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Class: MIE 578 Supply Chain Logistics
Prof. Ana Muriel

Supply Chain Synchronization Project

Introduction

Our high-tech manufacturing company is currently dealing with rising transportation costs for parts sourced from the Far East. To tackle these costs and streamline our operations, we are considering a new strategy: consolidating shipments from multiple suppliers into single container ocean shipments.

At present, we manage our orders and deliveries independently, opting to air-freight expensive parts while shipping cheaper parts by ocean freight. We have pinpointed the port of Shenzhen as an ideal consolidation point due to its frequent shipping schedules to our preferred port in Long Beach, at a rate of $1000 per 20-foot container.

Our goal is to develop a shipment scheduling tool that will minimize both transportation and inventory costs over a 26-week planning period. This tool will help us determine the optimal shipping schedules and quantities for each part. Additionally, we will explore the advantages and disadvantages of synchronized shipping, assess the potential need for air-freighting or individual ocean shipping for certain parts, and consider how changes in inventory cost rates might influence our strategy.

Model:

```
reset;

# set

set Part;
set week;


# parameter

param c{Part}; # cost per unit
param w{Part}; # weight per unit
param f{Part}; # New Strategy Fixed Order Cost
param demand{Part,week};  # Demand of part at that week
param h{Part}; # Inventory holding cost rate


# Decision Variables
var X {Part,week} >= 0; # Quantity of part shipped in week
var I {Part,week} >= 0; # Inventory of part at the end of week
var Y {week} binary; # Binary variable indicating if a container is shipped in week

# Objective
minimize totalcost: sum {i in Part, t in week} (f[i] * (X[i,t]) + c[i] * X[i,t]) +sum {t in week} (1000 * Y[t])
                    +sum {i in Part, t in week} h[i] * I[i,t];

subject to Inventory_Balance {i in Part, t in week}:I[i,t] = (if t > 1 then I[i,t-1] else 0) + X[i,t] - demand[i,t];
subject to Demand_Satisfaction {i in Part, t in week}:I[i,t] >= demand[i,t];
subject to Container_Capacity {t in week}:sum {i in Part} w[i] * X[i,t] <= 48000 * Y[t];


data Project_5_data.dat;


option solver gurobi;

solve;

display X, I, Y, totalcost;
```

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Order and Total Cost:

```
Y [*] :=
 1 1    4 1    7 1   10 0   13 1   16 1   19 0   22 0   25 1
 2 1    5 1    8 1   11 1   14 0   17 1   20 1   23 1   26 1
 3 1    6 1    9 1   12 1   15 1   18 1   21 1   24 1
;

totalcost = 11801700
```

What are the benefits of the synchronized shipping strategy?
The benefits of synchronized shipping strategy mainly include reduced transpiration cost, Inventory holding cost and reduced excess stocks, also it helps manage fewer shipments and streamline logistics operations.

Current Operation
We have used the Wagner-Whitin inventory Model to calculate frequency of order and order quantity for each part.

Part 1:
Q [*] :=
1 1197;

f[n] = 682.171

Part 2:
Q [*] :=
1 1074;

f[n] = 1177.25

Part 3:
Q [*] :=
1 1530;

f[n] = 1971.13

Part 4:
Q [*] :=
1 576
13 756;

f[n] = 2823.55

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Part 5:
Q [*] :=
1 680
13 709;

f[n] = 7294.04

Part 6:
Q [*] :=
1 694
13 836;

f[n] = 15818.4

Part 7:
Q [*] :=
1 393
9 198
14 277
20 325;

f[n] = 30514.1

Part 8:
Q [*] :=
1 366
11 344
19 498;

f[n] = 62156.9

Part 9:
Q [*] :=
1 216
6 330
12 298
17 257
23 257;

f[n] = 104090

Part 10:
Q [*] :=
1 226
6 218

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12 220
16 271
21 392;

f[n] = 135160

Part 11:

```
Q [*] :=
 1  124
 5  225
 8  250
11  352
17  177
20  142
23  239;
```

f[n] = 305305

Part 12:

```
Q [*] :=
 1  148
 5  138
 8  107
10  161
13  146
16  224
20  122
22  183
24  208;
```

f[n] = 435135

Part 13:

```
Q [*] :=
 1  148
 5  138
 8  107
10  161
13  146
16  125
18   99
20  122
22  183
24  208;
```

f[n] = 579275

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Part 14:

Q [*] :=
1 88
3 41
4 98
6 63
7 94
10 73
13 85
15 45
17 93
18 92
19 92
20 132
23 111
25 75
26 70;

f[n] = 627958

Part 15:

Q [*] :=
1 72 5 22 8 40 12 41 15 38 18 22 22 24 26 35
3 87 6 44 9 49 13 54 16 76 19 93 24 19
4 62 7 72 10 96 14 28 17 39 21 63 25 91;

f[n] = 701406

Part 16:

Q [*] :=
1 83
2 86
3 112
5 57
6 100
7 96
10 36
12 147
15 100
18 102
20 64
23 53
24 114;

f[n] = 808392

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Part 17:

Q [*] :=
1 23   4 39   7 39   11 89   14 17   18 28   21 45   24 87
2 78   5 71   8 64   12 15   15 12   19 14   22 63   25 47
3 60   6 46   9 59   13 25   16 66   20 66   23 76   26 90;

f[n] = 975957

Part 18:

Q [*] :=
1   94
2   85
3 123
5   92
7   91
8   77
9 110
11   55
14 117
16 111
18   81
19   55
21   54
24   65
25   54
26   93;

f[n] = 1224730

Part 19:

Q [*] :=
1   54
2   76
3   60
4   69
5   63
6   94
8   24
10   37
12   49
13   70
14   64
15   97
17   97
18   76

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19 49
20 42
21 121
23 67
25 80
26 77;

f[n] = 1369450

Part 20:
Q [*] :=
1 103
3 85
4 132
6 162
8 88
9 111
11 134
13 108
15 59
16 125
18 85
21 126
24 105;

f[n] = 1428950

Total Cost of all the 20 parts considering current given situation which is basically orders and delivery of each part are considered independently managed.

Total Cost: $88,18,245.54

If we are using independent method instead of synchronization it will save 25.27% cost.

Are there any drawbacks or potential problems that could diminish its effectiveness?
Cost: Huge and very few rarely shipped shipments can result in very high inventory cost.
Delay: If shipments of consolidation are delayed for one supplier it can result in delay for all the next suppliers.
Complexity: Coordinating shipments from different suppliers at the same time needs to be planned carefully and can be difficult to manage.

Should some parts still be air freighted?
We think that the parts that have a huge value or are costly and which result in high turnover price and are critically produced should be air freighted for cost effectiveness.

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Should any parts continue to be individually ocean shipped?
Parts which are huge and extremely heavy or bulky and which are not giving any benefit from consolidation shipment can be continued to be shipped individually.

Given the very low interests rates in the recent past, how would the solution change if the inventory cost rate were just 10%? Can we intuitively explain the changes observed regarding the timing of shipments?

```
Y [*] :=
 1 1    4 0    7 1    10 0    13 1    16 0    19 0    22 0    25 1
 2 0    5 1    8 0    11 1    14 0    17 0    20 1    23 1    26 0
 3 1    6 0    9 1    12 0    15 1    18 1    21 0    24 0
;

totalcost = 11778500
```

If we reduce the inventory cost rate it will save around 0.19% cost and the order quantity increases and the frequency of order is reduced.

The company's production plan, which drives the weekly demand for supplies is very stable (frozen) for the first 12 weeks of the planning horizon, but changes may occur after that and new weeks of demand will be added to the horizon each week. How would the tool the team develops be used over time to accommodate these changes?

For the first 12 weeks we can plan the supply by the same method. After that we can forecast the demand by using past trends and according to that we can plan for some safety stock.
If demand for a few parts will be unpredictable then we can plan only for that change of demand.