

**PROCORE - FRANCE/HONG KONG JOINT RESEARCH SCHEME  
COMPLETION REPORT**

**Project Reference Number**

F-HK22/11T

**Project Title**

Minimizing Inventory Level through Supply Chain Collaboration

**Particulars**

	Hong Kong team		French team					
Name of Project Co-ordinator (with title)	English: Dr. S.H. CHUNG Chinese: 鍾世豪 (Dr. CHUNG Sai Ho)		Prof. Van-Dat CUNG					
Name of Co-Investigator (if any)	English: Prof. F.T.S. CHAN Chinese: 陳東燊 (Prof. CHAN Tung Sun)		Dr. Fabien MANGIONE					
Institution or Institutional affiliation	<input type="checkbox"/>	CityU	<input type="checkbox"/>	HKU	<input type="checkbox"/>	CEA	<input type="checkbox"/>	INRA
	<input type="checkbox"/>	CUHK	<input type="checkbox"/>	HKUST	<input type="checkbox"/>	CNRS No.	<input type="checkbox"/>	INRIA
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	<input type="checkbox"/>	HKIEd	<input checked="" type="checkbox"/>	PolyU	<input checked="" type="checkbox"/>	Grenoble Institute of Technology		
	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Others:		
Other project team members (if any)								

**Funding Period**

	1 <sup>st</sup> year	2 <sup>nd</sup> year (if applicable)
Start Date	2012-01-01	2013-1-1
Completion Date	2012-12-31	2013-12-31

**Objective(s) as per original application**

1. Study the best practice of supply chain integration of manufacturing industries in France and in Hong Kong.
2. Study new collaboration strategies for supply chain integration in inventory control.
3. Development of multi-agent simulation model to test the performance of the determined supply chain collaboration strategies.

**i) Outline of proposed research and results obtained**

Outline of proposed research

For objective (1)

1. Study the best practice of supply chain integration of manufacturing industries in France and in Hong Kong.

Company visits had been carried out. We had visited a company in France, called “re commerce solution”. This is a mobile phone remanufacturing company, which purchases (buy back) used mobile phones from the market and remanufactures them for re-sell. It collaborates with the 3<sup>rd</sup> largest mobile phone service provider in France. In addition, it collaborates with a logistics company for transportation. We studied its business model and its collaboration approach. Similarly, in Hong Kong, we also carried out a study in the mobile phone trade-in company to see if there is any collaboration between companies.

For objective (2)

2. Study new collaboration strategies for supply chain integration in inventory control.

In the literature, two decision-making approaches, known as centralized and decentralized, are usually proposed and studied. Centralized decision making is able to achieve very good performances, and under some conditions can achieve optimal. But it requires a central decision maker with the knowledge of all private information of the parties in the supply chain for coordination. However, as stated by some researchers, this approach is considered as an ideal but unrealistic approach. On the contrary, decentralized decision making considers each supply chain party takes its own decisions, and align their decisions using coordination mechanisms (supply chain collaboration policy). Thus, in this research project, we will study decentralized approach and develop a supply chain collaboration policy in order to improve the overall performance of supply chains in terms of inventory level reduction.

Accordingly, in this research project, we construct and simulate a typical supply chain model with 2-echelon. It is a divergent model with 1 manufacturer and  $n$  retailers as shown in Figure 1 below (later on we studied a multi-manufacturers model as in the attached paper). Each retailer has its own demands received (named as Final client). In the model, the Final clients start the process by sending their demands (for the coming periods) to their retailer. Each retailer optimizes its own planning and then sends the requested quantities to the manufacturer. The manufacturer will wait until the demands are received from all the retailers. Then the manufacturer will optimize its planning and replies to every retailer for the demands. We simulate the negotiations process between the retailers and the manufacturer for the whole planning horizon. The negotiation process is known as our supply chain collaboration policy studied.

For objective (3)

3. Development of multi-agent simulation model to test the performance of the determined supply chain collaboration strategies.

The whole supply chain model mentioned above is simulated by using Multi-Agent approach.

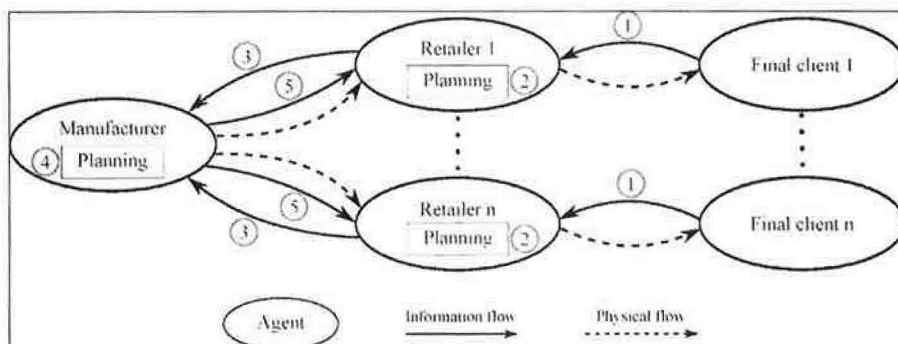


Figure 1. Planning process in the 2-echelon divergent Supply Chain.

The objective of the model seeks to maximize the profit of the manufacturer, i.e. the revenue from the sale of the product minus production and holding costs, which regarded as the inventory cost induced by inventory level (safety stock level required).

### Results Obtained

For objective (1)

1. Study the best practice of supply chain integration of manufacturing industries in France and in Hong Kong.

From the visits, we identified the collaboration mechanism of the visited company (re commerce solution) with its logistics service provider. We conclude that this objective is fulfilled.

For objectives (2)

2. Study new collaboration strategies for supply chain integration in inventory control.

In this study, we proposed quantity discount approach. There are two major types of quantity discount approach, namely all-unit discount (where the discount price is applied to every ordered unit), and incremental discount (where the discount price is applied only for the unit above the breakpoint). We studied the lateral one especially the influence of the two parameters:

$Q_{min}$  = discount breakpoint, i.e. order quantity from which the discount price is applied;  
 $p_{QD}$  = discount price.

It is assumed the manufacturer fixes these two parameters before the first negotiation with the retailers, and all the retailers know these parameters (because of collaboration, this information is known). They would not be changed during the simulation of the whole planning horizon. The shape of the price is presented in Figure 2.

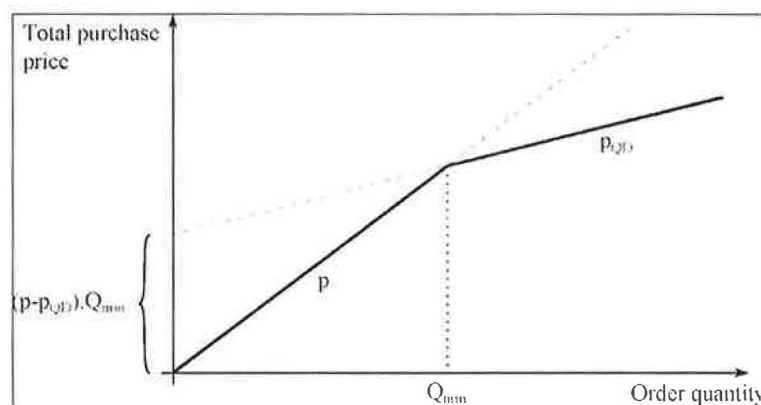


Figure 2. Incremental Quantity Discount with one breakpoint

For objective (3)

3. Development of multi-agent simulation model to test the performance of the determined supply chain collaboration strategies.

We constructed a simulation model by using multi-agent approach and studied the following questions about the supply chain collaboration model:

1. The influence of final inventory level on the total supply chain profit.
2. The influence of the rolling horizon length on the profit.
3. The influence of the two quantity discount parameters on profit increasing.

For (1) and (2):

We found that both the final inventory level and the horizon length have influences on the profits as shown in Figure 3 below. This demonstrates that is sensitive to the inventory level and the collaboration horizon.

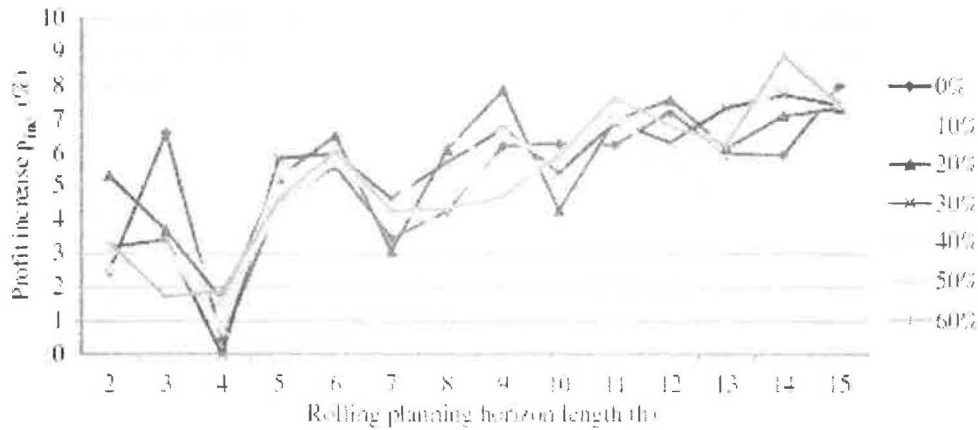


Figure 3. Profit vs Inventory level and Planning Horizon

For (3):

Lastly, we adjust the two quantity discount parameters by independently increasing the Quantity Discount Price and Quantity Discount Breakpoint. We measure the changes of profit to the manufacturer, and retailers. The results are shown as in Figure 4 below. We found that when the Quantity Discount Prices increases, the profit gained by the manufacturer increases, but the profits gained by the retailers decrease. Meanwhile, the Quantity Discount Breakpoints seems that it does not have significant influence to the profit in retailer, but a decrement to manufacturer as it increases. Thus, we conclude that objectives (2) and (3) are fulfilled.

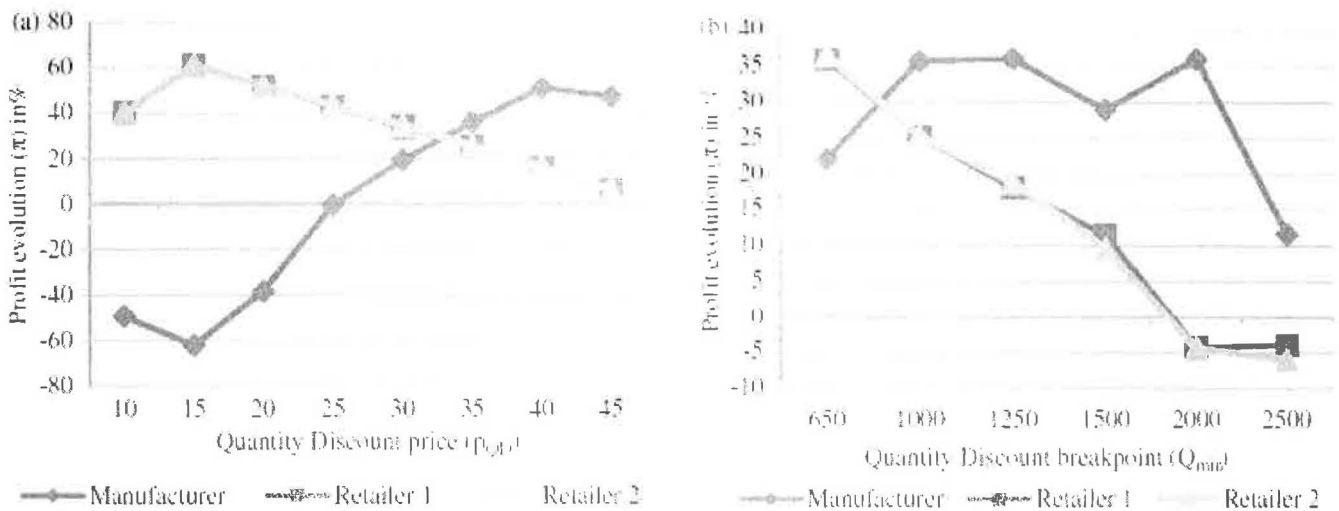


Figure 4. Sensitivity analysis of the two Quantity Discount Parameters

**ii) Significance of research results**

In contrast to the traditional way in considering the supply chain activities in a single and centralized model, we developed a much more practical model, which is capable of simulating the real supply chain decisions making. We not only model the production planning part as in literature, but also the transportation, and storage activities in a decentralized approach and the coordination mechanisms in the supply chain. From our knowledge, this is the first known research in integrating numerous realistic aspects in supply chain planning. With the results obtained from this research, it provides more practical insight and background for companies to determine the adoption and adjustment of Quantity Discount

Parameters in supply chain collaboration (detail see the Managerial Insights section in the attached paper).

**iii) Research output**

An international journal paper is submitted to The International Journal of Production Research: Maxime Ogier, Felix T.S. Chan, Sai Ho Chung, Van-Dat Cung, and Julien Boissière, Decentralized capacitated planning with minimal-information sharing in a 2-echelon supply chain, [under review].

**iv) Potential for or impact on further research collaboration**

The supply chain collaboration model developed in this project was in single product. The teams of Hong Kong and French are interested in multi-product with distribution centre(s). This is because this model is even more practical. It can cover even more supply chain situations in reality. Thus, the impact of the research result may even be more significant.

**Signatures and Dates**



Hong Kong Principal Investigator  
Date: 2014-06-25



Hong Kong Institution's Representative  
Date: 26 June 2014