Faculty of Manufacturing Engineering

EVALUATION OF CERAMIC LAB FACILITIES LAYOUT DESIGN OF KKTM MASJID TANAH USING SLP METHOD.

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A thesis submitted

In fulfilment of the requirements for the degree of Master Manufacturing Engineering (Industrial Engineering).

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DECLARATION

I declare that this thesis entitled "Evaluation of Ceramic Lab Facilities Layout Design of KKTM Masjid Tanah Using SLP Method" is the result of my own research except as cited in the references. The thesis has not been accept for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	.....
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Date	:	15th August 2014

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering).

Signature : .....

Supervisior Name : Prof. Dr. Adi Saptari

Date : 18/08/2014

DEDICATION

This thesis is dedicated to my beloved mother, father and wife. They have been a source of motivation and strength during moments of despair and discouragement, support has been shown in incredible ways recently.

ABSTRACT

Facilities layout design is a significant factor contribute to the efficient manufacturing systems. A good design in facility layout may reduce travel time, expedite flow of material, operators and tools. It greatly affects the system performance of an organization. This study is related the facilities layout at the Ceramics Workshop, KKTM Masjid Tanah, Melaka. The reliable layout of this workshop is required to support Production-Based Education (PBE) practiced in KKTM, especially when PBE program run entirely by high-volume products. The current layout of workshop is not appropriate to support the activities as the flows of material of different products produced are not considered. The objective of this study was to redesign a new layout of the Ceramic workshop using Systematic Layout Planning (SLP) method and suggests of improvements designed layout. Data collection was performed such as the flow of process for each product, the area of each station, the distances between the regions. SLP is widely used in manufacturing industries to plan the layout of the facility. SLP procedures are based on data input of production activities, the flow of materials, relationship activities, relationship diagram, the need for space, spatial relationships diagram, modifying considerations and limitations, development and evaluation of alternative layouts. The study proposes some alternatives layout for improvement. Based on minimum distance criteria the alternatives were evaluated. Each layout alternative has its own advantages. Therefore, a decision was made where alternative number 2 is suggested as it is more effective layout in terms of flow, and distance.

ABSTRAK

Rekabentuk susun atur kemudahan adalah faktor penting di dalam menyumbang kepada sistem pembuatan yang cekap. Satu rekabentuk yang baik di dalam susun atur kemudahan boleh mengurangkan masa perjalanan, mempercepatkan aliran bahan, pekerja atau pengendali dan alat. Ia memberi kesan yang besar di dalam meningkatkan prestasi sesebuah organisasi. Kajian ini adalah berkaitan susun atur kemudahan di Bengkel Seramik, KKTM Masjid Tanah, Melaka. Susun atur yang baik di dalam bengkel diperlukan untuk menyokong Pendidikan Berasaskan Pengeluaran (PBE) yang diamalkan di KKTM, terutamanya apabila program PBE ini dijalankan sepenuhnya dengan hasil pengeluaran produk yang tinggi. Susun atur di bengkel pada masa ini adalah tidak sesuai untuk menyokong aktiviti seperti aliran bahan untuk menghasilkan produk yang berbeza tidak diambil kira. Objektif kajian ini adalah untuk mereka bentuk semula susun atur yang baru di Bengkel Seramik dengan menggunakan kaedah Perancangan Sistematik Susunatur (SLP) dan cadangan penambahbaikan untuk susun atur yang telah direka. Pengumpulan data dilakukan seperti proses aliran untuk setiap produk, kawasan setiap stesen atau hentian, jarak antara satu tempat ke satu tempat. SLP digunakan dengan meluas dalam industri pembuatan untuk merancang susun atur bagi setiap kemudahan tersebut. Prosedur SLP adalah berdasarkan kepada input data atau pengumpulan data melalui aktiviti pengeluaran, aliran bahan, aktiviti yang berhubungan, rajah hubungan, ruang yang diperlukan, gambaran hubungan antara ruang atau kawasan, pertimbangan untuk had pengubahsuaian, pembangunan dan penilaian pada susun atur alternatif. Kajian ini mencadangkan beberapa susun atur alternatif untuk penambahbaikan. Berdasarkan kriteria jarak yang minimum, alternatif tersebut akan dinilai. Setiap susun atur alternatif mempunyai kelebihannya yang tersendiri. Oleh itu, satu keputusan telah dibuat dimana alternatif nombor 2 dicadangkan kerana ianya susun aturnya yang lebih berkesan dan efektif dari segi aliran dan jarak.

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Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis. Special appreciation goes to my supervisor, Prof Dr Adi Saptari for his supervision and constant support. His invaluable help of constructive comments and suggestions throughout the thesis works have contributed to the success of this research. His patience and considerate nature made him accessible whenever I needed his assistance. My work also benefitted much from his consistent probing as well as his ability; his resourcefulness inspired my imagination now. Not forgotten, all lectures in faculty manufacturing engineering, UTeM for support and knowledge regarding this thesis.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Manufacturing is the process of converting raw materials into the product. Manufacturing is the backbone of any industrialized nation. (Kalpakjian and Schmid, 2001). The higher level of manufacturing activity in a country, the higher the standard of living of its people. Kalpakjian (2001) state, the level of manufacturing activity is directly related to its economic health and manufacturing involves making product from raw materials by means of various process, machinery, operation thought a well-organized plan for each activity required.

At present the world full of challenges, the organization needs a fully effective use of time and quality. An organization has to plan everything that we would do for a quality production. Facilities planning is also one of the things that effective yield and quality. These are using machines, storage areas, work areas, offices, warehouses, rest area and so on.

There are many definitions related facilities layout, one of the definitions is facility layout of all facilities required for production of goods or delivery of services. A facility is an entity that facilitates the performance of any job (Heragu, 1997). Meller et al. (1999) found that the facility layout problem including finding a non-overlapping planar orthogonal arrangement of rectangular facilities within rectangular plan site so as to reduce the distance measure based. While, Azadivar and Wang (2000) defined that the facility layout problem such as the determination of the relative locations, and allocation, the

available space among the few observations that facilities. Lee and Lee (2002) reported that the facility layout problem consists in arranging an unequal-area of different sizes in a given amount of space, which can be tied to the length or width of the site, with a way to reduce the amount material handling cost and slack area cost. Shayan and Chittilappilly (2004) defined the facility layout problem as an optimization problem of trying to make the layouts more efficient by taking into account various interactions between facilities and material handling systems while designing layouts.

All arrangements have been made to facilitate workers and machines can provide the best support to achieve the organization. For example, how the facilities available at the hospital to support the provision of medical care to patients. There are several objectives of the facilities; (Tompkins et al., 1996)

i. Support the organization's vision through more efficient handling, material control, and good housekeeping.

ii. Increase the return on assets to maximize the conversion of inventory, reduce inventory time, maximize employee engagement, and maximize continuous improvement.

iii. Reduce the cost and expand the supply chain profit.

iv. Effective use of labor, equipment, and space.

v. Provide for the safety of employees, job satisfaction, energy efficiency and environmental responsibility.

Facilities planning determine how an activity's tangible fixed assets best support achieving the activity's objective (Kalpakjian and Schmid, 2001). Advantages and good facility planning, which can increase productivity efficiency, minimized congestion in the workplace, effective use of space, the minimum cost of material handling, facilitate supervision and work environment that is safe and comfortable.

This study is conducted in Ceramic Workshop KKTM. The Workshop equipped with various machines. The layout of this workshop somehow needs improvement to support Production Based Education (PBE) activities. PBE is one of the learning systems in Malaysia. KKTM Masjid Tanah practices this system in shaping the learning environment in the workplace. Each learning and teaching for each syllabus will produce a product.

1.2 Problem Statement

A workshop building and two experimental rooms are allocated to the Department of Ceramics. Building workshop is divided into several sections including classrooms, storage, wet working area, dry working area, and furnace area. In addition, there are a storage area mould, products and raw materials. Machine capacity and the storage capacity have a limited space workshop area, this contribute to a problem in obtaining production with a structured and efficient manner. An alternative layout plan should be proposed to solve this problem.

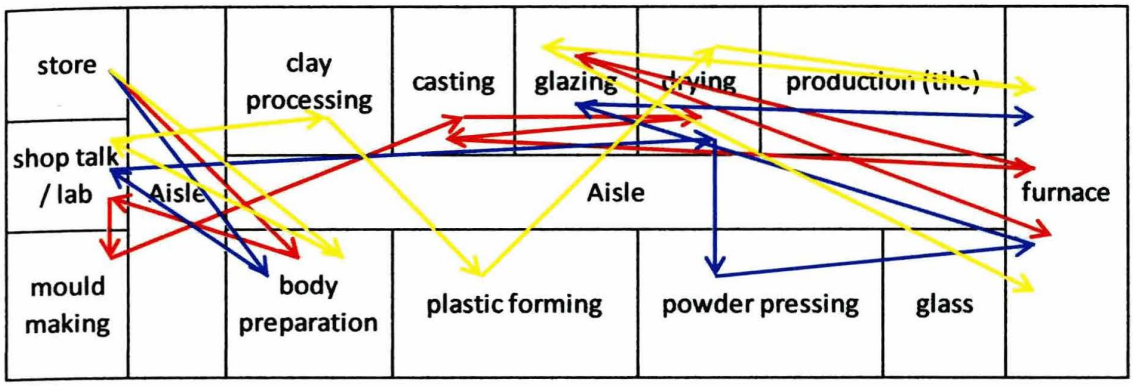
The Figure 1.1 shows the movement of each manufacturing technique practiced in the ceramic workshop, KKTM Masjid Tanah now. These movements show three techniques in producing ceramic products. These are:

i. Plastic forming.

ii. Powder pressing.

iii. Slip casting.

The movement shows the activities of production is overlapping and fibrous causing distraction and efficiency and may contribute to accident. The flow of production need to be revisited and layout may need to change to eliminate distraction and inefficiency.



→ Plastic forming technique.

→ Powder pressing technique.

→ Slip casting technique.

Figure 1.1: Flow Fabrications for Each Technique

1.3 Objectives

The objectives of this study are:

i. To evaluate the facilities layout of ceramic workshop using Systematic Layout Planning (SLP) method.

ii. To recommend facilities layout improvement of ceramic workshop.

1.4 Scope

The scope of is focusing on layout design at Ceramic workshop KKTM Masjid Tanah. Many factors that influence the layout; example volume, weight of items to be produced, the nature of the service to be provided and operations of production.

The scope of is focusing on facilities layout:

i. Utilizes available space effectively and efficiently.

ii. Bottlenecks in moving people or material.

iii. Materials-handling.

iv. Hazards to personnel.

1.5 Organization of Report

Chapter 1 begins with an overview of facilities layout planning definitions and its principles. Objectives, problem statement and scope of the case study are also well defined. Subsequently, some relevant literature is reviewed to justify the significance of this study. Chapter 2 will be the literature review on facilities layout planning with the focus area in Systematic Layout Planning (SLP) methodology. Other than that the integration of layout design will also be discussed. Finally, relevant research and previous journals will be summarized with emphasis on the strengths and gaps. Chapter 3 will discuss about the methodology of the thesis, including types of data to be collected, tools and techniques used to solve the problem and performance measures. Chapter 4 will adopt the Systematic Layout Planning (SLP) methodology to generate preliminary proposed layout alternatives to the current production line. The existing and proposed layout will be modelled. Verification and validation of the model will be included as well. Chapter 5 will review on the background; the current layout structure will be described. The problem identification will also be discussed. Cross over diagrams, process flow mapping and travelling cost calculation will be utilized to describe the problem of the production line. Chapter 6 will discuss on the best model (layout) to be selected It will summarize the findings from this study and recommendation for future work will be proposed.

1.6 Activity Planning

The activity planning is a guiding to manage the time to make the design. Duration of time for each step to research will be shown. Based on this table, the process of research will be better organized within the time period specified in accordance with plans that has been made. Appendix A and B show the activity planning for MP 1 and MP2.

CHAPTER 2

LITERATURE REVIEW

Many researchers have questioned the appropriateness of choosing a single objective, criteria for solving the facility layout problem because qualitative and quantitative approaches each have advantages and disadvantages. However, the approaches described above is usually used individually to solve a facility layout problem (Chen and Sha, 2004).

2.1 Facilities Layout

The placement of the facilities in the plant area, often referred to as ''facility layout problem'', is known have a significant impact on manufacturing costs, work in process, lead times and productivity. A good placement facility contributes to the overall efficiency of the operations and can reduce up to 50% of total operating expenses (Tompkins et al.,1996).

The research facility layout varies, depending on factors such as: the specificities of the manufacturing systems, facility design, material handling system, and evolution of the layout. The method recovers the formulation of the solution of problem, the objectives and constraints and the resolution approaches (Drira et al., 2007).

The layout designs usually depend on a variety of products and the production volumes. Four types of organization mentioned in articles that are available, namely fixed product layout, process layout, product layout and cellular layout (Dilworth,1996).

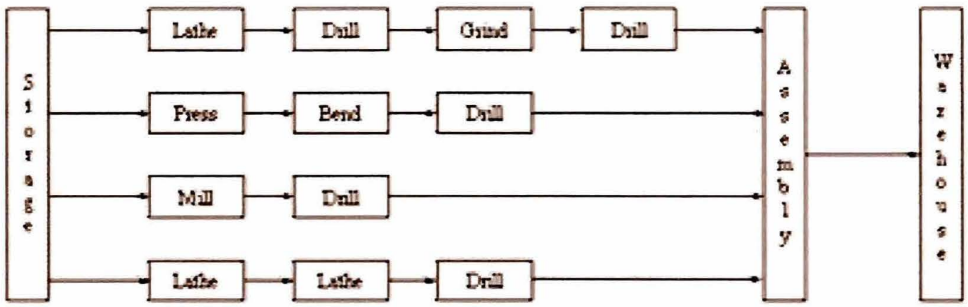
These key organizations are important sometimes differ discussed according to the authors (Hamann and Vernadat, 1992):

i. Fixed product layout, the products generally circulate within the production facilities (machines, workers, etc.) in this particular type of layout, the product does not move, it is the different source to perform the operations on the product. This type of layout is commonly found in the industry producing large size products, such as ships or aircrafts.

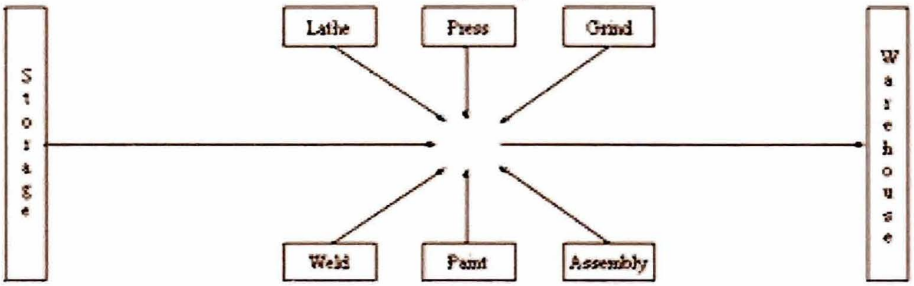
ii. Process layout groups facilities with the same functionality together (resources of the same type). The organization is often reported when there is a wide variety of product.

iii. Product layout is used for systems with high production volumes and a low range of products. Facilities are organized according to the sequence of the successive manufacturing operations.

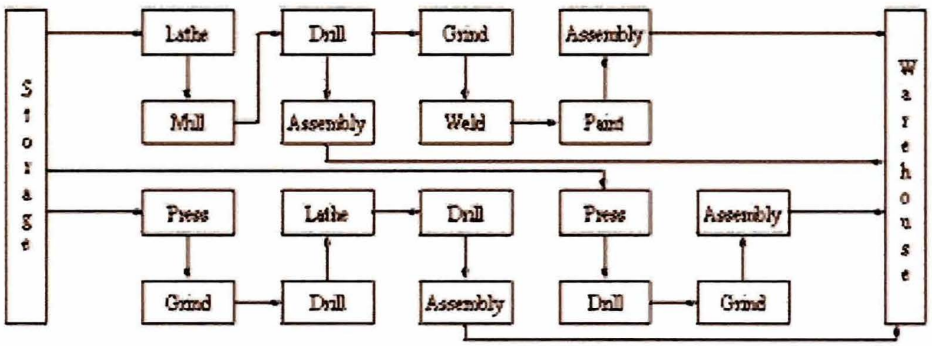
iv. In Cellular layout, machines are grouped into cells, to process families of the same parts. These cells also need to be placed on the factory floor. Therefore, one is also generally concerned with is known intra cells machine layout problems. Here, one is concerned with finding the best arrangement of machines in each cell.



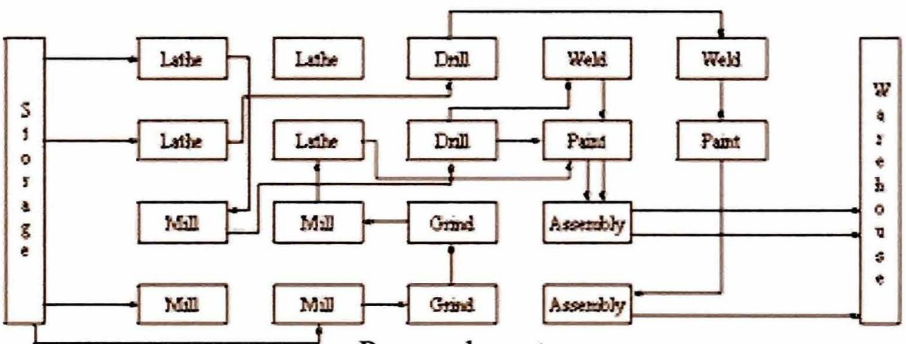
Production layout



Fixed layout



Group Layout



Process layout

Figure 2.1: Types of Layout (Tompkins et al., 1996)

The layout of the facility is an important problem for modern manufacturing systems and it plays an important role in the design process manufacturing systems. Traditionally, there are two approaches to facility layout problem (Zhenyuan et al., 2010). Approach to facility layout has been divided into two categories. The first category is characterized by the use of quantitative material-handling distances and load handling for developing layouts which attempts to reduce the amount of material-handling. The second category is characterized by a qualitative approach to maximize the overall subjective assessment of the closeness ratings between various departments. These factors can comprise different qualitative terms, such as ease of supervision and communication, utilization of manpower, worker safety, flexibility, etc. An effective method in this category is known as SLP (Systematic Layout Planning) introduced by Muther (1973).

The concept in these approaches continue to serve as the foundation of many of the methodologies proposed today; the approaches are (Tompkins et al., 1996)

i. Naddler's Ideal System Approach.

- The ideal system approach is based on the following hierarchical approach toward design:
  - Aim for the "theoretical ideal system."
  - Conceptualize the "ultimate ideal system."
  - Design the "technologically workable ideal system."
  - Install the "recommended system."

ii. Immer's Basic Steps.

- Immer described the analysis of a layout problem as follows: "This analysis should be composed of three simple steps, which can be applied to any type of layout problem. These steps are:
  - Put the problem on the paper.

- Show lines of flow.
- Convert flow lines to machine lines."

iii. Apple's Plant Layout Procedure.

- Apple recommends that the following detailed sequence of steps be used in designing a plant layout (Table 2.1).

Table 2.1: The step in designing a plant layout (Tompkins et al., 1996)

1. Procure the basic data.	11. Determine storage requirements
2. Analyze the basic data.	12. Plan service and auxiliary activities.
3. Design the productive process.	13. Determine space requirements
4. Plan the material flow pattern.	14. Allocate activities to total space
5. Consider the general material handling plan	15. Consider building type
6. Calculate equipment requirements.	16. Consider master layouts
7. Plan individual work stations.	17. Evaluate, adjust and check the layout
8. Select specific material handling equipment	18. Obtain approval
9. Coordinate groups of related operations.	19. Install the layout
10. Design activity relationships.	20. Follow up on implementation of the layout

iv. Reed's Plant Layout Procedure.

- In "planning for and preparing the layout," Reed recommended that the following steps be taken in his "systematic plan of attach":
  - Analyze the product to be produced.
  - Determine the process required to manufacture the product.

- Prepare layout planning charts.
- Determine work stations.
- Analyze storage area requirements
- Establish minimum aisle widths.
- Establish office requirements.
- Consider personnel facilities and services.
- Survey plant services.
- Provide for future expansion.

v. Muther's Systematic Layout Planning (SLP).

- The procedures of SLP method are
  - Flow of materials
  - Activity relationships
  - Relationship diagram
  - Space requirements
  - Space available
  - Space relationship diagram
  - Modifying considerations
  - Practical limitations
  - Develop layout alternatives
  - Evaluation

2.2 Muther's Systematic Layout Planning, SLP

Filippo et al. (2013) states that the SLP was developed in 1973 by Richard Murther, is one of the most frequently used methods in the design or redesign of the layout of the facilities. SLP includes three specific phases, namely: