Use of Artificial Intelligence in Supply Chain Management Practices and 3PL Selection

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ABSTRACT

This study is focused on discuss the application of Artificial Intelligence (AI) techniques in the general case of SCM practices, on the one hand, and in the particular case of the 3PL selection process, on the other hand.
Concerning the SCM, the main purpose is to identify how current knowledge in AI could contribute to and be used effectively in SCM, especially in the conduction of its more dynamic managerial practices. In the case of 3PL selection process, the objective is to identify the proposed AI techniques used, taking into account the business sector of the company, and the logistics services that the company plans to outsource.

Keywords: Artificial Intelligence, Supply Chain Management, Third-Party Logistics, Performance evaluation.

1. INTRODUCTION

The concept of Supply Chain Management (SCM) aims to manage efficiently the physical, financial and informational flows exchanged between all the actors of a supply chain (suppliers, subcontractors, wholesalers, retailers, customers, etc.), for an intra/inter-organizational coordination. Nowadays, this concept is a strategic challenge for any company seeking to achieve its objectives in terms of economic competitiveness, delivery, and quality of service; especially in an economic environment characterized by the globalization of trade, the complexity of trade flows, the increased competition, and the sustainable development requirements.

In this complex and uncertain environment, characterized by the massive data exchanges, the use of information technologies and systems to interact with all supply chain partners is crucial. Among these systems, there are Electronic Data Interchange (EDI), Enterprise Resource Planning (ERP), Radio Frequency Identification (RFID), and Artificial Intelligence (AI).

Figure 1 below gives an overview of a global supply chain of a given company, as well as products flows and information flows exchanged between its various partners: its suppliers and their suppliers, its customers and their customers, and also the 3PL.

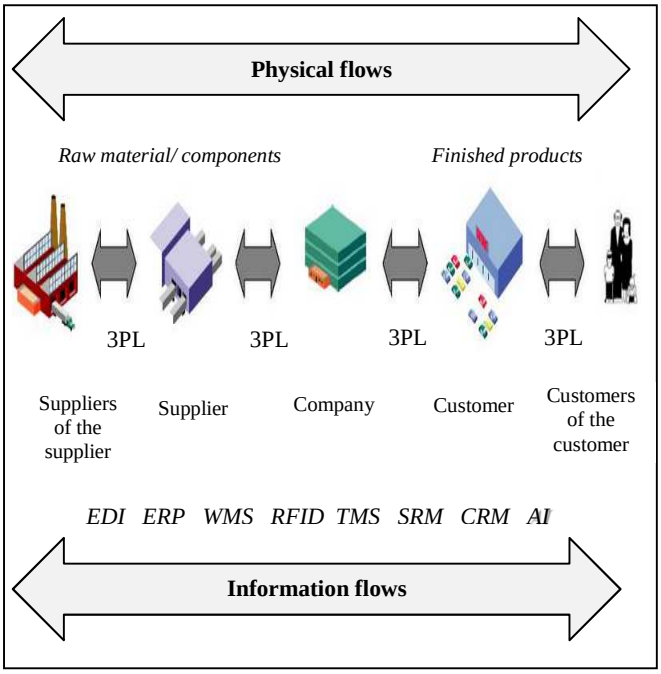

Figure 1. Global Supply Chain

As shown in this figure, others information systems such as WMS (Warehouse Management System), TMS (Transportation Management System), SRM (Supplier Relationship Management), and CRM (Customer Relationship Management) are used in a SCM.

The methods derived from AI are such as Expert Systems (ES), Case-Based Reasoning (CBR), Rule-Based Reasoning (RBR), Artificial Neural Networks (ANN), inference method, etc.

Therefore, this study is focused mainly on discuss the application of AI techniques in the general case of SCM practices, on the one hand, and in the particular case of the 3PL selection process, on the other hand.

Thus, our paper is organized as follows. The next section presents the main applications of AI in the SCM. In the section 3, we present the some studies that propose the use of AI

methods in the case of 3PL selection. Last section concludes the study and summarizes its findings.

2. APPLICATION OF AI IN SCM

Supply chains daily generate a high volume of data (structured and unstructured) in companies, which are often underutilized. Nowadays AI allows more effective exploitation and use of such data [1].

Considering that usually the AI technology applied to SCM consists of Sensing, Processing and Learning components, it is possible to highlight some key points regarding the use of AI in SCM:

- Traditional ERP systems are still restricted in the scope of transactional management;
- Systems using AI (such as Big Data Analytics and Machine Learning) allow going beyond transactional management, enabling more extensive, complex and analytical management of supply chains;
- AI permits the optimization and orchestration of supply chains efficiency that cannot be achieved only with transactional systems

.

At the *Strategic and tactical level*, the use of AI in SCM can provide:

- More effective use of optimization tools in tasks such as the planning of the company's business;
- Better configuration of supply chains (defining its main players, its geographic distribution, its main transportation systems, etc.), demand forecasting, and risk analysis, among others.

At *the Operational level*, the use of AI in SCM can provides:

- Optimization and greater dynamicity in the traceability of transport routes (both in the internal scope of the company as in its inbound and outbound material flows;
- Improved quality management of products/processes and inventory management, by using, for example, new methods of object detection/recognition of visual patterns;
- More precise demand management through the continuous use of Machine Learning algorithms;
- Improved monitoring and visibility of the operations carried out in the supply chain, allowing decision making and optimizations much more dynamic;
- Improved shop floor scheduling and control, allowing more dynamic, broad and optimized operations management;
- Improved predictive management of assets, maximizing its use and avoiding interruptions in supply chains due to the shutdown of machines and equipment.

Finally, in terms of SCM practices, AI with its breadth, scalability and general analytical features, can provide immediate improvements to SCM practices that require more complex and/or dynamic execution, such as Milk Run, Transit Point, Cross Docking, Routing, Postponement and Outsourcing.

3. AI USE IN 3PL SELECTION

Outsourcing strategy has become an increasingly important issue pursued by companies seeking for improved efficiency. In the field of logistics, it involves using a key player in the SCM, named Third-Party Logistics (3PL) services providers, to carry out all or part of the logistics activities of a company such as transportation, warehousing, and product returns management (reverse logistics).

The company can then focus on its core business tasks such as research and development, manufacturing, marketing, etc., and thereby improve its responsiveness as well as its performance.

However, to integrate the 3PL in its supply chain, the company must select an efficient set of them, those that must meet its requirements in terms of cost, expertise, innovation, delivery time, quality of service, flexibility, information technologies, etc. The 3PL selection and performance evaluation is a complex process that depends on several quantitative and qualitative criteria, business sector of the company, and outsourced logistics activities.

The figure 2 illustrates the main criteria and their rank.

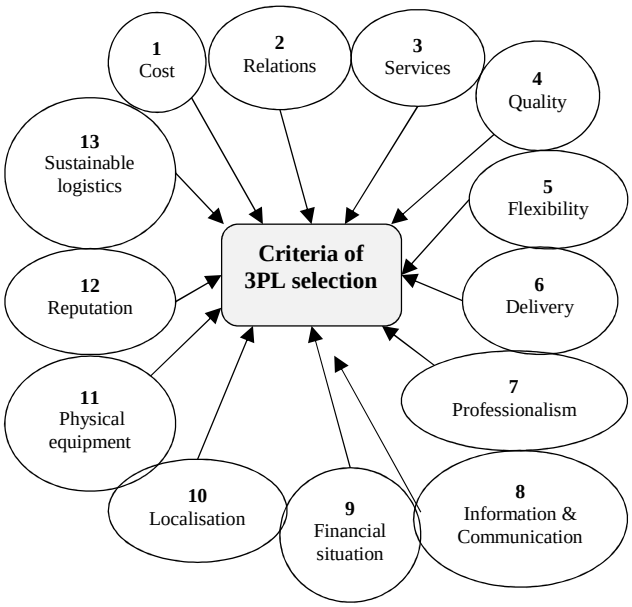

Figure 2. Rank of 3PL selection criteria

The in-depth analysis of the literature on 3PL selection shows that most studies are empirical, and that different methods are proposed to solve this problem [2]. These methods include mathematical programming models, MCDM (Multi-Criteria Decision Making), statistical tools, and artificial intelligence (AI). The latter, namely AI, aims to integrate qualitative factors and human expertise in this selection process.

As discussed in [2], the AI methods applied to the case of 3PL selection process are rare. We cite below some proposed studies:

In [3], the authors proposed the use of CBR/RBR model for 3PL selection by considering six criteria: source allocation

(logistic network, transportation power, storage source, etc.), organization allocation, service quality, financial power, information system, and value-added services.

In [4], a hybrid system combining Data Mining and CBR is proposed to assist 3PL on logistics strategy development in China. 3PL performance is measured according to eight criteria: price, real time information, delivery accuracy, stock status, communication, customer service, reporting, and stock spacing.

An integrated fuzzy AHP-ANN model for selecting 3PL in the context of reverse logistics is proposed in [5]. For such, twelve performance indicators are considered, namely: on time delivery ratio, confirmed fill rate, service quality level, unit operation cost, capacity usage ratio, total order cycle time, system flexibility index, integration level index, increment in market share, research and development ratio, environmental expenditures, and customer satisfaction index.

Finally, a hybrid model integrating CBR and NLP (Non-Linear Programming) techniques is suggested in [6] to select suitable 3PL among 13 transporters and 12 freight forwarders, in the use of the re-configuration of supply chain network in China. The performance criteria considered are related to cost, delivery, quality, services, flexibility, and relationship.

From these few studies, the main AI methods used in 3PL selection problem are CBR and ANN.

4. CONCLUSION

While the use of analytical systems/softwares (such as APO of SAP) in addition to transactional ones has been occurring significantly for more than a decade in many companies, the recent advent of Industry 4.0 has brought a series of new perspectives to the use of AI in the area of SCM and Logistics.

Nowadays AI and Machine Learning technologies have enabled computers to “learn” and emulate actions as if they were human, in a continuous and autonomous learning process based on information received and interactive processes. This enables AI to make increasingly assertive inferences about new situations and scenarios in supply chain management.

AI has also allowed the development of autonomous cars and trucks and also makes available to industrial companies a series of vehicles that are able to move autonomously within the companies (such as Automatic Guided Vehicles - AGV) or even drones that perform logistics operations.

Our future research is to further explore the main AI applications in SCM and in logistics outsourcing (3PL).

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