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Supply Chain Risk Evaluation Based on Bayesian Network

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Keywords: Supply chain risk; Bayesian network; Evaluation technology; assessment indexes

Abstract. The evaluation for supply chain risk is very important to show the latent risk and eliminate the risk. In the study, Bayesian network is proposed to evaluate the supply chain risk. The assessment indexes of supply chain risk are analyzed before supply chain risk assessment. Then, the assessment indexes of supply chain risk can be used to construct the supply chain risk assessment model. We apply a certain logistics company to study the evaluation ability of Bayesian network evaluation model proposed here. The experimental results prove the effectiveness of the proposed model.

Introduction

Supply chain risk evaluation can show the latent risk, take suitable action, and eliminate the risk. In the study, Bayesian network is proposed to evaluate the supply chain risk. Bayesian network is a kind of probability model, which is described by graphical terms[1,2]. Bayesian network is defined as a directed graph with no cycles. In the graphical model, the dependence between the nodes can be described by probability. The assessment indexes of supply chain risk are analyzed before supply chain risk assessment. Then, the assessment indexes of supply chain risk can be used to construct the supply chain risk assessment model. In the paper, we apply a certain logistics company to study the evaluation ability of Bayesian network evaluation model proposed here. Safe, fair and danger are three degrees of supply chain risk evaluation and its evaluation indexes. The experimental results prove the effectiveness of the proposed model.

Evaluation index of supply chain risk evaluation

The assessment indexes of supply chain risk are analyzed before supply chain risk assessment. The assessment indexes are described in Tab.1.It can be seen that the assessment indexes of supply chain risk includes the first-class index and second-class index. In the first-class index, logistics risk, financial risk, information risk, management risk and environmental risk are considered.

TABLE I. THE EVALUATION INDEX OF SUPPLY CHAIN RISK

objective	first-class index	second-class index
supply chain risk /b0	logistics risk/b1	late deliver rate/b6
		product fault rate/b7
	financial risk/b2	capital flow blockage percentage/b8
		increasing rate of product cost/b9
	information risk/b3	coordination between information sharing and protection of intellectual property/b10
		fault rate of information equipment/b11
	management risk/b4	entire coordination control capacity of enterprises/b12
		fair distribution rate of benefit/b13
	environmental risk/b5	political stability/b14
		uncertainty of national policy/b15
		undulatory property of money market/b16

Logistics risk includes two hands, which are late deliver rate and product fault rate. Financial risk includes two hands, which are capital flow blockage percentage and increasing rate of product cost. Information risk includes two hands, which are coordination between information sharing and protection of intellectual property and fault rate of information equipment. Management risk includes two hands, which are entire coordination control capacity of enterprises and fair distribution rate of benefit. Environmental risk includes political stability, uncertainty of national policy and undulatory property of money market. The assessment indexes of supply chain risk can be used to construct the supply chain risk assessment model.

Supply chain risk evaluation based on bayesian network

A. Bayesian Network

Bayesian network is a kind of probability model, which is described by graphical terms. Bayesian network is defined as a directed graph with no cycles. In the graphical model, the nodes denote the random variables and the arcs denote probabilistic dependence between the nodes [3,4].The conditional probability distributions are created among the nodes. In Bayesian network, the nodes include the parent node and child node, among which the parent node is the node that causes another node, the child node is the affected node by the parent node[5,6]. As shown in Fig.2, Bayesian network is described, the node b1 is the parent of node b3 and b6,and the node b7 is child of node b3 and b4.

B. Supply Chain Risk Evaluation Based on Bayesian Network

The assessment indexes of supply chain risk can be used to construct the supply chain risk assessment model. The supply chain risk evaluation model based on Bayesian network is described in Fig.2. The Bayesian network has 17 variables including supply chain risk node, logistics risk node, financial risk node, information risk node, management risk node and environmental risk node, late deliver rate node, product fault rate node, capital flow blockage percentage node, increasing rate of product cost node ,coordination between information sharing node, protection of intellectual property node, fault rate of information equipment node, entire coordination control capacity of enterprises node , fair distribution rate of benefit node, political stability node, uncertainty of national policy node and undulatory property of money market node, and 16 arcs which represent probabilistic dependence between the nodes.

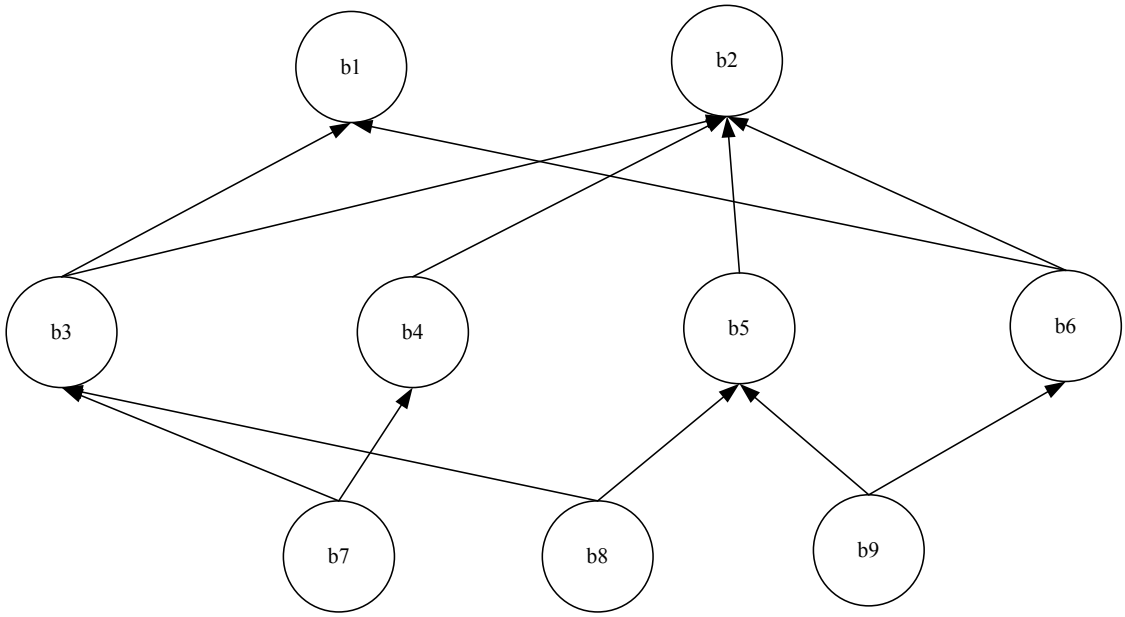

Figure 1. The structure of Bayesian network

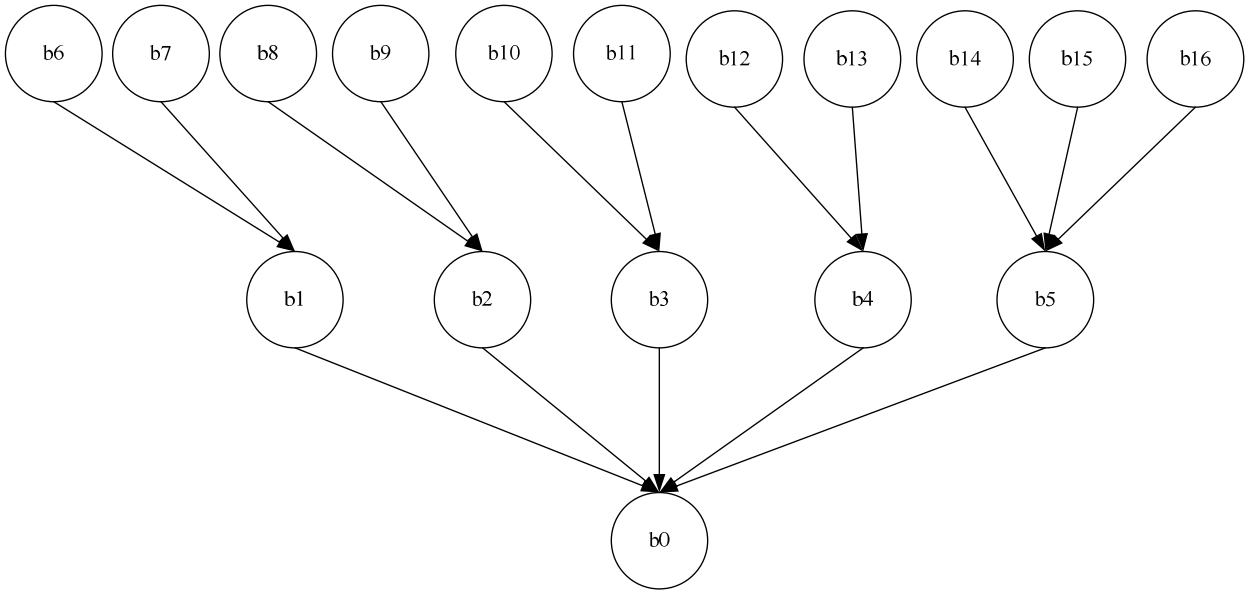

Figure 2. Supply chain risk evaluation model based on Bayesian network

Experimental research

In the paper, we apply a certain logistics company to study the evaluation ability of Bayesian network evaluation model proposed here. Safe, fair and danger are three degrees of supply chain risk evaluation and its evaluation indexes. The priori probability of Bayesian network is given in Tab.1. The conditional probability of Bayesian network is given in Tab.2.The conditional probability describes the affected extent of child node by parent node. The evaluation value of supply chain risk of the logistics company is safe, which is shown in Fig.3.

TABLE I. PRIORI PROBABILITY OF BAYESIAN NETWORK

degree/ second- class index	***b*6**	***b*7**	***b*8**	**…**	***b*16**
safe	0.4218	0.2721	0.2129	**…**	0.1922
fair	0.4157	0.5922	0.5491	**…**	0.6787
danger	0.1625	0.1357	0.2380	**…**	0.1291

TABLE II. CONDITIONAL PROBABILITY OF BAYESIAN NETWORK

first-class index / second-class index	***b*1**	***b*2**	***b*3**	***b*4**	***b*5**
*b*6	0.7270	0	0	0	0
*b*7	0.8232	0	0	0	0
*b*8	0	0.6975	0	0	0
*b*9	0	0.8781	0	0	0
*b*10	0	0	0.9169	0	0
*b*11	0	0	0.6602	0	0
*b*12	0	0	0	0.7649	0
*b*13	0	0	0	0.6926	0
*b*14	0	0	0	0	0.6572
*b*15	0	0	0	0	0.7854
*b*16	0	0	0	0	0.7419

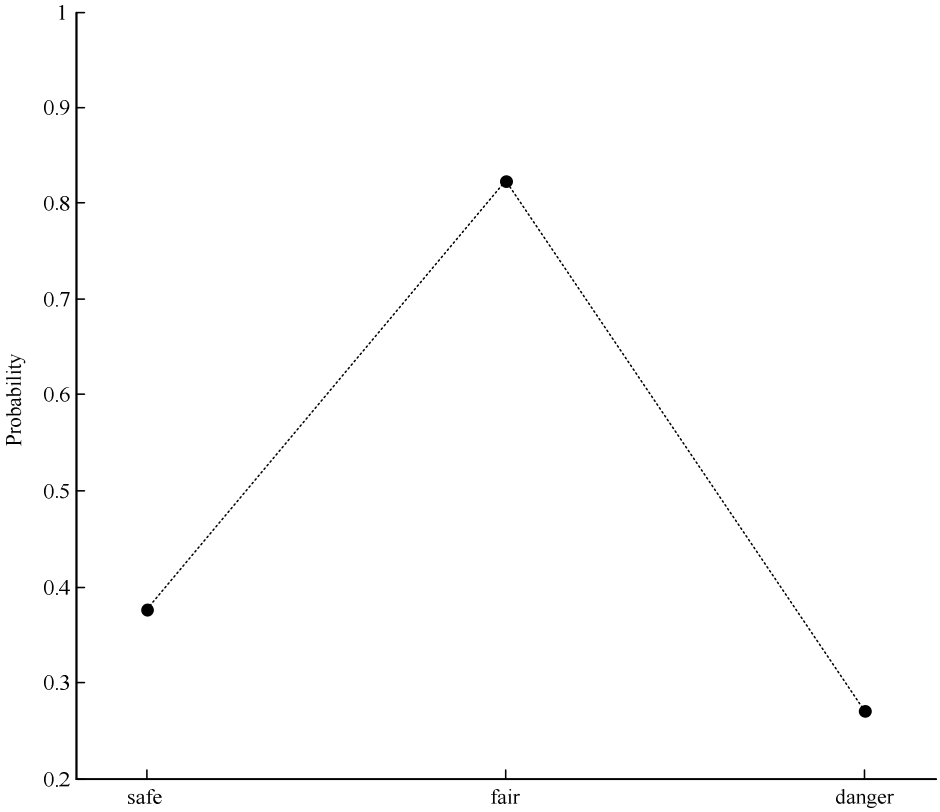

Figure 3. Evaluation values of supply chain risk

Conclusion

In the study, Bayesian network is proposed to evaluate the supply chain risk. we apply a certain logistics company to study the evaluation ability of Bayesian network evaluation model proposed here. Safe, fair and danger are three degrees of supply chain risk evaluation and its evaluation indexes. Then, the priori probability and conditional probability of Bayesian network is given. The experimental results prove the effectiveness of the proposed model.

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