PROBLEM 3 – OPERATIONS RESEARCH

Maximizing the number of buyers through optimized advertising

Raul Almuzara

A prestigious company is going to launch a new product on the market. The company's advertising manager has a budget of 500 million euros to carry out the advertising campaign over the next 2 months.

The advertiser has considered three possible advertising media: television, radio and billboards. Depending on the media used and the number of exposures (number of times the advertisement appears on television or radio, or the number of billboards placed), there is a different theoretical attraction of potential buyers. Each of the three advertising media has 2 associated costs: a fixed cost for the creation of the ad (recording the ad for television, recording the ad for radio or creating the template from which to print the billboards) and a variable cost for the number of exposures.

The fixed costs for each type of ad are 300 million euros for television, 100 million euros for radio and 1 million euros for billboards.

The variable costs per exposure for each type of ad are 2 million euros for television, 0.1 million euros for radio and 0.01 million euros for billboards.

The number of potential buyers attracted by each ad exposure are 20,000 for television, 5,000 for radio and 50 for billboards.

In addition, if it is decided to advertise on television, at least 100 repetitions of the ad must be made; if it is advertised on radio, at least 200 repetitions of the ad must be made; and if billboards are used, at least 2000 must be placed.

Pose and solve a problem that allows to determine the media used, as well as the number of exposures (repetitions on television and/or radio and/or number of billboards placed) so as to maximize the number of potential buyers, while staying within the budget of 500 million euros.

Variables of the advertising problem in *Gusek*:

- $x['T']$, $x['R']$, $x['B']$ are integer variables associated to Television, Radio and Billboards, respectively. They refer to the number of exposures in the case of television and radio or the number of billboards used.
- $y['T']$, $y['R']$, $y['B']$ are binary variables associated to Television, Radio and Billboards, respectively. The value of each variable is 0 if that particular medium is not used and 1 if that particular medium is used.

Code preview (available in a separate file):

```
set media dimen 1;
set name dimen 1;
param fCost{media};
param vCost{media};
param buyers{media};
param minimum{media};
param values{name};
param M:=values['M'];
param budget:=values['budget'];

table Data IN 'ODBC'
  'DRIVER={Microsoft Excel Driver (*.xls)};dbq=.\problem3-data.xls'
  'SELECT * FROM [Data$]':
  media <- [media], fCost, vCost, buyers, minimum;

table Scalars IN 'ODBC'
  'DRIVER={Microsoft Excel Driver (*.xls)};dbq=.\problem3-data.xls'
  'SELECT * FROM [Scalars$]':
  name <- [name], values;

var x{media}, integer, >= 0;
var y{media}, binary;

maximize potential_buyers: sum{m in media}(buyers[m]*x[m]);
s.t. budgets: sum{m in media}(vCost[m]*x[m] + fCost[m]*y[m]) <= budget;
s.t. ms{m in media}: x[m] <= M*y[m];
s.t. minimums{m in media}: x[m] >= minimum[m]*y[m];

end;
```

The data are located in a separate *.xls* file containing the following information:

- In the *Data* tab:

	A	B	C	D	E
1	media	fCost	vCost	buyers	minimum
2	T	300	2	20000	100
3	R	100	0.1	5000	200
4	B	1	0.01	50	2000

- In the *Scalars* tab:

	A	B
1	name	values
2	M	50000
3	budget	500

where *M* is a high value which serves as an upper bound.

Solution:

```
Problem:    problem3
Rows:       8
Columns:    6 (6 integer, 3 binary)
Non-zeros:  21
Status:     INTEGER OPTIMAL
Objective:  potential_buyers = 20000000 (MAXimum)

  No.   Row name        Activity     Lower bound   Upper bound
------ ------------ ------------- ------------- -------------
     1 potential_buyers
                           2e+07
     2 budgets                500                         500
     3 ms[T]                    0                          -0
     4 ms[R]               -46000                          -0
     5 ms[B]                    0                          -0
     6 minimums[T]              0            -0
     7 minimums[R]           3800            -0
     8 minimums[B]              0            -0

  No. Column name       Activity     Lower bound   Upper bound
------ ------------ ------------- ------------- -------------
     1 x[T]         *           0             0
     2 x[R]         *        4000             0
     3 x[B]         *           0             0
     4 y[T]         *           0             0             1
     5 y[R]         *           1             0             1
     6 y[B]         *           0             0             1
```

According to this solution, the maximum number of potential buyers is **20,000,000**.

Note that, considering all the constraints, the optimal solution is to use only radio ads. In that case, we would need 4000 exposures in radio, none in television and zero billboards.