DESIGNING A SUSTAINABLE COMMERCIAL KITCHEN

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Abstract - Designing a sustainable commercial kitchen has been an interesting topic in food service industry, especially in safety, productivity, efficiency, and financial viability. This research is to introduce the space planning, energy efficiency, and investment aspects and process that are necessary to be configured in designing a sustainable commercial kitchen as well as an interactive tool to communicate these elements and process to owner, operator, consultants, and kitchen planner who involve during a commercial kitchen design process.

I. INTRODUCTION

The growth of tourism industry stimulates the growth of hotel industry and food service sector as well as the high competition that enforce all persons who involve in this industry to manage the business sustainably. A commercial kitchen is normally extremely used in a hotel which operates 24/7 so it requires using heavy duty equipment. On the other hand, the investment has to be at the lowest to maximize the profit in the high competition. As the result, commercial kitchen design process creates a long process as compromises have to be achieved from different people involved.

Space in the new development is getting more compact and expensive so the demand to have a compact commercial kitchen is getting higher to deliver high production output in good quality and flexibility. Energy efficiency in a commercial kitchen is very important since it costs 28% to 30% of the total energy cost in the building. On the other hand, energy cost is getting more expensive. Initial investment for commercial kitchen equipment takes 3%-4% out of the total budget in a hotel project. It is critical to provide the elements and process of designing, implementing, and balancing the layout design, energy efficiency, and investment plan in order a commercial kitchen is able to operate safely, productively, efficiently, and financially viable.

II. DESIGN PROCESS AND ELEMENTS

A sustainable commercial kitchen has to have a well-planned layout, productive and efficient equipment, and financially viable to operate. These three criteria have to be configured so the facility can be operated sustainably.

It is important to have a systematic design process and a communicating tool in designing a sustainable commercial kitchen so all parties who are involved can agree on a certain concept or result including its implications during design process. Model of designing a sustainable commercial kitchen design process is as follow:

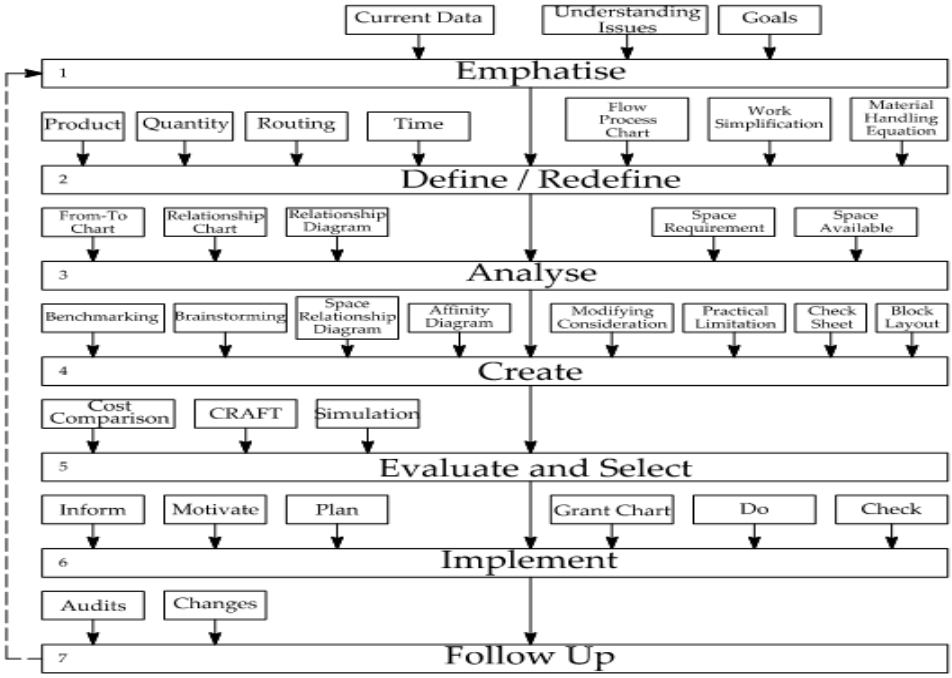


Figure 1 Model of commercial kitchen design process

Configuration management is a technical and management process applying appropriate resources, processes, and tools to establish and maintain consistency between the product requirements, the product, and associated product configuration information. It is an integral part of the project life cycle and has great influence on reducing product development time, minimizing through life cost, and enhancing overall product quality. The studies Niazi et al., Fortune and white, and Yeo et al., provide baseline guidelines on process maturity. The research of Yeo et al. emphasizes on extracting key capability areas which are mainly based on critical success factors and barriers to a process.

The description of each sustainable commercial design elements and processes is as follow:

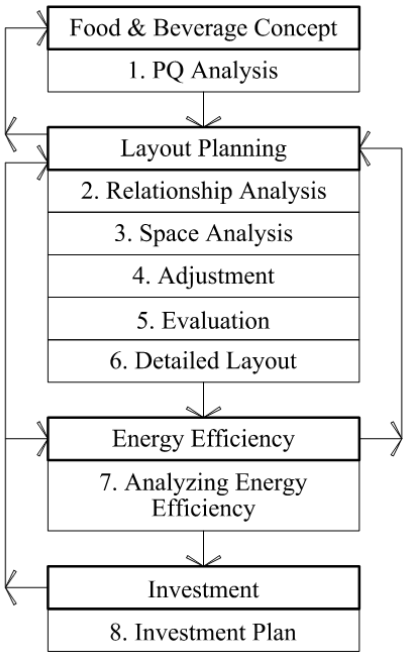


Figure 2 Design process in implementing a commercial kitchen design

A. Layout Planning

Layout planning analysis is to get an efficient and productive space arrangement and equipment. It results an integrated layout and consolidated equipment where the space arrangement and equipment selection are systematically calculated and arranged based on the operation requirements which refer to product quantity and variety, safety, and quality of the outputs.

Systematic layout planning (SLP) as developed by Muther and Haganas (1969) is to provide facility design process from the generation of alternatives, evaluation, selection and implementation. The primary purpose of any plant layout is to facilitate the manufacturing process.

Computerized Relative Allocation of Facilities Technique (CRAFT) was introduced in 1963 by Armour, Buffa, and Vollman; and it is also called as computerized heuristic algorithm which takes inputs of the load matrix of interdepartmental flow and transaction costs with a representation of a block layout. Algorithmic approach can help the layout analyst to develop or improve a layout, and it provides objective criteria to facilitate the evaluation of various layout alternatives that emerge in the process. Closeness and relationship activity are calculated to gain the optimum result by having the lower material handling effort which is important for food safety and quality. The calculation for distance based objective as follow:

$$\text{Min } z = \sum_{i=1}^{m} \sum_{j=1}^{m} f_{ij}\, c_{ij}\, d_{ij}$$

1. m = the number of departments
2. f_{ij} = the flow from department i to department j (unit load/unit time)
3. c_{ij} = the cost of moving a unit load one distance unit from department i to j
4. d_{ij} = the distance from department I to j

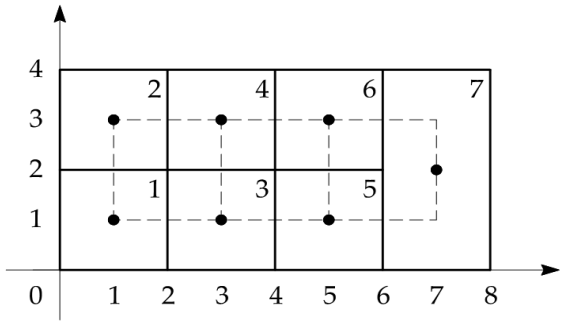


Figure 3 A layout matrix of departments

Quality and price of commercial kitchen equipment come in different stages and they affect the equipment's useful life that leads to the depreciation schedule. Foodservice equipment should be manufactured according to industry standards governing safety, such as: the National Sanitation Foundation (NSF), Underwriters Laboratories (UL), etc.

While designing the commercial kitchen layout, the following principles must be kept in view:

1. Space utilization.
2. Minimal movement.
3. Smooth flow. It reduces work bottlenecks and facilitates uninterrupted flow of work throughout the kitchen which flows forward.
4. Safety that applies to fire and hygiene guidelines.
5. Flexibility. Layout should be flexible enough to be adaptable to changes.
6. Economy. The layout should aim at effecting economy in terms of investment in fixed assets.

There will be six steps to be done during layout planning of a sustainable commercial kitchen as follow:

1. Step 1 - Product Quantity Analysis

a. Activities in commercial kitchen - Area requirement

b. Capacity and variety
c. Type of cooking method
d. Type and quantity of equipment - Determine quality of equipment
e. Operation processing sequence – flow of materials
f. Output: food and beverage concept and area program

2. Step 2 - Relationship analysis
a. Service system
b. Operation process chart - work of flow
c. Safety requirements
d. Hygienic requirements
e. From-To chart
f. Output: Activity relationship diagram

3. Step 3 - Space analysis
a. Study the allocated kitchen space by architect
b. Analyze equipment technical data sheet
c. Space requirements
d. Zoning
e. Output: Space planning drawing

4. Step 4 - Adjustment
a. Coordinate with other consultants' requirements

b. Modifying to other consultants' requirements

c. Analyze the serving distance of the initial layout

d. Prepare an alternative layout
e. Output: Initial and alternative layouts

5. Step 5 - Evaluation
a. Analyze the serving distance of the alternative layout
b. Comparison: Material handling effort matrix

c. Select the preferred layout
d. Output: Selected layout

6. Step 6 - Detailed layout plan
a. Put the equipment block into the layout plan

b. Analyze the space and capacity of actual equipment to equipment block
c. Identify the selected kitchen equipment
d. Prepare bill of quantity: Type of equipment, brand, model, dimension, quantity, and price
e. Output: final layout and bill of quantity

B. Energy Efficiency

A commercial kitchen uses the highest energy compared to the other facilities. Energy efficiency analysis is to select the equipment with the most efficient energy and maintenance costs. This analysis analyzes the energy requirements and selects the energy efficient equipment including the identification of energy and maintenance costs which is based on the selected layout and bill of quantity that are resulted by layout planning process.

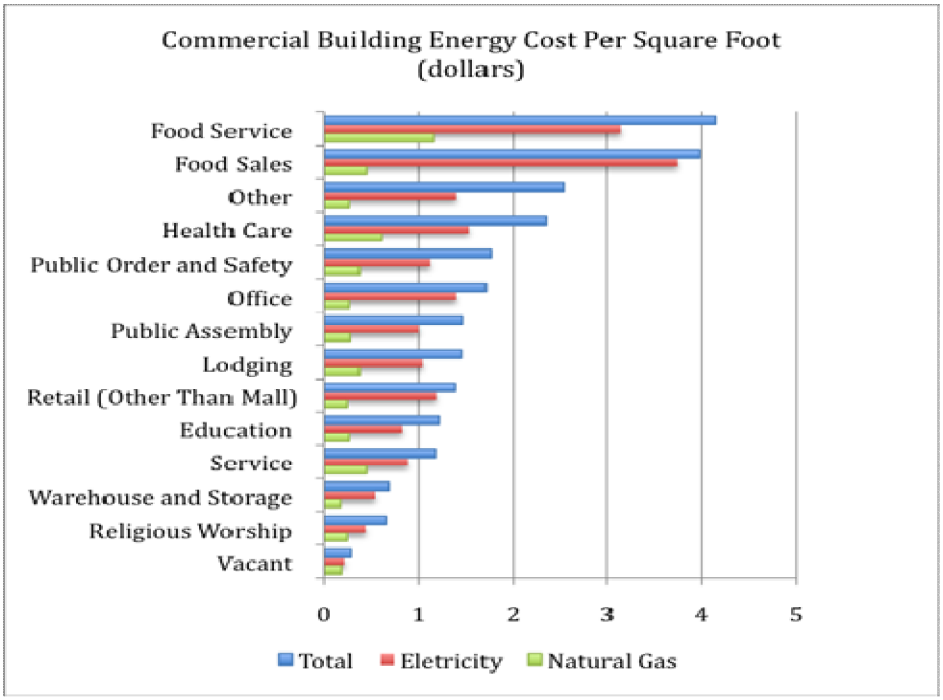


Figure 4 Commercial Building Energy Cost Per Square Foot (Dollars)

The selection of equipment can refer to the energy benchmarks, such as: CIBSE (Chartered Institution of Building Services Engineers) or BSRIA (Building Services Research and Information Association).

The step 7 which is analyzing energy efficiency consists of the following activities:
a. Select type of energy
b. Identify efficiency of equipment

c. Identify electric requirement
d. Identify gas requirement
e. Identify water requirement
f. Identify ventilation requirement
g. Identify other energy requirement
h. Energy cost
i. Prepare alternative energy cost of related alternative equipment
j. Output: Consumption load sheet and energy cost

C. Investment

Investment plan analysis is to analyze the actual data to gain the most profitable investment plan and it should be done in preliminary design process instead of after tender process is finished which leads to value engineering process. Investment aspect analyzes the different financial options in selecting equipment, energy, and maintenance costs using the actual data that are created from layout planning and energy efficiency analysis so the decision to select the commercial kitchen equipment in investment analysis is highly accurate.

A life cycle cost analysis is to quantify costs over the entire life cycle of the project investment. The life cycle cost method sums the costs of acquisition, maintenance, repair, replacement, energy, and other costs such as salvage value that are affected by the investment decision. All amounts are usually measured either in a present value or in an annual value. The time value of money must be taken into account for all amounts over the relevant period. Two important parameters for a life cycle cost analysis are the lifetimes of equipment and the interest rate. A formula for calculating the life cycle costs of each alternative is given by:

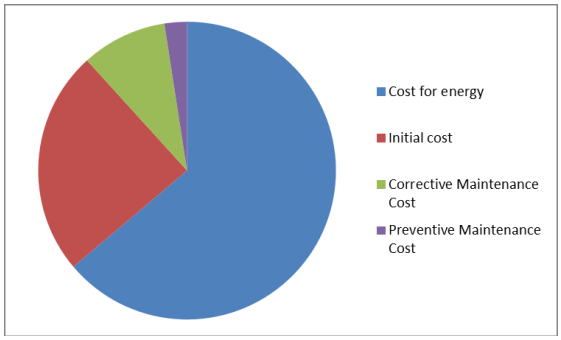
$$LCC_n = I_n + E_n + M_n + R_n - S_n$$

1. LCC_n is the life cycle cost of alternative n
2. I_n is the present value of investment costs of alternative n
3. E_n is the present value of energy costs associated with alternative n
4. M_n is the present value of nonfuel operating and maintenance cost of alternative n
5. R_n is the present value of repairing and replacement costs of alternative n
6. S_n is the present value of resale or salvage value associated with alternative n

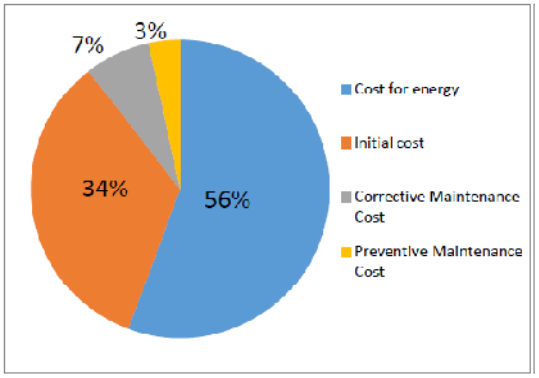
Supplementary measures of economic evaluation are Net Savings (NS) and Simple Payback (SPB) or Discounted Payback (DPB) which is sometimes needed to meet specific regulatory requirements with evaluation criteria as follow:

1. Lowest LCC (for determining cost-effectiveness).
2. NS > 0 (for determining cost-effectiveness).
3. SPB, DPB < than study period (for screening projects).

A financial plan needs to be developed to understand all the costs involved in commercial kitchen operation. A financial plan is a comprehensive evaluation of an investor's current and future financial state by using currently known variables to predict future cash flows, asset values, and withdrawal plans.



Investment in economical equipment



Investment in quality equipment

Figure 5 Total cost comparison for economical and quality equipment in 5 years

A good financial plan can alert an investor to changes that must be made to ensure a smooth transition through life's financial phases, such as decreasing spending or changing asset allocation. Financial plans should also be fluid, with occasional updates when financial changes occur. The element of financial plan includes the following data:

1. Revenue plan: capacity, serving time, projected occupancy rate, selling price, and projected sales growth.
2. Initial cost: building, interior works, MEP, tools, and equipment costs.
3. Operation cost: salary, utility, etc.
4. Other costs, such as: insurance, bank interest, etc.
5. Some alternative financial plans should be developed based on period of investment and each alternative has to be analyzed to understand the most profitable option.

The step 8 which is investment plan analysis consists of the following activities:

a. Prepare financial plan in different time options
b. Analyze the total cost to financial plan
c. Select the most profitable option
d. Output: Selected financial plan

III. BENEFITS

Layout planning aspect results integrated layout and consolidated equipment where the space arrangement and equipment selection are systematically calculated and arranged based on the operation requirements which are product quantity and variety, safety, and quality of the outputs. Energy efficiency aspect selects the most energy efficient equipment including the identification of energy and maintenance costs. Investment aspect analyzes the different financial options in selecting equipment, energy, and maintenance costs using the actual data so the decision making process is highly accurate.

The design process is communicated to owner, operator, consultants, and kitchen planner to give a whole picture so during design process they can balance the requirements at the early design stage and they are aware of the consequences of not aligning themselves to the process. As the result, the value engineering process which is normally done during tender process and it takes at least 2 months can be eliminated so the whole design process can be 2 months faster.

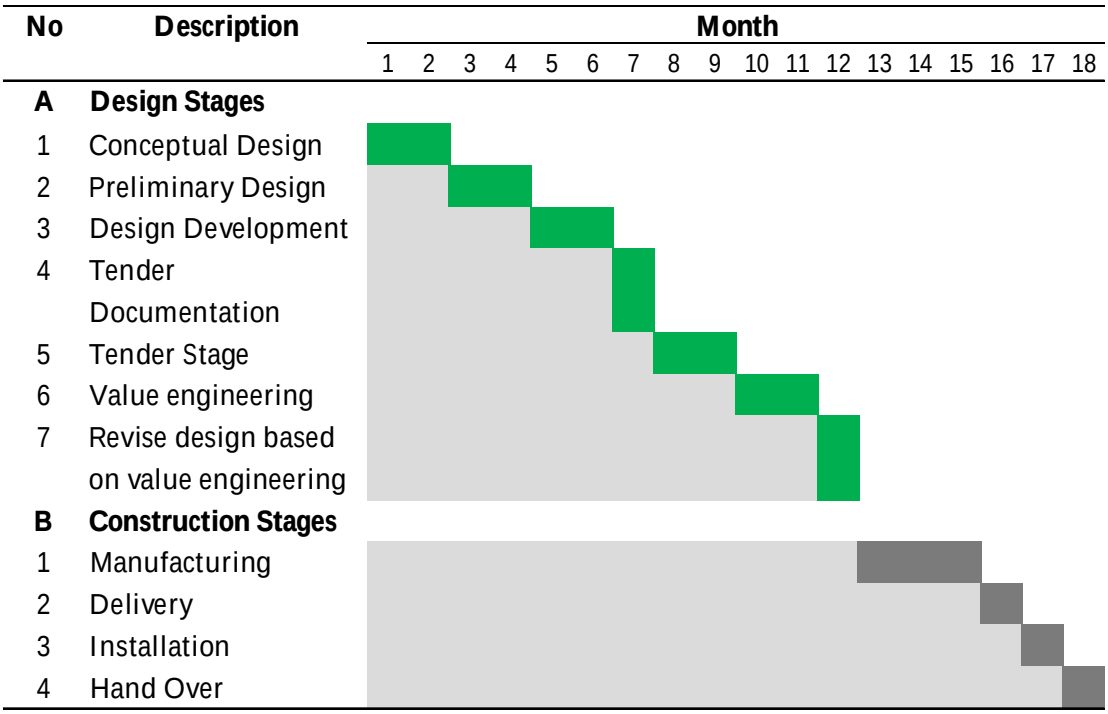


Figure 6 Regular schedule of designing foodservice facility in a hotel

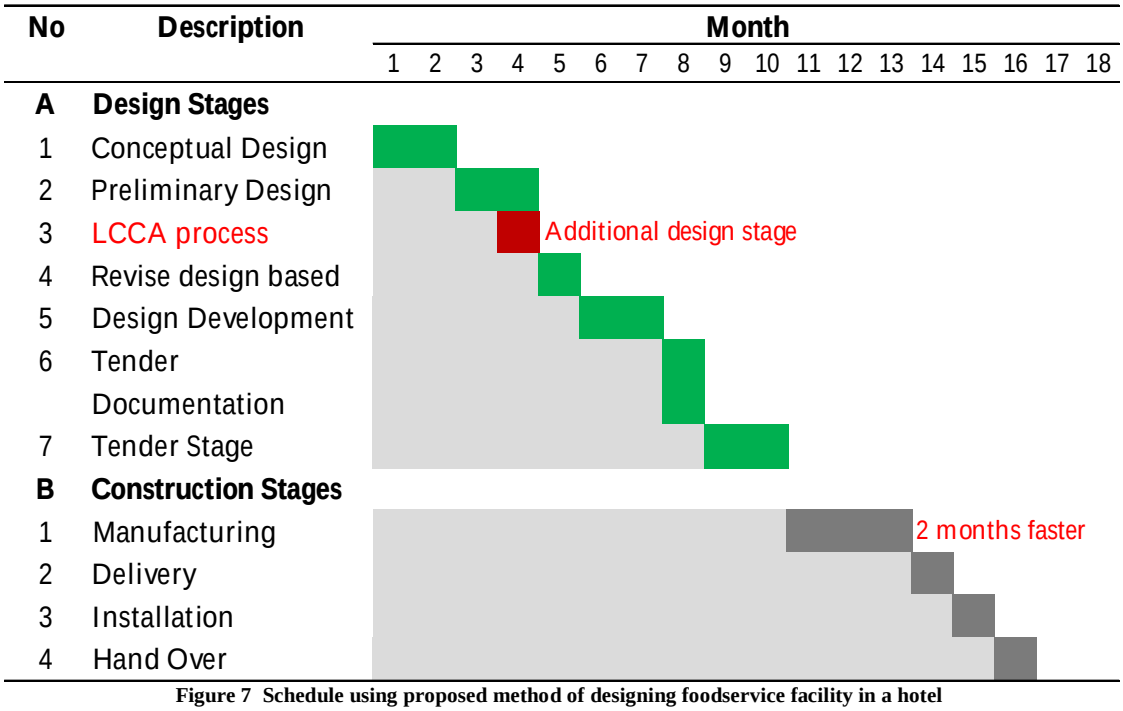


Figure 7 Schedule using proposed method of designing foodservice facility in a hotel

CONCLUSIONS

A commercial kitchen must have the capacity to endure the operational requirements to produce the quality products effectively in order to generate revenue and maintain the operation cost efficiently. So it will be sustainable by balancing the requirements of layout planning, energy efficiency, and the direction of investment and put them in harmony.

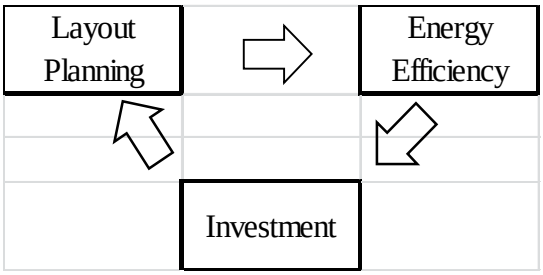


Figure 8 Relationship of layout planning, energy efficiency, and investment in designing a sustainable commercial kitchen.

Space efficiency and optimization and equipment selection are the key factors to achieve high productivity in a commercial kitchen. Energy efficiency is to use less energy to accomplish the same task. Investment should consider the whole operation expenses as a total cost.

The result and consequences of balancing them must be communicated clearly to owner, operator, consultants, and kitchen planner during design stages so they can agree with the conditions and scenario that will happen in the project. A clear direction will speed up the design process and prevent the disputes.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Burgess, T. F., McKee, D. and Kidd, C. Configuration management in the aerospace industry: a review of industry practice. International Journal of Operations & Production Management, 25(3-4), 290-301. 2015.

[2] Costas Katsigris and Chris Thomas. Design and Equipment for Restaurants and Foodservice, A Management Review, Third Edition. John Wiley & Sons, Inc., Hoboken, NJ. 2009.

[3] E. S. Buffa, G.C. Armour, and T.E. Vollman. Allocating Facilities with CRAFT, Harvard Business Review. 42 (2): 58 – 136. 1964.

[4] James A Tomkins and John A White. Facilities Planning. John Wiley & Sons. 1984.

[5] Richard L Francis, Leon F McGinnis Jr, John A White. Facility Layout and Location: An Analysis Approach. Prentice Hall, Englewood Cliffs, NJ. 1992.

[6] Richard Muther and Lee Hales, Systematic Layout Planning, Fourth Edition, Management & Industrial Research Publication, GA. 2015.

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