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"SYSTEMATIC LAYOUT PLANNING: Improvement in the Layout Design of Pulse Processing Unit"

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Abstract— **The objective of this research is to study plant layout of Pulse Mill to eliminate obstructions in material flow and thus obtain maximum efficiency of employee. Evaluate the proposed alternative layouts based on the Systematic Layout Planning pattern theory (SLP) for increased productivity. In this case study, number of equipment and tools in Pulse milling are studied. The detailed study of the plant layout such as flow of material and activity relationship chart and space relationship diagram has been investigated. The new plant layout has been designed and compared with the existing plant layout. The SLP method showed that new plant layout significantly decrease the distance of material flow from one stone roller to another stone roller.**

Keywords—**Plant layout, Layout Planning, Systematic Layout Planning, Flow analysis, Activity relationship chart, Productivity.**

I. INTRODUCTION

Due to increased globalization and constant technological improvements and other competitive pressures, the organizations have to increase the pace of change to adapt to new situations. Material flow throughout the supply chain, the merits and demerits of the material flow in the supply chain is vital impact. Based on the study in the Dal mill, there are various problems when produce the split pulse or dal. The various challenges occur during pulse milling due to quality of pulse, improper milling and packaging. Another problem is when the improper arrangement of machinery and plant layout leads to effect in productivity.

The availability of Pulses per capita has steadily decreased due to poor growth in the rate of production. According to an estimate, the post-harvest losses from harvesting to milling and from storage to transport may vary from 25-30% in Pulses. If this loss is decreased by 50%, there is an increment of 1.5-2.0 million tons pulse grains which is almost equal to current import. The most important post-harvest operations are Milling and storage being got the maximum focus. As a result, a large number of low capacity dal mills were developed to fulfill the milling requirement of small-scale industry. Now some large scale processing reviewed by scientific innovation which improve the method of Pulse milling. [4]

The basic industrial layout planning is applied to Systematic Layout Planning (SLP) method in which there is step-by-step procedure of plant design from input data and activities to evaluation of plant layout. This method provides the new plant layout and also better utilization of space which improves the process flow through the plant which help to increases production in industries.

The objectives of the present study are as follows:-

- Modification of plant layout design to improve the efficiency of workers.
- Improve the plant layout to improve the productivity.
- By improving the flow of pulse from each workstation prevents the pulse from damage.
- Identification and analysis of various methods for improve productivity.
- Minimizing the losses occur during the pulse production.
- It provides ease in the flow of materials.
- Minimizing the movement of people, material and resources.

II. PROPOSED ALGORITHM

The data were collected and the number of tools & equipment for manufacturing were counted in terms of directional flow of raw materials and product. The operation process chart, flow of material and activity relationship chart have been used in analysis.

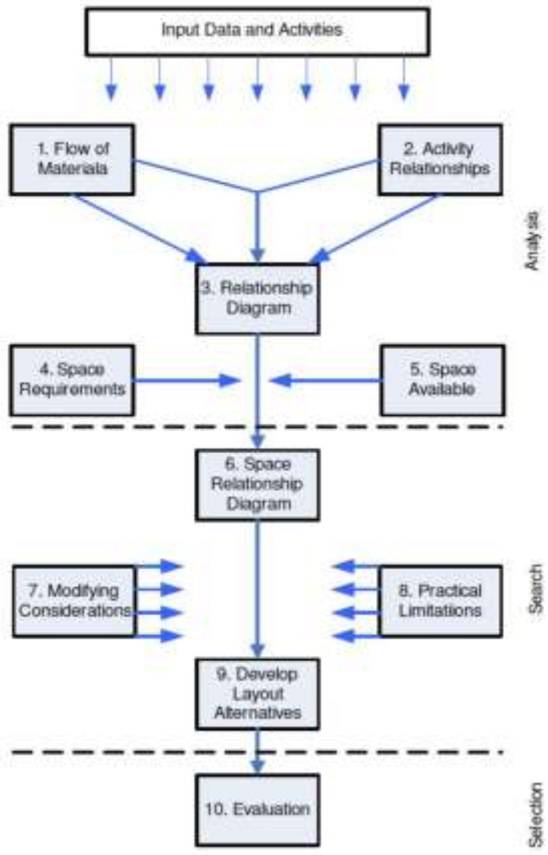

Figure 1: Procedure of SLP [3]

III. METHODOLOGY

A. INTRODUCTION OF JAIDEEP DAL MILL

JAIDEEP DAL MILL INDUSTRIES is a small scale manufacturing plant of pulse production. It was established in year 1997 and since then, it is working in the field of processing of all type of pulses in Sidhguma industrial area in Sagar district, Madhya Pradesh. It operates its plant in process such as Cleaning, Dehusking, Grading, Conditioning, Splitting, Separation, Sizing, Polishing and Packaging. It is spread in total area of 5610ft^2 includes Dal mill plant, warehouse and office with well-organized structure. It has a production of 150 tons per month which leads it to 1800 tons per year with its small man power. It has multiple distributors in every district and there is a great competition in overall market. This unit is able to fulfill the demand of customers with highly satisfied terms.

B. PROCESS OF JAIDEEP DAL MILL

1. Cleaning:-
This is the first stage of milling process. In this process the raw pulse is lifting from raw material godown with the help of bucket elevator and passing through five sheet vibratory sieves. The vibratory sieves with different size holes sheets help to match the requirement of variety of dal being processed. These vibratory sieves is used to remove the dust particles, stone and aggregate and separate the minute dal, reject raw dal and clean dal through vibratory sieves. It is required to remove contaminated matters from pulse.

2. Dehusking:-
Now, the second stage of pulse milling is dehusking in which the pulse is dehusked twice by using two stone rollers. On its first pass it crack the husk layer and it dehusked about 25-30% of pulse. On its other pass it dehusked about 80% of pulse. So the pulse is further passes through the stone roller for getting maximum dehusked pulse.

3. Grading:-
Now come to the third stage which is Grading, here the shelled pulse passing through four sheet vibratory sieves where appropriate grading is done. Different sieves separate cattle feed, broken dal, donkey or rejected dal and semi-finished dal. The semi-finished dal is now supplied for conditioning.

4. Conditioning:-
In this stage of process, the semi-finished dal is supplied to the varam machine with tape with the help of bucket elevator. The tape is required to moisturizing the dal in the required amount. The moisture pulse is now lying on the roof for soaking extra water with the help of sun drying method.

5. Splitting:-
In this stage of process, the conditioning dal from roof gets split into two equal halves with the use of Chakki or attrition mill.

6. Separation:-
In this stage of process, the split dal are passes through four sheet vibratory sieves and separate the powered dal, broken dal, finished or split dal and semi-finished dal. The semi-finished dal is again passes through the second stone roller and further completes the whole process.

7. Sizing:-
In this stage of process, the finished dal is standardizing as small size, medium size, bold and overflow dal. The bold size dal includes standard size of pulse and overflow dal include unsplit dal.

8. Polishing:-
In this stage of process, the different sized pulses are supplied separately to varam machine with tape for polishing the dal.

9. Packaging:-
In this stage of process, the finished pulses are packed to prevent from any damage such as broken or powdering of dal.

C. Analysis of Original Plant Layout

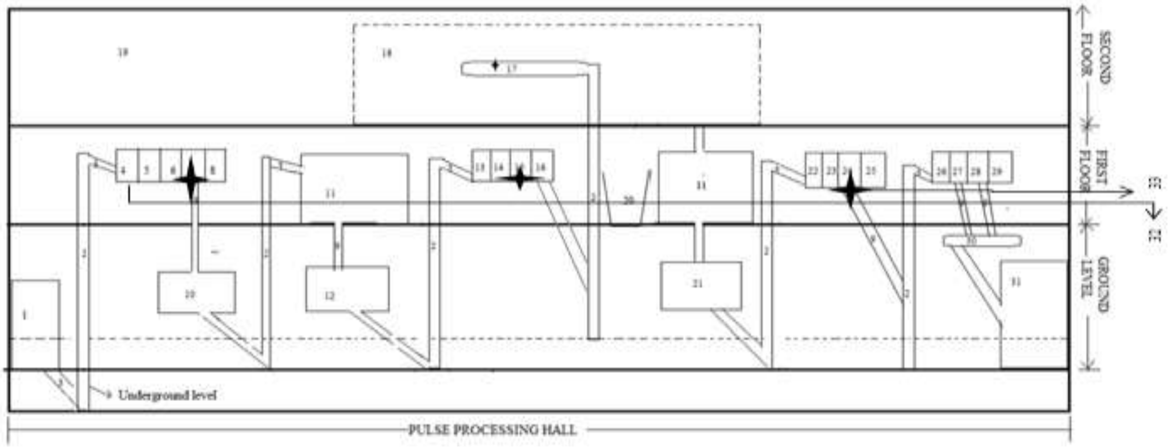

Figure 2: Existing Plant Layout

NOMENCLATURE

1. RAW DAL GODOWN
2. BUCKET ELEVATOR
3. PIPE (3 sq. ft.)
4. DUST
5. MINUTE DAL
6. REJECT RAW DAL
7. CLEAN DAL
8. SOIL PARTICLES
9. PIPE (12 sq. ft.)
10. STONE ROLL MACHINE
11. STOCK TANK
12. STONE ROLL MACHINE
13. CATTLE FEED
14. BROKEN DAL
15. DONKEY OR REJECT DAL
16. SEMIFINISHED DAL
17. VARAM MACHINE WITH TAPE
18. STOCK ROOM (STOCK TANK)
19. ROOF
20. DRYER
21. CHAKKI OR ATTITION MILL
22. POWERED RAW DAL
23. BROKEN DAL
24. FINISHED DAL
25. REJECTED DAL
26. SMALL SIZE DAL
27. MEDIUM SIZE DAL
28. BOLD SIZE DAL
29. OVERSIZE DAL
30. VARAM MACHINE
31. FINISHED DAL GODOWN
32. VIBRATORY SIEVES
33. FAN OR BLOWER

D. ANALYSIS OF PLANT LAYOUT BASED ON SLP

In this study, the processing of pulse unit analyzed. The P-Q Chart represents the total quantity of each product obtained during pulse processing as shown in figure 3. The flow of material is shown in Figure 4 .The size of the equipment was relational to the area as shown in Table 1. According to the original plant layout, total production, total working area, distance travelled of materials could be discussed as follows:

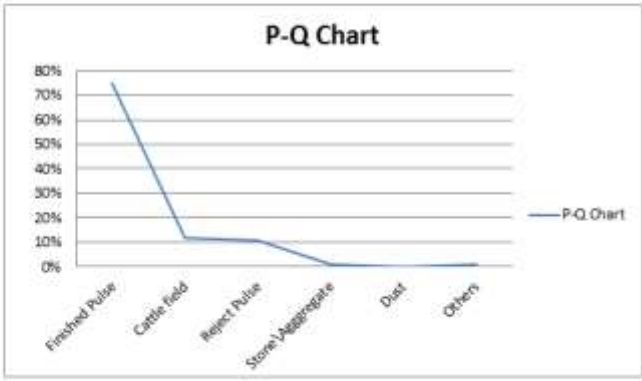

Figure 3: P-Q Chart

From the above P-Q chart, we can observe the range of product and quantity. From current layout, for processing of 200 tons of input, we obtained 150 tons of finished pulse; 24 tons of pulses, 22 tons of reject pulse and remaining 4 tons of contaminated matters which include dust particle, stone or aggregate etc.

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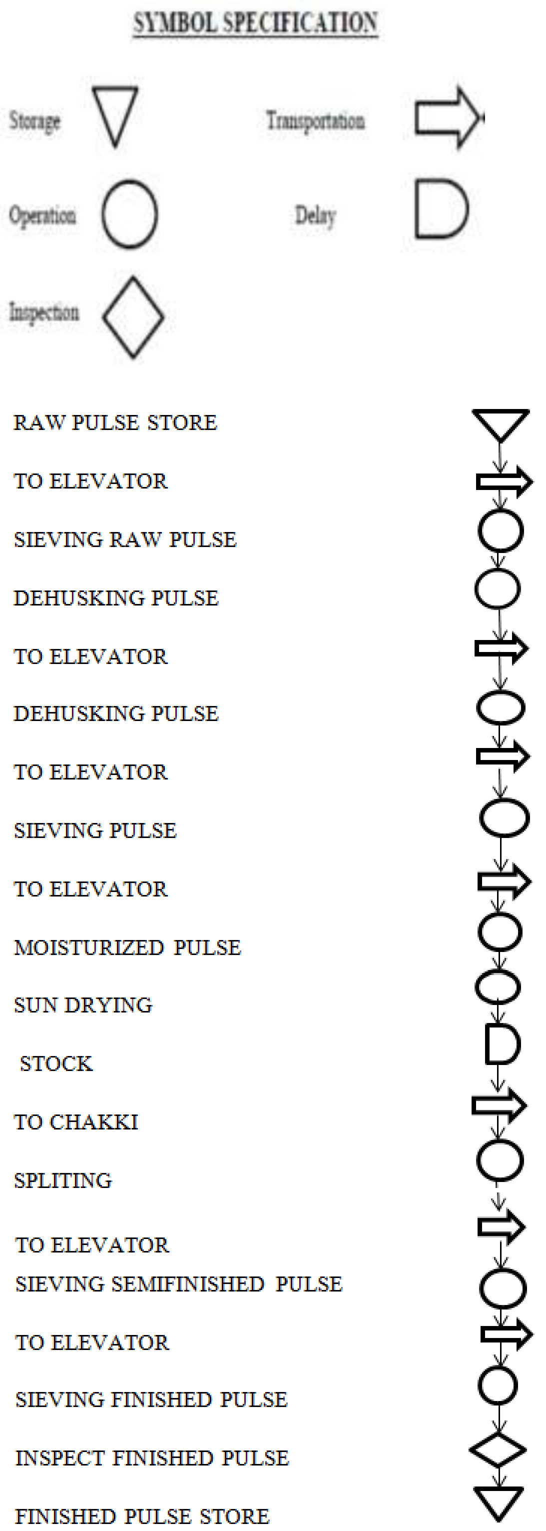

Figure 4: Flow of material in Dal Mill

From this flow of material chart following information is collected. These are

- The sequence of the activities.
- The intensity of the flow in tons.
- The total share of each sub flow.
- Special activities which performed under special circumstances.
- The overall process of pulse production.

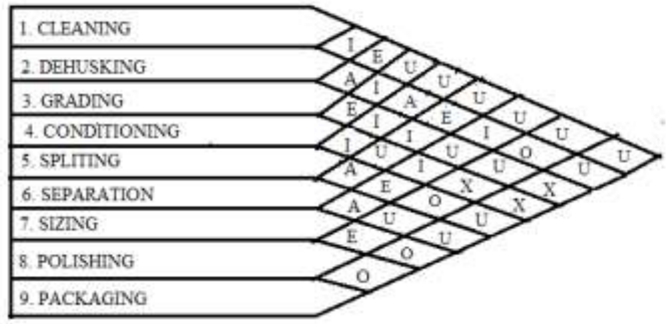

figure 5: Activity Relationship Diagram

Here, the method of diagramming Activity Relationship chart involves connecting the activities with the use of vowels code. It indicates the rated closeness where "A" indicates that it is absolutely necessary that the activities be next to each other. "E" indicates that it is especially necessary that the activities be close to each other. "I" indicates that it is important the activities are close to each other. "O" indicates that ordinary closeness be maintained and "U" indicates that it is unimportant the activities be close to each other. "X" indicates that it is undesirable the activities be close to each other.

Equipment / Process	Godown 30X20	Elevators 25X2	Elevators 34X2	Sieves 15X7	Sieves 12X7	Stone Roll 4.5X3	Stock tank 15X15	Pipes 5X1	Pipes 12X1	Pipes 8X1	Varam machine with tape 7X1	Attrition mill or chakki 5X3	Total space required in square feet
Cleaning	1	1		1				1	1				920
Dehusking		1				2	1	2		1			307
Grading		1		1				2					161
Conditioning			1				1	1			1		303
Splitting							1	1		1		1	251
Separation		1			1			2					140
Sizing		1			1			1	1				149
Polishing									2		1		31
Packaging	1								1				762
Dryer							1						225
TOTAL	2	5	1	2	2	2	4	10	5	2	2	1	3249

Table 1: Space requirements

IV. EXPERIMENT AND RESULT

The improved layout is based on the P-Q Chart, activity relationship chart and the theme of reducing travelled distance. Altering the positions between one another equipment will ensure smooth flow of materials as well as it will reduce total travelled distance throughout the production unit.

According to the study of the CFTRI technique of pulse milling, treatments have been suggested for the preconditioning of pulses before milling to loosen the adhesive bond between the kernel and the husk. This helps to completely loosening of husk without the help of oil application by successive heating and cooling of pulses. The pulses grains subjected to heated air about 120°C–160°C for a specific duration of time. When grain temperature reached between (65°C – 75°C), the grains were cooled by forcing ambient air through the grains. The successive heating and cooling of pulses grains leads to be most effective in breaking the adhesive bond between the husk and the cotyledons. Dehusking Roller machine dehusked more than 95 percent in single pass.

The preconditioning of pulse before dehusking of pulse increases efficiency to 80% which is more than existing plant layout. This involved 10 processes such as Cleaning, Preconditioning, Dehusking, Grading, Conditioning, Splitting, Separation, Sizing, Polishing and Packaging without using of excessive space.

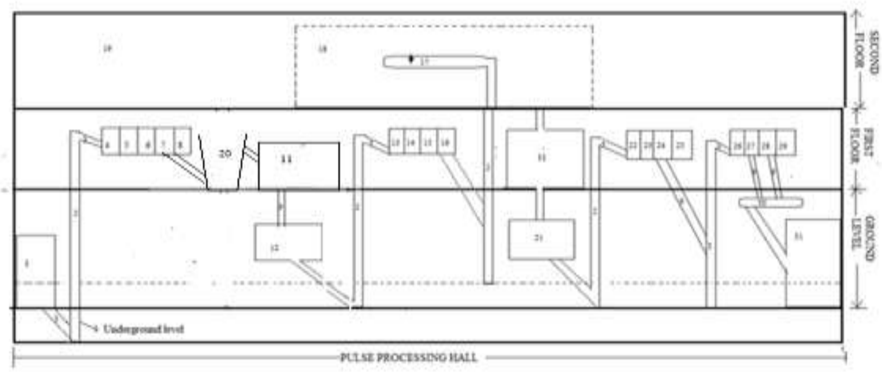

Figure 6: Alternative Design I

Design I have following advantages:

- It will increase production.
- It will improve methodology.
- It will reduce waste.
- It will reduce scrap.
- It will produce a better product.
- It will improve the quality of Pulses.
- Efficient utilization of available floor space.
- Volume and product flexibility.

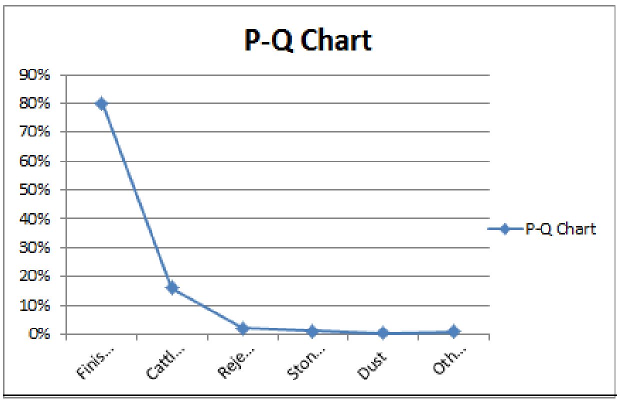

Figure 7: Modify P-Q chart

After analysing the existing layout, the Modify P-Q chart shows that the production of 150 tons of pulse varies to 160 tons of pulse in the input of 200 tons of raw pulse per month for the modified layout. Remaining 32 tons of cattle feed, 4 tons of reject pulse and remaining 4 tons of contaminated matters which include dust particle, stone or aggregate etc. It is observe that if the grains are soaking for 2 hours followed by 1 hour sun drying gave the best milling results. Implementation of newly developed layout can gives about 80% efficiency which is about 5% more than existing plant layout. It is due to the reduction of the distance between two stone rollers to single stone roller and by using the CFTRI techniques for completely loosening of husk.it provides smooth and efficient flow of material throughout the cycle. Therefore rearranging the layout improves material flow, reduced travelled distance and increase in production of finished pulses.

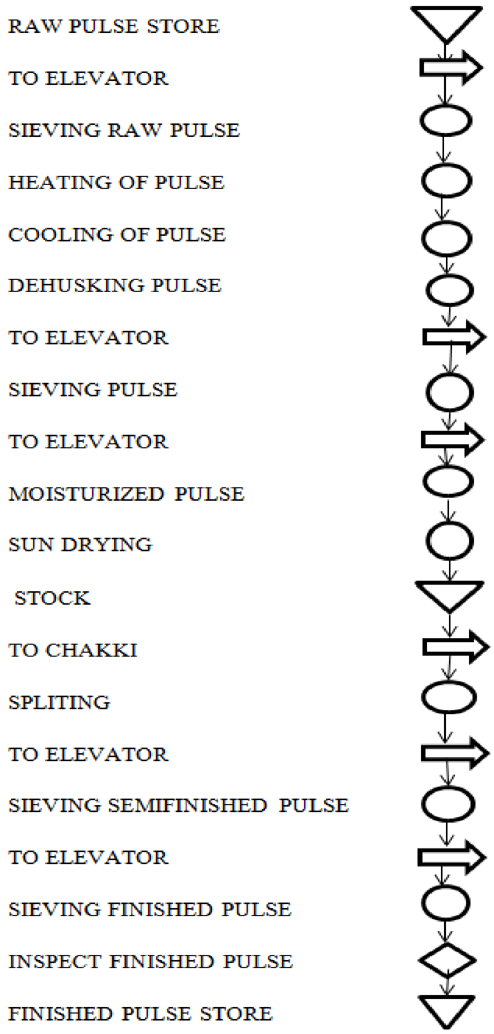

Figure 8: Modify Flow of material

After analyzing the improved layout, the Modify flow of material shows that the improved effective sequence of the activities as comparison to Figure 3 as we discussed before. It also represents overall process of pulse production by increasing productivity from 75% to 80%.

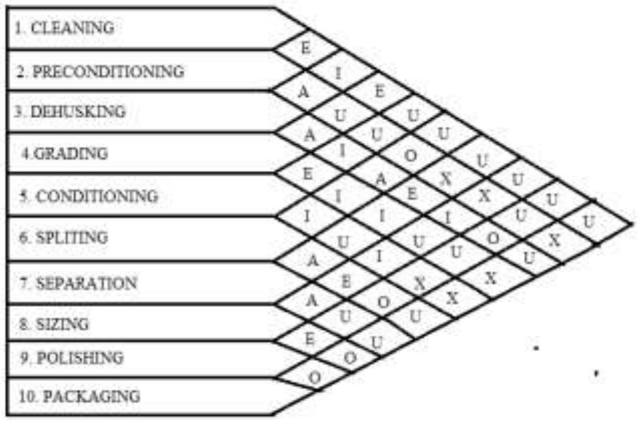

Figure 9: Modify Activity Relationship chart

After analyzing the improved layout, the Modify Activity Relationship chart includes 10 steps. These are Cleaning, Preconditioning, Dehusking, Grading, Conditioning, Splitting, Separation, Sizing, Polishing and Packaging. We can also analysis that "E" represents that the cleaning and preconditioning processes are especially important to each other. Similarly "U" represents the cleaning and packaging processes are unimportant to each other. In the same way each vowel represents the relative importance with each process. Thus the new process "Preconditioning" is an especially important process in the process of pulse milling which is not only increase the dehusking efficiency but also increase the milling efficiency.

Equipment / Process	Godown 10X25	Elevators 25X2	34X2	Sieves 15X7	12X7	Stone Roll 4.5X2	Stock tank 15X15	Pipes 10X1	12X1	8X1	Vacuum machine with tape 7X1	Attrition mill or chakki 3X3	Total space required in square feet
Cleaning	1	1		1				1					908
Preconditioning							1						225
Dehusking						1		2		1			20
Grading		1		1				2					161
Conditioning			1				1	1			1		303
Splitting							1	1		1		1	251
Separation		1			1			2					140
Sizing		1			1			1	1				149
Polishing									2		1		31
Packaging	1								1				762
Dryer							1						225
TOTAL	2	4	1	2	2	1	4	10	4	2	2	1	3175

Table 2: Modify Space Requirements

After analyzing the improved layout, the Modify Space Requirements consider the total space requirements of each processing area in relation with the equipment. Here the total space required by the modify plant layout is 3175ft^2 which is less than 74ft^2 of existing plant layout.

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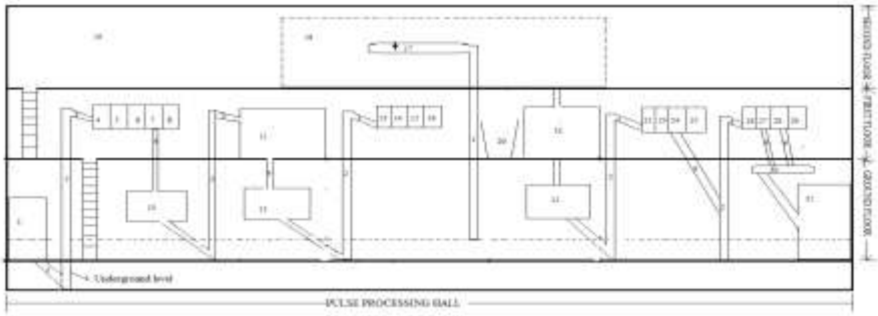

Figure 10: Alternative Design II

The advantages of Alternative Design II are as follow:

It will easy to handle: For new layouts, Machinery and equipment are arranged as that the workers reach at any floor without taking more time as in existing plant layout. So, it is easy to handle the machinery without wasting time. It also reduces the effort of the worker to handle the machinery and product. It also helps to eliminating congestions.

It will easy to reach in any floor: When new layout is planned, it helps to improve proper utilization of floor space. The equipment is well established as close as the point where it is to be used.

It will increase floor space: It enables to increase floor space by utilizing existing staircase space. As we observe in improved alternative design, there is easily reaches at any floor by using direct staircase to each floor which obviously helps to increase floor space.

It will require less number of workers: In improved layout, the processing of pulse milling does not need large number of workers. It will be reduced to 6 from 8. So that it will reduce labour cost and hence increases labour productivity.

It will improve other working conditions: It improves working condition of workers. In this alternative design, they have to cover short distance as before in existing layout. It will provide better employee services and facilities.

It enables to utilise labour efficiently: It helps to utilize labour efficiency by increasing output per man-hour. It also reduces overall time of processing of raw pulse to finished pulse.

It is easy in supervision and control: It helps in easily control of supervisor by taking whole views from ground floor. It removes the burden of supervisor in large extent. It helps to eliminate various unnecessary movements by easy supervising and controlling.

After proper analysing of layout design II, it is found that layout design II results in terms of reduce total travel distance, total travel time, travelling cost and utilization of floor space in the system. This will enable ease in work of workers and supervisor. This layout provides some ergonomics advantages over existing plant layout.

V. CONCLUSION

On the basis of two alternative designs, we find the layout design I have more advantages and it can successful implementation over existing plant layout. As layout design II requires more cost and gives lower productivity than layout design I.

The following are the list of advantages to select the layout design I:

- From existing and improved plant layout, it is observe that preconditioning of pulse helps to increase in dehusking efficiency to 97-99% from 80-85%. This will help to provide higher milling efficiency.
- From existing and improved P-Q chart, it is observe that there is increase in milling efficiency from 75% to 80%. The amount of finished pulse or split dal obtained will be 80%.
- From existing and improved flow of material chart, it is observe the altering the positions of equipment will ensure improved sequence of material flow such as reduces the pulse passes twice through stone roller to single pass.
- From existing and improved Space Requirements chart, it is observe the total area is reduced to $74ft^2$. In the present layout, the total area available to the layout is $3249ft^2$ while

in the case of modified layout; the area covered by the layout is 3175ft^2.

Therefore in the optimized layout, the total area reduced in the processing of pulse by reducing the distance between two stone rollers to single stone roller is74ft^2. By the application of SLP, the design of an optimized plant layout will able to increase the productivity by reducing wastes due to broken or excessive powdering of pulses. Therefore increase the productivity of the plant from 75% to 80%.

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