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Knowledge Map: An Extension of FCM to Describe and Model Knowledge on A Complex System

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ABSTRACT
This paper provides an overview of a new technique to make better decision in complex problem for the people who works in financial firm .This tool reduces the complex data into Knowledge Map or System Map or Process Map.This is also known as Business Structure Map.Two types of analysis can be perform static analysis and time domain analysis.For monitoring the health of the company Knowledge Map is very useful. Knowledge Map is the extension of Fuzzy Cognitive Map (FCM), which in turn is the extension of Cognitive Map.This paper also deals with the different company strategy to mitigate the risk factors.
Keywords- business structure, extension, knowledge map, static, strategy

I. INTRODUCTION

Knowledge Map as a one of the Knowledge Management tools is a navigation aid to explicit information and tacit knowledge, showing the importance and the relationships between knowledge stores. This software tool was specifically designed for Knowledge Management. It is a proper to remember that Knowledge Map does not store knowledge. It just points to people who own it.This paper uses a model-free method to extract knowledge from the historical data of the company by constructing the knowledge map and advice some useful measures to increase the growth of the company.

This concept can be applied in many fields, like product design, management, medicine and air trafiic control They are a convenient modeling tool, usually categorized as a neuro-fuzzy method, for modeling and simulation of dynamic systems. One of their main advantages is an ability to incorporate and adapt human knowledge.

Fuzzy cognitive map (FCM) is a fuzzy digraph with feedback that represent the causal relationships between node. There are three types of elements in a FCM, namely the concepts or nodes, the causal relationships between concepts and the effects one concept influences another concept.These elements are represented by vertices, directed arcs and numerical values (called weights) associated with the arcs, respectively. Each vertex has it's own state,1,0.

1.1 Knowledge Management

Knowledge Management (KM) refers to a multi-disciplined approach to achieving organizational objectives by making the best use of knowledge. KM focuses on processes such as acquiring, creating and sharing knowledge and the cultural and technical foundations that support them.

1.2What is knowledge?

As usual, definitions state the knowledge is:

'Justified True Belief'

Things are not as simple they are , however because it can be shown quite clearly that there are situations that someone can be justified in believing in something that is also true and yet this is not knowledge. There is not space here to go into this sort of analysis. These definitions remain inconclusive and reasoning can become circular when one looks.At the very basis of what can really be believed.

However, for the purposes of working with knwledge.There are some useful observations that can be made.

1) If something is not true then it is not knowledge

2) There needs to be some justification for believing that something is true

3)Knowledge does not have to be complex although much of it is.

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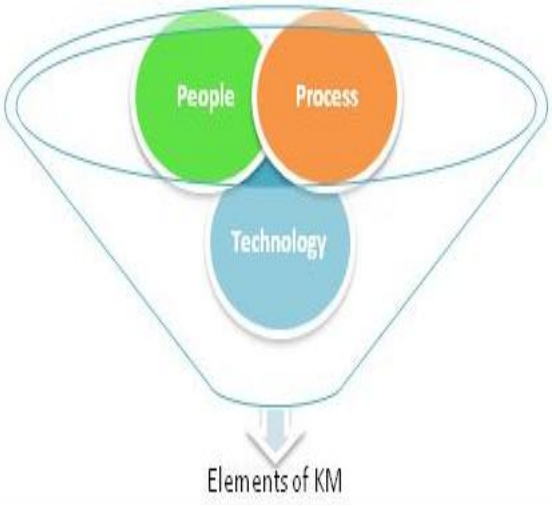


Fig.1.Knowledge Management :A multidisciplinary approach

As per the figure no 1,Knowledge Management may be viewed in terms of

* People –It tell about how do you increase the ability of an individual person in the organisation to influence others with their knowledge.

*Processes – Its approach differs from organization to organization. There is no limit on the number of processes.

*Technology – It needs to be chosen only after all the requirements of a knowledge management initiative have been established.

Take a look towards the flow of data

1.2.1From Data to Information

We are fed with a large amount of data many time, and we are pretty better at sorting through the incoming data and applying our understanding of the relationships between the different units of data and its meaning to us, so we can convert the data into **information.**In this method, we:

- delete,
- distort, and
- filter

the data to fit our understanding of the world. The raw data is convert into something that is summarized, described and defined in terms that fit with the information we already know.

1.2.2 From Information to Knowledge

We need to turn the information into knowledge, so we generalize the information and look for overall patterns that fit with our current knowledge. Knowledge allows us to have the concept of how things work, so we can develop strategies and methods that we know from experience will work. We will also be able to more easily process information because we know the patterns that we expect the information to fall into, and are able to recognize those patterns with new information.

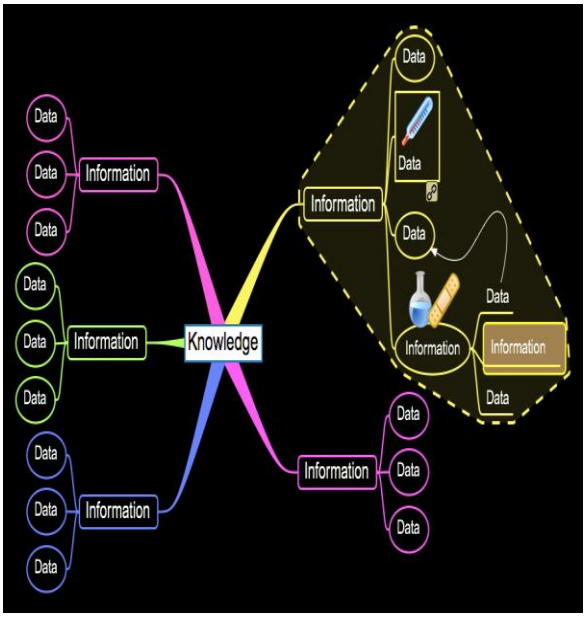


Fig 2. Level of Knowledge

II. PROBLEM DEFINATION

2.1Fuzzy Cognitive Maps (FCM)

Fuzzy Cognitive Maps (FCM) can model dynamical complex systems that change with time. FCMs use a symbolic representation for the description and modeling of the system. In order to illustrate different aspects in the behaviour of the system, a fuzzy cognitive map is consisted of nodes ,with each node representing a characteristic of the system.

These nodes interact with each other showing the dynamics of the system in study. An FCM integrates the accumulated experience and knowledge on the operation of the system, as a result of the method by which it is constructed, i.e., using human experts who know the operation of system and its behaviour. who know the operation of system and its behaviour. Fuzzy cognitive maps have already been used to model behavioral systems in many different scientific areas. For example, in political science fuzzy cognitive maps were used to represent social scientific knowledge and describe decision-making method.

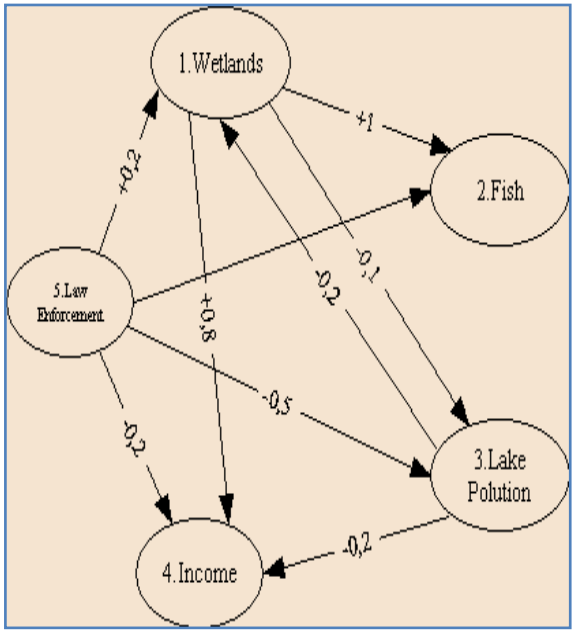


Fig 3. A Simple FCM Example

FCM consist nodes and links.Nodes are nothing but the concept.And each link are nothing but the arc.Links are used to connect different nodes or group of nodes.In the above fig no 3,it represent a simple FCM example.the weight are positive and negative which represent the negative and positive causality.
The main drawback of FCM was when too many parameters came into map, it become very complex to judge. So KM replaced this drawback by replacing this complex view by segmented view. The segmented view is selected because it reduces redundancy.

The segmented theory is based on Design Structure Matrix (DSM) theory.

This process reduces complex data to a "Knowledge Map." .and how to generate Knowledge Maps from complex data sets and how Knowledge Maps can be used to help make better decisions.

III. III RELATED WORK

A number of algorithms for learning FCM model structure have been introduced. In general two main learning paradigms are used. Hebbian learning and genetic algorithms. Dickerson and Kosko proposed simple Differential Hebbian Learning law (DHL) to be applied to learning FCMs .The learning process iteratively updates values of weights of all edges from the FCM graph until the desired structure is found.

In 2002 Vazquez presented an extension to DHL algorithm by introducing new rules to update edge values . This new algorithm was called Balanced Differential Algorithm (BDA). The new algorithm eliminates the limitation of DHL method where weight update for an edge connecting two concepts (nodes) is dependent only on the values of these two concepts. Therefore proposed learning method was applied only to FCM with binary concept values which significantly restricts its application areas.

Another method based on Hebbian learning was proposed in 2003. Papageorgiou et al. developed an algorithm called Nonlinear Hebbian Learning (NHL) to learn structure of FCM . The main idea is to update weights associated only with edges that are already suggested by expert, non-zero weights Therefore the NHL procedure allows obtaining model that retains structure which is enforced by the expert but at the same it requires human intervention before the learning process starts.

Active Hebbian Algorithm (AHL) introduced by Papageorgiu et al. in 2004 is the next attempt to develop Fuzzy Cognitive Map development. This approach introduces and exploits the task of determination of the sequence of activation concepts. The main limitation of this algorithm is that it still requires human interference.

In 2001 Koulouriotis et al. applied the Genetic Strategy (GS) to learn fuzzy cognitive map model structure weights of relationships from data. In this procedure, the learning process is based on a collection of input/output pairs which are called examples Its main drawback is the need for multiple state vector sequences which might be difficult to obtain for many real-life problems.

Parsopoulos et al. in 2003 applied Particle Swarm Optimization (PSO) method which belongs to the class of Swarm Intelligence algorithms to learn FCM structure based on a historical data consisting of a sequence of state vectors that leads to a desired fixed-point attractor state. PSO is a population based algorithm which goal is to perform a search by maintaining and transforming a population of individuals. This method improves the quality of resulting fuzzy cognitive map model by minimizing an objective function.

Next state of the art learning method for Fuzzy Cognitive Map, introduced by Stach et al. in 2005 applies real-coded genetic algorithm (RCG.A) to develop FCM model from a set of historical data .This approach is very flexible in terms of input data:\it can use either one time series or multiple sets of concepts values over successive iterations.

IV. LITERATURE SURVEY

Author B. Kosko developed a fuzzy causal algebra for governing causal propagation on FCM.. FCM matrix representation and matrix operations are presented in this context. Dickerson and Kosko proposed a simple Differential Hebbian Learning (DHL) algorithm which iteratively updated the values of the weights until they converged to certain predefined state. The generated FCM then become very complicated and difficult to understand.

J. Aguilar proposed the automated construction of FCM using learning procedure is a new field. These approaches have lots of advantages of quantified results but have several drawbacks. First thing is that the model typically requires a great deal of effort and specialized knowledge outside the domain of interest. And the second thing is that systems involving significant feedback propagates casual influences in complicated chains may be nonlinear in which case a quantitative model may not be possible. FAs a result numerical data may be hard to come.

J. L. Salmeron suggest to build an Augmented Fuzzy Cognitive Map based for modelling Critical Success Factors in Learning Management Systems. The study of Critical Success Factors helps decision makers to extract knowledge from the multidimensional learning process the core activities that are necessary for success.

V. PROPOSED WORK

5.1Module 1 : Requirement Gathering

Collect different dataset from various companies and need to create the database to mine knowledge maps from it.

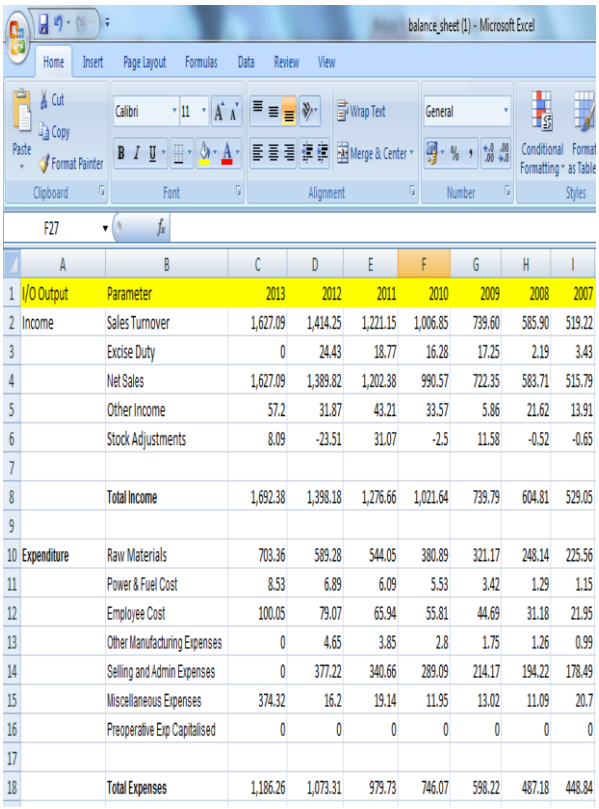
These databases can be from financial companies or any companies having major finance background. And need to collect revenue, income tax returns and maintenance cost like parameter The database used is financial related, the charted account firm or Market share data of any financial firm. If any dataset is available for research we will use that, or we need to create our ownKnowledge map always represent the concepts. Concept can be anything related to your domain like profit, loss, expenses, customer satisfaction, hr satisfaction etc. So we are keeping the data related to these sections.

5.1.1.About UI & Software Used

UI is created in PHP- MySQL as it has quality graph and chart support in the form of P-Chart Library. Our paper is mostly based on graph we choose PHP.

5.1.2. Dataset Preparation

Most of companies refuse to give their confidential data even for student research purpose we need to create sample financial dataset for research based on real time values.



	A	B	C	D	E	F	G	H	I
1	I/O Output	Parameter	2013	2012	2011	2010	2009	2008	2007
2	Income	Sales Turnover	1,627.09	1,414.25	1,221.15	1,006.85	739.60	585.90	519.22
3		Excise Duty	0	24.43	18.77	16.28	17.25	2.19	3.43
4		Net Sales	1,627.09	1,389.82	1,202.38	990.57	722.35	583.71	515.79
5		Other Income	57.2	31.87	43.21	33.57	5.86	21.62	13.91
6		Stock Adjustments	8.09	-23.51	31.07	-2.5	11.58	-0.52	-0.65
7									
8		Total Income	1,692.38	1,398.18	1,276.66	1,021.64	739.79	604.81	529.05
9									
10	Expenditure	Raw Materials	703.36	589.28	544.05	380.89	321.17	248.14	225.56
11		Power & Fuel Cost	8.53	6.89	6.09	5.53	3.42	1.29	1.15
12		Employee Cost	100.05	79.07	65.94	55.81	44.69	31.18	21.95
13		Other Manufacturing Expenses	0	4.65	3.85	2.8	1.75	1.26	0.99
14		Selling and Admin Expenses	0	377.22	340.66	289.09	214.17	194.22	178.49
15		Miscellaneous Expenses	374.32	16.2	19.14	11.95	13.02	11.09	20.7
16		Preoperative Exp Capitalised	0	0	0	0	0	0	0
17									
18		Total Expenses	1,186.26	1,073.31	979.73	746.07	598.22	487.18	448.84

Fig 4. Excel Balancesheet of Profit and Loss

Above fig no.4 refer to the balancesheet of the company determining the total profit and loss over seven years of the Alchemy company.

5.2 Module 2 : Knowledge Map Creation

This is very important step of research as we are creating knowledge maps based on the historical data collected in module1. Knowledge map creation step has 4 steps

- Scatter plot generation
- Fuzzy Rule Generation
- Map construction
- Hubs & Inactive node identification

1) Scatter Plot Generation

A scatter diagram is a tool for analyzing relationships between two variables. One variable is plotted on the horizontal axis and the other is plotted on the vertical axis. The pattern of their intersecting points can graphically show relationship patterns. Most often a scatter diagram is used to prove or disprove cause-and-effect relationships. While the diagram shows relationships, it does not by itself prove that one variable *causes* the other. In addition to showing possible cause and-effect relationships, a scatter diagram can show that two variables are from a common cause that is unknown or that one variable can be used as a surrogate for the other.

Scatter diagrams will generally show one of six possible correlations between the variables:

• Strong Positive Correlation

The value of Y clearly increases as the value of X increases.

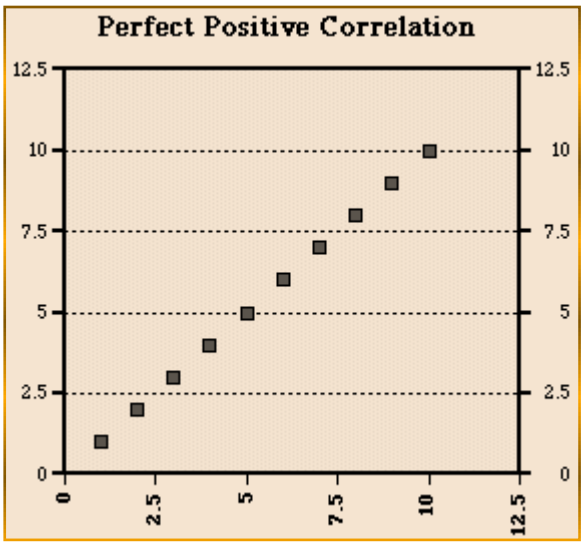


Fig 5 Strong positive correlation

• Strong Negative Correlation

The value of Y clearly decreases as the value of X increases.

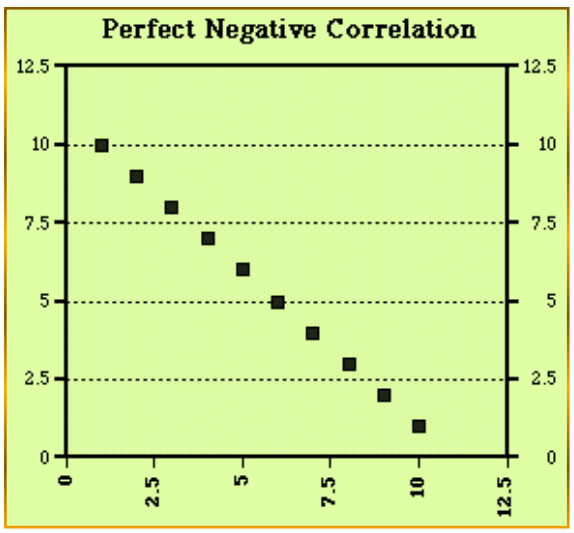


Fig 6. Strong Negative Correlation

• Weak Positive Correlation

The value of Y increases slightly as the value of X increases

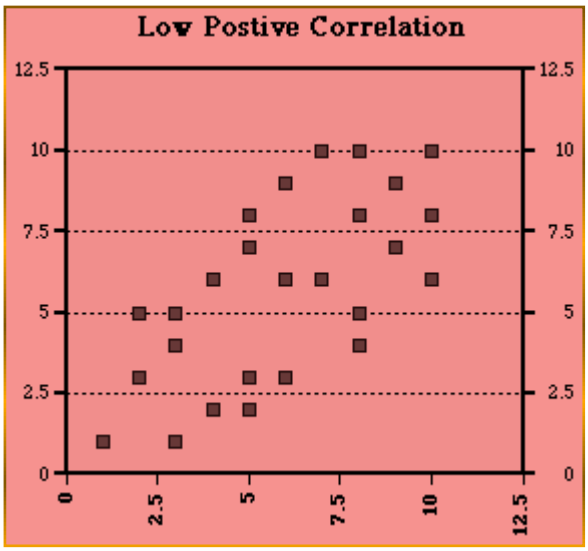


Fig 7. Weak Positive Correlation

• Weak Negative Correlation

The value of Y decreases slightly as the value of X increases.

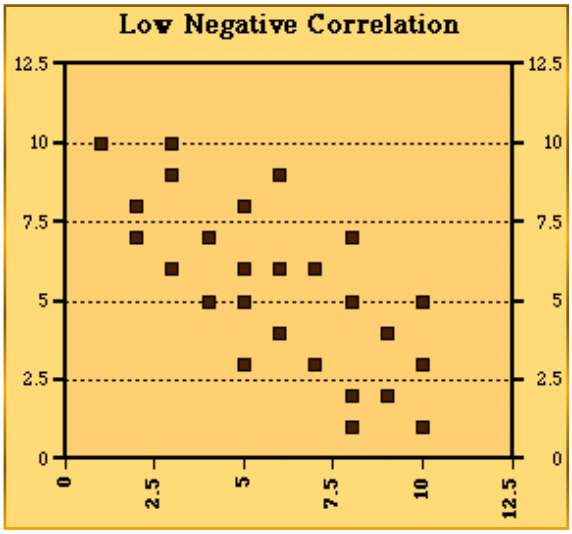


Fig 6 Weak Negative Correlation

• No Correlation

There is no demonstrated connection between the two variables

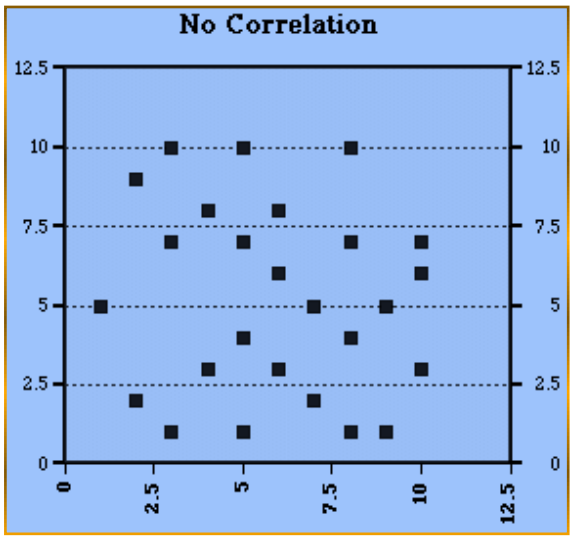


Fig 7 .No Correlation

In order to generate scatter plots wefirst create the excel file that consist financial data upto 10 years i.e from year 2004 to year 2013.After creating the excel file,we have to first filter that cells so that it occupy less space.At the last we have to import that file into our database. After importing ,it automatically takes the file.

The next process is to create the scatter plots from the available data of the file.If we want to plot a graph between Income v/s Expenses then we have to take "Income" on X axis and "Expenses" on Y axis.The "Income" consist parameters like Sales turnover,Excise duty,Net Sales,Stock adjustments and "Expenses" consist Raw materials,Power and fuel cost,Employee cost,Other expenses etc.

2)Fuzzy Rule Generation

Fuzzy set A on a universe of discourse U is characterized by a membership function that takes values in the interval [0, 1].

In 1975 Professor Ebrahim Mamdani of London University built one of the first fuzzy systems to control a steam engine and boiler combination. He applied a set of fuzzy rules supplied by experienced human operators.

For ex

O Input x: research_funding

O Input y: project_staffing

O Output z: risk

• Rules

Rule1: If research_funding is **adequate** or Project_staffing is **small** Then risk is **low.**
Rule2: If research_funding is **marginal** and Project_staffing is **large** Then risk is **normal.**
Rule3: If research_funding is **inadequate** Then risk is **high.**

3) Map Construction

BSMs are of fundamental importance towards the understanding of the structure of a business. BSMs indicate which business parameters are related and which are particularly important.

In a Business Structure Map the following components are present

o Nodes- These are the business parameters located along the map's diagonal and represented by red squares or discs.The node represent the concept or entity.

Examples: profit, loss, expenses, customer satisfaction, hr satisfaction etc can be represented as node.

There are two type of nodes that is input and output.Input nodes are those which brings input to the firm and output goes are output nodes.
Example: Revenue is input node and taxes are output node

Input and output nodes are represented by 2 different colours.

o Links – These are either strong or weak and are represented by black and grey connectors respectively. These links represent the strong and weak dependency between various parameters. These dependencies can be represented by the different colour connectors.

o Hubs– The red discs correspond to those parameters which are related to the highest number of other parameters.

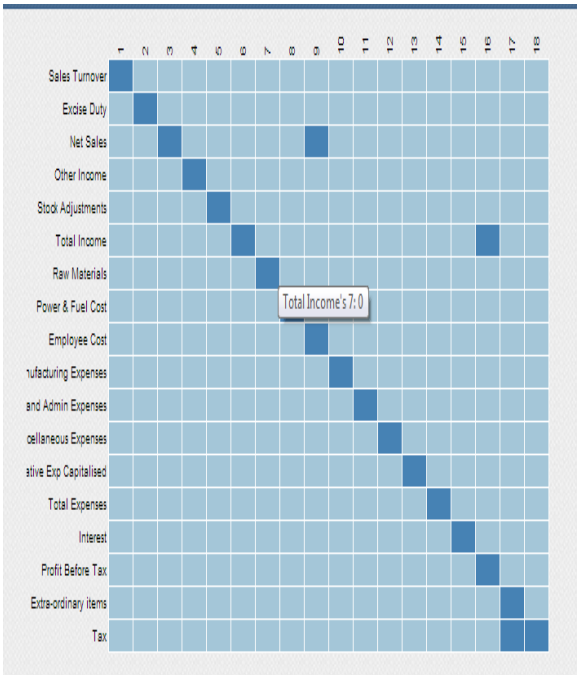


Fig.8 A Knowledge Map

In the above Knowledge Map,the design structure is based on the design structure matrix(DSM) theory. DSM is nothing but the analysis tool.It is square matrix with diagonal elements left blank.There are same number of parameters are placed between rows and columns.If there are 16 elements in verticle side(row) then same is also for in horizontal side(column).In this matrix the parameters are,Net Sales,total Expenses,Profit before tax,Tax, etc.DSM shows the information flow.It shows the relationship between various parameters with the help of nodes,link and connectors.

The above fig shows the relationship between Net sales and employee cost,Total income and profit before tax and Tax against Extraordinary items.

To analyse the Knowledge Map,we have to first find out the deviation.For finding the deviation,we have to first find the variance.for ex:If we want to see the relationship between Net Sales and Sales turnover of year 2003 and 2004 than

Year	Sales Turnover	Net Sales
2003	200	150
2004	300	200

For finding the variance ,

(200 -150)^2 + (300-200)^2 + .../ 10

Take the difference of Sales turnover and Net Sales upto 10 years and take the whole square.Add all such differences and divide it with total number of years.

Deviation=sqrt(varience)

3- 7 range weak dependency
7 -14 range strong dependency

For ex; if the deviation is,3 to 7 or 30 to 70 or 0.30 to 0.70 then it is weak dependency

Similarly, 0.7 to .14.700 to 1400 is strong dependency.
If the deviation is 4.5 ,it is strong dependency between Net sales and Turnover.

Online self-rating system delivers the so-called Business Structure Map which reflects the relationships between the various parameters of your business.The full power of our technology lies in its ability to analyze the complexity of systems of systems. Think of portfolios of financial products, companies or conglomerates of corporations and banks. How are they related to each other , How do they interact, Which are the most important ones, Which would cause the largest amount of damage in the event of default ,How would contagion propagate, All these and other questions may be answered with our tools in a truly innovative manner.

4) Hubs and inactive nodes identification

The number of links in a node decide which node is hub and which node is inactive node. The node with themost relationships is called the hub, while node withno links are inactive. Both kinds of nodes are clearlyrepresented in the map. The hubs that have close relationships with other nodes appear as circular shapes while the inactive nodes are shown as white squares.

5.3 Module 3: Analysis

1) Static Analysis
The static analysis uses all the historical data to construct a KM to give complete picture of companies.

2) Time Domain Analysis
In time domain analysis the data will be split into several continues periods or windows. For ex ,to view the salary of particular month or year.

VI. RESULTS

Knowledge map is useful for representing knowledge and for monitoring the health of companies. Further more sudden changes of the key features of the KM should be taken seriously by policymakers as an alarm of a crisis. The main objective is to get good results from historical data so that the prediction and formation of policies. This method can be used in many fields, such as product design, management, medicine and air traffic control. maps mined from historical data are more valid and

lose less information than those relying on the perceptions of experts..The KM mining method proposed by Marczyk eliminates the long iterative procedure and constructs a KM directly by analyzing the data resource.

Based on knowledge map you can judge which parameters has the greatest impacton the company policy. You can see the relationship between employee salary and productivity.

(1) Identification of cause-effect relationships between variables,
(2) Visualization of how information flows within a given system, and
(3) Ranking of variable importance indicated by hubs and inactive nodes

When we will construct knowledge map with regular parameter, we will add few more parameters based on the output of KM and which factors are affecting lot.

VII. CONCLUSION

This paper describes a mining method to construct knowledge maps utilizing historical data without the intervention of domain experts. The software is used to apply the method to analyze component stock corporations. The static analysis results show that the KM is apable of discovering the structure of the examined systems given through fuzzy rules. Time-domain analysis reveals the evolution of the main feature so the knowledge maps which can be used by policymakers to monitor the company health. The results demonstrate that the mining of knowledge main properties of the KM can effectively indicate crises, which is not possible by conventional risk rating methods.

The scatter plot is the basis of the knowledge map. It helps to understand the relationship between various parameters of the company.Thus the Knowlede Map is very much useful in company to analyse the financial data.Both the static and time domain analysis is shoud be perform.

This idea is very much useful in automobile and aerospace industries as a design simulation. It will be also very helpful to other related areas such as textile industries, bank , sales etc. Banking, E-commerce, HR, and Production industries.

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