Supply Chain Process Modeling for Manufacturing Systems

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INTRODUCTION

A supply chain can be simply defined as a set of inter-related business processes that add value to the products and/or services for the end customer (Christopher, 2010). A business process is a series of steps, procedures or activities that are designed to transform inputs into outputs to produce a product, service, transaction and/or information (Verdouw et al., 2011; Bolstroff & Rosenbaum, 2012). The Global Supply Chain Forum identifies eight core business processes covering internal and external supply chain processes at both the strategic and operational levels (Croxton et al., 2001). Modeling of supply chain processes is fundamental to analysis of these processes and is essential for understanding, design, or re-engineering of the processes. From the information system perspective, supply chain process modeling (SCPM) provides the basis on which information systems are developed (Stefanovic & Stefanovic, 2008). On the other hand, SCPM is a complex task requiring effective iterations and communication between various parties involved in the supply chain, which pose many challenges (Brown et al., 2011).

In this chapter, business process modeling (BPM) is first introduced to provide some background information on SCPM. This is followed by a summarized description and critical discussion of prominent standards/notations and techniques for SCPM. Finally, future trends and research directions are indicated and the chapter is concluded.

BACKGROUND

In the body of literature on supply chain management (SCM), researchers have claimed that a business process orientation of SCM has been proven to be an effective way to enhance business performance as well as customer satisfaction (Trkman et al., 2007). Cooper et al. (1997, p. 20) define SCM as 'the integration of key business processes from end-users through original suppliers that provide products, services and information and add value for customers and other stakeholders. Therefore, a supply chain can be regarded as an overarching business process starting from the original supplier to the end customer. Therefore, SCPM is essentially about an extended business process which crosses the boundaries of individual companies along the supply chain.

It is clear that SCPM is deeply rooted in BPM, which provides a platform for achieving a common understanding of a business process (Aguilar-Saven, 2004). Good process models are critical for making well-informed decisions when it comes to business process (re-)design and (re-) engineering and information system development. BPM can be defined as a methodology using software systems to design, analyze, manage and improve business processes in order to increase the productivity and revenue of a company (Bae & Seo, 2007; Trkman et al., 2007).

In the BPM literature, it is a common view that when constructing a business process model, one should use a particular modeling technique

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for a particular modeling purpose (Aguilar-Saven, 2004). Due to the ongoing interest in BPM both in research and in applications, there are a wide variety of BPM techniques which range from the basic tools such as flowcharting, to academically studied techniques such as Petri Nets (Ricker et al., 2009). Essentially, the techniques used for BPM can be classified into two categories: (1) descriptive (or pragmatic) approaches such as UML, and (2) formal (or rigorous) approaches such as Petri Nets (Ryan & Heavey, 2006; Aguilar-Saven, 2004). As a supply chain can be regarded as an extended business process, many BPM techniques can be used for SCPM.

On the other hand, as a supply chain has gone beyond the boundary of a single organization to include its business partners such as immediate suppliers and customers, SCPM has its own challenges in comparison with traditional BPM. Particularly, it is imperative to have a systemic view of the entire supply chain process, which includes material management (inbound logistics), internal operations and physical distribution (outbound logistics) (Min & Zhou, 2002). In response to this special challenge, Supply Chain Council (SCC), which was founded by AMR Research in 1996 as a non-profit organization, developed the supply chain operations reference (SCOR) model. This model has become a well-known standard for supply chain modeling for research and applications (Kasi, 2005).

MAIN FOCUS

Given a wide range of available standards and techniques for BPM and/or SCPM, it is not our intention to provide a comprehensive review of all the available techniques for BPM and/or SCPM in this chapter. Rather, it will be focused on the prominent modeling standards and techniques which have been well adopted for SCPM. Particularly, this chapter will focus on three descriptive approaches (i.e. SCOR, IDEF and UML) and two formal approaches (i.e. Petri Nets and simulation) for SCPM.

Descriptive Approaches

The SCOR Model

The SCC developed the SCOR model and published its Release 1.0 in November, 1996. The SCOR model provides a standardized terminology for describing supply chain operational processes. It is the first cross-industry framework for measuring, evaluating and improving supply chain performance. The SCOR model provides a glossary of standardized terminology in relation to supply chain processes so that supply chain members can use the same language for effective communication (Persson, 2011). This process framework enables business process re-engineering (BPR) by identifying and comparing the 'as is' (or current) versus the 'to be' (or future) state of a process. It also allows a company to benchmark their processes against best performers' processes in the industry and to extract best practices for specific processes. Therefore, the SCOR model incorporates BPR, benchmarking and best practices.

According to the SCOR model, a supply chain process can be stratified into four hierarchical levels: process types, process categories, process elements and implementations as shown in Figure 1. The SCOR model does not cover the implementation level as it is outside of its current scope. Level 1 consists of five basic processes: plan, source, make, deliver and return and this is where the supply chain performance targets are set. At the 2nd level, the five process types are decomposed into 26 process categories, each of which is assigned to either planning, execution or enabling. A company can choose from these core process categories to configure its own SCOR model. Level 3 provides the actual process elements (e.g. scheduling, production) within a specific configuration.

Overall, the SCOR model provides a three-level detailed analysis of a company's processes, from defining the business scope (*level 1*), configuring the supply chain (*level 2*), to providing the detailed process elements and performance attributes (*level 3*) (Li et al., 2011; Trkman et al.,