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Multi-criteria decision making based on trust and reputation in supply chain ☆

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ABSTRACT

Decision making is a core problem in Supply Chains. A large number of studies in literature have reported various decision making techniques based on customers' requirements. Taking into account high risk transactions in virtual Supply Chain market, trust is a very critical element and should be treated as an important reference when customers try to select proper suppliers. Recently, a great effort has been carried out to develop decision making based on trust and reputation. However, these research works still stay on the stage of theoretical research. This paper presents and implements a multi-criteria decision making approach based on trust and reputation in Supply Chain. Firstly, this paper defines general trust indicators in real Supply Chain settings, and designs a multi-dimensional trust and reputation model. This paper also introduces K-mean clustering algorithm to remove unfair rating scores. Then, based on this trust and reputation model, we propose a multi-criteria decision making approach based on variable weights and satisfaction principle. In order to validate the performance of this approach, we simulate a practical Supply Chain setting with multi-agents platform. The simulation experiments demonstrate that the proposed trust and reputation model can effectively filter unfair ratings from those customers who did lie and the proposed multi-criteria decision making method can help customers make right decisions.

1. Introduction

In the past decade, development of Information Technology has forced rapid growth of online business, including business-to-business (B2B) and business-to-customer (B2C) e-commerce. As a typical B2B application, Supply Chain (SC) is turning into virtual organization within Internet. A SC is defined as a network of various enterprises that supplies raw material, converts them into products and then delivers products to customers according to a distribution system (Billington, 1994). SC builds a bridge of communication between suppliers and customers, and make them collaborate when a transaction occurs.

The life-cycle of a SC is made up of two main steps: supply chain formation and supply chain management (Walsh and Wellman, 2003). Supply chain formation is the process to select proper suppliers and the way to reach an agreement between suppliers and customers. The goal of supply chain management is to predict and plan production and transportation to meet requirements of customers and to minimize inventory of suppliers. Supply chain formation has become a crucial problem in SC, because each participant, i.e. customers as well as suppliers, needs to determine its partners as soon as possible in order to maximize its profits.

The development of Internet has deeply influenced traditional SC form and brought new opportunities and challenges. On one hand, it further expands the scope of traditional SCs and builds interaction between suppliers and customers from different regions. On the other hand, it also makes the selection of partners become more difficult.

To quickly establish the relationship between suppliers and customers, the important precondition is to assess the trustworthiness of the partner. Trust has been identified as an important ingredient in SC. Especially for SC based on electronic market, trust is not only the base of all interactions, but also is an efficient mechanism to foster the cooperation between suppliers and customers, and to reduce transaction costs and risks. Trust is related to interdisciplinary subjects, including Philosophy, Psychology, Economics and Computer Science (Josang et al., 2007; Pinyol and Sabater-Mir, 2011). Due to autonomy of enterprises in SC, every customer has to evaluate trustworthiness of other

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suppliers and select the most trusted one. At the same time, the chosen supplier should satisfy basic requirements of the customer. Consequently, it is necessary to develop a trust mechanism to evaluate suppliers' trustworthiness.

Nowadays, a general way in electronic market to evaluate trust is to build reputation model. Reputation is defined as the opinion or view of one about something (Josang et al., 2007). This kind of opinion is formed and updated along time according to direct interactions and indirect information provided by other customers in electronic marketplace about past experience. Since Internet has greatly expanded the degree and scope of information sharing, enterprises can achieve appraisals on a specific supplier from other customers easily. Although a large number of reputation models have been proposed to help trust assessment (Li et al., 2011; Khosravifar et al., 2011; Teacy et al., 2006; Dong-Huynha et al., 2004; Xiong and Liu, 2004; Zhao and Li, 2009a,b; Qureshi et al., 2010; Wang et al., 2010), it is worth noting that trust is context-dependent. Trust and reputation model should be adopted to application domains. However, it should be recognized that trustworthiness based on reputation model is only a means. In the stage of supply chain formation, the ultimate goal of supply chain formation is to help customers make decisions using trust and reputation model as a reference.

In this paper, we propose a multi-criteria decision making approach based on a trust and reputation model. Firstly, we define general trust indicators in SC and develop a multi-dimensional trust and reputation model oriented SC. In order to integrate feedbacks from multiple aspects, this model takes individual and social experiences into account, and introduces K-mean clustering algorithm to removes unfair ratings. Then the weights are defined by customers to make reputation adapt to their requirements. Secondly, based on the proposed trust and reputation model, we propose a multi-criteria decision making method based on variable weights and introduce the satisfaction principle to maximize the adequation to requirements of customers. At last, we simulate real SC environment with multi-agent software. The experiments have demonstrated that our approach has the capability to reflect trustworthiness of suppliers, avoid malicious behaviors of suppliers and help customers make decisions in business activities. Our works are mainly contributed to the following issues:

- Based on previous works on supplier selection, the paper summarized seven trust indicators including subjective and objective indicators. These indicators are general and can be used into any SC.
- Concerning unfair feedback removal, it can be modeled as a clustering problem and is solved by K-mean algorithm, which has been proven effective in a large number of clustering applications.
- For multi-dimensional reputation based on the trust indicators, a multi-criteria decision making framework based on variable weights are employed. The paper defines a kind of piecewise function as the variable state vectors and proves its feasibility theoretically under this framework.
- A real SC environment is simulated to validated the performance of the proposed algorithm.

It is worth noting that even though the paper only focuses on the decision making based on reputation in SC. Except the indicators, the techniques used in the paper can be used into any industrial settings. The workflow is represented in Fig. 1.

The remainder of this paper is organized as follows. Section 2 reviews literatures related to decision making and reputation models in SC. In Section 3, we define trust indicators in general SC and develop a multi-dimensional and customized trust and reputation model. Section 4 proposes the satisfaction principle based on variable weights to conduct multi-criteria decision making. The simulation experiments based on Netlogo are described and discussed in Section 5. Finally, Section 6 concludes this paper and proposes future works.

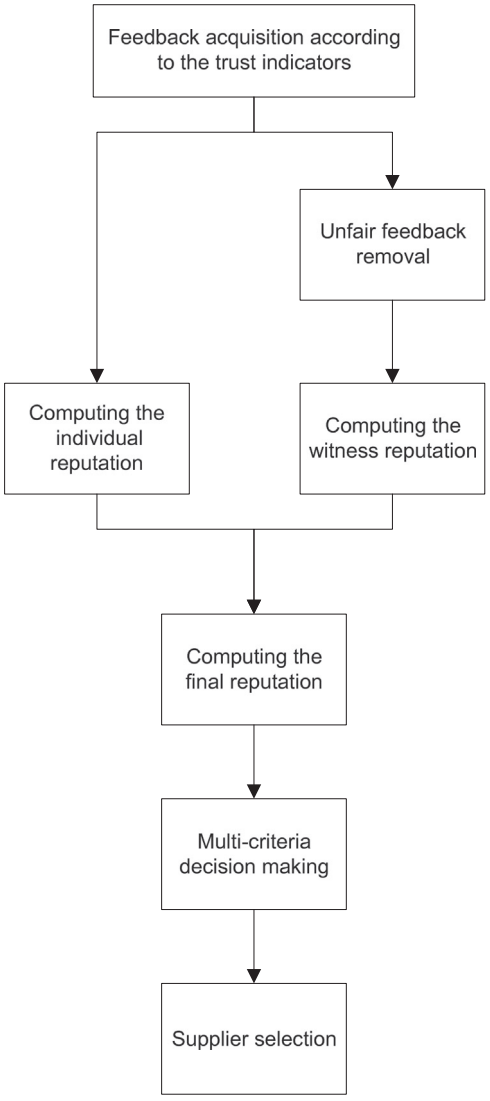

Fig. 1. The workflow of supplier selection.

2. Literature review

2.1. Existing trust and reputation models

Trust is the belief of a participant that the other participant will fulfill its promise, given the possibility that the participant might defect to get higher benefits. Generally speaking, trust is built on reputation and reputation provides support to determine trustworthiness of each participant. Until now, trust and reputation models have been widely investigated in different application settings. According to the used computation engine (Noorian and Ulieru, 2010), these general trust and reputation models are classified according to different kinds of mathematic model used: deterministic approach (Xiong and Liu, 2004; Huynh et al., 2006), belief model (Yu and Singh, 2002), fuzzy model (Sabater and Sierra, 2001a), Bayesian approach (Jsang and Ismail, 2002; Josang and Haller, 2007) in term of used mathematic model.

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