The agent – based warning modelling of internal quality risks in supply chain for manufacturer

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Abstract

With the dynamic of market and deepening competing, enterprises will to be faced with much uncertain quality risks in supply chain. At present, the quality risk has been seen as one of the most important risks of supply chain, which is the most difficult to prevent and manage. To do it, the entities-attributes model based on the business of manufactures was used as the reference data sources of building evaluation index system for internal quality risks of supply chain. Because the early warning of risks manually has the limits of information insensitivity and risks identification slowly, this is apt to cause the delay of risks precautions. Therefore, the intelligent Agent based modelling method will be applied to construct the four early warning situations based warning model according to the internal risk of supply and demand for manufacturers. In addition, the evaluation algorithm, the rules of early warning and the running process for this Agent were focused in the study. This study will play a reference role to the analysis and management on the quality risks of supply chain.

Keywords: Quality risks, Supply chain (abbr. SC), Agent, Manufacturing enterprise, Early-warning modelling

1 Introduction

Because of the anfractuosities of structure, instability of environment, managers pursuing lean supply chain and neglecting risk management, and so on, supply chain is having been more and more subject to affected by all kinds of risks [1].

Presently, the supply chain is the most favourable management model for enterprise. Especially, the manufacturers businesses are mostly operating on the supply chain. However, with the widely using of supply chain in the management of manufacturing enterprises, enterprises mainly focus on their core business, and outsource their non-core business to other companies, it can help enterprises to do fine, but due to the lack of supervision on the other outsourcing and the complex of market, we will encounter many problems about the quality of products [2]. So is it that we will to be facing with more quality risks of supply chain for manufacturers.

Furthermore, we are being the active period of reform and opening up in China, which makes manufacturers in China, faces more uncertainty. As a result, some unexpected events from uncertainty become more frequently, such as, the "melamine milk" incident in 2008, the capital chain rupture in enterprise in 2011 made Wenzhou in Zhejiang province encountering great economic crisis, the lean meat powder event in China caused huge losses to the pork market, etc. These are the typical quality risk event in supply chain. In addition, China is becoming the world's manufacturing plants, to improve the Chinese' international competition in products, markets and technology, some new challenges for SC are increasing. The study on it has become a new hot in the field of supply chain management in China.

Under the environment of Globalization, many risk in SC for manufacturer come from these relation interrupting of supply and demand. Such as, the third party intervention, strike, natural disasters, human error [3], the habits change of customer, technical failure, financial difficulties, and etc. these problem can be seen as resulting from the external cooperation based on resources of supply and demand and internal management. Namely, enterprise is challenged by the supply chain quality.

Although it is all but is impossible to predict a specific risk case. However, it is feasible to permit us to predict the risk patterns or trends in the evolution of sprout from the perspective of macro management. In view of the quality risk in SC for manufacturers, if no natural disasters and political change, should to be formed by the internal quality of manufacturer and the quality of cooperation with others in marking. It is to say that this risk can arise from the internal of enterprise and the external interface business. From the point of SC system, the external interface businesses to manufacturers are based on the supply and demand cooperation between manufacturers to other nodes in its SC and nodes in other SC. In view of this, on the premise of no big natural disasters and political reform, we will analyse the quality

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risk factors from the internal operation of enterprises and external interactions for all kinds of supply and demand, furthermore, the Agent based model of predicting quality risk will to be provided to recognize the possible macro risks related to the quality of enterprise.

2 Literature review

With the integration of various management concepts, risk management theories begin to be applied in quality management, which makes more scholars to research the quality risk in various fields. Furthermore, in the competition environment of the high and dynamical requirements of customers on product quality and service level, the quality risks in SC has become one of the bottlenecks of enterprise operation. Although, the study on it has become hot, but superficial.

Levy (1998) [4] found in the environment of SC, the quality had a paradigm shift. Quality problems are not only in internal of enterprise, but also in these aspects of customers, supplier, and collaboration to ensure the quality of the products. Chu-Hua Kuel (2003) [5] and etc., by comparing and analysing the supply chain quality management, total quality management and comprehensive quality assurance, provided the key factors of risks in SC are composed of information, relation, and innovation are analysed, that information, and the relationship between the reform and the three is a key factor to guarantee the quality of products, reduce the quality risk in supply chain. Svensson G. (2000) [6] discussed the supply risk in production logistics, and proposed a conceptual framework of supply chain vulnerability analysis. As a famous expert in supply chain management, Christopher S.T (2006) [7] studied the supply chain quality risk management from the four aspects of product, supply, demand and information. Batson & McGough (2007) [8] build quality model of supply chain for quality prediction and quality improvement by the ideas of quality engineering. Dahiya et al (2009) [9] studied a HACCP (The Hazard Analysis and Critical Control Points) system, It aimed at preventing and reduction these known risks in physical, chemical and biological hazards by identification, assessment and safety control.

In the last ten years, in China, the study on supply chain quality risk can to get attention. The typical research mainly presents the following. Zhou Chao-yun, Lu Zhi-qiang (2011) [10] studied the supply chain operation strategy with product quality risk and transport service quality risk under the condition of information asymmetry, and used three-stage dynamic game theory to study how the members of the supply chain constitute reasonable strategies to make sure that they can gain maximum profits themselves while facing the asymmetrical quality risk. Ye Han-yan [11] studies some theories about supply chain risk management and presented that the disruption risk and forecast risk are two most important risk of supply chain. Gu Li-gang, Gao Tao (2009) [12] studied the coupling mechanism of supply chain quality risk and its characteristic, and put forward a quality risk disruption management which faces to the final products from core conception level and operational level respectively. Qian Ying (2007) [13] in her paper discuss the rules of quality flow in supply chain and how supply chain members collaborate and coordinate with each other to achieve the synergetic operation of supply chain quality system. Yan Zhong-e (2013) [14] from the view of customer satisfaction deviations, studied the formation mechanism of supply chain quality risk and provide the quantitative analysis model of quality risk transfer in SC based on quality function.

The above study observed that the analysis of risk is not much unified, the combined SC risk and enterprise risk is lack. As a result, we obtain the factors of risks relatively poor in effectiveness. Moreover, due to the lack of risk prediction methods and techniques, the research in this area is still in the basic theory, such as the connotation, characteristics, risk evaluating, or a certain level of quality problems (such as risk analysis of supplier), and so on. There is one more point, the study of SC quality risk is still at an initial term, there is not a accepted concept by most people, so is it that the SC risk and quality risk of SC is easy to be confused.

To help more enterprises developing smoothly, it is very necessary to study risks management, in which early warning of risks is essential to enhance the capability of recognition risks. Therefore, here, the study on intelligent early warning assisting the operation of SC in manufacturer successfully will be focused on.

3 The Core Quality Risk Fields of SC for Manufacturer

3.1 CONNOTATION OF QUALITY RISK IN SC

Quality risk refers to the occurrence possibility and consequences of negative quality events in a certain time. It is that can lead to a certain quality loss or other adverse consequences. Under the supply chain, the quality risk of enterprise is sum of the risks in all aspects of supply chain [15-16].

Most experts believe that the quality risk in SC is more difficult to be prevented and be managed. Compared with other risks in SC, the quality risks have some unique characteristics [17]:

1) Transitivity: Any small perturbations on supply chain may take "the Butterfly Effect" to itself. This process is non-linear with all kinds of unexpected happens that it can lead various quality risks to us.
2) Time lag: Quality risk derived from various kinds of quality problems. When time was is enough**,** risks latent in these questions are to be burst out. Therefore, quality risk of supply chain need undergo a complex evolutionary process, but not

timely.

3) Complexity: The quality risk of the supply chain is a new dimension of coordination management in supply chain. Compared to the three dimension of the price, order quantity and delivery time, quality dimension has greater complexity in the supply chain coordination.
4) Interaction: on the role of transitivity, there are also interactions between the quality of supply chain risk and other risks in supply chain.
5) Easily happening: In the complex and dynamic business environment, supply chain quality risk is prone to happening. And so on.

These characteristics are regarded as "black box of quality" for further increasing the difficulty of quality risk management.

3.2 ANALYSIS ON CORE QUALITY RISK AREAS IN SC

Supply chain is formed by the activities of supply and demand, including of raw materials procurement, production, processing, sales and other business behaviours. It is every step has itself procedures and has interaction with other steps**.** In the open complex and dynamic environment, SC is actually a resources network of supply and demand [18]. Each node in the SC is the host of supply or demand. Resource flows between nodes in fact mapped out a logical relationship between the nodes, it is that the forming of the supply chain structure [19]. If the strategy of node in SC is fully open cooperation, SC should to be a dynamic and opening network, which is more in line with the actual market environment. So, here, the study is based on this supply and demand network to analyse the risks in SC for manufacture. As a manufacturing enterprise, from the internal, its quality is composed of the enterprise itself and the supply and demand relationship (briefly, the cooperation on all kinds of resources in SC). At these premise, we propose the following analysis.

Firstly, as for the quality in the manufacturers, it is depended on the ability of quality management. Such ability is mainly manifested in: the R & D of enterprise, the production, the average knowledge level of employees, management skills, service, equipment capacity, quality of supply chain information communication, the docking of technology platform and so on. Such as, manufacturer, in the development and design of product, is no clearly grasping the supplier's ability of meeting the requirements of new product. As a result of the blind cooperation, risks in product might be brought about for the inferior raw materials. So, the quality risk in SC, which caused by the defects of quality ability and the defect of information communicating on quality, will reduce the performance of cooperation.

Secondly, In terms of the cooperation risk in enterprise mainly arising from the cooperation contract of collaborators, the credit is the key of cooperation successfully. Zhang Hai-feng [20] studied the credit risk sources of enterprise, and pointed out if the co-operators are unwilling or unable to fulfil the stipulated quality in contract, the credit risk of SC can to be come from the corrupting influence of moral on each other, including three kinds of situations: one is that the contract party has the ability of supply or demand, but has no intention to perform the contract; the other is no ability but is willing to fulfil its obligations; the third is that partners have neither the capacity to carry out the contract, but also unwilling to carry out contract.

On the above analysis, the early-warning issue areas are suggested as U , U ={ U_1 , U_2 , U_3 , U_4 }, U_1 and U_2 presents respectively the warning conditions. In which, U_1 = f (f' (index$_1$)× f' (the weight of index$_2$),…, f' (index$_n$)× f' (the weight of index$_n$)), With the same method, the values of U_2 , U_3 , U_4 will be worked out. It shows that the key of the early-warning lays in the construction of the indexes system and the obtaining of index values.

According to the traditional setting method of index, such as the risk classification based on enterprise business process and the sector process, etc., we will obtain a complex index system. It was not conducive to the core index, but also not conducive to the judgment of early warning. Considering the quality risk of manufacturer in SC mainly is focused on the perspective on the ability of quality management of enterprise and on the ability of supply or demand of collaborator. That is to say, these aspects are the two core source ways of core quality risks in SC for manufacturer. So, the evaluation indexes can be transformed from some of the behaviours properties of the two kinds of risk source. To do so, the model of E-R as an effective method is applied in the any sis of attributes. Therefore, the source of risk index will rely on the E-R model of the supply and demand between enterprise and its co-operators.

4 Setting Up the Evaluating System of Quality Risk in SC for Manufacturer

4.1 THE MODEL OF ENTITY-RELATIONSHIP (E-R)

The E-R (Entity-Relationship) model is also named as the conceptual data model. According to the core field of risks, the core behaviour of a manufacturing mainly is included in these aspects of service providers, production and supply and demand of resources based on strategic partners. Based on this, the entity-property in the conceptual data level is shown as the following figure1.

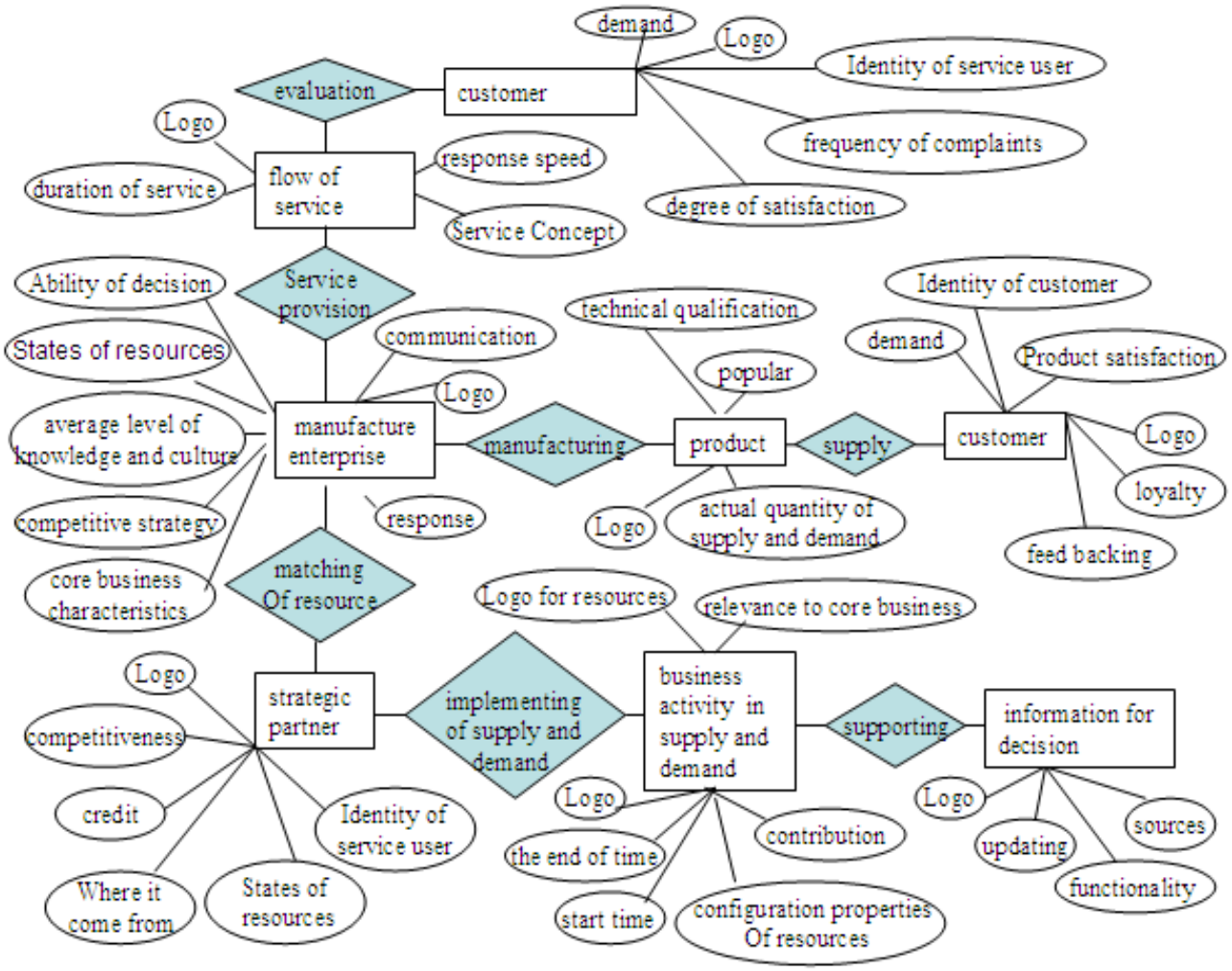

FIGURE 1 The E-R model of manufacturer

In figure1, the rectangle marks the entity; the ellipse represents the attributes of entities; the diamond indicates the links between entities. Here, we think evaluation index as another style of entity' attribute. According to the relationships attributes, the early-warning indexes can be set, which not only simplifies the complex issues of the index origin, but also endows the following early-warning index system with certain objective evidence based on the conceptual model of database.

4.2. TRANSFORMING THE E-R MODEL INTO EARLY-WARNING INDEX SYSTEM

Thinking the Entity-Attributes reflect in the quality of entities and the SC quality for manufacturing, and the conceptual entities in figure1 are the source of database, it can provide some meta-level data parameters for the risk management of enterprise. As for the warning, the early warning relies in the monitoring that is indispensable to the evaluate indexes [21], and the evaluate indexes are parameters from attributives of entity behaviours. So, the index system of risks early warning is constructed as shown in figure2.

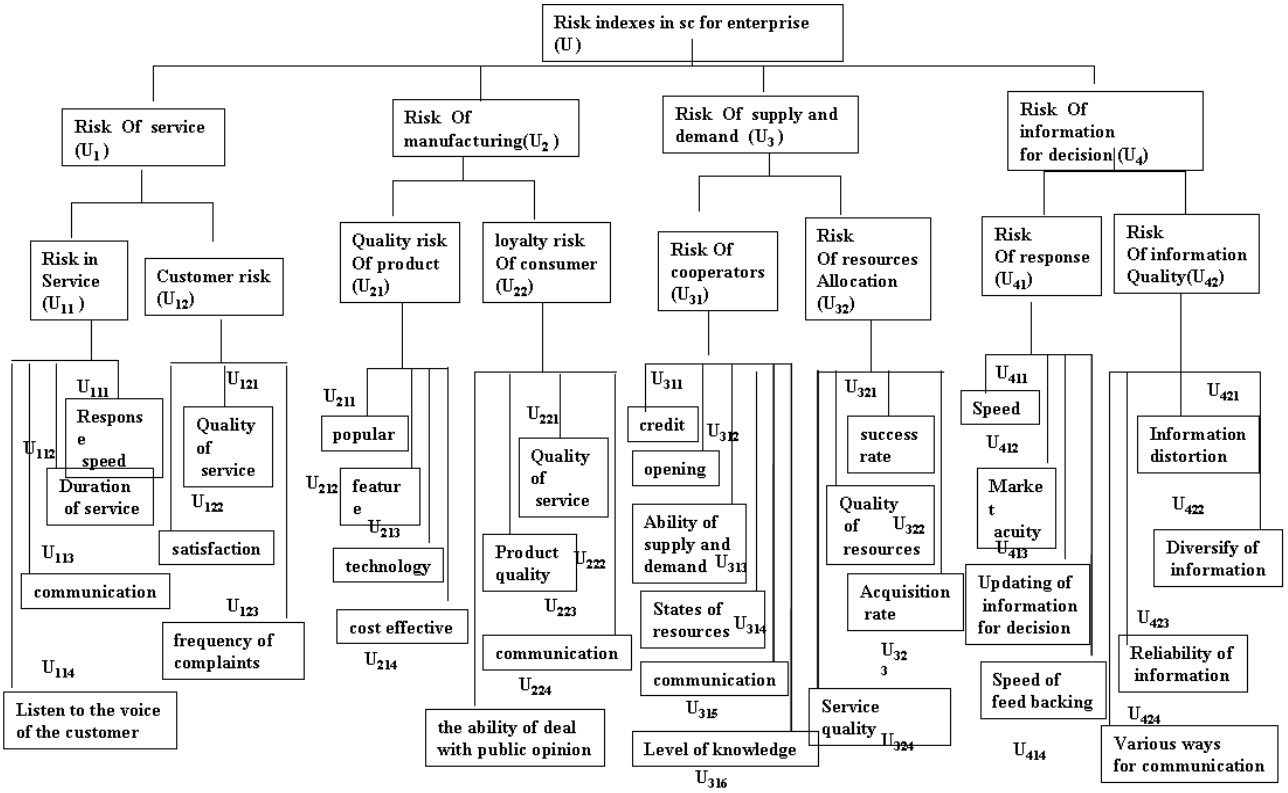

FIGURE 2 The index system of risks early-warning

From figure2, as can be seen that risks in SC for manufacturer lies in these aspects: The cooperation risk (partnership, cooperation content risk, etc.), configuration risk of resources (logistics risk, etc.), after-sales service risk (public opinion risk, customer loss risk, etc.), and the risk of quality management (correct and timely decision-making, information integration ability, knowledge and cultural lacking, etc.).

5 The Agent-based Modelling of Quality Risk Early Warning for SC of Manufacturer

5.1 THIS STRUCTURE OF EARLY-WARNING AGENT

Agent is an intelligent system with the characteristics of autonomy, reactivity, initiative and interactivity, which can solve some comparatively complex problems. The intelligent decision builds on the structure of Agent [22], which usually has the cognitive model, sensor model and the mixed model. In terms of this transformation, the early warning is a serial complex behaviour process involving information processing, information exchange and reasoning. Therefore, the E-W Agent will be constructed as mixed model shown as figure3, which is usually composed of three parts of perception, cognition and output [23-24].

The main task of the Agent structure is to solve what modules they are composed of, how the modules exchange information, how the perceived information influence its behaviours and the inside situation as well as how these modules are combined to form an organic whole through certain software and hardware so as to realize genuinely the subject. In figure3, the function of the component parts is listed as follows.

(1) Perception. Some information produced in the supply-demand activity are obtained through the sensors of all kinds of supply-demand activity, which include the names of the supply-demand flow, the ways of supply-demand (participant nodes), the fluctuating information of the supply-demand and the information of the profit and loss in the supply-demand. All kinds of the data obtained through the sensor will offer the lower data support to the further settlement of the information.

(2) Information processing. The input information by outside environment as primarily information is sorted by the thought of Figure2 to find out the risks inducement from the mixed information. Because the inducement information is generally obscurely described, it is difficult to estimate the harmfulness of the risks in quantification and to classify the risks in the qualitative aspects. Because the inducement is indefinite and the expression is incompletely identical, it is impossible to mark the all the inducement information separately with the quantitative method. Then the inducement information can only be classified and analysed on the consideration of the classification of resource, so the Agent can only predicate the SDN core risks in a rough way. By this way, the value of risks is analysed to the early-warning value on the basis of the strategy of estimating risks and then the corresponding early-warning information will be output. In this sense, only the origin path and scope can be predicated.

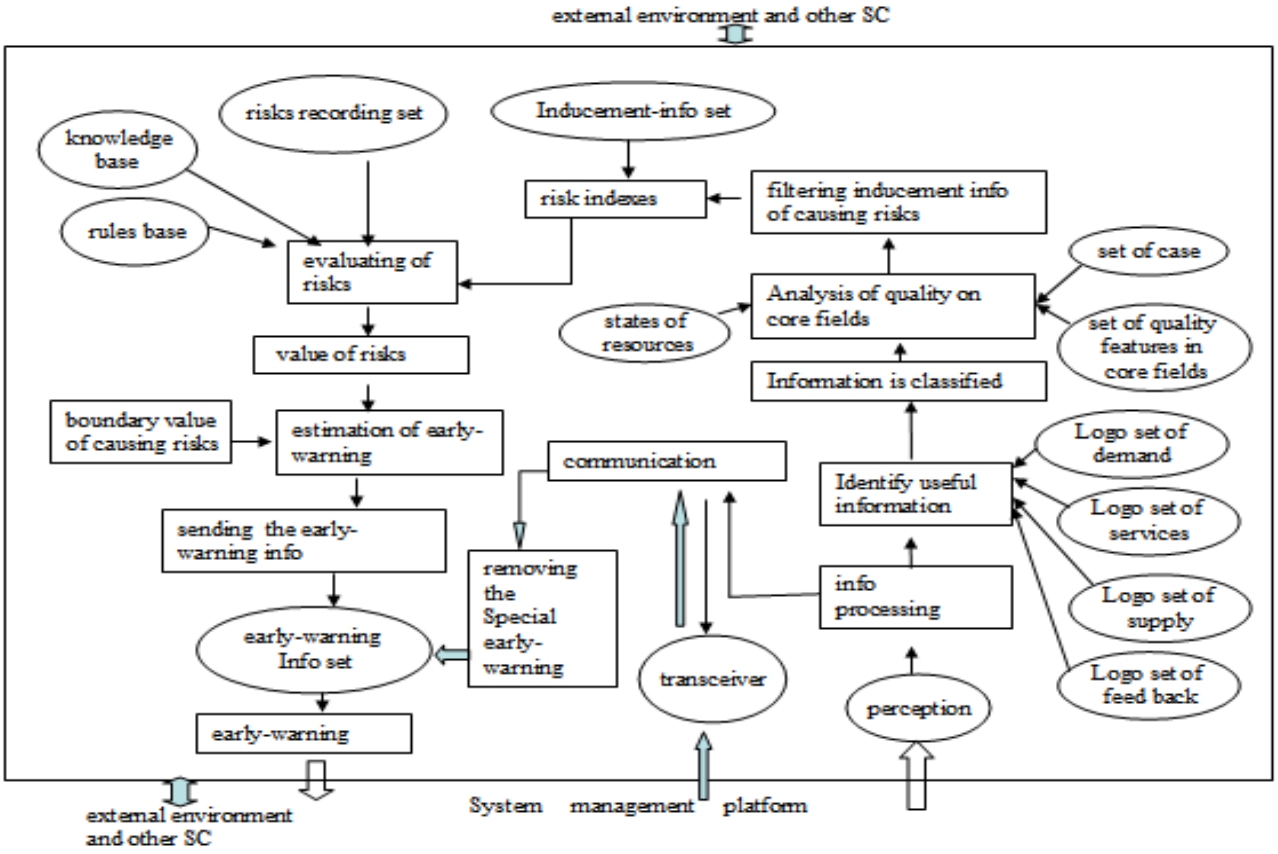

FIGURE 3 The structure of this early-warning Agent

(3) Base of knowledge and culture is compose of these knowledge of quality risk in SC, evaluating risk, the core risk fields, classification knowledge, supply and demand knowledge, management knowledge, culture of enterprise, and so on.

(4) The Class Define of Data for this Agent

According to figure3, the data class of the Agent is defined as follows:

```
Class Agent
{  private:
Strategy of cooperation A[2]; /* full-opening or semi-opening*/
quality feature qf[4][10]; /* the set of quality feature for service, supply, demand, and info */
rule-base rb; /* the rule base of reasoning or the alerting threshold ascertained*/
knowledge-base  kb; /* knowledge base */
index-kb  ikb;  /* the knowledge base of evaluating index systems */
case-base    pc;    /*the case base of early-warning*/
public:
database  db; /*database for system*/
business    bs; /*the base of business*/
core-task  ct; /*the core business of enterprise*/
resources-base   rb;   /*the sharing  set of resources*/
strategic-co-objects  sco;  /* the library of strategic cooperation objects */
resources state   s [2][6];  /* the quality states of all resources for manufacturer and  collaborator*/
index-base   ib;   /*the base of evaluating indexes*/
logo-set      Ls[4]   /*logo set of four core field*/
Communicator  M-communication   // the class of communicator
Void infoobtain( );  //the function for filtering the information of indexes
float  second-index-important(name,value); //the function of evaluating weights of indexes
float jingqingjisuan( );  //the function for calculating warning
Void jingdupanduan( );   //the function of reasoning alerting threshold
Void SearchDataSet(); // the function for searching database of system
int  states of quality( ) ; //analysis of quality in core fields
Void SearchCaseSet(); //the function for searching case-set
…     //other defining of extending
}
```

(5) Databases constructing

Supposing a manufacturer enterprise as "M-E", according to practical situation, databases to be used are described informally as follows:

Logo bases::=<base mark, classification of demand, supply classification, service classification, information classification, information source direction, expanding base>.

All resources bases in "M-E"::=<base mark, classification of supply-demand flows, identity of resource possessor, name of resource possessor, quality of resource (worse: 0; general: 1; better: 2; very good: 3), quantity of resource (surplus:1 or loss:0), the current utility state (possible: 1, impossible: 0) of resource, expanding base>.

information database::=<base mark, key words, information integrity (good: 3, general: 2, poor: 1, very poor: 0), information authenticity (good: 3, general: 2, poor: 1), contents, information-source, contribution for decision, expanding base>.

strategic co-partners base:: =<base mark, name of co-partner, identity of co-partner (as to say role mark), resources base of co-partner, credit of co-partner, competitiveness of co-partner in peers, cooperative strategy of co-partner, cooperative state of co-partner (external, strategy, under the relation), expanding base>.

information base of roles being required:: =<base mark, role mark, the main supply-demand flows marks in roles, the pattern sets of the main supply-demand flows in roles, expanding base>. Different co-partners should to act different roles in performing certain supply-demand task such as role of material, role of sale, role of human resource, role of funds, role of technology and so on. These roles separately correspond to the flowing of resources on material, products, human resource, funds, technology etc.

core business base of "M-E":: =<base mark, business mark, supply-demand flow mark, possible roles describing, its main function, sets of roles required in core business (such as production, manufacture, sale, scientific research, talent cultivation, purchasing, information collection, capital supplying, management etc.), the actual shapes of certain supply-demand flow generating from a certain role (such as, the resource flow of cultivated talents can be classed practically by top manager, fitter technician, miller technician and so on), expanding base>.

information base of new supply-demand business:: =<base mark, business mark, mark of role under the business, mark of main supply-demand flows, identity of enterprise, co-partner sets, the predicted transaction value, the predicted payment cost, time for starting, expanding base>.

base about supply-demand relations:: =<base mark, classification of supply-demand relations, the horizontal supply-demand relations base indicating the cooperation between competitors, the vertical supply-demand relations base showing the compatibility of different roles to a systematically task, the crossing relations base displaying the complexity of this supply-demand relations, the hub node with some different properties neighbour nodes, times of terminating of supply-demand relation positively or passively in activities, expanding base>.

base of horizontal supply-demand relations:: =<base mark, horizon function mark, the affiliated business mark, the activated state of relations (active or dormancy), sets of participants, mark of this main supply-demand flow, cooperative strategy being adopted (alliance with finite scope or "all comers are guests"), the invalidation relations, times of terminating of these relations positively or passively in activities, expanding base>.

base of vertical supply-demand relations:: =<base mark, vertical function mark, the affiliated business mark, the activated state of relations (active or dormancy), sets of participants, mark of this main supply-demand flow, cooperative strategy being adopted (alliance with finite scope or "all comers are guests"), the invalidation relations, times of terminating of these relations positively or passively in activities, expanding base>.

base of early-warning cases:: =<base mark, inferential rules, warning condition, warning level, key words of contents about risks, expanding base>.

base of boundary value of risk: =<base mark, boundary rules, classification of boundary, boundary value, boundary warning, expanding base>. In figure1, the rectangle marks the entity; the ellipse represents the attributes of entities; the diamond indicates the links between entities. Here, we think evaluation index as another style of entity' attribute.

(6) Evaluation Algorithm of Index

Suggest the weight of the second-level indexes is considered, and the weight values are respectively taken as K_{11}, K_{12}, K_{21}, K_{22}, K_{31}, K_{32}, K_{41}, K_{42}. The evaluation degrees of the weight are set like this: very important (3), comparatively important (2), general (1), unimportant (0). The experts give the specific values after the comprehensive evaluation. Except that the index weight is evaluated subjectively, the evaluation is made by extracting the objective data of the indexes with consideration of the above listed database in order to evaluate the warning condition objectively. The descriptions of all the warning conditions and index evaluation are as follows.

For a wide table you can use 1-column section (Table 1), for a small standard table 2-column section is used (Table 2).

TABLE 1 U_1 and its index evaluation

U_1	$U_1=K_{11}\times U_{11}+K_{12}\times U_{12}$
U_{11}	$U_{11}=(\log_{(U112\times U113\times U114)}^{U111})\div DV$. In which, the character DV is supposed as the desired value of U_{11}. If U_{11}>0, then the risk boundary value of U_{11}=1; otherwise, the boundary value of U_{11}=0.
U_{12}	For the U_{122} and U_{121} respectively has an inverse relationship with U_{12}, and U_{123} is positive proportional to U_{12}. Then, $U_{12}=(U_{123})^{U_{122}\times U_{121}}$.

It can be concluded from the table1 that max (U_1) = $K_{11}\times 1+K_{12}\times 1$, min ($U_1$)=0.

TABLE 2 U_2 and its index evaluation

U_2	$U_2=K_{21}\times U_{21}+K_{22}\times U_{22}$
U_{21}	Supposing Q as the desired value of U_{11}, then $U_{21}=Q\div(U_{211}\times U_{212}\times U_{213}\times U_{214})$
U_{22}	For the range of each sub-index value in U_{22} is set four stage (very high: 3, high: 2, general: 1, poor: 0). Then, $U_{22}=U_{223}\div(U_{211}+U_{212}+U_{213}+U_{214})\times 10.$ If U_{22}>2, then the risk boundary value of U_{22}=0; if $1=<U_{22}<2$, then the risk boundary value of U_{22}=1; otherwise, the boundary value of U_{22}=2.
U_{23}	Suppose three kinds of state information in the active supply-demand for the strategic objects: unused, using, and used. There are *Q* objects recorded in the database with Q' objects unused, then $U_{23}=Q'/Q$, which shows the use utility of the nodes in the supply-demand relation structure. $0\leqq Q'\leqq Q$, so $0\leqq U_{23}\leqq 1$.
U_{24}	Suppose H_k as the number of the role relations of the supply-demand with abnormal termination in certain supply-demand behaviour, H_k' as the number of all the role relations in the supply-demand activity and *h* supply-demand businesses running in the current enterprise, then $U_{24}=(\sum_{k=1}^{k=h} H_k/H_k')/h$, which represents the abnormal supply-demand phenomena for the current average appearance. $0\leqq U_{24}<1$.

It can be known from the description on the index valuing of the warning condition U_2 in the table2 that $0\leqq U_2<(4\times K_{21}+K_{22}+K_{23}+K_{24}$.

TABLE 3 U_3 and its index evaluation

U_3	$U_3=K_{31}\times U_{31}+K_{32}\times U_{32}$
U_{31}	Suppose H_k as the number of the relation quality of the supply-demand with abnormal termination in certain supply-demand behaviour, H_k' as the number of all the role relations in the supply-demand activity and *h* supply-demand businesses running in the current enterprise, then $U_{31}=(\sum_{k=1}^{k=h} H_k/H_k')/h$, which represents the abnormal supply-demand phenomena for the current average appearance. $0\leqq U_{31}<1$, in which, $H_k=1\div(U_{311}+U_{312}+U_{313}+U_{314}+U_{315}+U_{316})$
U_{32}	V_{yT} and V_{yt} represent the quality states of the high-quality resources V_y at the time of T and t (T>t). If there are *m* high-quality resources in the current enterprises and $(\sum_{y=1}^{y=m}(V_{yT}-V_{yt})/\sum_{y=1}^{y=m} V_{yt})$>0, then it means some high-quality resources loss, U_{31}=1; otherwise, U_{31}=0, which means no risks. And, $V_y=(U_{324}\times U_{322})^{(U_{321}\times U_{323})}$.

TABLE 4 U_4 and its index evaluation

U_4	$U_4=K_{41}\times U_{41}+K_{42}\times U_{42}$
U_{41}	Suppose three kinds of state information in the active supply-demand for the strategic objects: unused, using, and used. There are Q objects recorded in the database with Q' objects unused, then $U_{41}=1/(U_{411}+U_{412}+U_{413}+U_{414})-Q'/Q$, which shows the use utility of the nodes in the supply-demand relation structure. $0\leqq Q'\leqq Q$, so, $-1\leqq U_{41}\leqq 1$.
U_{42}	If the number of info-flows is g' and the number of obtaining information is *g*, then $U_{422}=g'/g$. According the role of sub-index, then, $U_{42}=\sqrt[U_{422}]{(U_{421}+U_{423}+U_{424})}$.

The evaluation is made by extracting the objective data of the indexes with consideration of the above listed database in order to evaluate the warning condition objectively.

6 Conclusion

The study on quality risks in SC is hot, but difficult. The main contribution of this study is to elaborate the predicating thought of core quality risk in SC and the structure of early warning Agent, put forward the attribute definition, data class definition of Agent and database for early warning and evaluation algorithm of index. This study will provide certain theory and practice preference to following up development of this intelligent early-warning system. However, it needs further researching in the following research.

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