Optimization of Process Layout for Maintenance unit of XYZ Industry using Flexsim Simulation Software

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Abstract- **To reduce industrial process time Optimization techniques are useful for modern industries. As it depend on the industry what method should be applied to it.**
Facility layout design involves a systematic physical arrangement of different departments, work stations, machines, equipment's, storage areas and common areas in a manufacturing industry. In today's competitive global environment, the optimum facility layout has become an effective tool in cost reduction by enhancing the productivity. It has become very essential to have a well-organized plant layout for all available resources in an optimum manner to achieve the maximum returns from the capacity of facilities. To achieve the optimization objectives a lot of techniques are developed by many researchers in the domain area.

One of the techniques is the simulation by which one can easily be manipulate the present layout condition within a small interval of time. There are many simulating soft wares which can be helpful in analysing the layout for the optimized time or distance according to requirement. In this project the optimization of layout is to be performed for reducing maintenance time of a locomotive.

Keywords: - **Facilities Layout; Layout Design; Simulation; Redesign facility layout; Material flow.**

I. INTRODUCTION

Optimizing facility layout is an important problem for modern maintenance systems and it plays a key role for designing the process and material flow. Maintenance facilities design is the company's physical assets to promote the efficient use of resources such as worker, material, equipment, time and cost. Facilities design includes plant location, process flow, plant layout and material handling systems. Only the proper process flow of layout can ensure the smooth and rapid movement of material, from the first stage of material until the end of process. Optimizing the flow layout also can reduce the wastes or non-value added activities in the repairs and improve the overall effectiveness in the repairs. **[1]**

In maintenance industry, there are two main problems that need to be considering for the facility layout. **[1]**

- The first one is the quantitative approach aiming at minimizing the total material handling cost between workstations based on a distance function.
- Secondly is the approach aiming at minimizing the non-value added activities.

Material handling and process flow have close relationship in production. Material handling accounts for a significant portion of the total repairing cost. Workers and materials have to travel long distances in the course of the repairing process; this leads to loss of time and energy and nothing is added to the value of the product. Through effective plant layout analysis and design, much material handling operations can be reduced or eliminated. The choice of material handling methods and equipment is an integral part of the plant layout design. Furthermore, by optimizing the process flow, it will maximize the closeness between the workstations and effectively reduce the cross flow cause by workers in the repairs.

II. PLANT LAYOUT

Plant layout refers to the arrangement of physical facilities such as machines, equipment, tools, furniture etc. in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of raw material to the delivery of the final product. [2]

- "Plant layout is the arrangement of machines, work areas and service areas within a factory". —George R. Terry
- "Plant layout involves the development of physical relationship among building, equipment and production operations, which will enable the manufacturing process to be carried on efficiently". —Morris E. Hurley
- "Any arrangement of machines and facilities is layout". —F.G. Moore
- "Plant layout can be defined as a technique of locating machines, processes and plant services within the factory so as to achieve the greatest possible output of high quality at the lowest possible total cost of manufacturing". —Sprigal and Lansburg

- "Plant layout ideally involves the allocation of space and the arrangement of equipment in such a manner that overall operations cost can be minimized."— J. Lundy **[3]**

There are mainly three types of plant layout: **[2]**

- Product layout
- Process or functional layout
- Combined or Group layout
- Fixed position or location layout

2.1 Characteristics of Good Plant Layout

- Proper and efficient utilization of available floor space
- Transportation of work from one point to another point without any delay
- Proper utilization of production capacity.
- Reduced material handling costs
- Utilize labour efficiently
- Reduced accidents
- Provide for volume and product flexibility
- Provide ease of supervision and control
- Provide for employee safety and health
- Allow easy maintenance of machines and plant.
- Improve productivity

2.2 Importance of Plant Layout

The basic objective of the plant layout is to develop a facility layout that should be functionally better for the industry and cost savings. For functionally better industries the placing of necessary departments such as the operating and recovery rooms should be close together and keeping apart those departments which should not be together. Overall the Facility Layout includes the features of a layout which may not be immediately quantifiable, such as facilitating communication and improving staff safety.

III. FACTORS AFFECTING THE PLANT LAYOUT

The following factors should be considered while designing the layout. **[4]**

1. Nature of the product: The nature of the product to be manufactured has a significant influence on plant layout. Small and light products can be moved from one machine to another with minimum effort and time and therefore line layout would be more suitable. Stationary layout would be suitable for heavy and bulky products. In case of production of large variety of non-standardized products, process layout is ideal.

2. Production volume: Line layout should be preferred if standardized commodities are manufactured on a large scale. Functional layout is suitable if production is based on customers' orders. It is better suited for low volume job production.

3. Location of the site: The topology and size of the site influences the choice of a particular layout. The idea is to maximize the utilization of space. Layout should also suit the factory building. The positioning of elevators, stairways, parking lots and storage points also influence the layout.

4. Type of machines: Stationary layout is preferable if machines are heavy and emit more noise. Such heavy machinery can be fitted on the floor. Adequate space should be provided for the location of machines and also there should be sufficient space between them to avoid accidents.

5. Climate: Temperature, illumination, ventilation should be considered while deciding on the type of layout. The above factors should be considered in order to improve the health and welfare of employees.

6. Service facilities: The layout should provide for the comforts and welfare of the employees. It should have adequate provision for rest rooms, drinking water, and lavatory. There should be sufficient space for free movement of workers.

7. Safety of employees: While deciding on a particular type of layout, the safety of employees should be given importance. The layout should provide for obstruction free floors, non-slippery floors, protection against dangerous fumes, excess heat, strong odours Etc.

8. Type of production: Layout plans differ according to the type of production. In case of job orders, production of non-standardized products are undertaken and therefore functional or process outlet is suitable. Line layout would be suitable when there is mass production of standardized goods.

9. Type of process: In the case of intermittent type of production (bi-cycle manufacturing, electronics), functional layout is suitable. For synthetic type of Production (cement and automobile industries), line layout is preferable.

10. Management policies: Policies of the management relating to type of product, quality, scale of production, level of plant integration, type of production, possibility of future expansion etc., influence the type of layout to be adopted.

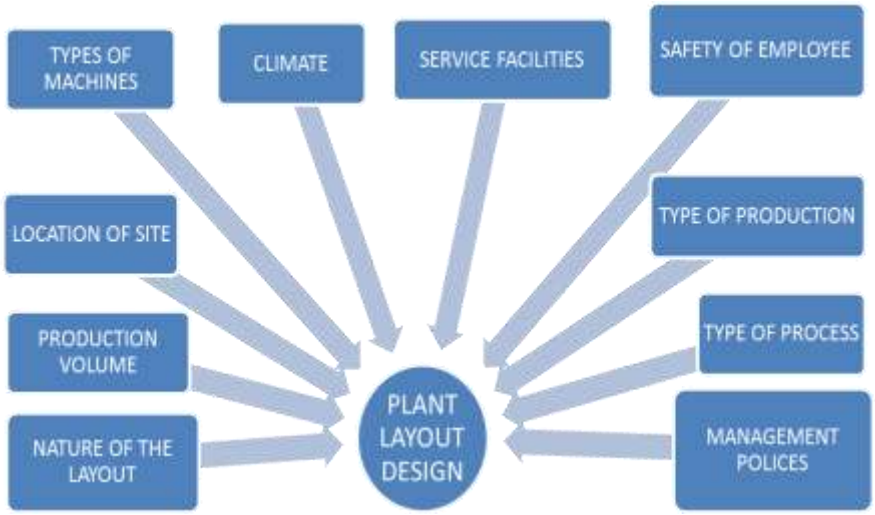

*Figure 1- Factors affecting Plant Layout Design**[5]***

IV. RESEARCH METHODOLOGY

The research objective is to reduce the maintenance lead time and WIP in order to increase the working rate in so that customer time is being fulfilled**.**

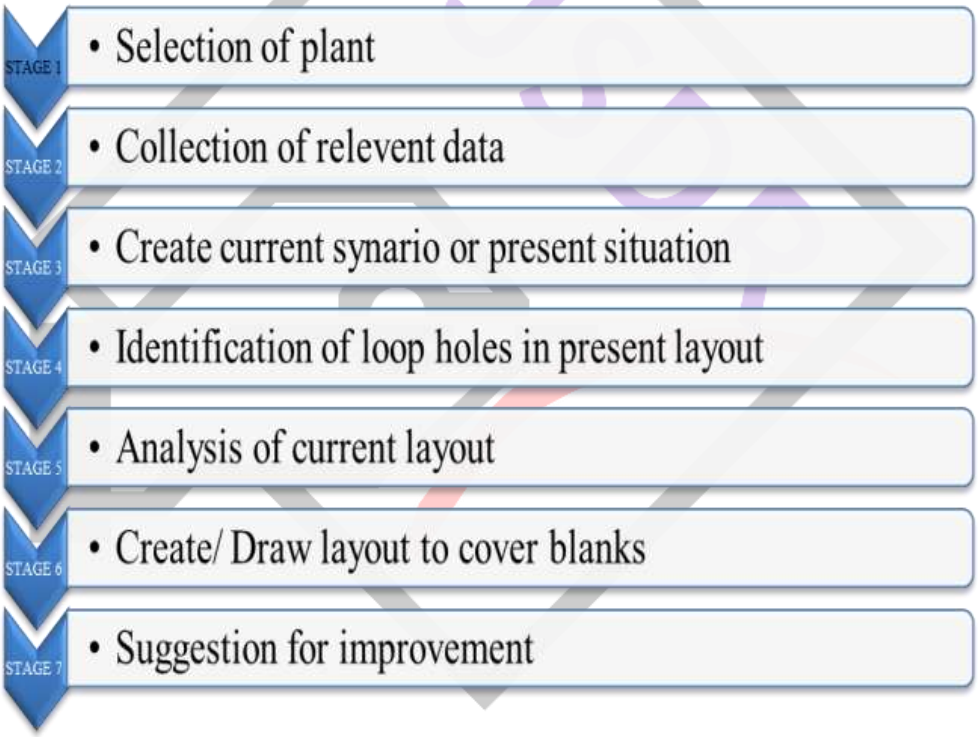

*Figure 2:- Methodology Steps for Implementing new plant layout**[5]***

The following strategies were applied for achieving the methodology steps:

- Detail of product, processes and other information obtained from unit.
- Time studies for finding the time duration & data collected from shop floor observation.
- For drawing current and future layout Flexsim software and AutoCAD software would be used.

V. DATA COLLECTION

From XYZ Industry survey we came across some facts about the maintenance schedule of diesel electric locomotive has various sections to work as follows:

RUNNING REPAIRS-

- It has various time intervals for servicing; a locomotive came for running repairs after every 10 days and after 15 days servicing depend on the old and new loco respectively.

- Also running repairs known as Trip servicing.
- It can be distinguished the repair work on following 3 factors:
    1. Troubleshooting
    2. Minor repair
    3. Major repair

We are considering the running repairs operations for calculation purpose; the running repairs encounter **following steps to repair a locomotive:**

1. Locomotive enters atXYZ Industry from one of the gate.
2. Firstly it goes to fuel point for checking fuel level and refill.
3. Then secondly it goes to washing area for washing and cleaning.
4. Then locomotive goes to lobby to check for schedule time.
5. Then it enters to line no. 1 or maybe line no. 2 depends on the condition of plant.
6. Then supervisor checks drivers booking.
7. As we see that the material store and tool room are at near line no.3 the worker should go and cross all rooms to go there and components get replaced or repaired after checking the check list of TRIP or GI schedule the main three concerns in checking are i) Abnormal sound; ii) Abnormal Temperature; iii) Abnormal bearing.
8. After checking and completing all faults and repairs the locomotive goes to final inspection and supervisor check before it leaves the shed.
9. At the same point of entry the locomotive gets exist from the end gate.

5.1 FLEXSIM ANALYSIS

FOR PRESENT LAYOUT

The following flowchart will shows the running repairs of the present layout of XYZ Industry:

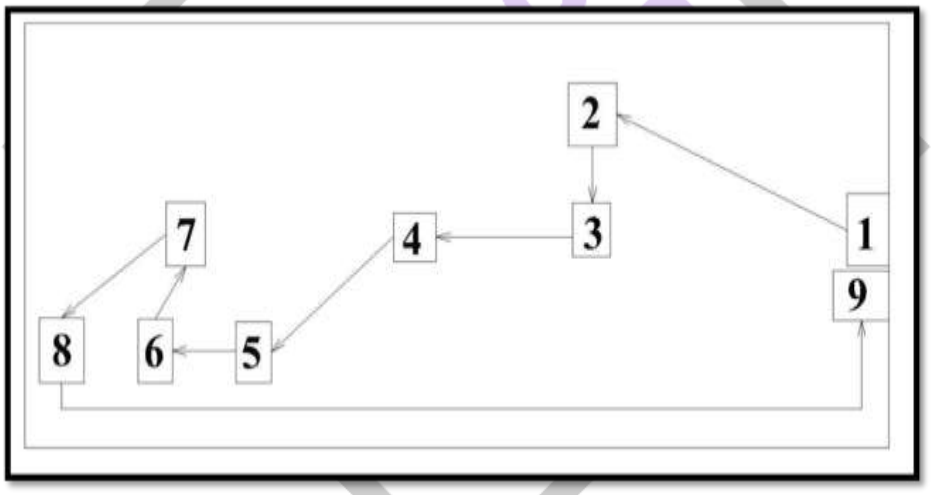

Figure: 3- Process Flow chart of present layout for the running repairs.

Model Documentation

SOURCE1

Spatial Information

X Location: 509848.775476
Y Location: 15903.959335
Z Location: 0
X Rotation: 0
Y Rotation: 0
Z Rotation: 180
X Size: 3000
Y Size: 4300
Z Size: 2000

Variables

Arrival mode: 2
Inter arrival time: exponential (0.0, 200.0, and 0)
Item class: 10

SINK1

Spatial Information

X Location: 509710.093148
Y Location: 11216.517044
Z Location: 0
X Size: 3200
Y Size: 4158.752213
Z Size: 2403.484322

FUELING POINT

Spatial Information

X Location: 390000
Y Location: 31000
Z Location: 0
X Rotation: 0
Y Rotation: 0
Z Rotation: 180
X Size: 17903.684088
Y Size: 10000
Z Size: 4000

Variables

Cycle time: 15
Send to port: First Available

WASHING AREA

Spatial Information

X Location: 389998.018591
Y Location: 13429.944291
Z Location: 0
X Size: 18454.542623
Y Size: 6308.500576
Z Size: 3000

Variables

Cycle time: 30

LOBBY

Spatial Information

X Location: 267739.067265
Y Location: -3668.765154
Z Location: 0
X Size: 5385.245509
Y Size: 3593.853537
Z Size: 800

DRIVER BOOKING

Spatial Information

X Location: 233699.963592
Y Location: -4296.315588
Z Location: 0
X Size: 4303.955146
Y Size: 7005.148965
Z Size: 1360.106005

WORKING ON LOCOMOTIVE

Spatial Information

X Location: 209440.740691
Y Location: -3857.814787
Z Location: 0
X Size: 6362.422876
Y Size: 4570.157015
Z Size: 758.757427

Variables

Cycle time: 45

FINAL INSPECTION

Spatial Information

X Location: 173673.249004
Y Location: -3816.949878
Z Location: 0
Y Size: 4000
Z Size: 1128.212413

Variables

Cycle time: 30

The tabular data from Flexsim Software for present layout of XYZ Industry.

Table 1 Flexsim time analysis of each process for running repairs.

Serial No.	Processes	Time Taken in minutes
1	Entry	0
2	Check Fuel Level and Refill	15
3	Washing Area	30
4	Enters Schedule time	10
5	Enters at running repair section	30
6	Driver booking	30
7	Working on Locomotive	105
8	Final Inspection	30
9	Exits	30

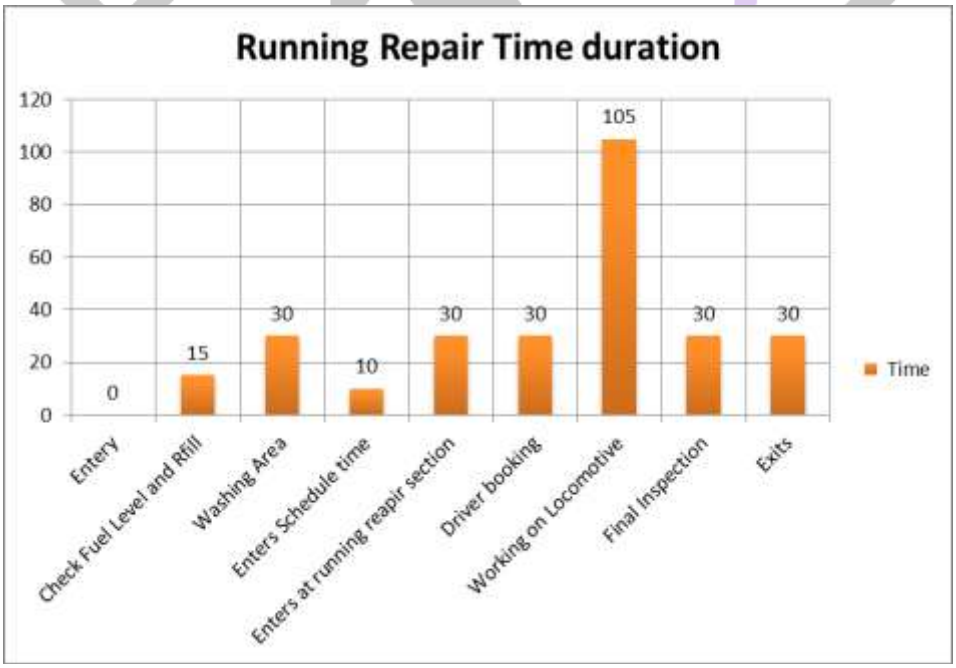

Figure 4- Graphical Representation of Flexsim Analysis

Some more data from Flexsim Analysis are as follows:

• Average Stay time of each process (in hours.)

Average Staytime		
	Average Staytime	Maximum Staytime
Fueling Point	0.2	0.2
Wasshing Area	0.5	0.5
Lobby	0.2	0.2
Driver booking	0.5	0.5
Working on Locomotive	1.8	1.8
Final Inspection	0.5	0.5

Figure 5- Tabular data for average stay time

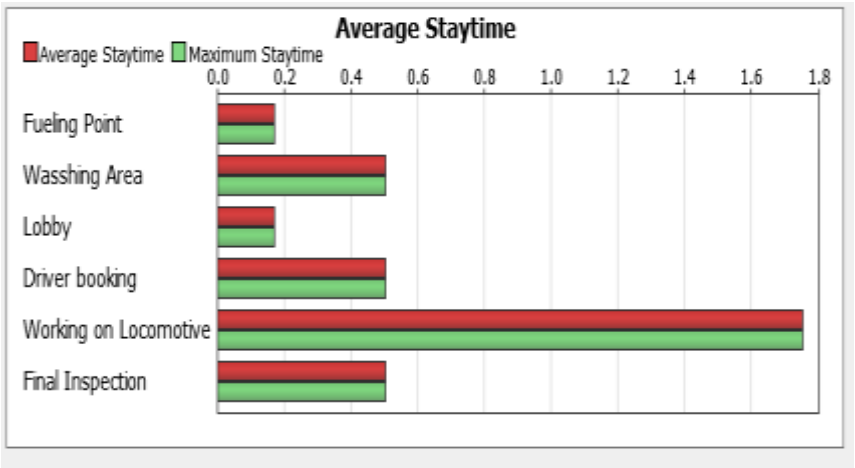

Figure.6- Graphical representation of average stay time.

• State Pie Chart of all working processes under running repairs, also a state Gantt chart.

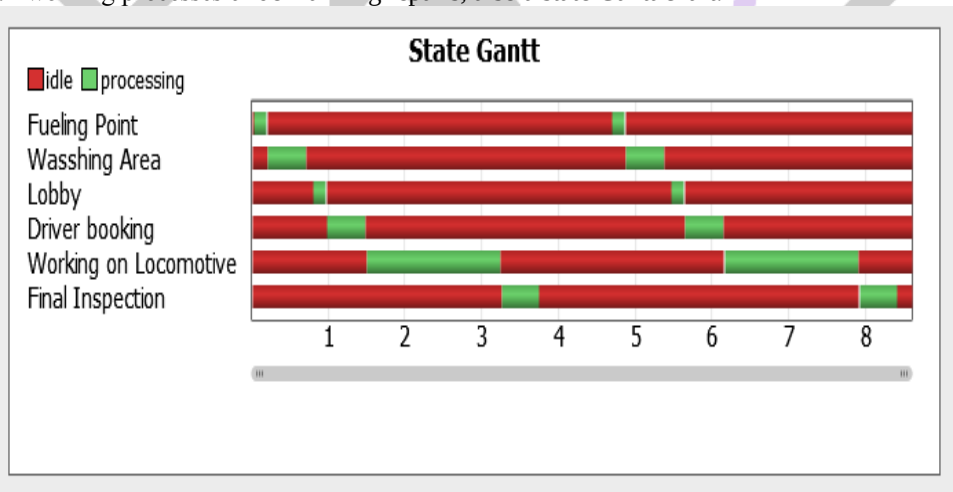

Figure 7- Graphical representation of Gantt chart.

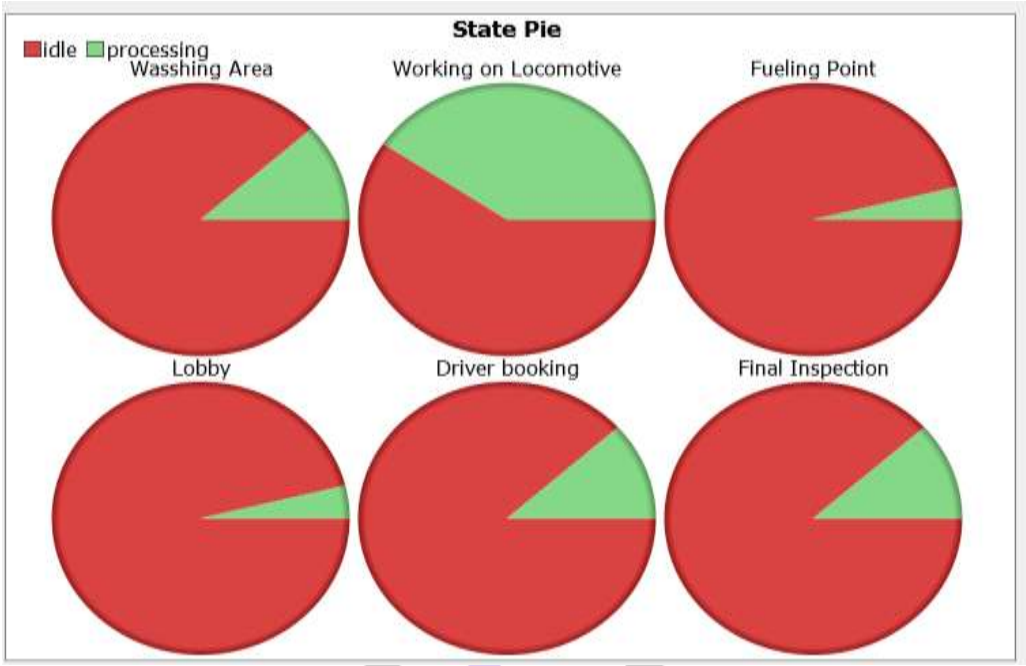

Figure 8- Graphical representation of State Pie Chart.

State Pie

	idle	processing
Wasshing Area	88.4%	11.6%
Working on Locomotive	59.4%	40.6%
Fueling Point	96.1%	3.9%
Lobby	96.1%	3.9%
Driver booking	88.4%	11.6%
Final Inspection	88.4%	11.6%

Figure 9- Tabular data of state pie for all processes.

FOR MODIFIED LAYOUT

Model Documentation
SOURCE1

Spatial Information

X Location: 652056.359988
Y Location: 22200
Z Location: 0
X Rotation: 0
Y Rotation: 0
Z Rotation: 180
X Size: 2521.873637
Y Size: 2430.515135
Z Size: 1630.037995

Variables

Arrival mode: 2
Item class: 10

SINK1

Spatial Information

X Location: 652000
Y Location: 19545.171621
Z Location: 0

X Size: 2639.471995
Y Size: 2429.676581
Z Size: 1592.483042

FUELING POINT

Spatial Information

X Location: 576745.780872
Y Location: 22000
Z Location: 0
X Size: 9489.771216
Y Size: 5091.238658
Z Size: 2584.145180
Cycle time: 15

WASHING AREA

Spatial Information

X Location: 533303.729544
Y Location: 24000
Z Location: 0
X Size: 16283.881791
Z Size: 4314.281675

Variables

Cycle time: 20

LOBBY

Spatial Information

X Location: 408000
Y Location: 6000
Z Location: 0
X Size: 7000
Y Size: 4074.817011
Z Size: 2000

DRIVER BOOKING

Spatial Information

X Location: 376451.611493
Y Location: 4000
Z Location: 0
X Size: 7000
Y Size: 4418.242959
Z Size: 1400

Variables

Cycle time: 30

WORKING ON LOCOMOTIVE

Spatial Information

Variables
X Location: 346000
Y Location: 3708.751163
Z Location: 0
X Size: 5836.073959
Y Size: 4000
Z Size: 1363.864816

Variables

Cycle time: 100

FINAL INSPECTION

Spatial Information

X Location: 318044.207008
Y Location: 4669.170036
Z Location: -88.804658
X Size: 5650.846330
Y Size: 5312.716360

Z Size: 1614.630152

Variables

Cycle time: 30

The tabular data from Flexsim Software for modified layout of XYZ Industry.

Table 2 Flexsim time analysis of each process for running repairs in modified layout.

Serial No.	Processes	Time Taken in minutes
1	Entry	0
2	Check Fuel Level and Refill	15
3	Washing Area	20
4	Enters Schedule time	10
5	Enters at running repair section	30
6	Driver booking	30
7	Working on Locomotive	100
8	Final Inspection	30
9	Exits	30

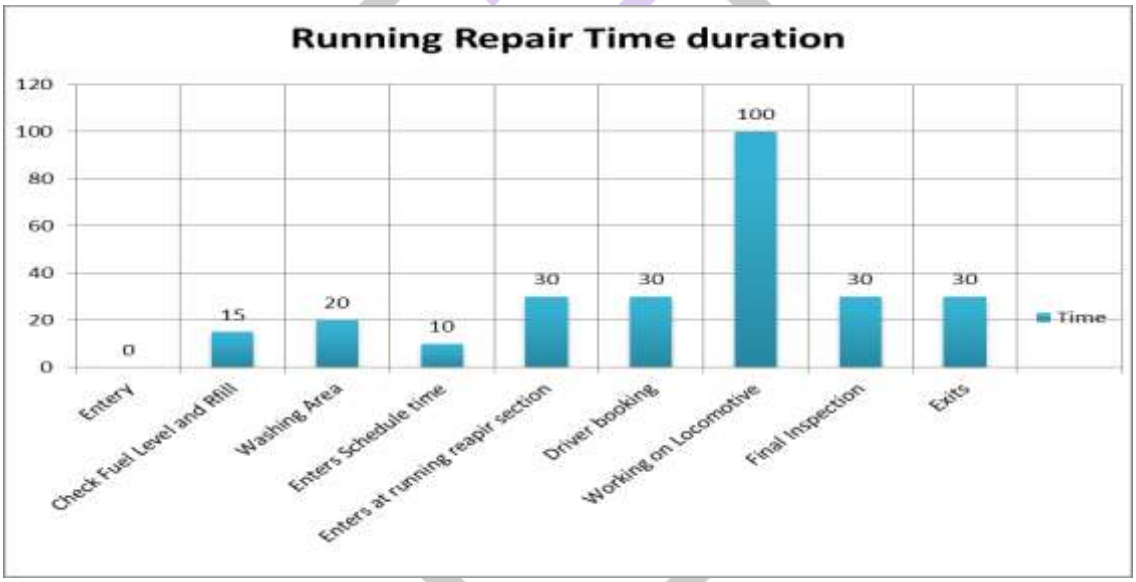

Figure 10- Graphical Representation of Flexsim Analysis

Some more data from Flexsim Analysis are as follows:

- Average Stay time of each process (in hours.)

Average Staytime

	Average Staytime	Maximum Staytime
Fueling point	0.3	0.3
Washing area	0.3	0.3
Lobby	0.2	0.2
Driver Booking	0.5	0.5
Working on Locomotive	1.7	1.7
Final Inspection	0.5	0.5

Figure 11- Tabular data for average stay time

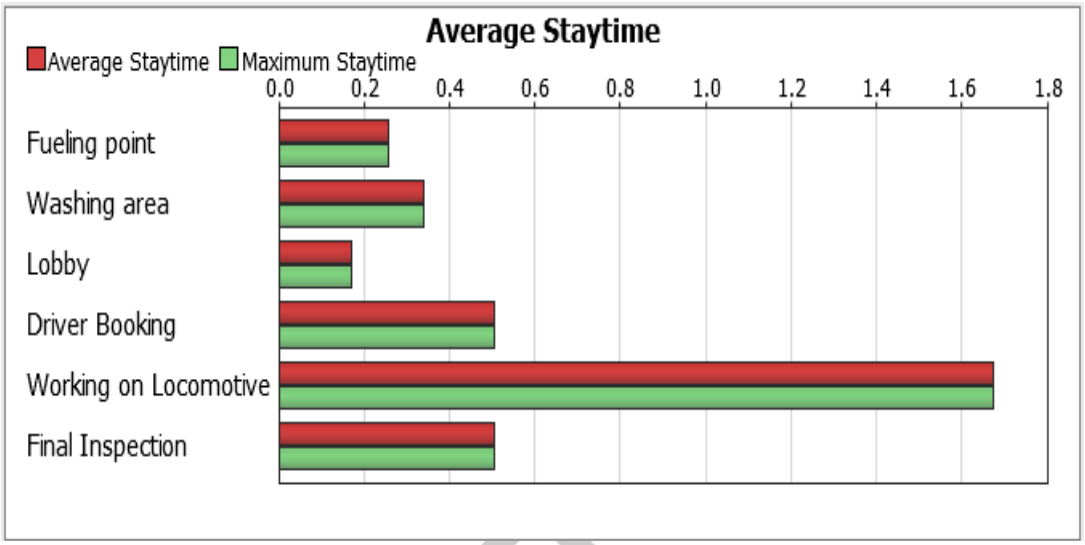

Figure 12- Graphical representation of average stay time.

- State Pie Chart of all working processes under running repairs, also a state Gantt chart.

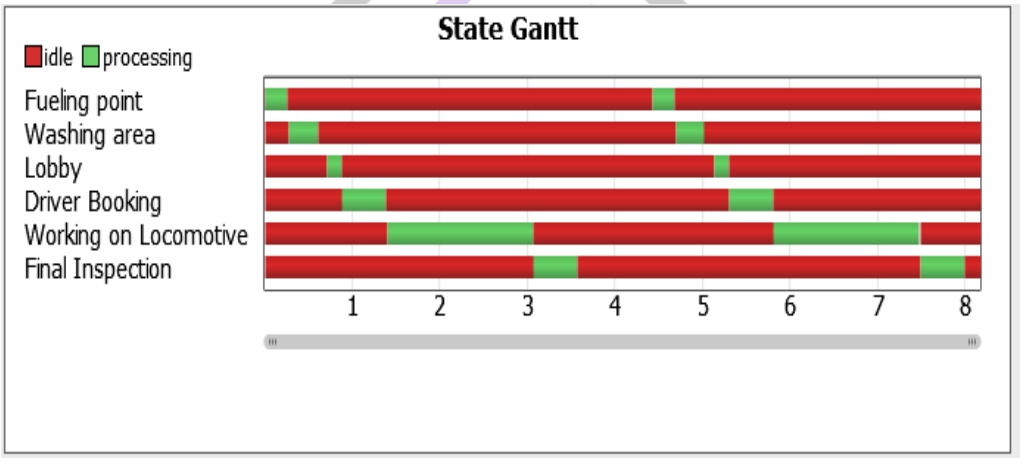

Figure 13- Graphical representation of Gantt chart.

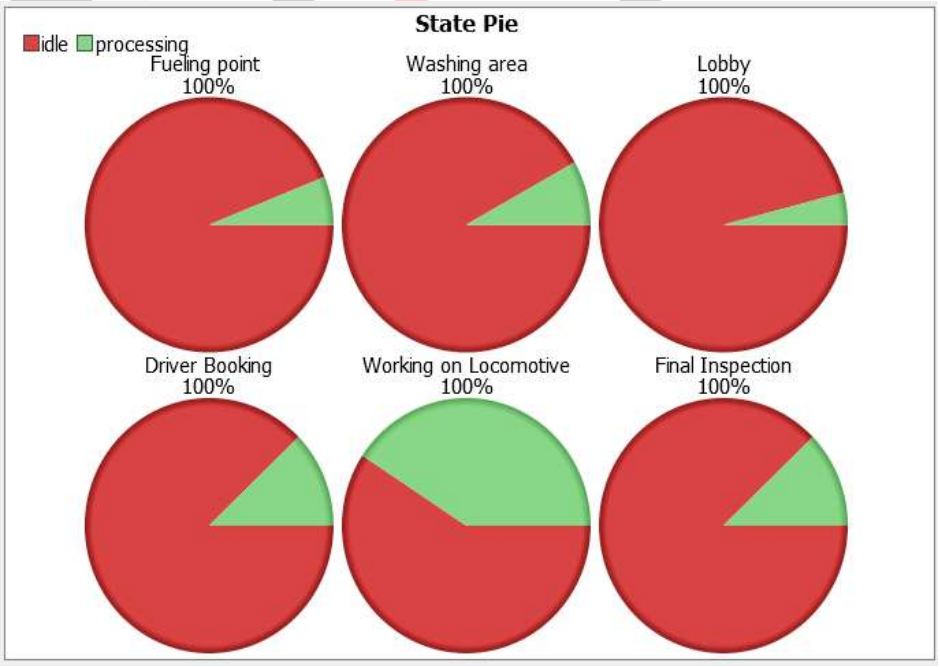

Figure 14- Graphical representation of State Pie Chart.

	State Pie		
	Total	idle	processing
Fueling point	100.0%	93.9%	6.1%
Washing area	100.0%	91.9%	8.1%
Lobby	100.0%	95.9%	4.1%
Driver Booking	100.0%	87.8%	12.2%
Working on Locomotive	100.0%	59.3%	40.7%
Final Inspection	100.0%	87.8%	12.2%

Figure 15- Tabular data of state pie for all processes

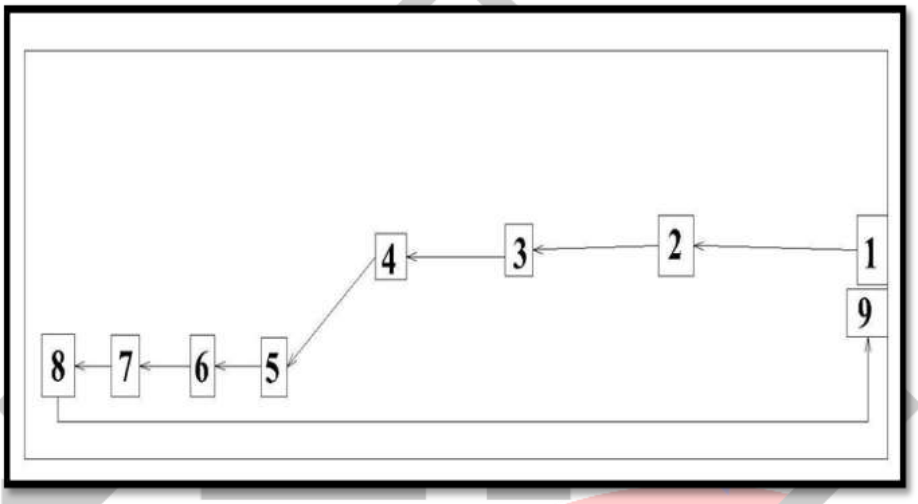

Figure: 16 - Process Flow chart of modified layout for the running repairs

5.2 ANALYTICAL CALCULATIONS

CALCULATIONS FOR RUNNING REAPIRS:

Standard time required to attended a locomotive = 4 hours = 240 min.

No. of technicians required = 4

Actual time taken according to present layout = 280 min.

No. of working Shift / day = 3

Available time per shift = 480 min.

Tea break per shift = 2 x 10 min. =20 min.
Lunch break duration= 60 min.

Networking time during day shift = [available time – (breaks)]
= [480-(20+60)]
= 400 min.

Locomotive attend during a shift = 2

Take time = Available time / Locomotive attend in a shift
= 400/2 =200 min.

Cycle time $= \frac{Useful\ Maintenace\ time}{Unit\ sever\ per\ day}$

$= \frac{400*3}{6}$ = 200 min.

5.3 CALCULATION OF DISTANCE TRAVELLED FOR RUNNING REPAIRS OF PRESENT LAYOUT

Process Distance from 1 – 2: = 109.9864 m
Process Distance from 2 – 3: = 210. 5536 m [2→1→3 = 2→3]
Process Distance from 3 – 4: = 285.3941 m
Process Distance from 4 – 5: = 24.6029 m
Process Distance from 5 – 6: = at same position
Process Distance from 6 – 7: = 97.8690 m
Process Distance from 7 – 8: = at same position
Process Distance from 8 – 9: = 545.8438 m

5.4 CALCULATION OF DISTANCE TRAVELLED FOR RUNNING REPAIRS OF MOIDFIED LAYOUT

Process Distance from 1 – 2: = 63.5786 m
Process Distance from 2 – 3: = 23.0146 m
Process Distance from 3 – 4: = 285.3941 m
Process Distance from 4 – 5: = 24.6029 m
Process Distance from 5 – 6: = at same position
Process Distance from 6 – 7: = 22.3544 m
Process Distance from 7 – 8: = at same position
Process Distance from 8 – 9: = 545.8438 m

5.5 PROCESSES LENGTH DIFFRENCE OF NEW AND MODIFIED LAYOUT

Table 3- Difference in distance travelled in present layout and modified layout on the basis of running repair processes

PROCESSES	**PRESENT LAYOUT DISTANCE** ***(in meters)***	**MODIFIED LAYOUT DISTANCE** ***(in meters)***	**DIFFERENCE IN LENGTH** ***(in meters)***
Process 1 – 2	109.9864	63.5786	46.4078
Process 2 – 3	210.5536	23.0146	187.5390
Process 6 – 7	97.8690	22.3544	75.5146

5.5 CALCULATION OF EFFICIENCY:-

The modified plant layout efficiency is 90.56% which is greater than the efficiency of the current plant layout i.e., 85.71%. The efficiency improvement of the plant was increased up to 5.65%. This efficiency is based on repairing time for single locomotive from entrance to exit.

Efficiency of the current plant layout (A) $= \frac{prescribed\ \ travel\ \ time\ \ by\ Disel\ Locomotive\ \ scdelue}{current\ \ travel\ \ time} X100$

Efficiency of the current plant layout (A) $= \frac{240}{280} X\ 100$

Efficiency of the current plant layout (A) $= 85.71\%$

Efficiency of the proposed plant layout (B) $= \frac{prescribed\ \ travel\ \ time\ \ by\ Disel\ Locomotive\ \ scdelue}{current\ \ travel\ \ time} X100$

Efficiency of the proposed plant layout (B) $= \frac{240}{265} X\ 100$

Efficiency of the proposed plant layout (B) $= 90.56\%$

Percentage improvement $= \frac{(B-A)}{A} X\ 100$

Percentage improvement $= \frac{(90.56-85.71)}{85.71} X\ 100$

Percentage improvement $= 5.65\%$

VI RESULTS

The results gained from the findings of this work indicate that the running repair time is improve by the execution of balancing for the running repair section; and layout of plant would result in improvement of time margin for internal and external work. In other words, with decrease in the running repair time, the time margin for internal and external work increases. Therefore it is suggested that the working personnel in theXYZ Industry unit should perform the execution of balancing in the organization and defining the minimum running repair time and in this way they could managed and systematic working of the unit. Although the results differ across different models, the key variables determining these process layouts would be better than the previous one.

EFFICIENCY TABLE

Table 4- Efficiency of existing and modified layout

PARAMETER	EXISTING LAYOUT	PROPOSED LAYOUT
Time travelled by the locomotive for repairing (min.)	280	265
Efficiency	85.71%	90.71%

Table 5- Final Comparison of Present and Modified Layout.

Serial No.	Processes held in Running Repairs	Present Layout Time Duration (in Mins.)	Modified Layout Time Duration (in Mins.)
1	Entry	0	0
2	Check Fuel Level and Refill	15	15
3	Washing Area	30	20
4	Enters Schedule time	10	10
5	Enters at running repair section	30	30
6	Driver booking	30	30
7	Working on Locomotive	105	100
8	Final Inspection	30	30
9	Exits	30	30
	Total Time Duration for all Processes	280	265

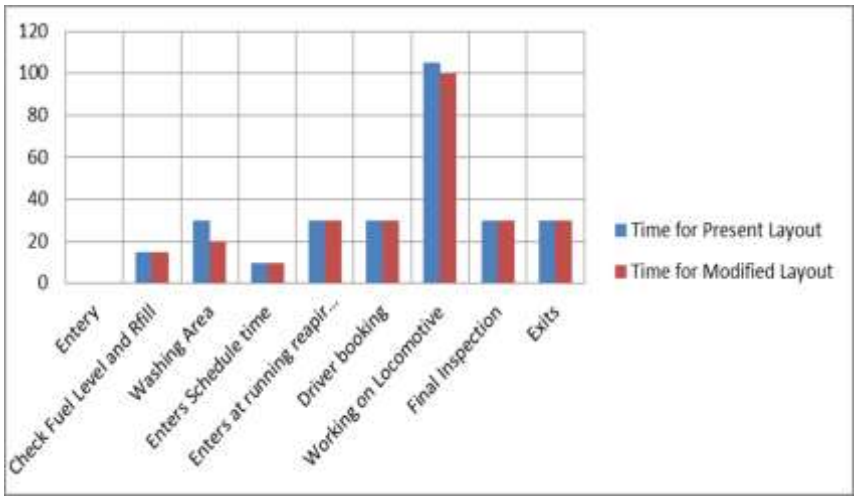

Figure 17 Combined Graph for both modified and presents Layout

VII CONCLUSION

In this work, we have presented an analytical methods and simulation techniques for the access and process time of a maintenance unit likeXYZ Industry. By comparing the existing system to software model of the Flexsim. The computational complexity, however, is considerably better in the software. This software would make the model much closer to real values.

On the basis of above problem identification we can find out the regular layout of XYZ Industry requires a rearrangement of layout so as to increase overall efficiency of unit. This situation can be solved by both analytical and simulating techniques for optimization industrial layout. For this purpose we use Flexsim software for identify layout difference of present and future proposed.

VIII FUTURE SCOPE OF THE STUDY

I would plan a simulation model for modelling in a diesel electric locomotive maintenance unit and analyse shop floor management. With the transitioning Flexsim I would be able to overcome the excessive time for automation and layout design. Hence, for future scope if the professional edition of Flexsim would be used then there might be options for changing or reshuffling the existing layout of the unit to achieve 80 to 90 present of shop floor utilization.

Therefore, the core and add-on approach to simulation will be used for new controls software and new interface requirements for shop floor management. These changes could include intelligent shop floor management controls and work rule scheduling methodologies. The main thing, I expect is to compare the different things for simplifying the techniques by using the advanced techniques and different methodologies. Further some more following improvements can be implemented.

- The Flexsim software can be implemented in advanced layout management for time saving and better improvement.
- The layout can be aligned and the comparison done between them. The comparison obtain is multi usual.
- The comparison between traditional and proposed is done to check all the error encountered up to now.
- The features are compared from both deviation and errors.
- Suggestion will be proposed to management for the rearrangement of layout for better plant efficiency.

XI. ACKNOWLEDGMENT

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REFERENCES

[1]Francesco Longo, Giovanni Mirabelli, Enrico Pap off Mechanical Department, University of Calabria, Italy " MATERIAL FLOW ANALYSIS AND PLANT LAY-OUT OPTIMIZATION OF A MANUFACTURING SYSTEM" Francesco Longo, Giovanni Mirabelli, Enrico Pap off / Computing, 2006, Vol. 5, Issue 1, 107-116 ISSN 1727-6209 International Scientific Journal of Computing.

[2] Armour, G. C., and Buffa, E. S. (1963). "A HEURISTIC AND SIMULATION APPROACH." Management Science. Vol. 9 pp.294-309.

[3] http://www.yourarticlelibrary.com/industries/meaning-and-objectives-of-plant-layout-industrial-management/26163/

[4] http://www.yourarticlelibrary.com/industries/meaning-and-objectives-of-plant-layout-industrial-management/26163/

[5]
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