Global Sourcing and Vendor Risk Management in Supply Chains

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REFERENCE

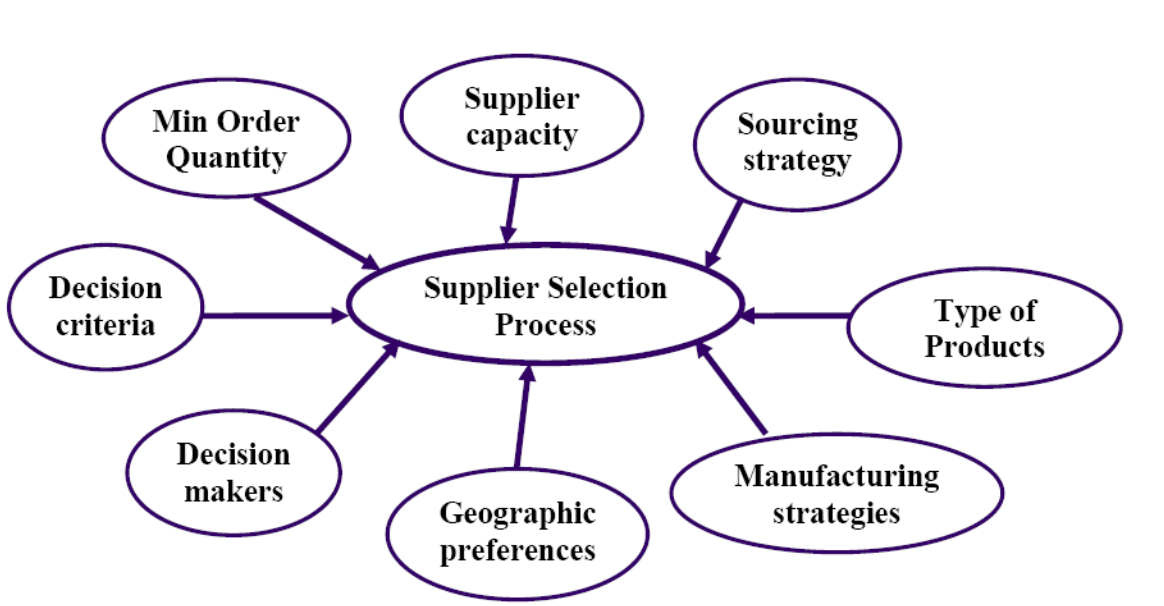
- Ravindran, A. Ravi, R. Ufuk Bilsel, Vijay Wadhwa and Tao Yang, “Risk Adjusted Multi Criteria Supplier Selection Models With Applications”, *International Journal of Production Research*, vol. 48, No. 2, PP. 405-424, January 2010.

Agenda

- Supplier Selection problem and its Importance
- Supplier Risk Management
  - Cost of supply disruptions
  - Risk Identification and Assessment
  - Risk Mitigation Strategies
- Multi Criteria Models for Supplier Selection
- Case Study Results

Supplier Selection Process

- In most procurement situations buyers have to choose among a set of suppliers.
- The buyer must choose which suppliers to order from and how much to order from each supplier.



Importance of Sourcing Decisions

- Wal-Mart assumed responsibility for global procurement from a third party in 2001 to better coordinate entire global supply chain from product development to delivery.
- Raw material cost is 40-60% of production cost for US manufacturers; for high tech companies, it can be up to 80%.
- Example : General Motors
  - Cost of components and parts from outside suppliers exceed 50% of sales (2001 GM sales $180 billion)
  - Life cycle of a new car
    - 18 months of concept phase, 18-24 months of Development phase, 7 years of program life to build cars for sales and 15 years of parts life for service
  - Major sourcing decisions with key suppliers are made 3 years before actual production!

Vendor Management

- Cost Reduction Versus Risk Management
- Risk management lags behind cost reduction in procurement decisions
- In a recent survey of companies, A.T. Kearney found
  - 74% have plans in place for reducing procurement cost
  - Only 23% have plans in place to reduce supply risk

Practices affecting vendor management

- Global Sourcing
  - Benefit: Lower procurement cost
  - Risks: Supply disruptions, Longer & uncertain lead times, Exchange rate and security concerns
- Outsourcing Non-core Functions
  - Benefits: Reduced cost and improved service levels
  - Risks: Less flexibility and poor quality/yield at supply source

Practices affecting vendor management (Continued)

- Supply Consolidation
  - Benefits: Economies of scale and strong strategic supply partnerships
  - Risks: Higher dependency on single source and bankruptcy issues
- JIT/Lean Approach
  - Benefits: Lower inventory cost
  - Risk: Even small disruptions can have major impacts on production

Importance of Vendor Management

- Suppliers can change quickly impacting the entire supply chain
- Every day, 200 suppliers go bankrupt and a similar number open for business
- Every hour, 360 suppliers have court judgments against them and 112 change senior leadership
- Supplier Monitoring is vital

Source: "The Danger Detectives", Supply Management, Vol.8, No. 3, pp. 28-29, 2003.

Costly Supply Disruptions - Examples

- 18 day labor strike at Delphi Brake Plant in March 1996 idled 26 GM assembly plants, costing $900 million in first quarter earnings.
- Nokia-Ericsson Supplier Fire.
- Each day of disruption in supply network can cost an average of $50-100 million (2003 study)

Win vs. lose - Nokia and Ericsson story

03 – 17 – 2000		
	NOKIA CONNECTING PEOPLE **Multiple suppliers**	ERICSSON **Single suppliers**
	Do not know	knew
03 – 20 – 2000	Events Management System found out that order does not coming in as expected, contact supplier and send engineer to evaluate the severity	Assured by supplier and doing nothing
	Changed the design, sent representatives to other suppliers in the US and Japan for emergency supply and made the lead-time less than a week	Doing nothing
Early April, 2000	Supplier base reorganization done. Back to normal.	Still waiting
End of the year	Was able to meet its production goals, and even boost its market share from 27% to 30%.	1.7 Billion loss and ultimately outsourced its cellular handset manufacturing business to another firm

Hyundai Motor India

- Major fire in June 2004 at a Tier-2 supplier Polyflex disrupts the “seat supply chain” to HMIL.
- No supply of seats for 3-4 days for the Chennai plant.
- Result
  - HMIL has to airlift seats from S. Korea to meet export schedules.
  - Export “Backlog” of more than 1000 cars

(Source: The Economic Times, June 24, 2004)

Land Rover and UPF Thompson

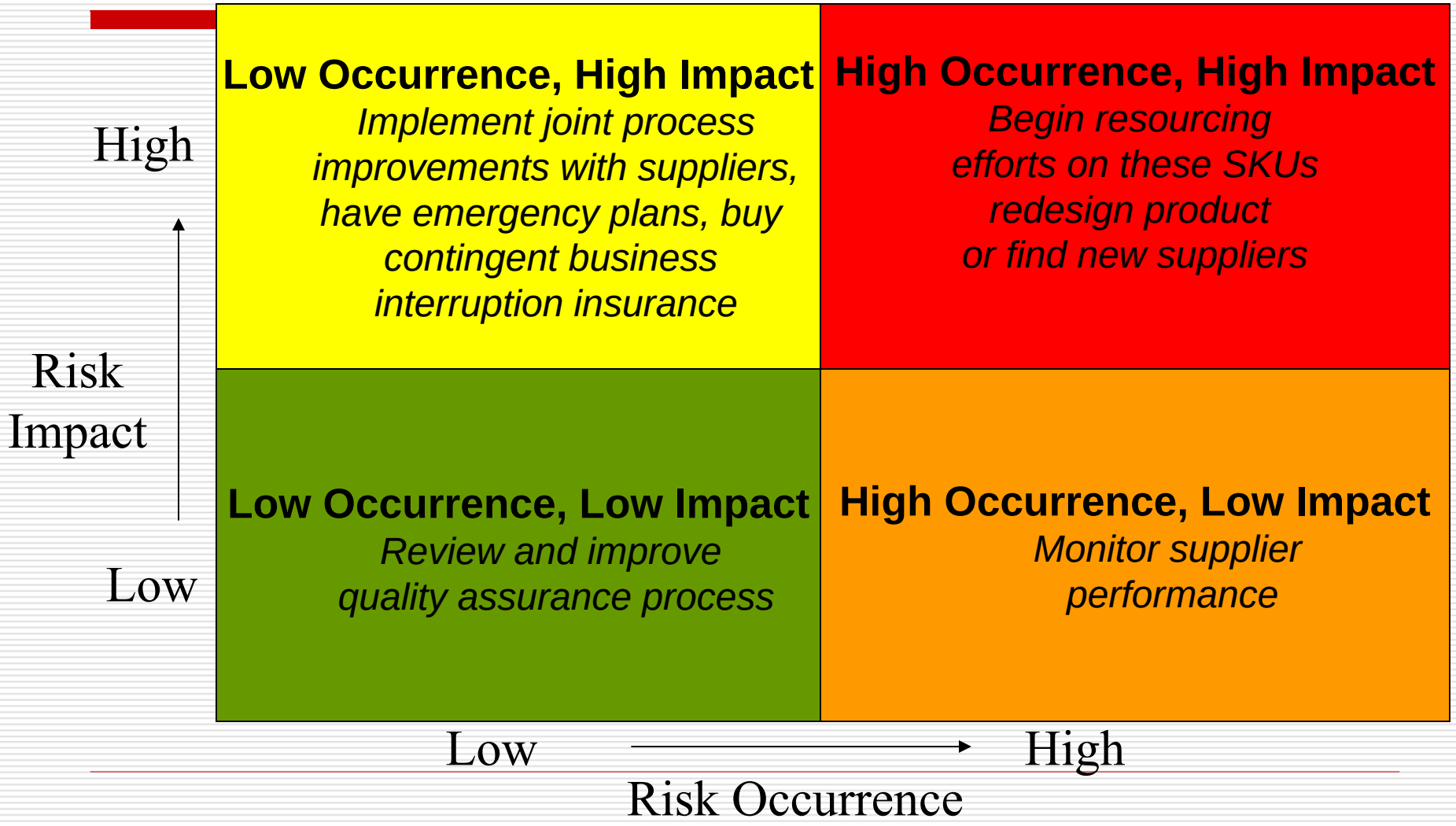
- UPF-Thompson, sole supplier of chassis to Land Rover, went bankrupt in 2001
- Receiver KPMG demanded 50-70 million Euros up front from Land Rover for the supply of chassis
- Court sided with KPMG declaring sole supplier agreement is a valuable asset
- A higher court injunction saved the day for Land Rover from laying off 1400 plant workers and many more at its network of suppliers

Supply Risk Management

- Identify and Assess Supply Risks
  - Risk Occurrence
    - On time delivery, quality, cost/piece etc.
  - Risk Impact
    - Cost, revenue, entire supply chain
- Develop Supply Risk Map
  - 2x2 matrix
  - Frequency of occurrence – high & low
  - Risk Impact – high & low

Penn State

Supply Risk Mitigation Strategies



Overview of a Research Project funded by a Global IT Company

- The objective was to demonstrate the use of multiple criteria optimization models incorporating supplier risk when making sourcing decisions.
- Two different risk models developed:
  - Value-at-Risk (VaR) for rare events.
  - Miss-the-target (MtT) risk for others.
- Two phase risk-adjusted supplier selection model.
  - Phase 1: Screen and shortlist suppliers.
  - Phase 2: Select suppliers and their order quantities.
- Solution methods were demonstrated using case scenarios and company staff as decision makers.

Definition and quantification of risk

- We define *risk* as events (natural or man-made) that cause SC disruptions
- We quantify *risk* as being a function of ***Impact*** and ***Occurrence:***

$$Risk = f(\ Impact,\ Occurrence)$$

- *Impact:* Impact *of events & potential loss*
- *Occurrence:* Occurrence or frequency *of risk events*

Quantification of Risk

- Risks are natural/man-made events that cause SC disruptions

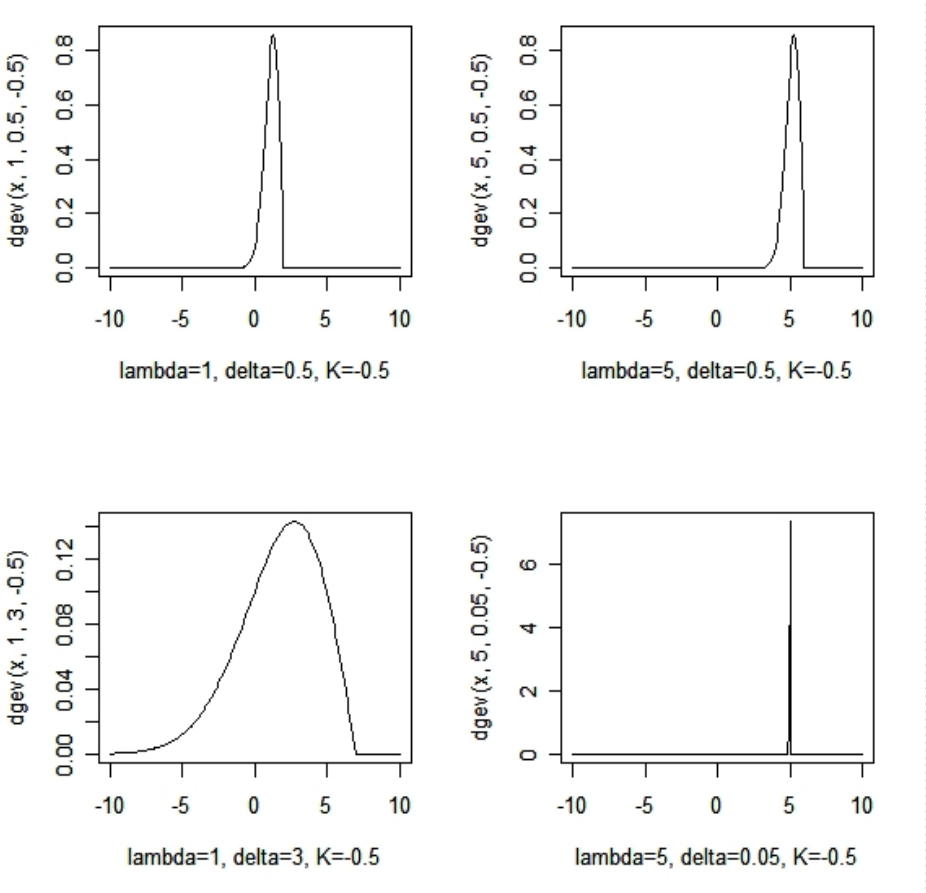
Type	***Occurrence***	***Impact***	***Example***
Value-at-Risk (VaR)	Rare	Severe	Hurricane, strike, fire, terrorist attack
Miss-the-Target (MtT) risk	Frequent	Mild to Moderate	Late delivery of raw materials, low quality replenishment

VaR Type Risk
(Use Extreme Value Distributions)

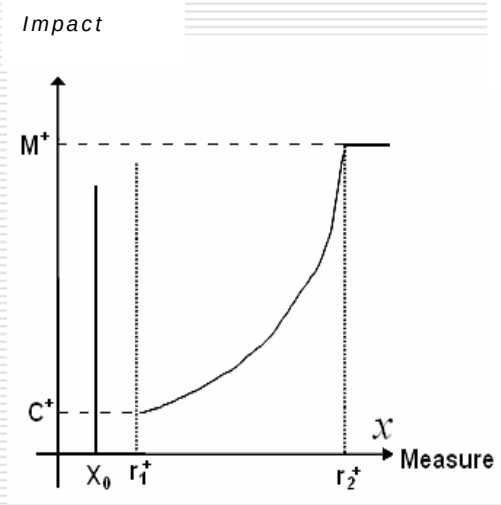
$$f(x;\lambda,\delta,K)=\exp\left[-\left[1-K\left(\frac{x-\lambda}{\delta}\right)\right]^{1/K}\right]\left[1-K\left(\frac{x-\lambda}{\delta}\right)\right]^{1/K-1}\frac{1}{\delta}$$

Parameter	Interpretation
K	Shape parameter
	• $K>0$, corresponds to a Frechet distribution,
	• $K=0$, corresponds to a Gumbel distribution,
	• $K<0$, corresponds to a Weibull distribution.
δ	Scale parameter
λ	Location parameter

VaR Type Risk



MtT Type Risk
(Use Taguchi's Loss Functions)



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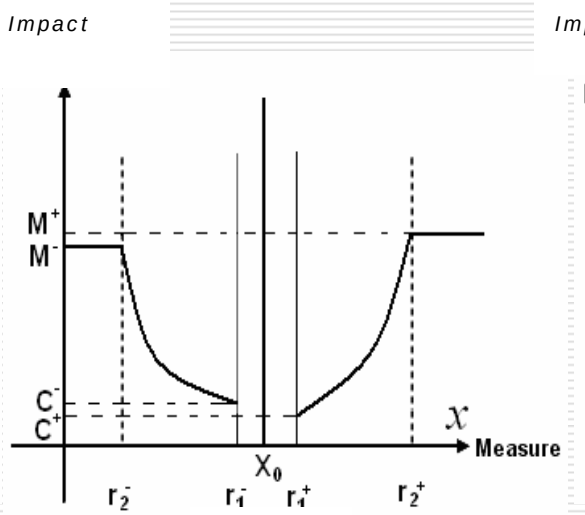

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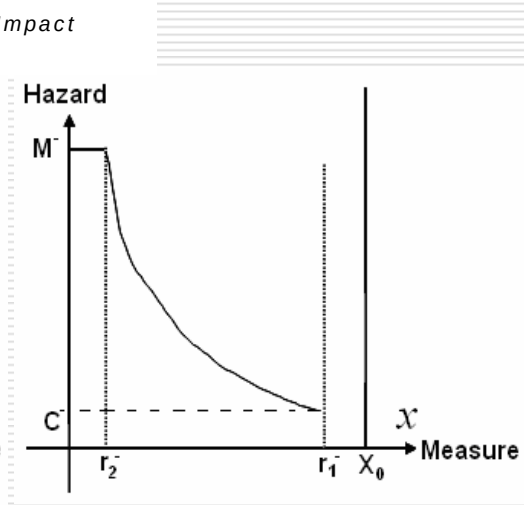

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Case Scenario

Phase 1: Short List Suppliers

- Seven criteria with 14 attributes and 20 suppliers
- Experiments to test multi criteria optimization methods to rank suppliers:
  - Rating method
  - Pair-wise comparison method using Borda count
  - Analytic Hierarchy Process (AHP).
- Experiments to test Group Decision Making methods for ranking suppliers.
- Company staff as Decision Makers for both experiments.

MCDM Methods for Phase 1

- *Rating method*: Each criterion is rated on a scale of 1-10. weight associated with each criterion is obtained through normalization.
- *Pair-wise comparison method using Borda count*: Based on pair wise comparison of criteria. If P criteria are ranked, the most important criterion gets P points, the second most important gets (P-1), etc. Weights are calculated via normalization.
- *Analytic Hierarchy Process (AHP):* Pair wise comparison of criteria with strength of preference reported on a 1-9 scale.

Criteria and Attributes considered in Phase 1

No	Criterion	Attribute
1	**Delivery**	Accuracy
2		Capacity
3		Lead time
4	**Business performance**	Financial status
5		Compatibility of business strategy
6	**Quality**	Defective rate
7		Responsiveness
8	**Costs**	Unit cost
9		Order change and cancellation charges
10	**Information technology**	Online
11		EDI
12	**Long term improvement**	Improvement programs
13		R&D activities
14	**Supply Disruption**	Risk score

Phase 1 Experiment

- 4 DMs participated the study and provided the following data:
  - Rating of each attribute (1-10) scale
  - Pairwise comparison of attributes
  - Strength of preference (1-9 scale) for pairwise comparisons
- Experiment was conducted electronically through survey sheets.

Criteria rankings for different methods by a single DM

	Rank using		
Criterion	**Rating**	**Borda**	**AHP**
Delivery	1	2	2
Business Performance	3	3	3
Quality	1	1	1
Cost	5	4	4
IT	6	5	6
Long Term Improvement	6	7	7
Risk	3	6	5

Phase 1 Conclusions

- Cost, quality and delivery are the most important criteria,
- No appreciable difference between Procurement and R&D staff,
- Borda Count results are in line with AHP.
  - Borda Count is a good method for ranking due to less cognitive burden
  - Results are consistent with prior studies

Phase 2: Case Scenario

- Phase 1 reduced initial supplier set of twenty to five
- Considered multiple products, multiple buyers and multiple suppliers with each supplier having multiple price breaks
- Allocate order quantity between different suppliers to meet demand
- Four conflicting criteria for decision making.

Multi Criteria Models for Supplier Selection

- Wadhwa and Ravindran
  - *Computers & OR*, Vol. 34, No. 12, pp. 3725-3737, Dec. 2007
- Criteria – Cost, Quality, Lead time
- Solution by Weighted Objective, Goal Programming and Compromise Programming methods
- Goal programming more flexible

Mathematical Model

Indices:

I Set of products to be purchased

J Set of buyers

K Potential set of suppliers

M Set of Price Breaks

Variables

X_{ijkm} = Number of units of product i supplied by vendor k to buyer j at price level m

$$Z_k = \begin{cases} 1 \text{ if a vendor is chosen} \\ 0 \text{ otherwise.} \end{cases}$$

Objective Functions

- Minimize the purchasing and fixed cost.

$$\min\left(\sum_i\sum_j\sum_k\sum_m p_{ikm}.x_{ijkm} + \sum_k F_k.z_k\right)$$

- Minimize the average lead-time.

$$\min \frac{\sum_i\sum_j\sum_k\sum_m l_{ijk}.x_{ijkm}}{\sum_i\sum_j d_{ij}}$$

- Minimize loss due to rejects (modeled as MtT risk)

$$\min \sum_i\sum_j\sum_k\sum_m MtT_k.x_{ijkm}$$

- Minimize loss due to hurricanes (modeled as VaR risk)

$$\min \sum_i\sum_j\sum_k\sum_m VaR_k.x_{ijkm}$$

Model Constraints

- Capacity Constraints
$$\sum_j \sum_m x_{ijkm} \le CAP_{ik}.z_k \quad \forall\ i,k$$
- Demand Constraints
$$\sum_k \sum_m x_{ijkm} = D_{ij} \quad \forall i,j$$
- Maximum number of suppliers
$$\sum_k z_k \le N$$
- Linearizing Constraints for quantity discounts
$$x_{ijkm} \le (b_{ikm} - b_{ik(m-1)}).y_{ijkm} \quad \forall i,j,k \quad 1 \le m \le m_k$$
$$x_{ijkm} \ge (b_{ikm} - b_{ik(m-1)}).y_{ijk(m+1)} \quad \forall i,j,k \quad 1 \le m \le m_k - 1$$
- Non-negativity constraints.
$$x_{ijkm} \ge 0$$
- Binary Constraints.
$$z_k \in \{0,1\} \quad y_{ijkm} \in \{0,1\}$$

Solution Method

Goal Programming (GP) is used to solve the multi-objective supplier selection problem.

- Get from the decision maker goals/target. All the goals may not be achievable.
- Get decision maker's preference on achieving the goals.
- Find a solution that will come as close as possible to the stated goals in the specified order.

GP Methods

- Preemptive GP
  - Target set at 110% of the Ideal values.
  - Preemptive priorities, Price, MtT risk of quality, lead-time, VaR risk (from Phase 1 results)
- Non-preemptive GP
  - Weights obtained from Phase 1.
- Tchebycheff (Min-Max) GP
  - Minimize the maximum weighted deviation from the targets. Weights obtained from Phase 1.
- Fuzzy GP
  - Minimize the maximum weighted deviation from the ideal values. Weights obtained from Phase 1.

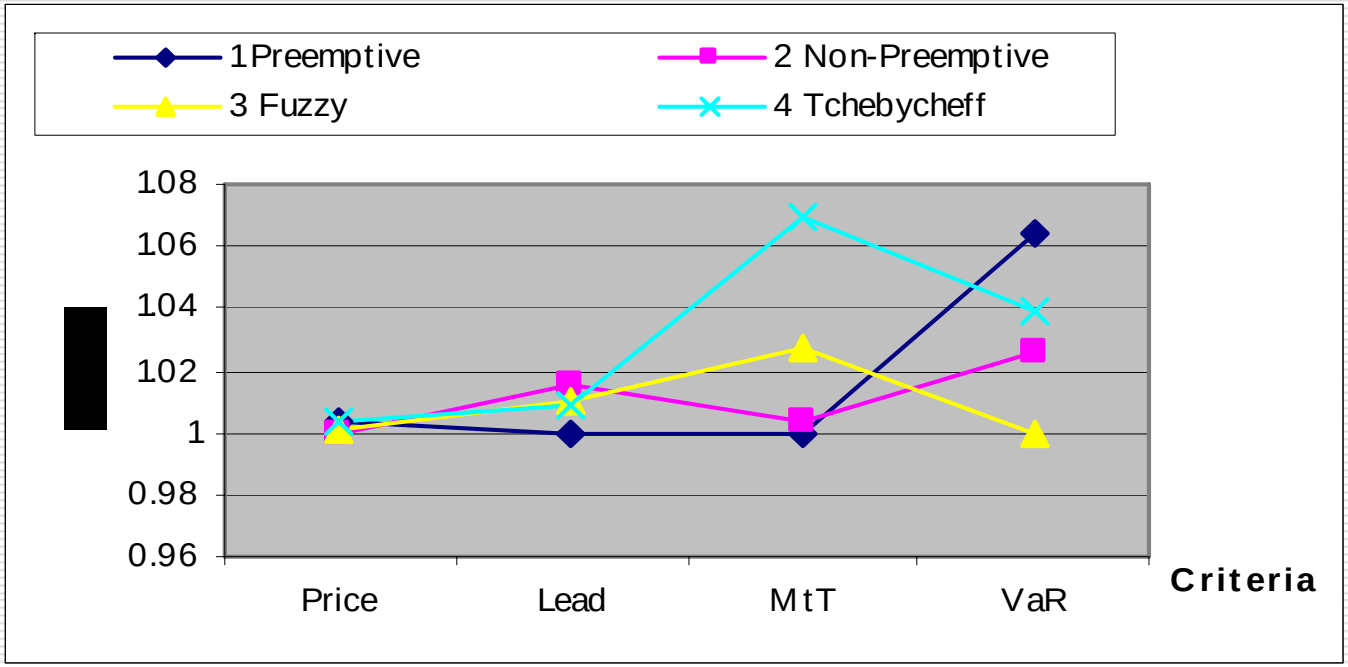
Problem Size

- For a problem with *2* products, *2* buyers, *5* suppliers with each supplier having *2* price breaks, the problem size is as follows:
  - Total number of continuous variables: *40*.
  - Total number of binary variables: *45*.
  - Total number of constraints:
    - Capacity constraints: *10*.
    - Demand constraints: 4.
    - Number of supplier constraint: *1*.
    - Linearizing constraints: *60.*

Value Path Approach

- Efficient way to visualize different solutions and their trade-offs
  - Display contains set of parallel lines; one for each objective.
  - Value of each solution on the axis is that solution value divided by the best solution for that objective.
  - If two lines intersect then neither solution dominates the other.

Value Path Contd..



Phase 2 Conclusions

- Including conflicting criteria in supplier selection improves the quality of decision making process by providing valuable tradeoff information that can be used to optimize the supply network,
- Goal programming models provide multiple solutions that can be discussed by procurement before selecting an optimal procurement strategy.
- Tradeoff information can be effectively visualized using the Value Path Approach

Summary

- Vendor management plays a big role in Supply Chain efficiency
- Increasingly companies have to adjust current domestic strategies to accommodate global needs
- Several factors impact the chance of success in Global Sourcing
- Consider cost and risk in vendor management
- Monitor supplier performance

Note: There is No Reward without Risk!