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Algorithm For Optimizing Warehouse Capacity And Procurement Model

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Abstract: ***This paper presents the building of static algorithm and converts it in to dynamic algorithm. In static algorithm, we carried out how the competitive bidding take place in the case of contracting company. A competitive bid process is typically used in the procurement of goods and services. The process involves tendering a closed covering specifying the price and footings of a bid. The addressee of the bid later chooses the cheap dealer that has provided the lowest price. While in case of dynamic algorithm, we are reflecting the scenario of maximum warehouse utilization in which objective function, constraints like demand uncertainties and warehouse capacity will come as part of it.***

I. INTRODUCTION

STATIC ALGORITHM SCENARIO

In many areas of industry, procurement of goods and services takes place by competitive bidding. Competitive bidding takes stretched remained used as technique aimed at assigning and buying agreements in the contracting industry. By a stoppage in the worldwide fiscal growth, companies must take business away from competitors if they are to withstand their growth rate. However, quickly fluctuating technology are producing new sources of competition. In order to be fruitful in the aggressive economy some contractors have related plans in competitive bidding situation. Here in this paper one of the approach used is the static algorithm (Vendors Comparison Sheet).

CREATION OF STATIC ALGORITHM

Once the project is on, client will submit the specifications, bill of materials (BOM) and drawings. The drawings can revise according to the changes. The engineers will double check the drawings whether it is as per the specifications or not. Then the estimation of quantity required by using AutoCAD and PDF Exchange Viewer Software's. Then the estimated BOM will send to the suppliers as per the specified vendor list for the project. Suppler will bounce back the quotation reflecting the price of materials. Then creation of Vendors Comparison sheet. Results-From the Vendor Comparison Sheet, Competitive bidding is more efficient, instead of go with Single bidding. As in the single bidding, many limitations can arise. Finally, Procurement Manager will choose the best suppliers who provided the lowest price.

DYNAMIC ALGORITHM SCENARIO

Warehouse is one of the essential components in a supply chain. The major roles of warehouses include storage of raw material and finished goods, handling the material flow along with accommodating the variability factors like demand uncertainty, product seasonality, production factors and transportation. Other processes like consolidation of products according to requirement of organization and value added services like packing, labelling, documentation and usage IT technologies such as Warehouse Management Systems, bar coding etc. to ensure the smooth flow of services.

Our major objective in creating dynamic algorithm is to ensure the maximum utilization of warehouse always. The seasonal variation and demand uncertainties are the key issues faced to keep warehouse fully utilized. Two types of goods mainly utilize warehouse capacity are raw material goods and finished goods. Demand of the goods is directly proportional to finished goods i.e., as demand decreases finished goods requirement decreases and as demand increases finished goods requirement increases. Therefore, during the low demand period, we need to procure more raw materials to keep the warehouse space utilized effectively.

II. REVIEW OF LITERATURE

(Guofeng Qin, Jia Li, Nan Jiang, Qiyan Li & Lisheng Wang, 2013) discussed the problem on how to assign a position for goods on the shelf in the automated warehouse system. They brought out models like efficiency model and classification model. They also found that the genetic algorithm could be used to solve and optimize multi objective problem. The algorithm improved the efficiency of the storage and the cost and time has reduced.

(Vrysagotis, Vassilios & Patapios Alexios Kontis, 2011) presents solution algorithms for various warehouse layout problems. The solution algorithm they presented provides further discern to analytical models and uses of simulation models. They proposes for more research on the categorization of simulation models according to the software used for it and further scopes on the types of metaheuristics for solving warehouse layout problems.

(Tran, Xuan-Thuong & Thanh-Do Tran & Hwan-Seong Kim,2014) studies on optimizing transportation sequence in warehouse by concentrating on double cycle storage and retrieval problems(DCSRP) by soving it using genetic algorithm. They concludes that swap mutation provides better convergence than the inversion and algorithm can effectively solve the instances to optimality with limited number pf function evaluations. They proposes investigations on effectiveness of algorithm when problem size grows to a larger number of items.

(Xiandong Zhanga, Yeming (Yale) Gong b, Shuyu Zhouc, René de Koster c, Steef van de Velde, 2015) considered a self-storage warehouse facing orders for homogenous and heterogeneous storage units for a certain period of time. With operational constraints like the maximal upscaling level, precedence order constraints, and maximal idle time, the established mixed-integer program cannot be solved efficiently by commercial software. They proposed a column generation approach and a branch-and-price method to find an optimal schedule. The analysis showed that compared with current methods in self-storage warehouses, the method proposed by them can significantly increase the revenue.

(Sabo, Aleksandra, 2012) discusses on optimization of shortest path which employee takes during supply of goods in the stock by using the heuristic algorithm. They mainly concentrated on daily work in high-rise warehouses and problems associated with rotation of goods. They concluded that heuristic algorithms and implementing them with provide satisfactory results. They propose further study on modifying classic algorithms and increasing efficiency of the algorithm by various means.

(Angatha, Veera Venkata Sudhakar & Karri Chandram & Askani Jaya Laxmi, 2015) studies on solving bidding strategy in deregulated power market by using Differential Evolution algorithm. They concludes that proposed algorithm is an effective method in terms of quality and profit generated. The paper also predicts the scope of study on using bidding problem on improving competitiveness and number of consumers.

(Matic, Dragan & Vladimir Filipovic & Aleksandar Savic & Zorica Stanimirovic, 2011) presents a genetic algorithm (GA) for solving NP-hard Multiple Warehouse Layout Problem. Experimental results show that the algorithm reaches most of optimal solutions for problems containing up to 40 item types. The algorithm implementation described in this paper can be extended to compare obtained results with other metaheuristics to hybrid genetic algorithm.

III. LINEAR PROGRAMMING ALGORITHMS

STATIC ALGORITHM FOR COMPETITIVE BIDDING

Raw materials need to be purchased from a supplier who gives a minimum quote out of n number of supplier

Let $S_1, S_2, \ldots, S_n$ be suppliers who are giving us different quote.

SUPPLIER 1 (S_1)

Unit rate of a raw material $= x_1$, $x_1 > 0$

Bill of Quantity required for meeting the demands= a_1, $a_1 \geq 0$

Total cost $TC_1 = x_1 \times a_1$ were $x_1 > 0$, $a_1 \geq 0$ (1)

SUPPLIER 2 (S_2)

Unit rate of a raw material $= x_2$, $x_2 > 0$

Bill of Quantity required for meeting the demands= a_2, $a_2 \geq 0$

Total cost $TC_2 = x_2 \times a_2$ were $x_2 > 0$, $a_2 \geq 0$ (2)

SUPPLIER N (S_n)

Unit rate of a raw material $= x_n$, $x_n > 0$

Bill of Quantity required for meeting the demands= a_n, $a_n \geq 0$

Total cost $TC_n = x_n \times a_n$ were $x_n > 0$, $a_n \geq 0$ (3)

From (1), (2) and (3)

Selection of Suppliers based on minimum total cost quote given by the supplier

Min ($TC_1, TC_2, \ldots, TC_n$) = Min ($x_1 \times a_1, x_2 \times a_2, \ldots\ldots, x_n \times a_n$) were $x_1 > 0$, $a_1 \geq 0$, $x_2 > 0$, $a_2 \geq 0$, $x_n > 0$, $a_n \geq 0$ (4)

DYNAMIC ALGORITHM

Objectives: Maximum Utilization of Warehouse capacity and minimum total cost incurred for procurement model

Variables: Daily Demand (DD)

Daily Demand varies according to factors such as Seasons, demand uncertainties.

DD ∝ Finished Goods

$\sum w = w_1 + w_2 + \ldots + w_e$, (5)

$\sum w$ = Maximum Warehouse Capacity Utilized, fixed value which varies according to infrastructure facilities, w_1 be the capacity of warehouse 1, w_e be capacity of warehouse e

$\sum b = b_1 + b_2 + \ldots + b_m$, $\sum b \le w$ (6)

$\sum b$ =Total Raw Materials Amount, b_1 be the number of raw materials required for component 1, b_2 be the number of raw materials required for component 2,.., b_m be the number of raw materials required for component m

$\sum c = c_1 + c_2 + \ldots + c_n$, $\sum c \le w$ (7)

$\sum c$ = Total Finished Goods Amount, , c_1 be the number of finished goods for component 1, c_2 be the number of finished goods for component 2,.., c_n be the number of finished goods for component n

From (5), (6) and (7) Maximum Warehouse Utilization can be analyzed by using equation

$\boldsymbol{\sum w = \sum b + \sum c}$ were $\sum b \le w$, $\sum c \le w$ (8)

MAIN OBJECTIVE: Maximize raw materials required for effective warehouse utilization during low demand periods

Let us assume maximum buffer time given for storage of finished goods is 3 days, to reduce the cost incurred in storing finished goods

Taking time constraints t into consideration

$\sum c_t$ = Total finished goods stored, $t \le 3$

$\sum c_{t1} \ge 0$, $\sum c_{t2} \ge 0$ and $\sum c_{t3} = 0$ (9)

By the third day, it is necessary to remove finished goods from warehouse.

So when $\sum c_{t3} = 0$, equation (8) will become

$\boldsymbol{\sum w = \sum b}$ (10)

During that, time maximum raw materials required is needed be procured after a proper market analysis for a particular buffer period.

Main advantages:

- ✓ As raw materials increases, per unit cost of goods decreases. Supplier will reduce the cost for raw materials.
- ✓ Effective warehouse utilization can be obtained.
- ✓ Long-term relationships with supplier
- ✓ Inventory problems like Delayed inventory supply and Delayed production can be avoided
- ✓ Transportation scheduling and costs can be minimized.
- ✓ New orders can be completed easily, by avoiding supply idle time.

Steps of processes:

- ✓ After the warehouse utilization, we will understand number of raw materials and finished goods required.
- ✓ The number of raw materials required will be provided for competitive bidding process.
- ✓ The competitive bidding will provide us the information regarding raw materials cost and number of raw materials ordered.
- ✓ The price for finished goods can be analyzed by considering market demand and production cost
- ✓ The cost of storing finished goods is analyzed by using warehouse daily storage cost and maintenance cost along with packaging, labelling etc.

Contribution Margin can be calculated as follows:

MINIMIZING COST OF WAREHOUSE UTILIZATION

$\sum r = r_1 + r_2 + \ldots + r_m$ were $r \ge 0$ (11)

$\sum r$ = Total Raw materials cost per unit, r_1 be the cost of raw materials per unit for component 1, r_2 be the cost of raw materials per unit for component 2,, r_n be the cost of raw materials per unit for component m

$\sum f = f_1 + f_2 + \ldots + f_n$ were $f \ge 0$ (12)

$\sum f$ = Total Finished goods cost per unit, f_1 be the cost of finished goods storage per unit for component 1, f_2 be the cost of finished goods storage per unit for component 2, f_n be the cost of finished goods storage per unit for component n

$\sum P = P_1 + P_2 + \ldots + P_n$ $P \ge 0$ (13)

$\sum P$= Total Price of finished goods per unit P_1 be the price of finished goods per unit for component 1, P_2 be the price of finished goods per unit for component 2, P_n be the price of finished goods per unit for component n

Z= Total cost incurred in warehouse storage $Z \ge 0$

From (6), (7), (11) and (12)

Min Z= $\boldsymbol{(\sum b \times \sum r) + (\sum c \times \sum f), 0 \le Z}$ (14)

SCENARIO 1

As raw materials increases, per unit cost of goods decreases

$\sum b \propto \frac{1}{\sum r}$

SCENARIO 2

As demand increases, finished goods increases. So that revenue will be increased and can generate more profit

i.e, DD ∝ $\sum c \propto \sum P$

Contribution Margin = Revenue – Cost Incurred

R PROGRAMING CODES FOR WAREHOUSE SPACE ALLOCATION

```
isc<-function()
{
Days<-as.numeric(readline(prompt="Enter no of days"))
n<-Days
TD<-numeric(0)
TD<-as.numeric(readline(prompt="Enter Demand"))
Fin<-TD
WarehouseCap<-as.numeric(readline(prompt="Enter your Warehouse Capacity"))
RawMat<-WarehouseCap-Fin
Cost_of_Fin<-as.numeric(readline(prompt="Enter Cost of Finished Goods"))
TC<-Fin*Cost_of_Fin
Price_of_Fin<-as.numeric(readline(prompt="Enter Price of Finished Goods"))
TP<-Price_of_Fin*Fin
Margin<-TP-TC
a<-data.frame(RawMat,Fin,TD,TP,TC,Margin)
print(a)
```

```
return(a)
}
```

IV. CONCLUSION

Demand uncertainty is an important problem in warehouse space utilization and procuring raw materials from suppliers. In the linear programming algorithm solution, we used daily demand for effective utilization of warehouse space by allocating raw materials and finished goods optimally. This raw material requirement is provided for competitive bidding for achieving minimal price quotation from quality suppliers. Ultimately profit can be maximized which provide a drastic change to contribution margin of organization. Further studies are possible on programming these linear programming algorithms according to requirement of small and large-scale organizations.

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