The analytic network process for managing inter-enterprise collaboration: A case study in a collaborative enterprise network

María-José Verdecho *, Juan-José Alfaro-Saiz, Raúl Rodríguez-Rodríguez, Angel Ortiz-Bas

Research Centre on Production Management and Engineering (CIGIP), Department of Business Organization, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain

ARTICLE INFO

ABSTRACT

In the last years, collaboration among enterprises has gained attention in the business environment as a means to remain competitive. Enterprises that are collaborating look for improving their performance but, in real assessments, they often do not establish efficient frameworks to structure and manage the enterprise association/inter-enterprise performance. In addition, there are many factors that act as barriers to effective collaboration and have to be also properly managed as they impact on the inter-enterprise performance. This paper provides a methodology based on the analytic network process (ANP) to identify and measure, under an integrated approach, both factors and inter-enterprise performance considering their reciprocal impact. With this innovative approach, enterprises will obtain significant information for the decision-making process regarding which are the factors and inter-enterprise performance elements that generate a higher impact and therefore have a high priority within the specific collaborative relationship. Thus, enterprises can focus their efforts on improving those most important factors and performance elements, and consequently, enhancing their competitiveness.

1. Introduction

Enterprise collaboration has been one of the most used business models to compete and adapt to market requirements. Simatupang and Sridharan (2002) define supply chain collaboration as '*two or more companies working together to create a competitive advantage and higher profits than can be achieved by acting alone*'. These companies are actively working together towards common objectives and share information, knowledge, risks and profits (Mentzer, 2001). Enterprises that are collaborating look for improving their performance in different aspects such as increased inventory turnover, increased revenues, cost reductions, product availability, and economic value added (Fawcett, Magnan, & McCarter, 2008).

However, enterprises that desire to collaborate or are collaborating often do not establish efficient mechanisms to manage the performance of the enterprise association, called global or inter-enterprise performance, which can be measured, and therefore, managed through performance measurement elements (objectives, performance indicators, etc.). In these contexts, it is important to define inter-enterprise performance elements in order to

lead the activities of all the members towards the achievement of the commonly agreed objectives (Alfaro, Rodríguez, Verdecho, & Ortiz, 2009; Bititci, Mendibil, Martinez, & Albores, 2005; Verdecho, Alfaro, & Rodriguez-Rodriguez, 2009). Thus, it is important for those enterprises to define and use a structured performance measurement framework that allows managing performance under various perspectives or dimensions so that they provide a relevant overview of their performance status. One of the most important performance frameworks developed in the academic literature and business applications is the balanced scorecard (BSC) by Kaplan and Norton (1992). In fact, the BSC, developed initially for managing performance of enterprises, has been extended by different authors for inter-enterprise performance management such as the works by Brewer and Speh (2000), Bititci et al. (2005), Folan and Browne (2005) or Alfaro, Ortiz and Rodríguez (2007).

Despite the benefits of collaboration, there are many factors that act as barriers to effective collaboration (Fawcett et al., 2008): lack of top management support, cross-functional conflicts, lack of trust, etc. In fact, many collaborative initiatives that initially were developed to improve the competitiveness of the enterprises, fail due to these factors (Bititci et al., 2007; Kampstra, Ashayeri, & Gattorna, 2006; Sabath & Fontanella, 2002). For that reason, it is important to manage those factors as they impact on the resulting performance. In addition, the achievement or not achievement of the performance element targets impact on the factors, configuring a system of reciprocal influences between factors and performance

* Corresponding author. Address: Department of Business Organization, Camino de Vera s/n, Building 7D, Universidad Politécnica de Valencia, 46022 Valencia, Spain. Tel.: +34 963877007x76888; fax: +34 963877689.

E-mail addresses: mverdecho@omp.upv.es (M.-J. Verdecho), jalfaro@omp.upv.es (J.-J. Alfaro-Saiz), raurodro@upvnet.upv.es (R. Rodríguez-Rodríguez), aortiz@omp.upv.es (A. Ortiz-Bas).

elements. For example, the achievement of one financial objective, e.g. increase profitability, impacts on trust, one of the most relevant factors widely analyzed in the literature. At the same time, trust among members impacts on increasing profitability, and thus, a reciprocal relationship between trust and increasing profitability objective is established. On the other hand, both factors and inter-enterprise performance elements are linked among themselves at the internal level. Therefore, it is needed to develop a proposal that identifies and measures the factors and inter-enterprise performance elements under an integrated manner and make explicit the overall real influences that exist within the system so that accurate and significant results are obtained. This proposal should address some questions in order to manage effectively collaborative relationships (Busi & Bititci, 2006; Simatupang & Sridharan, 2005): What are the relevant factors of collaborative relationships? How can these factors be associated to a performance measurement framework? How are these factors and performance elements linked together? How should both factors and performance elements be measured? etc.

From a methodological point of view, it is important to select an adequate method to solve this issue. Suwignjo, Bititci, and Carrie (2000) suggest that integrating the multidimensional effects of factors on performance into a single unit of measurement can only be done through subjective, individual or group judgment. An example of this fact is the valuation of the trade-off between trust and performance. There are not measures that can objectively deal with this issue. For that reason, subjective measurement is widely accepted in Multi-Criteria Decision Analysis (MCDA) to deal with multi-criteria problems (Suwignjo et al., 2000). MCDA comprises a large variety of methods. One of the most extensively method used is ANP introduced by Saaty (1996). There are three main reasons that suggest using ANP to model and solve the problem of this paper. First, ANP allows modeling complex problems with a network structure integrating interdependences and feedback among elements. Second, ANP is adequate to solve problems with both qualitative and quantitative factors (Peniwati, 2007). This is important as many of the collaboration factors are qualitative such as cultural factors, and many of the methods are developed solely for quantitative measurement. Third, ANP has been used in group-decision problems (Erdoğmuş, Kapanoglu, & Koç, 2005; Levy & Taji, 2007), which is the case of a collaborative relationship.

The aim of this paper is to provide a methodology based on ANP that aids to make decisions to enterprises that collaborate by identifying and measuring, under an integrated approach, both factors and inter-enterprise performance elements considering their reciprocal and internal relationships. The structure of this paper is as follows. Firstly, a literature review regarding relevant factors of collaborative relationships and the application of ANP for performance measurement are analyzed. Secondly, the methodology developed is described. Then, the application of the methodology

to a case study is exposed. Finally, conclusions and research implications are presented.

2. Literature review

2.1. Relevant factors of collaborative relationships

There are numerous works within the literature that deal with identifying main factors of inter-enterprise relationships. Some of these works present classifications of inter-enterprise environments according to the level of maturity reached in different aspects of their relationships, i.e. they present supply chain evolutionary models (from lower to higher level of collaboration). Sabath and Fontanella (2002) present a supply chain classification depending on two main aspects: strategic value of the relationship and technology used to support it. From a process perspective, Lockamy and McCormack (2004) develop a model to classify supply chains based on the maturity of their processes. Each level is characterized according to different factors such as alignment of processes, organizational structure, cooperation, process performance and trust. Lejeune and Yakova (2005) expose a typology for supply chain characterization related to social relationships theory and the interdependence concept.

Other works aim at identifying the main factors that impact on partnerships. Mohr and Spekman (1996) identify, from an empirical study, the factors that contribute to successful partnerships: relationship attributes (coordination, commitment, and trust), communication behaviour and joint problem solving techniques. Boddy, Macbeth, and Wagner (2000) identify seven factors for partnering contexts: business processes, people, trust, technology, structure, financial resources and culture. Table 1 presents a summary of relevant factors on collaborative relationships. The classification is structured by adapting the main blocks of the MIT'90 framework (Scott-Morton, 1991). Despite the MIT'90 framework was developed for individual enterprise contexts, if we conceptualize a collaborative inter-enterprise context as an organization that pursues common objectives, its application is justified.

2.2. ANP for performance measurement

ANP has been recently applied for performance measurement applications at both intra-enterprise and inter-enterprise levels. Talluri and Sarkis (2002) develop an ANP model with traditional quality control methods in manufacturing. The approach consists in a system to monitor the performance of a manufacturing enterprise at the strategic, tactical and operational levels. Yurdakul (2003) present an ANP model to select those areas of higher success (priority areas) within a company, depending on the competitive strategy (innovation, customization, cost reduction, etc.).

Table 1
Summary of relevant factors on collaborative relationships.

Factors		References
Strategic factors	Joint vision, design of the inter-enterprise network, equity, top management support	Spekman, Kamauff, and Myhr (1998), Boddy et al. (2000), Sabath and Fontanella (2002), Barratt (2004), Chopra and Meindl (2004, chap. 1), Simatupang and Sridharan (2005) and Wu et al. (2009)
Business process and infrastructure factors	Process alignment, IS/ICTs interoperability, complementary skills, coordination between activities	Mohr and Spekman (1996), Barratt (2004), Lockamy and McCormack (2004), Lejeune and Yakova (2005), Min et al. (2005), Simatupang and Sridharan (2005) and Matopoulos, Vlachopoulou, Manthou, and Manos (2007)
Organizational structure factors	Collaboration leadership, compatibility of management styles, joint decision-making, multidisciplinary teams	Boddy et al., 2000, Barratt (2004), Lockamy and McCormack (2004), Min et al. (2005), Burgess and Singh (2006), Camarinha-Matos, Afsarmanesh, Galeano, and Molina (2009) and Wu et al., 2009
Cultural factors	Trust, commitment, cooperation, information shared, conflict resolution management	Mohr and Spekman (1996), Boddy et al. (2000), Barratt (2004), Handfield and Bechtel (2004), Lam and Chin (2005), Lejeune and Yakova (2005), Burgess and Singh (2006), Giannakis (2007), Matopoulos et al. (2007) and Wu et al. (2009)