Study on Recommender Systems for Business-To-Business Electronic Commerce

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ABSTRACT

Recommender systems have become a popular technique and strategy for helping users select desirable products or services. Most research in this area focused on applying the method to help the customers in Business-to-Customer (B2C) electronic commerce (e-commerce), however, the participants in Business-to-Business (B2B) market can also get useful assistance from the recommender system. In this article we discuss the application of recommender system to B2B e-commerce. First, we examine how recommender system help B2B participants do transactions easier, then we design an effective system framework for the B2B e-commerce's recommender system based on B2B business practices and business intelligence; and then, we define the model components and processes; in the end, the ongoing challenges of the application will be discussed.

Key Words: B2B E-commerce, Recommender System, Business Intelligence

INTRODUCTION

In the Internet age, the biggest problem for a person who wants to buy something online is not how to get enough information to make a decision, but how to make a right decision from the enormous information. Nowadays, people always search the Internet to find the proper products and services needed they, consciously or unconsciously, depend on recommender systems to help them to overcome information overload. In the current business practice, recommender systems are widely used in B2C e-commerce to actively provide the most useful information to a particular people, which is based on the analysis of the person's past transaction history and other information collected.

We have had many discussions on how to improve the accuracy and efficiency of the recommendation to customers, in these researches, most of the system designers consider the customers are the system's primary user and beneficiaries, that is, the application of recommender system in B2C is used as a tool to help the sellers promote their sales and help facilitate the customers' purchasing process. It is currently used as virtual salespeople, and is unable to give the type of feedback needed for marketing professionals. However, from the view of company, the recommender system should not only be able to help the buyers find their expected products and services, but also to help the sellers understand their customers better, moreover, the system should also assist both the seller and buyer to setup strategy relationship in the long-term cooperation. According to the latest B2B research report of Accenture Company (http://www.accenture.com), the consumer satisfaction of B2B is lower than that of B2C, which indicates that the enterprises in B2B market did not understand their customers profoundly and make efficient response to their needs. We apply the recommender system to the B2B e-commerce, hope it can focus both on the needs of the consumers and the suppliers, contribute to streamline the business transaction process, better the customer relationship management, improve customer satisfaction, and make business dealers understand each other better. Moreover, we suppose the recommender system to B2B e-commerce to be linked with the enterprise's back-end information system and contribute to the company's marketing professionals. We believe that this application of recommender system in B2B e-commerce is a new and promising research field.

There is no definite definition of recommender system to B2B e-commerce yet; here we try to give an experimental definition: a recommender system to B2B e-commerce is a software agent that can learn the interests, needs, and other important business characteristics of the business dealers and then make recommendations accordingly. The systems use product/service knowledge - either hand-coded knowledge provided by experts or "mined" knowledge

learned from the behavior of consumers - guide the business dealers through the often overwhelming task of locating transactions their companies will like.

In this paper, based on the analysis of the characteristics of B2B e-commerce, we analyze the requests of different participants of B2B e-commerce for recommender system, then we build a recommender system framework for B2B electronic commerce, we also discuss the problem of how to present the recommendation results and other factors should be considered in the B2B area. At the last part of this paper, we describe the future work to do and give a conclusion.

LITERATURE REVIEW

Recommender systems are widely used in B2C e-commerce sites, they use one or more of recommender system technology in their applications. For example, the use of recommender system to aid users' selection of books, music, and movies is increasingly popular and wide spread. The following online stores are famous websites who provide B2C recommending services (table 1). The products can be recommended based on the demographics of the consumer, on the top overall sellers on a site, or on an analysis of the past buying behavior of the consumer. The forms of recommendation include suggesting products/services to the consumer, providing personalized product/services information, and providing community critiques.

Company	Recommendations
Launch.com	Online music
Amazon.com	Book , CD, etc
Moviefinder.com	Movie
Drugstore.com	Medicine

Table 1: B2C Recommender System Examples.

B2B e-commerce is different from B2C e-commerce. Though the participants in B2B transactions are still the seller, the buyer, the intermediary, the network platform provider, and the deliver, the consumption by business is significantly different from the consumption by individual consumer, the business buying decision are more formal, involve complex interactions among many people, and must consider the organization's needs. But like final consumers, organizations purchase products and services to fill needs, and their needs are meeting the demands of their own customers. There are several kinds of B2B purchase situation: strategic new task, judgmental new task, simple modified rebuy, complex modified rebuy, routine low priority, and causal occasional purchase. Although the B2B purchase is conducted by professional buyers who are well informed about the products and the marketplace, they still need to face numerous new emerging data and have to select useful information in this fast changing business environment. Although the application of recommender system in B2B e-commerce can not replace the professional purchasers in making decisions, we believe it can help them do a better job easier, especially under the situations of judgmental new task and complex modified rebuy.

Based on the B2B market classification of Efraim Turban et. al. (2001) there are several kinds of B2B e-market, includes seller-oriented e-market, buyer-oriented e-market, and intermediary-oriented e-market. Figure 1 shows how recommender system help the business participants do transactions. The seller-oriented e-market is setup from the seller's point of view, when the vendor has a superb reputation in the market and has a group of loyal customers (e.g. Intel), they open there own web site and do transactions via it. Evidently, the sellers need to understand their customers and promote the up-sell and cross-sell by giving the right customers right suggestions at the right time. The seller can use the recommender system to analysis the buyers' behavior, their obvious needs and potential needs, and even anticipate their procurement tendency to make appropriate suggestions and recommendation. From the buyer's point of view, by receiving pertinent suggestions when visiting suppliers' web site, the buyers can reduce their search time and energy. On the other hand, buyer-oriented e-market is founded from the view of buyers, big companies like GM are large and repetitive business buyers, it is necessary to integrate the transaction information with their back-end information systems. So these companies invite the suppliers to do business in the

buyer's own web site. This time, the sellers are recommendation receivers, the buyer use recommender system to collect and analyze different suppliers' products and other information, and then push relevant procurement requirements to appropriate supplier. Moreover, the recommender system can recommend better suppliers to the buyer according to the suppliers' information and transaction history. The widespread use of the Internet has led to

the emergence of numerous intermediaries (e.g. manufacturing.net) that bring buyers and sellers together and leverage their knowledge of the marketplace to provide value-added services. In B2B e-commerce, intermediaries offer not only matching services that facilitate establishment of a buyer-seller agreement, but also value-added services that either provide a standalone benefit or enhance benefits from matching services. By using recommender system, the intermediary can provide both seller and buyer valuable and appropriate information to do business. In conclusion, the three different categories of B2B e-commerce participants can receive different useful suggestions from the system to help them do better business.

As a new branch of business intelligence application (BI is a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions. BI applications include the activities of decision support systems, query and reporting, online analytical processing (OLAP), statistical analysis, forecasting, and data mining.), recommender system inherits the basic thoughts and framework of BI (fig.2). A typical recommender system has three steps: first, system users provide information of their tastes, these can be explicit or implicit; then, the information is used to compute a user profile, a representation of the users preferences; finally, the recommender system make recommendation by using these users profiles (Mustafa Bilgic, Raymond J. Mooeny, 2000).

Today, there are three types of recommend methods to build a users profile and computing recommendations being used: collaborative filtering (D. Goldberg,1992; J. Herlocker, 2000), content-based (R M. J. Pazzani, 1996. J. Mooney, 2000), and hybrid system that integrate these two different approaches (C. Basu, 1998; P. Melville, 2002). Many different approaches have been applied to the basic problem of making accurate and efficient recommender systems. Some important approaches are (Bhanu Prasad, 2003): automated collaborative filtering approach, knowledge-based approach, and hybrid approach, a survey of hybrid recommenders can be found at (R. Burke, 2002).

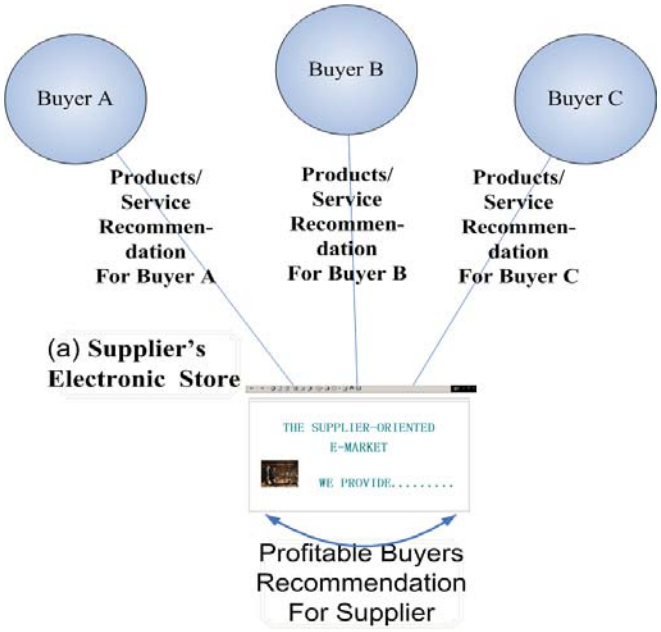

Figure 1(a): Recommendations in Supplier-oriented E-market.

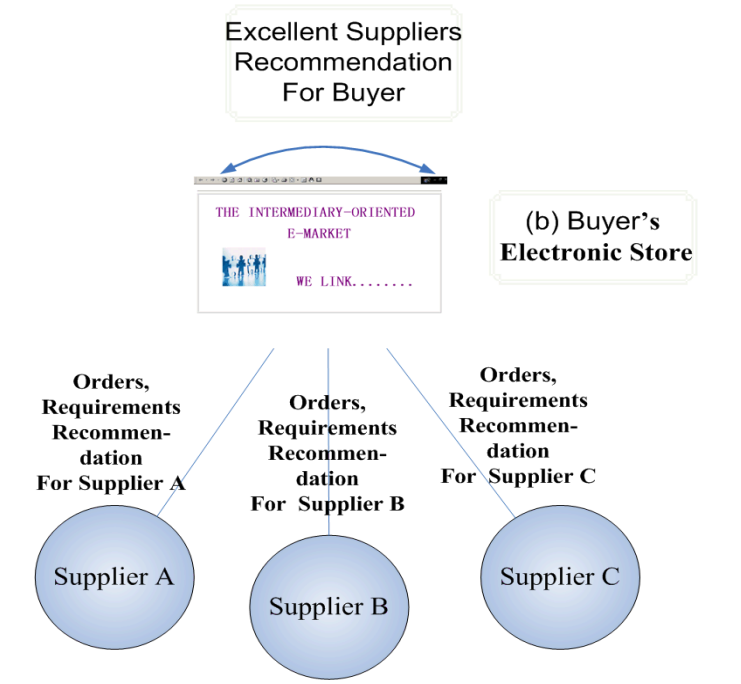

Figure 1(b): Recommendations in Supplier-oriented E-market.

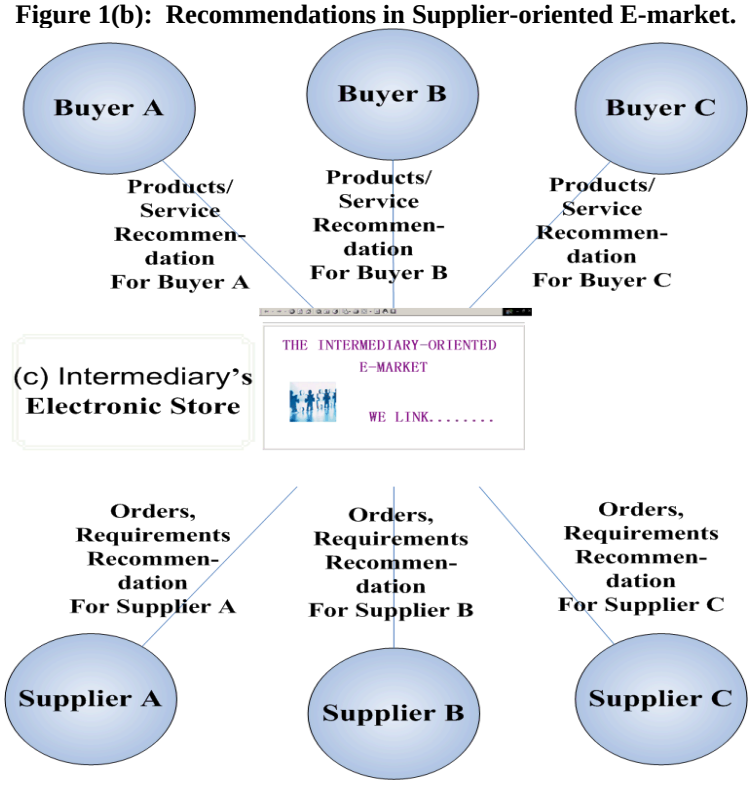

Figure 1(c): Recommendations in Intermediary-oriented E-market.

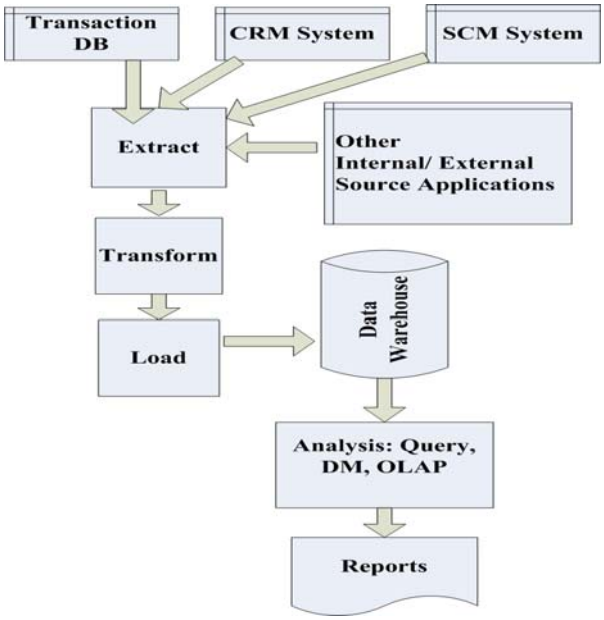

Figure 2: Framework of Business Intelligence.

Summarily, using the previous discussed knowledge about B2B e-commerce, recommender system, and the BI working framework, we have developed a framework for the recommender system to B2B e-commerce. This paper differs from the conventional recommender systems in two key ways. First, it is neither a new algorithm nor a new method, but a novel concept of application. Second, the framework for the recommender system to B2B e-commerce has been developed, and the main players in the market have been encompassed.

FRAMEWORK FOR RS TO B2B E-COMMERCE

The attributes of one B2B e-commerce recommender system's framework can be classified by six categories (fig.3): inputs, process, feedback, out puts other systems' assistance, and other useful knowledge (rules, database, knowledge base).

Figure 3 illustrates how subparts of these parts are used in the B2B recommendation process, these parts cannot be rigidly separated, and certain design choices require specific outputs. Similarly, certain outputs can be produced only by some of the recommendation methods (J. Ben Schafer, Joseph A. Konstan, and John Riedl, 2001). Here, we do not claim the framework is complete, rather, it represents the range of our research in use at the time of this writing, we fully expect new I/O, methods and other design to emerge.

This framework for B2B e-commerce's recommender system is only a experimental model, in order to simplify the process, the focus is put on the data flowing into/out of the system, which is the main difference between B2B and B2C's framework. In short, one B2B's recommender system not only supports buyers and sellers but also has the meta-problem solving and communication control function.

System Inputs

Each system takes in a collection of inputs that may contribute to make the useful outputs. This framework needs three kinds of different inputs: the targeted users' inputs, the industry inputs and the users' back-end information systems. Based on these inputs, recommender system can produce the desired and valuable information for every particular party involved. Based on the buyer's / supplier's current activities or long-term preferences, the recommender system can make more accurate and valuable suggestions. The targeted users' inputs include the users' implicit or explicit navigation on the website, the keywords they used, the items they browsed, the attributes they concern, or their purchase / sale history.

For example, in the buyer-oriented B2B e-market, sellers will visit many buyer-hosted websites to promote their products. They browse the needs and requirements of the buyers (implicit inputs), register their detailed information about themselves and their products (explicit inputs). All this information are stored into the buyers' recommender

system and will be analyzed together with those long-term information stored in the buyer companies' back-end information system (e.g. the ERP system). In the case of intermediary-oriented B2B e-market, both buyers and sellers can visit the website hosted by the industry intermediary to find their appropriate partners. The buyers post their purchase needs and requirements, the suppliers provide their products information. Both transaction participants can publish their comments according to their own experience. This kind of input is essentially same as the comments made by B2C participants. Here it is defined as "Industry input". Just like the community inputs in B2C e-commerce, the industry inputs include a broad range of data regarding how multiple buyers in the community, or the community as a whole, perceive products and services. As we described using the purchase history of a company buyer as a set of implicit ratings about products, we can utilize the industry purchase history to do the same. These can be combined to produce site-specific top seller lists, or mined to discover similarities, and draw conclusions about sales trends or item similarity.

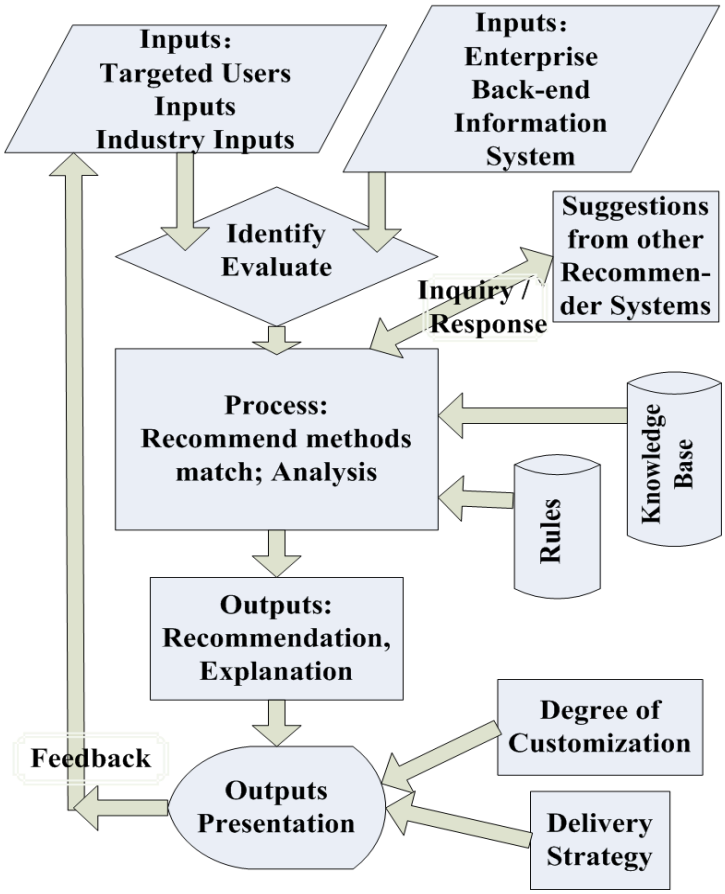

Figure 3: The Framework for RS to B2B Model.

All these inputs form the targeted users, the industry, and the users' back-end information systems are the fundamental base for recommender system to actively provide right (accurate and efficient) information to right participants at the right time.

System Process

Inputs collections only initiate the process of recommendation. These inputs will be identified and evaluated to filter the valuable and relevant data, and then it comes to the next stage. The system process stage has two steps: fist, match the recommendation method, second use the selected method to analyze.

The most widely applied recommendation methods in business practice include row retrieval, manual select, statistical summarization, attribute-based, item-to-item correlation, or user-to-user correlation. Breese et al (1998) has compared these varieties of algorithms for recommendation generation. However business practices have shown that none of these methods could be the best choice for all users in different situations. The better practice is to choose the appropriate method based on products' attributes, users' requirements and industry characteristics. The

system should be designed to use a combination of those methods to ensure the online recommender system is as responsive as possible to the interactive input form the user.

Based on the proper recommendation methods, the system begins to analyze the inputs, the information from system database, and the knowledge base to make recommendation. To construct accurate and efficient recommender systems, many different approaches have been applied, such as the nearest-neighbor collaborative filtering algorithms, Bayesian networks, clustering techniques, Horting technique, etc. The outputs, results of the analysis, could be presented as suggestions, predictions, or simply ratings and reviews.

System Outputs

Recommender system outputs vary in type, quantity, and look of information. The most common types of output are: a suggestion of a single item or a set of items; a prediction of the rating for an item; the rating made by the individuals of the community; or the reviews made by the participants of the market.

In B2B e-market, the outputs of recommender systems are used not only to promote sales but also to make the business participants understand their cooperators and themselves better. So the system brings benefits to both the buyer and the supplier. For example, in the buyer-oriented e-market, the supplier can receive the recommendations such: the most suitable products they can offer to the buyer, the buyer's most desirable products they can provide, or the trends of the buyer's purchase activities. On the other hand, the buyer can get recommendations from their own system too, e.g. the right supplier for the particular product purchase.

Another important point that must be considered in system output design is the presentation of the output. How to deliver the recommendations to the users? Should the system explain the results to the users? Matching the delivery of recommendation to the system user's activity is a very important design issue in recommender system, there are three methods: you can use push technologies (e.g. e-mail) to reach out to a user when he is not currently interacting with you; you can use pull technologies (e.g. display a link to the user) to allow the user to control the recommendations are displayed; you can also use passive delivery (e.g. display suggestions for items related to the topic of a text article) to present the recommendation in the natural content of the rest of the e-commerce application (J. Ben Schafer, 2001). System users receive different kinds of recommendations, some of the users may wonder why should they accept these suggestions? Are these recommendations reasonable? Certain styles of explanation for the system output can increase the Possibility to persuade users to adopt these suggestions. The most important contribution of explanations is to allow the system users to make more informed and accurate decisions about which recommendations to utilize. More detailed studies on recommendation explanation can be found in the study of Mustafa Bilgic and Raymond J. Mooeny .

A Virtual Example

B2B participants have the potential to improve efficiency significantly, which will enforce their competitive edge. Application of recommender system to B2B e-commerce provides the B2B participants a new and profound way to improve their business process. By helping the buyer and supplier identify their appropriate cooperators, recommender system reduces the business transaction costs. In the following part, we stimulate a simplified e-market includes both B2C and B2B transactions to illustrate the possible applications of our system model.

Bicycle-Mall is an electronic bicycle marketplace, intended to serve the entire bicycle industry. The market includes an array of supplies including industry specific suppliers like screw manufactures and service suppliers like repairman. It also includes bicycle manufactures industry distributors, retailers, and customers. For each participant, the recommender system can provide suggestions accordingly. Customer A browses the website, searches for his favorite bicycle, the recommender system can list him one or a set of bicycles based on A's personal information, available products information, similar customers' comments, etc. Retailer B has a store in the Bicycle-Mall, he sells several brands of bicycle. In Bicycle-Mall, B can find manufacturers, distributors, service providers, and products.

For example, the system can recommend B qualified service provider and manufacturer based on the price, quality, response time, the customers' and other retailers' comments, the history cooperation relationship, etc. Moreover, if retailer B, C, and D all purchase only a small quantity of a certain type of bicycle from manufacturer E, recommender system can help them band together to negotiate price with E. From manufacturer E's perspective, recommender system can assist his business in two ways: a) after comparing E's purchase requirements, suppliers' detailed products information, prices, quality, other manufacturers' comments, the system lists the rating of the most qualified suppliers for E; b) the system can also recommend worthwhile retailers for E in the similar way.

Furthermore, by analyzing the sales history and customers' comments, the system can give E advices on marketing issues such as: how to improve the bicycle design, the customers' purchase trends, etc. For screw supplier F, assuming it's the first time for him to enter the Bicycle-Mall, he wants to know who can be his customer. After comparing F's product, price, quality, and credit factors with the purchase requirements of the manufacturers in the market, the system can give F a list of the manufacturers who are the most likely to do business with him.

Form the above virtual example, the recommender system to B2B e-commerce shows benefits to each participant in the market. The potential benefits include: increased information transparency and bargaining power for customers, retailers and manufacturers in the supply chain; significant reduction of search costs; improvement of retailers' ability to deal with manufacturers directly; improved information access by manufacturers at terminals; enhancement of comparison-shopping; improvement of supply chain processes and information sharing.

CONCLUSION

We has discussed the topic of applying the recommender system to B2B e-commerce in this paper, designed a framework for the system, and examined the system components and effects to its users. This research is the first systematical study on the application of recommender system to B2B e-commerce. Our framework illustrates the system's main components and processes, though it's only an experimental trial, we gave a clear definition to the topic we studied, described the differences between the recommender system to B2C and B2B e-commerce, we also used a virtual B2B e-market - Bicycle-Mall to explain the possible applications of our system model. Recommender system currently use a wide range of input to develop recommendations, one of the problem in B2C e-commerce is the lack of data, sometimes individual customers are unwilling to provide detailed and true information due to several reasons. In B2B e-commerce, this problem can be released because of the long-term cooperation, more security environment, and supply chain data sharing. But there are still some research challenges such as real-time response, recommender system's scalability (e.g. to produce each recommendation within a few tens of milliseconds while serving hundreds or even thousands of consumers simultaneously), different types of data integration, and recommendation evaluate criteria.

Our research points out a direction of studies on recommender system, and we estimate the applications of recommender system to B2B e-commerce will bloom in the near future given the potential benefits recommender system can bring about to the B2B participants.

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