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Improving the Facility Layout Design in Aqua Dire Purified Mineral Water Factory: A Case Study

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Abstract - *Facility layout design determines how to arrange, locate and distribute the machines, departments , equipment and support services in a manufacturing facility to achieve minimization of overall production time, maximization of operational and arrangement flexibility, maximization of turnover of work-in-process and maximization of factory output in conformance with production schedules. It is essential to have a well developed plant layout for all the available resources in an optimum manner and get the maximum out of the capacity of the facilities. The work in the present paper is based on study conducted in an Aqua Dire Purified Mineral Water Factory located at Dire Dawa, Ethiopia, which manufactures water bottles and soft drinks. In existing plant layout the arrangement of materials and space utilization are not properly used due to improper of facility layouts. The scope of the work is on four sections commonly known as section 1(Raw Materials), section 2 (Blow molding), section 3(Injection molding) and section 4 (Raw Materials) of the company. This research aims to improve the facility layout design in an Aqua Dire purified mineral water and soft drink factory to eliminate obstruction in material arrangement and thus obtain maximum productivity. The newly proposed facility layout enhance productivity of the company in terms of reducing material searching time, providing well arrangements of facility and good working environment.*

Key Words: **Facilities layout design, Plant layout, Production, Plant layout planning,**

1. INTRODUCTION

Facility layout is an important problem for modern manufacturing systems and it plays a key role for the manufacturing system design process. Lean facility layout means to arrange the physical equipments within a workshop to help the facility work in a productive way. Traditionally, there are two approaches for the facility layout problem. The first one is the quantitative approach aiming at minimizing the total material handling cost between departments based on a distance function. The second one is the qualitative approach aiming at maximizing closeness rating scores between departments based on a closeness function. The most important example for this approach can be systematic layout planning-SLP procedure, suggested by Muther (Muther, 1988). In recent years, with the improvement of the computer performance and the development of the digital analysis methods, computer-aided system layout planning (CASLP) method appears based on applying computer and its related technologies to SLP method. The changes of production planning, technological process, production organizational mode and material handling will all affect the facility distribution scheme of a production line the approaches stated above were used separately to solve the facility layout problem. However both approaches have advantages and disadvantages. In order to do a lean layout design, we need to solve the problem by using a new method. A good facility layout is cost low, minimize material searching time, help to proper utilization of space and reduces unnecessary material handling. Improving the facility layout also increases the machine utilization that enhances the machining capacity of the shop floor. The research content of this paper is a part of the facility layout design .This study has assessed about the improvement of facility layout design to enhance productivity.

2. LITERATURE REVIEW

Many researchers have been done in facility planning area. Effective facility planning can reduce significantly the operational costs of a company by 10-30% [1]. Proper analysis of facility layout design could result in the improvement of the performance of production line. This can be realised by optimising the capacity of a bottleneck; minimising material handling costs; reducing idle time; maximising the utilization of labour, equipment and space [1]. Facility planning is an overall approach concerned with the design, layout and incorporation of people, machines and activities of a system [2]. Huang [3] emphasises that facility layout design defines how to organise, locate, and distribute the equipment and support activities in a manufacturing facility to accomplish minimization of overall production time, maximization of operational efficiency, growth of revenue and maximization of factory output in conformance with production and strategic goals.

In as much facility redesign and implementation may be considered imperative; however relocating equipment can be an expensive and time-consuming endeavour. In addition, determining whether a potential new layout or staffing scenario would perform better than the current configuration is difficult to determine until the new setup is

complete. If the new layout fails to produce the anticipated positive results, then a lot of time and money would have been wasted. Therefore, ability to test the proposed layout before relocating equipment or even purchasing new equipment is desirable. Simulation models provide an alternative of evaluating the proposed layouts so as to obtain the near-optimal solution. Simulation software has the capability to determine factory conditions which include the determination of plant capacity, balancing manufacturing and assembly lines, managing bottlenecks and solving inventory and work-in-process problems [4] [5]. Simulation also enables the ability to model "what-if" scenarios to test changes in labour levels. In this research Simio® simulation modelling software is used to identify and optimise the bottleneck and perform line balancing by comparing different scenarios and selecting the near-optimal solution.

3. BACKGROUND OF THE COMPANY

Aqua Dire Purified mineral water plant, which is located Dire Dawa, Ethiopia and was started operation in 2006 E.C. It is the leading company in the production of drink water bottling in Ethiopia. The company has 0.5 liter 1 liter 2litre and 20 liters bottling plants and also it bottle soft drinks like apple drink called rancher and future cola. The factory has water reservoir that can hold above 96000 liters of raw water. The water treatment have digital automatic control machine that have sand filter, active filter, water softeners, cartridge filters and first reverse osmosis and second reverse osmosis ,PH adjustment, Ozone sterilization machine and UV-sterilization device .The intensive water treatment and bottling operations compromises several processes and modern machinery. It is the leading plant in Ethiopia in terms of its new technology and complex operations. In addition the company has two injection machines used to manufacture perform bottle and cap of 20 liters and also has Dire Plastic Factory.

3.1. Statement of the problems

The overall performance of an industrial firm is significantly affected by the design of its manufacturing facility. A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work center, a manufacturing cell, a machine shop, a department, a warehouse, etc. A facility layout is an arrangement of everything needed for production of goods or delivery of services. It is obvious that implementing efficient facility layout helps to facilitate or accelerate production, faster material handling, and reducing lead time. In Aqua Dire Purified Mineral Water Factory the manual blowing and injection section, there are so many obstacles that affecting productivity of the company. Because, the factory is currently using poor facility layout and material arrangement system. Due to this the company frequently facing problems mention below:

- Take Long time for material searching
- Improper utilization of space
- High lead time
- Unseparated working area like products and raw materials are storing in production section
- Low productivity.

3.2. Scope of the Study

The scope of this work focuses only on the two sections commonly known as blow molding, injection molding section of the company for proper space utilization and material arrangement; In addition, the study will have much importance on workers by making the working area simple and uncomplicated, safe and protected, and enjoyable while making good working environment. This study also focuses on improving the material arrangement in the blow molding and injection molding section of the company. The study helps the Aqua Dire Purified Mineral Water Factory to have high production by implementation facility layout of the blow molding and injection molding section and proper utilization of space.

3.3. Methodology

The methodologies used in this study to identify the problems encountered in the different sections of the company are as data collection, observation of existing facility layout, drawings of existing facility layout. 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. The problem of the plant was determined and analyzed through SLP method to plan the relationship between the equipment's and the area. Based on the data such as product, quantity, route, support, time and relationships between material flow from –to chart and activity relation chart are displayed. From the material flow and relationship activity in production, the relation between each operation unit can be observed.

4. EXISTING DESIGN OF FACILITY LAYOUT

The figure 1 shows the overview of the four different sections together which are in the scope of the project. From the layout it is understood that each section is utilized for different purposes in which two sections for raw material storage and other two sections for injection molding and blow molding processes. Within raw materials store (section 1) there are different type's raw materials, finished product, waste product and old machines. But they are arranged in fussy and mixed each other. Therefore the figure 2 and 3 shows the existing arrangement of material in section 1. Within blow molding section (section2) the same to section1 there are work in progress product, waste, finished product, and three automatic blow molding, seven air compressor and four heat compressor machineries have in this section 2. and facility arrangement of section 3 and 4 as shown in figure 4 . In this section production also take place, 20 liter bottle and 500ml bottles are produced. In case of this the section in very crowded and even difficult for workers movement. The figure 5 blow indicates the existing layout of the section 2. Within injection molding section 3 workstation there are four injections, one air compressor, one scrap mill

machine, and the same to the above in this section have waste, old machine, and operations take place. The operation carried out here is the bottle handle, bottle cup, and the rag (scrap) is rework. Fig 6. shows the current layout section 3.Within raw material store section 4 relatively store only store different types raw materials even though they are a problems in this section arrangement. Store different type raw materials by mixing each other. Therefore the figure 7 blow shows the existing arrangement of material in section 4

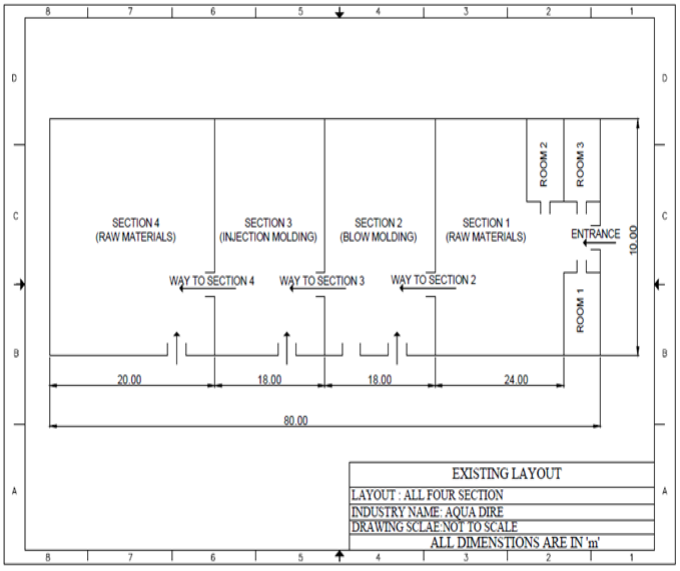

Fig.1 Overview of the existing layout of the company

Fig. 2. Facility Arrangement of Section 1and 2

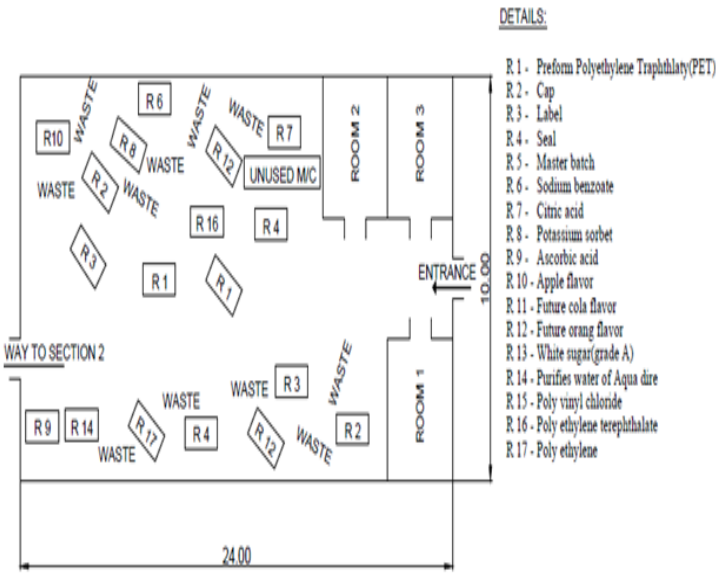

Fig.3. Existing Layout of Section 1

Fig.4. Facility Arrangement of Section 3and 4

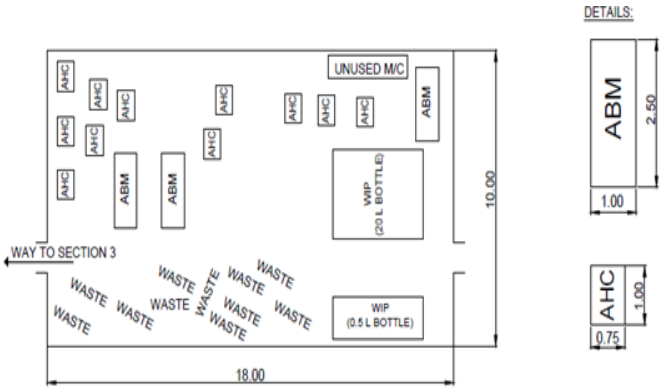

Fig 5. Existing Layout of Section 2

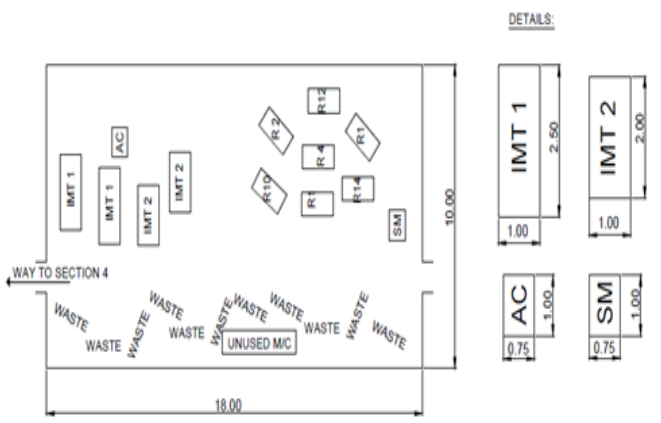

Fig.6. Existing Layout of Section 3

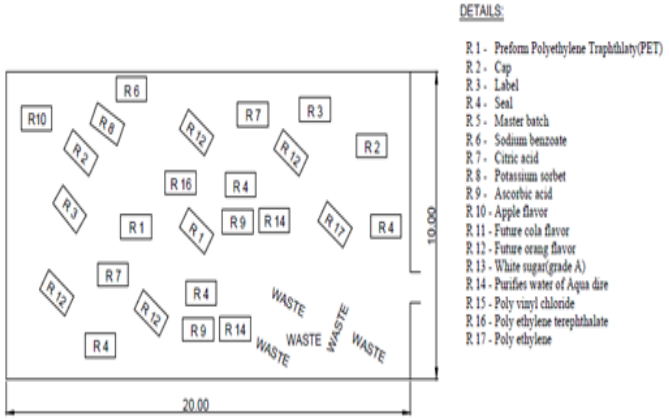

Fig.7. Existing Layout of Section 4

4.1 Proposed Facility Layout Design

The proposed new facility layout by rearranging and by separating facilities like raw materials, finished products, waste and production area in a way that allow effective use of available floor area, minimization of production cycle time, avoiding of long searching time, better supervision, improved labor utilization, improve employee morale and increase production capacity. The newly proposed facility layout, considering improved floor space utilization, and eliminated bottle necked area. The figure shown blows are newly proposed facility layout in the section of the company.

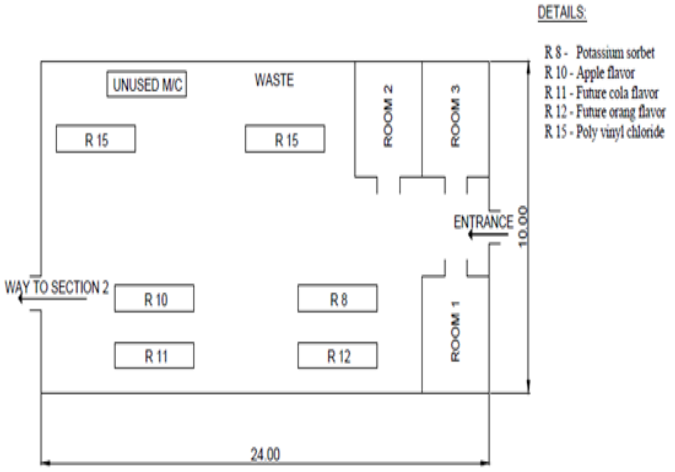

Fig. 8. Proposed Layout of Section 1

The proposed layout minimizes the problems, because the layout of this section 1(Fig.8) is designed in the form of kaizen and also contains specific types of material at separated position. Blow molding section is different size bottle production section and contains more machineries relatively than other section, non-value added products(unused machine and waste products).in this section has enough spaces for the arrangement of those machineries. But air and heat compressor machineries are installed fussily. Therefore newly proposed layout prepare by rearranging those machines and avoiding non value added products from working area. The figure 9shows that the proposed layout

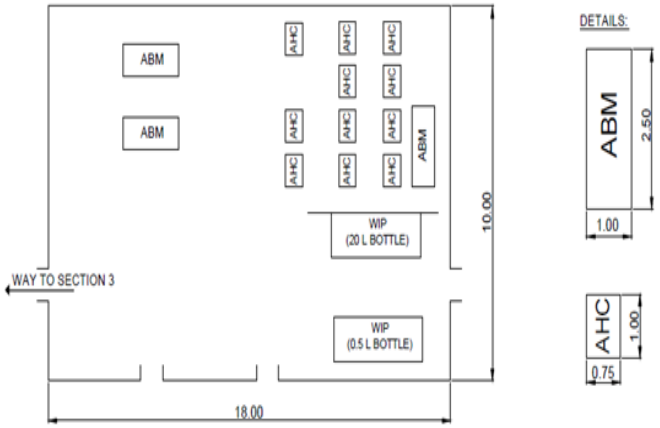

Fig.9. Proposed Layout of Section 2

includes only functional machineries and work in progress products. Different size bottle cups, bottle handler, scrap recycling make in injection sections 3(Fig.10) in this section only have six functional machineries. But wider spaces are occupied in waste products and raw materials. Based on this the proposed layout of section 3 is includes only six

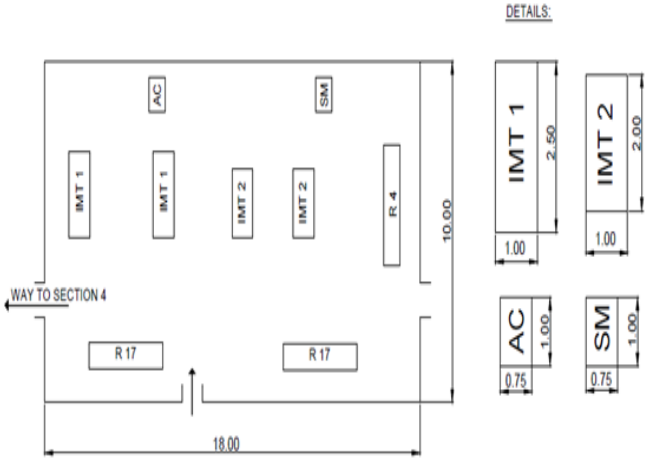

Fig.10. Proposed Layout of Section 3

machines and two types of raw materials. Section 4 is relatively the largest section of the other, free from non-value added products and company use the section for raw materials storing only. The proposed layout of this section is rearranging the raw materials used for water production process. Because water production process uses many types of raw materials. Figure 11 shown blow proposed layout block of section four.

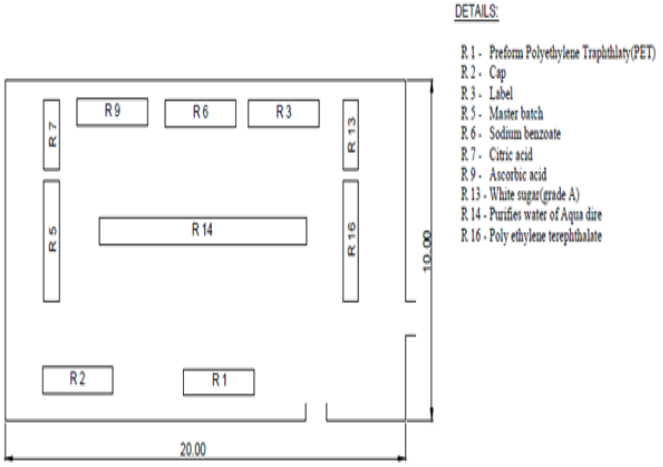

Fig.11. Proposed Layout of Section 4

5. CONCLUSIONS

This case study has assessed about the improvement of facility layout and to enhance productivity, a case study on Aqua Dire Purified Mineral Water Factory which its specific focus area is blowing and injection section (section1 to section 4). The problem of existing layout is large comparative distance between several departments that's forced to travel long distance and impedes the smooth material flow and leads to higher cost. So, this proposed model will mostly be preferable while setting up a new plant. The proposed facility layout improves the reduced the material searching time, proper utilization of space, reduces the unnecessary material handling, reduce the lead time .Therefore rearranging the layout improves material flow, reduced travelled distance and cost resulting in an increase in production.

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REFERENCES

[1] Dwijayanti K, Aoyama H. 2010. A Proposed Study on Facility Planning and Design in Manufacturing Process. III

[2] Garcia, A.D., Smith, McG. 2008. Facility Planning and Design. Pearson International Edition. Prentice Hall.

[3] Huang, H. 2003. Facility layout using layout modules, Ph.D. Thesis, The Ohio State University.

[4] Baraka, J., 2012. Discrete event simulation modeling to improve productivity on an automotive production line. CIE 42 Conference Proceedings, 15-18 July 2012, Cape Town, South Africa pp 16-18

[5] Dewa, M., 2012. Bottleneck management through discrete event simulation for manual automobile assembly systems. CIE 42 Conference Proceedings, 15-18 July 2012, Cape Town, South Africa

[6] Dwijayanti K, Aoyama H. 2010. A Proposed Study on Facility Planning and Design in Manufacturing Process. III

[7] TE-KING CHIEN, (2004), "An empirical study of facility layout using a modified SLP procedure", Journal of Manufacturing Technology Management, Vol. 15 Issue: 6 pp. 455 – 465

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