ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 5, Issue 7. January 2016

Is it possible to proactively detect frauds with zero cost?

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***Abstract*—Investors worry about fraud activities and financial risks which would surround them in financial markets. Supervision department is established to protect investors from potential risk in the market. The regulatory duty involves motioning detail of market transactions for finding suspected cases to frauds. Electronic surveillance systems are intended to improve both speed and quality of supervision. This paper briefly analyzes current surveillance systems and proposes a new state of the art surveillance system which can provide fully automated fraud detection for regulatory firms to support a proactive strategy for protecting investors.**

This innovative idea is implemented as an intelligent visual surveillance system called, Intelligent Visual Fraud, which not only facilitateslive monitoring of fraud pattern progress, but also reduces the time needed for reaction against fraud makers by proposing an innovative Visual Modeler. For demonstrating usefulness of new approach, a demo application is provided and two cases are illustrated for proactive risk analysis and fraud detection in stock market. This innovation provides a visual designer for creating state-of-the-art visual models. In this paper two sample models are illustrated for evaluating bankruptcy risk and detecting insider trading frauds.

Innovative models of bankruptcy risk process XBRL files of annual and quarterly financial reports and regulators can lively monitor bankruptcy risk of listed companies. The results indicates that the innovation can be rapidly applied over all companies to proactively evaluatefinancial risk and detect frauds with zero cost.

***Index Terms*—XBRL, Visual Fraud Detection, Proactive Surveillance Systems, Financial Risk Analysis**

I. INTRODUCTION

Protection of investors in stock market is a concern of regulatory organizations. This important goal is one of three securities regulation principles which were introduced by IOSCO 1 in ‘Objectives and Principles of Securities Regulation’. IOSCOrecommended that proper resources should be available for regulators. Regulators in financial markets are accosted by various types of frauds. They use modern surveillance systems for challenging with creative fraud makers in such tricky arena.[5]

There is a far way to reach the acme of surveillance systems. Detection of fraud is mostly started after performing fraud case. This is because fraud makers always are active previous to regulator actions. In real world, they try to hide their scenario from supervision. Detection of fraud involves investigating many logs and it would be a time consuming task. So, informing investors in its initial steps of performing fraud is still a dream of supervision authorities. Investors heeding to regulators’ warring could protect them. Although taking early reaction is very critical but regulars can’t take a strong action when they are not themselves sure about it.

The results of late firing regulators in fraud cases is much loss for damaged investors.

Since fraud patterns are very creative, developing a system for supporting detection of all types of current and future scenarios is a very complicated task.

In the other hand, most of surveillance systems become adamant after final design phase and they lake sufficient flexibility for reacting against new type of frauds. Although some fraud scenarios and at least some parts of them may be repeated in the other situation, but wrapping new cases in complex compositions make recognizing them a very convoluted job.

Although current surveillance systems used many intelligent techniques to improve their process capabilities but it seems that there are some potential for new generation of proactive surveillance systems which would be an efficientresponse to the supervision industries’ needs.

The main goal of this paper is to build a new vision for future surveillance framework, by introducing Intelligent Visual Fraud which in it, regulator plays its role as an analyzer not just a data worker. The new suggested solution as the next generation of surveillance system can support visually whole process of fraud detection supply chain.

The remainder of the paper is organized as follows. The next section will discuss prior researches about various types of surveillance system for various regulatory users in capital market. Different surveillance Strategies in capital market are introduced in section 3. Section 4 and 5 describe the scope of the current research and provide an overview about attempts made by XBRL 2009 academic completion team for designing a proactive surveillance system for detecting financial frauds.

Section 6 and 7 introduce ‘Intelligent Visual Frauds’ as new a new framework for future surveillance systems and suggest a demo application for illustration the idea of visual modeling.

Finally, next section discussed some potential areas for future research and conclusions are drawn in next the end.

[1]INTERNATIONAL ORGANIZATION OF SECURITIES COMMISSIONS

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 5, Issue 7. January 2016

II. STATE-OF-THE-ART VISUAL MODELER FOR PROACTIVE SURVEILLANCE

Investors are very sensitive to their rights and are worry about financial risks which would surround them in financial market. In the other hand, regulatory firms are established to maintain a fair and competitive market and duty of supervision department is to protect investors from potential risk in the market.

The regulatory role involves motioning lots of market transactions for finding suspected cases to frauds. Electronic surveillance systems are intended to improve quality of supervision. This paper briefly analyzes current surveillance systems and proposes a new generation of surveillance system which can provide a framework for fully automated fraud detection for regulatory firms to support a proactive strategy for protecting investors.

In reactive method, regulators perform several tasks for detecting frauds including, monitoring check lists for market control, and checking suspicious alerts. However such monitoring attempts are done after frauds have already been performed. These alerts are set based on previous experiences of fraud cases. An example of reactive surveillance would be a periodic full review program for analyzing issuer companies.

Performing above tasks by surveillance experts are very time consuming process and in most cases, financial frauds are detected after finalizing fraudulent action by fraud makers in market.

Most of recent surveillance systems were developed applying intelligent techniques, but their resulted alerts must be compiled by human experts.

The idea of detection of all suspicious cases to fraud is in its initial steps of development and still there is a long way to reach acme of proactive surveillance. Proactive supervision is required for preventing losses in market and motived authors to design a new surveillance framework entitled “Intelligent Visual Fraud” which is capable of designing visual models for checking of dynamic fraud patterns in the market to report suspected fraud cases to regulators. It makes possible to design the fraud detection scenarios for a very first abstract sample case and then check it over and over again in the others cases and reuse the process as a part of complex situations.

In the course of time, this capability can be automatically applied in different situations and its progress can be monitored by the regulators in real time basis. Implementing the idea should be supported by a multi-layer platform which could be able to support designing and documenting fraud scenarios as back boxes, to be reused as designed scenarios for next situation. For detecting special cases, users can merge saved scenarios and create complex scenarios.

To demonstrate the usefulness and usability of this idea, a sample visual risk analysis scenario is designed in current research. A fraud detection workflow is developed for investigating bankruptcy risk of a typical listed company in stock exchange. This innovation can be applied for detecting other fraudtypes, such as insider trading case, which is illustrated in the currentstudy.

What makes this research distinguished from previous ones is that this is the first time that financial regulation is supported by a fully automated visual surveillance system, which can be applied for supporting proactive strategy in market supervision. This innovation would lead to a revolution in financial regulation because it not only boosts the objectives and methods of surveillance, but also opens a new window to future research about upgrading the role of regulator as data worker to an analyzer in markets. This innovation for the first time enable regulators to think and plan earlier to agile fraud makers and proactively hinder fraud pattern to be accomplished.

III. RESEARCH BACKGROUND

Precise, Speed and effective fraud detection is concern of many regulatory entities. During recent years many researches in academic and business scale were developed to provide efficient surveillance supports including electronic surveillance systems and procedures. Some if these researches suggests using red-flags for finding fraud cases, like a research which was developed by Conan C. Albrecht, W. Steve Albrecht, J. Gregory Dunn in 2000. They found that red-flag is suitable for finding fraud when there is an exact defection of fraud. They research showed that pro-active searching red-flag need a carefully specified formulization of related fraud. They finally concluded that, it is possible to use red-flags to detect fraud but there would be an excessive number of type I and II errors in such detection systems.

Next researches were ran for minimizing type II errors in surveillance systems, for example, Peter Goldschmidt(2005), conducted a research for reducing such errors in continuous auditing surveillance systems. He designed a knowledge management for verifying alarms into true and false. In his application a heuristic searching module is used for classifying information which was used as input for alert searching data set. This approach was used in different context but same goals in the NASD’s Securities Observation, News Analysis and Regulation System (SONAR). Henry Goldberg and his colleagues presented their work in Stock Exchange and Market Integration Belgrade's Conference in 2006. This project was awarded by Artificial Intelligence Prize in 2003 for effectively using AI and NLP techniques such as data mining in their application. In that speech Henry said that, the Market Regulation Department (MRD) developed Stock watch Automated Tracking (SWAT) in 1998 that covered insider trading and fraud. Next the MRD developed the Advanced Detection System (ADS) for finding practice of violated behavior of rules by firms. The ADS system became a framework for developing SONAR system as knowledge based automated surveillance system. (Goldberg, Henry G., 2006) Mining techniques in the new system was used for classifying news and SEC filings for entities. Henry concluded that the new project has made significant improvement over its predecessor, SWAT. Their 4 months periods’ test showed that the new system resulted in reducing false positive alerts, type II errors which was a same

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goal as Goldschmidt (2005) founded in his research.

Although, as mentioned above, both research got succeed to reduce the number of wrong flags in their system but they didn't eliminate such errors. For example, they results showed that the total number alert from 10247 in SWAT (old system) reduced to 4820 in SONAR system which 0.58% of alerts was true in old system while this percent in new system was 3.73%. This means that we have still some false alerts, 4802 (96.27%) misleading alerts means spending 72030 to 96040 minutes by human expert on mistaken alarms, based on his reported statistics.[13].[22],[38]

Also, another challenge in these research is lake of consider about changing the role of human experts from manual investigator of data related alerts to an analyzer of information. Still none of alert could lead to finding meaning full fraud case. Regulatory expert should observe several alerts, find a relation between then and investigate detailed date to build a fraud case. This is a time consuming process.

The question here is, is there any way to rest regulators from boring alert checking procedures? Can new modern information systems enable regulation department to at least reduce (if not remove) manual task burdens?

The answer of this question is the topic of current research which is discussed in next sections.

IV. REACTIVE AND PROACTIVE SURVEILLANCE SYSTEMS

In reactive method regulators perform task for detection frauds:

a. Controlling market control check list
b. Checking Suspicious Alerts: Monitoring is done as indicator of performed fraud.

These alerts are set based on previous experienced fraud cases. Periodic full review program for analyzing issuer companies doing above task w by surveillance experts is a time consuming process and in most cases financial frauds are detected after finalizing fraudulent action in the market.

There are some surveillance system which were designed based reactive surveillance strategy such as SONAR which is used for surveillance in NASDAQ stock exchange and NYSE, the MonITARS (Monitoring Insider Trading and Regulatory Surveillance) Systems in London Stock Exchange, ARAMIS is used by Euronext and 4 European regulatory and SMART used by Australian Stock Exchange.[13].[22],[38]

Although, most of these system were developed using intelligent method but they still designed based on compiling alert by human experts. For example SONAR system in its updated version provided a modern set alert which claimed that it is fired when a suspicious case in market in happened. The new feature of its latest version is fewer alerting results in comparison with previous version which make the job of investigating alert by expert simpler.

In figure 1, we can see a sample reactive surveillance system, SAMAP, surveillance system which was used for surveillance in Tehran Stock Exchange (TSE). For example if non operation revenue is increased more that 10 percent it will turn on red flag for warning.

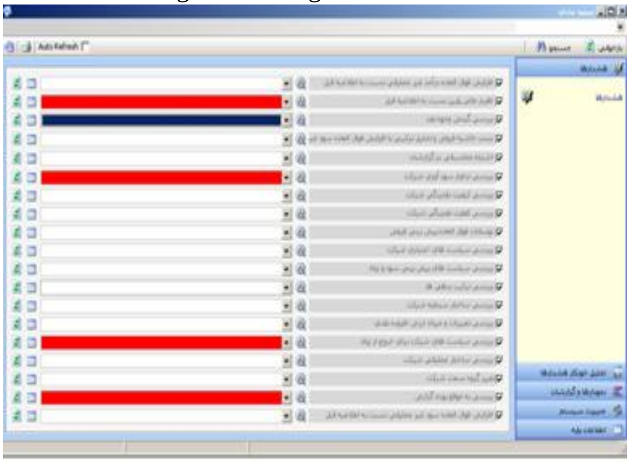

Fig1: Alerting desktop of SAMPA, surveillance system which was designed for finding financial fraud of listed companies in Tehran Stock Exchange (TSE).[4]

V. PROACTIVE SURVEILLANCE

In contrast to reactive method, proactive method is performed by following process:

a. Forecasting/estimating risk of frauds
b. Monitoring progress of frauds and estimating risk of frauds, in a continuous way, instead of static alerts after completing the fraud process. Monitoring progress of fraud help regulators to prevent fraud to be completed and protect investors in its initial steps. In stock exchange there are some tools for protecting investors in critical situations. For example when there is high degree of information asymmetry in the market, supervisor halts or suspends trading in the specific ticker (company trading symbol) and request further disclosure by issuer companies. This action urges informed decision making among market investors.
c. Automatic applying fraud patterns in all candidate cases: Analyzing the composite report for complex fraud cases which are generated by analyzing transaction by system. Regulators can use Visual Fraud Modeler for designing and testing probable fraudulent action, theses pattern are controlled by system automatically.

The questions here are: Can a visual modeler detect all complex fraud cases (see Fig. 2)? How it can detect and prevent from completing progress fraud flow? Can we look into surveillance system as something more that an alerting system? Can regulators be rested from boring task of checking lots of transaction logs? And finally, how reactive surveillance can be replaced by with live proactive surveillance?

The visual representation of fraud would be helpful for prevention of frauds before being completed if they be detected in their initial step and it is possible if surveillance systems have capabilities of representing live workflow of fraudulent activities, called Visual Fraud.

In the other word, protection of investors is possible by

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ISO 9001:2008 Certified
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estimation of risk frauds and prevention of performing fraud. So, there is a need for new generation of surveillance system capable of supporting such requirements.

Fig. 2: A sample of visual illustration of recent complex fraud in US capital market. (Ref: WallStreetFollies.com)

VI. CAPITAL MARKET FRAUDS AND SCOPE OF CURRENT RESEARCH

Market fraudulent attempts are deliberate attempts intended to deceive the market by disseminating false or misleading information, lake of sufficient public disclosure of right information or conducting manipulative transaction in market, in order to create an opportunity for unfair profit for a special group. (Bagherian, Kasgeri, Abbas, Bagherian Kasgeri, Roghaye, 2007)

There are many types of fraud in different context of capital market. Banking, stock exchange and auditing are three main scopes of financial frauds. There many surveillance system which are design for these applications. Fraud in stock exchanges are divided into three types of trading frauds (such as price manipulation), financial reporting fraud(such as earning manipulation and lake of transparency) and insider trading which are done in same order by traders and brokers, managers and insiders. There many fraud cases which are a composite of mentioned types of frauds (Ex. Enron and WorldCom cases). This paper was intended to introduce Intelligent Visual Fraud. For better illustrating proposed solution, the financial fraud scope is selected as a sample for developing a case study of proposed method. So, the next of current paper arranged a below:

Re-implement alert based surveillance system for listed companies in Tehran Stock Exchange using XBRL date of annual and quarterly reports

Suggest a new type of surveillance system as a solution for proactive supervision, call Intelligent Visual Fraud. This way the Visual Fraud is introduced as a framework for next generation surveillance systems.

Discuss a case study for upgrading designed alerting system in prior for risk analysis and introduce a sample application for detecting risk of financial reporting frauds using proposed Visual Fraud framework.

Analyze the test results of risk analysis for quarterly and annual report of listed companies in Tehran Stock Exchange

VII. A SAMPLE XBRL ALERTING SYSTEM FOR FINANCIAL RISK ANALYSIS

In 1999, Messod D. Beneish designed a model for detecting earning manipulation. The model's variables were designed to capture either the effects of manipulation or preconditions that may prompt firms to engage in such activity. His results suggested a systematic relation between the probability of manipulation and financial statement variables. In 2005, Dr. Cynthia Harrington in Indiana University has devised analysis ratios for identifying possible financial statement frauds. He examined Beneish's model for analysis of recent fraud cases in US capital market. In this paper the results of Dr. Cynthia Harrington study is used for designing risk analysis alerts. These ratios which can be used as red flags of potential frauds are Sales Growth Index (SGI), Gross Margin Index (GMI), Days' Sales in Receivables Index (DSRI) and SGAI(1,2,3 and 4).[8]

Since the application intended to process real companies' data, it need to compile financial report from online disclosure website of Securities and Exchange Organization of Iran (SEO), called CODAL. Registered companies under SEO regulation obliged to disclose their financial reports by CODAL Website which is accessible in www.CODAL.com.

In this website, data is available in various formats such as HTML, PDF and XML. The XML format is use as input to be converted into XBRL as international recognized format. For this purpose Codal XML elements are mapped to the IFRS 2006 taxonomy elements. The project domain was become limited to only two type financial report categories, including Income Statement and Balance Sheet. Figure 6 illustrated IFRS 2006 elements, which was used in the XBRL conversion project.[2]

IFRS XBRL Elements(Used ID)
Administrative Expenses
AssetsCurrentTotal
AssetsNonCurrentTotal
Assets Presentation
Assets Total
BankBorrowingsCurrent
BankBorrowingsNonCurrent
CashDividendsDeclaredProposedDividendReserves
CashOnHand
CostOfSales
CurrentIncomeTaxExpenseNetTotal
DeferredTaxLiabilities
EarningsPerSharePresentation

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IFRS XBRL Elements(Used ID)
EquityAndLiabilitiesTotal
EquityPresentation
EquityTotal
GrossProfit
IncomeLossFromInvestments
IntangibleAssetsNet
InterestExpenseBankBorrowings
Inventories
InvestmentProperty
LegalAndStatutoryReserves
LiabilitiesCurrentTotal
LiabilitiesNonCurrentTotal
LiabilitiesPresentation
LiabilitiesTotal
OtherAssetsNonCurrent
OtherNonOperatingExpenses
OtherNonOperatingIncome
OtherOperatingExpenses
OtherPayablesCurrent
OtherReceivablesNetCurrent
OtherReserves
PostEmploymentBenefitObligationTotal
PrepaymentsCurrent
PrepaymentsNonCurrent
PriorPeriodError
ProfitLoss
ProfitLossBeforeTax
ProfitLossFromOperations
RetainedEarningsAccumulatedLosses
SaleOfGoods
ShareCapitalOrdinaryShares
TradeAndOtherPayablesCurrent
TradeAndOtherPayablesNonCurrent
TradeAndOtherReceivablesNetCurrent
TradeAndOtherReceivablesNetNonCurrent

Fig 6: IFRS 2006 Elements in the XBRL conversion project [Authors]

Then ratios (1,2,3 and 4) which was suggest firstly by Dr. Messod D. Beneish was used for formula section of financial alerts in surveillance desktop.

These formulas [8] which can be used as red flags of potential frauds are:

$$\text{Sales Growth Index} = \frac{\text{sales current year}}{\text{sales prior year}} \quad (1)$$

$$\text{Gross Margin Index} = \frac{\dfrac{\text{sales prior year minus cost of goods sold prior year}}{\text{sales prior year}}}{\dfrac{\text{sales current year minus cost of goods sold current year}}{\text{sales current year}}} \quad (2)$$

$$\text{Days' Sales in Receivables Index} = \frac{\dfrac{\text{receivables current year}}{\text{sales current year}}}{\dfrac{\text{receivables prior year}}{\text{sales prior year}}} \quad (3)$$

$$\text{SGAI} = \frac{\dfrac{\text{sales, general and administrative expenses current year}}{\text{sales current year}}}{\dfrac{\text{sales, general and administrative expenses prior year}}{\text{sales prior year}}} \quad (4)$$

In 2005, Dr. Cynthia Harrington research showed that companies which manipulated earnings have a mean SGI of 1.607 and a median of 1.411. Also, his research indicated that manipulators sported GMIs of 1.193 at the mean and 1.036 at the median. His results for DSRI are 1.465 and 1.041 for SGAI. (Harrington,C, 2005) These values are use as triggering parameters in designed financial risk alerts which can be customized by regulators. Each four alert in web-based alerting desktop is triggered when the calculated parameter exceeded the related parameter values.

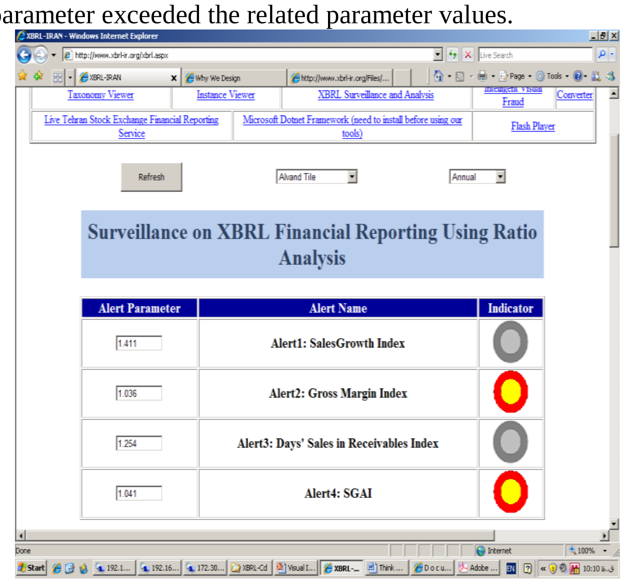

Fig. 3: Web-based alerting desktop for listed companies in Tehran Stock Exchange available online for the9th XBRL Global Academic Competition 2008-09, which was held in Bryant University, USA.

Four mentioned alerts were used for finding similar suspicious cases to fraud among listed companies in Tehran Stock Exchange. (See figure 3) This web-based alerting system receive live XML file of disclosed financial report for official disclosure website of Securities and Exchange

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
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Organization of Iran. This desktop can compile annual and quarterly report of listed companies in Tehran Stock Exchange.

VIII. TOWARD THE DREAM OF 'INTELLIGENT VISUAL FRAUDS'

The idea of sitting down human surveillance expert relax and just design fraud detection algorithm and delegating all computing hardship to the computer, was lead to designing a new surveillance framework entitled "Intelligent Visual Fraud".

The base idea is to system capable of designing visual models for checking of dynamic pattern of suspected fraud cases. It should make it possible to design the fraud detection scenarios for first sample case and then checking it over and over again in the others cases and as a part of complex situations.

This capability can be automatically applied during the time and it progress can be controlled by the regulators in timely basis. Implementing the idea should be supported by a multi-layer platform which could be able to support designing and documenting fraud scenarios, reusability of designed scenarios for next situation, combining saved scenarios for designing a complex scenarios and programming special cases. Although, this abstract idea should be implemented in sample industry, but the design structure should have potential to be expanded to other industries and business scopes like stock trading fraud detection, insider trading, continuous auditing and banking surveillance application.

To demonstrate the usefulness and usability of this idea, an insider trading scenarios is designed in figure 4. The workflow is developed for investigating insider trading case in a typical stock exchange.

Collaboration between Insider Trading Agent, Insider Revenue Agent, Company Revenue Agent and Auditor Reporting Agent is being performed for detecting insider illegal trading in its initial step. Each agent has its special algorithm for check suspicious case and it can use a workflow of alert which can be dynamically edited by regulators. For example, Company Revenue Agent can access to XBRL data which are released to the public as quarterly or annual report, compare earning's value and estimate the probabilities of information asymmetry in supervised issuer company. Then private information trading can be checked by insider agents and so on.

Using Intelligent Visual Fraud Desktop regulators can define each step and develop a fraud detection scenario. Also, they can change the scenario to monitor various type of fraud and can save and reload it as component. As figure 5 illustrated, data are driven from first layer from different resources such as XML (like XBRL for financial report and MMTP for market trading data messages) and web services. The next layer, data will be aggregated in database format and a data ware house system will classify and accumulate information which are generated from prior layer data.

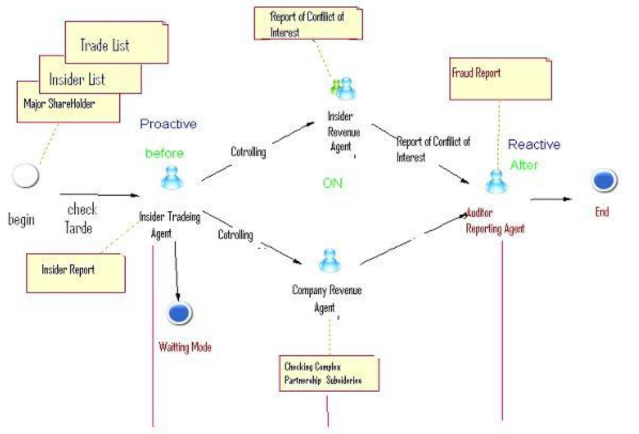

Fig. 4: A sample demonstration for insider trading detection model.[Authors]

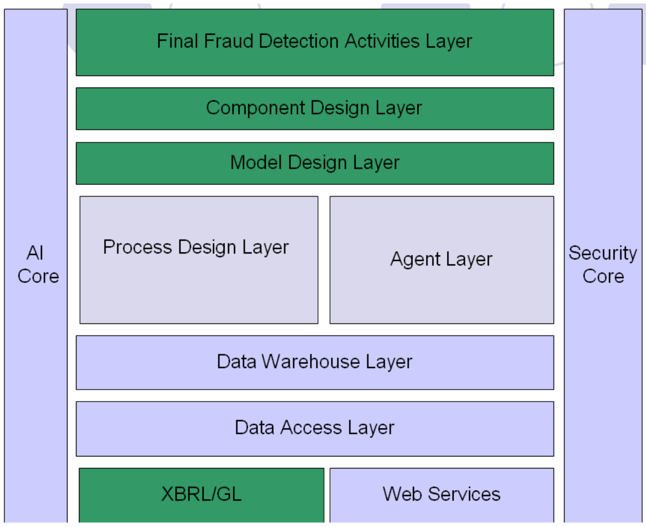

Fig. 5: Intelligent Visual Fraud abstract architecture [Authors]

Agent are defined and activated with designing their special process which become a handler for running Dynamic alerts work flow in next layer. Dynamic alerts combine alerts for collaboration in a live workflow to become as a part of fraud detection component. Construction the framework will be completed with designing a user interface for managing fraud surveillance project in top layer. Like most of other similar multi-layer applications, all layers are supported with security considerations and AI modules. The green section (see figure 5) are covered by a sample implementation as a demo application for financial fraud case study which is introduced in the next section.

IX. THE DEMO APPLICATION

The demo application is developed for upgrading sample alert system which was introduced in section 5 of this paper by visual modeling idea. In the design desktop (see Fig. 6) users can design dynamic patterns for detecting financial frauds. It processes XBRL files for calculation fraud alert and then compiles fraud pattern to detect financial statement frauds.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
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The demo application checks 4 alerts (can be increase) via dynamic sequence models and apply it to the selected companies. For working with this surveillance system, regulators don't need to have technical knowledge and the system automatically generate background code for checking new pattern. This ability is essential for following up dynamic patterns of fraud making in a developed capital market. Figure 3 shows a typical workflow for checking financial ratios of selected companies.

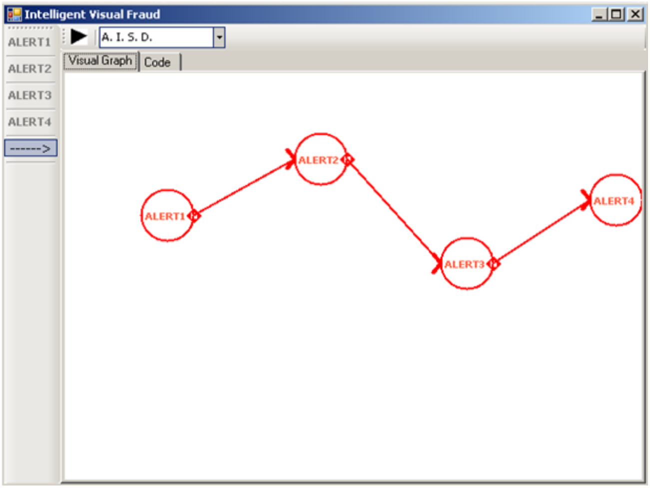

Fig. 6: An innovative visual model for bankruptcy risk detection of a company [Authors]

The background code is generated automatically and it can be edited for various situations. (See Fig. 7) This capacity rest regulator from worrying about technical details and it is possible to design fraud checking pattern in visual desktop.

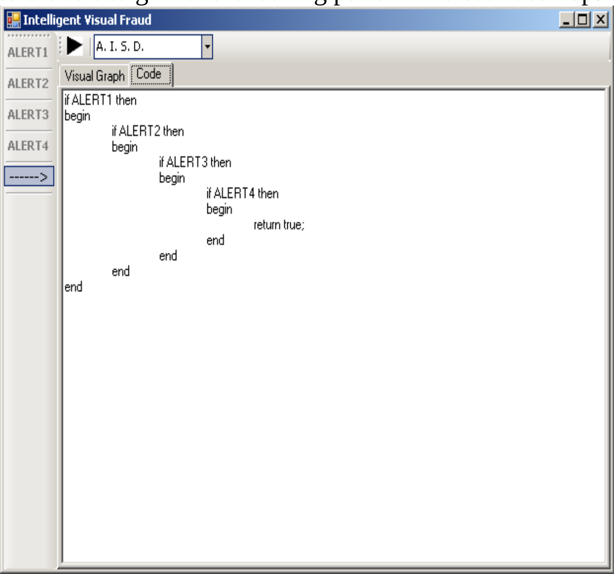

Fig. 7: A demo for automatic code generation for running dynamic pattern in Intelligent Visual Fraud [Authors]

The statistical results of calculating fraud alerts are represented in figure 8.

Based in, Dr. Cynthia Harrington findings, high degree of activating SGAI alert in figure 8 shows that there are high probabilities of overstated revenues in listed companies of Tehran Stock Exchange.

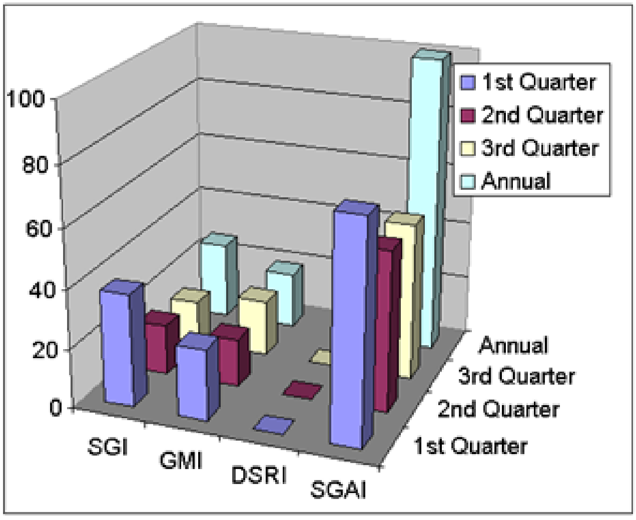

Fig. 8: The statistical of alert for 1 year period ending to 2014 for listed companies in Tehran Stock Exchange [Authors]

X. Future Work

The current research need to be completed by further research analyzing implication of new idea in different business applications. Especially there is a potential for studying differences between performance of fraud detection in IVF and similar surveillance systems.

Supportive language for compiling fraud scenarios should be completed by comprehensive grammar to be capable of supporting modeling for various fraud detection scenarios.

This idea need to be customized by industry and be developed for related network of supervisors which deserve to be considered as topics for further researches.

Visual modeling opens new doors to the regulation departments to cost the cost and boost their performance.

XI. CONCLUSION

Since fraudulent attempts are very creative and rapidly change over the time, there is a need for modeling and running detection algorithm dynamically in various situations. The proposed modeling framework should be reusable with little or no changes in source code. This requirement involved designers to get help from a multi-layer defining and processing of detection algorithms.

In this paper, reporting fraud case to regulators was performed by a visual desktop which is capable of monitoring progress of fraud through its life cycle. Security considerations and artificial intelligent techniques are supported in various layers.

Supporting fully automated fraud detection and supervision in fraud supply chain was possible through following IVF applications:

- Designing fraud detection model
- Monitoring Fraud
- Investigating
- Reporting
- Collecting audit trial and evidential matters

In this paper the original idea was illustrated by developing a demo application for detection of financial frauds.

The one of benefit behind the proposed visual framework is reusability of predefined fraud detection model for regulators. Designed framework provides intelligent adjustment of parameters for alerts in a multi-layer interaction framework with supervisor.

ACKNOWLEDGMENT

Author wants to thank Dr. Messod D. Beneish and Dr. Cynthia Harrington for their research about ratio analysis which was used in this study for designing risk indicators and Mrs. Roghaye Bagherian Kasgari for her kindly recommendations during this project. Also, author want to thanks Young Researcher Club for supporting this research.

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