



Perspectives and relationships in Supply Chain Simulation: A systematic literature review



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ABSTRACT

The main purpose of this article is to develop a meta-analysis about the relationships and potential perspectives of modeling and simulation in supply chains. The research methodology used in this paper was a systematic literature review, exploring the state of the art in Supply Chain Simulation. The methodological procedures were based on a systematic literature review and statistical analysis of a sample of papers. The results indicated that modeling and simulation in supply chains can be better integrated. The models could be more sophisticated to capture the dynamics and behavior of these networks. The combination of optimization methods with agent-based simulation is an observed trend. Hybrid simulations involving normative models and empirical applications can be useful to represent the reality of supply chains, generating alternative solutions that improve supply chain performance. The relevance of this article is to analyze the interfaces related to this field of research, in order to establish a theoretical framework that improves the process of modeling, simulation and decision-making in supply chains.

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1. Introduction

Participation in Supply Chains (SCs) can generate competitive advantages for the various stakeholders that make up a SC network. Based on the contributions of several authors [61,134,89,56,44,92,104,111,47] we define a SC as an aggregate set of value chains linked by inter-organizational relationships, both upstream and downstream of the leader company in order to deal with all the flows involved (cash, material, goods, and information), from the first supplier's supplier to the last customer of the end customer, as well as the reverse flow of products and returnable and/or disposable products, generating value for the end consumer and for SC stakeholders. However, these relationships and the number of role players can increase the complexity of SCs [40,66], signaling the need for decision support tools that can better deal with the dynamics in SC networks.

Considering the complexity, dynamics and interactions that permeate a SC, computational modeling and simulation (M&S) can support managers in the decision-making process [36]. Furthermore, the SC simulation (SCS) can assist decision-makers in the analysis of various scenarios and the selection of appropriate solutions [72,69], and can also be a useful tool for understanding interactions and improving SC performance. Cross-cutting issues in the field of SC combining M&S have been studied by several authors [132,60,105]. Several of these issues were discussed in articles in a literature review (LR) context, however not referring directly to the relationship between simulation, modeling and SCs. The main motivation for

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this research is based on the need to investigate the interfaces and perspectives related to this field of study through a systematic literature review (SLR).

Focusing on the literature reviews conducted by other authors, Santa-Eulalia et al. [149] reported advances in methodological frameworks; however, these frameworks are associated with modeling and agent-based simulation (M&ABS), therefore excluding the broader aspects of Supply Chain Management (SCM). Barbati et al. [14] followed the same line of research, however, focusing on the application of M&ABS in optimization problems. Mustafee et al. [122] conducted a LR about M&S covering the period between 2000 and 2011, but they did not discuss M&S in the context of SCs. Manuj et al. [105] developed a detailed LR addressing discrete events modeling, by providing a systematic process of 8 phases for M&S in SCs and logistics operations. Bellamy and Basole [16] discussed the SCM theme, but with no substantial insights on SCS. Furthermore, it was observed that there is a paucity of articles that discuss the state of the art in SCS.

A key motivation for this research is to identify developments and advancements that can contribute to improving the field of SCS. Key research questions to be investigated in this paper include: What are the main decision support tools applied in SCS? What is the nature of simulation models that are developed to represent SC issues? In addition, this paper seeks to explore perspectives in order to support the theoretical development of the SCS field, creating a historical timeline of the progress made by other researchers. The study may signal certain SC relations and point out possible directions in the M&S in SCs for management purposes. Therefore, this research covers aspects not discussed in other LR papers, such as the methodological classification of simulation models. Furthermore, this paper explores the scientific developments reported in other articles found in SCS literature. It is concluded that the main objective of this paper is to investigate potential perspectives and to identify patterns established in the literature about SCS.

2. Research methodology: a systematic literature review

There are several concepts to define in the field of M&S. Generally, M&S is a field with its own body of knowledge, theories and methodological research, which focuses on the development of models to closely reproduce real-world behavior. For that reason, M&S is a set of tools, techniques, methods, concepts and procedures involved in modeling, computer simulation, visualization and the analysis of a system/event, in order to understand, interpret, improve or test the performance of models, especially those built from real-world systems or applications [84,140]. In this sense, M&S can be used in training, understanding, educating, learning, entertaining, problem solving, and decision support simulations such as a "what-if" analysis, to name but a few applications [156]. One of the most popular applications for M&S is to support the decision-making process. In the strictest sense, M&S offers a set of decision support tools to facilitate the selection of the best alternative solutions to a particular problem, usually modeled from a real-world system, in this case SCs. The methodological framework built for this research paper consider the broadest scope of M&S, as mentioned earlier, and include the analysis of the implementation of simulation models in the reviewed articles.

A LR is an important method for researchers to explore various fields of study [135,152,67]. Articles [e.g. 15,107,125,8] make use of a more descriptive form of LR, not following a systematic approach. The LR method enables the researcher to develop its exploratory research without conforming to rigorous methodological standards. Another method that can be used in exploratory research is the SLR method. According to Cook et al. [43], SLR can support the development of guidelines, as it encompasses the search, selection, critical evaluation and synthesis of primary research results. In order to give a pattern to the SLR, Wong et al. [180] and Kamal and Irani [83] developed frameworks containing the main steps to avoid the likelihood of bias and possible distortions in the research and analysis of data.

Tachizawa et al., for instance [158], apply the contributions of Tranfield et al. [166] and Denyer and Tranfield [49] as a basis method to perform a SLR. One of the strengths of a SLR is its systematic methodology, therefore providing the required criticism in the performance of all research steps. For the purposes of this study, SLR procedures were based on Tranfield et al. [166] and Denyer and Tranfield [49], who developed well-defined stages for the method. Therefore, in order to assess perspectives between M&S and SC, this paper applied the SLR method, which was used in four phases: planning, searching/screening, analysis/synthesis and the presentation of findings. These stages summarize the basic research methodology that was followed for this paper.

2.1. Planning

The first phase was to form a research panel to investigate the SCS subject. The review panel consisted of researchers (advisory group), 3 experts in the SCS domain, one SLR specialist, and 2 graduate students; all members had academic knowledge and practical expertise in this domain. The authors of this paper participated actively in the development of this research. An exploratory search on the theme of research was done in the SCOPUS and Web of Science (WOS) online research bases using title keywords such as "Supply Chain" and "Simulation". Another search using the words "Supply Chain", "Simulation", "Literature Review", "State of the art" and "Overview" was performed to assess the evolution of the related subjects based on literature reviews. Therefore, Boolean Logic (And/Or/ Not) was used as part of the search process. From the initial analysis of papers in the literature, knowledge and experience of experts and discussions about aspects related to the research topic, the researchers identified gaps in the literature and relationships that could better integrate M&S processes and SC aspects. Table 1 depicts the key issues that were addressed in the LR on SCS. Only selected papers that discussed SCS issues are shown in the following table.

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