An Intelligent Supply Chain Design for Improving Delivery Reliability

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ABSTRACT

In order to flexibly respond to market demands and changing business environments, today’s European machinery and equipment manufacturers are organized in agile, non-hierarchical business networks. As a consequence, relationships with suppliers are often highly volatile, unstable and inapprehensible, which in turn causes turbulences with respect to reliability of deliveries. Following the design research paradigm, both practical and knowledge problems are considered by this paper. First, from a practical point of view, a new intelligent supply chain design for non-hierarchical manufacturing networks is developed, that pledges to improve the delivery reliability. Second, from a knowledge point of view, the underlying hypotheses that go along with this new design are validated using structural equation modeling. The results confirm several previously proposed assumptions, including the importance of an electronic procurement process as well as the use of incentive mechanisms for influencing a supplier’s delivery reliability.

Keywords: Design Research, Electronic Business, Extended Enterprise, Intelligent Supply Chains, Supply Chain Analytics

INTRODUCTION

Operating competitive firms in today’s turbulent and volatile business environment is becoming an extremely difficult task as product variety increases, product’s complexity and quality demands augment, product’s life cycles reduce, and revenue margins decrease (Dioguardi, 2010). In this context, collaboration between companies is indeed a key for competing in the global market, and participating in supply chains has nowadays become very important for any organization that strives to achieve a competitive advantage, especially if the company is small or medium sized (Camarinha-Matos et al., 2009). With an 84% growth between 2002 and 2007, and contributing a considerably portion of approximately 58% of the added value, these small and medium sized enterprises (SMEs) represent the backbone of many European industrial economies (Audretsch et al., 2009). However, due to the typically limited capabilities and resources available to them, they face many problems.

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For instance, such limitations typically induce the necessity of joining efforts with other SMEs, constituting inter-organizational relationships to achieve business goals that might be difficult to accomplish by individual organizations alone (Cheng, 2010). Moreover, SMEs are often involved in many different networks that, independently from each other, pull them from different parts, having different scopes and purposes.

In order to implement an effective inter-organizational relationship, suitable ICT tools and paradigms able to support the formation and management of the supply chains are required. Such tools and paradigms are intended to reduce, or even eliminate, the main issues in collaboration, such as lack of trust (Panayides, & Venus Lun, 2009), information asymmetry (Fiala, 2005), loosely managed inter-organizational collaboration (Daugherty et al., 2006) and so forth.

Aiming at overcoming these problems, an emerging organizational model in manufacturing context is represented by non-hierarchical manufacturing networks (Teich et al., 2002), the conceptual vision of a virtual enterprise mainly intended to improve competitiveness of SMEs through collaboration. Unlike the more traditional hierarchical networks characterized by the presence of a leader with strong market power that creates lasting relationships with its suppliers (typical example is the automotive sector), a non-hierarchical model implies a direct process of peer-to-peer collaboration and trading between the different actors.

The advantages of a non-hierarchical network model are the elimination of the dominance of single companies and the creation of more intelligibility with regard to yield and customer communication within the network (Mehnert, & Dürr, 2003). It is meant to use the potential of close cooperation and available capabilities as effective as possible without relying on an administrative superstructure (Teich et al., 2002). However, despite the mentioned benefits of this network orchestration model, usually its complexity might result in highly volatile, unstable and non-transparent market conditions leading to high turbulences within the network. According to Schuh et al. (2010) within machinery and equipment industry this is manifested by a poor delivery reliability of less than 65%.

Hence, the goal of this paper is to address the problem of delivery reliability by proposing a new and intelligent supply chain design. To this end, the paper is organized as follows: First, an overview of the applied research methodology is provided. Then, a more detailed exposition of the challenges of the European machinery and equipment manufacturers is given. The solution design consisting of the business logic and the technical architecture of a new, intelligent supply chain design, is discussed in the section that follows. Subsequently, the underlying assumptions of this new design are evaluated. Finally in the last section, we discuss the consequences for the future and give an outlook for continued research.

**RESEARCH METHOD**

Since Herbert Simon’s foundational “The Sciences of the Artificial” (Simon, 1969) numerous contributions have been made by Information Systems (IS) scholars all over the world to explain and promote design-oriented research. Especially in Europe, this research paradigm has a long tradition.

The major difference to natural sciences, which try to explain and predict behavioral aspects of reality by developing and verifying theories (March, & Smith, 1995), is that design-oriented research aims at building and evaluating ‘artificial solutions’ in order to extend existing capability limitations (Hevner et al., 2004). Rather than theory-driven research, it thus can be seen as research towards systematical problem solving (Wieringa, 2009).

According to Hevner et al. (2004), the construction and evaluation of these solutions can be reflected on a generic level, focusing primarily on the design research process and on creating standards for its rigor (by some authors designated as ‘science of design’ (Cross, 2001).
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