ISSN : 0974-0066

84

Vol-84 No. 29,
January – June: 2023

# मध्य भारती

मानविकी एवं समाजविज्ञान की द्विभाषी शोध-पत्रिका

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UGC Care List, Group-C (Multi disciplinary), Sl.no.-15

**विशेषांक**
राष्ट्रीय शिक्षा नीति-2020 : परिप्रेक्ष्य और परिवर्त्य



**डॉक्टर हरीसिंह गौर विश्वविद्यालय**
सागर (मध्यप्रदेश) - 470003

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ISSN 0974-0066 (पूर्व-समीक्षित अर्द्धवार्षिक शोध-पत्रिका)
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**सम्पादकीय पत्र व्यवहार :**
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CONTENT

# CONSTRUCT AND OPTIMIZE PLANT LAYOUT USING META-HEURISTIC APPROACH

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**Abstract—**
In the growing global competition, optimization is the key for the survival of any business organization. Among different functions in an organization, optimization plays a vital role in minimizing wastages which automatically result in productivity improvement. This can be done starting from the stage of manufacturing processes, material handling, and implementation of proper plant layout. This can be done by the usage of suitable techniques augmented with fitting algorithms for decision-making. Process optimization is the discipline of adjusting a process so as to optimize some specified set of parameters without violating constraints.

**Introduction:**
When constructing a new layout, one of the problems that occur in a manufacturing plant is to determine the location of each department in the facility. Plant layout is the arrangement of facilities such that the factory or workplace runs smoothly and efficiently. It includes removal of bottlenecks, improved material handling, decreased cost, and improved utilization of the workplace. Various heuristic tools for constructing and improving plant layouts are Automated Layout Design Program (ALDEP), Computerized Relative Allocation of Facilities Technique (CRAFT), Computerized Relationship Layout Planning (CORELAP), etc. ALDEP is one of the meta-heuristic approaches that can be used for the construction of the new layout from the given relationship between the departments desired.
The purpose of this study is to understand the ALDEP methodology for the generation of optimal and feasible layouts. When layouts are generated manually there aren't enough layouts to find the best one to fulfill the purpose. That's why a programming tool was considered to generate 'n' number of layouts to find the optimal one amongst all. Another construction approach that was used is CORELAP. The layout was created using this and optimized using an improvement algorithm called CRAFT. The distances were then measured with the help of AutoCAD for every layout (ALDEP, CORELAP, CRAFT) and compared to find the optimal layout amongst all.

**Scope & Objective Of Study:**
Problem Identification:
- The company is expanding its unit since its existing capacity cannot possibly supply the demand.
- For this, they have provided us with the processing sequence and size of the departments using which we need to construct a facility layout.

**Objectives:**
- To construct a plant layout using ALDEP.
- To construct a layout using ALDEP and understand the ALDEP methodology of generating layouts so that we can generate some of the possible layouts according to the relationship given and find the optimum layout.

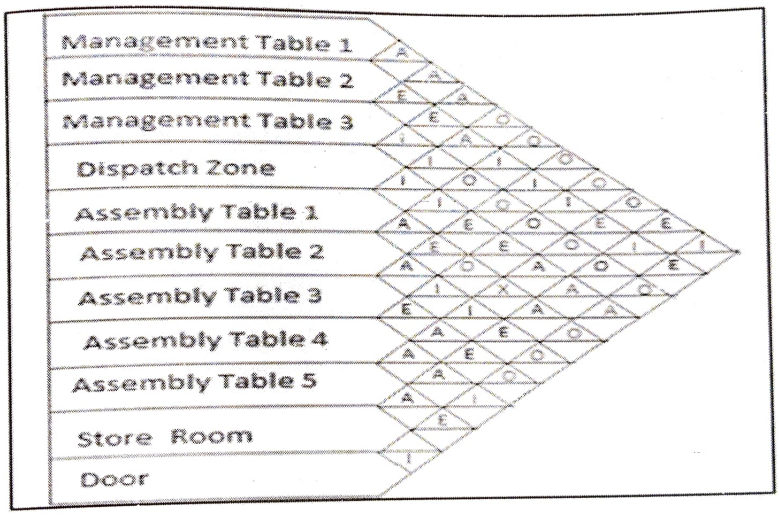
**Theory:**
ALDEP:-
ALDEP stands for Automated Layout Design Program. It was developed by Seehof and Evans. It is

also a construction routine. ALDEP is a variation of CORELAP. Its objective is also to create a layout with "high-ranking" departments close together. But ALDEP has special characteristics of randomness, up to three floors capability, and departments (docks, elevators, aisles) that can be fixed. The input data of ALDEP are length, width, and area of each floor; location and size of restricted area for each floor; the scale of layout printout; the number of layouts to be generated; the number of departments; department areas; relationship chart; and minimum allowable score for an acceptable layout. Selection procedure (sequence) of ALDEP:

- Randomly select a department.
- Add a department with an important relationship with previous departments. If none, add an unimportant department randomly.
- Continue until all departments are added.

CORELAP:-

CORELAP stands for Computerized Relationship Layout Planning. It was developed by Lee and Moore in 1967.CORELAP is the oldest and best-known construction routine. Its objective is to create a layout with "high-ranking" departments close together. It is a computerized version of Muther's Systematic Layout Planning (SLP). The approximations used in the relationship diagram may be more appropriate than the exact cost approach of CRAFT and COFAD because of a lack of data. The assumption of CORELAP is that the department will have a dispatch area and a receiving area on the side of its layout nearest its neighbor. The input data of CORELAP are a number of departments; department areas; relationship chart; and weights for the relationship chart. The optional input data are the scale of output printout; length to width ratio; and department pre-assignment (only along the periphery of the layout).




**Relationship Chart**

- CORELAP uses the letter symbols A, E, I, O, U and X for the closeness relationship:
- A = Absolutely necessary
- E = Especially important
- I = Important
- O = Ordinary closeness
- U = Unimportant
- X = Not desirable

The letter ratings are converted to their numerical equivalents (A = 6, E = 5, etc.). The weighted relationship values ( A = 35 = 243, E,= 34 = 81, etc. ) are used for placing departments.

**Data Collection:**

We were provided with the Muther's grid that shows the relationship between various departments and the area of each department given below:

**Area of Departments**

| Sr.no | Department | Grids | Sq. meter area Sq meter area |
|---|---|---|---|
| A | Management Table 1 | 30 | 10.26 |
| B | Management Table 2 | 18 | 6.16 |
| C | Management Table 3 | 12 | 4.1 |
| D | Dispatch Zone (including area of dispatch table) | 6 | 2.05 |
| E | Assembly Table 1 | 18 | 6.16 |
| F | Assembly Table 2 | 18 | 6.16 |
| G | Assembly Table 3 | 18 | 6.16 |
| H | Assembly Table 4 | 20 | 6.84 |
| I | Assembly Table 5 | 18 | 6.16 |
| J | Store Room | 46 | 15.73 |
| K | Door | 4 | 1.36 |

Area of Departments

Here, 1 grid= 0.342 sq mtr

**Methodology:**

ALDEP:-

The method used to construct the layout of the production floor is ALDEP (Automated Layout Design Program). This method is one of many construction algorithms for designing layouts. The use of the ALDEP method is expected to make a better layout proposal. The relationship chart and the area of each department were provided by the company. Some of the possible layouts of ALDEP were created manually using relationship matrix and areas of each department. After that their relationship score was calculated. The layout having highest relationship score was considered to be the optimal one.

AUTOCAD:-

After the construction of some of the possible layouts, optimal layout was made using AutoCAD. Firstly, centroids of each department were found using the MASSPROP command and marked using the POINT command. After that, the centroid of each department was connected according to the processing sequence in the layout. The total distance was then calculated using the DIST command.

**Layout Generation:**



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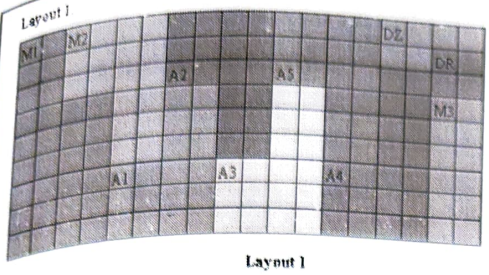
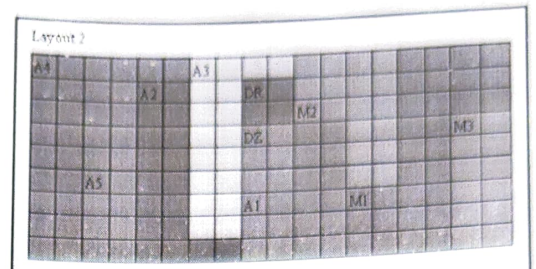



Layout 1

Relationship score table for layout 1

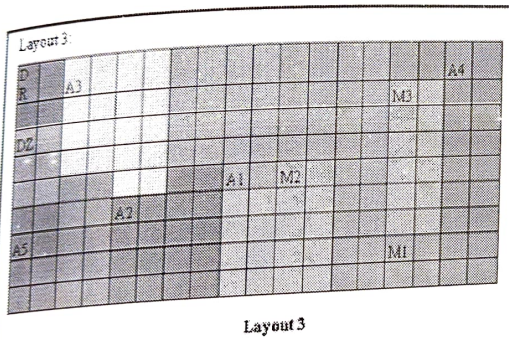
| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| M1 | M2 | A | 64 |
| M1 | A1 | O | 1 |
| M2 | A2 | I | 4 |
| M2 | A1 | A | 64 |
| A1 | A2 | A | 64 |
| A1 | A3 | E | 16 |
| A2 | A3 | A | 64 |
| A2 | A5 | I | 4 |
| A3 | A5 | A | 64 |
| A3 | A4 | E | 16 |
| A5 | A4 | A | 64 |
| A5 | DZ | A | 64 |
| A4 | DZ | E | 16 |
| A4 | DR | I | 4 |
| A4 | M3 | O | 1 |
| DZ | DR | A | 64 |
| DR | M3 | O | 1 |
| | | | 575 |




Layout 2

Relationship score table for layout 2

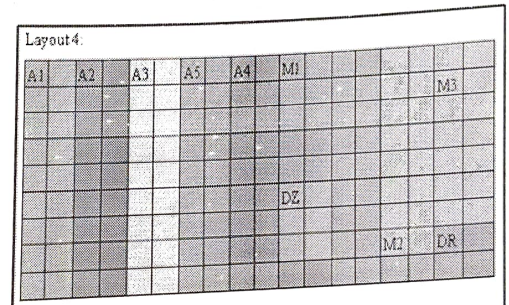
| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| A4 | A5 | A | 64 |
| A4 | A2 | I | 4 |
| A5 | A2 | I | 4 |
| A5 | A3 | A | 64 |
| A2 | A3 | A | 64 |
| A3 | A1 | E | 16 |
| A3 | DZ | E | 16 |
| A3 | DR | O | 1 |
| A3 | M2 | I | 4 |
| DR | DZ | A | 64 |
| DR | M2 | E | 16 |
| DZ | A1 | I | 4 |
| A2 | A1 | A | 64 |
| A1 | M2 | A | 64 |
| A1 | M1 | O | 1 |
| M2 | M1 | A | 64 |
| M1 | M3 | A | 64 |
| | | | 578 |




Layout 3

Relationship score table for layout 3

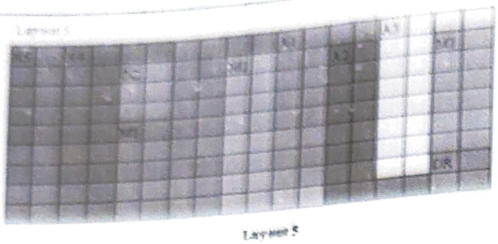
| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| DR | A3 | O | 1 |
| DR | DZ | A | 64 |
| DZ | A3 | E | 16 |
| DZ | A5 | A | 64 |
| A5 | A3 | A | 64 |
| A5 | A2 | I | 4 |
| A3 | A1 | E | 16 |
| A3 | A2 | A | 64 |
| A2 | A1 | A | 64 |
| A2 | M2 | I | 4 |
| A1 | M2 | A | 64 |
| A1 | M1 | O | 1 |
| M2 | M1 | A | 64 |
| M1 | M3 | A | 64 |
| M1 | A4 | O | 1 |
| M3 | A4 | O | 1 |
| | | | 556 |




Layout 4

Relationship score table for layout 4

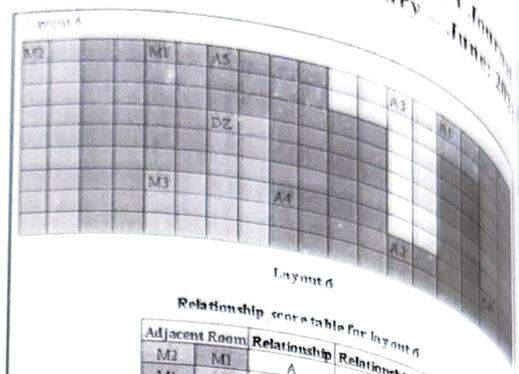
| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| A1 | A2 | A | 64 |
| A2 | A3 | A | 64 |
| A3 | A5 | A | 64 |
| A5 | A4 | A | 64 |
| A4 | M1 | O | 1 |
| A4 | DZ | E | 16 |
| M1 | DZ | A | 64 |
| M1 | M2 | A | 64 |
| M1 | DR | I | 4 |
| M2 | DR | E | 16 |
| M2 | M3 | E | 16 |
| M3 | DR | O | 1 |
| | | | 438 |



Layout 5

**Relationship score table for layout 5**

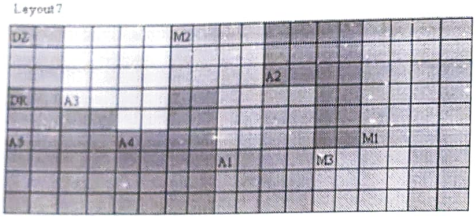
| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| A5 | A4 | A | 64 |
| A4 | DZ | E | 16 |
| A4 | M1 | O | 1 |
| DZ | M3 | A | 64 |
| M1 | M2 | A | 64 |
| M1 | A1 | O | 1 |
| M2 | A1 | A | 64 |
| M2 | A3 | I | 4 |
| A1 | A2 | A | 64 |
| A1 | A3 | E | 16 |
| A2 | A3 | A | 64 |
| A2 | DR | O | 1 |
| A3 | M3 | O | 1 |
| A3 | DR | O | 1 |
| M3 | DR | O | 1 |
| | | | 426 |



Layout 6

**Relationship score table for layout 6**

| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| M2 | M1 | A | 64 |
| M1 | M3 | A | 64 |
| M1 | A5 | O | 64 |
| M1 | DZ | A | 1 |
| M3 | DZ | I | 64 |
| M3 | A4 | O | 4 |
| DZ | A5 | A | 1 |
| A5 | A4 | A | 64 |
| A5 | A3 | A | 64 |
| A4 | A3 | E | 64 |
| A4 | A2 | I | 16 |
| A2 | A1 | A | 4 |
| A2 | DR | O | 64 |
| A1 | DR | O | 1 |
| | | | 1 |
| | | | 476 |

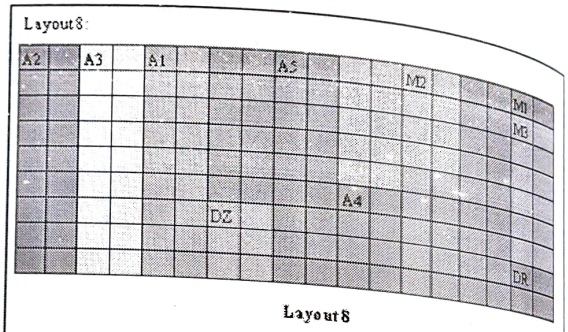


Layout 7

**Layout 7**

**Relationship score table for layout 7**

| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| DZ | DR | A | 64 |
| DZ | A3 | E | 16 |
| DR | A3 | O | 1 |
| DR | A5 | E | 16 |
| A5 | A3 | A | 64 |
| A5 | A4 | A | 64 |
| A3 | A4 | E | 16 |
| A3 | M2 | I | 4 |
| A4 | M2 | I | 4 |
| A4 | A1 | O | 1 |
| M2 | A1 | A | 64 |
| M2 | A2 | I | 4 |
| A1 | A2 | A | 64 |
| A1 | M3 | I | 4 |
| A2 | M3 | O | 1 |
| A2 | M1 | O | 1 |
| M3 | M1 | A | 64 |
| | | | 452 |

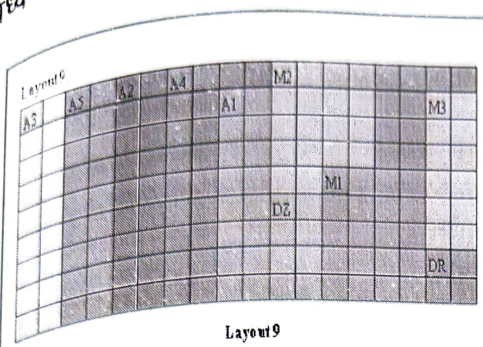


Layout 8

**Layout 8**

**Relationship score table for layout 8**

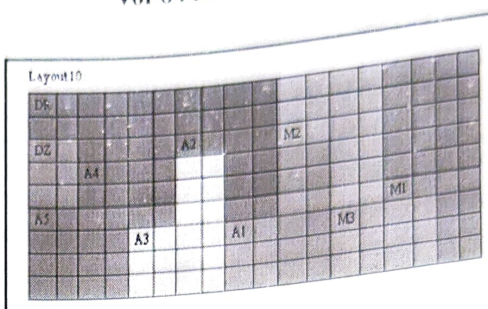
| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| A2 | A3 | A | 64 |
| A3 | A1 | E | 16 |
| A1 | A5 | X | -1024 |
| A1 | DZ | I | 4 |
| DZ | A5 | A | 64 |
| DZ | A4 | E | 16 |
| A4 | M2 | I | 4 |
| A4 | M1 | O | 1 |
| M2 | M1 | A | 64 |
| M1 | M3 | A | 64 |
| M3 | DR | O | 1 |
| | | | -726 |




Layout 9

. Relationship score table for layout 9

| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| A3 | A5 | A | 64 |
| A5 | A2 | I | 4 |
| A2 | A4 | I | 4 |
| A4 | A1 | O | 1 |
| A1 | DZ | I | 4 |
| A1 | M2 | A | 64 |
| DZ | M2 | E | 16 |
| DZ | M1 | A | 64 |
| M2 | M1 | A | 64 |
| M1 | M3 | A | 64 |
| M1 | DR | I | 4 |
| M3 | DR | O | 1 |
| | | | 354 |




Layout 10

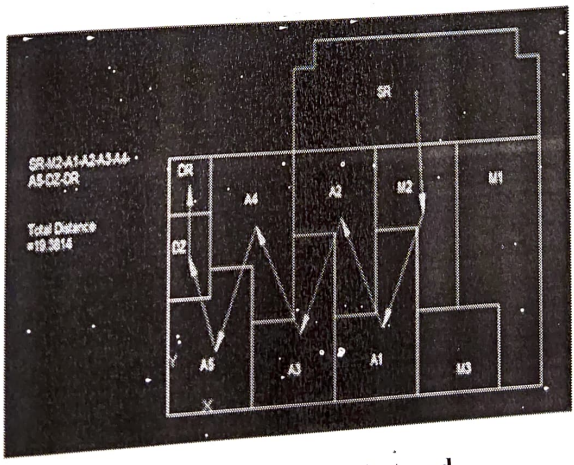
. Relationship score table for layout 10

| Adjacent Room | | Relationship | Relationship Score |
|---|---|---|---|
| DR | DZ | A | 64 |
| DR | A4 | I | 4 |
| DZ | A4 | E | 16 |
| DZ | A5 | A | 64 |
| A5 | A4 | A | 64 |
| A5 | A3 | A | 64 |
| A4 | A3 | E | 16 |
| A4 | A2 | I | 4 |
| A3 | A2 | A | 64 |
| A3 | A1 | E | 16 |
| A2 | A1 | A | 64 |
| A2 | M2 | I | 4 |
| A1 | M2 | A | 64 |
| A1 | M3 | I | 4 |
| M2 | M3 | E | 16 |
| M2 | M1 | A | 64 |
| M3 | M1 | A | 64 |
| | | | 656 |

The optimal layout is layout 10 with a score of **656.**

**AutoCAD:**

The optimal layout of ALDEP was drawn in AutoCAD and the total distance of the processing sequence was calculated.




ALDEP Layout In Autocad

| Centroids | |
|---|---|
| Departments | Co-ordinates |
| A5 | X: 1.2350 Y: 1.3325 |
| A4 | X: 2.4570 Y: 3.7440 |
| A3 | X: 3.7050 Y: 1.4625 |
| A2 | X: 4.8750 Y: 3.8025 |
| A1 | X: 6.0450 Y: 1.4625 |
| M2 | X: 7.2150 Y: 3.8025 |
| M3 | X: 8.1900 Y: 0.8775 |
| M1 | X: 9.4770 Y: 2.9835 |
| SR | X: 7.0200 Y: 6.3968 |
| DZ | X: 0.5850 Y: 3.2175 |
| DR | X: 0.5850 Y: 4.6800 |

Total distance:19.3814

**Flow Chart: Man Type And Summary Table:**

**Summary Table:**

| Activity | Summary | Distance |
|---|---|---|
| | | ALDEP |
| Operation | 5 | - |
| Movement | 8 | 19.3814 |
| Inspection | 2 | - |
| Delay | 0 | - |
| Storage | 1 | - |
| **Total** | **16** | **19.3814** |

**Findings & Results:**

Given below are the results obtained for various layouts:

**Algorithm and ITS optimal relationship score**

| Algorithm | Optimal Relationship score |
|---|---|
| ALDEP | 656 |

**Algorithm and the total distance of processing sequence**

| Algorithm | Distance (in meters) |
|---|---|
| ALDEP | 19.3814 |

The layout 10 generated by **ALDEP** is considered to be the most optimal layout as the distance is minimum i.e. **19.3814 meters** when compared to others.

**Conclusion And Suggestion:**

In this project, the overall cost was reduced by reducing the travel distance, work flow, time, and cost. There was a significant rise in efficiency for the proposed layout as compared to the existing layout which was achieved by integrating the ALDEP software to determine an optimum layout with high closeness rating.

The problem of existing layout is the large comparative distance between several departments

that's forced to travel a long distance and impedes the smooth material flow and leads to higher cost. In proposed layout, the position of various departments is altered with various others based on activity

| Sr. No. | Activity | ● | ➡ | ■ | D | ▼ | Dist.(mm) ALDEP |
|---|---|---|---|---|---|---|---|
| 1 | Collection of raw material from store room. | • | | | | | - |
| 2 | Movement of man from store room to management 2 | | • | | | | 2.6016 |
| 3 | Inspection of material | | | • | | | - |
| 4 | Movement of man from management 2 to assembly 1 | | • | | | | 2.6162 |
| 5 | Assembling of PCBs at assembly 1 by man | • | | | | | - |
| 6 | Movement of man from assembly 1 to assembly 2 | | • | | | | 2.6162 |
| 7 | Assembling of wires in the product by man | • | | | | | - |
| 8 | Movement of man from assembly 2 to assembly 3 | | • | | | | 2.6162 |
| 9 | Final assembly of product | • | | | | | - |
| 10 | Movement of man from assembly 3 to assembly 4 | | • | | | | 2.6005 |
| 11 | Inspection of final product | | | • | | | - |
| 12 | Movement of man from assembly 4 to assembly 5 | | • | | | | 2.7489 |
| 13 | Packing of product | • | | | | | - |
| 14 | Movement of man from assembly 5 to dispatch zone | | • | | | | 2.1193 |
| 15 | Storage of product | | | | | • | - |
| 16 | Movement of man from dispatch zone to door | | • | | | | 1.4625 |
| | Total | | | | | | 19.3814 |

relationship chart and using the ALDEP software.

**Future Scope:**

Programming like Python can be used to generate more layouts by ALDEP methodology. Other methodologies like CRAFT and CORELAP can also be applied to existing layout to improve it. Simulation can be done using various software like Simio, Simuls, FlexSim, etc. to further optimize the layout. Construction of layout and finding the total distance of the processing sequence can also be done in Microsoft Excel using Visual Basic.

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that's forced to travel a long distance and impedes the smooth material flow and leads to higher cost. In proposed layout, the position of various departments is altered with various others based on activity

| Sr. No. | Activity | | | | | | Dist.(mm) ALDEP |
|---|---|---|---|---|---|---|---|
| 1 | Collection of raw material from store room. | • | | | | | |
| 2 | Movement of man from store room to management 2 | | • | | | | 2.6016 |
| 3 | Inspection of material | | | • | | | - |
| 4 | Movement of man from management 2 to assembly 1 | | • | | | | 2.6162 |
| 5 | Assembling of PCBs at assembly 1 by man | • | | | | | - |
| 6 | Movement of man from assembly 1 to assembly 2 | | • | | | | 2.6162 |
| 7 | Assembling of wires in the product by man | • | | | | | - |
| 8 | Movement of man from assembly 2 to assembly 3 | | • | | | | 2.6162 |
| 9 | Final assembly of product | • | | | | | - |
| 10 | Movement of man from assembly 3 to assembly 4 | | • | | | | 2.6005 |
| 11 | Inspection of final product | | | • | | | - |
| 12 | Movement of man from assembly 4 to assembly 5 | | • | | | | 2.7489 |
| 13 | Packing of product | • | | | | | - |
| 14 | Movement of man from assembly 5 to dispatch zone | | • | | | | 2.1193 |
| 15 | Storage of product | | - | | | • | - |
| 16 | Movement of man from dispatch zone to door | | • | | | | 1.4625 |
| | Total | | | | | | 19.3814 |

relationship chart and using the ALDEP software.

**Future Scope:**

Programming like Python can be used to generate more layouts by ALDEP methodology. Other methodologies like CRAFT and CORELAP can also be applied to existing layout to improve it. Simulation can be done using various software like Simio, Simuls, FlexSim, etc. to further optimize the layout. Construction of layout and finding the total distance of the processing sequence can also be done in Microsoft Excel using Visual Basic.

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