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Editorial

Special issue: Data-driven decision making in supply chains

1. Introduction

Since regionalization of global economy is becoming a tendency, supply chains must currently face the competitive challenge of integrating global value-added networks with more local content. Actually, industrial policy is currently being used to provoque friction to global flows and "*indigenize*" production (Kearney, 2018), which represents a great challenge when it comes to improving supply chain fluidity (Cedillo-Campos, Lizarraga-Lizarraga, & Martner-Peyrelongue, 2017). Furthermore, with the growth of international trade, port operations have steadily grown in importance worldwide. However, expansion and sustainable growth demand modern, higher-capacity infrastructure, and environmental awareness (Schulte, González-Ramírez, Ascencio, & Voß, 2016). For this reason, several contributions in the literature are focused on proposals that can foster more sustainable operations based on collaborative schemes (Gonzalez-Feliu, Semet, & Routhier, 2014; Schulte, Lalla-Ruíz, González-Ramírez, & Voβ, 2017). On the other hand, and considering the increasing number of elements related to global uncertainty such as political risk, but also the feasibility to produce some amounts in a cost-effective way, as well as the fact that customers now tend to prefer local products, industries, and cultures, we are now facing a new stage in which companies require more and better data to make supply chain decisions. There is a need for analytical methods that would be able to process great amount of data and generate support systems for decision making in different organizations (Maldonado, González-Ramírez, Quijada, & Ramírez-Nafarrate, 2019).

Improving decision making in supply chains is a key element to competitiveness that requires the best data and analysis, especially in emerging countries (Cedillo-Campos, Morones-Ruelas, Lizarraga-Lizarraga, Gonzalez-Feliu, & Garza-Reyes, 2017; Fransoo, Blanco, & Mejia-Argueta, 2017). For example, in the emerging regions there are important barriers as well as opportunities to achieve world-class efficiencies. Also, there are risks due to factors like market and financial volatility, dynamic socioeconomic features, security issues, infrastructural challenges, uncertainty caused by delays and disruptions in distinct points of the supply chains (e.g., international borders, congested areas) which affect the supply chain dynamics (Cedillo-Campos, Sanchez, Vadali, Villa, & Menezes, 2014). But on the other hand, companies could benefit of advantages as qualified human resources at a lower labor cost, increasing local demand for their products, tax incentives, development of infrastructures and resources for specific purposes, among others. In any case, global companies are constraint to adapt their original business model to be more resilient and flexible to local conditions, and at the same time, enrich their competitive advantages from tailored strategies, customized products and value-added services based on local environment.

Decision making in supply chains is a critical support of organizational competitive advantage. It helps coordinating technical, commercial, logistics, and relational capabilities internally and externally with other stakeholders. However, the transfer of flows among diverse stakeholders throughout supply chains and with their environment, forces decision makers to find reliable data to improve their operations. Hence, any organization must count with updated and good-quality data to adapt to changes in the business environment, and improve their capabilities to react more swiftly to requirements imposed by global-local circumstances. The importance of data-collection techniques and methods when making supply chain decisions is recognized not only as a strong determinant of competitive advantage for companies, but also a relevant enabler to boost regional business development and more sustainable operations (Savy, 2016).

Therefore, methods to understand, analyze reliable data, and improve supply chain decisions based on these data, are key elements to transform strategic planning into concrete competitive actions across different supply chain echelons. Currently, means and procedures used by academics and practitioners to identify and collect the right data and methods to analyze them remain largely neither mapped nor discussed. In fact, even if some articles using a large variety of methods to gather and study data related to decision-making in supply chains were published in the past decade, the main stimulating discussion focus was usually on the results. Consequently, most of them set aside the fundamental debate on why the method used was the most suitable option for the particular case study or the data set under analysis. Consequently, this Special Issue aims to close the existent gap by selecting significant contributions that use a data-driven supply chain approach to address specific decision making problems.

2. Overview of selected papers

Seventeen papers were selected based on their technical quality, originality, and connection with the Call for Papers. The papers were divided into six categories: (i) Transportation systems; (ii) Inventory management; (iii) Multi-criteria decision making; (iv) Risk management; (v) Sustainability, 4.0 industry, and resilience; (vi) Facilities planning and design, packing, and warehousing.

First-of-all, three papers in the transportation systems category present innovative methodological approaches to solve one of the key issues in supply chain decision making. Second, in the inventory management category, four papers were selected for their balanced contribution to better understand why certain methodological approaches are suitable/limited for a specific supply chain decision-making contexts. Third, in the multi-criteria decision making approach two papers propose integrated methods, allowing readers to understand their empirical application by considering their methodological

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strength and limitations. Fourth, two other papers in the risk management category were selected for their approaches used when collecting and analyzing data. Fifth, in the sustainability, 4.0 industry and resilience category, three papers were selected. A first paper was selected for its interesting contribution when exploiting the machine learning techniques to efficiently approximate the optimal management decisions considering a set of uncertainty parameters that continuously influence the process behavior as an input. A second paper on 4.0 industry exposes a model for assessing productivity and technical efficiency of the Chilean manufacturing sector. Finally, one interesting paper from a resilience perspective covers a need by developing a resilient integrated production and procurement model considering sustainability and uncertainty in production, supplier, and carrier capacities. Sixth, in the facilities planning and design, packing and warehousing category, three papers were selected. Thus, based on a facility location point of view, a stimulating paper uses the data-driven approach coupled with optimization to address block layout in grocery stores. A second paper addresses the packing issue based on a mathematical model optimized by Genetic Algorithms, and harmonized with the Russian theory of problem solving and invention (TRIZ) to design an export packing of Persian Lime. Finally, from a warehousing perspective, a paper was selected for its significant contribution to improve responsiveness based on a job priority management perspective.

Thus, under the first category, transportation systems, the first paper proposed by Qiao, Pan and Ballot investigates a less-than-truckload (LTL) request pricing and selection problem taking forecasting and uncertainty of transport requests at the selected destination into consideration. This paper makes an interesting contribution to the development of a revenue optimization model for LTL carriers, from a Physical Internet perspective. At the same time, it contributes to the development and application of appropriate data-driven methods for analyzing variations under uncertain scenarios of transportation market, focusing on data-driven dynamic pricing and revenue optimization decision making for carriers. The second paper proposed by Muñuzuri, Onieva, Cortés and Guadix, exposes an IoT system designed to optimize, manage and monitor container transport operations along an intermodal corridor, combining rail scheduling and inland vessel navigation. As the authors proved, this paper identifies stimulating lessons regarding conventional tracking and tracing systems. At the same time, based on the proposed system, it provides directions of future research to foster smarter and digital supply chains. The third paper in this category is proposed by Caballero-Morales and Martinez-Flores, and exposes the critical importance of transportation services between offshore oil platforms and land facilities as part of emergency logistics. It is in fact a helicopter routing model with non-deterministic failure rate for the evacuation of multiple oil platforms in Mexico. This paper contributes to the discussion about what quantitative/qualitative methodological approaches should be used when collecting and analyzing data from real-life environments. Their contribution allows to better understand why certain methodological approaches are suitable/limited for a specific supply chain decision-making contexts. The model integrates a non-deterministic failure rate as function of the helicopters cumulative traveled distance/time, and at the same time, due to the complexity of the transportation task, it uses a Bayesian approach to generate instances for accurate testing, as well as an evolutionary metaheuristic to provide suitable solutions for large instances. Since in logistics reliability is one of the key competitiveness factors, this contribution can be extended to other logistic areas where reliable route planning is required in the presence of failure risks associated to the vehicles used for the transportation chain.

As part of the second category, inventory management, the first paper proposed by Cárdenas-Barrón, Shaikh, and Treviño-Garza deals with an economic order quantity (EOQ) inventory model under both nonlinear stock dependent on demand and nonlinear holding cost. Authors develop an inventory model from a retailer's perspective, where the supplier offers a trade credit period to the retailer. Authors argue that today and more than ever, due to a growing intensity of inter-organizational flows (physical, informational, and financial), and diversity of markets, supply chain management is facing issues such as inventory management, trade credit and customer satisfaction. Thus, they deliver two models to determine the optimal ordering quantity and the ending inventory level, which maximizes the retailer's total profit per unit time. Thus, authors argue their methodological contribution is suitable for a specific supply chain decision-making contexts where nonlinear stock holding cost, non-linear demand and trade credit are involved. The second paper in this category is delivered by Tiwari, Cárdenas-Barrón, Shaikh, and Goh under the title of: "*Retailer's optimal ordering policy for deteriorating items under order-size dependent trade credit and complete backlogging*". Authors address the significant issue related to the fact that retail inventory management literature usually accepts that suppliers look for stimulating demand by proposing to retailers a delay in payments, but in practice, suppliers are more likely to suggest to retailers a partial delay in payments. Therefore, authors deliver theoretical results when determining the optimal replenishment time and the length of time for the stock to draw down completely. Thus, based on these time values, the retailer's optimal ordering quantity and backlogging policies are calculated for reducing the total inventory cost per unit of time. The third paper on this category was developed by Mehdizadeh who uses the case of auto spare parts in Iran. He argues that a lack of data reliability not only affects the real levels of demand numbers but also, consequently, the demand forecasting and ordering supply chain decisions. One of the advantages of the proposed methodological approach is its capability to capture the dynamic behavior (influenced by the mileage of the cars in the planning horizon) of the retailer when placing orders to the distributor. This interesting data-driven approach leaves open the analysis faced by decision makers when deciding to invest in sensors or/and self-learning algorithms and advanced hybrid data-optimization approaches for getting more reliable information in real-time as well as better tools to support decision making process. Finally, in this category, Goodarzi and Saen present an interesting contribution, which engages the always theoretically interesting and practically important discussion on how to reduce the bullwhip effect (BWE) from a network perspective. As authors argue, usually BWE is analyzed based on the standard perspective of series or parallel supply chains structures. For this, authors propose the use of network data envelopment analysis (NDEA) to provide a network worst-practice frontier of slacks-based measure (SBM) model in presence of undesirable factors for measuring the relative BWE of non-serial supply chain networks (SCNs). As a result, based on a pharmaceutical industry case study, it is possible to identify the worst non-serial SCNs and their worst members in terms of BWE. Thus, supply chain decision makers can recognize inefficient partners, and then, improve operations. Authors allow to focus on another suitable aspect when looking for fostering smarter and digital supply chains.

Under the third category, multi-criteria decision-making, DeCastro-Vivas, OSanńAnna, Esquerre, and Freires, based on a Brazilian oil and gas company, propose a method combining analytical and mathematical models for evaluating and optimizing sustainable supply chains. Thus, authors use the analytical hierarchy process (AHP) and preference ranking organization method for enrichment evaluations (PROMETHEE). At the same time, a preemptive goal programming is used. Thus, this paper provides a stimulating approach to evaluate supply chain sustainability by allowing decision-makers the use of key performance indicators. On the other hand, Cheng, Peng, Gu, Liu, Yang, Zhou, and Huang present a supplier evaluation model based on a support vector regression. As authors argue, expert experience is one of the most important bases when evaluating supplier performance in global supply chains. To improve this process, authors use a data-driven support vector regression (SVR) combined with a genetic programming (GP). A contribution that allows a better understanding about how novel methodological approaches or combination of them are suitable for a specific complex supply chain decision making contexts.

In the fourth category, risk management, Kara, Oktay-Firat, and Ghadge deliver a paper in which authors address the identification, assessment, and mitigation of different type of risks in supply chains based on a data mining-based framework. For this, looking for a holistic approach, authors used a case study to test their data driven contribution. Thus, for the framework validity, a case study based on a series of semi-structured interviews, discussions, and a focus group is used. Since the model was tested using a single case company, the applicability, lessons, and limitations of the framework are difficult to generalize. However, this paper provides a significant contribution to foster smart supply chains running operations under complex context. The second paper on this matter is delivered by Qazi, Akhtar, and Wieland. The authors introduce an innovative risk management process analysis, namely risk matrix driven supply chain risk management (RMSCRM). For this, they adapt risk matrix based tools for modeling interdependent risks and risk appetite. Thus, instead of modeling and managing supply chain risks from a separated approach, authors propose the idea of modeling and managing a network of risks. It appears as a way to be useful for practitioners by looking for an improved real-life use for data-driven decision making in supply chains.

Under the fifth category, sustainability, 4.0 industry and resilience, Medina-González, Shokry, Silvente, Lupera, and Espuña provide a paper in which they address the optimal management of a multi-objective bio-based energy supply chain network exposed to multiple sources of uncertainty. Indeed, complexity to achieve an optimal result using typical uncertainty management methods dramatically increases with the number of uncertainty factors measured. The results show a data-driven model that predicts the optimal decisions with important accuracy, time efficiency, and flexibility to simultaneously handle several uncertainty sources disregarding their distributions. From a 4.0 industry, De la Fuente-Mella, Rojas-Fuentes, and Leiva deliver an econometric model for assessing productivity and technical efficiency of the Chilean manufacturing sector. The results shown by the authors proved that for both the standard model and the proposed factorial model, the economic theory is validated in terms of the importance of the inputs that form the manufacturing outputs. Under that context, authors identify stimulating lessons and recommendations to foster smarter and digital supply chains. Finally, in this category, Kaur, Singh, Garza-Reyes, Mishra present a paper that from a resilience perspective, offers an independent and integrated production and procurement model considering sustainability and uncertainty for resilient supply chains. In fact, authors proved that data driven integrated production and procurement model is more efficient than traditional (independent) models in terms of profit generation and resource management. This represents an interesting contribution when considering specific methods and their empirical application to real-life resilience challenges.

In the sixth category, facilities planning and design, packing and warehousing category, Ozgormus and Smith expose a paper based on a data-driven approach coupled with optimization techniques to address the block layout problem in grocery stores. It was based on a case study in which participates Migros, the largest retailer in Turkey. The research is focused on end-user portion of supply chain purchases in supermarkets. The methodology employed was a Tabu Search metaheuristic and the results were validated by simulation. The authors also used data mining to infer the correlations among products bought and to estimate their propensity for impulse purchases. The proposed methodology can be combined with emerging technologies like sensors on where the carts go through the store as the customer shops for data gathering. An interesting contribution that is susceptible to integrate in the future to the approach proposed by the authors is the use of emerging approaches such as social network methods, and self-learning algorithms. The second paper, delivered by Aguilar-Lasserre, Torres-Sánchez, Fernández-Lambert, Azzaro-Pantel, Cortes-Robles, and Román del Valle, addresses the design of an export packing of a fresh fruit problem based on the case of the Persian lime. The authors propose a methodology based on a multi-objective mathematical model (with functional elements of non-spatial type) that is solved by a genetic algorithm. The proposed approach is harmonized with the Russian theory of problem solving and invention (TRIZ). They aim to optimize the spaces of the packing, maximize the resistance to vertical compression, and minimize the amount of material used. As a strength of their proposal, we can highlight the replicability of their proposed framework to design the packing of any other export product, either another fresh-produce or even other type of products. They are also considering the airflow and friction of the product inside the packing. Another important element is that the proposed design takes into consideration the regulations of three international markets for the design of the packing. As a limitation of the study, we can mention that the authors are considering only paperboard in the design and have not considered any compostable and/or biodegradable materials. This is proposed as a further research avenue. The proposed methodology can be suitable for analyzing variations in terms of the regulations of the international markets that may require other conditions for the packing. In terms of supply chain fluidity, the specific decision problem presented by the authors is not related to the flow of products along the supply chain and the interconnection to other echelons, as it is dealing with a packing design problem. In terms of challenges faced by decision makers in front of emerging technologies in data gathering, the decision problem is related to packing design, so it is not so related to data gathering or decision-making along a supply chain. But it could be more related to the introduction of new materials and new packing and transportation alternatives for fresh products. Finally, Kim presents a stimulating paper for improving warehouse responsiveness. The author proposes to schedule jobs more efficiently to meet compressed response times. Thus, this paper provides a data-driven decision-making methodology to achieve a right implementation when practitioners decide to implement it. The author proposes a stochastic simulation model to address the uncertainty of the task requests in a warehouse. It also contributes to the fluidity of the supply chain by assisting decision makers in the job scheduling process and reducing the response times by prioritizing each job. The performance of each scheduling rule is evaluated in terms of a joint cost criterion that integrates the objectives of low earliness, low tardiness, low labor idleness, and low work-in-process stocks. This is an interesting contribution when looking for improving supply chain fluidity based on data. Thanks to this paper, readers would identify stimulating lessons and directions of future research to foster smarter and digital supply chains.

Even though the use of technologies is an increasing part of data-driven decision making in supply chains, the effective implementation of decisions in the organizations is still greatly linked to the skills of human resources. In fact, decision makers as well as researchers are facing a growing complexity related to the introduction of emerging technologies providing a great amount of data. It is under this context that it is critical to know what quantitative/qualitative methodological approaches are the best when collecting and analyzing data, as well as why a defined methodological approach is suitable/limited for the specific supply chain decision making context. The two are critical competences when looking for smarter and digital supply chains. As the challenge derived from the supply chain complexity is at the same time an opportunity to create new theoretical paradigms and technologies, this Special Issue attempts to be a bibliographic reference because of the different approaches, methodologies, technologies, and cases it exposes. This Special Issue pretends to motivate the development of tailor-made theoretical contributions that increase the body of knowledge about Data-driven Decision Making in Supply Chains, and practical solutions that contribute to create new technologies and practices.

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