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Knowledge Sharing Risk Warning of Industry Cluster: an Engineering Perspective

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Abstract

Knowledge Sharing in Enterprise Clusters has become an important way for industry clusters to gain competitive advantage, but knowledge-sharing behavior implies some risk. In this paper, enterprise Clusters is taken as the research object in order to identify various risks during the process of knowledge sharing by use of fuzzy mathematics and artificial neural network technology.

Keywords: industrial cluster enterprises; knowledge sharing; risk; warning

1. Introduction

In the time of knowledge economy, knowledge management has become a critical factor for a business' survival and development of industrial clusters. The enterprise knowledge management in Industrial clusters aimed at achieving spread and proliferation of explicit knowledge and tacit knowledge in industrial clusters, and overcome obstacles for knowledge sharing, and to promote knowledge interaction between different subjects, cultivates creative capacity of a business' individual or the whole cluster. Among them, the knowledge communication and flow between various actors within the cluster is so-called knowledge sharing, it is the core point of knowledge management in industrial clusters.

The knowledge sharing among enterprises in the industry cluster has very important practical significance for reducing the cost of knowledge acquisition, enhancing the synergy between the enterprises in the cluster, improving the ability of cluster innovation, and promoting the overall competitiveness of the cluster enterprises. But it is undeniable that knowledge-sharing activities between enterprises within industry clusters also bear some risk. Industry cluster is formed as a body of knowledge integration linked by knowledge and information, is a knowledge alliance organization existing at the middle between the market and enterprise. Because the Union(alliance organization) is not a legal complete economic entity, each cooperative member has its own different background, objectives and expectation,

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furthermore the Union itself faces future uncertainty and organizational instability, so between the needs of knowledge-sharing and knowledge proprietary for the members there exists a natural "boundary conflicts (boundary paradox)", the co-members want to seek knowledge and ability from outside the enterprise on one side while they shall face the risk of leakage of key internal knowledge. Besides, in the industrial cluster, the risk tolerance of each member is not the same for different enterprises, As for the industrial clusters, the high investment of collaborative R&D and innovation and knowledge sharing would bring a destructive/devastating attack to some enterprises once this knowledge sharing activity is failure.

The risk management of knowledge sharing in Industry Cluster focuses on the predicting and preventing of the future possible risk factors. Therefore, it is appropriate way to take use of the risk early warning methods for prediction and prevention of knowledge sharing risk in the industry cluster. In this paper, take the enterprise in Industry Clusters as the research object, some discussible study for knowledge sharing risk warning is being done in order to provide a theoretical basis for risk prevention for business success running and risk prevention in the industry cluster.

2.The feasibility of the application of fuzzy neural network technology for knowledge sharing early risk warning in the enterprise of an industrial cluster

Knowledge sharing risk on enterprise of industry clusters is both an objective risk, it can be quantified through certain techniques and methods for the risk loss and the probability of occurrence; the same time, it is a subjective risk, i.e. the different subject, based on its different risk tolerance and the attitude on risk, will give different subjective values under the same degree of objective risk. Meanwhile, some factors that impact knowledge sharing risk are normally described in the form of natural language; it is very difficult to give these factors the exact value of mathematics. This bring much more difficult for the measuring and evaluating of knowledge sharing risk.

Fuzzy math provides a kind of effective tool for turning the fuzzy natural language into a precise digital form. Through the membership function and membership grade, fuzzy semantic index can be assigned and classified in a highly certain degree of confidence; through the fuzzy rules and fuzzy reasoning, fuzzy risk effect factors can be mapped onto the corresponding risk form and risk degree, and establishing the relationship between risk factors and outcomes. Through the fuzzy technology to measure and evaluate the knowledge sharing risk, it is both in conformity with human habits of thinking, but also has considerable objectivity, and is conducive to risk prevention and control for knowledge sharing risk.

Artificial neural network has a good learning ability; it is an effective tool for forecasting and risk early warning. It is widely used in such activities or study topics for prediction of financial risk and the macroeconomic situation forecast, loss risk of bank deposits and loans and bad debt etc. This method is based on past historical experience, the collection of historical data and the statistics of risk profile over the past years, to establish and train the neural network, and this tested, proven effective neural network will be applied in the prediction of future risk early warning.

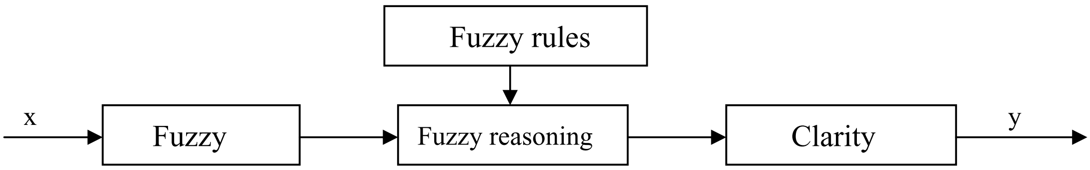
Fuzzy technology and neural network technology, each with advantages and disadvantages, but they are complementary each other. Fuzzy technology has got the ability of processing fuzzy language information, and has the ability to simulate human intelligence to judge and make decision, but the fuzzy logic does not have the learning function. Artificial neural network has learning function, but it can not handle and describes the fuzzy information. This paper try to combine the fuzzy technology and neural network technology together, in order to discuss knowledge sharing risk early warning problems for the enterprise in industry clusters.

3. Establishment of knowledge sharing risk warning model for the enterprise in industry clusters based on fuzzy neural network cluster

3.1 The principle of establishment of a risk warning model

In this paper, a solution is suggested using fuzzy function approximation methods to achieve the risk early warning, the solution is that the input will be made fuzzy by the feed-forward neural network, complete the fuzzy logic reasoning and fuzzy comprehensive process of a variety of early warning signals. Fuzzy rule is constructed on the experts experience with fuzzy, and integrated output the risk early warning. The principle is shown in Figure 1:

Figure 1 Schematic fuzzy neural network



3.2 Risk warning model structure

According to the characteristics of neural networks and the problems to be solved, the network topology structure applied in knowledge sharing risk warning for the enterprise in industry clusters.

First layer: input layer. Each node represents a component, each node directly connected with each components xi of the input vector x, and transfer the input values to the second layer. Vector x represents the main factors which cause the risk, while components x_i of the fuzzy linguistic variable represents the state of various factors. Ambiguity of knowledge, information asymmetry and opportunism, the knowledge dependency of core competence of enterprise are three root causes which cause knowledge sharing risk in industrial clusters, so they can be seen as the three top level risk assessment indicators. The refining risk indicators are derived from the roots of the three. So these three indicators can be used as signs and signals of knowledge sharing risk warning for cluster enterprise, and they can be taken as input of the fuzzy neural network

Second layer: fuzzy layer. Each node in this layer represents a linguistic variable and its degree of membership. Three linguistic variables are given three scales {high, medium, low}, their corresponding values are {3, 2, 1} respectively, A_i^k representing scale value of the linguistic variables, i represents each component of x_i of the first layer output vector x, k represents the No. k-scale of the component i; $\mu_{Ai}^k(x_i)$ represents the membership degree k-scale of component i to each component of output vectors x_i of the first layer. Membership degree here is the weight of each input vector, i.e. refers to the confidence level of status in which the risk factors are. We use expert scoring way to obtain membership degree.

The third layer: fuzzy reasoning layer. The role of the layer is to map the risk factors on the impact of knowledge sharing onto two directions of risk through the fuzzy reasoning rules, namely, risk of less knowledge sharing and risk of over knowledge sharing. The first three nodes of the layer represent the three scales of risk of knowledge less-sharing; the last three nodes are the three scales of risk of knowledge over-sharing. This layer involves three parameters, B_i^k in the figure represent the language variables –the scales for the risk of knowledge less-sharing and the risk of knowledge over-sharing of over the scale of risk, $\mu_{Bi}^k(x_i)$ represent the membership degree of the scale, W_{ij} represent the weight for connection between node i of the first layer and node j of next layer .and membership degree between the second and third layer is transferred through the operation and synthesis of fuzzy relations, the connection weights firstly get random value, then it is adjusted by the network training way. This layer describes the fuzzy rules of the relationship between input and output, is actually a intelligent integrating for the theory knowledge and expertise experience of knowledge sharing risk in industry clusters.

The fourth layer: normalized layer. The nodes of this layer represent the three scales of knowledge sharing risk for enterprises in industry clusters. Among them, $C_i^k(y_i)$ represent the scale value; $\mu_{Ci}^k(x_i)$ indicating the membership degree of the scale value. The task of this layer is to map the three scale {high, medium, low} is three status of knowledge less-sharing risk and knowledge over sharing risk of third layer onto the three scale of knowledge sharing risk of the virtual enterprise through computing the weighting plus. Similarly, the scale value is transferred in a form of the weighted plus just as the parameter transfer rules as that of the second and third layers. The membership degree is computed through fuzzy set; get the greatest value as the degree of membership according to the result of calculation. Namely:

$$C^j(y_j) = \sum_{i=1}^{2} w_{ij} \bullet B_i^j(z_i^j) = w_{1j} \bullet B_1^j(z_1^j) + w_{2j} \bullet B_2^j(z_2^j) \quad (1)$$

$$\mu_{C^j}(y_j) = \bigcup_{i=1}^{2} \mu_B(z_i^j) = \bigvee_i (\mu_B(z_i^j)) \quad (2)$$

Where, i = 1, 2. Represent of risk of knowledge less sharing risk and sharing of knowledge over the risk, j = 1, 2, 3. Represent the three scale of risk.

Fifth layer: defuzzification layer, to achieve clarity calculation. This layer is to judge the three scale of knowledge sharing risk of the forth layer based on the principle of maximum of membership degree, take the knowledge sharing risk scale of the greatest degree of membership as the actual output state of . Knowledge sharing risk. Namely:

$$y = y_i \quad , \quad j = \varphi'(\max(\mu_{C^j}(y_j)) \quad (3)$$

Where is the inverse function of the symbol that, where the greatest risk on behalf of the membership scale symbols.

4. Learning algorithm of Warning Model

Based on the above discussion, it can be seen that the parameters to be learned for the network are the connection weight value W_{ik} and W_{kj} (i = 1,2 ..., 9; j = 1,2 , ..., 6; k = 1,2,3) between the of the second layer, third layer and fourth layer. The above given fuzzy neural network is essentially a multilayer feed forward network, so the parameters learning algorithm could be designed and adjusted by using error back propagation method as the BP network can do. Error function defined as:

$$E(W) = \frac{1}{2}\sum_{j=1}^{3} (d_j - y_j)^2 \quad (4)$$

Where d_j is the expected output, y_j is actual output. As the largest judge criterion for membership degree will lose a lot of useful information, so the calculation error is considered from the fourth layer from the network, not counting from the fifth floor. The error back propagation algorithm is given as follows to calculate $\frac{\partial E}{\partial W_{ij}}$, and then use a step- optimization-algorithm to adjust Wij..

When in the fourth level, by the formula (5)

$$\delta_j = \frac{\partial E}{\partial net_j^{k+1}} = \frac{\partial E}{\partial O_j^{k+1}} \bullet \frac{\partial O_i^{k+1}}{\partial net_j^{k+1}} = [O_i - d_i] \bullet f'(net_j^{k+1}) \quad (5)$$

Obtained

$$\delta_j^{(4)} = -\frac{\partial E}{\partial y_j} = d_j - y_j \quad (6)$$

Then from (7)

$$\frac{\partial E}{\partial W_{ji}^k} = \frac{\partial E}{\partial net_j^{k+1}} \bullet \frac{\partial net_j^{k+1}}{\partial W_{ji}^k} = \frac{\partial E}{\partial net_j^{k+1}} O_i^k \quad (7)$$

Obtained

$$\frac{\partial E}{\partial W_{kj}} = \frac{\partial E}{\partial y_j}\frac{\partial y_j}{\partial W_{kj}} = -\delta_j^{(4)} z_k^{(3}) = -(d_j - y_j)\bar{z}_k \quad (8)$$

for the third layer by equation (9)

$$\delta_j = \frac{\partial E}{\partial net_j^k} = \sum^m \frac{\partial E}{\partial O_j^k} \bullet \frac{\partial O_j^k}{\partial net_j^k} = f'(net_j^k) \bullet \sum_m \frac{\partial E}{O_j^k} =$$

$$f'(net_j^k) \bullet \sum^m \frac{\partial E}{\partial net_j^{k+1}} \bullet \frac{\partial net_j^{k+1}}{\partial O_i^k} = f'(net_j^k) \bullet \sum^m \bullet W_{mj}^k \quad (9)$$

Obtained

$$\delta_k^{(3)} = -\frac{\partial E}{\partial z_k} = -\sum_{j=1}^{3} \frac{\partial E}{\partial y_j}\frac{\partial y_j}{\partial z_k} = -\sum_{j=1}^{3} \delta_j^{(4)} W_{kj} \quad (10)$$

Similarly from (7) obtained

$$\frac{\partial E}{\partial W_{ik}} = \frac{\partial E}{\partial z_k}\frac{\partial z_k}{\partial W_{ik}} = -\delta_j^{(3)} x_i^{(2)} = -(\sum_{j=1}^{3} \delta_j^{(4)} W_{kj})\bar{x}_i \quad (11)$$

The error back-propagation calculation in each layers, provided and are random value.

5. Training and testing of early warning models network

The above two sections solves the structure of fuzzy neural network and algorithmic problems, this section is to solve the data collection and network training.

5.1 Training data collection

Due to the Data preservation and archiving on knowledge-sharing risk of most enterprises in industrial clusters is not doing enough so that to increase the difficulty of this data collection. Therefore, this section will use the typical small samples to train the network, although the sample data are less, but have diversity and representation for them.

By way of questionnaires, from 12 companies of Baoji Titanium Industry Cluster, we got the survey data as many as 12 groups, 10 groups of data are used to build fuzzy neural network of the model and train them, 2 groups are used to test them. Specific survey data are shown in Table 5.1.1:

Table 5.1.1 Early warning models training data

Enterprise No.	Risk Type.											
	x_1			x_2			x_3			x_4		
	Low	middle	high	low	middle	high	Low	middle	high	low	middle	high
1	0.15	0.62	0.12	0.23	0.41	0.55	0.38	0.29	0.21	0.60	0.32	0.72
2	0.33	0.21	0.24	0.58	0.32	0.31	0.33	0.37	0.53	0.48	0.12	0.62
3	0.45	0.32	0.56	0.50	0.26	0.25	0.28	0.53	0.22	0.42	0.37	0.25
4	0.22	0.56	0.31	0.14	0.31	0.21	0.46	0.50	0.47	0.48	0.25	0.31
5	0.25	0.44	0.57	0.41	0.23	0.38	0.39	0.47	0.60	0.68	0.39	0.45
6	0.18	0.22	0.32	0.47	0.11	0.32	0.23	0.60	0.12	0.17	0.31	0.44
7	0.15	0.54	0.32	0.34	0.56	0.27	0.52	0.67	0.32	0.23	0.43	0.49
8	0.22	0.55	032	0.33	0.51	0.27	0.29	0.32	0.51	0.33	0.65	0.48
9	0.33	0.20	0.38	0.39	0.48	0.18	0.34	0.18	0.57	0.46	0.39	0.27
10	0.21	0.45	0.18	0.36	0.28	0.39	0.47	0.38	0.61	0.43	0.57	0.63
11	0.26	0.43	0.66	0.37	0.46	0.31	0.36	0.39	0.55	0.51	0.36	0.44
12	0.38	0.32	0.67	0.27	0.36	0.10	0.19	0.34	0.63	0.37	0.61	0.46

5.2 Training and testing of fuzzy neural network

Fuzzy neural network created on the 4.1 is trained with the first 10 sets of data in Table 1, the trained with 500 times, range of allowable error is 0.001, the training process is stopped once the required training number of network or required training error are reached. That is, to suspend training. In practical training, the network training times is 465 times, the error meets the requirements, the training stopped. After training, the part of the weight value of network is shown in Table 2:

Table 2 weight value table of network

W_{11}	W_{41}	W_{22}	W_{52}	W_{33}	W_{63}
0.51	0.43	0.48	0.32	0.25	0.46

Where, i represent the i-node in the third layer in the network model in, j represent j- node of fourth layer. From the size of the weights it can be seen, that contribution of knowledge less-sharing risk and knowledge over- sharing risk is equivalent, which is consistent with subjective risk analysis judgment by human experience for knowledge sharing risk of enterprises in industry clusters.

The trained network is tested with the latter two data from Table 1.For the first set of data, the network's actual output is:
y_j = {2.995，2.011，0.979}，
Network error:

$$E(W)=\frac{1}{2}\sum_{j=1}^{3}(d_j-y_j)^2=\frac{1}{2}[(3-2.995)^2+(2-2.011)^2+(1-0.979)^2]$$

$$= 0.0003<0.001$$

For the latter set of data, the network's actual output is:

y_j = {2.977，2.016，0.989}，
Network error:

$$E(W)=\frac{1}{2}\sum_{j=1}^{3}(d_j-y_j)^2=\frac{1}{2}[(3-2.995)^2+(2-2.011)^2+(1-0.979)^2]$$

$= 0.0002 <0.001$

Testing results showed that the actual output of the two sets of data are similar to expected output, they all meet the error requirement. Therefore you can use this fuzzy neural network to detect knowledge sharing risk warning of enterprise in industry cluster.

6.Conclusion

Industry cluster is formed by the accumulation of related businesses, and it is the cooperation and competition relationship within industry cluster enterprises, more and more enterprises in industrial clusters attached great importance to knowledge sharing, and to create good conditions for knowledge sharing within the industry cluster. However, there are also some examples of the failure cases because knowledge-sharing behavior of enterprises in industrial clusters, which led to the risk of the loss of core competence of the enterprise, or failure cooperation of industry clusters, such cases are gradually increasing . Therefore, effective prevention, avoidance and control of knowledge sharing risk (especially the core knowledge sharing) turn to be a prerequisite for business success in industry clusters.

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