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An Approach to Maximize Profit of a Constructing Project within Limited Budget by Using Simplex Method

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Abstract—The design and operations of constructing project has become of concern to an ever-increasing segment of the scientific and professional world. It is very difficult task to complete the selected project within the ranges of Budget and limited source. Sometimes we haven't enough money to complete a project work. In this work a new idea is developed, which is very effective to find out the maximum benefits by formulating a constructing project, applying linear programming and using simplex methods. The linear requirements and non-negativity conditions state that the variables cannot assume negative values. It is not possible to have negative resources. We also use the graphical method to solve a linear Programming problem involving resource allocation. .

Index Terms— Maximize, Profit, Constructing projects, Feasible solution, Graphical method, Linear programming, Optimization, Simplex methods

1 Introduction

THE process of planning, designing, financing, constructing and operating physical facilities has a different perspective on project management for construction. Specialized knowledge can be very beneficial, particularly in large and complicated projects, since experts in various specialties can provide valuable services. However, it is advantageous to understand how the different parts of the process fit together. Waste, excessive cost and delays can result from poor coordination and communication among specialists. It is particularly in the interest of owners to insure that such problems do not occur. And it behooves all participants in the process to heed the interests of owners, because in the end, it is the owners who provide the resources and call the shots.

The 1940s was a time of innovation and reformation of how products were made, both to make things more efficient and to make a better-quality product. The Second World War was going on at the time and the army needed a way to plan expenditures and returns in order to reduce costs and increase losses for the enemy. George B. Dantzig is the founder of the simplex method of linear programming, but it was kept secret and was not published until 1947 since it was being used as a war-time strategy. But once it was released, many industries also found the method to be highly valuable. Another person who played a key role in the development of linear programming is John von Neumann, who developed the theory of the duality and Leonid Kantorovich, a Russian mathematician who used similar techniques in economics before Dantzig and won the Nobel Prize in 1975 in economics.

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In the years from the time when it was first proposed in 1947 by Dantzig, linear programming and its many forms have come into wide use worldwide. LP has become popular in academic circles, for decision scientists (operations researchers and management scientists), as well as numerical analysts, mathematicians, and economists who have written hundreds of books and many more papers on the subject. Though it is so common now, it was unknown to the public prior to 1947. Actually, several researchers developed the idea in the past. Fourier in 1823 and the well-known Belgian mathematician de la Vallée Poussin in 1911 each wrote a paper describing today's linear programming methods, but it never made its way into mainstream use. A paper by Hitchcock in 1941 on a transportation problem was also overlooked until the late 1940s and early 1950s. It seems the reason linear programming failed to catch on in the past was lack of interest in optimizing.

Linear programming can be viewed as part of a great revolutionary development which has given mankind the ability to state general goals and to lay out a path of detailed decisions to take in order to 'best' achieve its goals when faced with practical situations of great complexity. Our tools for doing this are ways to formulate real-world problems in detailed mathematical terms (models), techniques for solving the models (algorithms), and engines for executing the steps of algorithms (computers and software)."

2 NATURE AND SOURCES OF DATA

The data for the thesis were collected from the book *Schedule of rates for civil works* published by *Public work department* (Government of the people's, republic of Bangladesh) and the *Mat Home Limited*, a real estate company. The actual expenditure incurred on material, labour and overheads were obtained from the book *Schedule of rates for civil works* published by *Public work department* and *Mat Home Limited.*

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This data are used to formulate a linear programming problem and solving it by simplex method, graphical method and using Mat lab that we maximize our benefits with a limited resource.

3 DESIGN METHODOLOGIES

While the conceptual design process may be formal or informal, it can be characterized by a series of actions: formulation, analysis, search, decision, specification, and modification. However, at the early stage in the development of a new project, these actions are highly interactive as illustrated in Figure 3-1. Many iterations of redesign are expected to refine the functional requirements, design
concepts and financial constraints, even though the analytic tools applied to the solution of the problem at this stage may be very crude.

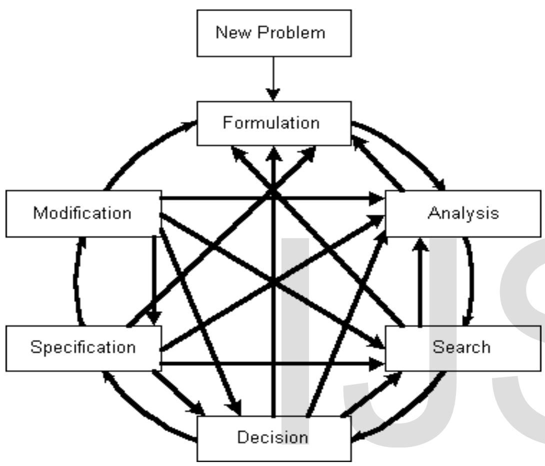

Figure: Conceptual Design Process

The series of actions taken in the conceptual design process may be described as follows:

- Formulation refers to the definition or description of a design problem in broad terms through the synthesis of ideas describing alternative facilities.
- Analysis refines the problem definition or description by separating important from peripheral information and by pulling together the essential detail. Interpretation and prediction are usually required as part of the analysis.
- Search involves gathering a set of potential solutions for performing the specified functions and satisfying the user requirements.
- Decision means that each of the potential solutions is evaluated and compared to the alternatives until the best solution is obtained.
- Specification is to describe the chosen solution in a form which contains enough detail for implementation.
- Modification refers to the change in the solution or re-designs if the solution is found to be wanting or if new information is discovered in the process of design.

4 ACTIVITIES OF CONSTRUCTION PROJECT

Construction planning is a fundamental and challenging activity in the management and execution of construction projects. The choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks are very important. A good construction plan is the basis for developing the budget and the schedule for work. Developing the construction plan is a critical task in the management of construction, even if the plan is not written or otherwise formally recorded. In addition to these technical aspects of construction planning, it may also be necessary to make organizational decisions about the relationships between project participants and even which organizations to include in a project.
The building construction project usually divided into three major works. These are as follows in a sequential manner.

1. CIVIL WORKS
   a) Foundation Up-to PL
   b) Superstructure Works
2. SANITARY & WATER SUPPLY WORKS
3. INTERNAL ELECTRICAL WORKS

4.1 EFFECTS OF SCALE ON CONSTRUCTION COST

We are now going to estimate cost of the project in Control Estimates manner. In this process we collect data from the book *Schedule of rates for civil works* published by *Public work department* and *Mat Home Limited.* In this project the projected total Budget is Tk. 3962700.
Whose Head of the work as follows in the below:

CIVIL WORKS (per sqf)	Material cost (per sqf) 68%	Labour cost (per sqf) 30%	Transport cost (per sqf) 2%
1200	816	360	24

INTERNAL ELECTRIC WORKS (per sqf)	Material cost (per sqf) 68%	Labour cost (per sqf) 30%	Transport cost (per sqf) 2%
120	82	36	2

SANITARY & WATER SUPPLY (per sqf)	Material cost (per sqf) 68%	Labour cost (per sqf) 30%	Transport cost (per sqf) 2%
70	48	21	1

5 RESOURCES AVAILABILITY AND PROCEDURE

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Constructing building is a large scale project. It's very difficult task to arrange total amount in starting of large project. Sometimes we are failure to arrange it. In this situation we start our work with limited budget. Here we arrange such type of model problem to complete maximum work in our limited budget. a constructing building
starting its work with limited budget. after completing design and foundation work we have 2 crore to complete the work. So what will be the maximum floor totally completed in this limited budget. Here we use data from previous chapter. using two variable x_1, x_2. x_1 represents civil works (per floor) and x_2 represents Internal electric work, sanitary & water supply work (per apartment).three types of cost calculate here. Material cost, labour cost and transport cost. we divide our amount as total material cost never exceed Tk 14000000, total labour cost never exceed Tk 5600000 and total transport cost never exceed Tk400000. All costs are collected from Mat home limited on 12 April. civil work means completing ceiling,philar,door,window and color.for civil work the material cost(per floor) is 2496960,labour cost(per floor) is 1101600, transport cost(per floor) is 73440.and for Internal electric work, sanitary & water supply work the material cost(per apartment).is 198900,labour cost(per apartment).is 8721, transport cost(per apartment) 4590.

METHOD FOR CONSTRUCTING BUILDING

For our required constructing building, our plot size is ten katha.

We know that,

1 katha = 720 sqf ; [sqf means square feet]

So, 10 katha = 7200 sqf

Useable area:

According to the rules of RAZUK, for a residential building we can use 57.5% area of the total area.

In this conection, $7200 of \frac{57.5}{100}$

Or, 4140 sqf

We can use maximum 4140sqf area out of 7200 sqf for our constructing project.

FAR:

FAR means Floor Area Ratio. From RAJUK restriction far must be 4.25. If we want to construct 10 floors, then we can use 3060 sqf per floor out of 4140 sqf. Each floor contains two apartments and each apartment area is (3060/2) = 1530 sqf
Standard maximization problem – a linear programming problem for which the objective function is to be maximized and all the constraints are "less-than-or-equal-to" inequalities.

6 MATHEMATICAL ANALYSES BY SIMPLEX

	Civil work (per floor) BDT	Internal electric work, sanitary & water supply work (per apartment) BDT	Total BDT
Material cost	2496960	198900	2695860
Labour cost	1101600	8721	1188810
Transport cost	73440	4590	78030
Total	3672000	290700	3962700

CHECK

Table: Mathematical Formulation for Constructing Building

By the reason of limited money we start our project work with 20000000.this money distribute as follows that total material cost never exeed 14000000,labour cost must be lie on 560000 and for transport cost we can't spent more than 400000.in this limitation we have to find out the maximum completed work.

6.1 FORMULATION

To assembly standard simplex method we organize objective function by 'z' and also dispose constraint equation by

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the following:

Maximize: $3672000x_1 + 290700x_2$

Subject to the constraints,

$2496960\, x_1 + 198900\, x_2 \leq 14000000$

$1101600\, x_1 + 87210\, x_2 \leq 5600000$

$73440\, x_1 + 4590\, x_2 \leq 400000$

$x_1 \leq 10$

$-2\, x_1 + x_2 \leq -2$

$x_1, x_2 \geq 0$

Introducing slack variables

i.e, Maximize: $3672000x_1 + 290700x_2$

Subject to the constraints,

$2496960\, x_1 + 198900\, x_2 + s_1 = 14000000$

$1101600\, x_1 + 87210\, x_2 + s_2 = 5600000$

$73440\, x_1 + 4590\, x_2 + s_3 = 400000$

$x_1 + s_4 = 10$

$-2\, x_1 + x_2 + s_5 = -2$

$x_1, x_2, s_1, s_2, s_3, s_4, s_5 \geq 0$

where s_1, s_2, s_3, s_4, s_5 are slack variables

6.2 SOLUTION BY SIMPLEX METHOD

The solutions of simplex table are given below:

c_0	c_j	3672000	290700	0	0	0	0	0	Constant	Ratio
		x_1	x_2	s_1	s_2	s_3	s_4	s_5		
0	s_1	2496960	198900	1	0	0	0	0	14000000	5.61
0	s_2	1101600	87210	0	1	0	0	0	5600000	5.08
0	s_3	73440	4590	0	0	1	0	0	400000	5.45
0	s_4	1	0	0	0	0	1	0	10	10
0	s_5	-2	1	0	0	0	0	1	-2	
E_j-c_j		-3672000	-290700	0	0	0	0	0		

c_0	c_j	3672000	290700	0	0	0	0	0	Constant	Ratio
		x_1	x_2	s_1	s_2	s_3	s_4	s_5		
0	s_1	0	1224	1	2.27	0	0	0	1306666.67	1067.5
3672000	x_1	1	0.079	0	9.08×10^{-7}	0	0	0	5.08	64.3
0	s_3	0	-1224	0	0.07	1	0	0	26666.67	
0	s_4	0	-0.08	0	-9.08×10^{-7}	0	1	0	4.92	
0	s_5	0	1.16	0	0	0	0	1	8.18	7.05
E_j-c_j		0	-612	0	3.33	0	0	0		

c_0	c_j	3672000	290700	0	0	0	0	0	Constant	Ratio
		x_1	x_2	s_1	s_2	s_3	s_4	s_5		
0	s_1	0	0	1	2.27	0	0	-1055.17	1298035.36	
3672000	x_1	1	0	0	9.08×10^{-7}	0	0	-0.068	**4.57**	
0	s_3	0	0	0	0.07	1	0	1055.17	35297.98	
0	s_4	0	0	0	-9.08×10^{-7}	0	1	0.068	5.48	
290700	x_2	0	1	0	0	0	0	0.86	**7.05**	
		0	0	0	3.33	0	0	306		

Table: Solution of simplex table

6.3 OPTIMAL SOLUTION

The objective row contains no negative elements.

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Therefore the solution of this dilemma is

$x_1 = 4.57$, $x_2 = 7.05$

As we obtain approximate cost for our limited budget. Also obtain the maximum work which is totally completed by using available resources.
The optimal solution would be,

$z = (4.57 \times 3672000) + (7.05 \times 290700)$

$= 16781040+2049435$

$= 18830475$

6.4 GRAPHICAL METHOD

Evaluate the objective function in these points and that one or those that they maximize (or minimize) the objective, they correspond to optimal solutions of the problem. For our constructing problem,

We have ,

Maximize: $3672000x_1 + 290700x_2$

Subject to the constraints,

$2496960\ x_1 + 198900\ x_2 \leq 14000000$

$1101600\ x_1 + 87210\ x_2 \leq 5600000$

$73440\ x_1 + 4590\ x_2 \leq 400000$

$x_1 \leq 10$

$-2\ x_1 + x_2 \leq -2$

$x_1, x_2 \geq 0$

To draw the graph and solve this desired problem, First we have to draw a coordinate system Cartesian, in which each decision variable be represented by an axis, with the measure scale, that fits properly to his associated variable.
Now draw on the coordinate system the restrictions of the problem (including no negativeness).
i.e, draw the lines

$2496960\ x_1 + 198900\ x_2 = 14000000$

$1101600\ x_1 + 87210\ x_2 = 5600000$

$73440\ x_1 + 4590\ x_2 = 400000$

$x_1 = 10$

$-2\ x_1 + x_2 = -2$

In order to establish maximum proHelveticafit, we formulated the linear programming model to describe the problem stated in the methodology. Then the resulting linear programming model was solved by using Simplex method. The summary of the optimal solution for linear programming models formulated is as shown in below:
From our formulation we get the number of completed floors,

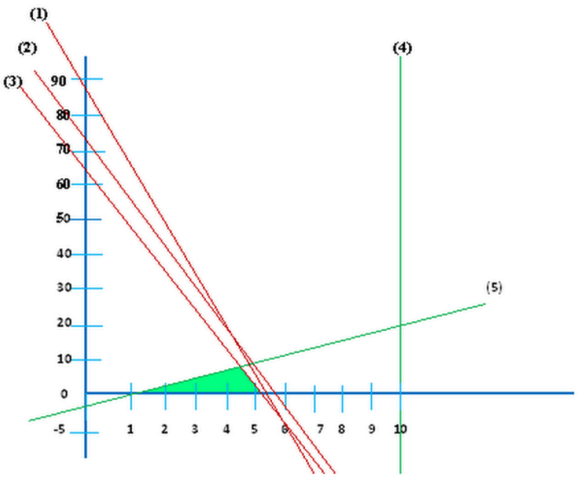

Figure: feasible region is shown in colored portion

Here the feasible region is shaded one. The maximum (or minimum) value of the objective function occurs at one of the vertices of the feasible region. From the feasible region we get the vertices (1,0) ; (4.57,7.05) ; (5.08,0) respectively. We know,

The objective function is

$z = 3672000x_1 + 290700x_2$

At (1,0)

$z = 3672000+0$

$= 3672000$

At (4.57,7.05)

$z = (4.57 \times 3672000) + (7.05 \times 290700)$

$= 16781040+2049435$

$= 18830475$

At (5.08,0)

$z = 3672000 \times 5.08$

$=18653760$

The maximum value of z is 18830475 occurring when $x_1=4.57$, $x_2=7.05$.

7 RESULT ANALYSES

$x_1=4.57$ and the number of completed apartment including internal works are $x_2=7.05$.

The approximate cost of this completed project is,

$z=(4.57 \times 3672000)+(7.05 \times 290700)$

=16781040+2049435

= 18830475

In our thesis using the available resources we can completed four and half floors civil work and also sanitary, water supply & internal electric works in seven apartments.

So the total cost of this completed work is

z = (4.5×3672000) + (7 ×290700)

= 16524000+2034900

= 18558900

Consequently by comparing this two cost, we have the difference of cost is

18830475-18558900 = 271575 which is 1.44% of total cost may be reduced.Thus it fufill maximize benefits for the aforsaid constructing project.That is why this is very effective for a large scale project.

8 CONCLUSIONS

Maximization is the process by which a constructing project determines the output level that returns the greatest profit. It is the mathematical process of finding the maximum value of a function. Simplex method is the easiest LP solution which usually find a solution quickly. It solves any linear program; It detects unnecessary constraints in the problem formulation; It identifies instances when the objective value is unbounded over the feasible region; and it solves problems with one or more optimal solutions. For long time the Simplex method was considered to be the leading solver of linear optimization problems. But when solving large linear programming problems, it might be an advantage to have deferent, more time-efficient methods to choose. But their big disadvantage is that in every iteration an ill conditioned equation system needs to be solved. In spite of some ill condition equation, we apply simplex method to maximize benefit for a constructing project. In this thesis the result demonstrate that this method maximize the profit by 1.44% for our desired project.

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