



ENERGY CONSIDERATION IN PHARMACEUTICAL FACTORY LAYOUT

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ABSTRACT

This paper focuses on energy consumption in a pharmaceutical industry. The efficient energy consumption depends on energy layout planning. Materials handling consideration may save the energy. The wastage of energy resources leads to wastage of money. The proposed new layout has been designed for the company X for energy efficiency. The energy efficiency calculation is based on total weekly energy usage in the company X. After the research, the work flow analysis can be planned for ease material handling. The saving of the energy consumption leads in saving 20% of electricity bills. In the other way, it save money and environment friendly because energy consumption used is less.

Keywords: energy consumption, energy layout, energy efficiency.

INTRODUCTION

The increasing numbers of Small and Medium sized companies also contributed to the economy vibrancy in Malaysia. The Small and Medium sized company or known as SME company compete with each other in order to secure in current economic scenario in Malaysia. The increasing numbers of companies led to the increase in the energy usage especially the electricity.

According to the statistics reported in the Report of The National Energy Balance (2008), Malaysia recorded a higher primary energy use at 6.1% per annum between year 2000 and 2008 and this approaching the average annual increase of 6% in Gross Domestic Product (GDP) for the same period. The increase of population and the numbers of company closely associated with the increase of energy demand.

The consumption of energy becomes more widespread proportional to the increase in the commercial sector especially in manufacturing sectors. The world nowadays tries to establish a new way of manufacturing systems that lead to an efficient usage of energy. Every single manufacturing phase that related to the energy consumption should be monitored to ensure the energy efficiency from every aspect. This related to every single phase including the modeling phase, planning phase and production phase of the manufacturing sector that need to be ensure that they are energy-efficient.

In manufacturing sector, layout planning can be described as the most important planning that determine the efficiency of the production as well as the flow of materials and finished goods in the production line. Most of the manufacturing sectors put a high attention to the layout planning where they consider that the efficient layout planning will save more cost in materials flow or handling where it was stated that 10–30% of material handling cost can be reduced by having an effective facilities layout [1]. Apart from that, they also consider that the good layout planning will increase the production efficiency of goods. The layout planning has been a vital research area for many decades but most of them overlooked the factors of energy in the layout planning.

The awareness about the wastage of energy resources related to the layout planning still not considered to be important among the manufacturer.

The objective of this paper is to relate the consumption of energy (focus in electricity) with the layout of the production area and also compare the new better proposed layout with the current layout in term of energy saving and material process flow.

LITERATURE REVIEW

Types of layout planning

As mentioned earlier, layout planning is one of the most important aspects in the production where everything needed for producing and deliver the goods are located near to each other and flow smoothly from one process to another. Material flow planning and layout planning can be considered as inseparable in major planning phase. Usually in every two or three years, the established manufacturing companies need to change the layout of their several departments [2].

The layout designer usually face the problem in designing the new layout not only when they create a new system of manufacturing but the problems also faced when they expand, consolidate or modify the existing system. Singh and Sharma [3] analyzed the recent trends of layout planning that focusing into the changes made in one single factor that is Material Handling Cost and this shows the emerging trend of multi-attribute design approach. In layout design, there are so many factors that influenced it. Kettner and Schmidt [4] have divided the factors that influence the layout design into three parts as:

- Production Flow: This flow focus more onto material flow, energy flow, person flow and information flow.
- Production Design: This related to organizational influences, resources, production condition and work condition.
- Building Relevant Influencing Factors: This more to the property-determined influencing factors, structural and building usage.



In the layout designs that focus more onto the energy efficiency, there are several factors that need to be considered such as the energy consumption, the installation system and also the substation orientation. Nowadays there are multi-influencing factors that need to be considered in the layout planning process. The recent research has proved that most of the layout designs only focus on the single main factor that is the material flow. Apart from the design layout that focus more on the material flow, the energy efficiency factors also one of the critical factors that author believes will have a bright future in the manufacturing sector as well as preserved the environment and natural resources.

Energy efficiency in industries

Energy efficiency can be described as the comparison between the energy consumption with the value of the output produce by the company. From the manufacturing industry view, the energy efficiency was achieved whenever they can have high value of production output with minimum energy consumption. The energy efficiency have become significantly more important nowadays when most of the manufacturers have open their eyes about the important of energy saving and the preservation of the natural resources. The increasing of the energy tariff nowadays also contributes as one of the crucial factors that lead to the focus on energy saving and thus led to the energy efficiency. In the Quran, there was a verse about prevent wastage in our daily life.

“Indeed, the wasteful are brothers of the devils, and ever has Satan been to his Lord ungrateful.” (17:27)

Most of the manufacturers nowadays have the inaccurate data of energy consumption in their production planning. As mention earlier, the energy consumption also play a main role in order to minimize the cost although usually the cost of the energy for example like electricity bill only considered as the utility cost that is have less focus compared to the cost needed in the production and process. According to Devoldere *et al.* [5], up to 65% of the energy was consumed in non-productive mode. In the production planning and control levels, the awareness about the energy consumption should be highly promoted. This to be sure that the areas that consumed the highest rate of energy can be controlled and supervised so that there will be more initiative for the energy saving. Chiotellis *et al.* [6], has identified missing information regarding energy consumption and potential in introduction energy efficiency into various production planning and control levels. From the findings, Chiotellis [6] have proposed the framework a daily energy awareness control to make sure the energy consumption can be revised daily.

Weirnet [6] has developed the concept of energy block which functioning as the planning system for the energy consumption in the production system. In this concept, they used a time based prediction of the amount

of energy required by each of the machine and this also possible for the whole production system.

Layout planning with energy efficiency

The integration of energy efficiency into planning process is one of the initiatives of approach in realizing the sustainable layout planning. To make sure the sustainable layout planning can be realize, the main concept is to put the energy efficiency as the main objectives in each of the layout planning aspect. For example, the energy efficiency was put as the main priority at each of the high- energy consumption area like the manufacturing or production line, the assembly area and also the main office area.

In making the layout planning, one should put the energy consumption profile as one of the main consideration. This will led to the evaluation of various alternative of layout design that put the energy efficiency as the main factor to be evaluated before the real layout planning will be implemented. During the phase of designing the layout, the layout planner team can do a brainstorming session in order to express as many as ideas that concerning about the energy efficiency. All of the ideas need to evaluate by using the data of energy consumption either by the exact data recorded or by using the approximate data with the limit so that the evaluated data will give minimum or less energy consumption from before.

Production process sequences also need to consider in designing the layout in order to establish a good process layout with minimum consumption of energy. In the production line, each of the workstation may have different rate of energy consumption. The data of the energy consumption at each of the workstation need to evaluate and more ideas needed in order to reduce the rate of energy consumption and at the same time ensure the process flow become more efficient from both aspect of material flow and energy consumption.

Energy oriented layout will give more priority to the energy efficiency compared to the usual production layout that only focus into the material and process flow. In the current production layout, there might be some initiative that can be considered to minimize the consumption of the energy. In production line, most of the processes are running simultaneously and this cause high energy consumption. To minimize the usage of the energy, besides the awareness campaign about the energy saving, the new system that run the production by using minimum consumption of energy need to be establish.

METHODOLOGY OF RESEARCH

The current layout analysis

The research has been conducted at one of the company name as Company “X”. In the research, the current layout of the company was analyzed. The analysis focuses more onto the energy consumption especially the electrical energy. The Figure-1 shows the plan of the current layout at company “X”.



This area includes the Mixing Room, Equipment Room, Inspection and Quality Control (IPQC) Room, Washing Bay, Intermediate Store, Capsule and Polishing Room, Weighing Room, Sampling Room and Secondary Packaging Room. The last area is the Utilities area that consists of Toilet, Buffer Room, Changing Room and Cold Room. The production line area is the main focus for the research.

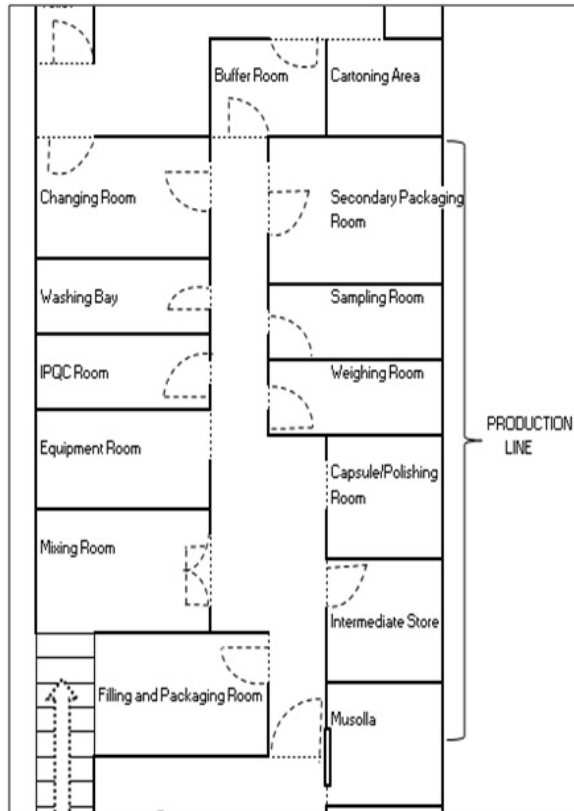


Figure-1. Company "X" production line layout.

The energy (electrical) consumption of the current layout

The list of the electrical appliances and machines used has been recorded and the average time of the usage of each appliance also recorded to know the total consumption either daily or weekly.

From the recorded data, the total kilowatt hour (kWh) used has been analyzed and tabulated in the Figure-2. The workstations that have high energy consumption were highlighted as stated in the Figure-3. From the analysis, the area was divided into three colors according to the energy consumption distribution. The black areas are the area that consumes the highest electricity. Next, the dark grey area that has the intermediate electricity consumption and lastly the light grey areas are the area with lowest electricity consumption. The workstation with high electricity consumption is the Filling Room, Capsule Room and Secondary Packaging Room.

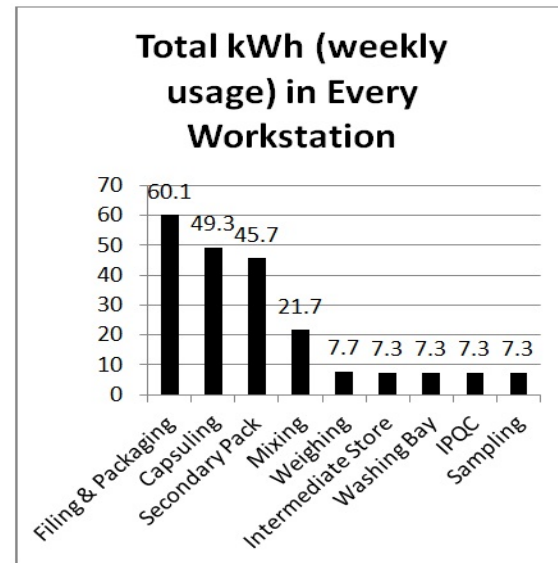


Figure-2. Total kilowatt-hour (weekly) in each workstation.

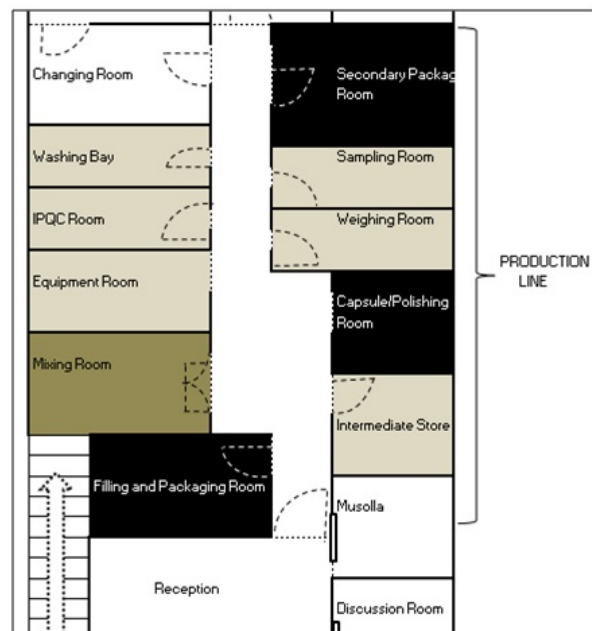


Figure-3. The energy consumption analysis at each workstation.

Proposed new layout

After the analysis of the energy consumption in each of the workstation was done, some of the consideration and initiative have been taken to ensure the layout done satisfy the energy efficiency as well as make the workflow easier. In the current layout, we can see that there are about three work stations that need to be restructured named as Filling and Packaging Room,



Capsule and Polishing Room and lastly the Secondary Packaging Room.

With the priority to enhance the energy efficiency, the initiative done must be more onto minimizing the energy consumption. Nowadays there are many electrical appliances that promote to the green environment. For example the electric bulbs that consume less energy compared to the existing fluorescent light. In the current state layout, the production line use about 4 fluorescent lights at each of the workstation and each of the fluorescent light consumed about 36 Watt for every 60 minutes of usage. By using the Compact Fluorescent Light (CFL), about half amount of energy can be minimized. CFL consumed about 10 to 16 watts that is half or less than half of the consumption of the existing fluorescent lamp. In addition, the CFL can last up to 8,000 hours compared to existing fluorescent light that can only be used up to 1,200 hours. This indicate that the CFL can minimize the cost either in purchasing the bulbs or also in the electric bills.

In the current layout design, we can see that there are some work stations that can be improved. There are two work stations that working on two identical process (packaging process). To make it easier, the primary and secondary packaging processes need to be done in the same workstation. This alternative can save the consumption of the electrical appliance especially the lamp and also the exhaust fan. The figure below shows the example of the proposed layout design with the priority of energy efficiency.

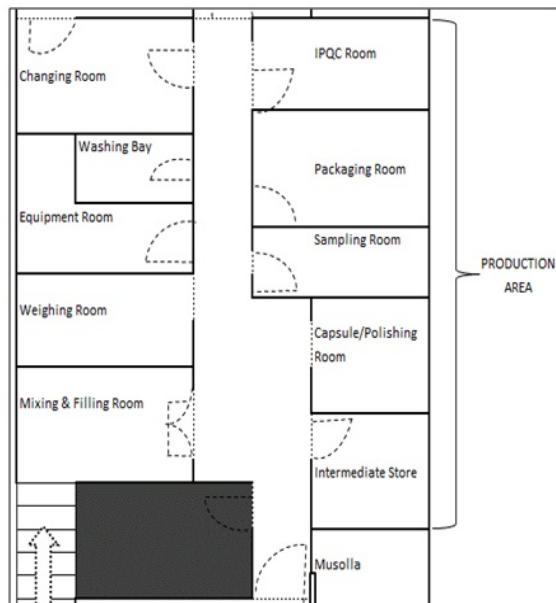


Figure-4. Proposed new layout.

From the new proposed layout (Figure-4), we can see that there was one workstation that can be closed known as the Filling and Packaging workstation before. Apart from that, there are only one workstation that focus

on packaging process either primary or secondary packaging. By using this layout, the processes have been specialized according to its workstation and there are no work stations that do the identical process at different workstation.

This new layout also improved by using the energy saving lamp (Compact Fluorescent Lamp) that have been discussed earlier. Besides that, the number of the lamp used in the new layout is less than before because of the CFL that can emit brighter light and also comfortable for the eyes.

RESULT ANALYSIS

Electricity consumption distribution analysis on proposed layout

In term of the distribution of the electricity consumption, the proposed new layout has less critical areas compared to the current layout. From the current layout, we have identified three critical areas (black area) and one less-critical area (dark grey area). Logically, we cannot eliminate all of this critical area because this black area (high energy-consumption) area consists of the machines that consume high value of wattage. From the new proposed layout, we managed to eliminate two black areas in the current layout. The Figure-5 and Figure-6 below shows the electricity consumption distribution through the new proposed layout for the company.

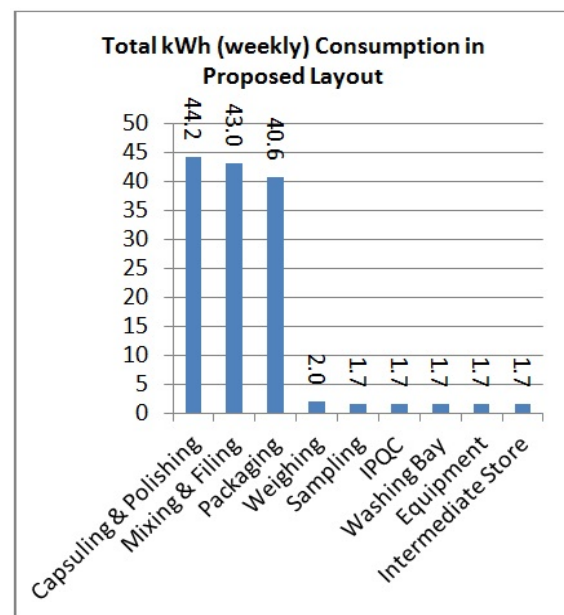


Figure-5. Total kWh (weekly) consumption in proposed layout.

On the proposed layout, we can see that the consumption of the electricity become less. With this new layout, the electricity consumption can be minimized. In the current layout, the total electricity consumption per week on the production area is about 214.01 kWh. By



using this new proposed layout, the total electricity consumption per week drop to 138.18 kWh. This means that by implementing this new layout, Company "X" have reduced the energy consumption about 75.83 kWh per week. This shows that the company has save about 35.4% of the total energy consumption.

In term of bill tariff, in Malaysia, the industrial tariff a little bit different compared to the commercial tariff. For this company, their electrical bills were calculated by using Industrial Tariff D-033. For the first 200 unit kWh, the charge is RM0.33 per kWh and RM0.441 for the next unit after the first 200 kWh. From the current layout, the estimate electric consumption is about 2062 kWh per month and this cost the company around RM887.14 for the monthly electric bill.

By using the proposed layout planning, the estimated total electric consumption was about 1672 kWh per month and this cost around RM715.15 on the monthly electric bill. This shows that by implementing this proposed layout, the company can save up to RM172 (around 20%) monthly on the electric bill. Annually, the total saving of the electric bill can up to RM2064.



Figure-6. The energy consumption analysis at new proposed layout.

Work flow analysis

In the production line, there are two major process of work flow consist of two different main process that are filing for sachet and also capsuling process. The process flows were stated in the Figure-7.

The process flow starts from weighing of the materials to make sure it follows the formulas given for each product. Then, the next step is the mixing process followed by the filing process (for sachet product) and capsuling process (for capsule product). Then, the products will be proceed to the sampling room for the quality check before being sent to the packaging room for the finishing and packaging process. After all the process has been completed, the equipment used for the process will be cleaned at the washing bay and then stored in the equipment room.

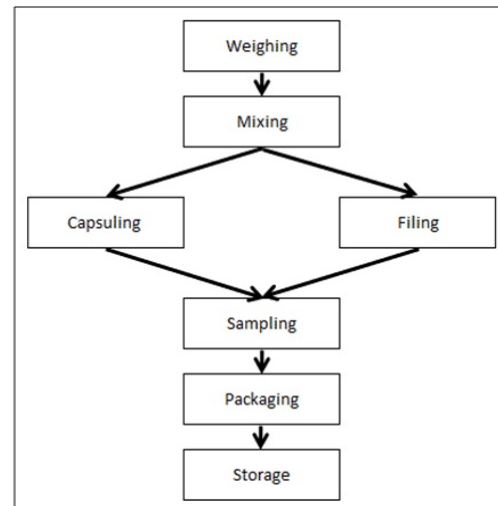


Figure-7. The major process flow at company "X".

By using the proposed layout, the workflow become easier and thus can reduce the wastage in the material transportation. The Figure-8 shows the workflow of the process on the current layout that seems to look unorganized compare to the new proposed layout (Figure-9). In the new proposed layout, the material flows become more organized with the U-shape flow.

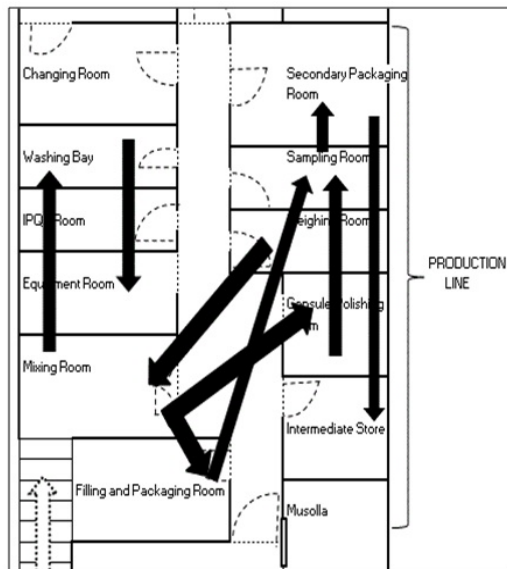


Figure-8. Workflow on the current layout.

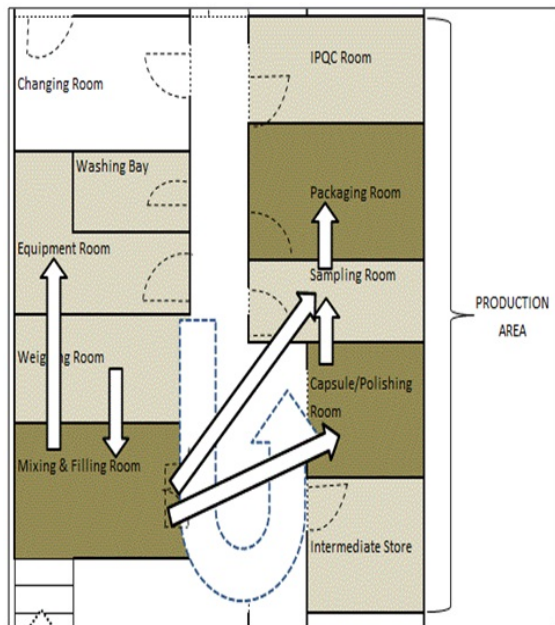


Figure-9. Workflow on the proposed layout.

CONCLUSIONS

In the production, layout can be best described as the main factor that determined the success. Most of the layout does not consider about the energy efficiency throughout all the process. In this research, we can prove that the production layout that based on the energy efficiency (focus on the electricity) as the priority can save around 35% of the energy consumption at the production area and about 20% saving in the monthly electricity bills. This new approach can be used as one of the initiative in

order to preserve the energy and thus led to the green environment.

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