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Improving Cost Efficient Manufacturing unit by Considering unit facility and Supplier Routing Cost in Supply Chain

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Abstract - Inventory management is an important part of any business because inventories are usually responsible for the majority of the expenses incurred in business operations . Supply chain management is the management of the series of suppliers and purchasers, encompassing all phases of processing from procuring of raw materials to delivery of completed goods to ultimate consumers. Routing has become one of the most important types of supply chain management software as it is indisputably one of the most important components in managing the global supply chain. Identification and correction of the organization's capability to generate products and services in par with customer demand is the objective of facility planning. The proposed system is used to find the optimized usage of the facility of the manufacturing unit and also it finds the optimized usage of the facility of the manufacturing unit and also it finds the best routed supplier with minimum routing cost.

Keywords-Delay cost, facility, Inventory control, path cost, routing , supply chain, Transportation cost, Total cost.

1. INTRODUCTION

Global competition, shorter product life cycles, dynamic changes of demand patterns and product varieties and environmental standards frequently cause significant changes in market scenario compelling manufacturing enterprises to supply their best in order to survive [5]. Considerable stress is placed on their supply chains by this change that demands for an improved coordination of the performed actions and supply chain management techniques that can concurrently improve the customer service and reduce the cost are available for companies [6]. Supply chain (SC) management is a network of organizations, people, activities, information and resources and it is engaged in the physical flow of products from supplier to customer [4]. Nowadays, inventory management is considered as an important field of Supply chain management [2]. Maintaining the cost efficiencies while transporting the right product to the right place at the right time is the basic objective of supply chain management [10]. Inventory is a reserve of goods preserved for meeting future demand. Determining appropriate ordering time and ordering quantity is the objective of inventory management. Typical supply chain configuration decisions include identifying location for production and distribution facilities, choosing supplier and creating links between the supply chains units [13]. Several manufacturing companies use a production inventory system to manage changes in demand of the consumers for the product. A completed goods warehouse to store products that are not sold immediately after production and a manufacturing plant exists in such systems [8]. The material handling and storage system greatly influence the performance of any manufacturing company .Routing has emerged as one of the most significant kinds of supply chain management, because it is one of the most crucial elements in managing the global supply chain. Companies are compelled to constantly search for ways to improve their operations by the characteristics of the present competitive environment for example the rapidity with which products are designed, produced and delivered, in addition to the requirement for superior efficiency and lower operational expenses (30). One of the difficult to optimally solve combinatorial optimization problems is the inventory-routing problem (27). Identifying a distribution strategy that

decreases long term distribution costs is the objective of inventory routing problem (IRP) (29).

Finding the best reordering point and best ordering quantity according to the facility of the manufacturing unit is an important factor which avoids the over ordering and lack ness in product storage. The prior research of the author [] finds the optimized reorder point and the ordering quantity of the manufacturing unit which develops the sample best chromosome as in table:1. The proposed research improves the prior research by finding capacity agreeable efficient solution demand matrix. In the real time, the shipment department in each supplier plant considers the factors like delay cost, path cost and transportation cost. The decision of choosing the best supplier providing the minimum routing cost for the required raw materials is the challenging feature for the inventory control of the manufacturing unit. The proposed system also finds the best routed supplier with minimum routing cost.

2. Finding efficient facility agreeable solution demand matrix and minimum routing cost supplier

. In this research we improve the ordering quantity according to the facility of the manufacturing unit by finding the facility agreeable efficient solution demand matrix using Genetic algorithm. This research also finds the best routed supplier for ordering the products. Let 'MN' be the manufacturing system which uses the raw materials $R = \{R_1, R_2, R_3 .... R_n\}$ for production and these raw materials are shipped from the suppliers $S = \{S_1, S_2, S_3 .... S_n\}$. The demand rate of each raw material for the preceding M period is forecasted to determine the optimized amount of order and optimized reorder point of 'MN' for the period of $M = \{M_1, M_2, ... M_k\}; 1 < k \le 12$. Let $D1 = \left\{ D1_{ij} \middle| i = 1, \cdots, |R|;\ 1 < j \le |M| \right\}$ be the forecasted demand rate for each material in R, where $D1_{ij}$ is the predicted demand for the i[th] raw material for the j[th] month forecasted using the observed historical data.

2.1. Finding the efficient Facility agreeable solution demand matrix

he forecasted demand rate $D1$ is used to create the associated solution demand matrix $D2 = \left\{ D2_{ij} \middle| D2_{ij} < N_{\max};\ i = 1, \cdots, |R|; 1 < j \le |M| \right\}$ consisting of the forecasted solution demands for each raw material for the interval M, where $N_{\max} = Max(D1) + 0.20 \times Max(D1)$. The arbitrarily created solution demand rate for each raw material is smaller than $N_{\max}$ and each row of the connected solution demand matrix yields the likely ordering amount of each raw material in R. From the solution demand matrix $D2$ the efficient solution demand matrix $\Delta D2 = \left\{ \Delta D2_{ij} \middle| \Delta D_{ij} = D2_{ij} - \mathrm{Re}_j;\ if \sum D2_{ij} > C; i = 1, \cdots, |R|; 1 \le j \le |M| \right\}$ where $\mathrm{Re}_{ij} = \dfrac{\sum D2_{ij}}{Cnt}$ is the reduction amount and Cnt is the no of positive orders in the i[th] month. The generated ordering quantity in the solution demand matrix is tuned to be efficient by using the holding capacity 'C' of the manufacturing unit. The Pseudocode-1 represents the process of finding the capacity agreeable efficient solution demand matrix. The generated solution demand matrix and the maximum holding capacity of the manufacturing unit is given as input to the procedure. The sum of ordering quantity of every positive order and the number of positive orders are calculated. If the sum of ordering quantity for a month in the demand solution matrix is greater than the capacity of the manufacturing unit then the ordering quantity is adjusted by the Re_j value so that it can satisfy the holding capacity. Eventually, we obtain $\Delta D2_{ij}$, an efficient solution matrix that can satisfy the capacity of the manufacturing unit.

Input : Solution Demand matrix $D2$, Maximum Holding capacity C
Output : The Resultant Solution demand matrix $\Delta D2$ with facility
Parameters:
M_k →Months
$D2_{(ki)}$ → Ordering quantity of i[th] raw material for the k[th] month.
Re_j → Reducing amount
Pseudocode:

For each $M_k \in M$
Set $S_k = \sum D2_{ki}$
Set $count_k =$ no of positive order for k[th] *month*
Set $\mathrm{Re}_k = S_k / count_k$
For each $D2_{ki}$
If positive order and $S_k > C$
$\Delta D2_{ki} = D2_{ki} - \mathrm{Re}_k$
End If
End For

Pseudo code 1: The process of finding facility agreeable efficient solution demand matrix

2.2. Finding the best routed supplier

The manufacturing unit 'MN' purchases the raw materials 'R' from the supplier 'S' that are needed for production .Each supplier has the different routing cost for shipping the product from the supplier plant to the manufacturing unit. The same raw material may have the different routing cost among the various suppliers. For example for the raw material 'R1' the 'Supplier-1' may fix the cost 'C1' where the 'Supplier-2' may have the cost 'C2' which is greater than 'C1'.The Table -1 illustrates the sample best chromosome which represents the optimized reorder point of the raw materials for the 'M' months. The table1 represents that the raw materials to be purchased for the month 'M1' is 'R1,R4,R9,R10'. The '1' in the table illustrates the positive ordering status of the raw material and '0' represents the negative ordering status of the raw material.

Table I : Sample best Chromosome

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
M1	1	0	0	1	0	0	0	0	1	1
M2	1	0	0	1	0	0	0	0	0	1
M3	0	0	1	1	0	0	0	0	0	1
M4	1	0	0	0	0	0	1	0	0	1
M5	1	0	0	1	0	0	0	0	0	0
M6	0	1	0	0	0	0	0	1	1	0
M7	0	0	1	0	0	0	1	0	0	1
M8	1	0	0	0	0	0	0	0	0	0
M9	0	0	0	1	1	0	0	0	0	0
M10	1	0	0	0	0	0	1	0	0	1
M11	0	0	1	0	0	0	1	0	0	0
M12	0	0	0	0	0	1	0	0	0	0

Let $PR_{ki\ ;\ i\ =\ 1..10}$ be the set of the raw materials to be purchased for the k[th] month, where k=1..12, $SC=\{SC_i;\ i=1..|S|\}$ be the set of raw materials that are supplied by the each supplier where $SC_i=\{R_j\ |;\ j\in 1..10\}$ is the raw materials supplied by the i[th] supplier and $RC=\{RC_{ij}\ |;\ j\in 1..10\}$ is the routing cost of the raw materials supplied by the i[th] supplier. For example, from the table1 the raw materials to be purchased for the 1st month is $R1, R4, R9, R10$. The $DA=\{DA_i\ |;i\in 1..10\}$ is the combination of the raw materials supplied by the supplier with their routing cost are separated and stored according to their length wise.

The Pseudo code 2 below represents the steps used for finding the best routing supplier. From the best chromosome, the raw material list to be purchased for a month is identified and their each combination list is generated. The 'n' combination list of supplier having the minimum routing cost is found out first and among 'n' combination the combination having the minimum routing cost is selected for the first month. This process is repeated for every month and the supplier list ΔS with minimum routing cost for the required raw material is generated.

Input : Best Chromosome BC, The raw materials supplier by the Suppliers SC, RC the routing cost of the raw materials supplied by the supplier, DA_r the combination database.

Output : The Supplier list ΔS with minimum routing cost for the required raw material.

Parameters:

M_k → Months

PR_k → Purchasing raw material

PR_{comb_i} → Combination list of purchasing raw material

Pseudo code:

For each $M_k \in M$
  Get PR_k
  Generate PR_{comb_i}
  Set $l = length(PR_k)$
  Randomly select r < l
  For each $i \le r$
    Sel = r length data in PR_{comb_i}
    If Sel exist in DA_r
    $RCost = RC_r$
    Endif
    SS = min (Rcost)
    RR = DA_r *(min (Rcost))*
    r=r-1
  End for
  ΔS = ΔS + RR
End for

sample best chromosome having the optimized reorder point for ordering the raw materials.

Table 2: Sample best chromosome

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
M1	0	1	1	0	0	0	0	1	0	0
M2	1	0	0	1	0	0	0	0	0	0
M3	0	1	0	0	0	1	0	1	0	0
M4	0	0	0	0	1	1	0	0	0	0
M5	0	0	1	1	0	1	1	0	0	0
M6	1	1	0	0	0	0	0	0	0	0
M7	0	0	1	0	0	0	1	0	1	0
M8	0	0	0	1	1	0	1	0	0	0
M9	0	0	1	0	0	0	1	0	0	1
M10	1	0	0	0	1	0	0	0	0	1
M11	0	0	0	1	0	1	0	0	0	0
M12	1	0	0	0	1	0	0	1	0	0

Table 3: The Purchasing list of raw materials.

Month	*Raw materials to be purchased*
M1	*R2,R3,R8*
M2	*R1,R4*
M3	*R2,R6,R8*
M4	*R5,R6*
M5	*R3,R4,R6,R7*
M6	*R1,R2*
M7	*R3,R7,R9*
M8	*R4,R5,R7*
M9	*R3,R7,R10*
M10	*R1,R5,R10*
M11	*R4,R6*
M12	*R1,R5,R8*

From the table 2 the raw materials to be purchased are identified by their values and table 3 represents the purchasing list of the raw materials to be purchased for the whole period. The raw materials which are supplied by the supplier are listed and their combination with the routing cost is stored in the database according to their length wise.

Table 4:(a) the sample supplying

Raw material list arranged with the Length 1.

Supplier	Combination	Routing cost
1	2	75
1	3	84
1	9	40
1	7	10
1	1	27
2	5	58
2	6	100
2	4	37
3	8	18
3	10	88
3	2	28
3	3	85
3	9	81
3	7	19
3	1	98

The table 4 represents the sample raw material list supplied by the suppliers which are arranged by their length. The Raw materials to be purchased for the month 'M1' is chosen first also the combination of the purchasing list are generated. The table 5 illustrates the combination list of the materials.

Table 5: Combination List of the raw materials to be purchased

Sno	Combination
1	R2
2	R3
3	R8
4	R2,R3
5	R2,R8
6	R3,R8
7	R2,R3,R8

The count of the raw materials to be purchased is found out first. In our example the count of the raw materials to be purchased for the first month is 'l=3'. Randomly choose a number less than 'l' for choosing the supplier list. If the randomly choose number is 2 then the occurrence of the two length combination in the purchasing list is searched in the two length supplier list. It is occurs then the corresponding routing cost 'RR' is selected and stored, then the all the '1' length combination item in the purchasing list is searched in the 1 length supplier list and their routing cost is found out and finally a best combination represents the supplier list to be chosen are found. The above steps are repeated 'n' times to get 'n' combination of the supplier list. From the 'n' combination, the best combination having the minimum routing cost is selected for the first month. Like wise the best combination are chosen for the each month in the whole period. The best combination supplier list, corresponding routing cost and minimized total routing cost for the dataset -1, are illustrated in table-6(a).

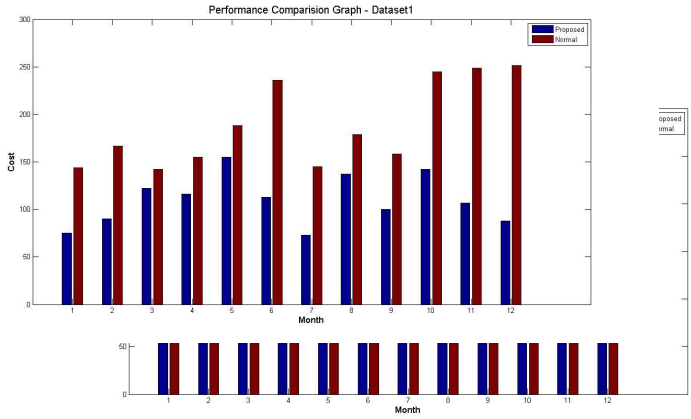
Table-6(a) Best supplier combination list with the minimized routing cost
Dataset 1.

```
Resource => Supplier => Cost
Month :1
2 3    =>    5    =>    39
8    =>    4    =>    36
Total Cost :75
Month :2
1    =>    4    =>    46
4    =>    5    =>    44
Total Cost :90
Month :3
2    =>    3    =>    67
6 8    =>    2    =>    55
Total Cost :122
Month :4
5    =>    4    =>    53
6    =>    4    =>    63
Total Cost :116
Month :5
3 4    =>    2    =>    56
6    =>    4    =>    63
7    =>    2    =>    36
Total Cost :155
Month :6
1    =>    4    =>    46
2    =>    3    =>    67
Total Cost :113
Month :7
3    =>    5    =>    30
7    =>    2    =>    36
9    =>    3    =>    3
Total Cost :69
Month :8
4    =>    5    =>    44
5    =>    4    =>    53
7    =>    2    =>    36
Total Cost :133
Month :9
3    =>    5    =>    30
7 10    =>    5    =>    70
Total Cost :100
Month :10
1    =>    4    =>    46
5    =>    4    =>    53
10    =>    2    =>    43
Total Cost :142
Month :11
4    =>    5    =>    44
6    =>    4    =>    63
Total Cost :107
Month :12
1    =>    4    =>    46
5 8    =>    4    =>    42
Total Cost :88
```

Performance evaluation

The performance of the proposed approach is evaluated using different data set. The performance is evaluated by comparing the total routing cost given by the recommended suppliers by the proposed method with the routing cost of the non recommend suppliers. The figure(a) represents the comparison graph of the routing cost of the recommend suppliers with the routing cost of the non recommendedsuppliersfordataset-1,

The figure-(a) below illustrates that the routing cost of the suppliers recommend by the proposed method is less than the routing cost of the non recommended suppliers.



Conclusions

Inventory management is fundamentally related to specification of the quantity and placement of stocked goods. Safeguarding the normal and forecasted course of production against the arbitrary disturbance of running out of materials or goods necessitate inventory management at several locations within a facility or within multiple locations of a supply network. Selection of the least cost, distance, and time route from diverse choices for a good decision to arrive at its destination is called routing. Inventory routing problems in which inventory control and routing decisions are to be made at the same time is one of the more significant and more challenging extensions of vehicle routing problems. It can be used for the management of storage capacity for raw materials in manufacturing units. The proposed system improves the prior research of the author by finding the facility agreeable solution demand matrix and also this research finds the best routed supplier having the minimum routing cost.

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