THE RESTRICTED TASK ASSIGNMENT PROBLEM SOLVING BY HUNGARIAN METHOD: ONLINE PRODUCT ENTRY

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ABSTRACT

Choosing the best person for a task to be done always is a high priority. An online bookseller entity has a job to entry some books online. To make the job easy it has been divided that job into a few tasks. But it is a great challenge, who will assign for which task to get the best result among the available alternatives. Hungarian Method used to resolve this problem. The study shows that the seven resources are respectively fit for tasks 2, 5, 8, 1, 3, 6, 7, and task 4 will be done by the sixth resource. By the best-allocated resources it will take only 28 minutes to entry per book.

Keywords: Human Resources, Task Allocation, Assignment Problem, Hungarian Method.

INTRODUCTION

When a group of people works some similar types of tasks, then we can say it as a job. The objective of the task is to fulfill a job. According to the J. J Verzijl, job types are Small, Rush, Big, Overlapped, Interrupt, Split, Hours-per-hour, Start job, Date, Equal-start, Reference, Loop job, Double, Lead-time, Delivery, Part, Difficult, Assembly, Explosion, Stock, Minimum-utilization, Subcontracting. A person should be given such type of tasks that supports his personality types. A manager must be careful about the outcomes of a team member. It is very much usual that a man can perform well when he finds that tasks are liked by him inherently. When work type and a person's ability to do the job match well then it is a person-job fit condition. Person-job fit condition allows a manager to get the best output.

An organization should make sure team members are performing the tasks they are perfectly suited for. To find the out the perfect person for a perfect job a manager can get help from Mayer Briggs personality type indicator. It also helps a team member to get well trained. As a job is generally divided into some tasks, so we must assign a specific people to do specific task. Here proper task allocation is necessary to get the job done in the best alternative ways. If we don't do so then the human resource will be wasted. Production cost will be increased. This online bookseller company wants to entry a lot of books into its website. It should process a hard copy book into softcopy, while entry that book into its website. For doing the job, it has divided the total job into eight tasks. But it has a scarcity of human resources. It has only seven persons to do the eight tasks. Seven persons are differently skilled in doing most of the tasks. Although some of them are not. So it is essential to know who the best for which task is. Then it is formulated as an assignment problem. The main aim of the assignment problem is to minimize the operating time or cost and otherwise maximize the profit by assigning the right person to the right job.

The operating time matrix (t_{ij}) is given below:

Resources	Activity						Supply
	J_1	J_2	J_3	….	….	J_n	
M_1	t_{11}	t_{12}	t_{13}	….	….	t_{1n}	1
M_2	t_{21}	t_{22}	t_{23}	….	….	t_{2n}	1
M_3	t_{31}	t_{32}	t_{33}	….	….	t_{3n}	1
…	….	….	….	….	….	….	1
…	….	….	….	….	….	….	1
M_m	t_{m1}	t_{m2}	t_{m3}	….	….	t_{mn}	1
Demand	1	1	1	1	1	1	

The operating time matrix is the same as that of a Transportation problem except for that availability at each of the resources and the requirement at each of the destinations is unity.

Let, x_{ij} denotes the assignment of the ith resource to the jth activity, such that

$$x_{ij} = \begin{cases} 1, & \text{if the resource is allowed for to activity j} \\ 0, & \text{if the resource is not allowed for to activity j} \end{cases}$$

Then the mathematical formulation of the assignment problem is given as follows:

Minimize $Z = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij}$

Subject to the constraints

i) Every person should be allocated to one and only one job i.e.

$x_{i1} + x_{i2} + \ldots\ldots\ldots + x_{in} = 1; \sum_i x_{ij} = 1, j \in J$

ii) Every job must be allocated to one and only one person i.e.

$x_{1j} + x_{2j} + \ldots\ldots\ldots + x_{mj} = 1; \sum_i x_{ij} = 1, i \in I$

iii) $x_{ij} = 0$ or 1 for all i,j; $x_{ij} \geq 0, i \in I$ and $j \in J$ where $I = J = \{1,2,3\ldots\ldots.,n\}$

There are 4 ways usually used to solve an assignment problem and these are

1. Enumeration method

2. Transportation method

3. Simplex method

4. Hungarian approximation method

To solve this problem the Hungarian Method can easily help the researcher. Thought it is an unbalanced problem to solve, but the Hungarian Method can best solve this problem. Anyone can apply the following algorithm to a given n × n matrix to find out the best solution for an assignment problem.

Step 1: Check whether the number of rows and the number of the columns are equal. If the answer is yes, this is a balanced problem; if not, then make it balanced by adding a dummy row or column and assign a zero for every dummy cell.

Step 2: Row Reduction: Subtract the least element of each row from all elements of that existing row. If there is a dummy column, then there is zero in each row and no need of row reduction.

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Step 3: Column Reduction: Deduct the lowest element of each column from all elements consisting of that column. In a case of dummy row, there is a zero in each column, and column deduction is no need of.

Step 4: A minimum number of horizontal and/or vertical lines will be drawn to cover all the zeros. The procedure is as follows:

a. Choose a row containing just one uncovered zero and pull a vertical line through the column with this zero and recap the process till no such row has remained.

b. Target a column that exactly one uncovered zero and draw a horizontal line through the row existing that zero and continue the process until none such column is left.

Step 5: If the total lines covering all zeros and the dimension of the performance matrix is coinciding, the optimal solution is obtained; if it is not, deduct the smallest uncovered element from all uncovered elements, and also add this element to all elements at the crossing point of the lines covering zeros.

LITERATURE REVIEW

The Assignment problem is a special type of transportation problem. It helps to assign a perfect man or machine to do the perfect job. This assigning problem can be balanced, or unbalanced, or restricted. A balanced, unbalanced and also the restricted problem can be easily solved by using the Hungarian method. There are several types of research done on the job assigning problem.

Paul A. et al. studied on solid waste management, Eastern Nigeria. They formulated the allocation of the recommended sites as an assignment problem and they obtained the best schedules by using the Hungarian method. Comparing to the existing practice consumed by the waste management authority, the outcomes display that execution of the proposed schedule can lead to 70% lessening in the surviving cost of waste disposal, and also make a 21% return on the capital investment.

MaXian-yang applied the Hungarian method in the allocation of human resources to sports management. Sudradjat et al. used the Hungarian method to make the traveling time minimized. In this research, 10 traveling time workers from the central post office Bandung in distributing the package to 10 the destination location was assigned, and the optimal traveling time is 387 minutes.

Douglas Kwasi Boah et al. applied the Hungarian method in solving an assignment problem of a Legal Firm. There was a difficulty in allocating nine diverse cases to the nine junior legal representatives. It was established that Case 1 to Case 9 should be allocated to the Lawyers as L_1, L_9, L_2, L_6, L_7, L_8, L_5, L_3, and L_4 respectively. Also, the minimal hours to be spent by the firm from Case C_1 to C_9 are 180, 170, 169, 143, 190, 159, 162, 176 and 167 hours respectively. Lastly, the total minimum hour on altogether the nine cases is 1516 hours.

G. Ayorkor et al. presented the dynamic Hungarian algorithm in solving the assignment problem in conditions with varying edge costs or weights. Jacob Goldberger et al. utilized the Hungarian method as the basic building block of the clustering algorithm and proposed a novel classified clustering procedure for data-sets in which merely pairwise distances between the points are given. They reported an upgraded performance of the algorithm in a change of examples and compared it to the spectral clustering algorithm.

Michael M. Zavlanos et al. considered the linear assignment problem in the perspective of networked structures, where the key challenge is dealing with the lack of global information due to the restricted communication abilities of the mediators.

By using the Hungarian method anyone can easily allocate the resources perfectly. E-commerce in Bangladesh is a new concept; this type of assignment problem is also so newly raised. Any research is not done before on the assignment problem on any online company. And hence The Hungarian method helps them to find their allocation problem. The perfect man is given the perfect job to do and the optimal output is easy to get.

OBJECTIVE OF THE STUDY

The aim of the study is to allocate the efficient resources to the selected tasks which help to complete the whole task in the minimum time.

METHODOLOGY

This study is conducted on an online service provider. Their product is merely book which has been shown on their website frequently. To do so they divide the entire job into eight tasks. They have permanent seven resources (manpower) in completing these tasks. To make this manpower utilized for the entire job with cutting minimum operating time, a table for this assignment problem is framed. Hungarian method is used here, in solving this assignment problem

CASE STUDY

Rokomari.com has to enter their product on online and this job is divided into 8 tasks as follows:

Physical Book Loading Time (T_1)

Details Entry of the Book on the website (T_2)

Initial 20 Page scanning of the book (T_3)

Resizing, Correction, Watermark on the scanned pages (T_4)

Produce "Ektu Porhe Dekhun" PDF (T_5)

Adding Front view and "Ektu Porhe Dekhun" PDF on the website (T_6)

Final Checking and Correction (T_7)

Category and Tagging (T_8)

Rokomari.com has employed seven persons to complete the whole job. Most of them are able to do more than one task. Following list is showing their competence level based on the minutes:

Person	Job							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
M_1	5	2	6	10	3	4	3	-
M_2	5	4	5	11	2	3	2	-
M_3	-	10	-	-	-	-	-	9
M_4	3	-	-	-	-	-	-	-
M_5	5	-	5	17	5	-	-	-
M_6	6	3	9	4	3	2	-	-
M_7	5	4	8	-	4	2	1	15

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Solution by Hungarian Method

Person	Job							
	T₁	**T₂**	**T₃**	**T₄**	**T₅**	**T₆**	**T₇**	**T₈**
M₁	5	2	6	10	3	4	3	-
M₂	5	4	5	11	2	3	2	-
M₃	-	10	-	-	-	-	-	9
M₄	3	-	-	-	-	-	-	-
M₅	5	-	5	17	5	-	-	-
M₆	6	3	9	4	3	2	-	-
M₇	5	4	8	-	4	2	1	15

Step 1-Make the unbalanced problem to balanced

As this studied problem is an unbalanced problem, we should make it balanced by introducing a dummy row:

Person	Job							
	T₁	**T₂**	**T₃**	**T₄**	**T₅**	**T₆**	**T₇**	**T₈**
M₁	5	2	6	10	3	4	3	-
M₂	5	4	5	11	2	3	2	-
M₃	-	10	-	-	-	-	-	9
M₄	3	-	-	-	-	-	-	-
M₅	5	-	5	17	5	-	-	-
M₆	6	3	9	4	3	2	-	-
M₇	5	4	8	-	4	2	1	15
M₈	0	0	0	0	0	0	0	0

Step 2- Row Reduction

Select the lowest element in each row and subtract this element from all elements in the existing row, that's called row reduction and result matrix is a row reduced matrix. The least elements of Row-1 to Row-8 are 2, 2, 9, 3, 5, 2, 1, 0 respectively. So deducting these values from each of the elements in the rows individually, and got:

Person	Job							
	T₁	**T₂**	**T₃**	**T₄**	**T₅**	**T₆**	**T₇**	**T₈**
M₁	3	0	4	8	1	3	1	-
M₂	3	2	3	9	0	1	0	-
M₃	-	1	-	-	-	-	-	0
M₄	0	-	-	-	-	-	-	-
M₅	0	-	0	12	0	-	-	-
M₆	4	1	7	2	1	0	-	-
M₇	4	3	7	-	3	1	0	14
M₈	0	0	0	0	0	0	0	0

Step 3- Column Reduction

Select the lowest element in each column and subtract this element from all elements in the existing column, that's called column reduction and result matrix is a column reduced matrix.

Hence 0 is the lowest element in each column and subtracting 0 from all elements of the columns individually, we get:

Person	Job							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
M_1	3	0	4	8	1	3	1	-
M_2	3	2	3	9	0	1	0	-
M_3	-	1	-	-	-	-	-	0
M_4	0	-	-	-	-	-	-	-
M_5	0	-	0	12	0	-	-	-
M_6	4	1	7	2	1	0	-	-
M_7	4	3	7	-	3	1	0	14
M_8	0	0	0	0	0	0	0	0

Step 4-Assigning Zeros

Choosing any row or column with a single zero and assign it by squaring it. Cut off the remaining zeros, if any, in that row and column until all the assignments have been made.

Person	Job							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
M_1	3		4	8	1	3	1	-
M_2	3	2	3	9		1	0	-
M_3	-	1	-	-	-	-	-	
M_4		-	-	-	-	-	-	-
M_5	0	-		12	0	-	-	-
M_6	4	1	7	2	1		-	-
M_7	4	3	7	-	3	1		14
M_8	0	0	0		0	0	0	0

RESULT AND DISCUSSION

Resource	M_1	M_2	M_3	M_4	M_5	M_6	M_7	M_8	Total
Task	T_2	T_5	T_8	T_1	T_3	T_6	T_7	T_4	8
Optimum operating time	2	2	9	3	5	2	1	0	24 minutes

 Now, for this unbalanced problem, task T_4 is lagged. A Manager has to allocate this job to the new one. But in a developing company, it cuts a huge cost to assign a new one. So, it should be passed to an efficient worker within this team. This unallocated work can be done either by M_1, or M_2, or M_6. If M_1 or M_2 does this task, they can complete it in 10 or 11minutes respectively and the total time elapsed by 34 or 35 minutes. And by assigning M_6, the total task will be completed within 28 minutes as he can do the same work in the least time comparing others and it is only 4 minutes. Shown in the mentioned table below:

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Unassigned Task	Resource	Complete his assigned work in the min time	Operating time	The total Elapsed time per product entry
T_4	M_1	2√	10	34
	M_2	2√	11	35
	M_3	9	-	-
	M_4	3	-	-
	M_5	5	17	-
	M_6	2√	4	28
	M_7	1 (He is ineligible for T_4)	-	-

CONCLUSION

Job assigning is so essential to complete any job perfectly. It is helpful to complete the entire work efficiently. Who can do which job smoothly within least cost and time, it's very important for any online or offline company. And in a developing country and also in a rising company has not extra money to spend on an extra job. They allocate these extra jobs to those workers who can finish their work earlier. In the future, any research can be done on finding the most effective way under concerning these problems.

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