MIDDLE EAST TECHNICAL UNIVERSITY

Term Project Report

IE407

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Body intro...

2.1 Proposed Model

Parameters:
I : Set of products
I^1: Set of product pairs (i1, i2) that cannot be placed on the same shelf.
I^2: Set of product pairs (i1, i2) that will be included together in the assortment.
K : Set of shelves
π_i: Profit made by selling one unit of product i
w_k : Width of shelf k
γ_k : Shelf k's effect on demand
ds_k : Depth of shelf k
dp_i : Depth of unit product i
b_i: Width of a facing for product i
d_i: Coefficient for demand rate for product i per unit width and one facing
β_i: Space elasticity factor for product i
s_i^l : Lower bound on the shelf inventory of product, if i is selected in the assortment
s_i^u : Upper bound on the shelf inventory of product, if i is selected in the assortment

Calculated Data Sets:
N_{ik}: number of product i in shelf k per allocation:
$N_{ik} = (ds_k/dp_i) - ((ds_k/dp_i)\%1)$

Decision Variables:
X_{ik} : Will the product i be on shelf k
f_{ik}: number of allocated facings for product i on shelf k.

Objective function:
max $\sum_{i=1}^{productCount} \sum_{k=1}^{shelfCount} \pi_i \gamma_k d_i (f_{ik} * b_i)^{\beta_i}$

Subjected To:
$\sum_{k=1}^{shelfCount} X_{ik} \leq 1$ (comes from Rule 1)

$f_{ik} \leq 4$ for all i and k. (comes from Rule 2)

$\sum_{k=1}^{shelfCount} f_{ik} * N_{ik} \leq s_i^u * X_{ik}$

$\sum_{k=1}^{shelfCount} f_{ik} * N_{ik} \geq s_i^l * X_{ik}$
(above 2 constrains comes from Rule 3 and 4)
(above 2 constrains also enforces f_{ik} to be 0 when X_{ik} is 0)

$\sum_{i=1}^{productCount} f_{ik} * b_i \leq w_k$ for all k (comes from 6)

$X_{2,k} + X_{5,k} \leq 1$ for all k (comes from Rule 7)
$X_{3,k} + X_{8,k} \leq 1$ for all k (comes from Rule 7)
$X_{16,k} + X_{20,k} \leq 1$ for all k (comes from Rule 7)
$X_{1,k} - X_{12,k} = 0$ for all k (comes from Rule 8)
$X_{3,k} - X_{8,k} = 0$ for all k (comes from Rule 8)
$X_{9,k} - X_{15,k} = 0$ for all k (comes from Rule 8)
$X_{16,k} - X_{20,k} = 0$ for all k (comes from Rule 8)

2.1.1 Q2

Q2

2.1.2 Q3

Q3

2.1.3 Q4

Q4

2.1.4 Q5

Q5

2.1.5 Q6

Q6

2.1.6 Q7

Q7

2.2 Discussion

Discussion...

3 Conclusion

Conclusion

4 Appendix

4.1 Sub1: Data Set for Q1,Q2

Table 1: Sets of product pairs

I^1 :	(2, 5) , (3, 8), (16, 20)
I^2 :	(1, 12), (3, 8), (9, 15), (16, 20)

Table 2: Product based data

Product number	π_i	b_i	dp_i	d_i	β_i	s_i^l	s_i^U
1	15	10	7	4	0.5	2	15
2	8	9	6	10	0.2	1	19
3	12	5	10	10	0.3	1	23
4	6	7	7	7	0.2	1	9
5	11	9	9	5	0.9	1	16
6	14	6	8	2	0.4	1	21
7	14	9	6	1	0.5	1	11
8	6	5	9	6	0.3	1	18
9	5	9	9	7	0.8	2	11
10	11	10	9	3	0.8	1	11
11	12	7	5	4	0.1	2	17
12	8	5	6	7	0.8	2	22
13	11	7	6	2	0.1	1	12
14	13	8	9	9	0.8	3	12
15	7	9	8	11	0.8	3	19
16	14	23	5	2	0.1	2	16
17	9	25	6	9	0.1	1	10
18	10	17	8	1	0.8	2	16
19	13	15	9	4	0.2	2	20
20	5	23	6	2	0.6	3	19
21	11	19	8	6	0.6	2	24
22	11	19	9	6	0.4	1	16
23	7	16	7	8	0.5	2	13
24	10	14	5	2	0.8	1	16
25	13	16	10	4	0.9	2	14

Table 3: Shelf based data

Shelf number	w_k	ds_k	γk
1	50	34	0.25
2	65	30	0.60
3	80	26	1
4	95	27	0.60
5	110	29	0.25

4.2 Sub2: Rules

1- **If a product is selected in the assortment, than all facings for the product must be placed on the same shelf.** $\surd$
2- **The manager does not want to allocate more than four facings for a product.** $\surd$
3- **If a product is selected in the assortment, then a minimum shelf inventory amount must be placed on the shelves. Similarly, for each product there is an upper bound on the shelf-inventory.** $\surd$
4- **If a product is selected in the assortment, lower and upper bounds on its facing number are calculated by using shelf depth, product depth and lower and upper bounds on the shelf-inventory.** $\surd$
5- *Each product provides a certain profit per unit sold.*
6- **Each shelf has a certain width and the total width of the facings placed in the shelf cannot exceed its width.** $\surd$
7- **For some pairs of products, there is a restriction that if one is included in the assortment, the other product must also be included.** $\surd$
8- **For some pairs of products, there is a restriction that they cannot be on the same shelf** $\surd$

References