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VALIDATION OF REPLACEMENT ANALYSIS IN CONJUNCTION WITH OPTIMAL INTEGRATION OF FACILITY DESIGN

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ABSTRACT
Facilities location means the placement of facilities on a particular plot of land. The placement of a facility is done with respect to customers, suppliers and various other facilities. Facilities design comprises of facility the system design, the layout design and the handling system design1. The facility system design includes four systems; the structural system, the environmental system, the lighting/electrical system and the safety system. The layout design consists of all the machinery, equipment's and furnishings within the building structure. The handling system design consists of all those mechanisms which are much needed to take care and satisfy all the required facility interactions.
For a manufacturing plant, the plant layout or the facility layout comprises of three areas- the production area, the personnel area and the production related or support area2. Layout problems are very common to any manufacturing plant. They mostly relate to location of facilities-such as machines, departments, in a manufacturing plant. These layout problems greatly affect the effectiveness of system performance. Various researches have been done, been published, to solve the facility layout problems, but they don't provide solution for every aspects, as they are restricted to certain specific aspects of facility layout problems3. Most of the research work is not recent as well.
According to replacement analysis, the replacement problem falls in to two categories, keeping in view the life pattern of the equipment involved- replacement of those equipment's that wear out or become obsolete with time and replacement of those equipment's that do not deteriorate with time but fail suddenly4. The problem with those items or equipment's that become obsolete due constant use or due to new technological development is to balance the cost of new equipment against the cost of maintaining efficiency on the old, and to balance the cost due to loss of efficiency5.
Another problem involves the replacement of those items that do not deteriorate with time but give up suddenly. Here the main concern is to find which items to replace and whether or not to repave them in group and if so, then when. For both the replacement problems no general solution is possible, still many models have been constructed and solutions have been derived using simplified assumption about the condition of the problem6. In the present paper we approach to minimize the cost of the item, cost of replacing the item and cost associated with failure of item.
In this paper, the overall development of a new facility layout design algorithm and computer based system are outlined. The major algorithms are elaborated to details. A different approach has been presented to incorporate flexibility in layout designs. The presented approach for plant layout design comprises of- a replacement analysis tool, new layout design algorithm and an evaluation tool that gives the layout alternatives, analysis and evaluation. Finally the results of replacement analysis in conjunction with optimal integration of facility design will be compared and validated with previous research findings.
Keywords:
Facility planning; Plant layout; Optimization methods; Replacement analysis

INTRODUCTION

The system is implemented by using Microsoft Access and MATLAB by Application. All the information required for designing of a layout and the result obtained from the layout design algorithm are stored in Microsoft Access's tables. For simple MATLAB by Application has been used. Finally, Microsoft Access's report is used to output the layouts to the screen or to the printer.

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The case study presented here is taken from J.A. Tompkins, J.A. White, et al, Facilities Planning, 2nd edition, 1996. Pp 324-325, problem 7.23. There are ten departments. Their areas are different and given. The material flow is assumed to be deterministic and known. The change in material flow is not taken into account7. The problem is to arrange these ten departments into a rectangular plant building to minimize the total material handling cost. Table shows the material flows of the departments.

Dept	Area	A	B	C	D	E	F	G	H	I	J
A	400	-	0	12	0	132	16	0	220	20	24
B	1000	0	-	176	0	216	0	144	128	0	0
C	2600	0	0	-	0	0	184	0	0	28	0
D	400	212	136	240	-	36	0	236	0	164	0
E	2400	0	0	140	0	-	0	192	0	0	160
F	1000	0	180	0	188	108	-	248	228	0	0
G	3600	172	0	156	0	0	0	-	112	224	152
H	1200	0	0	32	40	204	0	0	-	0	0
I	400	0	168	0	0	104	156	0	148	-	200
J	2400	0	124	196	120	0	116	0	108	0	-

It is assumed unit cost cij = $ 1 /unit load/unit distance for any department i, j in this problem. The input layout is A-B-C-D-E-F-G-H-I-J. This order expression is the same as the one used by CRAFT. The number of bays is set to three. Travel distances are rectilinear. The resulting layout from CRAFT is H-A-I-D-F-J-G-E-B-C. The total material handling cost is $445,476.80. The resulting layout from the pair exchange layout design algorithm presented in this dissertation is E-B-C-F-D-I-A-H-J-G. The total material handling cost is $406,985.10. After the flexible layout design algorithm is used in this case, the total material handling cost is $390,113.9.

Following is the comparison between the results obtained by application of algorithm by some previous publishing and the present paper (flexible split layout design algorithm).

In [Rosenblatt, 1986], for stages 1 and 2, the optimal solution layout is(2, 4, 6, 1, 3, 5); for stage 3 (2 ,4, 6, 1, 5 ,3); for stage 4 (2, 6 ,4, 1, 5 ,3) and for stage 5 (2,1,4,6,5,3). The total cost of material handling is $71,187. Author's heuristic algorithm results in-layout (6, 3, 1, 5, 4, 2) for stages 1 and 2; and layout (6, 5, 1, 3, 4, 2) for stage 3, 4 and 5. The total cost of material handling is $72,228. Now, by using the flexible split layout design algorithm presented by the paper, the total cost savings are 71,187-66,432.70 = $ 4,754.30 or 6.7% and 72,228-66,432.70 = $5,795.30 or 8.0% respectively. Another advantage of this algorithm is that there is only one single layout, and it is not necessary to relocate the departments at each stage.

In [Rosenblatt, 1992], the probabilities assumed for each future flow are 0.3, 0.1, 0.05, 0.15 and 0.4 respectively. The layout is (2, 1, 5, 6, 3, 4). The total cost of material handling is $14,573. The method I n [Shore, 1980] was also used for comparison. The result obtained is layout (1, 4, 2, 6, 3, 5) and the total cost of material handling is $14,625. Under the assumption of these probabilities, the cost by using flexible split layout design algorithm to split only one department is 0.3*11,328.31 + 0.1*13,144.25 + 0.05*13,078.80 + 0.15*13,637.80 + 0.4*15,243.54 =$13,509.94.The total cost savings are 14,573- 13,509.94 = $1,063.06 or7.3% and 14,625 – 13,509.94 = $1,115.06 or 7.6% respectively. The present algorithm provides flexibility for more comparisons, as we can try some other probabilities for each future flow. Table 5-13 lists the cost of material handling or different flows. Table 5-14 shows the expected cost of material handling for different probabilities. From the obtained results, it is evident that cost saving and cost reduction is very significant if compared to these current algorithms, for all of these different distributions. So the layout created by flexible split layout design algorithm method is very flexible.

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INTEGRATION OF LAYOUT WITH THE APPLICATION OF REPLACEMENT METHODOLOGY

The present dissertation highlights the importance of integrating various problems of a facility layout. With the application of replacement analysis methodology the layout problems or layout may be integrated to study more than one problem of facility layout together, so that the total cost of production stays minimal8. The facility problems, the research is pointing are, the costs incurred on the repairing of the equipments and the cost incurred on the maintenance of the existing equipments. Both these problems are important to consider while planning a facility layout9. Both the problems that are the cost of repairing the existing equipments and the cost of maintaining them are faced by every manufacturer. They tend to increase with times and at times the amount spent on them is more than the cost of new equipment.

With the continuous usage of the existing machines or equipments, they become obsolete, or may become slow, or out model or may become old fashioned. Most of the manufacturer will try to repair them, but will not dispose the machinery10,11. So, these machines will definitely need high rate of maintenance and repair. So half of the production cost is spent on the repair and the maintenance of the machinery. So, at a particular it becomes absolutely necessary to dispose such machinery which are costing high on the account of repair and maintenance and either replace them with machinery or purchase a new machine12,13. Because here replacing the equipment is far more economical then maintaining the existing one.

So in this paper uses replacement analysis methodology to combine or integrate both these problems, so that they can be analyzed together while planning a facility layout.

CONCLUSION

In this research, the major emphasis is on the validation of the Flexible Split Layout Design Algorithm. It must be noted that in order to validate the algorithm the whole computer program and each module have been validated. The validation procedure show the robustness of the computer program and its results shows that the algorithms built in to the program function yields better results in all the cases, as is evident by the results obtained when comparison is made between the presented algorithm and already available data. The present paper also uses replacement analysis methodology to combine facility layout problems, so that they can be analyzed together while designing a layout. The results of replacement analysis in conjunction with optimal integration of facility design needs no validation as this methodology is already validated.

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