European Journal of Business and Management
ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online)
Vol 4, No.18, 2012

Strategic Selection of the Most Feasible Projects Using Linear Programming Models

Yara Hamdan
E-mail:eng.yhamdan@hotmail.com

Abstract

Project selection is a very critical major decision managers have to make. As business environment is growing more complex to include more considerations other than just cost and profit, the project selection process becomes more complicated and requiring more analytical and managerial skills than before.

Larger organizations tend to overtake more than just one project, since it has more labor, larger capital, and more diverse skills, variety of products and services, and some even working in more than just one industry.

In such a situation, Strategic selection of the most feasible projects in portfolio management is the best managerial practice to use, where the organization is interested in selecting the best combination of projects that makes all together that maximum benefit to the organization.

Keywords: Linear Programming, Feasible Projects, Objective function, Constraints.

1. Introduction

Each organization has different measures to its own benefit according to its unique weight and importance of each constraint to be included in the selection.

Project combination selection thus becomes more and more complicated, since it's not just one project, and it's not just profit and cost considerations, and benefit measures are unique and different, and above all that, we are looking for the projects that maximize that benefit when they all are combined all together, and not just by each individual benefit.

Linear programming models represent one of the best tools helping in such a process, where it can involve and include all the different multiple considerations required to make the best choice.

A Practical case is studied in this research in which the linear programming model is used and explained.

2. Case Description

Organization (X) is starting to plan for which projects combination it should choose to work on for the coming year. It has studied and searched for all possible projects available in its market, and found about 20 projects that match its selection criteria. Organization (X) has decided that the following constraints are the ones that should be considered in project consideration for selection:

a) Project cost
b) Labor hours
c) Priority
d) Quality level
e) Risk level
f) Historical information usage level
g) Newly acquired experience level
h) Communications complexity
i) Technology usage level

The management of organization (X) also set the required maximum accepted limits for each constraint as follows:

a) Cost: max value of 10,000,000 $
b) Labor hours: max value of 2,000,000 hours
c) Priority: If equal 1, then project MUST be included

d) Quality: max value of 1000 standards
e) Risk: max value of 600 points
f) Historical information usage: 10,000 data record
g) Newly acquired experience level: 5000 points
h) Communications complexity: 10,000 channels
i) Technology level: 3000 device

The projects' gathered data are shown in table (1).

3. Linear Programming Formulation

3.1 The Objective functions:

Max combination of projects= A+B+C+D+E+F+G+H+I+J+K+L+M+N+O+P+Q+R+S+T

Here, the objective function is formed in such that each project value is either going to be 1 or 0, this is called the Ghasemzadeh and Archer model.

If it's 1, then the project is selected, if 0, it's not selected. This is done in the software by assigning that the values of the projects variables are only ***binary values (1, 0)***, then after solving the numerical, the result would be values of 1s and 0s for the project variables, assigning which to choose and which to neglect.

The binary assignment feature is found in some software tools and is missing in others. One of the software providing this feature is LINGO, while it's missing in the POM windows.

3.2 Constraints:

3.2.1 Cost constraint:
1,000,000A + 2,600,000B +500,000C+3,200,000D+2,700,000E +4,500,000F +700,000G +250,000H +750,000I +2,300,000J +3,500,000K +1,700,000L +900,000M +3,600,000N +1,200,000O +2,200,000P +600,000Q +800,000R +3,000,000S +542,663T <= 10,000,000

3.2.2 Labor Hours constraint
300000A+550000B+90000C+700000D+500000E+850000F+120000G+75000H+200000I+450000J+560000K+350000L+270000M+750000N+320000O+480000P+100000Q+160000R+500000S+70000T<=2000000

3.2.3 Priority Constraint
M=1;

3.2.4 Quality Constraint
70A+130B+420C+360D+400E+200F+150G+90H+320I+120J+300K+90L+360M+400N+250O+220P+160Q+100R+340S+210T<=1000

3.2.5 Risk Constraint
80A+130B+40C+140D+100E+175F+65G+30H+70I+120J+155K+100L+70M+160N+110O+125P+60Q+75R+135S+60T<=600

3.2.6 Historical information usage constraint
1200A+2300B+550C+3500D+2500E+3800F+850G+400H+900I+2000J+3700K+1500L+1000M+2100N+1300O+2100P+780Q+950R+2900S+620T<=10000

3.2.7 Newly acquired experience level constraint
720A+830B+560C+1000D+870E+1200F+660G+400H+680I+880J+1100K+750L+700M+950N+730O+860P+700Q+790R+920S+560T<=5000

3.2.8 Communications complexity constraint
1400A+1950B+670C+3200D+2300E+3600F+800G+470H+890I+2200J+3400K+1800L+1300M+2400N+1000O+2400P+800Q+900R+3200S+590T<=10000

3.2.9 Technology level constraint
230A+410B+1230C+1200D+1000E+750F+560G+320H+900I+290J+1000K+320L+980M+
1500N+900O+720P+520Q+250R+900S+640T<=3000

4. Implementation

Using LINGO software, a code will be written in the following manner:

a) First, the objective function is written
b) The maximum constraint values for each constraint are entered in a variable named according to the constraint (i.e.: COST= 2000)
c) Projects with priority=1 will be assigned a value of (1) (i.e.: B=1)
d) The constraints formulas are inserted , and each is set as (<=) its corresponding named variable in step 2 (i.e.: <= COST)
e) Finally, the values of the projects (A,B,C,…,T) set to binary values by using the "@BIN" syntax. (example: @BIN(A)).

4.1 The complete code

```
MAX = A+B+C+D+E+F+G+H+I+J+K+L+M+N+O+P+Q+R+S+T;

COST = 10000000;

HOURS =2000000;

QUALITY= 1000;

RISK =600;

HISTINFO=10000;

NEWEXP=5000;

COMM=10000;

TECH=3000;

M=1;

1000000*A + 2600000*B +500000*C+3200000*D+2700000*E +4500000*F +700000*G +250000*H +750000*I
+2300000*J +3500000*K +1700000*L +900000*M +3600000*N +1200000*O +2200000*P +600000*Q
+800000*R +3000000*S +542663*T<= COST;

300000*A+550000*B+90000*C+700000*D+500000*E+850000*F+120000*G+75000*H+
200000*I+450000*J+560000*K+350000*L+270000*M+750000*N+320000*O+480000*P+
100000*Q+160000*R+500000*S+ 70000*T<= HOURS;

70*A+130*B+420*C+360*D+400*E+200*F+150*G+90*H+320*I+120*J+300*K+90*L+360*M+400*N+
250*O+220*P+160*Q+100*R+340*S+210*T<= QUALITY;

80*A+130*B+40*C+140*D+100*E+175*F+65*G+30*H+70*I+120*J+155*K+100*L+70*M+160*N+110*O+
125*P+60*Q+75*R+135*S+60*T<=RISK;

1200*A+2300*B+550*C+3500*D+2500*E+3800*F+850*G+400*H+900*I+2000*J+3700*K+1500*L+
1000*M+2100*N+1300*O+2100*P+780*Q+950*R+2900*S+620*T<=HISTINFO;

720*A+830*B+560*C+1000*D+870*E+1200*F+660*G+400*H+680*I+880*J+1100*K+750*L+700*M+
950*N+730*O+860*P+700*Q+790*R+920*S+560*T<=NEWEXP;
```


1400*A+1950*B+670*C+3200*D+2300*E+3600*F+800*G+470*H+890*I+2200*J+3400*K+1800*L+1300*M+2400*N+1000*O+2400*P+800*Q+900*R+3200*S+590*T<=COMM;

230*A+410*B+1230*C+1200*D+1000*E+750*F+560*G+320*H+900*I+290*J+1000*K+320*L+980*M+1500*N+900*O+720*P+520*Q+250*R+900*S+640*T<=TECH;

@BIN(A); @BIN(B);@BIN(C);@BIN(D);@BIN(E);@BIN(F);@BIN(G);@BIN(H); @BIN(I);@BIN(J); @BIN(K);@BIN(L);@BIN(N);@BIN(O); @BIN(P);@BIN(Q);@BIN(R); @BIN(S); @BIN(T);

5. The Results

After solving the numerical in LINGO, the following results were obtained:

Global optimal solution found.

Objective value:	7.000000
Objective bound:	7.000000
Infeasibilities:	0.000000
Extended solver steps:	0
Total solver iterations:	21
Model Class:	PILP
Total variables:	19
Nonlinear variables:	0
Integer variables:	19
Total constraints:	9
Nonlinear constraints:	0
Total nonzeros:	171
Nonlinear nonzeros:	0

Variable	Value	Reduced Cost
A	1.000000	-1.000000
B	0.000000	-1.000000
C	0.000000	-1.000000
D	0.000000	-1.000000
E	0.000000	-1.000000
F	0.000000	-1.000000
G	1.000000	-1.000000
H	1.000000	-1.000000
I	0.000000	-1.000000
J	1.000000	-1.000000
K	0.000000	-1.000000
L	1.000000	-1.000000
M	1.000000	0.000000
N	0.000000	-1.000000

O	0.000000	-1.000000
P	0.000000	-1.000000
Q	0.000000	-1.000000
R	1.000000	-1.000000
S	0.000000	-1.000000
T	0.000000	-1.000000
COST	0.1000000E+08	0.000000
HOUR	2000000.	0.000000
QUALI	1000.000	0.000000
RISK	600.0000	0.000000
HISTINFO	10000.00	0.000000
NEWEXP	5000.000	0.000000
COMM	10000.00	0.000000
TECH	3000.000	0.000000

Row	Slack or Surplus	Dual Price
1	7.000000	1.000000
2	0.000000	0.000000
3	0.000000	0.000000
4	0.000000	0.000000
5	0.000000	0.000000
6	0.000000	0.000000
7	0.000000	0.000000
8	0.000000	0.000000
9	0.000000	0.000000
10	0.000000	1.000000
11	2350000.	0.000000
12	275000.0	0.000000
13	20.00000	0.000000
14	60.00000	0.000000
15	2100.000	0.000000
16	100.0000	0.000000
17	1130.000	0.000000
18	50.00000	0.000000

So, as shown in the above results, projects (A, G, H, J, L, M, and R) have the value of (1), so they will be selected as they are the best combination that satisfies the required constraints, while all the other projects with the value of (0) will be disregarded.

Conclusion

The model used here provides a quick and easy way to select the optimal projects combination.

But what wasn't easy is the gathering, collecting, analyzing and studying the data shown in both the two tables; the constraint table, and the projects' data table.

The numbers provided in the tables requires a lot of professional work. Each row in each table is by itself a separate research or project, requiring a lot of work and time.

Also, this linear programming model is a very difficult and complicated model to solve, and a lot of software does not have the capability to solve it, so actually LINGO software has a unique advantage in this kind of models, where it makes it very quick and easy to us to obtain our required solution.

Still, LINGO in its solving technique assumes that all these projects have the same durations, and that their priorities will remain the same and never change, and these assumptions may sometimes not apply, so we're still looking for improvements in these areas in order to have a more robust model, hopefully we'll find it in the very near future.

References

1) LINDO systems, LINGO software. www.lindo.com
2) Guide to Project management Body of Knowledge (PMBOK), 2008, Project Management Institute (PMI).
3) Eric D. Brown, Aligning Technology, Strategy, People and Projects.
4) M. Greer, 2006, "What's Project Portfolio Management (PPM) and Why Should Project Managers Care About It".
5) F. Ghasemzadeh and N. P. Archer, 2000, "Project portfolio selection through decision support", *Decision Support Systems,* vol. 29, pp. 73-88.

Table 1: The projects' gathered data

	Project	**Cost**	**Labor**	**Priority**	**Quality**	**Risk**	**Historical Info**	**New Skills**	**Comm. Complex**	**Tech. Advance**
1	**A**	1,000,000	300,000	0	70	80	1200	720	1400	230
2	**B**	2,600,000	550,000	0	130	130	2300	830	1950	410
3	**C**	500,000	90000	0	420	40	550	560	670	1230
4	**D**	3,200,000	700000	0	360	140	3500	1000	3200	1200
5	**E**	2,700,000	500000	0	400	100	2500	870	2300	1000
6	**F**	4,500,000	850000	0	200	175	3800	1200	3600	750
7	**G**	700,000	120000	0	150	65	850	660	800	560
8	**H**	250,000	75000	0	90	30	400	400	470	320
9	**I**	750,000	200000	0	320	70	900	680	890	900
10	**J**	2,300,000	450000	0	120	120	2000	880	2200	290
11	**K**	3,500,000	560000	0	300	155	3700	1100	3400	1000
12	**L**	1,700,000	350000	0	90	100	1500	750	1800	320
13	**M**	900,000	270000	1	360	70	1000	700	1300	980
14	**N**	3,600,000	750000	0	400	160	2100	950	2400	1500
15	**O**	1,200,000	320000	0	250	110	1300	730	1000	900
16	**P**	2,200,000	480000	0	220	125	2100	860	2400	720
17	**Q**	600,000	100000	0	160	60	780	700	800	520
18	**R**	800,000	160000	0	100	75	950	790	900	250
19	**S**	3,000,000	500000	0	340	135	2900	920	3200	900
20	**T**	542,663	70000	0	210	60	620	560	590	640
Max. value		10000000	2000000	--------	1000	600	10000	5000	10000	3000