Chapter 5
Ontology-Assisted Enterprise Information Systems Integration in Manufacturing Supply Chain

Kamalendu Pal
City, University of London, UK

ABSTRACT

Manufacturing communities around the globe are eagerly witnessing the recent developments in semantic web technology (SWT). This technology combines a set of new mechanisms with grounded knowledge representation techniques to address the needs of formal information modelling and reasoning for web-based services. This chapter provides a high-level summary of SWT to help better understand the impact that this technology will have on wider enterprise information architectures. In many cases it also reuses familiar concepts with a new twist. For example, "ontologies" for "data dictionaries" and "semantic models" for "data models." This chapter presents the usefulness of a proposed architecture by applying a theory to integrating data from multiple heterogeneous sources which entails dealing with semantic mapping between source schema and a resource description framework (RDF) ontology described declaratively using specific query language (i.e. SPARQL) queries. Finally, the semantic of query rewriting is further discussed and a query rewriting algorithm is presented.

INTRODUCTION

All manufacturing business today appreciates the value and consequence of building an effective supply chain as part of enterprise proliferation and profitability. There exist different types of the industry-specific supply chain (e.g. automotive, pharmaceutical, apparel, agriculture). In simple, the supply chain is a system with organization, people, technology, activity, information and resource involved in, to deliver a product or service from suppliers to customers. Supply chain activity transforms natural resources, raw materials and components into final products, and delivers them to customers. A network is composed of the enterprises and enterprise departments involved in this process. The most important requirements of supply chain operation are to minimize the inventory, create seamless material and information

DOI: 10.4018/978-1-7998-1831-1.ch005

flow, effective communication must exist among the market, sale, purchase, manufacturing plan and control, appropriate customer delivery service, after-sales service, and so on. Therefore, a supply chain is a network of facilities and distribution options that performs the functions of material procurement, the transformation of these materials into intermediate and finished products, and distribution of these finished products to customers (Pal, 2017). Supply Chain Management (SCM) aims at improving the allocation, management and control of logistical resources. In this way, manufacturing SCM is a set of synchronized activities for integrating suppliers, manufacturers, transporters, and efficient customer service so that the right product or service is delivered at the right quantities, at the right time, to the right places. The ultimate objective of SCM is to achieve sustainable competitive advantage (Pal, 2019).

The first signs of SCM were perceptible in Toyota Motor Manufacturing's Just-In-Time (JIT) procurement system. Particularly, JIT was used to control suppliers to the factory just in the right quantities, to the right location, and at the right time, in order to optimize system-wide costs and customer affordability. The main goal was to reduce inventory level drastically, and to regulate the suppliers' interaction with the production line more effectively. It consisted of two distinct flows through the supply chain organizations: material and information. The scope of the supply chain begins with the source of supply and ends at the point of consumption. It extends much further than simply a concern with the physical movement of materials. Equal emphasis is given to supplier management, purchasing, inventory-management, manufacturing management, facilities planning, customer service, information flow, transport and physical distribution. Some of the important business processes, along supply chain, are shown in Figure 1.

The ultimate objective with the implementation of SCM, suppliers and customers are viewed as partners and their relationship becomes a cooperative one as enterprises in the supply chain recognize that coordination among partners within the supply chain is a key factor of success. In order to operate a supply chain efficiently in a cooperative manner, all related functions across the supply chain must operate in an integrated way the various partners within the supply chain must be efficient with respect to service provisions. This balances Constraint Satisfaction Problem (CSP) with appropriate customer service, minimum inventory holding cost and optimal unit cost. In this complex CSP environment, the design and operation of an effective supply chain is of fundamental importance for global manufacturing business.

It is worth noting that purchasing process does not finish when the customer places an order using an existing sales channel. Customer queries, before or after order placement, are inevitable. At the same time, the seller might want to contact customers with purchase confirmation and shipping information. Customer service encompasses all points of contact between the seller and the customer and is an important output of SCM. It results from the accumulated value of all business processes along the supply chain. These business processes are responsible for offering an acceptable level of customer service. Moreover, these business processes are also interdependent, if one business function fails to provide the expected level of customer service the chain is disrupted, and the scheduled workload in other areas is destabilized thereby jeopardizing customer satisfaction (Pal, 2018) (Pal, 2019).

To provide better quality of customer service at no additional cost or workload, all business processes along the supply chain must be balanced. This requires trade-offs throughout the supply chain. It is essential to think in terms of a single interconnected chain rather than narrow functional business processes when considering effective trade-offs. Seamless integration along the supply chain is challenged when there is a conflict between a company's functional behaviours and objectives, as is often the case. For example, suppliers typically want manufacturers to purchasing in bulk quantities, in stable volumes, and with flexible delivery dates. However, although most manufacturers desire long production shifts, they