

University of Wollongong - Research Online

Thesis Collection

Title: Multi-agent based modeling and analysis of collaboration strategies in supply chain

Author: Xin Li

Year: 2006

Repository DOI:

Copyright Warning

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site.

You are reminded of the following: This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part of this work may be reproduced by any process, nor may any other exclusive right be exercised, without the permission of the author. Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material.

Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Unless otherwise indicated, the views expressed in this thesis are those of the author and do not necessarily represent the views of the University of Wollongong.

Research Online is the open access repository for the University of Wollongong. For further information contact the UOW Library: research-pubs@uow.edu.au

2006

Multi-agent based modeling and analysis of collaboration strategies in supply chain

Xin Li
University of Wollongong

Follow this and additional works at: <https://ro.uow.edu.au/theses>

University of Wollongong

Copyright Warning

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site.

You are reminded of the following: This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part of this work may be reproduced by any process, nor may any other exclusive right be exercised, without the permission of the author. Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material.

Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Unless otherwise indicated, the views expressed in this thesis are those of the author and do not necessarily represent the views of the University of Wollongong.

Recommended Citation

Li, Xin, Multi-agent based modeling and analysis of collaboration strategies in supply chain, M.Info.Sys.-Res. thesis, School of Economics and Information Systems, University of Wollongong, 2006.
<http://ro.uow.edu.au/theses/623>

NOTE

This online version of the thesis may have different page formatting and pagination from the paper copy held in the University of Wollongong Library.

UNIVERSITY OF WOLLONGONG

COPYRIGHT WARNING

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site. You are reminded of the following:

Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Multi-Agent based Modeling and Analysis of Collaboration Strategies in Supply Chain

A thesis submitted in partial fulfillment of the requirements for the award of the degree

Master of Information Systems (by Research)

From

University of Wollongong

By

Xin Li

Master of Science (Logistics), University of Wollongong
Master of Information and Communication Technology, University of Wollongong
Bachelor of Information Science, FuDan University

**Information Systems
School of Economics and Information Systems**

2006

Thesis Certification

CERTIFICATION

I, Xin Li, declare that this thesis, submitted in partial fulfillment of the requirements for the award of the Degree of Master of Information Systems by Research, in the Information Systems discipline, School of Economics and Information Systems at the University of Wollongong, is wholly my own work otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Xin Li
October 2006

Acknowledgements

There are several people whose assistance has been invaluable in completing this thesis. I would especially like to thank my supervisor, Dr. Sim Kim Lau, for her help and guidance during the course of this study. I would also like to thank Min He and Chattrakul Sombattheera for their kind help and assistance. In addition, I would like to thank our department, School of Information Systems, has supported me financially to allow me to attend the conferences. Finally I would also like to thank many colleagues of mine, and especially my family who encourage me and support me to continue my study.

October 2006

Xin Li

List of Publications

This is a list of refereed conference papers related to this research.

Li, X. and Lau, S. 2005, 'A Multi-Agent approach toward Collaborative supply chain management', in *the Proceedings of The 5th International Conference on Electronic Business (ICEB) 2005*, CD-ROM, 5-9 Dec., Sheraton Hotel and Towers, Hong Kong, China.

Li, X. and Lau, S. 2005, 'Collaboration in supply chain: a multi-agent approach', in *the Proceeding of the 6th International We-B (Working For E-Business) Conference (We-B)*, 23rd-25th Nov., Victoria University, Melbourne, Australia.

List of Figures

	Page No.
Figure 2.1 Supply chain network	24
Figure 2.2 Four basic SCOR Processes in each organizational element	25
Figure 2.3 Four basic SCOR Processes	26
Figure 2.4 Hierarchy of supply chain planning.	28
Figure 2.5 The evolution towards collaborative supply chain planning	32
Figure 2.6 Agents' characteristics - Modularity, Decentralization, Changeability	47
Figure 3.1 Supply chain network	54
Figure 3.2 Framework of a multi-agent based supply chain management system	55
Figure 3.3 Agent-based supply chain coordination	58
Figure 3.4 Function of the distributor coordination agent	59
Figure 4.1 A simple supply chain	67
Figure 4.2 Multi-agent based supply chain system structure	70
Figure 4.3 Supply chain prototype structure and processes	75
Figure 4.4 Supply Chain Simulation Prototype	76
Figure 4.5 Supply chain model in scenario 1 and 2	77
Figure 4.6 Supply chain model in scenarios 3 and 4	78
Figure 4.7 Orders in Scenario 1	79
Figure 4.8 Orders in Scenario 2	80
Figure 4.9 Orders in Scenario 3	80
Figure 4.10 Orders in Scenario 4	81
Figure 4.11 Inventory level in Scenario 1	81
Figure 4.12 Inventory level in Scenario 2	82
Figure 4.13 Inventory level in Scenario 3	82
Figure 4.14 Inventory level in Scenario 4	83
Figure 4.15 Backorders in Scenario 1	83
Figure 4.16 Backorders in Scenario 2	84

Figure 4.17	Backorders in Scenario 3	84
Figure 4.18	Backorders in Scenario 4	85

List of Tables

		Page No.
Table 2.1	Definition of four management processes in supply chain	26
Table 2.2	The financial and non-financial benefits from effective supply chain collaboration	36
Table 2.3	Superior collaboration can help manufacturers and retailers	37
Table 4.1	Service level and safety factor	73

List of Abbreviations

AI	Artificial Intelligence
APS	Advanced Planning & Scheduling Systems
B2B	Business-to-Business
CPFR	Collaborative Planning, Forecasting and Replenishment
DSS	Decision Support Systems
EDI	Electronic Data Interchange
ECR	Efficient Consumer Response
ERP	Enterprise Resource Planning Systems
IS	Information Systems
IT	Information Technology
KQML	Knowledge Query and Manipulation Language
3PL	Third Party Logistics
MRP	Material Requirement Planning
MAS	Multi-Agent Systems
SCM	Supply Chain Management
VMI	Vendor Managed Inventory

Table of Contents

Thesis Certification	2
Acknowledgements	3
List of Publications	4
List of Figures.....	5
List of Tables	7
List of Abbreviations	8
Table of Contents	9
Abstract.....	11
Chapter I Background and Introduction	13
1.1 Introduction.....	13
1.2 Research Problems.....	15
1.3 Research Aim.....	19
1.4 Research Objectives.....	19
1.5 Overview of Research.....	19
1.6 Organization of Thesis	20
Chapter II Literature Review	22
2.1 Supply Chain Management.....	22
2.1.1 Definition of Supply Chains	22
2.1.2 Collaboration in Supply Chains	31
2.2 Information Technology and Information Systems in the SCM.....	37
2.3 Multi-Agent System.....	43
2.4 Research Gap	49
Chapter □ Proposed conceptual framework of multi-agent based supply chain management system	53
3.1 Conceptual framework of multi-agent based supply chain management system .	53
3.1.1 Function agents	55
3.1.2 Communication agents.....	56
3.1.3 Coordination agents	57
3.1.4 Monitoring agents	60
3.2 Contributions of the conceptual framework to supply chain collaboration	61

3.3 Summary	65
Chapter IV A multi-agent supply chain prototype.....	66
4.1 Supply chain structure.....	66
4.2 Overview of the model structure.....	69
4.3 Performance measures and simulation scenarios.....	76
4.4 Simulation results.....	79
4.5 Discussion	85
4.6 Summary	88
Chapter V Conclusion	89
5.1 Research summary	89
5.2 Future research direction.....	91
References.....	92
Appendix A - Program Codes.....	97

Abstract

A supply chain is a worldwide network of suppliers, factories, warehouses, distribution centers and retailers through which raw materials are acquired, transformed and delivered to customers. Modern supply chain management is moving away from vertically integrated companies that control all aspects of production and distribution toward networks of independent suppliers and distributors. Nowadays, supply chain collaboration has become the cornerstone of high performance in supply chain management. A key step in this collaboration process is to share information among the supply chain partners. However, current supply chain collaboration mainly focuses on the collaboration between two companies in a supply chain instead of in the whole system due to the limitation of the current modeling method and capabilities of current information systems. The multi-agent approach is a promising modeling method that can be used to design and develop supply chain management system to facilitate supply chain system-wide collaborative management. The aim is to investigate information sharing as a basic supply chain collaboration strategy through the application of the multi-agent approach to model and simulate the supply chain. This research presents a proposed conceptual framework of multi-agent based collaborative supply chain management system. The framework consists of four types of agents that include function, communication, coordination, and monitoring agents. The proposed framework illustrates the application of multi-agent techniques to integrate disparate supply chain information systems, to facilitate information sharing in the supply network, to support collaborative supply chain planning and to coordinate problem solving. A multi-agent based supply

chain prototype is developed to investigate the impacts of information sharing on supply chain performance. Four scenarios have been investigated to measure the performance of both the inventory cost and customer service levels. The simulation results show that information sharing as a basic supply chain collaboration strategy can reduce the bullwhip effect and result in lower amounts of the inventory holding, but it leads to higher stock-outs.