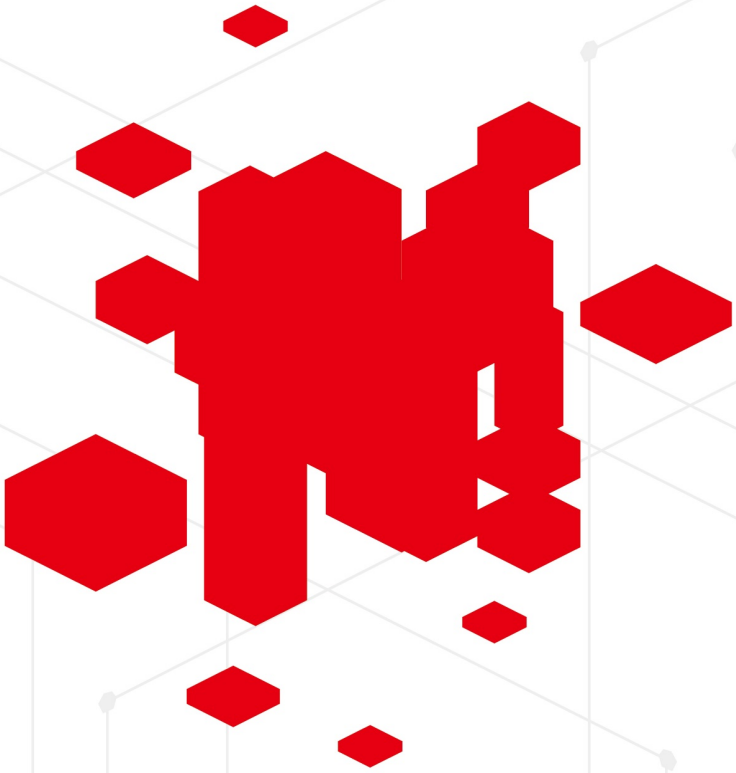
LOGISTICS HORIZONTAL COLLABORATION

AN AGENT-BASED SIMULATION APPROACH TO MODEL COLLABORATION DYNAMICS

物流横向协作体系

一种基于多智能体建模法的

仿真研究



朱杰 著

重庆大学出版社

内容简介

产能利用低、交货周期长、成本高、规模不足是物流和供应链运营之间存在的主要矛盾。企业间进行物流横向合作与协同是当今世界应对物流竞争与挑战的一种创新方法。这种合作协同式物流在实践中迅速发展，然而其对参与伙伴和供应链网络的影响却被低估。本专著基于案例研究并采用与多智能体仿真相结合的方法，研究探索物流横向协作的关键要素、模式与过程，并从微观到宏观层面量化分析企业行为与合作网络对物流系统的影响。研究结果表明，在物流横向协作背景下，各类合作与信息共享在多个维度产生了更好的收益。本专著为实践者和学者提供了关于如何开展供应链项目合作或研究的见解与参考。

图书在版编目（CIP）数据

物流横向协作体系：一种基于多智能体建模法的仿真研究：英文 / 朱杰著. --重庆：重庆大学出版社，2021.10

ISBN 978-7-5689-2893-9

Ⅰ. ①物… Ⅱ. ①朱… Ⅲ. ①物流－系统建模－英文 Ⅳ. ①F253.9

中国版本图书馆CIP数据核字（2021）第147847号

物流横向协作体系：一种基于多智能体建模法的仿真研究

Wuliu Hengxiang Xiezuo Tixi: Yizhong Jiyu Duozhinengti Jianmofa De Fangzhen Yanjiu

朱 杰 著

责任编辑：牟 妮　　版式设计：牟 妮

责任校对：王 倩　　责任印制：赵 晟

*

重庆大学出版社出版发行

出版人：饶帮华

社址：重庆市沙坪坝区大学城西路21号

邮编：401331

电话：（023）88617190　88617185（中小学）

传真：（023）88617186　88617166

网址：http://www.cqup.com.cn

邮箱：fxk@cqup.com.cn（营销中心）

全国新华书店经销

重庆升光电力印务有限公司印刷

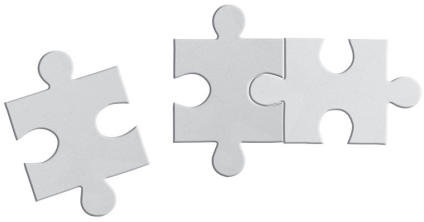
*

开本：720mm × 1020mm　1/16　印张：17.25　字数：440千

2021年10月第1版　2021年10月第1次印刷

ISBN 978-7-5689-2893-9　定价：96.00元

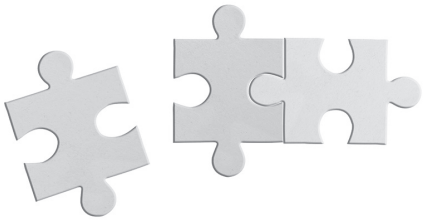
CONTENTS



LIST OF ILLUSTRATIONS

– TABLES –

– FIGURES –



INTRODUCTION TO THE THESIS

Underutilized capacity, long shipping lead time, high costs and lack of sufficient scale are showcases of logistics inefficiencies that have troubled many supply chain operations. Logistics horizontal collaboration (LHC) is believed to be an innovative approach to tackle the increasing logistics challenges. This kind of collaborative logistics is quickly gaining momentum in practice but relevant contributions in literature are scarcely seen. So far it remains unclear how LHC could be structured and operated given the limited understanding of the various characteristics and forms of LHC between companies. Furthermore, the explicit impact of LHC on the participating partners, as well as on the supply chain system is understudied. Very few studies have explored the process of collaboration and how it links to performance behaviours.

Case studies and agent-based simulation are employed in this thesis to study the research gaps identified above. Case studies are initially conducted to examine the key elements which can support the design of LHC, and to make a classification of models for collaboration. These are followed by agent-based simulation to model a typical collaboration process and work out what benefits would emerge if participating in horizontal collaboration and how the collaboration can produce the impacts on the supply chain operations

for individuals and the system as a whole.

The case studies suggest that "collaboration structures" "collaboration objectives" "collaboration intensity", and "collaboration modes" are the four key elements critical to the design of a LHC project. Each element represents an important aspect of the collaboration and exhibits different characteristics and forms. Based on these key elements, several typologies are derived which together provide a comprehensive view to explain the different types of LHC in practice. The simulation modelling demonstrates that LHC can significantly benefit the logistics efficiency in terms of capacity utilization and customer service in the sense of order fill-rate, and such beneficial effects are consistently observed in different supply chain environments. In particular, LHC can produce better logistics performance in a relationship-based supply chain network where downstream customers can support upstream shippers with more stable and predictable demands. On the other hand, information sharing in the collaboration, for the most part, does not facilitate the higher collaboration gains for partners. Specifically, sharing either the demand or supply information in the horizontal collaboration is not helpful in increasing collaboration gains. Hence there is a difference for the value of information sharing in the context of horizontal collaboration as opposed to vertical collaboration, the latter of which is often justified as providing more beneficial gains. The research findings provide insights for practitioners and scholars about how to develop a type of collaboration project or study, as well as enabling a better understanding of the dynamic collaboration effects.

Zhu Jie

June 2021

CHAPTER 1
INTRODUCTION

1.1 Background

Since the 1990s, the rapid development in information technology and the fast pace of globalization have brought a great change to the marketplace and business operations. Under such circumstances, the business operations have become more complicated. The business companies must view their operations from a totally new perspective — to operate from a broader view in terms of time and space. Supply chain management is developed from such a point of view which advocates that companies should act as a network that is based upon the concepts of collaboration and process integration (Sabath, 1998). This is because in today's global environment it is "supply chains that compete rather than companies" (Christopher, 2011).

Among the various supply chain activities, logistics is a key function since it acts as a physical link that connects the companies in the supply chain, enabling the flow of materials and resource (Coyle et al. 2003, Naim et al. 2006), making it a key integral part of the overall supply chain management (Ellram, 1991). In the execution of supply chain management, managing the logistics effectively is vital to enable the smooth running of a supply chain system because the failures in the logistics service would affect the business performance, either directly or indirectly, through sales, costs and quality of service. Thus, in an era of fast changing marketplaces and fierce competitions, mitigating the inefficiencies and risks in logistics can directly benefit the company's business operations and contribute to the achievement of a sustainable competitive advantage.

Entering into the 21st century, world economy growth has slowed down sharply and is battling with severe depression following the global financial crisis starting from 2008. In the meantime the pressure of market competition is increasing significantly at a global scale, particularly for commodities and services. In this situation, more companies are now trying to identify new ways and better ways to decrease operating costs in order to sustain their profitability and healthy development. They have

increasingly realized the importance of effective supply chain management to their global business, and logistics as a key part of this. This in turn has elevated the need to improve key logistics activities such as warehousing, transportation and distribution. These activities are directly associated with the services needed to deliver products to customers, and the associated costs. It is, therefore, now becoming critical that companies start to re-think and re-build their logistics processes for the purpose of cost saving and better delivery performance for customers.

Unfortunately, nowadays a great many companies are being troubled by the logistics inefficiencies, reflected by issues such as an underutilized transportation capacity, a long shipping lead time, a high cost and a lack of sufficient scale (Cruijssen et al. 2010, Palmer et al. 2012). In today's marketplace, companies often consider two logistics strategies for operating their supply chains (Abdur Razzaque and Chen Sheng, 1998).

(1) Outsourcing logistics — the dominant approach adopted by many industries and firms who want to concentrate on their core competency (Africk and Markeset, 1996, Foster, 1994) .

(2) Self-building (in-house) logistics — adopted by traditional vertical integration companies, or companies that increasingly believe they can build the logistics as a core competency (e.g. Amazon, JD.com)

There are intrinsic disadvantages in following either of these models, however. The first model (outsourcing) often results in a high cost with poor stability, predictability and flexibility in logistics service operations due to the shipper's lack of direct control over logistics. The shipper's logistics performance is greatly affected by, and subject to, the capability of the outsourced logistics service providers (LSPs), and this represents a significant risk to the shipper's ability to fulfil customer demand. The second model (self-building) requires a huge initial investment and entails significant challenges regarding how to plan a better demand supply matching between the logistics capacity being first positioned in the market and the actual demand volume that can be attracted to fill this capacity. If large, sufficient, stable and structural freight flow cannot be maintained, significant operating costs must be borne without creating any value which negatively affects the overall business performance. In addition,

most companies sell a great variety of products with countless configurations, the demand for which is extremely difficult, or impossible, to anticipate reliably, thereby creating a great risk that the pre-positioned capacity will be either under-utilized or over-stretched.

Operational inefficiencies seem to be a common problem in either the outsourcing or self-building logistics. One of the biggest root causes can be attributed to the fragmentation in both the demand and supply resources (Cruijssen et al. 2010). Most companies nowadays (shippers or logistics service providers) are highly dependent upon their own logistics networks and capacity if they are to fulfil the demand from their customers (Palmer et al. 2012). Due to the reactive and asset heavy nature of logistics and transport businesses, operations efficiency is vulnerable to the fast changing demand if the capacity utilization is completely planned for and subject to the company's own demand sources. Frequent capacity underutilization, on the one hand, or shortages, on the other, can become a critical issue when the demand is not stable, structural and predictable (Zhu et al. 2014). The unpredictability and structural inefficiencies have been a long-standing problem in the logistics marketplace, since it generally lacks an effective approach to connecting the existing available, but fragmented, logistics resources and networks for more productive use. Consequently, the logistics industry is undergoing a fundamental change in its operations style to counterattack the logistics inefficiencies as well as the deficiencies found in the current ways of managing logistics. One innovative logistics concept that has recently emerged is Logistics Horizontal Collaboration (LHC), which aims to bring together the compatible companies and parallel supply chains to share logistics capacity and capabilities in order to significantly improve the efficiency, flexibility and stability for running logistics.

1.2 The New Logistics Model—Horizontal Collaboration

In the past few years, logistics horizontal collaboration (LHC) has been gaining attention as a new business concept that can help to make the logistics sector more efficient, effective and sustainable. Horizontal collaboration in logistics is defined as

active collaboration between two or more firms that operate at the same level of the supply chain and perform comparable logistics functions (Cruijssen et al. 2007a).

An important distinction from traditional supplier-to-customer logistics collaboration is that horizontal collaboration encourages coordination and integration across rather than along the supply chains (as shown in Figure 1.1). This collaboration could be organized between suppliers upstream, or between customers downstream, who might belong to different supply chains but who are willing to form partnerships to share part of their logistics resources, such as transportation and warehousing. Under this logistics paradigm, a fragmented demand in logistics system can be effectively orchestrated to enable large, stable and structural freight flow, while a dispersed supply, such as transport capacity, can be additionally deployed at the cross-supply chain network level where its overall utilization rate can go up significantly, leading to greater cost savings.

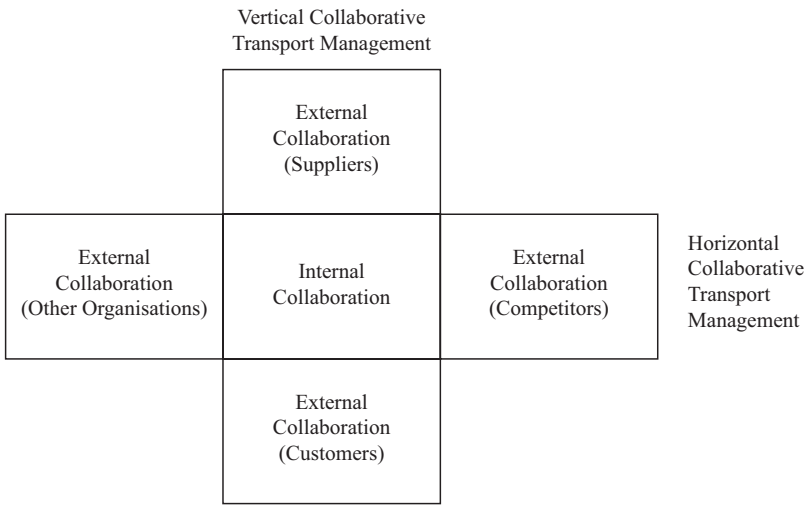


Figure 1.1 Differences between vertical and horizontal collaboration in logistics and transport (Mason et al. 2007)

One notable form of LHC is the collaborative distribution of goods between compatible shippers. In traditional vertical logistics collaboration, major interactions are between shippers and customers with the priority to coordinate the logistics process so that relevant shipments could be delivered on-time. In such situations,

the logistics distributions from the various shippers to the various customers are independent and separate. From the network perspective, there are considerable overlaps of the transport networks and goods are moved in parallel supply chains, which is very inefficient. Alternatively, horizontal logistics collaboration encourages shippers across these parallel supply chains to work more closely and proactively to plan and consolidate their goods in more synchronized ways, hence increasing the load utilization and cutting down the cost before shipments are delivered to the next stage of the supply chain.

Horizontal collaboration is in a sense an effective supplementation to supply chain logistics vertical collaboration to enable better optimization over the entirety of the logistics processes in the supply chain network. It can be expected that by collaborating horizontally, considerable improvements can be achieved in terms of asset utilization, the total logistics cost and the carbon footprint, while also, in many cases, improving the service level towards customers. Horizontal collaboration has until now, however, not been widely practised in the logistics marketplace, since its unfamiliar and complex nature has made it difficult to be implemented broadly (Palmer et al. 2012). Consequently, there is a strong need for both practitioners and researchers to contribute more relevant research in this area, so that better understandings can be developed regarding the forms and characteristics of such new collaboration model in logistics, eventually facilitating more successful implementations and thus contributing to a future improvement in the logistics industry.

1.3 Motivation

The motivation for this research is entirely driven by the practical issues and concerns I experienced in the logistics industry. Before 2012 I worked in an American PC manufacturing company based in China, and was responsible for architecting logistics projects and systems. It was at that time when I was deeply impressed by the complexity to manage logistics, and how difficult it is to maintain the logistics operations efficiency, the importance of which the company strongly emphasized and

is striving for excellence.

Unfortunately, logistics was often found to be the biggest constraint for this company, along with its extended supply chain, reflected by the high cost, long order delivery time, frequent capacity shortages or low utilization, unpredictability in demand and unstable service, etc. These logistics issues significantly hampered the other operations in the supply chain and prevented the company from retaining leadership in what was a hyper-competitive marketplace.

More specifically, I was able to observe very low utilization and delays in the daily logistics operations. This directly incurred high shipping costs for the company itself and poor delivery service for customers. The main reason for this low utilization was a lack of sufficient scale. For example, in order to maintain the delivery frequency and lead time commitment for customers, the company had to ship out orders every day regardless of whether the trucks, containers or airplane space were being efficiently used. Furthermore, transportation solutions such as rail often required a minimum volume threshold to provide the service. This led to difficulties in attracting sufficient volume in a very short time window and hence delayed the transportation. High order volatility and the unbalanced ordering pace and size from customers were also among the root causes for low utilization and delays. Logistics capacity needed to be planned in advance according to a forecast, but high demand variations led to the adoption of a conservative and high buffer strategy, with slack capacity being retained in order to cope with uncertainty. Capacity in the logistics marketplace, however, is unlike inventory that can be carried over: it is only usable for a specific time and if it is not used it perishes, causing frequent waste and low utilization. On the other hand, unbalanced order waves can pressurize the supply of capacity. Customers tended to release big orders, often at the end of the order receiving cycle, creating extreme challenges in preparing capacity in both production and logistics. In these circumstances supply shortages were also inevitable, causing shipment delays.

These problems are deeply rooted in the current supply chain and logistics configurations and show that using the traditional and internal optimization methods are difficult and unlikely to lead to significant improvements. By analysing the freight flow network, however it was found that many other manufacturers' outbound logistics