Kanan Telman FADANI
PhD student of Azerbaijan State Oil and Industry University
Email: kenan.fedani@gmail.com

A COMPREHENSİVE REVİEW OF SUPPLY CHAİN OPTİMİZATİON

Abstract

In the ever-evolving and intricate market landscape, it is imperative for enterprises to engage in continuous optimization of their supply chain. This elaborate process encompasses many business operations, ranging from the procurement of raw materials to the final delivery of the product to the end consumer. Within a societal framework characterized by pervasive digitalization, the integration of cutting-edge technologies in supply chain optimization has transitioned from being merely advantageous to an absolute necessity. The present research delves deeply into the realm of supply chain optimization, meticulously examining the amalgamation of novel technological advancements and conventional methodologies in this domain. Among the novel technologies in this research, particular emphasis was placed on artificial intelligence, a field that has garnered significant interest from both academic and industrial sectors due to its rapid exponential advancement and great potential.

Keywords: Supply Chain, Management, Optimization, AI, Methods

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Introduction

There are numerous definitions of supply chain management (SCM) available in modern science. To meet customer demands and boost the supply chain's (SC) overall competitiveness, for instance, supply chain management is the process of uniting organizational units along the chain and arranging the flow of materials, information, and money. (Dias and Ierapetritou 2017) The management of a network of relationships both within and between interdependent organizations and business units, including material suppliers, purchasing, production facilities, logistics, marketing, and related systems, is what Stock and Boyer (2009) define as supply chain management. Its goals are to add value, maximize profitability through efficiencies, and achieve customer satisfaction by facilitating the forward and reverse flow of materials, services, finances, and information from the original producer to the final customer. To put it simply, supply chain management is a complicated process that requires coordinating several different operations, from locating raw materials to shipping finished goods to clients. (Mukhamedjanova, 2020)

Based on the above definitions, we can divide the supply chain into 2 types, simple and extended, according to their complexity. These two types of supply chain are reflected in Fig. 1.

As illustrated in Figure 1, the growth and complexity of the supply chain operations call for the involvement of various specialized professionals and companies to ensure efficiency and effectiveness in the overall supply chain management process. These service providers encompass a wide array of sectors including but not limited to logistics, market research, finance, and information technology.

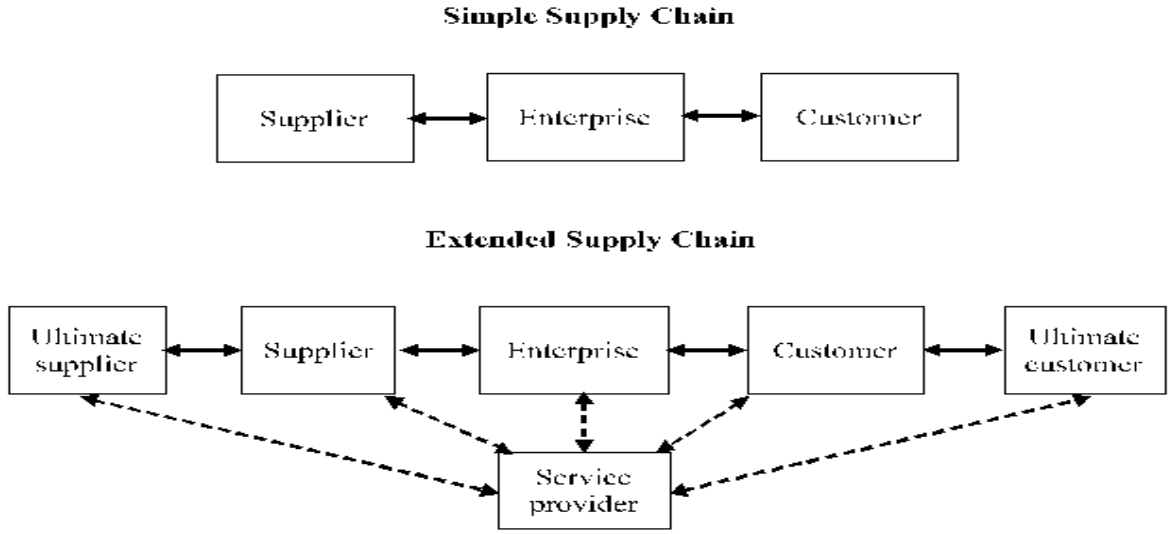
The discipline of supply chain management is frequently associated with four prominent scientific theories: firstly, the theory of transaction costs delves into the intricate arrangements of businesses through the utilization of multilateral contracts, shedding light on the organizational structures and their impact on operational efficiency; secondly, game theory delves into the complex realm of economic decision-making among various entities, such as

suppliers and consumers, aiming to optimize outcomes and understand the strategic interactions between different stakeholders; thirdly, the theories of interorganizational relations and industrial networks explore the dynamics of relationships between organizations and the networks they form, providing insights into collaboration, competition, and value creation within the industry; and lastly, systems theory, which gained rapid traction among management scholars, offers a comprehensive framework to elucidate the intricacies of business operations, individual and organizational behavior, as well as the broader economic landscape, facilitating a holistic understanding of the interconnectedness and interdependencies within the business ecosystem (Mukhamedjanova, 2020).

Supply Chain Optimization

Figure 1

Simple and Extended Supply chain



Source: Created by the author based on Hugos, 2024

In the contemporary business landscape, a multitude of factors have emerged that have significantly impacted supply chain management. These factors include, but are not limited to, the phenomenon of globalization, the continual expansion and intricate nature of supply chains, as well as the rising tide of customer demands both in terms of quantity and complexity. As a result of these intricate dynamics, the concept of optimality within the realm of supply chain management has garnered heightened significance and attention. It is evident that in the present era, the optimization of supply chains plays a pivotal and indispensable role in the overarching network of supply chain operations. This crucial role extends across various domains within the supply chain framework, encompassing critical areas such as supply chain management strategies and the intricate process of supply chain design (SCD).

But what is supply chain optimization (SCO)? There are various definitions to this phenomenon in the literature. (Table 1)

Table 1

Definitions of SCO

When processing client orders across a network of businesses, SCO refers to the most effective use of resources while adhering to restrictions on resource flow and consumption.	Hassini, 2008
Each member of the global network may optimize their own strategic capability thanks to SCO, which is a key component of strategic resource mobility along the value-added chain.	Yoo et al., 2010
The process of pooling resources within a supply chain to remove obstacles and bottlenecks that impede progress and make the chain function more swiftly, smoothly, and efficiently is known as supply chain optimization.	Khayyat, 2015
SCO is the process of streamlining an organization's R&D, procurement of materials, manufacturing, and distribution activities to cut expenses and inventory.	Garcia and You, 2015

Source: created by the author based on Baloch and Rashid, 2022

Optimization Techniques

Finding an optimal or nearly optimal solution with the least amount of computational work is the aim of optimization techniques. The amount of time and space used during an optimization process can be used to gauge its effort. Consideration must be given to the significant relationship that exists between effort and quality.

The majority of accurate optimization methods were developed up to the 1970s. After that year, things started to shift since researchers realized there were a lot of issues that exact approaches were not able to handle. Many analysts have since developed techniques to address those problems. According to a study (Sawik 2020), there are two types of optimization systems that may be distinguished, including approaches that are exact and approximate for single- and multi-criteria optimization.

Exact methods demonstrate efficacy when addressing problems of limited scale. They ensure the identification of an optimal solution, albeit typically requiring a substantial amount of time for resolution. Within the categorization of such methodologies, specific algorithms emerge, including complete enumeration, branch-and-bound strategy and the dynamic programming.

Only a few small-scale issues can be solved using exact methods. Consequently, alternative approaches have emerged, offering expedited computation at the expense of guaranteeing an optimal solution. These methodologies, known as approximate methods, are characterized by their simplicity and ease of implementation. In contrast to exact methods, they enable the resolution of intricate problems while demanding fewer resources. Approximate methods can be categorized into two groups: approximate algorithms and heuristics. (Sawik 2020)

Another research carried out by Oliveira and Machado (2021) mainly classified optimization methods into three groups: stochastic, deterministic and hybrid. (Fig. 2) In Figure 2, a technique was classified as deterministic if its input set was predetermined, leading to a specific output set. The utilization of stochastic techniques involved a random aspect due to the nature of stochastic numbers in the research decisions. And lastly, hybrid approaches combined heuristics with deterministic techniques, whereby potential solutions were created and converted into a set of criteria for minimizing or maximizing locally, iteratively running an algorithm until the completion criteria were met.

Current Developments in SCO

In light of the continuous progression in technological innovations, organizations are increasingly integrating highly sophisticated applications into their business processes, including but not limited to Blockchain, Internet of Things (IoT), and Artificial Intelligence (AI). Of all the cutting-edge technologies being embraced, Artificial Intelligence (AI) stands out as particularly auspicious, capturing the interest and engagement of stakeholders from the realms

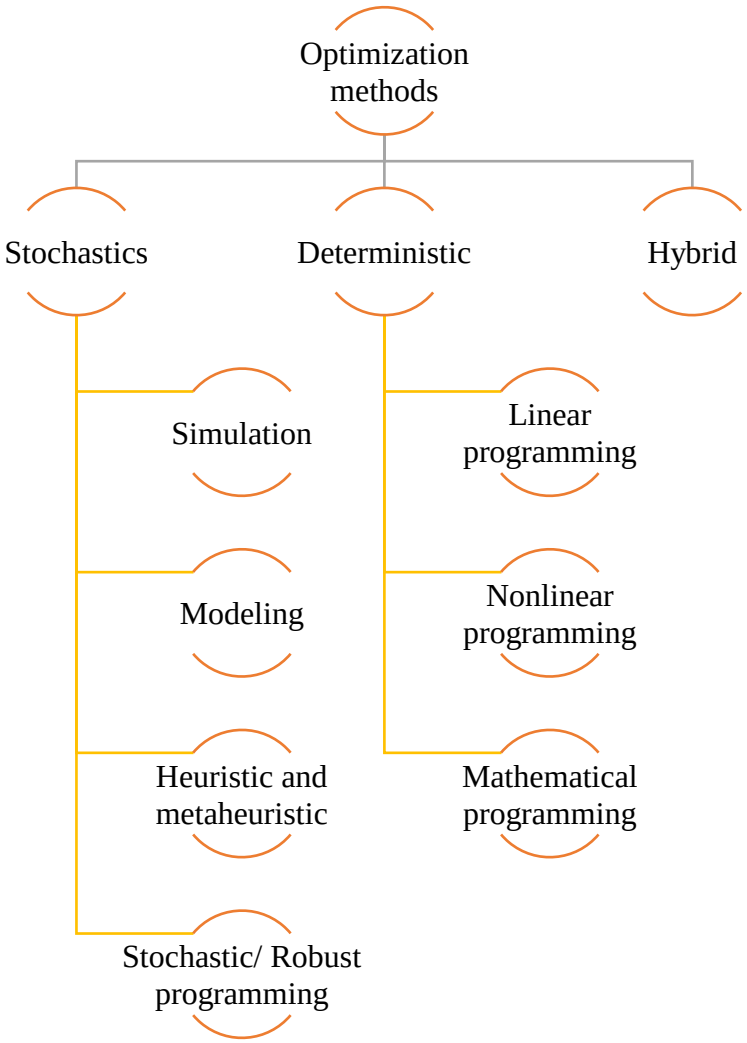
of industry (Awan et al., 2021) as well as academia.

Globalization has resulted in supply chains becoming progressively intricate, where products are frequently acquired from various locations across the globe. (Baldwin and Freeman, 2022) The intricate nature of this situation presents a multitude of obstacles including extended periods for preparation, elevated expenses for moving goods, and heightened probabilities of disturbances stemming from factors such as political unrest or environmental calamities. (Joel et al., 2024)

Artificial Intelligence has a significant and positive impact on supply chain performance (SCP) and adaptive capabilities (AC) (Belhadi et al., 2024). From this, we can infer that AI can help optimize processes and operations, improve efficacy, and enable businesses to implement more advanced technologies by increasing the adaptivity of the company.

Figure 2

Optimization methods



Source: Create by the author based on Oliveira & Machado (2021)

Applications of AI range from Demand Forecasting (Gayam, Yellu and Thuniki, 2021) to Customer Relationship Management (CRM) (Ledro, Nosella and Dalla, 2023), providing

chances to lower expenses through inventory optimization and raising satisfaction among clients.

Conclusion

As a conclusion of this study, we can observe that over time, various businesses have employed diverse optimization strategies to improve the efficiency of their supply chain operations. The advent of contemporary technologies has revolutionized the manner in which businesses tackle the challenges that were previously encountered through the utilization of conventional optimization techniques. Cutting-edge technologies like Blockchain, Internet of Things (IoT), and Artificial Intelligence (AI) have proven to be instrumental in optimizing different facets of the supply chain. Among these technologies, AI stands out as exceptionally promising, particularly considering the substantial lead that industry possesses over academia in the realm of AI adoption. The ever-changing nature of AI, and discrepancy between academia and industry underscores the pressing need for further exploration and research in this dynamic field.

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Kənan Telman oğlu FƏDANİ

Azərbaycan Dövlət Neft və Sənaye Universitetinin doktorantı

Təchizat Zəncirinin Optimallaşdırılmasının Kompleks İcmalı

Xülasə

Daim inkişaf edən və mürəkkəb bazar şəraitində müəssisələrin təchizat zəncirinin davamlı optimallaşdırılması ilə məşğul olması zəruridir. Bu mürəkkəb proses xammalın alınmasından tutmuş məhsulun son istehlakçıya çatdırılmasına qədər bir çox biznes əməliyyatlarını əhatə edir. Geniş rəqəmsallaşma ilə səciyyələnən sosial çərçivədə təchizat zəncirinin optimallaşdırılmasında qabaqcıl texnologiyaların inteqrasiyası sadəcə faydalı olmaqdan çıxıb, mütləq zərurətə çevrilmişdir. Hazırkı tədqiqat təchizat zəncirinin optimallaşdırılmasında yeni texnoloji irəliləyişlərin və ənənəvi metodologiyaların birləşməsini nəzərə alaraq, bu sahəni dərindən araşdırır. Bu araşdırmada yeni texnologiyalar arasında, sürətli eksponensial irəliləyiş və böyük potensialına görə həm akademik, həm də sənaye sektorlarından əhəmiyyətli maraq toplayan süni intellektə xüsusi diqqət yetirilmişdir.

Açar sözlər: Təchizat zənciri , Menecment, Optimizasiya, Suni intellekt, Metodlar

Канан Тельман ФАДАНИ

Аспирант Азербайджанского государственного университета нефти и промышленности

Комплексный обзор оптимизации цепочки поставок

Аннотация

В постоянно меняющемся и сложном рыночном ландшафте предприятиям крайне важно заниматься постоянной оптимизацией своей цепочки поставок. Этот сложный процесс включает в себя множество бизнес-операций, начиная от закупки сырья и заканчивая окончательной доставкой продукта конечному потребителю. В условиях общества, характеризующегося повсеместной цифровизацией, интеграция передовых технологий в оптимизацию цепочек поставок превратилась из простого преимущества в абсолютную необходимость. Настоящее исследование глубоко углубляется в область оптимизации цепочки поставок, тщательно изучая сочетание новых технологических достижений и традиционных методологий в этой области. Среди новых технологий в этом исследовании особое внимание было уделено искусственному интеллекту — области, которая вызвала значительный интерес как в академическом, так и в промышленном секторах благодаря быстрому экспоненциальному развитию и огромному потенциалу.

Ключевые слова: Цепочка поставок, Управление, Оптимизация, Искусственный интеллект, Методы