Expert Systems With Applications 42 (2015) 8413–8422

Contents lists available at ScienceDirect

Expert Systems With Applications

journal homepage: www.elsevier.com/locate/eswa

Building a boundary-spanning service for coopetition

Kai Li [a], Timon C. Du [b,*]

[a] Business School, Nankai University, China
[b] Department of Decision Sciences and Managerial Economics, The Chinese University of Hong Kong, Hong Kong

ARTICLE INFO

Keywords:
Collaborative network
Boundary-spanning service
Intelligent agent

ABSTRACT

Coopetition is a revolutionary mindset, combining cooperation and competition and allowing companies to work with potential collaborators based on their preferences. It challenges the concept of a supply chain, where companies occupy different positions within a layered structure. Relationships in a supply chain set boundaries for the different collaborators. In contrast, the partners in coopetition can be either collaborators or competitors, and the relationship can evolve over time. To support coopetition, a platform is required for dynamic relationships to develop and for various types of collaboration to occur. This platform enables companies to effectively form networks via a boundary-spanning service, and thus gain competitive advantages. A boundary-spanning service is an intelligent intermediary, providing information, contingencies, and role routines with discretionary powers under constraints. This study demonstrates a process of collaborative purchasing whereby companies negotiate over different offers to increase their utilities using boundary-spanning agents.

1. Introduction

Collaborative networks allow businesses to extend collaboration agreements beyond the traditional layered supply chain to include various situations and participants. Networks allow for collaborations between members of a supply chain who are directly connected, on the same layer of the chain, or who are further upstream or downstream. Traditionally, forming tighter supply chain relationships results incompetitive advantages by enabling the quick responses that are necessary to achieve strategic goals (Daft & Weick, 1984), such as lower inventory levels. Companies on the same layer of a supply chain are normally considered as competitors. The relationships therefore form boundaries to the layered network.

However, when a collaborative network is established, the competitive relationship becomes blurred. A company must maintain good relationships not only with suppliers and buyers, but also with their same-layer competitors. This revolutionary approach is termed coopetition, and is a combination of cooperation and competition (Brandenburger & Nalebuff, 1996). The coopetition relationship can create different types of cooperation, which ultimately benefit a company; for example, a company can work with its same-layer competitors to obtain a better volume discount from a seller.

The establishment of a collaborative network allows the possible modes of cooperation and competition to be extremely dynamic. Suppliers, buyers, and other collaborators can be easily located, maximizing efficiency. In this study, we examine the use of purchasing data in a cloud-based collaborative network. Boundary-spanning agents allow participants to identify other collaborators and negotiate with them. These boundary-spanning agents—also known as boundary spanners or boundary-spanning individuals—are intelligent intermediaries. Their functions are to (1) process and filter information; (2) provide for contingencies; (3) create the role routine; (4) possess some degree of discretionary power; (5) take on different technological and boundary roles (mediating, an inter-dependent role, or intensive interaction) for different types of organizations; and (6) deal with environmental constraints (Aldrich & Herker, 1977; Ancona & Caldwell, 1992; Tushman & Scanlan, 1981).

In our study we have designed an intelligent, boundary-spanning agent that provides decision-making support and can automatically search for, negotiate, and evaluate solutions for a participant (Barbati, Bruno, & Genovese, 2012). A collaboration support tool is not a type of collaborative software or "groupware" (Ellis, Gibbs, & Rein, 1991) enabling different individuals involved in a common task to achieve their goals. It instead works at the firm level, similar to a negotiation support system (NSS), such as active collaboration and negotiation frameworks (ACNF), where active documents with embedded business rules are used to adapt to different collaborative strategies in a business-to-business (B2B) environment (Du & Chen, 2007). It is also comparable to DSS agents used to reason cooperatively with other agents in a process of interactive constraint satisfaction (Wang, Liao, & Liao, 2002). A collaboration support tool should be more than an NSS, in which the primary concerns are the negotiations with other

* Corresponding author. Tel.: +852 39438569, fax: +852 26035104.
E-mail addresses: likai@nankai.edu.cn (K. Li), timon@cuhk.edu.hk (T.C. Du).

http://dx.doi.org/10.1016/j.eswa.2015.06.055
0957-4174/

participants to obtain a lower price or achieve other goals. An effective tool should create a collaborative working environment based on a collaborative network, but also search for, evaluate, and recommend potential partners based on the collaborative strategies of firms.

2. Collaborative networks

A traditional supply chain integrates the entire production line, from upstream component suppliers to downstream consumers. The relationships between the upstream and downstream parties are linear, regardless of the numbers in each layer. Supply chain collaboration is currently an indispensable strategic business tool (Chopra & Meindl, 2003; Ramanathan, 2014). Extension of the supply chain in turn extends links vertically and/or horizontally. These types of extensions take advantage of Web technology to form a network structure known as a collaborative network (CN). This can be established in many different formats, and can be either mobile or stationary. It can integrate information, products, and services. Examples of CN applications include vendor management inventories (VMI), information sharing between P&G and Wal-Mart, retailer–supplier collaboration at Target, transportation and inventory enhancement at Unilever, and design cycle reduction at Adaptec (Turban, Lee, King, & Liang, 2010). ACN integrates various business functions including demand planning, planning and scheduling, order management, product development, vendor management, and sales support. The quality of a collaboration can be measured through various improvements: (1) better relationship management with unidirectional partners; (2) improved integration of business functions; (3) a stronger foundation of trust in knowledge and information sharing; and (4) an atmosphere more conducive to establishing a collaborative culture (Li & Du, 2005).

Collaboration is markedly more effective when a network is cloud-based where an innovative platform providing highly scalable Web-based services (Buyya, Yeo, & Venugopal, 2008; Foster, Zhao, Raicu, & Lu, 2008; Jula, Sundararajan, & Othman, 2014). The geography of computation shifts from local computers (Hayes, 2008) to the broader environment of the cloud, where the on-demand services can be optimized by participants (Armbrust et al., 2009). Based on the architecture, services can be divided into software, platforms, or infrastructure (Grossman, 2009; Rhoton, 2010). The software can comprise a wide range of applications such as CRM, ERP, or email, which can be purchased from service providers, and also shared. Various commercial platforms such as Google, Amazon, and Apple apps can be used, as can tools such as specific programming languages or development environments. Users can determine the level of investment (monetary and technological) required before deciding whether to purchase services. Downstream infrastructure services can extend beyond the adoption of hardware to areas such as power, real estate, computation, memory, storage, or virtualization (asking other users to act on one's behalf). There are many possible adoption modes available, and toolkits can be used to evaluate these using simulated solutions (Calheiros, 2011) or cost models (Khajeh-Hosseini, Greenwood, Smith, & Sommerville, 2012).

3. Boundary-spanning service

3.1. Framework of boundary-spanning service

A collaborative network can involve numerous participants, such as production firms, service providers, non-profit organizations, and governmental units. A boundary-spanning service is responsible for sharing data between all participants, and in the cloud is a collaborative support tool designed to help organizations gather, store, and access information and knowledge easily, and also to provide them with decision-making support within collaborative networks. The functions of the boundary-spanning service agent include those of profile manager, relationship manager, and service engine (shown in Fig. 1). The profile manager provides basic information about the parties involved and the corresponding preference vectors describing their inclination toward other parties. The corresponding preference vectors can be updated on the basis of past transactions, such as previous purchasing information. The preference P is represented as: $P = (p_1, p_2, \ldots, p_m)$, where $\sum_{i=1}^{m} p_i = 1$ and i is an involved party.

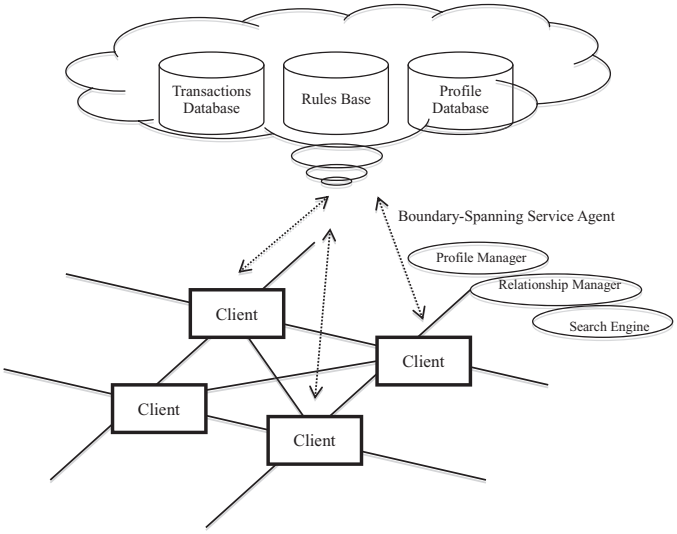

Fig. 1. The boundary-spanning service.

The main role of the relationship manager is to compute, store, and update relationships, i.e. the preference vector established by the profile management function. It is dynamic in nature depending on the contracts, negotiation, and other factors between two companies in coopetition of the collaborative network. The service engine is the core feature of the boundary-spanning service. It can enable a company to search for and contact service providers, and negotiate and recommend collaborators according to different criteria, such as price and delivery date. Recommendations are not limited to potential cooperators (e.g., sellers to a purchaser), but can also encompass competitors (e.g., those looking to buy the same items) if cooperation can enhance utility (e.g., giving a better discount for a cooperative quantity purchase).

3.2. Boundary-spanning service design

In a cloud-based collaborative network, clients (buyers or sellers) collaborate with others by delivering active documents through the boundary-spanning service agents. These active documents, written in XML, are embedded with business logics that can adapt the content to different collaborative strategies. Active documents, as opposed to passive documents that contain only content and a structured presentation, include dynamic and interactive components that are similar to the application interfaces for human use (Nam, Jang, & Bae, 2003). For example, an active document can be used by a buyer to search, evaluate, and recommend potential partners based on the collaborative strategies. This design means that the document's function is no longer limited to serving as a medium for data storage. In fact, if advanced inferences are built-in, the document can also process applications.

Following the predefined instructions and threshold values, which are written in the active document, a boundary-spanning service agent can inquire, collaborate, and negotiate with the boundary-spanning service agents of other sellers or buyers in a cloud-based collaborative network. For example, when a participant asks for a buying service, the following information is provided: the purchasing target is 100 laptops; the product specifications include the size