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Distribution Optimization Plan for Library Service Offices

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Abstract: ***In this research, more than one plan to distribute the service offices in the library of the faculty of engineering, University of Benghazi were proposed by using Relationship Diagramming method, and they number 12 offices according to the working relationship between these offices and the students' use of them. The optimal plan was chosen, as we made five plans according to the first method. Plan number three is considered the best among the five. The proposed plans, where the lowest point was given for the calculated distances. All plans are also considered better than the existing plan. There are 12 offices in the library building of the Faculty of Engineering, University of Benghazi, which are frequented by students for the purpose of benefiting from the service provided through them. There are also relationships between these offices according to the nature of their work.***

Keywords: Layout, Activity, Office, Relationship Diagramming, Grid Representation, Row Value.

1. Introduction

Uma, et.al. [11] explored and exploited the Reason/Why code of RDM. The Reason and why codes are associated with a restraint and for recording the description respectively. The proposed concept is tested with data from a repetitive high rise construction project. The preliminary results have been well received.

The manufacturing plant layout has been designed by using Computerized Relative Allocation of Facilities Technique (CRAFT). JAVA programme has been developed to design the optimum plant layout by considering STEP file as input for developing an optimum plant layout by Hari, et.al. [16].

Andrew, et.al. [2] presented a methodology to optimize a wind–solar-battery hybrid power plant down to the component level that is resilient against production disruptions and that can continually produce some minimum required power, introduce the models and assumptions and use to simulate a hybrid power plant as well as the design variable parameterization and specific methods used to optimize the plant.

Healthcare facility layout design focused on the methods of simulation, procedural and algorithmic approaches with limited consideration of building operational performance, or the well-being of future occupants. A systematic decision-support approach that combines multi-objective optimization and simulation-based occupancy performance evaluation to offer a well-performance healthcare facility layout solution was proposed by Yongkui, et.al. [22].

Akhil and Deepthi [17] aimed to observe the flow of material and presents the explanation regarding the procedure of spinning of textile material (yarn). The major issues faced in this industry are scarcity of skilled labour. Researchers come up with a suggestion of addition and upgradation of machines, which eliminates manual handling of materials, thereby solving the labour problem.

The expected characters of a safe layout were analyzed at first in this work, and then four key metrics were proposed to evaluate the safety performance of the layout. These four metrics are accident triggered likelihood degree, improper degree of domino risk, improper degree of facility damage risk/human injury risk and evacuation difficulty degree. Based on the character analysis, the mathematical representations of the four metrics were also preliminarily analyzed by Meng, et.al. [14].

Shubham, et.al. [20] presented a systematic layout planning (SLP) is the best method to improve workshop layout, which shows step-by-step improvement in layout and evaluation of layout. This method suggests a new workshop layout that improves the flow among the shops and helps to decrease movement in the workshop.

Direct risks to humans from such hazards were quantitatively assessed as individual risk and converted into safety distances for each piece of process equipment. Then, a process layout optimization problem with risk zones constructed using those safety distances was formulated by Kyusang, et.al [12]. A case study for an ethylene oxide plant was conducted. With the proposed methodology, a cost-efficient and inherently safe layout can be provided in the early stage of the design of a process plant.

Kiran [5] developed the idea of arranging the workplace to suit to the convenience of the operative is as old as trade and craft itself. As factory and business systems, more attention was paid to the space utilization and efficient flow of materials required.
Zhongze and weisheng [24] identified the optimal Facility

Layout Design (FLD) for MCM in a factory by simulating and optimizing a real-life case. Firstly, the workflows and schedules of MCM are collected and re-engineered into nine categories. Then, data is collected and implemented to five candidate FLDs for simulation and optimization. The results show that 'cellular layout' has the most output and 'product layout' is the most economical selection in the case factory.

Toyoki [21] described the state of the art regarding the plant production process, as well as the floor plan and layouts of equipment and culture beds of a PFAL, and also discussed sanitation.

Zhuoran, et.al. [25] reviewed 102 articles, which are classified into five different categories concerning their layout-related challenges. Viewing the spatial complexity of a hospital as an indoor spatial environment is at least as complex as an urban environment, thus justifying a geographical approach.

A simulation-based optimization framework to simultaneously find the optimal facility layout design and resource allocation applicable for vegetable grafting nurseries that involve highly labor-intensive young plant production with multiple operational stages was developed by Sara, et.al. [18].

Mir, et.al. [15] proposed a methodology dependent on the fuzzy set hypothesis and Automated Layout Design Program and Computerized Relationship Planning to improve format interaction of facilities. The principal objective was to get the closeness rating esteems between every two facilities in the building site.

Buildings, structures, concentrators, solar towers, pipelines, and transportation routes within the plant area were arranged by Zhifeng [23] reasonably while giving overall consideration to the requirements of geographical latitude and longitude, elevation, solar radiation resources, wind speed, wind direction, production processes, transportation, fireproofing, explosion-proofing, environmental protection, hygiene, construction, and living.

Cassio, et.al. [3] were developed a framework integrating layout formulation with a quantitative risk assessment method to support risk-based decisions throughout the lifecycle of process facilities. The proposed methodology is divided into three steps: risk calculation, determination of safety distances, and layout optimization.

Results showed that some indicators of mental health (e.g. concentration, and stress) have frequently been related to indoor environmental quality (IEQ) (e.g. light and daylight), while others (e.g. burnout, engagement, and depression) have received less attention in relation to the physical workplace (especially to biophilia, views, look and feel) by Lisanne, et.al. [13].

Huang and Wong [4] developed a mathematical formulation to model and optimize site facility locations inside a construction site for a construction project's different stages.

The mathematical objective function established in the solution process aims to minimize the total cost, which consists of the material transportation cost between the relevant site facilities and the dismantling, setup and relocation costs for all of the involved site.

Feasible and efficient site layout solutions in a realistic representation scheme were developed by Ioanna, et.al. [8] taking into consideration not only the total distance traveled but also cost and safety parameters as well. A multi-objective optimization model is developed aiming at minimizing a generalized cost function which results from the construction cost of a facility placed at alternative locations.

The formulation approaches to address the problems and the relevant resolution methodologies were introduced by Abbas, et.al. [1]; the majority of the contributions proposed were analyzed from different perspectives.

Sean [19] design is always staged, these stages each run from an instruction for the designers to proceed, to the start of the sponsor's next decision-making process. At each of these stages, many projects fail to proceed, such that only a small percentage of stage one design projects proceed all the way through to plant construction.

A mathematical programming formulation for the optimal facility sitting and reallocation in an industry accounting for future expansions and involving simultaneously economic and safety objectives was proposed by Juan, et.al. [10]. The proposed formulation is based on a multi-annual framework and this corresponds to a multi-objective mixed integer linear programming problem. The proposed optimization approach was applied to a case study for the facility sitting (office buildings and control rooms) in an ethylene oxide plant.

Edwin [7] discussed different industrial plant layouts and the factors that affect layout selection for a plant. Proper plant sizing involves examination of present and future production needs. Three elements of production—manpower, machinery, and material—together with their required working spaces must be brought into balance. Plant layout may consider a wide range of product assembly patterns. Among the better-known general flow patterns are the straight line, serpentine, U-shaped, circular, odd-angle, and "job shop."

A fuzzy random multi-objective decision making model was proposed by Jiuping and Zongmin [9]. In this model, two objectives are considered: (1) minimizing the total cost of site layout; and (2) maximizing the distance between the 'high-risk' facilities and the 'high-protection' facilities to reduce the possibility of safety or environmental accidents.

2. Case Study

2.1 The subject

The subject of the paper is to make appropriate planning for offices department for officials working in the library of the faculty of engineering according to relationship diagramming method, and selection of the best planning as possible.

2.2 Body paragraphs

By making proper planning using a relationship diagramming method, we will achieve the following objectives:

- Ease of obtaining the required service and information for the student.
- Saving the student's time in the process of searching for scientific references.
- Facilitating service and information exchange between all offices.
- Improving and organizing the performance of library management.

In this study, there are 12 offices are: Administration of library, Stored files office, Specifications, References, Index, Café net, educational devices office, educational devices store, Archives, Cafeteria, W.C for woman, and W.C for man. The areas for these offices as shown in the Table 1 below. (For this case, 10 square meters could equal one block.) and the activity relationship chart for these offices illustration as shown in Figure 1.

Relationship-Chart Priority Codes and Reasons behind the "Closeness" Value illustration as shown in Table 2 and Table 3 below:

Table 1: offices areas and number of unit area templates

Code	*Function*	*Area (m^2)*	*Number of unit area templates*
1	Administration of library.	37	4
2	Stored files office	18	2
3	Specifications	37	4
4	References	37	4
5	Index	37	4
6	Café net	55	6
7	Educational devices office	93	9
8	Educational devices store	18	2
9	Archives	18	2
10	Cafeteria	18	2
11	W.C for woman	19	2
12	W.C for man	19	2

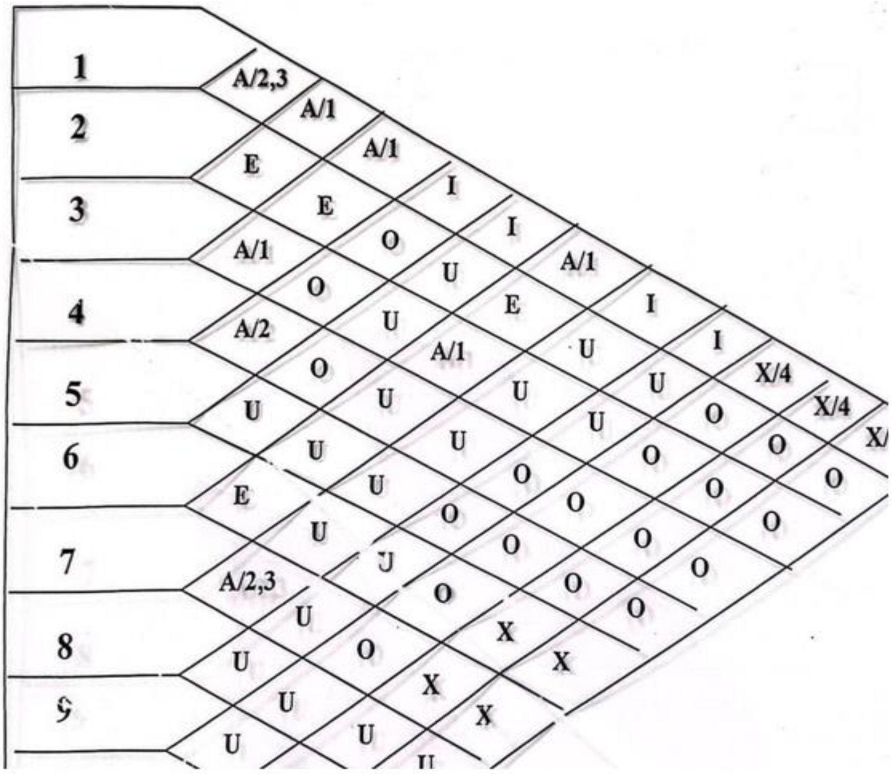


Figure 1: Activity relationship chart

Table 2: Relationship-Chart Priority Codes

Code	*Priority*	*Value*
A	Absolutely necessary	4
E	Especially necessary	3
I	Important	2
O	Ordinary	1
U	Unimportant	0
X	Undesirable	-1

Table 3: Reasons behind the "Closeness" Value

Code	Reason
1	Dealing with students
2	Exchange the information
3	Same official
4	Unsuitable

2.3 The existing layout

The grid representation for existing layout is shown in Figure 2:

2.4 The solution for this problem:

The information in activity relationship chart Figure 1 is converted into a relationship diagramming worksheet as shown in Table 4.

6	6	6	5	5	4	4	3	3	2	1	1
6	6	6	5	5	4	4	3	3	2	1	1
10	10		11	12	9	8	7	7	7	7	7
			11	12	9	8	7	7	7	7	

Figure 2: The grid representation for existing layout

Table 4: Relationship Diagramming Worksheet

	1	2	3	4	5	6	7	8	9	10	11	12
A	2,3,4,7	1	1,4,7	1,3,5	4		1,3,8	7				
E		3,4,7	2	2		7	2,6				12	11
I	5,6,8,9				1	1		1	1			
O		5,10,11, 12	5,10,11, 12	6,9,10,11, 12	2,3,10,9,11,12	4, 10	10		4,5	2,3,4, 5,6,7	2,3,4,5	2,3,4,5
U		6,8,9	6,8,9	7,8	6,7,8	2,3,5, 8,9	4,5,9	2,3,9, 4, 11, 5, 10,6, 12	2,3,10,6,7, 8,11, 12	8,11,9, 12	8,9, 10	8,9, 10
X		10, 11, 12				11, 12	11, 12			1	1,6,7	1,6,7

The steps in constructing a relationship diagram are:

Step 1: select the first office to enter the layout.
The office with the greatest number of "A" relationships is selected. If a tie exists, the tie-breaking rule is based on the following hierarchy of decisions: the greatest number of "E" relationships, greatest number of "I" relationships, the fewest number of "X" relationships' and lastly, one of the remaining tied offices are selected randomly.

Office 1 is selected since it has more " A" relationships with another offices. The selected office is placed in the center of the layout.

Step 2: select the second office to enter the layout.
The second office selected should have an "A" relationship with the first office selected. Additionally, it should have the greatest number of "A" relationships with the other office not yet selected. Ties are broken using the tie- breaking rules in step 1. In this layout office 7 is selected and it is placed in the adjacent to office 1.

Step 3: select the third office to enter the layout.
The third office selected should have highest combined relationship with the two offices already in the layout. The highest possible combined relationship would be an " A" relationship with the both of the offices already selected, the ranking hierarchy for the combined relationships is AA, AE, AI, A* ,EE, EI, E*, II, and I*, where the notation "*" indicates the relationship is an " O" or "U" relationships.
If there is a tie, the tie breaking rules in step 1 apply.
From Table 4, we see that office 3 has an "A" relationship with offices 1 and 7, then office 3 is selected to enter the layout.

Step 4: determine the fourth office to enter the layout.
The fourth office selected is based on the same logic as in step 3. The selection is based on the highest combined relationship with the three offices already in the layout. For this case, the ranking hierarchy is AAA,AAE,AAI,AA*,AEE, AEI,AE*, AII,AI*,A**,EEE,EEI,EE*,EII,EI*,E**,III,II*, and I**. From table (4), office (4) has a highest combined relationship AA* with offices 1, 3 and 7 respectively. Since the strength of the relationship office 4 with offices 1 and 3 are equal. Office 4 is placed so that it has a common edge with both 1 and 3, shown Figure 3(a).

Step 5: determine the fifth office to enter the layout.
The office 2 has a highest combined relationship and is AEEE relationship with the offices already in the layout. The office 2 is selected to enter the layout and located close to office 1, shown Figure 3(b).

Step 6: offices 5 and 8 has same and highest combined relationship is AI*** with the offices already in the layout. We will select office 5 to enter the layout randomly and located close to office 4 because it has A relationship with its, shown Figure 3(c).

Step 7: office 8 has highest combined relationship is AI**** with the offices already in the layout. The office 8 is selected to enter the layout and located close to office 7, shown Figure.3 (d).

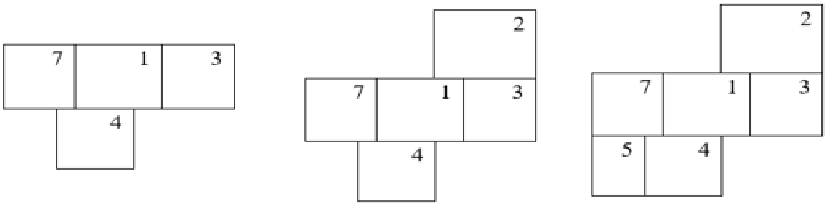
Step 8: the office 6 is selected to enter the layout. It has highest combined relationship EI***** with the offices already in the layout and located close to office 7, shown Figure 3 (e).

Step 9: the office 9 is selected to enter the layout. It has highest combined relationship I******* and fewest number of (X) relationship.

Step 10: the office 10 is selected to enter the layout. It has fewest number of (X) relationship with the offices already in the layout and located away from office 1 because it has (X) relationship with its.

Step 11: office 11 and office 12 enter the layout. They have (X) relationship with the offices 1, 6 and 7, thus they are located away from them .Offices 11 and 12 are related with (A) relationship, thus they are located adjacently as shown in Figure 3 (f).

Five final layouts proposed with different grid representation (6*7+1), (9*5-2), (9*5-2), (5*8+3) and (5*9-2) as shown in Figures 4 (a-b-c-d-e).



(a) (b) (c)

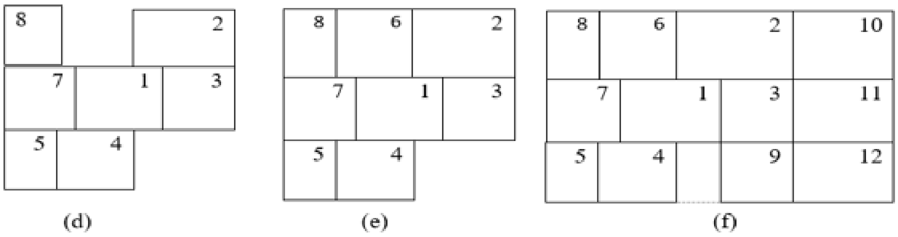


Figure 3 Relative location of block templates

					6
8	8	6	6	6	6
7	7	6	2	2	10
7	7	1	1	3	10
7	7	1	1	3	12
7	7	7	3	3	12
5	5	4	4	9	11
5	5	4	4	9	11

Figure 4 (a) The grid representation for first final layout by using the relationship diagramming technique.

8	8	6	6	6	6	4		
7	7	7	6	6	4	4	4	11
7	7	7	1	1	3	3	5	11
7	7	7	1	1	3	3	5	12
10	10	2	2	9	9	5	5	12

Figure 4 (b) The grid representation for second final layout

	9	3	3	3	3	7	7	8
	9	4	4	1	1	7	7	8
12	12	4	4	1	1	7	7	7
11	11	5	2	2	6	6	7	7
10	10	5	5	5	6	6	6	6

Figure 4 (c) The grid representation for third final layout

7	7	7		
7	7	7	3	3
8	7	1	1	3
8	7	1	1	3
6	7	2	4	4
6	6	2	4	4
6	6	6	5	5
9	9	10	5	5
12	12	10	11	11

Figure 4 (e) The grid representation for fifth final layout.

3. Discussion

To evaluate alternative plans, now we will choose one plan by calculate closeness measure. The closeness measure can be defined; it is equal to the shortest rectilinear distance between two areas multiplied by the value of relationship between those two offices.an effectiveness evaluation charts, similar to a value chart, is useful in developing this measure of all offices. The grand total gives the measure of effectiveness of the layout, the layout with minimum sum should be selected.

3.1 Effectiveness calculation for existing layout

From grid representation for existing layout determine shortest rectilinear distance between two areas, and from Figure 1 and Table 2 determine the value of the relationship between those two offices then calculate row value as shown in Table 5.

3.2 Effectiveness calculation for five final layouts proposed:

From Figures 4 (a-b-c-d-e), determine shortest rectilinear distance between two areas, and from Figure 1 and Table 2 determine the value of the relationship between those two offices, then calculate row value for all layouts as shown in Table 6, Table 7, Table 8, Table 9, and Table 10 below:

Table 5: Effectiveness calculation for existing layout

	Offices												
	1	2	3	4	5	6	7	8	9	10	11	12	Row value
1	-	0	4	12	10	14	0	8	10	-9	-7	-6	36
2		-	0	6	4	0	0	0	0	8	6	5	29
3			-	0	2	0	0	0	0	6	4	3	15
4				-	0	2	0	0	0	4	2	1	9
5					-	0	0	0	1	2	0	0	3
6						-	15	0	0	0	-1	-2	12
7							-	0	0	5	-3	-2	0
8								-	0	0	0	0	0
9									-	0	0	0	0
10										-	0	0	0
11											-	0	0
12												-	0
Total													104

Table 6: Effectiveness calculation for first final layout

	1	2	3	4	5	6	7	8	9	10	11	12	Row value
1	-	0	0	4	4	0	0	4	4	-1	-3	-1	11
2		-	0	9	5	0	3	0	0	0	4	2	23
3			-	0	2	0	0	0	0	0	1	0	3
4				-	0	3	0	0	0	4	1	2	10
5					-	0	0	0	2	6	3	4	15
6						-	15	0	0	0	-4	-2	-6
7							-	0	0	3	-3	-2	-2
8								-	0	0	0	0	0
9									-	0	0	0	0
10										-	0	0	0
11											-	0	0
12												-	0
Total													54

Table 7: Effectiveness calculation for second final layout

	Offices												
	1	2	3	4	5	6	7	8	9	10	11	12	Row value
1	-	0	0	4	4	0	0	6	0	-2	-3	-3	6
2		-	6	12	2	0	0	0	0	0	6	4	30
3			-	0	0	0	8	0	0	4	1	1	14
4				-	0	0	0	0	2	6	0	2	10
5					-	0	0	0	0	4	0	0	4
6						-	15	0	0	4	-3	-5	-4
7							-	0	0	0	-5	-5	-10
8								-	0	0	0	0	0
9									-	0	0	0	0
10										-	0	0	0
11											-	0	0
12												-	0
Total													50

Table 8: Effectiveness calculation for third final layout

	Offices												
	1	2	3	4	5	6	7	8	9	10	11	12	Row value
1	-	0	0	0	2	0	0	4	4	-4	-3	-2	1
2		-	6	0	0	0	6	0	0	2	1	2	17
3			-	0	2	0	0	0	0	4	3	2	11
4				-	0	2	0	0	0	2	1	0	5
5					-	0	0	0	2	0	1	0	3
6						-	0	0	0	3	-3	-4	-4
7							-	0	0	6	-5	-4	-3
8								-	0	0	0	0	0
9									-	0	0	0	0
10										-	0	0	0
11											-	0	0
12												-	0
Total													30

Table 9: Effectiveness calculation for fourth final layout

	Offices												
	1	2	3	4	5	6	7	8	9	10	11	12	Row value
1	-	0	0	0	0	0	0	4	2	-3	-1	-1	1
2		-	6	6	1	0	6	0	0	2	0	0	21
3			-	0	1	0	0	0	0	3	3	2	9
4				-	0	3	0	0	4	2	2	1	12
5					-	0	0	0	3	0	1	0	4
6						-	0	0	0	4	-2	-2	0
7							-	0	0	6	-4	-4	-2
8								-	0	0	0	0	0
9									-	0	0	0	0
10										-	0	0	0
11											-	0	0
12												-	0
Total													45

Table 10: Effectiveness calculation for fifth final layout

	offices												
	1	2	3	4	5	6	7	8	9	10	11	12	Row value
1	-	0	0	0	4	4	0	2	8	-3	-4	-5	6
2		-	6	0	1	0	0	0	0	1	3	3	14
3			-	0	2	0	0	0	0	5	4	7	18
4				-	0	1	0	0	3	2	2	4	12
5					-	0	0	0	1	0	0	2	3
6						-	0	0	0	0	-2	-1	-3
7							-	0	0	3	-5	-3	-5
8								-	0	0	0	0	0
9									-	0	0	0	0
10										-	0	0	0
11											-	3	3
12												-	0
total													48

4. Conclusion

From row value calculations, we conclude that:

1) The third layout is the best layout for this case because it has minimum row value and equal to 30.
2) By comparison between total row value for existing layout and total row value for several developed layout, all developed layout are better than the existing layout.
3) The shape of the grid can be changed without significantly affecting the results, show first and second layout, the block arrangement for first layout is (6*7+1) and total row value 54 and total row value for second layout is 50 and its block arrangement is (9*5-2), no significant difference between them in total row value.
4) Many other plans can be developed.
5) Other methods can be used for evaluating the existing layout.

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