Performance indicators for collaborative business ecosystems — Literature review and trends

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ABSTRACT

Nowadays, more and more enterprises are aware and motivated to adhere to collaborative platforms as business enablers, allowing groups of companies to improve their offer and competitiveness. As such, the concept of business ecosystem is becoming prominent. However, despite the evidences of collaboration benefits, for which some research efforts have been made, there is still a lack of suitable performance indicators and associated metrics to assess those benefits, promoting sustainability and resilience of the members of a collaborative business ecosystem. The analysis of the literature shows that a number of contributions can be found in several research fields, such as enterprise performance indicators, collaboration benefits, value systems, supply chain collaboration, and social network analysis. The purpose of this paper is to survey these areas, highlighting their potential contributions concerning the assessment of collaborative benefits and performance. The analysis also identifies the strengths and weaknesses of current proposals regarding the establishment of adequate performance indicators for collaborative business ecosystems.

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1. Introduction

The challenges of market turbulence and increasing levels of competition induced by globalization motivate companies to engage in collaborative processes as a way to gain agility and resilience. This trend is accompanied by the emergence of new organizational structures and supporting technology, providing enabling environments for business collaboration. A relevant example is represented by the notion of Business Ecosystem, a term introduced by Moore (Moore, 1993), which used biological ecosystems as an analogy to explain business environments. According to this author, a business ecosystem is "*an economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world. This economic community produces goods and services of value to customers, who themselves are members of the ecosystem*". The actors of the ecosystem "*coevolve their capabilities and roles*" (Moore, 1996) in an interdependent business environment.

The fast developments of the information and communications technologies (ICT), allowing the development of advanced collaboration platforms, motivated the refinement of this concept and the emergence of new areas of research, such as the Digital Business Ecosystem (DBE)

(Nachira, 2002), which aimed at boosting competitiveness and productivity growth of small and medium size enterprises (SMEs) through ICT adoption (Nachira et al., 2007). The DBE concept follows Moore's business ecosystem metaphor, but emphasizes de idea of a "*digital environment*" populated by "*digital species*" such as software applications, services, and agents, or business models, knowledge, laws, etc. These "*digital species*", interact in a similar way to living species, and can express an independent behavior, evolving, or becoming extinct, according to laws of market selection. The less adapted species, e.g., digital services not interesting for the market, are then less and less used until they eventually disappear. Under this view, more innovative digital services and business models continuously appear and replace obsolete ones. Similar to biological ecosystems, the digital business ecosystem should be populated by a critical mass of species in order to be attractive for the market and have a number of individuals enough to survive (Nachira, 2002).

Among several other forms of Collaborative Networks (Camarinha-Matos and Afsarmanesh, 2004, 2005), a business ecosystem can be classified as a long-term strategic collaborative networked organization and more specifically as sub-class of a virtual organizations breeding environment (VBE). A VBE is a source network of organizations providing a suitable environment for rapid formation of goal-oriented networks (e.g. virtual organizations) targeting specific business opportunities. Therefore, a business ecosystem typically promotes common business processes, providing interoperable collaboration infrastructures, and facilitating trust building among its members (Camarinha-Matos and

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Afsarmanesh, 2008a). In order to emphasize the importance of collaboration among organizations in facing a highly competitive and aggressive global market environment, we adopt the term Collaborative Business Ecosystem (CBE).

An important aspect in this context is the capability of assessing the performance of the ecosystem as a whole and the potential benefits it brings to its members. For individual enterprises management there are well-defined performance assessment methods and indicators. An example is the balanced scorecard, introduced by Kaplan and Norton (Kaplan and Norton, 1996), a classical method that comprises a set of performance indicators which are typically aligned with the vision and strategy of the enterprise. However, despite the benefits of collaboration widely mentioned in literature, there is still a lack of adequate performance indicators to measure such benefits for enterprise networks, and even more specifically for business ecosystems. As such, the following questions are raised:

(i) What are the adequate performance indicators to assess collaboration benefits in a CBE?
(ii) How can performance assessment methods based on economic and social value, promote sustainability and resilience in a CBE?

The aim of this article is to address these questions, while assuming that valuable contributions can be borrowed from other research areas such as digital and business ecosystems (Briscoe et al., 2011), collaborative networks (Camarinha-Matos and Afsarmanesh, 2008b), enterprise performance indicators, collaboration benefits (Camarinha-Matos et al., 2007), value systems (Camarinha-Matos and Macedo, 2010), (Macedo and Camarinha-Matos, 2013), supply chain collaboration (Lorentz et al., 2011), (Ramanathan, 2014), and social networks analysis (Freeman, 1978), (Battistella et al., 2013). The following sections give thus a summary of these areas, synthesizing relevant findings in a number of tables, highlighting their contributing elements, and complementing the findings with a critical analysis.

2. Collaborative Networks

A Collaborative Network (CN) is often presented as "a network consisting of a variety of entities (e. g. organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals, and whose interactions are supported by computer networks" (Camarinha-Matos and Afsarmanesh, 2004, 2008a). Important conceptual foundations for this area resulted from a number of projects including ARICON (Belecheanu et al., 2004), (Conte et al., 2004), VOSTER (Katzy et al., 2005), THINKcreative (Afsarmanesh and Camarinha-Matos, 2004), ECOLEAD (Camarinha-Matos and Afsarmanesh, 2008a), (ECOLEAD, n.d.), COIN (Sitek et al., 2011), (European Commission and CORDIS, n.d.), and many others.

2.1. Classes of Collaborative Networks

A wide variety of CNs can be identified in a growing number of sectors both in manufacturing and service industry. Given this diversity, the establishment of a taxonomy of collaborative networks becomes an important need. A relevant effort in this direction is ARCON (A Reference model for Collaborative Networks) (Camarinha-Matos and Afsarmanesh, 2008a), a modeling framework, which allows among other features, to classify collaborative networks according to their specific characteristics. According to ARCON, CNs are divided into two main groups - "organized collaboration" and "ad-hoc collaboration". Organized collaboration includes the long-term strategic networks, oriented to allow its members to be prepared for quick reaction to collaboration opportunities, and goal-oriented networks, aimed at grabbing and fulfilling a business opportunity. This taxonomy is illustrated in

Fig. 1, showing a Business Ecosystem which is seen as a class of a CNs, more specifically as a sub-class of a long-term strategic network. A business ecosystem is defined in (Camarinha-Matos and Afsarmanesh, 2008a) as "*a long-term strategic collaborative network similar to a cluster or industry district, although not limited to one sector but rather tending to cover the key sectors within the geographical region. A business ecosystem is inspired by the mechanisms of the biological ecosystems, tries to preserve local specificities, tradition, and culture, and frequently benefits from (local) government incentives*".

Since the target purpose of this work is about performance, which is related to the operation of the network, it makes sense to briefly consider the various forms of network management.

Traditional supply chains are also understood as a class of CNs, being a sub-class of goal-oriented networks, as suggested in Fig. 2. These traditional organizations have evolved to more integrated collaborative structures, which led to the emergence of the concept of Supply Chain Collaboration (SCC), described as "*a long-term partnership process where supply chain partners with common goals work closely together to achieve mutual advantages that are greater than the firms would achieve individually*" (Cao et al., 2010).

Considering collaborative networks in general, very few references concerning performance measurements can be found, as most works address issues such as organizational models, frameworks, tools, and interoperable platforms. However, for supply chains in particular, a variety of works can be found, including efforts to classify the levels of collaboration in these networks. For instance, (Botta-Genoulaz et al., 2013) distinguishes two types of collaboration, characterized by different levels of the intensity of collaboration. The type designated by "*information exchange*" is the most basic practice of collaboration, which can be followed by "*process integration*", also called "*structural collaboration*" (Vereecke and Muylle, 2006). Another example of typology is presented in (Whipple and Russell, 2007), differentiating three levels of collaborative practices, namely, "*collaborative transaction management (type I)*", "*collaborative event management (type II)*", and "*collaborative process management (type III)*". The higher the level, the higher the commitment to collaborate of the supply chain members. Fig. 2 depicts the diagram of classes of collaborative networks (Camarinha-Matos and Afsarmanesh, 2008a), showing only the branch of the goal-oriented networks, extended to the collaborative practices categorization described in (Vereecke and Muylle, 2006), and the collaborative practices typology introduced in (Whipple and Russell, 2007).

A summary description of the CNs classification taxonomy according to (Camarinha-Matos and Afsarmanesh, 2008a), describing long-term strategic networks, is presented in Table 1. Table 2 covers goal-oriented (continuous production driven) networks, trying to integrate contributions from three different lines of work, namely classes of collaborative networks (Camarinha-Matos and Afsarmanesh, 2008a), collaborative practices categorization (Vereecke and Muylle, 2006), and collaborative practices typology (Whipple and Russell, 2007).

2.2. Management of Virtual Organization Breeding Environments

As mentioned above, a business ecosystem, as defined in (Camarinha-Matos and Afsarmanesh, 2008a), corresponds to a sub-class of Virtual Organizations Breeding Environment (VBE), i.e. a source network of organizations established as a long-term strategic alliance. For a good understanding of the structure, functions, behavior, and governance rules of a VBE, it is important to consider existing relevant reference models.

A relevant proposal of a reference model for CNs can be found in (Camarinha-Matos and Afsarmanesh, 2007, 2008a). The authors define a reference model as "*a generally accepted framework for understanding the significant concepts, entities and relationships of some domain, and therefore a foundation for the considered area*". The proposed model, ARCON (A Reference model for Collaborative Networks), provides a modelling framework to organize the most relevant characterizing