

**University of Engineering & Technology
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Industrial Engineering Department

SEMESTER PROJECT REPORT



Subject Title:

Industrial Facility Design

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IED-2018 (7th Semester)

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Table of Contents

Abstract:	1
1. Literature review:	2
1.1. Day Care Centre:	2
1.2. Need of Day-Care Center:.....	3
1.1.1. Benefits of a Day-care Care facility:	3
1.1.2. Purpose of a Day-care Center Report:	4
1.3. Industrial facility Design:.....	5
1.3.1. Facility:	5
1.3.2. Facility Planning:.....	6
1.3.3. Importance of the facility location:	6
1.4. Problem Statement:	7
1.5. Objectives:	7
1.6. Methodology:.....	7
1.7. Attributes of Complex Engineering Problems (CEP) used in the report:	8
2. Daycare Facility Design Procedure:	8
2.1. Payback Analysis:	8
a) For the facility location at Faisalabad:	9
b) For Facility Location at Lahore:	10
c) For Facility Location at Islamabad:	10
2.2. Analytical Hierarchical Process:	10
2.3. Graph Base Method:	16
2.4. CRAFT Method:	19
a) CRAFT on Facility:	20
2.5. Flow Process of Layout:	22
a) Flow Process of Day Care Facility:	23
b) Structural Considerations of Daycare Centre:	23
c) Design and Sizes of Rooms:	24
d) Floors, Walls and Doors:	26
e) Furniture, Fittings and Fabrics:	27
2.7. Factors Affecting the Facility of Day Care Centre:	27

a) Hours of Operation:	27
b) Curriculum and Structure:	28
c) Ratio of Staff to Children:.....	28
d) References:	28
e) Cleanliness:.....	28
f) Training, Licensing and Credentials:	28
g) Snacks and Meals:	28
h) Turnover of Staff:.....	28
i) Location:.....	28
Conclusion:.....	29
References:	30
Assessment Rubrics:	31
Attributes to Complex engineering Problems:.....	32

Abstract

The design of the installation may contain the number of practical problems it involves. Layout design often has a significant impact on the performance of a production or service system and is usually a multi-criterion problem. This project proposed an analytical hierarchy process approach (AHP) to solve a layout design problem. A computer-based layout planning tool, ie. CRAFT was also used to select the best digital data available on the database. Qualitative performance measures were weighted by AHP. A day care structure is designed so that the first decision about the plant is made based on economy, then turns to alternatives to finally achieve the optimal plan of facilities.

1. Literature review:

Depth of knowledge required (*Attribute of CEP*)

For the designing of the Day-care Center facility, in-depth of knowledge is used for the evaluating the facility using different factors. The knowledge of different factors that is used to analyze the facility location. The basic knowledge of the facility design is also used in the designing of the health facility (Day-care Center) at best location. To design the Day-care Center facility at best location, the in depth knowledge is used to design the block layout and the improved layout. The knowledge of different software is also used in the project to make the improved layouts of the facility. The ARENA simulation is used to check the flow of the people in the facility between the different locations.

1.1. Day Care Centre:

Day care or childcare is the care of a child during the day by a person other than the child's legal guardians, typically performed by someone outside the child's immediate family. Day care is typically an ongoing service during specific periods, such as the parents' time at work.

Day care can also refer to daytime care for disabled or elderly people in both UK and US English, so child day care is often preferable at first mention.

The service is known as day-care or childcare in the United Kingdom, North America, and Australia and as crèche in Ireland and New Zealand.

According to Oxford Living Dictionaries, child care in two words can in addition have the broader meaning of the care of a child by anyone, including the

parents, but US dictionaries do not record that spelling or meaning. In English-

speaking and other conservative countries, the vast majority of childcare is still performed by the parents, in-house nannies or through informal arrangements with relatives, neighbors or friends, but most children are in daycare centers for most of the day in Nordic Countries, for example. Child care in the child's own home is traditionally provided by a nanny or au pair, or by extended family members including grandparents, aunts and uncles. Child care is provided in nurseries or crèches or by a nanny or family child care provider caring for children in their own homes. It can also take on a more formal structure, with education, child development, discipline and even preschool education falling into the fold of services.



Figure 1:Day care Center

The day care industry is a continuum from personal parental care to large, regulated institutions.

Some childminders care for children from several families at the same time, either in their own home (commonly known as "family day care" in Australia) or in a specialized child care facility. Some employers provide nursery provisions for their employees at or near the place of employment. For-profit day-care corporations often exist where the market is sufficiently large or there are government



Figure 2: Classroom in a Day Care Center

subsidies. Research shows that not-for-profits are much more likely to produce the high-quality

environments in which children thrive." Local governments, often municipalities, may operate non-profit day care centers. For all providers, the largest expense is labor. Local legislation may regulate the operation of daycare centers, affecting staffing requirements. In Canada, the workforce is predominantly female (95%) and low paid, averaging only 60% of average workforce wage. Some jurisdictions require licensing or certification. Legislation may specify details of the physical facilities (washroom, eating, sleeping, lighting levels, etc.).

1.2. Need of Day-Care Center:

Daycare is a necessity for most parents because many families require two incomes to get by financially. Others have made a personal choice to combine working and a supportive home life for the benefit of all members of the household. Single parents usually don't have the capacity to raise their young ones and hold down a job at the same time.

While the inability to do it all is often stressful for many parents, they can rest assured daycare is a viable option. It offers long-lasting social, economic and academic benefits for kids and their parents. Studies have shown that children, including babies and infants from the ages of 6 months to 4 years, benefit from the daycare environment, including its quality instruction, structure and social lessons.

1.1.1. Benefits of a Day-care Care facility:

a) Regular Schedule and Activities:

Even young children have a schedule at daycare. Although they might not be aware of the ticking clock, children are provided with a full slate of activities that include songs and storytelling. For toddlers, these fun tasks are essential to their intellectual growth and development. The scheduled activities are also satisfying for parents, who have less worry that their toddler's behavior will be erratic at the end of the day due to a lack of structured times for eating, playing and napping.

b) Academic Advancement:

An extensive study by the U.S. National Institutes of Health found that young children had higher cognitive and academic achievement scores as teens if they spent time in high-quality daycare as young children. Of the more than 1,300 children studied, over 90 percent had been in the care of someone other than a parent before the age of 4. The study defined “high-quality” daycare as facilities that provide extensive interaction with care providers, support, and cognitive-boosting activities.

c) Time With Peers:

Stay-at-home parents value the regular play dates they arrange with families and neighbors with kids of a similar age. Daycare interaction is an extension of this phenomenon, where kids get to spend time around one another in a supervised, structured and safe environment. Kids learn how to problem-solve, share and otherwise play and learn well together, while their minds are still growing and personalities still emerging.

d) Interaction With Other Adults:

When children are very young, they learn about adults mostly from their parents and senior members of their families. Daycare provides an opportunity for children to see other adults as mentors and authority figures able to provide positive guidance. A 2006 National Institute of Child Health and Human Development study found that high-quality daycare was directly connected to quality caregiving. Specifically, adult care providers respond to children’s vocalizations, provide encouragement, show a positive attitude and discourage negative interactions in the daycare environment.

e) Social and Economic benefit for parents:

Dropping your child at daycare can seem like a rushed, often anxiety-provoking experience. Even if you have done your research and are actively engaged in learning about the daycare’s staff, credentials and day-to-day operations, you are still leaving your precious child with a group of strangers. You may have little to no interaction with people who are sharing your experience: other parents. However, a recent study showed that even a small amount of time with other parents provides immense benefit.

1.1.2. Purpose of a Day-care Center Report:

Many parents rely on daycare centers to care for their children while they work. While some parents may just consider a professional daycare center to be the safest option for babysitting, there are many benefits and functions of a daycare center. Children who attend daycare centers benefit from the wide variety of social and educational opportunities the center provides.

Daycare centers can be profitable small businesses for those who love working with children. **a)**

Safety:

The primary function of a daycare center is to provide a safe and secure environment with quality caregivers, so that parents have the peace of mind of knowing their children are safe while they work. Each state has regulations in place that require compliance with established safety practices that you will need to consider before choosing a location for

your daycare center. Many states have departments dedicated to childcare licensing and conduct regular routine inspections of daycare facilities as well as responding to complaints. In these states, even in-home daycare providers must meet safety requirements and licensing rules.

b) Education:

From infants through preschool-aged kids, most daycare centers have planned educational activities that help build a foundation for later school success. Children learn through play as well as structured learning programs. Most children who attend a daycare through the preschool level are able to recognize and write letters and sight words and can do basic addition and subtraction. This makes the transition to kindergarten much easier, and gives them a head start on learning skills.

Unless you are offering a pre-kindergarten program, a good mix of reading, counting, art and writing will provide the children in your care the educational opportunities they need. Larger daycare centers tend to have a set schedule and operate more like a traditional school.

c) Socialization:

One of the best benefits a child receives while attending a daycare program is socialization. Through play with peers and interactions with adult staff members, children learn valuable social skills including sharing, compromising and language skills. Children who do not have access to peer groups tend to have a harder time adjusting to elementary school than those that attend daycare or preschool. Consider choosing play equipment that allows for exploring roles, such as toy kitchens and costume pieces for dressing up.

d) Health:

Daycare centers must provide healthy, well-rounded meals and snacks. Most states have regulations governing the types of foods and drinks that may be provided while children are attending daycare. Daycare centers are also responsible for ensuring children receive adequate opportunities for physical fitness. Usually these goals are achieved through a combination of song and dance, outdoor play and structured activities. Check with your state's licensing department to see if any programs exist that may help you ensure your daycare meets the nutritional requirements. If you serve a low-income area, some states have programs that help offset the cost of healthy food, drinks and snacks

1.3. Industrial facility Design:

1.3.1. Facility:

A facility is the specific piece of land and have a complete infrastructure and have a certain output. A facility has some characteristics.

- a) A piece of land that builds an infrastructure

- b) A place, amenity, or piece of equipment provided for a particular purpose
- c) The quality of being easily performed

1.3.2. Facility Planning:

It determines how an activity's tangible, fixed assets should contribute to meeting the activity's objectives. The facility planning comprises of two components

1. Facility Location
 2. Facility Design
- **Facility location** refers to the placement w.r.t. supplier and customer and other facilities with which it interacts. Also placement and orientation on a specific plot of land.
 - **Facility Design** consists of facilities Systems, facilities layout (plant layout) and handling System.
 - **Plant layout** refers to the arrangement of physical facilities such as machinery, equipment, furniture etc. within the factory building in such a manner so as to have quickest flow of material and information.
 - The **Handling system** consists of the mechanisms needed to satisfy the required facility interactions.

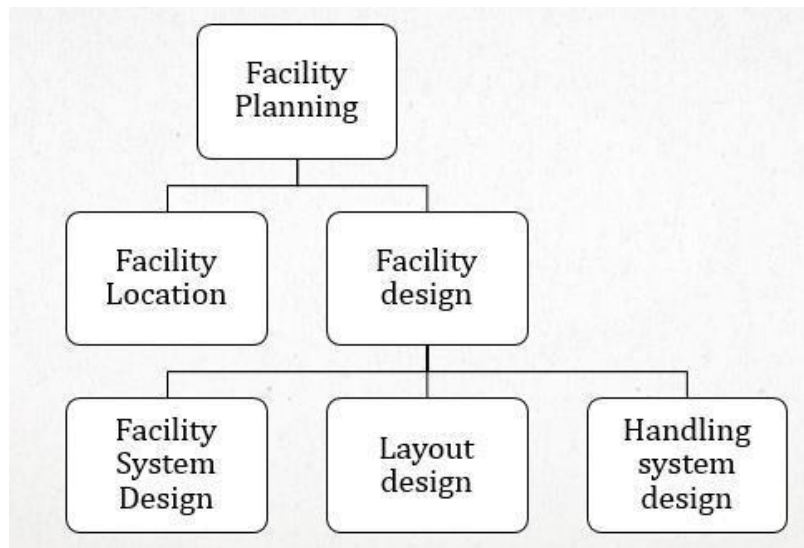


Figure 3: Hierarchy of facility planning

1.3.3. Importance of the facility location:

Location of an industry is an important management decision. It is a two-step decision: first, choice of general area or region and second, the choice of site within the area selected. Location decision is based on the organizations long-term strategies such as technological, marketing, resource availability and financial strategies. The objective of plant location decision-making is to minimize the sum of all costs affected by location.

Facility location is important because of the following:

- i. Location influences plant layout facilities needed.
- ii. Location influences capital investment and operating costs.
- iii. Location decisions are strategic, long-term and non-repetitive in nature. Without sound and careful location planning in the beginning itself, the new facilities may create continuous operating problems in future. Location decision also affects the efficiency, effectiveness, productivity and profitability.
- iv. The location decision should be taken very carefully, as any mistake may cause poor location, which could be a constant source of higher cost, higher investment, difficult marketing and transportation, dissatisfied and frustrated employees and consumers, frequent interruptions of production, abnormal wastages, delays and substandard quality etc.
- v. Therefore, it should be based upon a careful consideration of all factors that are essentially needed in efficient running of a particular industry. The necessary factors in the selection of plant location vary among industries and with changing technical and economic conditions.
- vi. Site selection is not an easy problem because if the selection is not proper then all money spent on factory building, machinery and their installation etc., will go as waste and the owner has to suffer a great loss. Therefore, while selecting a site, owner must consider technical, commercial, financial aspects which may provide maximum advantages.

1.4. Problem Statement:

Design of a Day-care center/facility at suitable/best location.

1.5. Objectives:

The objectives of the day-care center are as follows:

- Select a location for the Day-care center facility at the best location (alternatives).
- The objective for the day-care Center facility is to maximize the profit and the quality of health services.
- Use of graph method for block design and CRAFT method for the improvement of the existing design.

1.6. Methodology:

The method to achieve double capacity production consists of following stages:

1. Using AHP to choose the optimum/ most suitable alternative using engineering approach
2. Using Graph Based Layout
3. Using Visio to obtain Layout
4. Using CRAFT Algorithm to obtain layout

5. Drawing the 'Block layout' using engineering approach
6. Determining the factory flow
7. Analysis of results

1.7. Attributes of Complex Engineering Problems (CEP) used in the report:

According to the Pakistan Education commission (PEC) for the OBE requirements, semester project report should exhibit following attributes in the report, the following report exhibits the following attributes in the report.

1. Preamble
2. Range of Conflicting Requirements
3. Depth of Analysis Required
4. Depth of Knowledge
5. Familiarity of issues
6. Extent of Applicable codes
7. Extent of stakeholder involvement and level of conflicting requirements
8. Consequences
9. Interdependence

2. Daycare Facility Design Procedure:

Preamble (Attribute of CEP)

The report provides a detailed procedures and methods used to design a facility and selecting the most economical one. Different software and techniques are used to evaluate each alternative and optimize to get best results. It also includes all factors that are considerable for designing a new facility. In this project, different software are used to design the health facility. Net-Logo software is used to analyze the optimal location for the health facility according to the requirements and parameters related to the facility. Visio software is used to draw the block layout of the facility. Graph based layout method and CRAFT are used to design the block layout of the facility and the improved layout of the facility, respectively.

As we were supposed to design the facility of daycare. So, first we calculate the costs and the payback period based on costs calculation.

2.1. Payback Analysis:

Selection of alternatives and different factors for the facility location:

For the analysis on the expert choice, four different alternatives are selected at which the facility will be located. The alternatives are selected from the urban areas of Pakistan and the having very low number of day-care center facilities. The three alternatives are given below. For payback analysis and AHP, first we have to decide the locations where we have to establish a facility. So we have three locations.

1. Faisalabad
2. Lahore
3. Islamabad

Range of Conflicting requirements (*Attribute of CEP*)

There are different factors that can be used for the requirement for the Day-care center facility, so for the easiness some of the factors that affect the Day-care center facility significantly are used in the analysis. There are different optimal designs using the CRAFT method. There are different conflicting requirements that are used in the problem. For block layout formation of the facility the area constraint and the number of departments in the facility including the physician cells. The factor of minimizing the flow between the cells and the rooms is also lies in this attribute of complex engineering problem.

a) For the facility location at Faisalabad:

Year	Cash Flow	Net-investment
0	0	\$ 4,500.00
1	350	\$ 4,150.00
2	350+1160	\$ 2,990.00
3	350+1160+630	\$ 2,360.00
4	350+1160+630+1320	\$ 1,040.00
5	350+1160+630+1320+540	\$ 400.00
6	350+1160+630+1320+540+500	\$ -

Figure 4: Cash flow Analysis at Faisalabad

b) For Facility Location at Lahore:

year	Cash Flow	Net- Investment
0	0	\$ 3,800.00
1	600	\$ 3,200.00
2	600+450	\$ 2,750.00
3	600+450+1400	\$ 1,350.00
4	600+450+1400+800	\$ 550.00
5	600+450+1400+800+550	\$ -

Figure 5: Cash flow Analysis at Lahore

c) For Facility Location at Islamabad:

year	Cash Flow	Net-Investment
0	0	\$ 9,858.00
1	1500	\$ 8,358.00
2	1500+2300	\$ 6,058.00
3	1500+2300+3100	\$ 2,958.00
4	1500+2300+3100+2958	\$ -

Figure 6: Cash flow Analysis at Islamabad

2.2. Analytical Hierarchical Process:

According to Operations Management 4th Edition by Russell and Taylor III, AHP is a quantitative method for ranking decision alternatives and selection the one given multiple criterion. AHP is a process for developing a numerical score to rank each decision alternative based on how well each alternative meets the decision maker's criteria. The question "Which one do we choose?" or "Which one is best?" by selecting the best alternative that matches all the decision maker's criteria.

What does AHP use?

- a) Simple mathematics
- b) Criteria (set by the decision maker)
- c) Preferences of that criteria (also set by the decision maker)
- d) The standard preference tables

Standard Preference Table:

As the standard preference table has been determined by experienced researchers in AHP to be a reasonable basis for comparing two alternatives. So, avoid from using your own preference table.

Table 1: Standard performance table

PREFERENCE LEVEL	NUMERICAL VALUE
Equally preferred	1
Equally to moderately preferred	2
Moderately preferred	3
Moderately to strongly preferred	4
Strongly	5
Preferred	6
Strongly to very strongly preferred	7
Very strongly preferred	8
Very strongly to extremely preferred	9

Following are alternatives, goal and criteria to design a facility of auto workshop.

Alternatives:

Table 2: Table for Alternatives of locations

A	B	C
Faisalabad	Lahore	Islamabad

Goal:

Table 3: Table for goal of the AHP

Selecting suitable Location

Criteria:

Table 4: Table for criteria of the best location

Labor cost	Distance	Customer	Setup Cost
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Solution:

Use AHP to achieve the optimum option from three available alternatives. Step by step solution is explained below.

Step 01:

Since labor cost of A is moderately preferred to the labor cost of B. The score of A to B is 3 and B to A is the reciprocal or inverse of $1/3$. Similarly, construct the table for each mentioned criteria.

Later on, add up all the values in each column.

Labor Cost:**Table 5: Pairwise comparison matrix of Labor cost w.r.t Alternatives**

	A	B	C
A	1	$1/3$	$1/5$
B	3	1	$1/4$
C	5	4	1
COLUMN SUM	9	5.33	1.45

Distance:**Table 6: Pairwise comparison matrix of Distance w.r.t Alternatives**

	A	B	C
A	1	$1/6$	$1/9$
B	6	1	$1/3$
C	9	3	1
COLUMN SUM	16	4.17	1.44

Customer:**Table 7: Pairwise comparison matrix of Customers w.r.t Alternatives**

	A	B	C
A	1	1	$1/7$
B	1	1	$1/2$
C	7	2	1
COLUMN SUM	9	4	1.64

Setup Cost:

Table 8: Pairwise comparison matrix of Setup cos w.r.t Alternatives

	A	B	C
A	1	1/3	1/5
B	3	1	1/2
C	5	2	1
COLUMN SUM	9	3.33	1.7

Step 02:

- i. Next the values in each column are divided by the corresponding column sums.
- ii. Notice: The values in each column sum to 1.
- iii. Find the average of each row.

Labor Cost:**Table 9: Result matrix of pairwise comparison of Alternatives w.r.t labor cost**

	A	B	C	ROW AVERAGE
A	0.11	0.06	0.14	0.10
B	0.33	0.19	0.17	0.23
C	0.56	0.75	0.69	0.67

Distance:**Table 10: Result matrix of pairwise comparison of Alternatives w.r.t distance**

	A	B	C	ROW AVERAGE
A	0.06	0.04	0.08	0.06
B	0.38	0.24	0.23	0.28
C	0.56	0.72	0.69	0.66

Customer:**Table 11: Result matrix of pairwise comparison of Alternatives w.r.t customer**

	A	B	C	ROW AVERAGE
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A	0.11	0.25	0.09	0.15
B	0.11	0.25	0.30	0.22
C	0.78	0.50	0.61	0.63

Setup Cost:

Table 12: Result matrix of pairwise comparison of Alternatives w.r.t setup cost

	A	B	C	ROW AVERAGE
A	0.11	0.10	0.12	0.11
B	0.33	0.30	0.29	0.31
C	0.56	0.60	0.58	0.58

Step 03:

- i. From the row average of each criterion, following is achieved.

Table 13: Pairwise matrix all criteria w.r.t all alternatives

	Labor cost	Distance	Customer	Setup cost
A	0.10	0.06	0.15	0.11
B	0.23	0.28	0.22	0.31
C	0.67	0.66	0.63	0.58

Step 04:

- i. Rank the criteria in order of importance. Use the same method used in ranking each criterion.
- ii. Add up all the values in each column.

Table 14: Pairwise comparison matrix of criteria w.r.t criteria

	Labor cost	Distance	Customer	Setup cost
Labor cost	1	1/3	1/6	1/6
Distance	3	1	1/3	1/7

Customer	6	3	1	½
Setup cost	6	7	2	1
COLUMN SUM	16	11.33	3.5	1.81

Step 05:

- i. Next the values in each column are divided by the corresponding column sums.
- ii. Notice: The values in each column sum to 1.
- iii. Find the average of each row.
- iv.

Table 15: Result matrix of pairwise comparison of criteria w.r.t criteria

	Labor cost	Distance	Customer	Setup cost	ROW AVERAGE
Labor cost	0.06	0.03	0.05	0.09	0.06
Distance	0.19	0.09	0.09	0.08	0.11
Customer	0.38	0.26	0.29	0.28	0.30
Setup cost	0.38	0.62	0.57	0.55	0.53

Step 06:

- i. Multiplying the following two tables (matrix multiplication).

	Labor cost	Distance	Customer	Setup cost
A	0.10	0.06	0.15	0.11
B	0.23	0.28	0.22	0.31
C	0.67	0.66	0.63	0.58

 \times

	Criteria
Labor cost	0.06
Distance	0.11
Customer	0.30
Setup cost	0.53

 $=$

A	0.1153
B	0.2749
C	0.6092

Figure 7: Final probability matrix obtained for best alternative after AHP

From results it is computed that alternative C i.e., Islamabad has the highest value. So, under the given conditions, most suitable option that achieves our objective by fulfilling our criteria is C-alternative i.e., “Islamabad”.

Table 16: Final matrix obtained for the best location (Islamabad)

Faisalabad	A	0.1153
Lahore	B	0.2749

Islamabad	C	0.6092
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2.3. Graph Base Method:

Familiarity of Issues (*Attribute of CEP*)

In the designing of the health facility, different issues that are concerned and also effect the performance of the facility. The first one is that, the facility designed near the city so that a large population of the area can be targeted. The design and layout of the facility is such that, people can move easily in the facility. The service counter of the Day-care center facility is located near to the entrance of the facility so that the newly coming parents/customers can easily be guided about all the services being provided by the facility without wasting any single minute of time. The aesthetics related to the facility like luminosity, ventilation, play-rooms, toys are controlled by including these factors in the designing of the facility.

To perform graph base method, first we have taken the distances between all rooms, then we compare the distances between them. The largest distance was between room A and F, so we start with room A & F.



The following table shows the first step of graph base method where we take the distances of rooms as describe below and take their sum.

Table 17: Graph based method for facility design iteration 1

ROOMS	A	F	SUM
B	8.5	21.5	30
C	16.8	14.2	31
D	16.7	9.6	26.3
E	16.5	8.2	24.7
G	25.1	4.6	29.7
H	17	12.3	29.3
I	11	21	32
J	9.5	29.2	38.7

Room 10 has the highest sum, so the new sequence will be: **A-F**.

After getting the new sequence, the next step will be: A-F-J

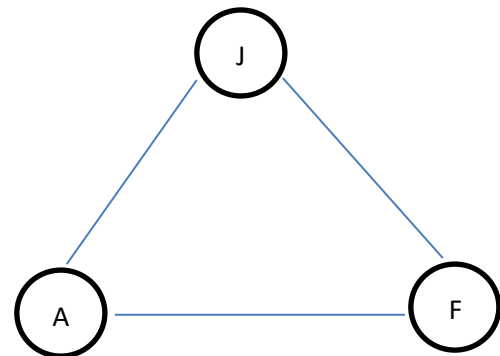


Table 18: Iteration 2

ROOMS	A	F	J	SUM
B	8.5	21.5	14	44

C	16.8	14.2	21.8	52.8
D	16.7	9.6	25.6	51.9
E	16.5	8.2	31	55.7
G	25.1	4.6	22	51.7
H	17	12.3	15.9	45.2
I	11	21	7.2	39.2

Like previous, this time room 4 has the highest sum so new sequence will be: **A-F-J-E**

Table 19: Iteration 3

ROOMS	A	F	J	E	SUM
B	8.5	21.5	14	14	58
C	16.8	14.2	21.8	6.6	59.4
D	16.7	9.6	25.6	4.6	56.5
G	25.1	4.6	22	9.6	61.3
H	17	12.3	15.9	13.1	58.3
I	11	21	7.2	19	58.2

The new sequence will be: **A-F-J-E-G**

Table 20: Iteration 4

ROOMS	A	F	J	E	G	SUM
B	8.5	21.5	14	14	16	74
C	16.8	14.2	21.8	6.6	11.1	70.5
D	16.7	9.6	25.6	4.6	10.5	67
H	17	12.3	15.9	13.1	6.9	65.2
I	11	21	7.2	19	15.2	73.4

The new sequence will be: **A-F-J-E-G-I**

Table 21: iteration 5

ROOMS	A	F	J	E	G	I	SUM
B	8.5	21.5	14	14	16	6.4	80.4

C	16.8	14.2	21.8	6.6	11.1	9.7	80.2
D	16.7	9.6	25.6	4.6	10.5	10.4	77.4
H	17	12.3	15.9	13.1	6.9	10	75.2

The new sequence will be: **A-F-J-E-G-I-B**

Table 22: Iteration 6

ROOMS	A	F	J	E	G	I	B	SUM
C	16.8	14.2	21.8	6.6	11.1	9.7	12.2	92.4
D	16.7	9.6	25.6	4.6	10.5	10.4	22.4	99.8
H	17	12.3	15.9	13.1	6.9	10	8.9	84.1

The new sequence will be: **A-F-J-E-G-I-B-D**

Table 23: Iteration 7

ROOMS	A	F	J	E	G	I	B	D	SUM
C	16.8	14.2	21.8	6.6	11.1	9.7	12.2	12.1	104.5
H	17	12.3	15.9	13.1	6.9	10	8.9	15.6	99.7

The new sequence will be **A-F-J-E-G-I-B-D-C-H**

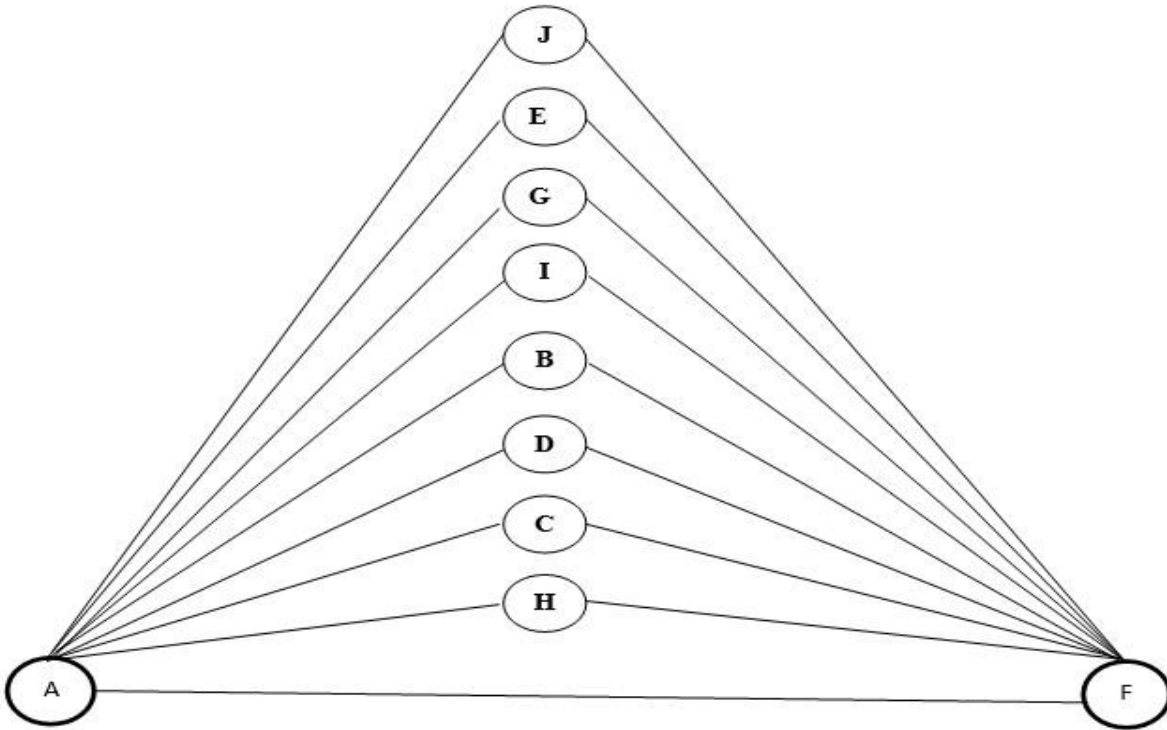


Figure 9: Graph based method optimal sequence of the departments

So, after performing the graph base method, we have got our final sequence of room allocation.

Interdependence (*Attribute of CEP*)

There is large inter dependence of the factors that effects on the facility location, layout selection and the other parameters of the Day-care center facility. Layout design precedes the knowledge of activities that the firm plans to execute. Location of facility need to be determined before the layout is designed and optimized. For evaluating the factors and designing the complete facility each factor is the precedence to the other. The first step is to analyze he different factors and the next is to analyze the location according to these factors. After selecting the location, the block layout of the facility is designed according to the requirements and under the constraints of the problem. After that, detailed layout is designed and the other facility factors, luminosity, ventilation, handling, and storage system and analyzed for the facility.

2.4. CRAFT Method:

This technique is for the improvement of an existing facility. Distance metric used is the rectilinear distance between department centroids. Input is FT Chart (From-To chart). The facility is improved by swapping two or more departments to help arrange the facility to an optimal floor plan.

a) CRAFT on Facility:

- i. To perform CRAFT method on excel, first we add the Excel add-in in Excel and make the new facility by defining our constraints of 10 rooms of day care centre. The define facility is shown below:

Layout Data

Problem Name:	Production
Number Depts.:	10
Fixed Points:	0
Dimension:	m



Facility Information

Scale-m/unit	1	Cells
Length-m	70	70
Width-m	50	50
Area-sq.m	3500	3500

Figure 10: layout data sheet

- ii. Now we have added the areas of different departments.

Department Information

	Name	F/V	Area	Cells
Dept. 1	D 1	V	15	15
Dept. 2	D 2	V	20	20
Dept. 3	D 3	V	10	10
Dept. 4	D 4	V	20	20
Dept. 5	D 5	V	15	15
Dept. 6	D 6	V	10	10
Dept. 7	D 7	V	18	18
Dept. 8	D 8	V	12	12
Dept. 9	D 9	V	8	8
Dept. 10	D 10	V	10	10

Figure 11: Department information sheet

- iii. Now we have added the distances between each room in the facility & Cost is assumed to be 1. The result is given below:

Flow Matrix

FROM	TO									
	D 1	D 2	D 3	D 4	D 5	D 6	D 7	D 8	D 9	D 10
D 1	0	8.5	14.4	16	17.8	19	25.2	31	33.5	40
D 2		0	5.9	7.5	9.3	10.5	16.7	22.5	25	31.5
D 3			0	1.6	3.4	4.6	10.8	16.6	19.1	25.6
D 4				0	1.8	3	9.2	15	17.5	24
D 5					0	1.2	7.4	13.2	16.3	22.2
D 6						0	6.2	12	14.5	21
D 7							0	5.8	8.3	14.8
D 8								0	2.5	9
D 9									0	6.5
D 10										0

Figure 12: Flow matrix

Cost Matrix

FROM	TO									
	D 1	D 2	D 3	D 4	D 5	D 6	D 7	D 8	D 9	D 10
D 1	1	1	1	1	1	1	1	1	1	1
D 2	1	1	1	1	1	1	1	1	1	1
D 3	1	1	1	1	1	1	1	1	1	1
D 4	1	1	1	1	1	1	1	1	1	1
D 5	1	1	1	1	1	1	1	1	1	1
D 6	1	1	1	1	1	1	1	1	1	1
D 7	1	1	1	1	1	1	1	1	1	1
D 8	1	1	1	1	1	1	1	1	1	1
D 9	1	1	1	1	1	1	1	1	1	1
D 10	1	1	1	1	1	1	1	1	1	1

Figure 13: Cost matrix from to chart for departments

- iv. After giving the data of everything to the system, the output of the facility is as below:



Figure 14: Final layout of facility obtained from software using CRAFT method

- v. However, the most optimum and random layout of the facility given by the CRAFT method. The above output shows the best arrangement of rooms to be done in the facility. it has also given us the initial cost of the project to be estimated at the start of the facility.

Depth of analysis Required (*Attribute of CEP*)

For analysis of the health facility in the rural area, there is much analysis is used to get the required and reliable results. So, for this purpose some software that are used in the analysis are AHP (Net-Logo), factory flow, Visio and Arena. For the better and reliable result for designing the facility, the deeper analysis is performed of the facility according to each criterion. The analysis is performed using the software given above

2.5. Flow Process of Layout:

Flow of Process:

In manufacturing engineering, process layout is a design for the floor plan of a plant which aims to improve efficiency by arranging equipment according to its function. The production line should ideally be designed to eliminate waste in material flows, inventory handling and management. In process layout, the workstations and machinery are not arranged according to a particular production sequence. Instead, there is an assembly of similar operations or similar machinery in each department (for example, a drill department, a paint department, etc.)

Advantages:

1. Provide visual control of activities
2. Use space efficiently
3. Use labor efficiently
4. Eliminate bottlenecks
5. Facilitate communication and interaction between workers and supervisors

a) Flow Process of Day Care Facility:

The flow for the process is shown in the diagram which is a model of flow process developed in Arena. The developed model shows the process that how the flow of the people is being maintained in the facility. It consists of the multiple modules of Arena to represent the flow of the process. The first module used is the create module which shows the incoming entities or in that case it is to represent the incoming people in the facility.

The reception is used as the decision-making stage; whether to go in the room or to wait for some formalities. The rooms are designated as the processes. These processes show the prescribed flow of the people inside the facility.

Another module used in the flow model is 'batch'. Batch represents the people coming in together in form of groups which may create the bottle neck and the queue at the reception.

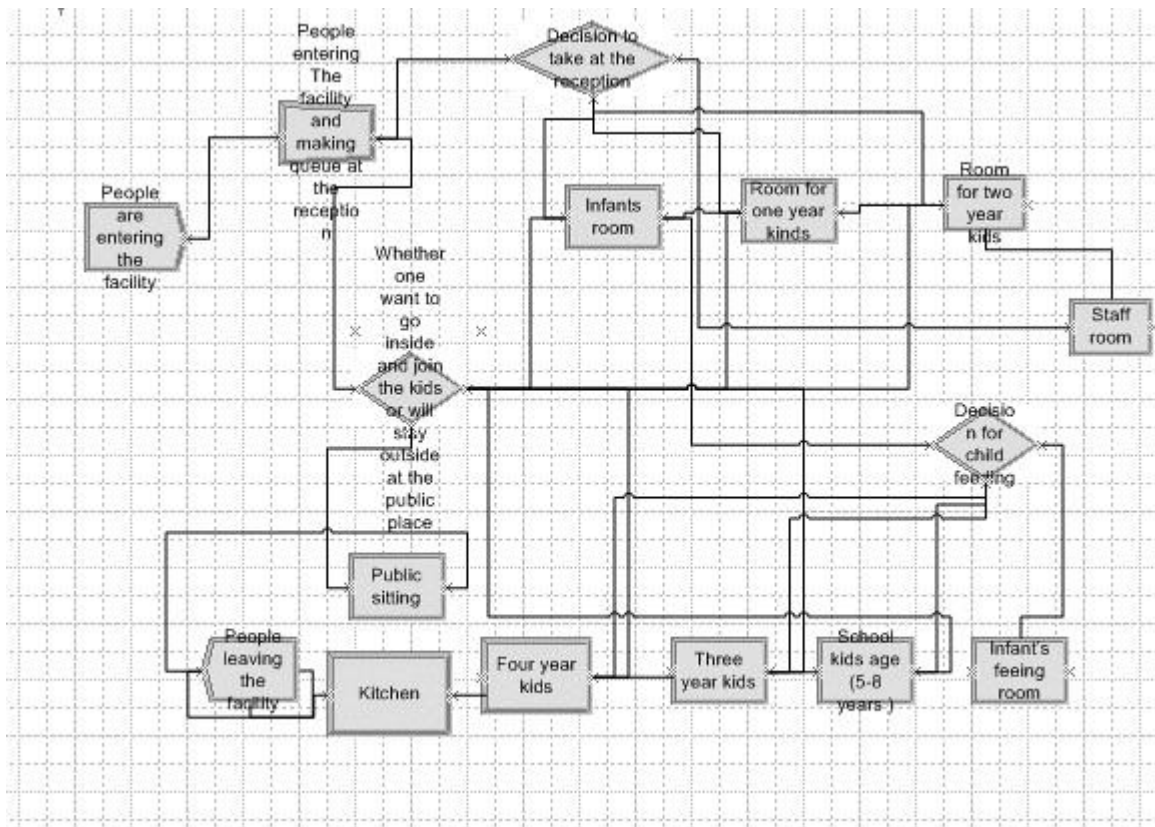


Figure 15: Arena module for the facility (Day-Care Center)

b) Structural Considerations of Daycare Centre:

Conversions many different types of converted and new buildings have been used for day care centers for people with dementia. The majority are converted buildings, probably because of the advantages of cost and availability. For example:

- i. A small, converted hall used by a local authority to provide day care on weekdays (12 clients max per day).

- ii. A single story hospital building, formerly a ward, converted and used by the district health authority as a day center on weekdays (13 clients max per day).
- iii. Converted houses used to provide day care on four weekdays (20-25 clients per day).
- iv. An old social services building on two floors, with a lift, used by the local authority as a day care center on weekdays (up to 25 clients max per day).
- v. A large converted church hall used by the social services department to provide day care five days per week (15 clients max per day).
- vi. A bungalow used by the local health authority on weekdays. New buildings Recent examples of new buildings for day care include the following:
- vii. A new single story building used by a local authority to provide day care seven days a week (15 clients max per day). viii. A community room in a sheltered housing scheme used as a day center for one day each week (12 clients max per day).
- ix. An annex, sometimes purpose built, which is attached to a private or local authority residential home.
- x. A mobile day care team, providing day care at different locations on different days of the week. (This is the method of staffing some of the part-time day centers described above and is more common in rural than in urban areas.)

c) Design and Sizes of Rooms:

1. Entrance:

The design of the entrance to the center is extremely important, both in practical terms and because the entrance immediately conveys an impression of the objectives, character and atmosphere of the center. The route between the entrance and the car or mini-bus park should be as short as possible and the entrance should preferably be protected from the weather by a porch or canopy. The entrance should be suitable for wheelchair and assisted access. It should be well lit, but without glare. A lockable space is required close to the entrance where the clients' outdoor clothes can be put away safely and clearly labelled when they arrive.

2. Main Room:

The main room for general use in the centre should be attractively designed and domestic in character, with suitable light fittings, furnishings, carpets and curtains and planting. Ideally it should offer attractive views onto a well landscaped garden or courtyard and where possible to a pleasant scene beyond. If the room is located immediately next to the entrance, anyone entering or leaving the building can be seen by the staff. This can help in general supervision and may help to prevent clients from wandering out of the building. Ideally, this room should also lead directly to a secure garden or courtyard which the clients can use in good weather.

3. Office:

Every day care center requires an office with a telephone for administration for quiet and confidential work and for record keeping. The room may also have to be used for consultations, especially if a quiet room is not available. The office should preferably be close to the entrance.

4. **Dining Room:**

It is preferable, but may not always be practical, to provide a separate dining room for taking main meals and snacks.

5. **Quiet Room:**

A small and comfortable room is required for consultations with carers or relatives, or for clients who are temporarily upset or disturbed. If necessary an office may have to be used as a quiet room. A quiet room may also be used for sessions with small groups of clients.

6. **Toilets:**

At least two toilets should be provided for the clients, preferably next to the main room and readily accessible from the entrance. Where possible a separate toilet and washbasin should be provided for the staff. All toilets for use by clients should have sufficient space for staff to be able to assist and one of the toilets must be suitable for a wheelchair. Doors which open inwards, or which are hung on the wrong side, are common problems which restrict access for people who are disabled or need assistance. There should be a medium sized washbasin within each toilet space. Rails and aids are likely to be required in each of the toilets used by the clients. The floors of these toilets should be washable and easy to clean.

7. **Fire Protection and Escape Routes:**

It is essential to discuss with the local fire brigade at an early stage any proposals for a conversion or a new building. The fire officer's requirements are likely to include the provision of clear main and alternative fire escape routes, protected by half hour fire resistant walls and doors, and with doors opening outwards toward the escape route. Smoke and heat detectors are likely to be required in the main rooms and circulation areas, together with fire alarms and fire extinguishers. These requirements are likely to be met most readily in small single story buildings, with short distances to the fire exit. If the use of an upper floor is being considered for a day care center for elderly people the requirements for fire escape, and particularly for elderly people to be assisted down the stairs, are likely to be stringent and could be prohibitively expensive. These issues should, therefore, be examined at an early stage in any proposal.

8. **Disabled Access:**

Access for wheelchair users and for people with walking difficulties is fundamental to the planning and design for a day care center. There needs to be sufficient parking space for a minibus with a wheelchair lift (approximately 3 x 6 meters), and the route to the front door must be safe and convenient for all users. This usually involves a ramp up to the front door (see page 10) but when space is limited it may be difficult to ensure that the ramp will not be an obstruction or that visitors do not trip over the end of the ramp.

9. **Lighting with safety:**

The eyes of elderly people are slow to adapt to changes in brightness or darkness. Abrupt transitions and glare, whether caused by artificial lights or by sunlight, should

therefore be avoided, particularly in entrance halls and circulation spaces. Avoid windows, mirrors and other bright surfaces which can cause glare at the end of corridors. Shield all light sources to minimize glare and select warm-toned lighting if possible. Ordinary fluorescent lighting emphasizes the blue-green tones which are the most difficult for elderly people to perceive. Day centers should not contain light fittings and flexes which could be a hazard.

10. **First Aid:**

A member of staff must have either nursing or first aid training and a first aid kit should be kept available for minor incidents and emergencies. An accident book must be kept in which all accidents must be recorded.

d) Floors, Walls and Doors:

1. **Carpets:**

Modern washable carpets are generally preferable to other alternatives for the floors of the main rooms in a day care center. Also consider carpeting in corridors. Carpets have a more domestic appearance, are softer underfoot and absorb noise more than sheet or tiled floors such as vinyl or linoleum. Traditional carpets with natural fabrics are not suitable in day care centers because they are difficult to keep clean in rooms used by people who may be incontinent. However there are synthetic carpets which are suitable for day care centers. These washable carpets generally have a short synthetic pile (polypropylene), which is totally impervious to liquids, and a waterproof backing which enables them to be cleaned by any standard method of carpet cleaning without loss of color. These carpets are available in a wide range of mixed colors and are similar in appearance to carpets of natural fiber. Most synthetic carpets are vulnerable to damage from cigarettes and similar burns and extra care is needed to prevent damage if clients are permitted to smoke at the centre.

2. **Washable Floors:**

The floors of toilets and kitchens in day care centers should be easy to wash and, although hard materials such as quarry tiles are practical in areas of heavy usage, vinyl flooring is equally practical and more comfortable. Non-slip vinyl flooring can sometimes be useful in kitchens and bathrooms but is slightly less easy to clean than the more usual smooth finishes.

3. **Walls and Doors:**

The walls in a day care center can be decorated with paint or wallpaper as for domestic use. Wall surfaces should have enough texture to enable clients to support themselves but not be so abrasive as to cause injury. Wallpapers with a vinyl finish are easy to clean and a wide range of attractive patterns are available. For painted walls, emulsion paint is practical and convenient. Gloss paint is very suitable for doors and woodwork but care should be taken to avoid shiny paints on walls as even the satin finishes, which are very easy to clean, can catch the light, causing high spots of glare and an institutional appearance in rooms which should be restful and domestic in character. Doors should have lever handles which are easy for elderly people to operate.

e) Furniture, Fittings and Fabrics:

1. General:

Furniture should generally be arranged in fairly informal groupings, and should be easy to move so as to enable room layouts to be rearranged. It should also be reasonably robust while retaining a domestic character. The main room should be sufficiently large to contain a piano, which is always popular and greatly extends the range of enjoyable activities for the clients. A TV set and a radio may or may not be considered to be desirable.

2. Chairs:

The selection of chairs requires very careful consideration. Most chairs used by clients should have arms and be fairly high (to Department of Health standards) so as to be easy to get in and out of without help. Select chairs where the arm is above or slightly in front of the front edge of the seat and with a clear space under the front of the seat so that the user's heels can be placed underneath. This greatly reduces the burden on staff and allows them more time and energy to attend to the clients. Chairs may have high or low backs. Avoid seats which are so firm that they may cause skin ulcers. A variety of chairs and fabrics can help to achieve a more informal atmosphere than in rooms where all the chairs are identical. For general purposes select chairs with a seat height of 420mm (17 inches) and tables about 760 mm high (30 inches). If incontinence can be contained it may be preferable to have domestic style chairs but the reality is that at most centers the furniture needs to be proof against incontinence and be easily cleaned. Chairs can be protected against incontinence by being fitted with a fabric with a waterproof lining to protect the seat, or with a vinyl covering or with a mixture of vinyl and fabrics. For example, the seat may be covered with vinyl and the back covered in matching tweed fabric. The choice of chairs and other furniture should take account of space, durability, weight, comfort and cost. A wide range of furniture, accessories and fabrics suitable for use in day care centers are available.

2.7. Factors Affecting the Facility of Day Care Centre:

To build the facility of day care center, there are some other factors too which can affect the facility, they are given below:

a) Hours of Operation:

Depending on your individual circumstances, this may be a critical piece that you will need to determine.

- Do you have flexibility to accommodate shorter hours of operation?

- Or are you committed to a fixed schedule at work where you may need longer hours for child care?

b) Curriculum and Structure:

There are so many different philosophies and curriculums out there today in the child care world, so make sure you do your research and find a facility that matches your expectations.

c) Ratio of Staff to Children:

Make sure you learn more about what the ratio is for staff to children. The more staff that a facility has may mean that every child will be getting more individual attention, which could be beneficial if your child does better in small groups.

d) References:

One of the best ways to find great child care facilities in your area is to ask for the recommendation of your friends, family and other parents. But even more than that, ask the child care facility if they can give you a list of potential parents you could contact to get more information about their particular center.

e) Cleanliness:

Hygiene is important for little ones and you want to make sure they are going to be well taken care of while they are out of your care.

f) Training, Licensing and Credentials:

Do the facilities that a person looking into have well-educated and experienced staff? He want to make sure his child is exposed to high quality interactions and activities on a daily basis. Make sure a person do his homework and that the teachers your child will be with have the right credentials and experience!

g) Snacks and Meals:

If your child is going to be attending child care all day, make sure you know what the policies are on snacks and meals. Will you be expected to provide the food for your child every day? Is this part of the overall tuition at the child care facility? If it is provided, what types of things are offered? So make sure you find one that meshes with how you want snacks and meals handled.

h) Turnover of Staff:

Having the same staff working with a child day after day builds a level of trust that helps to make a child's day go much easier and is more conducive to learning.

i) Location:

It is better to find a child care facility that is close to home or close to work. That is easier for a person to get to or his partner to get to.

Extent of stakeholder involvement and level of conflicting requirements *(Attribute of CEP)*

In the designing the day-care center facility, the knowledge is obtained by different resources, for valuable and reliable results, the different factors that are used in the analysis are obtained from the international report of Human Development Index of Pakistan that was published in 2017. The factors are decided by brainstorming and help of teachers.

Conclusion:

This project report proposed an analytic hierarchy process (AHP) approach to solve a plant layout design problem. A computer-aided layout-planning tool i.e., CRAFT was also used to select the best available on the bases numerical data available. The qualitative performance measures were weighted by AHP. A layout of the daycare facility is designed where the first decision for the facility is made on the basis of economics and then went for the alternatives and finally achieved the optimum facility plan. After considering all the manual and software calculations we are able to decide our optimal location for facility design that is Blue Area. The decision has taken after making best possible arrangements and calculations of the economical, population, workforce data and other parameters.

Consequences *(Attribute of CEP)*

The success of this project would result in the increase in the HDI of the selected location. Human Development Index (HDI) is the term that describes about the prosperity of the area or city. HDI consists of several factors including the health/Day-care centers facilities in the area, people education, thinking about the future etc. the one factor that is day-care center facility satisfaction, after the implementing on the facility plan it directly increase the HDI of the selected location and also effects the HDI of the area.

References:

- al, K. e. (2004). *Simulation with ARENA*.
- Esra E. Aleisa, L. L. (2005). FOR EFFECTIVE FACILITIES PLANNING: LAYOUT OPTIMIZATION THEN SIMULATION, OR VICE VERSA? *Winter Simulation Conference*, (p. 6).
- Ghorbanali Moslemipour, T. L. (2018). Solving stochastic dynamic facility layout problems using proposed hybrid AC-CS-SA meta-heuristic algorithm. *Int. J. Industrial and Systems Engineering*, Vol. 28.
- Grajo, E. S. (1995). Strategic layout planning and simulation for lean manufacturing a Layout tutorial. *Winter Simulation Conference*.
- José Tavares, C. R. (n.d.). ADDRESSING THE FACILITIES LAYOUT DESIGN PROBLEM THROUGH CONSTRAINT LOGIC PROGRAMMING.
- Kriel, M. (October 2010). *OPTIMIZING FACILITY LAYOUT THROUGH SIMULATION*. PRETORIA.
- Moslemipour, G. (2017). A hybrid CS-SA intelligent approach to solve uncertain dynamic facility layout problems considering dependency of demands. 14.
- Pillai VM, H. I. (2011). Design of robust layout for dynamic plant layout problem.
- Piplani, R. &. (2004). Simplification strategies for simulation models of. *Journal of Manufacturing Technology Management*.
- Sly, D. P. (1997). Systematic layout design from scratch. *Winter Simulation Conference*.
- Tompkins, J. W. (2003). Facilities Planning.

Assessment Rubrics:

Knowledge Component	Domain	PLO mapped	Taxonomy Level	Max Marks	Obtained Marks
Each group should use AHP to select the appropriate location of facility (Evaluate)	Cognitive	b	C-4	5	
Apply Factory cad	Cognitive	b	C-3	5	
Analyze different parameters using Craft method or any other optimization method	Cognitive	c	C-3	5	
Analyze designing/improvement of an industrial facility using graph based method	Cognitive	c	C-3	5	
Consider all other factors of facility design (Understand)	Affective	f	A-3	5	
Create Design of facility	Cognitive	c	C-5	5	

Attributes to Complex engineering Problems:

Sr. #		
1	Preamble	The Methodology, Techniques and Software used in designing new dispensary are: AHP , VISIO, Graph Based Layout Technique, Factory Flow, S-Shaped Heuristic and CRAFT Algorithm are used to get the best and optimal Layout.
2	Range of conflicting requirements	There are different optimal designs using the CRAFT method.
3	Depth of analysis required	For the analysis of the design of the dispensary the software used are AHP (Net-logo), factory flow, Visio and Arena.
4	Depth of knowledge required	For the designing of the health facility, in-depth of knowledge is required for the evaluating the facility using different factors.
5	Familiarity of issues	Must include non-routine tasks to be done.
6	Extent of applicable codes	Basic data for health related issues was needed. And Day-care center related data as used to make the best layout out of it
7	Extent of stakeholder involvement and level of conflicting requirements	The facility is designed as it is funded by the government. Doctors, Helpers and other staff members are involved in order to attain the same layout as designed. The requirement was of Land, equipment, furniture etc.
8	Consequences	The success of this project would result in the increase in the HDI of the selected location.
9	Interdependence	Layout design precedes the knowledge of activities that the firm plans to execute. Location of facility need to be determined before the layout is designed and optimized.