延伸企業聯盟競合關係與賽局策略之研究

A Simulation Study of Game Strategies for Competitions among Extended Enterprises

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OUTLINE

- Introduction
- Literature Review
- Research Design
- Experimental Results
- Conclusions & Discussions

Introduction

- The growth of e-Business has pushed online auction /order bidding to be a trend for enterprise competition
- How to adjust order bidding and order allocation strategies to create a win-win scenario for members of extended enterprise

Research Objectives

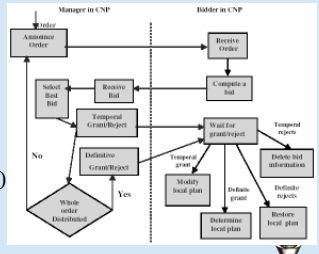
- To evaluate *game strategy* played by suppliers under different scenarios
- To establish a *dynamic bidding strategy* with Game Theory implication
- To develop a *dynamic order allocation* rule to improve overall performance of extended enterprise

Literature Review

- Level integration, level of information exchange, data transparency are limited in Supply Chain, significant in Extended Enterprise and completely required in Virtual Enterprise (Jagdev and Thoben, 2001)
- Supply Chain ≠ Extended Enterprise
- Extended Enterprise ≠ Virtual Enterprise

Literature Review

- Multiagent environment of bidding decision model included order receiving, order announcement, bid calculation, order scheduling and order execution (Hu *et al.*, 2001)



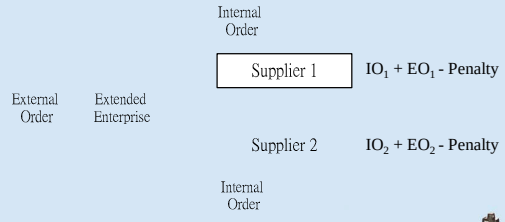
Literature Review

- Order allocation should be *fair distributed* among suppliers. Total cost, total lead time, *equity utilization*, and due date fulfillment were take as major criterion (Chan *et al*., 2004)

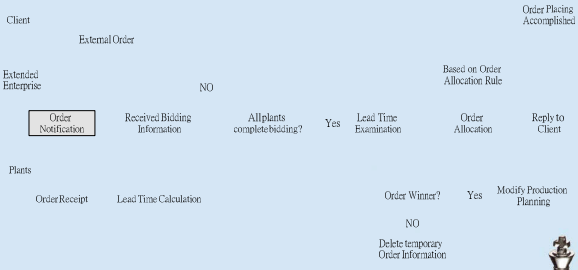
Literature Review

- Application of game theory in Supply Chain included non-cooperative and cooperative game in static and dynamic settings (Cachon and Netessine, 2001)
- In dynamic demand, cooperative interaction performs better than competitive interaction. Although cooperative interaction are costly in dynamic environment, they are much better in customer fill rate (Zhang and Dilts, 2005)

Model Framework



Order Bidding Process



Order Bidding Strategy

- Static Bidding Strategies: Aggressive, Medium, and Conservative
- *Dynamic Bidding Strategy* based on
  - Current work load
  - Competitor's recent moves (winning ratio)
  - Unit Profit of this order

Workload	Winning Ratio	Profit	Strategy
High	High	High	Medium
High	High	Middle	Conservative
High	High	Low	Conservative
High	Middle	High	Medium
High	Middle	Middle	Conservative
High	Middle	Low	Conservative
High	Low	High	Aggressive
High	Low	Middle	Conservative
High	Low	Low	Conservative
Middle	High	High	Aggressive
Middle	High	Middle	Medium
Middle	High	Low	Conservative
Middle	Middle	High	Aggressive
Middle	Middle	Middle	Medium
Middle	Middle	Low	Conservative
Middle	Low	High	Aggressive
Middle	Low	Middle	Medium
Middle	Low	Low	Medium
Low	High	High	Aggressive
Low	High	Middle	Medium
Low	High	Low	Medium
Low	Middle	High	Aggressive
Low	Middle	Middle	Aggressive
Low	Middle	Low	Medium
Low	Low	High	Aggressive
Low	Low	Middle	Aggressive
Low	Low	Low	Aggressive

Dynamic1

Dynamic2

Workload	Winning Ratio	Profit	Strategy
High	High	High	Aggressive
High	High	Middle	Medium
High	High	Low	Conservative
High	Middle	High	Aggressive
High	Middle	Middle	Medium
High	Middle	Low	Conservative
High	Low	High	Aggressive
High	Low	Middle	Medium
High	Low	Low	Conservative
Middle	High	High	Aggressive
Middle	High	Middle	Medium
Middle	High	Low	Medium
Middle	Middle	High	Aggressive
Middle	Middle	Middle	Medium
Middle	Middle	Low	Medium
Middle	Low	High	Aggressive
Middle	Low	Middle	Medium
Middle	Low	Low	Medium
Low	High	High	Aggressive
Low	High	Middle	Aggressive
Low	High	Low	Aggressive
Low	Middle	High	Aggressive
Low	Middle	Middle	Aggressive
Low	Middle	Low	Aggressive
Low	Low	High	Aggressive
Low	Low	Middle	Aggressive
Low	Low	Low	Aggressive

Order Allocation

- Based on Supplier's Promised Delivery Date
- Based on Supplier's Previous Performance used Weighted-point Method with criteria:
  - Promised delivery date (r_1)
  - Recent delivery performance (r_2)

$$Score = \sum_{i=1}^{k} w_i r_i$$

⇨ If very close, granted to supplier with lowest *order winning ratio* (equity utilization and fairness relationship)

Control Variables

- Market environment: due date tightness set by customer, penalty cost, order profit
- Supplier: capacity, order processing rule, bidding strategy

Output Performances

- Penalty $\quad \text{Profit} \times \frac{\text{Order Weight}}{\text{penalty factor}} \times \text{days of delay}$
- Mean Tardiness $\quad \frac{\text{Total Tardiness}}{\text{Total Number of Delay Order}}$
- Tardy Ratio $\quad \frac{\text{Number of Tardy Orders}}{\text{Total Order Number}}$
- Net profit performance = Profit – Penalty

1. Base Case Analysis

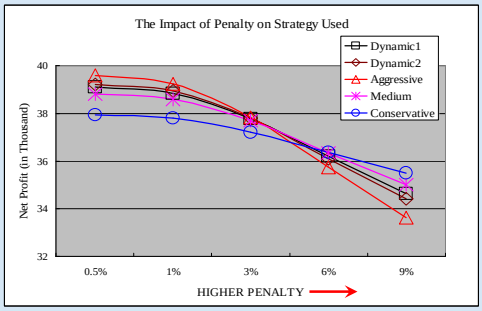
- Evaluate suppliers' order processing rule by comparing queue rule based on *agreed Due Date*, *PRIO1*, and *PRIO2*

$$\text{PRIO1} = \text{Profit} - (\text{Order Weight} \times \text{Slack Time})$$

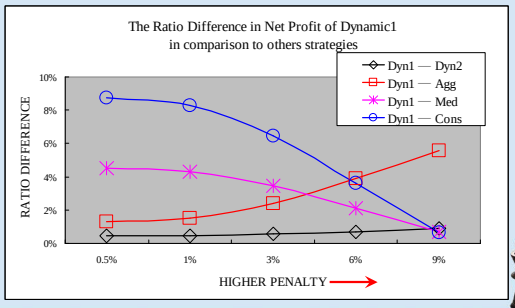
$$\text{PRIO2} = \frac{\text{Slack Time}}{\text{unit profit}}$$

- Overall comparison ⇨ PRIO2 performs better

2. Impact of Penalty



Dynamic Bidding Strategy



Game Matrix

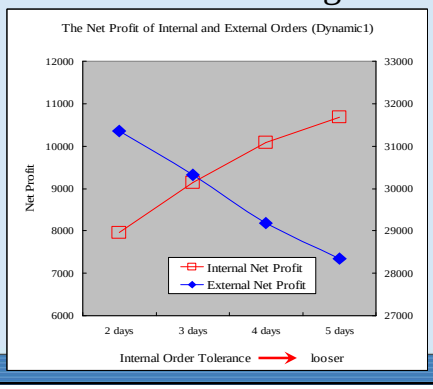
Equilibrium Point

Optimal Solution

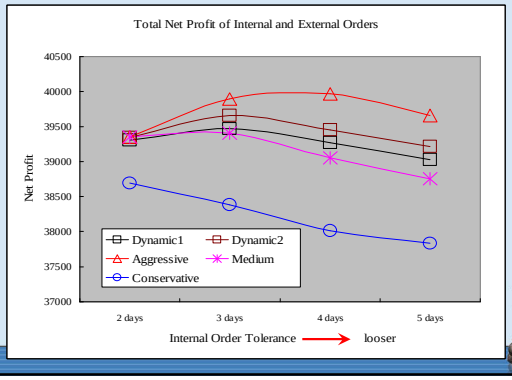
Supplier 1 Strategy	Supplier 2 Dynamic1 Plant 1	Supplier 2 Dynamic1 Plant 2	Supplier 2 Dynamic2 Plant 1	Supplier 2 Dynamic2 Plant 2	Supplier 2 Aggressive Plant 1	Supplier 2 Aggressive Plant 2	Supplier 2 Medium Plant 1	Supplier 2 Medium Plant 2	Supplier 2 Conservative Plant 1	Supplier 2 Conservative Plant 2
Dynamic1	**3.77%**	**4.00%**	4.30%	3.72%	5.22%	2.74%	3.73%	2.20%	6.46%	0.00%
Dynamic2	3.72%	4.30%	**3.87%**	**4.02%**	4.95%	3.17%	5.42%	2.50%	6.33%	0.38%
Aggressive	2.74%	5.22%	3.17%	4.95%	**3.96%**	**4.13%**	4.41%	2.93%	5.15%	1.05%
Medium	2.20%	5.73%	2.50%	5.42%	2.93%	4.41%	3.38%	3.89%	4.38%	1.67%
Conservative	0.00%	6.46%	0.38%	6.33%	1.05%	5.15%	1.67%	4.38%	2.50%	2.19%

Payoff Matrix of Net Profit Improvement
(order allocation based on supplier's delivery date)

3. Internal Order Bidding Strategy



Internal Order Bidding Strategy



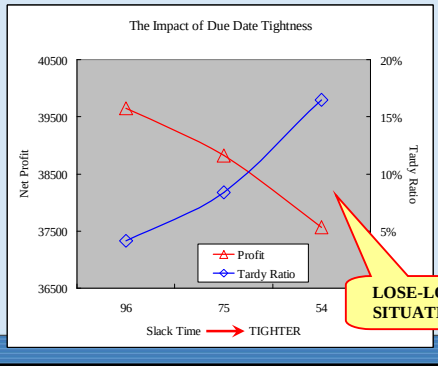
Higher Internal Order's Profit

- Internal Order's Profit set at 2.5, 5 and 7.5
- Experiment suggests that as profit of internal order is higher, suppliers should be conservative in taking external orders and allocate more capacity to internal orders by increasing internal order tolerance.

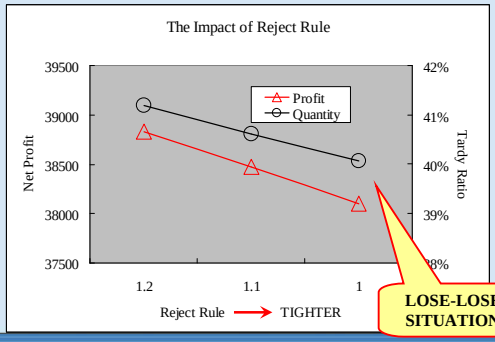
4. Customer's Delivery Requirement

- Due date from now =Processing time + Slack time
  = Processing time + c - (order weight × 10)
  Parameter c set at 54, 75, and 96
- Customer may reject supplier's bid if the promised delivery date appears to be unacceptable.
- Reject Rule = Delivery Date > Due Date × r
  Parameter r set at 1.2, 1.1, and 1.0

Due Date Tightness vs. Supplier



Reject Rule vs. Supplier



Customer's Order Allocation

- Dynamic order allocation rule based on supplier's previous performance is proposed to improve the overall performance
- In comparison to order allocation based on supplier's delivery date:
  - Net Profit is about same (around 36700 for Dynamic1)
  - Numbers of delay orders (around 6.2 decrease to 5.8)
  - Tardy Ratio (around 8.4 decrease to 7.9)

Order Allocation based on delivery date

Equilibrium Point **Optimal Solution**

Supplier 1 Strategy	Supplier 2: Dynamic1 Plant 1	Dynamic1 Plant 2	Dynamic2 Plant 1	Dynamic2 Plant 2	Aggressive Plant 1	Aggressive Plant 2	Medium Plant 1	Medium Plant 2	Conservative Plant 1	Conservative Plant 2
Dynamic1	**3.77%**	**4.00%**	4.30%	3.72%	5.22%	2.74%	5.73%	2.20%	6.46%	0.00%
Dynamic2	3.72%	4.30%	**3.87%**	**4.02%**	4.95%	3.17%	5.42%	2.50%	6.33%	0.38%
Aggressive	2.74%	5.22%	3.17%	4.95%	**3.96%**	**4.13%**	4.41%	2.93%	5.15%	1.05%
Medium	2.20%	5.73%	2.50%	5.42%	2.93%	4.41%	3.38%	3.89%	4.38%	1.67%
Conservative	0.00%	6.46%	0.38%	6.33%	1.05%	5.15%	1.67%	4.38%	2.50%	2.19%

Payoff Matrix of Net Profit Improvement

Dynamic Order Allocation

Equilibrium Point **Optimal Solution**

Supplier 1 Strategy	Supplier 2: Dynamic1 Plant 1	Dynamic1 Plant 2	Dynamic2 Plant 1	Dynamic2 Plant 2	Aggressive Plant 1	Aggressive Plant 2	Medium Plant 1	Medium Plant 2	Conservative Plant 1	Conservative Plant 2
Dynamic1	3.82%	3.89%	4.23%	3.55%	5.16%	2.76%	5.06%	2.11%	5.46%	0.77%
Dynamic2	3.55%	4.23%	3.89%	4.10%	4.60%	3.15%	4.69%	2.79%	4.85%	1.41%
Aggressive	2.76%	5.16%	3.15%	4.60%	3.32%	3.78%	3.86%	3.24%	4.03%	1.58%
Medium	2.11%	5.06%	2.79%	4.69%	3.24%	3.86%	2.98%	3.29%	3.37%	1.78%
Conservative	0.77%	5.46%	1.41%	4.85%	1.58%	4.03%	1.78%	3.37%	1.68%	1.94%

Payoff Matrix of Net Profit Improvement

5. The Leadership between Small & Large Suppliers

	Strategy	Supplier 2 (Large): Aggressive Plant 1	Aggressive Plant 2	Conservative Plant 1	Conservative Plant 2
Supplier 1 (Small)	Aggressive	25.52	52.50	25.62	52.07
	Conservative	25.08	54.07	25.36	53.72

54.07 – 52.50 = 1.47
25.08 – 25.52 = – 0.44

Conclusions & Discussions

- Impact of Penalty Cost on Strategy Used (Lower Penalty ➡ Aggressive; Higher Penalty ➡ Conservative)
- Advantage of Dynamic Bidding Strategy
- Higher profit set ➡ Aggressive towards internal orders and Conservative to external orders
- Due Date Tightness ➡ lower profit, higher tardy ratio ➡ LOSE-LOSE situations

Conclusions & Discussions

- Order allocation based on supplier's previous performances can reduce the delay time in order delivery
- When suppliers with different capacity compete for orders, the one with larger capacity has the leadership in the game

Future Research

- Better *order scheduling* for suppliers to improve competitiveness
- Optimize *dynamic bidding strategy*
- Apply *dynamic games* to analyze the co-opetition among members of the extended enterprise

Thank you for your attention

Anything can be a game