FACILITY LAYOUT REDESIGN IN A FMCG COMPANY: A CASE STUDY

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Abstract: *Layout design often has a significant impact on the performance of a manufacturing or service industry system and is usually a multiple-objective problem. As the business is getting more dynamic and competitive, new products are launched every few months. New manufacturing facilities are being appended. The manufacturing technology is improving. The layout that is best suited for today will lose its competitive edge in some time. The layout needs to be tweaked in order to satisfy the new demands and constraints. Neither an algorithmic nor a procedural layout design methodology is usually effective in solving such a practical layout redesign problem. The case study presented in this paper was conducted in a FMCG company in India at one of its detergent manufacturing facility. The bottleneck in the system was packing. The objective of the project was to deliver maximum volume without any threat of safety incident. The second objective was to reduce the wastes in terms of changeovers.*

Keyword(s): Facility Redesign; Case Study; Simulation; Linear programming

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1. Introduction

In this dynamic business world, organisations must continually re-evaluate their existing facilities to ensure that they are consistent with both the environment's demands and the management's strategic requirements. The goals of a Plant layout design are to minimize unit costs, optimize quality, promote effective use of people, equipment, space and energy, provide for employee convenience, safety and comfort, control project costs, and achieve production deadline. The placement of the facilities in the plant area, often referred to as ''facility layout problem'', is known to have a significant impact upon manufacturing costs, work in process, lead times and productivity. A good placement of facilities contributes to the overall efficiency of operations and can reduce until 50% the total operating expenses (Tompkins et al, 2008) Simulation studies are often used to measure the benefits and performance of given layouts (Aleisa, 2009). Since layout problems are known to be complex and are generally NP-Hard a lot of research has been carried out in this field.

The case study presented in this paper was conducted at one of the FMCG companies in India at one of its detergent manufacturing facility. In order to cater to the increasing size of detergent market in India, the company decided to expand existing manufacturing facility in one of its plant. The objective of this project was to integrate the newly constructed facility with the existing one and take benefit of the synergies between both of them.

2. Literature review

Systematic Layout Planning (SLP) represents the category (Muther, 1973) of approaches based on graphical representation in order to offer comprehensible procedures, options to add multi dimensional factors and not having accurately defined elements. However, this approach focuses on a functional way of thinking. In order to "get away from the functional mindset and meet today's rapidly changing strategic operations needs", the Strategic Facility Planning (SFP) was built on the earlier approach of SLP (Wrennall & Lee, 1994). The facility layout problem concerns the spatial and non-overlapping arrangement of numerous interrelated activities to achieve some objectives. There are numerous modelling techniques applied to solve the problem of facility planning. Some of them are Graph Theory, CRAFT, Optimum Sequence, BLOCPLAN and Genetic Algorithm.

However there is no single and user-friendly OR methodology that can ensure provably optimal solution and good run times and incorporate the strategic mindset.

3. Case Study

3.1 Background

We now discuss the case study implemented in one of the FMCG companies in India at its detergent manufacturing plant. To meet the increasing demand of detergents in India, the company is expanding its production capacity by 50%. With the constraints in terms of infrastructure in production unit and packing; it will be very difficult to run the plant to its full capacity after the expansion. With the new infrastructure being built, the potential for a safety incident will also be increased considerably. The need was come up with a strategy to run the plant efficiently to deliver maximum volume without any safety risk at minimum possible cost.

3.2 Plant overview

The plant makes two variant of detergent. For the purpose of anonymity let us call them as D1 and D2. D2 is the costlier variant and D1 is a value product. The plant building is divided into three parts. Second floor and the building above are called as making tower; the first floor is known as buggy floor and ground floor has the packing hall. The material in the plant moves from the production tower i.e. making to the packing hall via buggy floor. A buggy is a huge container on wheels carrying the output of the making tower. These buggies are then fed on to the packing lines which yield the final finished products. Presently the plant is producing 15 MMSU (1 MMSU = 1 Million Stat Unit, 1 Stat Unit = 12 kg) from its production tower B. A new facility, CIP5 with a capacity of 7 MMSU is to be connected to the existing facility at the buggy floor. CIP5 has better technology hence incurs a lower production cost per unit. The packing hall has six different packing technologies each capable of packing different SKUs. Let the different packing technologies be p1, p2, p3, p4, p5 & p6.

Buggy floor is the current bottleneck in the entire supply chain. The movement of buggies is slow and there is a potential of safety incident every time two buggies cross each other.

The present project aimed at delivering the capacity of both the towers without any safety risk.

3.3 Constraints

3.3.1 Making

a) Changing from one brand of detergent to another brand incurs a changeover time of 60 minutes.

b) Preferring CIP5 over Tower B gives a saving in total cost. The saving is due to the difference in technology used in either tower for manufacturing.

3.3.2 Packing

a) Sachets can be packed only from output of Tower B
b) Different packing lines have different throughput
c) Changing from one SKU to another SKU on the packing lines take 30 minutes

3.3.3 Buggy floor

a) Safety constraints in terms of buggy crossovers while managing supplies from two towers
b) Long distance travel of buggy to feed end lines from two towers

3.4 Different production scenarios

As there are only two brands of detergent to be manufactured in two production towers there can only be four possible scenarios:

Table 1: Different Production Scenario

Scenario	Tower B	CIP5
1	D1	D2
2	D1	D1
3	D2	D1
4	D2	D2

For each of these scenarios, a linear problem was formulated to find if the desired output volume can be achieved with present layout and constraints of the packing hall and buggy floor. After the capacity analysis a simulation model of the buggy floor was made in order to understand the buggy traffic. The simulation was done using software called Plant Simulation (made by Siemens PLC).

Here we illustrate scenario 1 in details and share the result of rest of the scenarios.

3.4.1 Scenario 1

This is the scenario where Tower B makes D1 and CIP5 makes D2. The first step was to perform capacity analysis. In order to find out which packing lines will be served with which tower and will pack which SKU; a linear minimization problem was formulated. Below is the mathematical representation of the problem:

i represents packing lines

j represents a SKU

U_i *= Utilization of each packing lines*

D_{1j} *= demand for j sized SKU of detergent D1*

D_{2j} *= demand for j sized SKU of detergent D2*

T_{Bij}*= Time for which output from Tower B runs on "i" packing line making "j" SKU*

T_{CIP5ij}*= Time for which output from CIP5 runs on "i" packing line making "j" SKU*

S_{ij}*= Throughput of packing line "i" when packing SKU of size "j"*

C_B *= Maximum production capacity of tower B*

C_{CIP5} *= Maximum production capacity of CIP5*

Objective function

$$\max z = \sum_i \sum_j \left(u_i * T_{Bij} * S_{ij} + u_i * T_{CIP5ij} * S_{ij}\right)$$

Such that

$$\sum_i u_i * T_{Bij} * S_{ij} \geq D_{1j} \;\; for\ all\ j$$

$$\sum_i u_i * T_{CIP5ij} * S_{ij} \geq D_{2j} \;\; for\ all\ j$$

$$\sum_j T_{Bij} + T_{CIP5ij} \leq 1 \;\; for\ all\ i$$

$$\sum_i u_i * T_{Bij} * S_{ij} \geq C_B \;\; for\ all\ j$$

$$\sum_i u_i * T_{CIP5ij} * S_{ij} \geq C_{CIP5} \;\; for\ all\ j$$

$$T_{CIP5ij} = 0\ for\ all\ i\ where\ j = 13\ or\ j = 20$$

Solving the above maximization problem we find the capacity can be satisfied given that CIP5 supplies to two HR packing lines in front of Tower B and Tower B supplies to 1 A line in front of CIP5. A simulation model was created in order to test the number of buggy crossovers in this condition. We got the following result:

Table 2: Results for Scenario 1

	Traffic	Volume
No relocation	35% higher traffic than safety requirements	15 MMSU volume can be packed safely
Moving 1 p2 to the new hall	20% higher traffic than	18MMSU volume can be

	safety requirement	packed safely
Moving 2 p2 to the new hall and bringing 1 p1 to the old hall	3% lesser traffic compared to base scenario	22 MMSU Volume can be delivered safely

Hence in order to run this scenario in the plant safely, relocation of packing line is mandatory. Also based on cost savings as mentioned earlier, this is the most desirable production scenario.

3.4.2 Scenario 2

This is the scenario where Tower B and CIP5 both make D1. After performing the capacity analysis and running the simulation model the following result were found:

Table 3: Results for scenario 2

	Traffic	Volume
No relocation	35% lower traffic than safety requirements	22 MMSU volume can be packed safely
Moving 2 p2 to the new hall and bringing 1 p1 to the old hall	15% lower traffic compared to base scenario	22 MMSU Volume can be delivered safely

3.4.3 Scenario 3

This is the scenario where Tower B makes D2 and CIP5 makes D1. After performing the capacity analysis and running the simulation model the following result were found:

Table 4: Results for scenario 3

	Traffic	Volume
No relocation	60% lower traffic than safety requirements	22 MMSU volume can be packed safely
Moving 2 p2 to the new hall and bringing 1 p1 to the old hall	50% lower traffic compared to base scenario	22 MMSU Volume can be delivered safely

3.4.4 Scenario 4

This is the scenario where Tower B and CIP5 both make D2. In this case the capacity analysis showed that only 70% of the total volume produced could be packed and hence running this production scenario in the plant was not recommended.

3.5 Results

With the results of the study, it was recommended to produce D2 in CIP5. D1 will be produced only in Tower B and if required CIP5 will take the spill over of D1 from Tower B. Also it was recommended to send Sachet lines to the contract site and bring another p1 line in their place. It is because was cheaper to outsource sachet lines than to manufacture them in house as their utilization was very low.

Below are the pros and cons of both the options:

Table 5: Comparing production of D2 in either tower

D2 in Tower B	D2 in CIP5
1. No safety hazard	1. No safety hazard
2. No formula savings	2. Formula savings of approx INR 1.8 crore annually
3. Making PR loss due to change over = 1.2 %	3. Making PR loss due to change over = 0.5 %
4. No layout changes required	4. Shifting of 2 p2 and 1 p1 lines required(approx INR 70 L)

The recommendations were implemented in the plant and the plant has now become an internal benchmark internationally for PR loss due to change over and one of their internal parameters known as days before next run.

4. Conclusion

In this case study we illustrate how little tweaking of facility layout can result in huge savings and can provide a competitive edge to any company. Layout redesign should be given a strategic importance and should be constantly monitored especially when technology is evolving rapidly and product life cycle has become short.

5. References

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