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SUPPLY CHAIN COORDINATION BY INFORMATION SHARING

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Abstract -Nowadays, the effective supply chain is one of the important issues in the industrial management context. In today's world that is confronted with rapid technological changes and high competitiveness, companies are more successful that respond to the customers' needs effectively, regarding the existing opportunities and threats. Since a supply chain consists of various organizations, it can satisfy customers' needs, only when the whole of its parties become integrated and coordinated.

Keywords- ***Information Sharing, Purchase problems, Suppy Chain***

I. INTODUCTION

Recent years have seen a growing globalization of markets and concentrations of companies on their core competencies on resulting in increasing supply chain coordination in supply chain management. Supply chain management can be defined as integrative philosophy to manage the total flows of entire business process . A supply chain is composed of trading partners that are interconnected with financial, information and product/service flows. Effective management of these flows requires creating synergistic relationships between the supply and distribution partners with the objective of maximizing customer value and providing a profit for each supply chain member **.**

Supply Chain Evolution and Information Sharing

The predecessor of supply chain technology was still in infancy as a modern management science. Since then, enterprises have made increasing efforts to adjust internal functions, reorganize business units, and implement enterprise software in order to optimize their operations. Supply chain technology goes even further in examining how to collaborate with business partners seamlessly and synchronize inter-organizational business processes to produce greater efficiencies and realize more value. In general, based on the degree of collaboration and the number of participants, supply chains could be classified into three categories: partner collaboration, value chains, and supply networks.

Since a supply chain consists of various organizations, it can satisfy customers' needs, only when the whole of its parties become integrated and coordinated. The results showed that one of the important objectives in a supply chain is coordinating all of its parties, so such coordination mechanisms that provide coordination between various members of a supply chain, have more importance. Supply chain coordination works when all stages of a supply chain work towards the objective of maximizing total supply chain profitability based on the shared information. Lack of coordination can result in a significant loss of supply chain profit. Coordination among different stages supply chain requires each stage to share appropriate information with other stages.

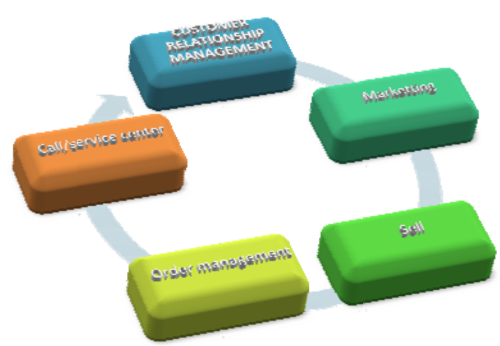

FIG.01 Coordination based on shared information

Supplier selection and purchase problem

In the real production process, some members in the supply chain system sometimes cannot effectively complete their production task because of defects involving the production or purchasing of components.

Today's rapidly changing conditions force firms to concentrate on reducing costs to increase their competence. Firms must choose the best supplier(s) to gain a competitive advantage over other companies. Selection of suppliers in the supply chain system is an important matter for an enterprise in today's competitively intensive commercial environment. Erroneous selection of supplier may lead to problems of operation and finance. The aim of supply chain design is to provide an optimal platform for efficient and effective supply chain management. This problem is often an important and strategic operations management problem in supply chain management. The challenge is to determine the number, location, capacity and type of production producers and distribution centers (DCs) to use so as to minimize the total cost, or to maximize the after-tax profit, of the supply chain.

For the entire chain, it is also necessary to select the set of suppliers hence to determine the number of supply contracts. In practice, it is necessary to consider suppliers in the comprehensive design of a supply chain.

The supply chain is a networked system needing the inter cooperation of partners at the upstream, midstream, and downstream echelons along the supply chain, and the previous one of each echelon is the partner, so the selection of partners is a very important topic for discussion in supply chain management.

The supplier selection and purchase problem are governed by two main decisions: which supplier should be selected and how much should be ordered from the selected supplier.

The supplier selection and purchase problem have attracted the attention of a number of researchers who have proposed various models and solutions. Burke et al. proposed an optimal approach in a case where a set of selected suppliers, with limitations on minimum order size, must supply a buyer facing stochastic demand. They analyzed single period, single product sourcing decisions under demand uncertainty. Their approach integrated product prices, supplier costs, supplier capacities, historical supplier reliabilities, and firm-specific inventory costs.

II. DETAILS OF THE SUPPLY CHAIN UNDER STUDY

Producer faces a known demand D for a finished product, this finished product is assembled using a special component or primary product, the primary product is being ordered in quantity q from the supplier assuming producer requires one unit of component to produce for one unit of finished product.

Therefore to fulfill known demand D for the finished product we require D units of primary product in total on the other hand the normal capacity (long term) of the supplier is denoted by C.

Supplier capabilities

The supplier might not have just one but several producers, supplier capability to process the order of considered producer as being limited to a portion which can be shown mathematically as: αc {with $\alpha \in (0,1)$ }

At the time producer places the order, the realized value of α is not known to the supplier but only its probability density function $f(\alpha)$ is known, this leads to supply uncertainty in considered supply chain

To cover the demand of the producer the supplier can build up "Extra Capacity Δ", in contrast to the normal capacity the extra capacity is built up exclusively for the considered supplier and therefore is deterministic.

III. MATHEMATICAL FORMULATION

From the above discussion it is clear that delivery quantity Q depends on following parameters:-

(1) Available capacity "αc"
(2) Extra capacity "Δ"
(3) Order quantity "q"

Assumption made: - The capacity consumption rate equals unity.

Therefore the delivery quantity is restricted by the following capacity constraints: $Q \leq \alpha c + \Delta$

Also the supplier does not deliver more than what is ordered hence the delivery quantity Q equals the minimum of the order quantity q and maximum deliverable quantity $\alpha c + \Delta$ based on the available capacity αc.

$Q = \min \{\alpha c + \Delta, q\}$-------------------------(1)

The delivery quantity depends on the extra capacity as well as on the available normal capacity αc of the supplier and might not match the ordered amount at the delivery date.

IV. PROBLEM AND SOLUTION

(Data Take Form Shawallace Factory, Jabalpur)
External demand D = 100 units

The price changed by the supplier to the producer per each unit of the supply product C_p= Rs. 10

The producer must store any unsold supply product i.e. holding cost c_h^p=Rs. 3 per unit

The shortage cost C_s = Rs.60 per unit

The normal capacity of the supplier C = 100 unit

α is the uniformly distributed over the range [0.7,1]

Cost for building up extra capacity i.e. to increase the capacity by one unit costs the supplier

C_e = Rs. 3/-

Holding cost for the supplier c_h^s = Rs. 1 /- per unit

In case the order coincides with the external demand, the supplier can meet the without building up extra capacity only in case ofα = 1.

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The producer order the quantity order quantity q= 100 units

The optimal capacity decision of the supplier in a worst case scenario

$\Delta^{worst}_{optimal}$= D – C $\frac{\mathrm{Ce}(\overline{\alpha}-\underline{\alpha})+\overline{\alpha}\mathrm{Ch}+\mathrm{Cp}\underline{\alpha}}{\mathrm{Ch}+\mathrm{Cp}}$ (from equation 8)

$= 100 - \frac{100\,[\,(3)(1-1.07)+1(1)+10\,(0.7)]}{1+100}$

= 19.09 units

The expected total cost for the entire supply chain E [C_{joint}(q,Δ^{worst}_{opt})] is

$= C_s\int_0^{\frac{(D-\Delta)}{c}} (D-(\alpha c+\Delta^{worst}_{optimal})f(\alpha)\,d(\alpha)$ + min $(c_h^p,\ c_h^s)$ $\int_{\frac{(D-\Delta)}{c}}^{1}(\alpha c+\Delta^{worst}_{optimal}$- D)f(α)d(α) + C_e $\Delta^{worst}_{optimal}$ (from equation 10)

$= 60 \int_0^{(100-19.09)/100}\{100-(1(100)+19.09)f(\alpha)d\alpha$ + min (3,1) $\int_{0.8}^{1}\{1(100)+19.09-100)\}f(\alpha)d\alpha$ + 3(19.09)

= Rs. 182.35

The expected cost for the producer

$E(C_{pc}) = 60 \int_0^{\min\{0.8,0.8\}} 100-\{1(100)+19.09\}f(\alpha)d\alpha + 60(100\text{-}100)\int_{0.8}^{1} f(\alpha)d\alpha 1_{\{D>q\}} + 3\int_{0.8}^{0.8}\{1(100)+(19.01-100)\}f(\alpha)d\alpha + 3(100\text{-}100)\int_{0.8}^{1} f(\alpha)d\alpha 1_{(D\le q)} + 10\int_0^{0.8}(1(100)+19.09)f(\alpha)d\alpha + 10(100)\int_{x(q,\Delta)}^{1} f(\alpha)d\alpha$

(from equation 3)

Where $y(\Delta) = \frac{D-\Delta}{c} = \frac{100-19.09}{100} = 0.8$

$x(q,\Delta) = \frac{q-\Delta}{c} = \frac{100-19.09}{100} = 0.8$

= Rs. 1099.17

The expected profit for the supplier

$E(C_{ps}) = C_p\ {}_0\int^{x(q,\Delta)}(\alpha c+\Delta)f(\alpha)d\alpha + C_p q_{x(q,\Delta)}\int^1 f(\alpha)d\alpha - C_h\ {}_{x(q,\Delta)}\int^1(\alpha c+\Delta\text{-}q)f(\alpha)d\alpha\text{-}C_e\Delta$

(from equation 5)

$= 10\ {}_0\int^{0.8}(1.100+19.09)f(\alpha)d\alpha + 10(100)\ {}_{0.8}\int^1 f(\alpha)d\alpha - 1\ {}_{0.8}\int^1 (1(100)+19.09\text{-}100)f(\alpha)d\alpha\text{-}3\,(19.09)$

= Rs.916.82

The optimal capacity decision in the best case scenario:

$\Delta^{joint}_{optionl} = \Delta - C\,\frac{\mathrm{Ce}(\overline{\alpha}-\underline{\alpha})+\overline{\alpha}\min[c_h^p,c_h^s]+\mathrm{Cs}\underline{\alpha}}{\min[c_h^p,c_h^s]+\mathrm{Cs}}$

(from equation 12)

= 28.03 units

The minimal expected total cost $E(c^{joint}_{optimal}, \Delta^{joint}_{optimal})$

$= C_s\int_0^{(D-\Delta_o^j)} D-(\alpha c+\Delta^{joint}_{optimal})f(\alpha)d\alpha$ + min $\{c_h^p, c_h^s\}\int_{(D-\Delta^{joint}_{optimal})/C}^{1}(\alpha C+\Delta^{joint}_{optimal}-$ $D)f(\alpha)d\alpha$ + $C_e\Delta^{joint}_{optimal}$

(from equation 10)

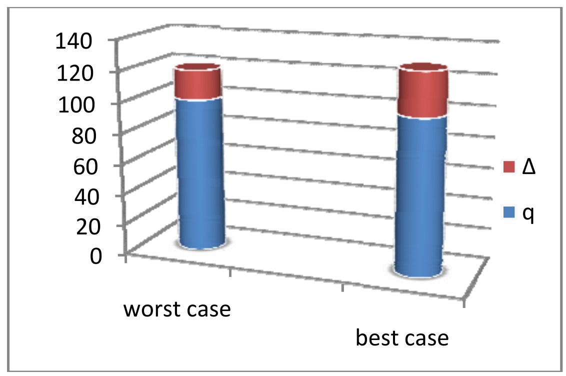
= Rs. 101.06

V. COMPARATIVE ANALYSIS

(1) Worst Case Vs Best Case

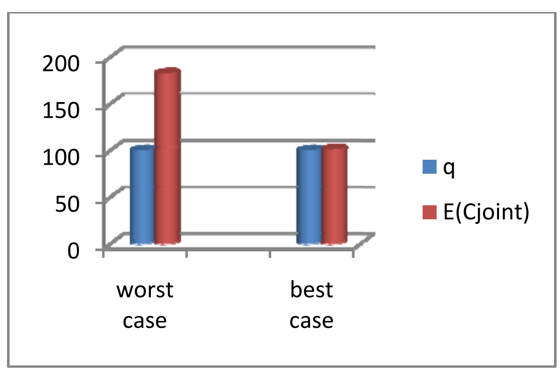
	q	$\Delta^{worst/best}_{optimal}$	E(C_{pc})	E(C_{ps})	E(C_{joint})
Worst case	100	19.09	1099.17	916.82	182.35
Best case	_	28.03	_	_	101.06

Table 4: Worst Case &Best-Case Comparative Analysis



Graphical comparison between Demand & Extra capacity

This graph clearly shows that for the same order quantity we achieve more extra capacity in best case as compared to worst case.



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Graphical Comparison between Demand & the Expected Total Cost for the Entire Supply Chain

The graph shows the result of the considered numerical example in which the total expected cost of the entire supply chain in best case is 55% less than in the worst case.

VI. CONCLUSION

Since the expected total cost of the entire supply chain using the coordination mechanism equals the expected total cost of the best case the gap between the worst and the best case shows the cost savings which can be achieved through the considered coordination mechanism.

Note that in the existing supply chain partnership the expected total cost will always be situated between the best and worst case. The figure shows that in case of the maximal bonus value A_{max} the producer must bear almost the whole expected total cost of the supply chain while in the case of maximal penalty cost C_{hmax} the supplier has to bear the expected total alone.

Assuming the producer orders precisely what he requires, he has to offer a bonus payment at a value of A_{max} or change a penalty cost at the value of C_{hmax} per unit in order to minimize the overall expected total cost of the entire supply chain.

The case study shows on one hand which substantial cost savings might be achieved in practice by implementing the developed coordination mechanism. This result is of particular interest from general point of view of s.c.m.

Since the cost savings refer to the overall cost of the entire supply chain. On the other hand, the study shows that the coordination mechanism is flexible enough to enable the different allocations of these overall costs thus allowing both parties in an existing supply chain partnership to make a profit.

VII. FUTURE WORK

Since the project primarily focused on finding general analytical results, the supply chain was described on a highly aggregated level and the results are based on assumptions which might not completely hold in practice. But it can be shown that the coordination mechanism is also applicable to realistic situation where the parties of the supply chain have some private information.

Another important extension to consider is the coordination of more than two parties in a supply chain. In particular it would be worth pursuing whether the concept of combining an execution-oriented decision with a control-oriented decision leads to similar flexible cost allocations for these observed multiple decisions.

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