistan dataset. In fact at this step of our proposed framework we are going to rate key

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word frequency for each article as well as all dataset. Later on, we would be able to discover key words which are repeated in most of the time.

In most of the cases key words can describe political events, especially when they are talking about physical events as well as environmental issues. In the collected dataset about political news of Pakistan, these events and news are normally observed as terrorism acts and civil wars. Whenever such events are going to be occurred, the business environment becomes unsafe. Thus, ranking key words can make our understanding clear about political issues and events which are announced in news's content. The processes in this level are illustrated in figure 4.
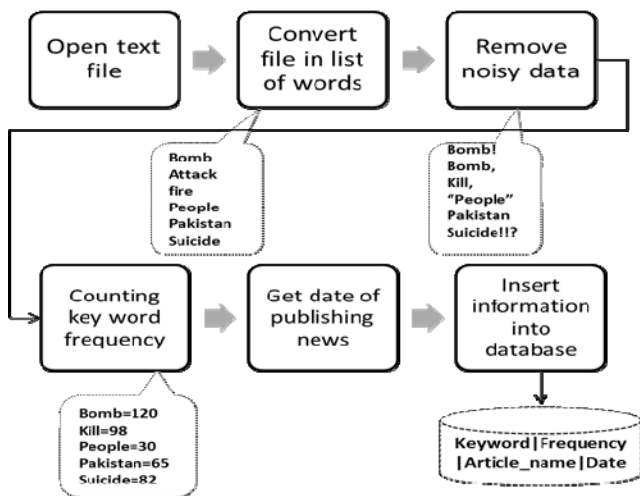

Fig. 4 Ranking all key words in dataset

After ranking key words of the specific article, we save ranking results in a database. By recurring same processes for all articles, our database enriches with all key words repeated in Pakistan dataset with their date of observing and article's name. Now, we can do searching specific key word as well as getting query from database in terms of key words, dates and article name.

By developing simple but efficient prototype, investors can take advantages of using GECR framework. As it is illustrated in figure 5, in the developed prototype we have provided some functionality such as ability to see content of each political article, removing stop words and noisy data from dataset and searching specific key words all through database to get statistical information about specific key words. Information regarding key words and their frequency across time is visualized by charts in the user interface to make it understandable for nonexpert investors.
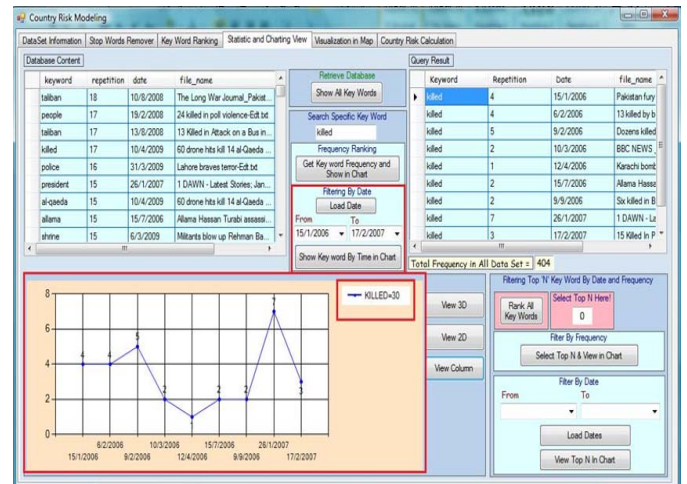

Fig. 5 GUI based on GECR framework

As it is discussed in earlier section, the events like terrorism, civil wars and attacking to people are most probable events which might be seen while a study is going to be conducted under political risk concept. So, everybody may know a few key words which have negative meaning and impact on the political stability. The words like: *war, bomb, killing, suicide, exploit, attack, terror* and etc. Proposed framework in this research empowers investors to find and search key words across time. They can also rank all key words of dataset in order to see most frequent key words in dataset. As it is clear in figure 5, user searched the word "killed" and the result will be appeared accordingly. If the frequency of the key words which have negative impact and meaning are going to rise over time then we can conclude the riskiness of that environment is high. Consequently, if this story happens for most of the key words with negative impact then we can say that selected location for investment is unsafe. In the developed prototype we have also provided this ability to rank all key words in dataset. So, the result of ranking top 20 key words in the Pakistan dataset is illustrated as table I.

TABLE I
TOP 15 KEYWORDS IN PAKISTAN DATASET

Key word	Frequency	Key word	Frequency
Killed	404	Injured	288
Attack	372	Blast	268
People	371	Security	218
Police	368	Militants	179
Suicide	319	Taliban	168
Bomb	120	Dead	109
Explosion	83	Forces	108
Army	69		

In this research we have combined expert opinion in the proposed framework. The expert opinion in this study can give us the idea of the indicators and events which might be included in political risk. In the next section the importance of

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the combining expert opinion with GECR framework will be discussed.

C. Combining expert opinion with GECR framework

The importance of the key words has become more visible in this research since, our dataset is selected from political news and the goal of this research is providing a framework for nonexpert people with minimum knowledge to predict political risks which might be happened to affect business transactions. There are lots of terms, phrases and key words which are defined by expert people under political risk concept.

Based on the study which has been conducted by Li Bing (2008) and Caroline Nganga, Elizabeth Curo (2008) political risk elements can be categorized as: Social instability, Political violence, Military in politics, War and violent conflicts, Terrorist acts [16]-[17].

In the other study by Edward Easop (2009), political risk can be determined as likelihood that governmental or bureaucratic inefficiencies, societal tensions or international tensions will cause adverse developments for an investor [2]. M. Busse, C. Hefeker (2006) Categorize political risk as government stability, socio-economic conditions, internal and external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions [18]. Political risk institution Group has provided information on risk indicators that address political risk as internal conflict, political violence within the country, civil war, terrorism, or civil disorder [19]. Again we can find the political violence which is defined by J.T.V.M. De Jong (2009) as: war and violent conflicts, state violence, terrorist acts, and mob violence [20].

One of the useful websites which contains key words, phrases, and acronyms related to the war, terror and terrorism in general is http://www.11-sept.org/Glossary/index.html. This website includes glossary of terms which are gathered after 11th of September in USA.

Based on the mentioned references and for combining expert opinion in proposed framework in this research, we have selected 16 distinct key words which might be seen in every corpus which is talking about political risks and issues. These key words in any political news articles may affect opinion and estimation of readers regarding safety and stability of the corresponding business environment. As it can be found in table II, we have listed 16 distinct key words, based on the expert opinion in political risk which can help us to predict political risk level in next steps of GECR framework.

Key words in table II will be helpful in this study when we are engaging Bayesian Network to model politic risk problem. Bayesian network enables us to combine expert opinion in constructed network for solving problems. In next steps we will discuss about constructing and utilizing Bayesian network for helping to solve the problem of predicting political risk across time.

TABEL II
POLITICAL RISK KEYWORDS

No.	Key Word	No.	Key Word	No.	
1.	Attack	2.	Army	3.	Killed
4.	Suicide	5.	Dead	6.	Explosion
7.	Terror	8.	Bomber	9.	Blast
10.	Violence	11.	Militants	12.	Bomb
13.	Terrorism	14.	Injured	15.	Security
16.	Force				

D. Finding and visualizing risk locations

After determining important key words based on the expert opinion, this would be so useful for investors if they want to see the geographical location in which they are going to invest. We have provided this ability in GECR framework which enables investors to observe the geographical location on the map in which specific key word is observed. This function would be useful when an investor decided to observe the geographical location of selected business environment in which the important key words are observed. By providing this ability we can search through the dataset for any key words which have effect on political situation and try to find the locations in which these key words are most frequent and observed. These key words can be selected as words that are cited in table I or II, since these words will affect negative impact on every business environment if they are observed frequently.

Strategy to provide this ability in GECR framework is just taking the advantages of Yahoo PlaceMaker web service accompany with Bing map API. Yahoo PlaceMaker is a new open and free API from Yahoo that helps developers to make their applications and data sets location-aware. This service works accurately and simply. What it needs is just passing unstructured or structured data as input to this web service then Yahoo PlaceMaker extracts geographical locations which are found in the text. This information about location will be saved in database, after that we can send the geographical information to Bing map API in order to see the geographical location of on the map surface in which specific key words observed. These processes can be summarized as figure 6.
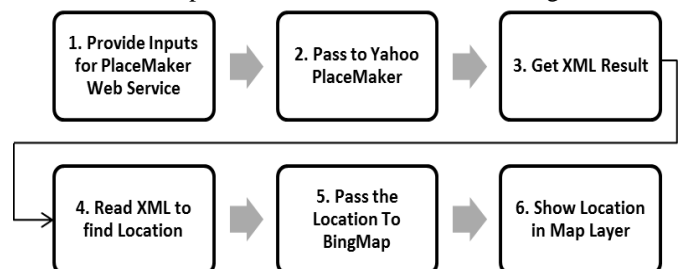

Fig. 1 Finding geographical location of key words on map

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In the developed prototype of this research we save corresponding paragraph for each key word. When investors intend to find the geographical location in which specific key word like "Kill" is observed, we send the corresponding paragraphs of key word "Kill" and receive the geographical locations which are found by Yahoo Placemaker web service. Later on, these locations will be sent to Bing map API to find the exact location on the map surface. This ability enables investors to see the places in which critical keywords are observed and help them to decide better about the business environment in which they are going to invest.

Figure 7 shows the user interface of the developed prototype while user searched to see locations in which key word "Attack" is observed. The pin points on the Bing map surface shows the locations for the searched key word.

Fig. 2 Location of searched key word on the map

III. ANALYSIS OF DATA

After gathering political news and trying to extract important key words with their geographical location in which they are observed, it is time to provide a solution to predict risk level of country. The solution provided in this study is using Bayesian Networks to model the problem. Bayesian Networks enables us to provide an interface for investors by which they can see the details of indicators and sub factors of political risk prediction as our problem.

A. Using Bayesian Networks to predict political risk

Bayesian networks are directed acyclic graphs whose nodes represent random variables in the Bayesian sense. These nodes would be observable quantities, unknown parameters or hypotheses. Links between nodes represent conditional dependencies. Nodes that are not connected in network represent variables which are conditionally independent of each other. In Bayesian Networks Each node is associated with a probability function that takes as input a particular set of values for the node's parent variables and gives the probability of the variable represented by the node.The mathematical definition of Bayesian network is presented as follows:

X is a Bayesian network if its joint probability density function can be written as a product of the individual density functions, conditional on their parent variables.

$$p(x) = \prod_{v \in V} p(x_v | x_{pa(v)})$$

Where pa(v) is the set of parents of v. For any set of random variables, the probability of any member of a joint distribution can be calculated from conditional probabilities using the chain rule as follows:

$$p(X_1 = x_1, ..., X_n = x_n) = \prod_{v=1}^{n} P(X_v = x_v | X_{v+1} = x_{v+1}, ..., X_n = x_n)$$

In order to apply Bayesian network in this study, we define a main node in our network as Political risk. Other nodes are sub factors which might affect the political stability of the business environment. According to our understanding from the extracted key words of Pakistan dataset which are most frequent key words in all through dataset and regarding to the expert opinion about important key words which may contribute in concept of political risk, our proposed Bayesian network model is illustrated as figure 8. Consequent nodes in network can be considered as 15 district key words which effect on the political risk stability based on the expert opinion.
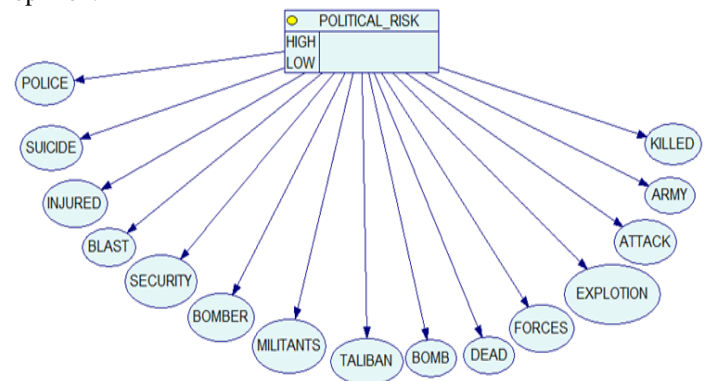

Fig. 3 Proposed Bayesian Network

Now it is easy to calculate the probability of political risk by investors for the specific date while nodes are observed. On the other hand we have implemented our prototype for GECR framework to calculate the probability of political risk based on the Naive Bayes and probability law which are explained earlier. Investors can easily choose specific duration of time and let the prototype calculate how many nodes are observed in each date. The more nodes observed in specific date the higher probability of political risk will be gained. Thus, the sequence of these probabilities for duration of time can be visualized as chart. This chart tells us the fluctuations of political risk level across time. As it is clear in figure 9 we have run this process for specific period of time in Pakistan dataset. The result is illustrated in figure 9.

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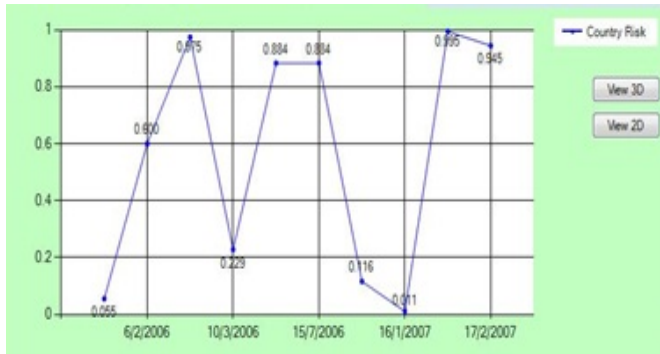Vol:5, No:2, 2011

Fig. 4 Bayesian approach visualization

As it is visible in figure 9, the fluctuation of political risk in the Pakistan dataset is high. This means, there is no safe and stable environment found in studied dataset. This chart can easily provide the facility for investors to observe whether the probability of political risk is going to be raised across time or not. Therefore, investors can make better and faster decision when they just have political documents in one hand and business idea in other hand. On the other hand, GECR framework aims to extract useful information from political news, rank most frequent key words in dataset, find geographical location of specific key word as political risk indicator and calculating risk probability across time for as simple as some clicks on developed prototype.

B. Testing result

It is so important to test the result which is gained by Bayesian network approach. We have to make investors convinced about the accuracy of political risk prediction which is achieved from the proposed Bayesian Network. In fact, we need to investigate how much our constructed Bayesian Network in this study is accurate. In order to overcome with this problem we use the Rule-Based approach for testing Bayesian Network result.

In fact, we have constructed some rules to see whether specific key words are observed in specific date or not? Then, the number of key words observed in specific date determines the probability of being high for political risk. These rules are constructed based on the main key words which are defined by expert opinion and presented in table II of this paper. The rules are based on the IF-THEN structure. For instance, they would be as follows:

If "Terrorism" Observed in Date X Then increase counter.
If "Killed" Observed in Date X Then Then increase counter.
If "Dead" Observed in Date X Then Then increase counter.
If "Bomber" Observed in Date X Then Then increase counter.

In order to implement this approach in the prototype, we define a variable as counter which keep the number of observed rules for specific date. This variable is set as zero at first. If specific key word observed in specific date in dataset then the value of the counter variable will be increased one. So, we have 16 distinct rules which are constructed based on the key words in table I. At the end of running all rules, the value of counter variable will be something between zero to sixteen for one specific date. Then, we set a probability between zero and one based on the counter value for each

specific date. The values of probability will be assigned in progressive manner as mathematical point of view. This means, the more rules observed the higher probability will be assigned for specific date. The values for assigning are mentioned in table III.

TABEL III
PROBABILITIES OF RULE BASED APPROACH

Counter Value	Assigned Probability	Counter Value	Assigned Probability
0 or 1	0.01	9	0.750
2	0.015	10	"0.850
3	0.025	11	0.900
4	0.060	12	"0.950
5	"0.120	13	0.960
6	"0.250	14	0.970
7	"0.380	15	0.980
8	0.550	16	0.980

Similar to the Bayesian approach we run this method for specific duration of time to observe the result on the graphical interface as chart. After running these two approach (Bayesian and Rule-Based) we can compare them to find out the accuracy of the Bayesian Network which we have proposed in this research. We found that proposed Bayesian Network in this research is working with high percentage of accuracy in compare with Rule-Based approach. Figure 10 shows the result of running Rule-Based approach to find out the accuracy of the Bayesian Network.
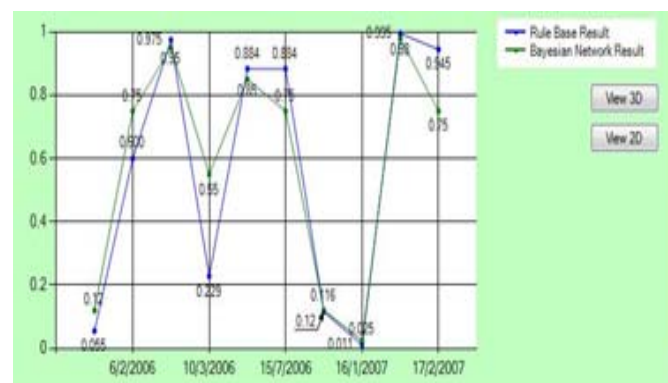

Fig. 5 Visulize Rule-Based and Bayesian approach

IV. CONCLUSION AND FUTURE WORK

In this research, we have tried to present reliable model for predicting political risk as the risks of investing in emerging market directly is not only higher, but also is difficult to forecast. Obtaining reliable and accurate forecasts of political risk is necessary for any multinational corporation decision maker. In fact, political risk rest on the fundamental issue that

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any changes in a foreign business environment will lead to reduce the profitability or riskiness of an overseas foreign direct investment. What we have done in this research can be summarized simply as following steps:
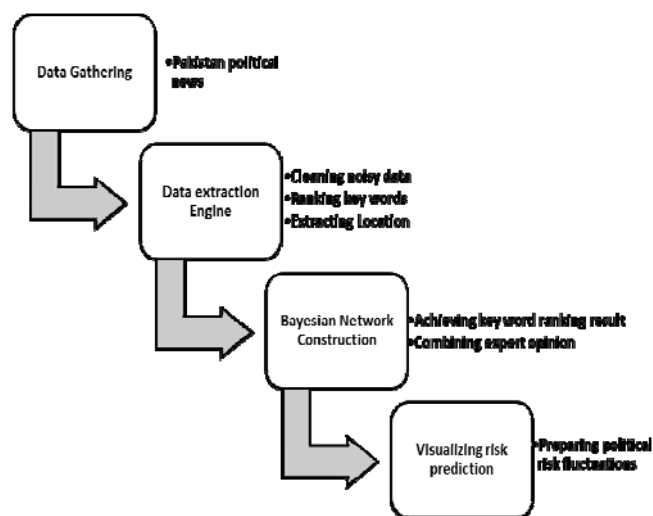

Fig. 6 Overview of GECR framework

For the future works, first the dataset can be made as rich as possible to extract information for the purpose of predicting political risk. In this research we have used 186 political articles which are published regarding Pakistan political events. In future we can import more articles not only for one country bust also for lots of countries for which we can find political news.

Secondly, in extracting key words from dataset more accurate data mining approaches as well as natural processing languages would be gained to classify documents in order to get better results. In fact documents can be classified based on the political risk indicators. So, in each class we would have so many articles regarding political risk. For instance, we can classify political risk as terrorism acts, civil wars, socio-economic changes and etc., regarding each category many documents can be gathered and classified by using machine learning algorithm. This classification algorithm will help investors in future to predict which kind of political risk indicator is specifically going to be raised or vice versa and the new documents for the system can be classified under predefined group for further processing using machine learning and classification algorithm.

Thirdly, as an alternative work in future, another Bayesian Network would be constructed that is enhanced by expert opinion. Meanwhile, political risk can be categorized in so many sub factors and regarding each factors a set of key words can be defined. These key words have negative or positive impact on each node as sub factors of political risk. This means, some key words lead to increase the risk of happening political risk sub factor and some of them may lead to decrees the political risk. So, these key words which are extracted from expert opinion can be compared with most frequent key words in dataset. The result of comparison can help to find better set of key words which may effect on political risk on the business environment.

Meanwhile, other AI approaches such as neural network and fuzzy logic can be applied to predict political risk across time. Then, comparison can be made for the result of Bayesian Network with other approaches in order to send information to the investors as accurate as possible.

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