IE 310
Operations Research
Term Project

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Sets

i: truck ids between 1-56

j: customer ids given in the file “customers.txt”

t: names of the transshipment centers given in the file “trcenters.txt” (Note: This set is not used because it does not have effect on the solution)

k: truck type (either small or large)

Alias

j1, j2: another representation of customer ids

Parameters

w(j): weight of demand of the customer j

v(j): volume of demand of the customer j

a(j1, j2): whether customer j1 and customer j2 can be transported in the same truck

u(j): unit cost of demand of the customer j

p(j, t): relation between customer j and transshipment center t (Note: This parameter is not used because it does not have effect on the solution)

Table

c(j, k): cost of transportation of the customer j with truck type k

Decision Variables

Binary Variables

d_type(j): whether customer j is transported directly or indirectly (1->direct, 0->indirect)

truck1(i, j): whether customer j is transported by small truck i

truck2(i, j): whether customer j is transported by large truck I

truck1_used(i): whether small truck i is used for transportation

truck2_used(i): whether large truck i is used for transportation

Nonnegative Variables

truck1_max(i): maximum of costs transported in small truck i

truck2_max(i): maximum of costs transported in large truck i

Objective Function

cost: total cost of transportation of all customers

$$\sum_j\big((1-dtype(j))\times\ w(j)\ \times\ u(j)\big)+\ \sum_i\Bigg(\Big(\Big(\big(\sum_j truck1(i,j)\big)-1\Big)\times 125\Big)+ truck1\max(i)+(1-truck1used(i))\times 125\Bigg)+\sum_i\Bigg(\Big(\Big(\big(\sum_j truck2(i,j)\big)-1\Big)\times 250\Big)+ truck2\max(i)+(1-truck2used(i))\times 250\Bigg)$$

Equations/Constraints

transportation_type(i): a customer can use only one truck or no truck according to its d_type value

$dtype(j)=\ \sum_i truck1(i,j)+truck2(i,j)$ for all j

customer_relation1(i, j1, j2): two customers can be transported together with small truck i if a(j1, j2) is true

$truck1(i,j1)+truck1(i,j2)=a(j1,j2)+1$ for all i,j1,j2

customer_relation2(i, j1, j2): two customers can be transported together with large truck i if a(j1, j2) is true

$truck2(i,j1)+truck2(i,j2)=a(j1,j2)+1$ for all i,j1,j2

truck1_capacity(i): number of customers transported in a small truck i should be less than or equal to 3

$\sum_j truck1(i,j)\leq 3$ for all i

truck2_capacity(i): number of customers transported in a large truck i should be less than or equal to 3

$\sum_j truck2(i,j)\leq 3$ for all i

truck1_volume(i): total volume of demand of customers transported in a small truck i should be less than or equal to 18

$\sum_j truck1(i,j)\times v(j)\leq 18$ for all i

truck2_volume(i): total volume of demand of customers transported in a large truck i should be less than or equal to 33

$\sum_j truck2(i,j)\times v(j)\leq 33$ for all i

truck1_maximum(i,j): enforce truck1_max(i) to be the maximum cost in small truck i

$truck1(i,j) \times c(j,'small') \leq truck1\max(i)$ for all i,j

truck2_maximum(i,j): enforce truck2_max(i) to be the maximum cost in large truck i

$truck2(i,j) \times c(j,'large') \leq truck2\max(i)$ for all i,j

truck1_usage(i): enforce truck1_used(i) to one if any customer is transported using small truck i

$\sum_j truck1(i,j) \geq truck1used(i)$ for all i

truck2_usage(i): enforce truck2_used(i) to one if any customer is transported using large truck i

$\sum_j truck2(i,j) \geq truck2used(i)$ for all i

Optimal Solution

MODEL MFW OBJECTIVE Z
TYPE MIP DIRECTION MINIMIZE
SOLVER XPRESS FROM LINE 4888

OBJECTIVE VALUE 16154.6356

Small trucks used to serve below customers

Truck ID – Customer ID
4 – 30004646
4 – 30008347
7 – 30003002
7 – 30008173
7 – 30006671
16 – 30002989
16 – 30003000
16 – 30007897
21 – 30008775
21 – 30008774
21 – 30000077
46 – 30002985
46 – 30005483
46 – 30008624
48 – 30007858

48 – 30002978
50 – 30003813
50 – 30008444

There are no large trucks used.
All other customers are served indirectly.