DESIGNING A NEW PARTITION LAYOUT FOR PAINT JOB MANUFACTURING IN CIKARANG, JAWA BARAT

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THESIS ADVISOR
RECOMMENDATION LETTER

This thesis entitle "**DESIGNING A NEW PARTITION LAYOUT FOR PAINT JOB MANUFACTURING IN CIKARANG, JAWA BARAT**" prepared and submitted by **Marten Oswald Gowtawa** in partial fulfillment of the requirements for the degree of Bachelor Degree in the Faculty of Engineering has been reviewed and found to have satisfied the requirements for a thesis fir to be examined. I therefore recommend this thesis for Oral Defense.

Cikarang, Indonesia, May 30th, 2017

Anastasia Lidya Maukar, ST, M.Sc, MMT.

DECLARATION OF ORIGINALITY

I declare that this thesis, entitle "**DESIGNING A NEW PARTITION LAYOUT FOR PAINT JOB MANUFACTURING IN CIKARANG, JAWA BARAT**" is, to the best of my knowledge and belief, an original piece of work that has not been submitted, either in whole or in part, to another university to obtain a degree.

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ABSTRACT

Health safety environment, good ambiance and good flow of new layout are very important in designing new facilities layout and design. Especially for the company which wants to start new manufacturing department, paint job manufacturing has a few process which are cleaning material, mixing paint, spray process material, heat treatment and polishing. Flow shop within department flow must be in a good flow. There are several requirement for each department, the mixing room and spray room must be as close as it can because the machine in mixing room is connected to the spray room machine, Oven room and Quality Control room need to be close as well because the oven machine is designed in an input and output system which output will be at the quality control room. Ambience in paint job manufacturing is necessary because the operator need good lighting and ambiance in checking the paint color, warehouse and storage size must fit with the material handling equipment. Health and safety environment really need to be considered because this kind of manufacturing using chemicals process in the process and waste management for the wasted chemical material. The result of this facilities design is aim to make above 75% of effective new working environment and work flow systems.

Keywords: *Paint Job, Spray Process, Spray Booth, Paint, Heat Treatment, Health and Safety, Luminaries, Ambience, Chemical Process, Warehouse, Storage, Department Flow.*

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6. All my friends in President University. Thank you.

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LIST OF TERMINOLOGIES

Spray Booth	:	Place for the painting process
Oven	:	Machine for heat treatment process
Heat Treatment Process	:	Process of heating the painted material
Spray Gun	:	Machine tools to spray the paint to material
Polishing	:	Process of coating the painted material
Illumination	:	Lighting or light
Ambiance	:	Types or characteristic of lighting
Flow Systems	:	Systems of material within departments and workstations
Activity Relationship	:	Activity within department
Material Handling	:	How the material will be moved
SLP Procedure	:	Procedure to determine the layout design
Aisle	:	Distance between placement of things for material handling movement

CHAPTER I
INTRODUCTION

1.1 Problem Background

A paint shop company, located in Jababeka wants to make new facilities for their company which are by designing a good environment layout design and giving a high attention to QHSE (Quality Health Safety Environment) can preventable all accidents are caused by human error. Moreover, It can also improve the good ambience of work environment and decrease the waste management system where making the production is getting efficient and effective meanwhile, there is an assumption of demand to be 300 units per month. By the company demand, so it planned by creating new facilities layout.

Having a good layout is important and very worthy for a manufacturing company. Paint service manufacturing rarely designing a good layout, because of simple looks of job shop. When it comes to chemical process the company must considering many things from safety of the operator, the lighting for checking process because without good lighting the operator cannot check clearly whether the color is already precisely with the demand or not. Lack of awareness in this chemical used can cause serious health problem of the operator. This manufacturing is also using heat treatment for the produce material, so the safety and good environment are important for the operator. Facilities planning treatment is a subject with ranged checklist.

When it comes to paint job it requires chemical in the process required, the process of chemical exist in the mixing of material for the spray machine and the spraying process, it needs high attention in calculating, analyzing and designing the proper works environment. After the process that requires chemical process, the next step is using heat for the half-finished material to be heat-treatment. In the design process this room needs to be carefully calculated for the air temperature and air flow. Design good facilities system is highly needed for the company considering the understanding that were described, and also the health and safety environment for the worker in chemical process must be the first attention of the company.

Worker that handling the hazardous substance, have to get workplace hazardous materials information systems knowledge or training, because of paint job manufacturing worker maintain multiple of hazardous substances in daily job desk, this knowledge has to applied by them.

A good layout must consider many things for the future planning, such as; how to design a layout that will ease the maintenance and some changing if it needed for the company in the future.

1.2 Problem Statement

How does the company design the new facility layout for paint job service manufacturing that consider the environment, health and safety and comfortable work space?

1.3 Objectives

The main purpose of this research is in order to create a new facilities design and planning for the company, which involves manpower in the making of the design to achieving the target output, Comfortable and safety in determining the factory partition layout design.

1.4 Scope and Limitation

In the limitation of resources and time when conducting the research, there will be limitation in this research:

- Only taking car bumper as the biggest product
- The calculation that will be discussed are space requirement, lighting, life safety system, and warehouse operation

1.5 Assumption

Assumptions are needed in order to run the research well which are:

- The demand is 300 Units / Month

- No cash flow calculated

1.6 Research outline

Chapter I **Introduction**

In this section describing the background of final project, project identification, objective, scope and assumption of the study.

Chapter II **Literature Study**

Section giving the previous study about facility design and layout planning, and the other supporting tools for this final project.

Chapter III **Research Methodology**

The flow of this final project is explained in this chapter.

Chapter IV **Data Analysis**

The data observation is processed and analyzed in this chapter. The result of data analysis is a new facilities layout and design of paint job manufacturing that considered safety, comfortable, and good work environment.

Chapter V **Conclusion and Recommendation**

After analysis and calculation, this chapter described the conclusion result of this final project, and also recommendation for future research.

After all, the next chapter will tell the background of study literature which are about the previous study about facility design, layout planning and other tools which support this research will be described in the chapter II.

CHAPTER II
LITERATURE STUDY

2.1 Product, and Process Design

Processes of facilities planning for manufacturing can be define as these list below:

- Determine products that need to be produced and/or disassembled
- Giving Detail information for the required manufacturing and/or assembly processes and related activities
- Define all processes which have reciprocal relationship
- Define the space requirement within all activities
- Conclude another alternative facilities plans which is effective and efficient
- Evaluate those facilities plans option
- Determining the preferred facilities plan
- Conducting the facilities plan
- Maintain and control the facilities plan
- Evaluate and keep-up in the products to be produced and/or assembled then redefine the purpose of those facilities

The facilities planning process will be greatly influenced and impacted by either the business strategic plans, the concepts of which kind facilities plan should be implemented, technique, and technologies to be considered effectively and efficiently in the manufacturing and assembly strategy (Tompkins et al, 2010).

2.1.1 Product Design

Product design analyzes the products that have to be manufactured with very detailed design of each product. Choosing the product to be build are commonly made by upper-level management that connected from the marketing result., manufacturing, and finance concerning on the projected economic performance or based on costumer's survey needs as well as the dynamic environment that insists people need something more effective and efficient. However, build facilities and the lead times to plan, in the face of a dynamic product environment, might develop a situation in that is not possible to accurately determine the products to be manufactured in a given facility.

Designing a facility must take a high attention of the uncertainty that exist when the mission of the facility being planned, the detailed to be design, and activities flow.

2.1.2 Process Design

Process designs seek through the process of the product for determining how the product is to be manufactured. Process design is designed step by step how a product will be run to which machine.

2.1.2.1 Selecting the Required Process

When the product detailed already been determined, the product are need to be how the products will be produced. This kind of decisions commonly known by experiences, related requirements, equipment availability, rates of production, and expectation. Sometimes different process can be produced in different facilities to perform identical operation. However, the process flow will be the same. Process selection can be determined in these following steps : (Tompkins et al, 2010).:

1. Define detail operations processes.
2. Acknowledge each operation alternative processes.
3. Observing alternative processes.
4. Process standard.
5. Evaluate another process
6. Processes select.

Process identification is inputting into the process selection procedure is called, Process identification include of information that need to be completed. For a produced product, identification of processes consists of the following:

(a) A list of parts concerning on what that will be determined
(b) Part of component showing to describee every component

(c) The product quantities to be manufactured

2.1.3 Facilities Design

When process and product design decisions have been determined, the designer have to maintain the information and conclude layout evaluation, storage, handling and alternatives of load design unit.

Some tools often used by quality practitioner can be very useful in efforts of facilities planning. Planning tools and the seven management have gained acceptance as a methodology for planning and implementation efforts improvement. The tools have their roots in post-WWII operations research work and the total quality control (TQC) movement in Japan.

2.2 Activity Relationships, Flow Systems, and Space Requirements

In order to determine the facility requirement, there are mainly three important considerations which are activity relationships, flow systems, and space requirements. Flow system depends on transfer lot sizes and production, material handling systems, unit load sizes, building configuration and layout arrangement. In measuring including flows the activity relationship between department and activity relationship between machines calculation.

2.2.1 Flow Systems

One of an important aspect is Flow Systems to the planner, who seeks goods movements flow, energy, information, materials, and/or people. A systems of flow may be defined in terms of

(a) The flow of subject
(b) The flow of resources
(c) The communications that coordinate the resources.

Item to be manufactured is the subject. The subject that bring the flow are the transporting and processing facilities need to be complete to the flow required. The connection that handling the resources include the systems that facilitate the management of flow process (Tompkins et al, 2010).

2.2.1.1 Material Flow Systems

When the flow of materials, parts, and supplies between a production process facility is one of the flow process subject, then the process is called the flow material system. The subject of the materials flow systems are the parts, materials, and supplies used by a company in produce the products and components within its facility. Material flow resources systems consist are the following:

1. Quality control and the production control departments
2. The assembly, manufacturing, , and storage departments
3. Move materials, supplies, and parts are required in material handling equipment
4. The warehouse of factory

Communication within the material flow system includes production schedules, work order release, move tickets, Kanban's, bar codes, route sheets, assembly charts, and warehouse records (Tompkins et al, 2010).

2.3 Material Flow System

Learning the knowledge of flow systems of material is a facilities planner values because it determine the whole flow systems defining the whole flow environment into which movement of materials takes place. The concept of minimizing work simplification of represented of total flow to approach the material flow. These all flow includes in:

1. Not inputting the flow by planning for delivered material , information, or people directly to the point of use and eliminating intermediate steps
2. Decreasing multiple flows by calculating the preferably one by the flow in two consecutive points that take place
3. Planning the materials flow, information, or people to be mix in the processing step by mixing the flow and operation

The concept of minimizing the flow cost can be viewed from one of the following perspectives:

1. Eliminate not needed material movements by decreasing the number of step of manufacturing
2. Decreasing manual handling by minimizing travel distances
3. Delete manual handling by automating or mechanizing flow
4. Decreasing material handling by decreasing the containerization of flow density through

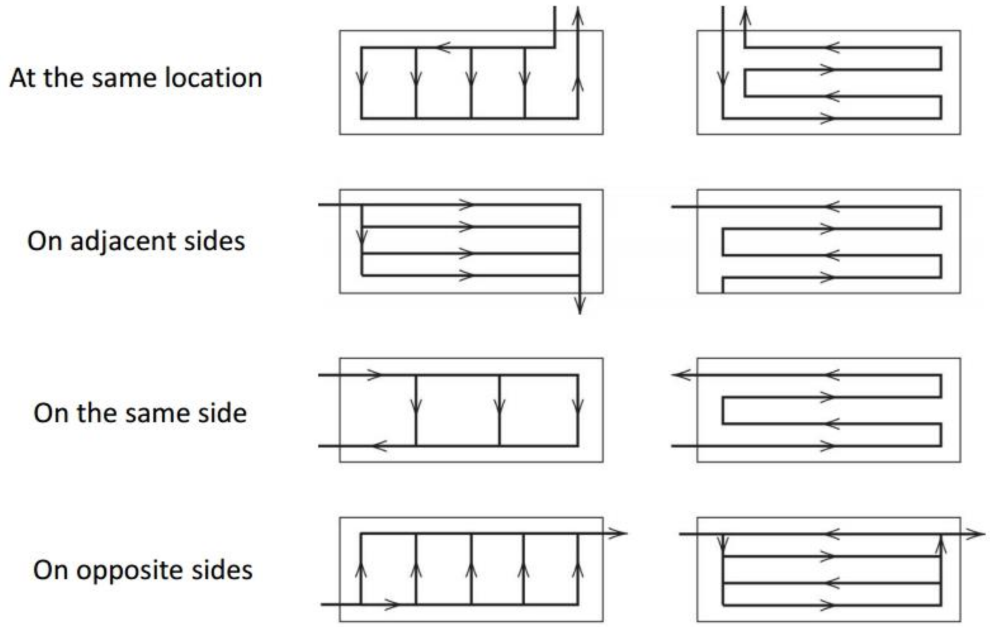
In the discussion to follow, focusing on flow systems of material with emphasis on flow patterns and structures, as seen in the workstation flow perspective , within departments, and between departments(Tompkins et al, 2010).

2.3.1 Flow within workstations

Ergonomic and motion studies consideration are needed in order to determining the flow within workstations. Flow patter that is natural is the standard for habitual flow patterns and rhythmical. Natural movements are curved, continuous, and make use of momentum. Habitual and rhythmical flow applies a methodical, automatic sequence of activity. Rhythmical and habitual flow patterns also needed to reduce the fatigue like mental eye, and strain and muscle fatigue.

2.4 Flow between Departments

Between departments flow is a helping tool often used to evaluate overall facility flow. A necessary option in the between departments flow is the location of the pickup and delivery stations for each department. The pickup location and delivery stations are given in Figure 2.7. As one will observe in this figure, a decision has to be made on whether a single station would service the entire flow of item in and out of the department, or whether multiple input/output stations should be used. In fact, if all machines are facing the aisle, the number of input/output station should correspond to the total number of machines (Tompkins et al, 2010).



Source: Tompkins et al, 2010 P.93

Figure 2.1 Flow within a department

2.5 Activity Relationship

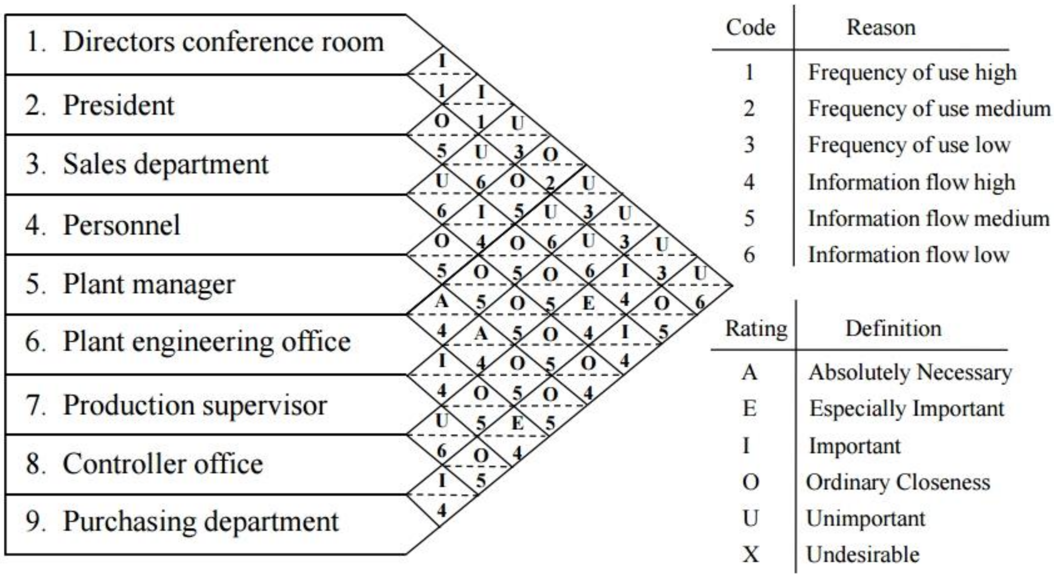
Analyzing the activities among departments is important things to do principles in the department's layout within a facility in order to analyze another arrangement' option, activity relationships must be established. Activity relationships can be explained in a qualitative or quantitative manner. Quantitative method may range from an absolute necessity that two departments are related to each other.

2.5.1 Qualitative Flow measurement

Flow may be calculated qualitatively by using the result of closeness relationship scored by Muther [21 in Tompkins at all] and shown in Table 2.2. The scores may be saved in intersection with the closeness reason score using the relationship chart shown in Figure 2.8

Table 2.1Closeness Relationship Values

Score	Closeness
A	Absolutely necessary
E	Especially Important
I	Important
O	Ordinary Closeness okay
U	Unimportant
X	Undesirable



Source: Tompkins et al, 2010 P.118

Figure 2.2 Relationship Chart

The steps in making relationship chart

1) Input every departments in the relationship chart
2) Conduct surveys or interviews with worker from with the management responsible for all departments and each department listed in the relationship chart
3) Determine the characteristic to inputting closeness relationships and itemize and record the characteristic as the reasons for relationship values on the relationship chart
4) Set up the reason and value relationship for the va lue for all companion of departments
5) Allowing worker to input to the relationship chart development a chance to evaluate and examine changes in the chart

It is necessary that this steps to be followed in creating a relationship chart. If, as a replacement of the planner synchronizing the relationship among departments as described above, the departments, inconstancies may develop. The inconstancies follow from the from to chart. The relationship chart by definition requires that the relationship between departments A and B be the same as the relationship vale between department B and A.

2.6 Space Requirements

It is possible the hardest determination in planning a facilities is the total amount of space that needed in the facility. 5 to 10 years in the facility is the year for the design. Assume that uncertainty commonly exists in the impact of technology, product mixture changes, demand level changes, and future organizational designs.

2.6.1 Workstation Specification

The general definition of the facility terms falls under the assets that fixed have to settle objectives of specific production. Because a composed workstation of the fixed assets needed to perform specific operations, a workstation can be considered to be a facility. Although it has a rather narrow objective, the workstation is quite important. Firm productivity is definitely related to each workstation. Productivity

A workstation, like all facilities, included equipment space, personnel, and material. The space of equipment for a workstation composed of space for

1) Equipment
2) Machine level
3) Machine maintenance
4) Plant services

Equipment space needs should be soon available from machinery data sheets. For machines that already in operation, machinery data sheets should be consist from either the maintenance department’s equipment history records or the accounting department’s equipment inventory records. For new machines, then a physical inventory should be performed to determine and machinery data sheets should be on hand least the following:

1) Machine type and manufacturer

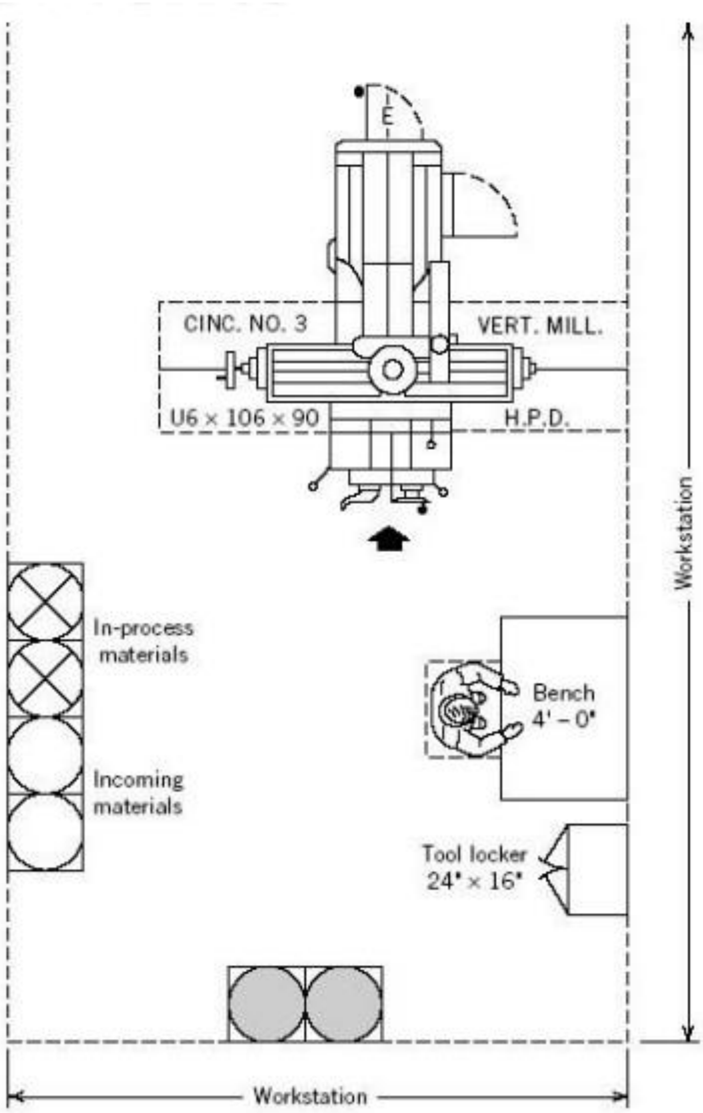
2) Machine serial number and model
3) Places of safety stops of machines
4) Requirement of floor loading
5) Maximum point of Static height
6) vertical travel had to be maximum
7) Maximum point of static width
8) Left maximum travel
9) Right maximum travel
10) maximum point static depth
11) Operator maximum travel
12) Away from operator maximum travel
13) Maintenance areas and requirement
14) Plant areas and requirement

Needs of floor requirement for every machine, including machine travel, can be calculated by multiplying total depth by width. Add the plant service area requirement and maintenance to the machine floor area requirement. The outcome total shows the machine total machinery area. The output sum represents the machine total machinery area. The calculation of all machines of the machinery areas among a workstation fives the workstation of machinery area requirement.

The material area for a workstation can be composed for

1) Storing and receiving
2) Keep in-process materials
3) Storing outbound shipping and materials
4) Storing and shipping scrap and waste
5) Holding tools, jigs, , fixtures, maintenance materials, and dye

To define of the needed area for storing and receiving in-process materials, materials, and storing and shipping materials, the load unit dimension to be handled and the material flow through the machine must be known.



Source: Tompkins et al, 2010 P.123

Figure 2.3 Workstation Drawing Required to Determine total area requirements

Figure 2.9 describes the space needs for a workstation. A drawing like Figure 2.9 should be including in every workstation in order to visualize the activities of operator (Tompkins et al, 2010).

2.6.2 Department Specification

If the area needs for each workstation has been calculated the area needs for each department can be calculated. Calculate the departmental service needs.

Service needs for each department equal the service requirements total for the individual workstations to be added in a department. These needs, as well as departmental requirement area, have to be save on a requirement sheets and service of department. Such as sheet is described in Figure 2.10

DEPARTMENTAL SERVICE AND AREA REQUIREMENT SHEET

Company A.B.C., Inc. Prepared by J.A.
Department Turning Date Sheet 1 of 1

Work Station	Quantity	Service Requirements: Power	Compressed Air	Other	Floor Loading	Ceiling Height	Area (square feet): Equipment	Material	Personnel	Total
Turret lathe	5	440 V AC	10 CFM @ 100 psi		150 PSF	4′	240	100	100	440
Screw machine	6	440 V AC	10 CFM @ 100 psi		190 PSF	4′	280	240	120	640
Chucker	2	440 V AC	10 CFM @ 100 psi		150 PSF	5′	60	100	40	200

Net area required 1280
13% aisle allowance 167
Total area required 1447

Source: Tompkins et al, 2010 p.125

Figure 2.4 Department service and area requirement sheet

2.7 Material Handling

Sketch of system in material handling is a necessary part of the whole design. Material handling system design and the layout design are inseparable. It is rarely the case that one can be allow without considered jointly to the other case. The connection among these two design functions is particularly important in the new facility design.

Material handling can be observed in one's day-to-day activities-mail delivered in a postal system, parts moved in a manufacturing system, boxes and pallet loads moved in an industrial distribution system, refuse collected in a waste management system, containers moved in a cargo port, or people moved in a bus or mass transit system(Tompkins et al, 2010).

2.7.1 Designing Material Handling Systems

The material handling systems design systems include in the six-step engineering design process. In the material handling context, which are :

1 Determine the material handling systems scope and objectives
2 Observing the storing, moving, controlling material, and protecting requirement

3. Generate design alternatives for meeting material handling systems needs
4. Evaluate material handling system designs alternatives
5. Select the preferred design for moving storing, controlling material, and protecting
6. Conducting the preferred design with the selection of training personnel and suppliers

2.7.2 Material Handling Planning Chart

Gather information related to a specific problem of material handling and to provide a preface examination of the solution alternatives option as used of a material handling planning chart. The result from analyses using this chart can then be used to further refine solution strategies using methods such as the simulation of alternative solutions.

An sketch of the material handling planning chart is shown in Figure 2.11. The first through eight columns are calculated in the same manner as the flow process chart. Expansion of the operations process in that it includes information on operations, transportations, delays, and storages and inspections. Cause of delays are committed in the material handling planning chart are delay and storage results in the same facility requirements.

WHERE | WHAT | WHEN | HOW

Product: Air Speed Control Value Date ______ Sheet 1 of 8

Step No.	O	T	S	I	Description	Oper. No.	Dept.	Cont. Type	Size	Wt.	Qty. Per Cont.	Freq	Dist	Method of Handling
1			X		Bar stock in Storage (2200)		Stores.							
2		X			Profit Stores to Saw Dept.			LDDSE (FK.TRK)	2.5" × 3.5 × 16"	5 lb	to bars	3 times daily	16 ft	Fork lift
3			X		Store in Saw Department		Saw							
4	X				Cut to length	0101	Saw							
5		X			From Saw to Grinding			TOTE pan	15" × 12" × 7"	30 lb	30	Twice daily	10 ft	Platform hand truck
6			X		Store in Grinding		Grinding							
7	X				Grind to length	0201	Grinding							
8			X					TOTE pan	15" × 12" × 7"	30 lb	30	Twice daily	13 ft	Platform hand truck
9				X	Store in Deburring		Deburring							
10	X				Deburr	0301	Deburring							
11		X			From Deburring to Dr. Prs			TOTE pan	15" × 12" × 7"	30 lb	30	Twice daily	16 ft	Platform hand truck
12			X		Store in Drill Press		Drill Press							
13	X				Dr. CD holes tap. rean,dsk	0401	Drill Press							
14		X			From Dr. Press to Tur. Lathe			TOTE pan	15" × 12" × 7"	30 lb	30	Twice daily	33 ft	Platform hand truck

Source: Tompkins et al, 2010 P.185

Figure 2.5 Material Handling planning chart for an air flow regulator

2.8 Layout Planning Models and Design Algorithms

The evaluation and generation of a layout number alternative is an important step in process of facility design, the selected layout will serve to describe the flow patterns material and physical relationships between activities. Knowing that the selected layout will be either chosen based or form on option of the generate alternatives it is necessary for the planner to be both comprehensive in generating and creative a layout alternatives reasonable number.

2.8.1 Basic Layout Types

Planning departments consist of four types

1) Departments fixed material location
2) Departments of Production line
3) Departments of Product family
4) Departments Process

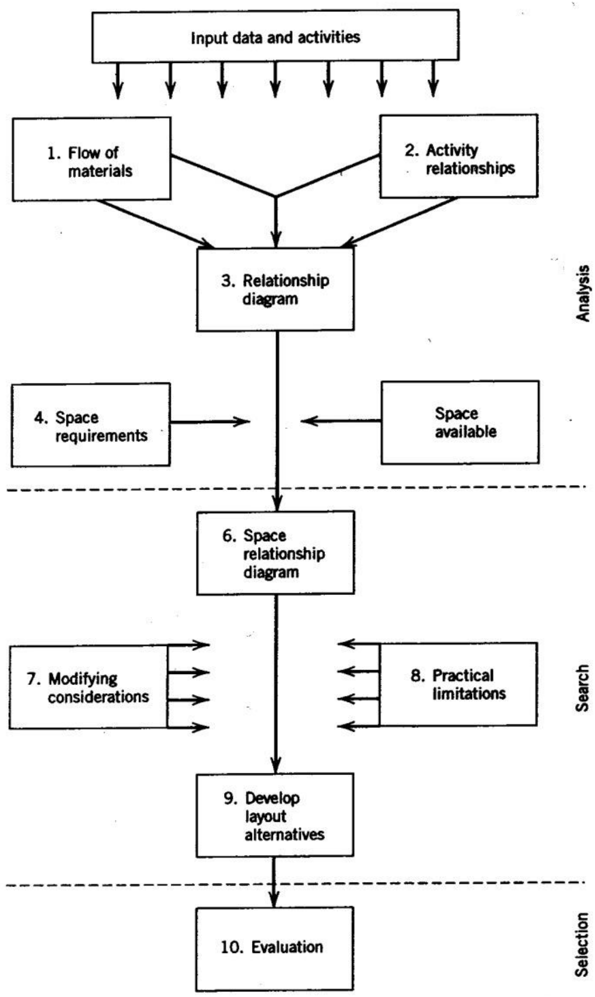
Based on the above types of departments, there are four types of layouts, will be shown in Figure 2.12.

A critical document for this purpose is the future state map. The facilities planner must establish very clearly the relationship between each "process box" in the FSM and each "department" that is to appear in the layout. Skipping this step may result in a layout that minimizes the flow distance between the "wrong" departments; that is, the flow distances in the layout may be minimized, but the departments that populate the layout may not be right type of departments needed to support lean manufacturing.

2.8.2 Muther's Systematic Layout Planning (SLP) Procedure

Murther's creating SLP. The framework for SLP is given in Figure 7,first determining the input data and activities, then define flow of materials and activity relationship. After getting the flow of materials and activity relationships determine the relationship diagram, with the space availability and requirement then will define the space relationship diagram. Observing for modifying consideration and practical limitation and from previous data develop the layout alternatives then do the evaluation of the layout.

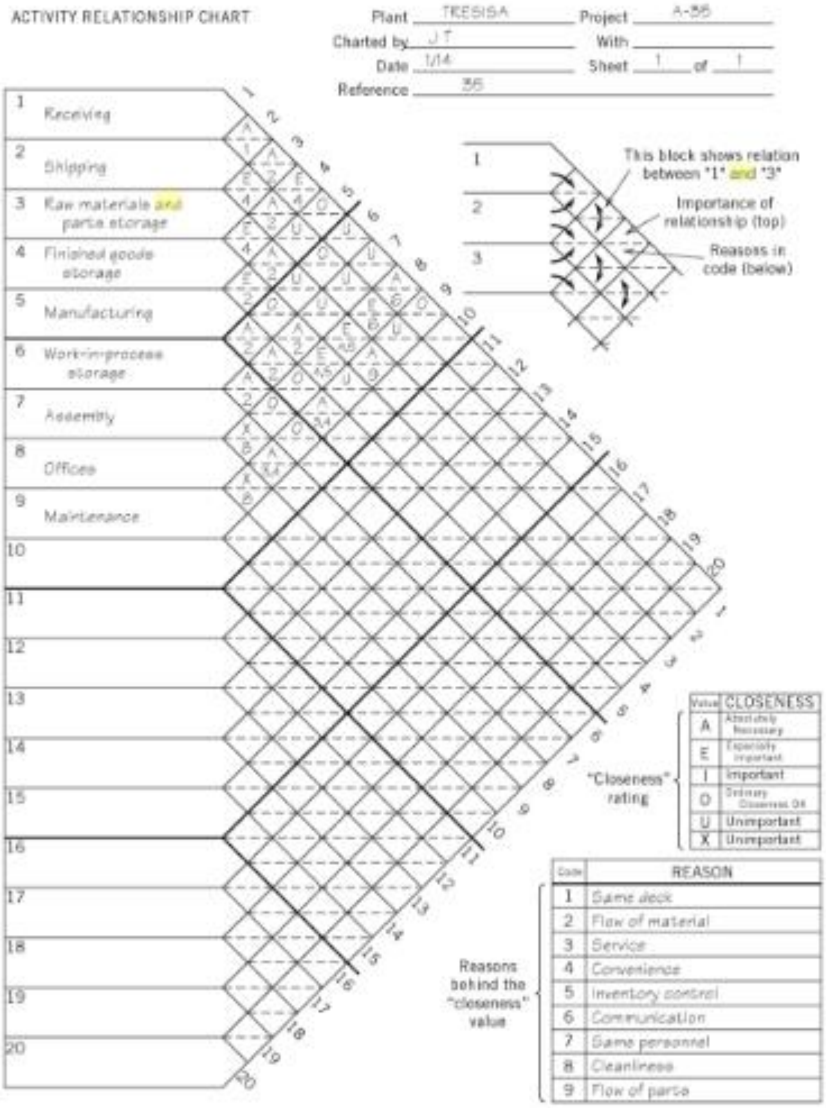
The relationship diagram positions activities spatially. Nearest option are typically used to shown the relationship between activities pairs. Although the relationship diagram is standardly in two-dimensional.



Source: Tompkins et al, 2010 P.299

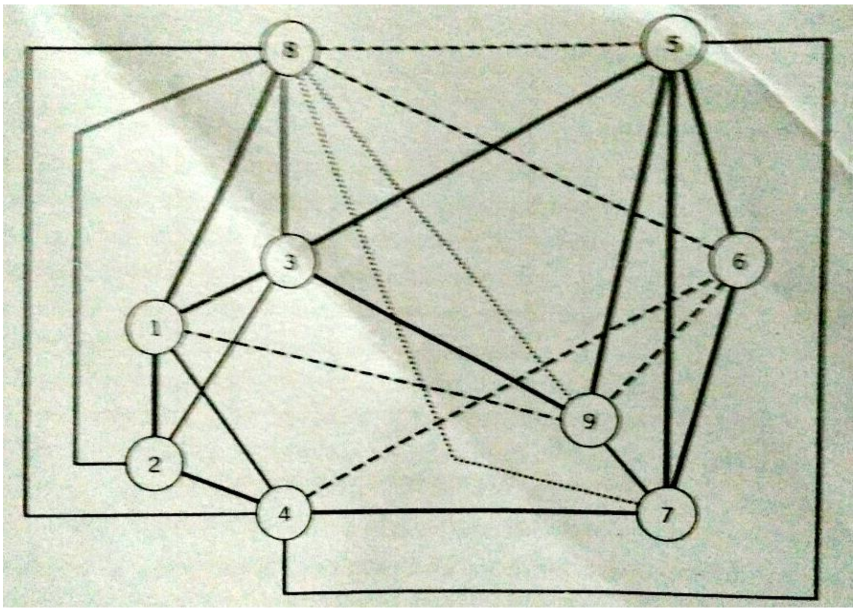
Figure 2.6 Systematic Layout Planning

The determination of the amount of space to be assigned to each activity involving two steps, area requirement and departmental would be completed for every planning department. If the space works have been made, space templates are developed for each planning department are space templates, and the space is "hung on the relationship diagram" to get the space relationship diagram



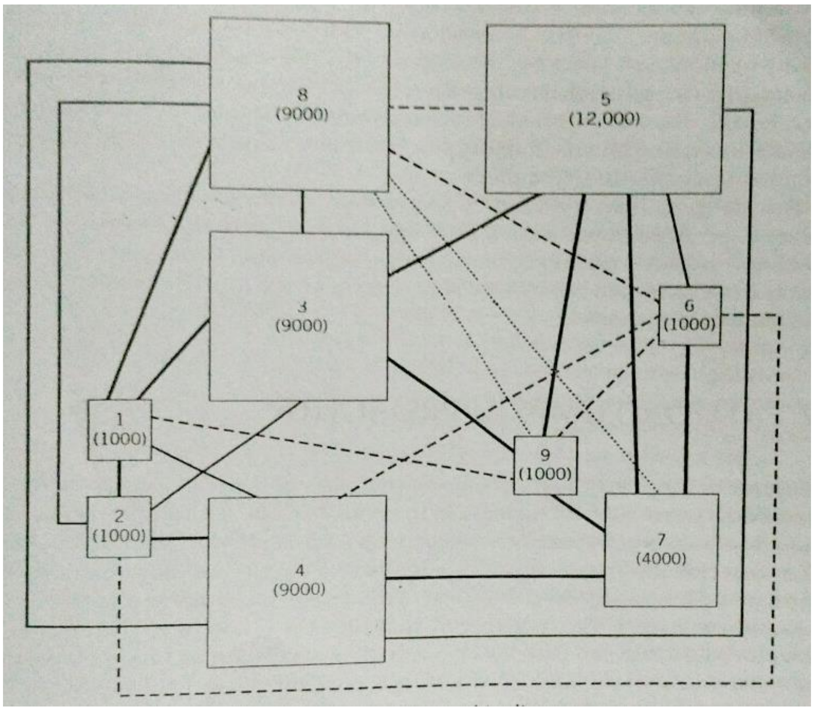
Source: Tompkins et al, 2010 P.300

Figure 2.7 Activity Relationship Chart



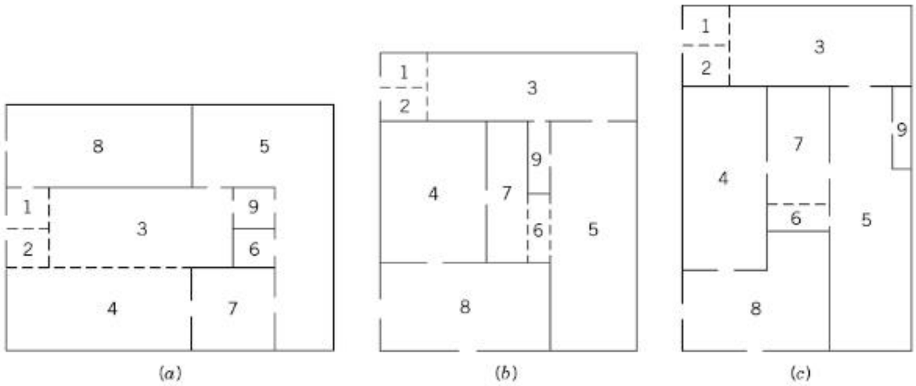
Source: Tompkins et al, 2010 P.301

Figure 2.8 Relationship Diagram



Source: Tompkins et al, 2010

Figure 2.9 Space Relationship Diagram P.301



Source: Tompkins et al, 2010 P.302

Figure 2.10 Alternative Block Layout

Stand on considered modification and practical limitation, a layout alternatives number are evaluated and developed. The preferred alternative is then identified and recommended

In the process involving the performing SLP is relatively straight forward, it doesn't necessarily have to follow that difficulties and do not arise in its implementation. Activity relationships prior assignment and the use of proximity as a measuring the degree of satisfaction of activity relationships for criterion.

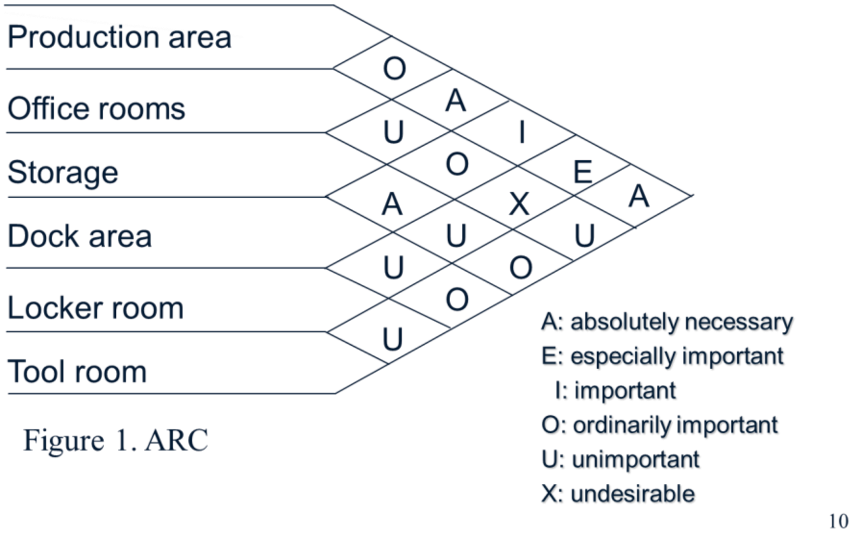
Sequentially to develop first at block layout and then a detailed layout for each planning department by using SLP procedure .In the implementation, relationships between machines, entrances, workstation and storage location to and exits from the department are used to choose the relative location of activities within every department.

2.9 ALDEP

ALDEP is a procedure of construction, this method didn't have to had initial layout for the designing processes when there isn't any of it, what need to be required for the ALDEP method are**:**

1. Size of the facility
2. The Department
3. Department Size
4. Relationship Proximity
5. A sweep width

Using activity relationship procedure to determine the relation between each department, using the closeness value then



Source: FacilityDesign_Week9_Computerized LayoutPlanning.P.19

Figure 2.11 ALDEP ARD

Department size will be assigned in block value that can be seen in Figure 2.13

- Production area (P) 14 blocks
- Office rooms (O) 10
- Storage area (S) 8
- Dock area (D) 8
- Locker room (L) 4
- Tool room (T) 4

D	D	P	P	P	P	O	O
D	D	P	P	P	P	O	O
D	D	P	P	P	P	O	O
D	D	P	P	T	T	O	O
S	S	S	S	T	T	O	O
S	S	S	S	L	L	L	L

Source: FacilityDesign_Week9_Computerized LayoutPlanning.P.20

Figure 2.12 ALDEP Block example

Using the layout, the adjacency relationships and the proximity ratings, we can find an overall rating of each layout. Then, the layout with the highest overall rating is selected.

After a layout is obtained, a score for the layout is computed with the following conversion of proximity relationships:

A	= 43	= 64,	E	= 42	= 16
I	= 41	= 4,	O	= 40	= 1
U	= 0,		X	= -45	= -1024

If two departments are adjacent in the layout then the weight corresponding to the rating between the two departments is added to the score. Compute the overall rating of the constructed layout.

- Adjacent departments:

(D,S)	(D,P)
(S,P)	(S,T)
(S,L)	(P,T)
(P,O)	(T,L)
(T,O)	(L,O)

D	D	P	P	P	P	O	O
D	D	P	P	P	P	O	O
D	D	P	P	P	P	O	O
D	D	P	P	T	T	O	O
S	S	S	S	T	T	O	O
S	S	S	S	L	L	L	L

Source: FacilityDesign_Week9_Computerized LayoutPlanning.P.22

Figure 2.13 Adjacent Departments

Table 2.2 ALDEP Score

Adjacents Dept	Proximity Ratings	Value	Score
(D,S)	A	64	128
(D,P)	I	4	8
(S,P)	A	64	128
(S,T)	O	1	2
(S,L)	U	0	0
(P,T)	A	64	128
(P,O)	O	1	2
(T,L)	U	0	0
(T,O)	U	0	0
(L,O)	X	-1024	-2048
		-763	**-1526**

Source: FacilityDesign_Week9_Computerized LayoutPlanning.P.22

The process is repeated using the same method and the highest score within the layout option are chosen, this is important because ALDEP also uses a cut-off score (if not specified by the user this cut-off is zero) to eliminate any layout which has a layout score less than the cut-off score.

2.10Warehouse Operation

At the mercy of myriad business, logistics, and government initiatives-including lean manufacturing, lean supply chain, global sourcing, quick response, continuous flow distribution, enhanced customer satisfaction, operator safety, and sustainability warehouse operations have been and are continuously being revolutionized.

2.10.1 Aisle of Material Handling

The space required for aisle of material handling may be determined by considering the number of carriers for which merchandise is to be stored in these areas and the space required to store the merchandise for each carrier.

This space is provided between the backside of the duckboard and the beginning of the buffer or staging areas. Maneuvering space is dependent on the type of material handling equipment in Table

Table 2.3 Minimum Maneuvering for receiving and shipping areas

Material Handling Equipment Utilized	Minimum Maneuvering Allowances (Feet)
Tractor	14
Platform truck	12
Forklift	12
Narrow-aisle truck	10
Handlift (Jack)	8
Four-wheel Hand Truck	8
Two-wheel Hand Truck	6
Manual	5

Source: Tompkins et al, 2010 P.406

2.10.2 Receiving and Shipping Operation

Uncertainty can occur in planning shipping and receiving facilities if the carriers that intersect with shipping and receiving operation are not properly considered. Their characteristics and placing of the carriers are necessary to shipping and receiving operations.

2.10.3 Storage Medium

The primary advantage of using storage rack is that they maximize of space utilization in a warehouse. Each rack has a number of storage spaces that are arranged from top to bottom and left to right, and that are used for storing items in the warehouse.

- Stacking frames

  Pallets are sometimes stacked using vertical steel frames that can be attached to the four corners of a standard wooden pallet. Horizontal beams that can be attached to the four vertical frames allow pallets to be stored on them.

- Cantilever Rack

  Cantilever beams supported from vertical members allow much storage flexibility. Although these are typically used for storage of long loads such as rods, tubes, and pipes, they can be fitted with decks and used us a regular rack to store smaller loads

- Selective Rack

For every storage bay, this rack has a pair of vertical uprights, horizontal beams, and cross-braces for stability. The bay length depends on the length of the horizontal beams.

2.11 Facilities Systems

The objective of this chapter is not to prepare the facilities planner to become an architect, mechanical engineer, structural engineer, or builder. Rather, it is to provide the facilities planner with a unsuited picture of the interrelationships and technology building of the planner to design a heating or its structure, air conditioning, and ventilation or other systems. The intent is to setup information of how the impact element system the whole process of facilities planning. The facility systems considered in this chapter are :

1. Structural Systems
2. Atmospheric systems
3. Enclosure systems
4. Lighting and electrical systems
5. Life safety systems
6. Sanitation systems
7. Building automation systems
8. Computerized maintenance management systems

In this case the used calculation are only using lighting and electrical systems and life safety systems

2.11.1 Electrical and Lighting Systems

The planner responsibility is to describe what service level is need and where it is required. The power company needs the electrical load requirement for a facility well before construction begins.

2.11.2 Lighting

Lighting systems may be designed using the following eight-step procedure:

Step 1. Determine the level of illumination

The minimum levels of illumination for specific task are given in table 2.4. When selecting the level of illumination for a particular workstation, the following criteria must be considered

- The nature of the task
- The amount of reflectivity of the workstation, components, and surrounding area
- The current levels of natural or general ambiance
- Natural illumination requirement
- Visual acuity and The worker's age

Step 2. Determine the room cavity ratio (RCR)

The RCR is an index of the shape of a room to be lighted. The higher and narrower a room, the larger the RCR and the more illumination needed to achieve the required level of lighting. The RCR may be calculated using equation.

(2-2)

$$RCR = \frac{(5)(Height\ from\ the\ working\ surface\ to\ the\ luminaris)(Room\ length + Room\ Width)}{(Room\ Length)(Room\ Width)}$$

Step 3. Determine the ceiling cavity ratio (CCR)

If luminaries are ceiling mounted or recessed into the ceiling, then the reflective property of the ceiling will not be impacted by the luminaries' mounting height, so the CCR need not be considered. The greater the distance to the luminaries from the ceiling, the bigger will be the CCR and the reduction in ceiling reflectance. The CCR may be calculated using equation

(2-3)

$$CCR = \frac{(Height\ from\ luminaries\ to\ ceiling)(RCR)}{Height\ from\ the\ working\ surface\ to\ the\ luminaries}$$

Table 2.4Minimum Illumination levels for specific visual task

Task	Minimum Illumination Level
Assembly	
Rough easy -seeing	30
Rough difficult-seeing	50
Medium	100
Fine	500
Extra fine	1000
Inspection	
Ordinary	30
Difficult	50
Highly difficult	100
Very difficult	500
Most difficult	1000
Machine Shop	
Rough bench and machine-work	50
Medium bench and machine work, ordinary automatic mahines, Rough grinding, medium buffing and polishing	100
Fine bench and machine work, fine automatic machine, medium grinding, medium buffing and polishing	500
Extra fine bench and machine work, fine grinding	1000
Material Handling	
Wrapping, packing, Labeling	50
Picking stock, classifying	30
Loading	20
Office	
Reading high or well-printed material; task not involving critical or prolonged seeing, such as conferring, interviewing, and inactive files	30
Reading or transcibing handwriting in ink or medium pencil on good quality papper; intermittent filling	70
Regular office work	100
Accounting, auditing, tabulatiuon, etc	150
Cartography, designing, detailed drafting	200
Corridors, elevators, escalators, stairways	20
Paint Shops	
Dipping, spraying, rubbing, firing, and ordinary hand painting	50
Fine hand painting and finishing	100
Extra-fine hand painting and finnishing	300
Storage rooms and Warehouse	2
inactive	5
Active	
Roughly	
bulky	10
Medium	20
Fine	50
Welding	
General	50

illumination Precision manual arc welding	1000

Source: by Tompkins et al, 2010 P.492

Step 4. Determine the wall reflection (WR) and the effective ceiling reflectance (ECR)

The WR and base ceiling reflectance (BCR) value can be obtained from table 2.5 if the luminaries are to be ceiling mounted or recessed into the ceiling, the ECR is equal to the BCR. If luminaries are to be suspended, the ECR is determined from the CCR, WR, and BCR using table 2.6

Table 2.5 Approximate Reflectance for Wall and Ceiling Finishes

Materials	Approximate Reflectance (%)
White paint, light-colored paint, mirrored glass, and porcelain enamel	80
Aluminum paint, stainless steel, and polished aluminum	65
Medium-colored paint	50
Brick, Cement, and concrete	35
Dark-colored paint, asphalt	10
Black Paint	5

Source: Tompkins et al, 2010 P.493

Step 5. Determine the coefficient of utilization (CU)

The CU is the ratio of lumens reaching the work plane to those emitted by the lamp. It is a function of the luminaries used, the RCR, the WR, and the ECR. The CU for standard luminaries is given in Table 2.7

Step 6. Determine the light loss factor (LLF)

Two of the most significant loss of light factors are lumen of lamp deprecation and dirt of luminary depreciation. Lamp lumen depreciation is the gradual reduction in lumen output over the life of the lamp.

Step 7. Calculate the lamps number and luminaries

Calculate the lamps number and the luminaries using Equation (2-4) and (2-5)

$$Number\ of\ Lamps = \frac{(Required\ level\ of\ lumination)(\ Area\ to\ be\ lit\ )}{(CU)(LIF)(Lamp\ output\ at\ 70\%\ of\ rated\ life} \quad (2\text{-}4)$$

$$Number\ of\ luminaries = \frac{Number\ of\ lamp}{Lamps\ per\ luminary} \quad (2\text{-}5)$$

Table 2.6The Percent (%) effective Ceiling Reflectance for various Combinations of ceiling Cavity Ratios, Wall Reflectance and Base Ceiling Reflectance

	WR																																			
	80						65						50						37						10						5					
	WR						WR						WR						WR						WR						WR					
CCR	80	65	50	35	10	5	80	65	50	35	10	5	80	65	50	35	10	5	80	65	50	35	10	5	80	65	50	35	10	5	80	65	50	35	10	5
0.5	76	74	72	69	67	65	64	60	58	56	54	52	49	47	46	44	42	41	36	34	32	31	29	28	12	12	11	11	9	8	8	8	7	6	5	5
1.0	74	71	67	63	57	56	60	55	53	49	45	43	48	45	43	39	36	35	35	33	31	20	26	25	14	13	12	11	9	8	10	7	8	7	5	4
1.5	72	67	62	55	49	47	58	52	49	44	38	36	47	44	40	35	21	28	35	33	20	26	21	20	16	15	12	11	8	7	14	11	9	7	4	4
2.0	69	63	56	49	41	39	55	49	44	38	32	30	46	42	37	31	26	25	35	32	28	23	18	17	18	17	13	10	8	6	15	12	10	7	4	4
2.5	67	60	51	43	35	33	54	45	40	33	26	25	46	40	35	28	22	21	35	31	26	21	16	13	20	19	13	10	7	5	17	14	10	8	3	3
3.0	65	57	47	38	30	28	53	42	38	29	22	21	45	39	32	25	19	18	35	31	24	20	14	12	21	20	13	10	7	4	19	15	11	8	3	3
3.5	63	54	43	34	26	25	52	39	33	26	18	17	44	38	30	23	17	16	35	31	23	18	12	10	22	21	13	10	7	4	20	16	11	8	3	3
4.0	61	52	46	34	22	21	50	37	31	23	15	14	44	38	28	21	15	13	34	30	23	17	10	8	23	22	14	10	7	3	20	17	12	8	3	2
5.0	58	46	35	26	18	15	48	33	26	18	9	8	42	35	25	18	12	10	34	29	21	16	9	7	25	23	14	10	6	3	23	18	12	8	3	2
8.0	50	36	25	17	11	6	41	24	18	11	5	3	40	30	19	13	7	5	34	28	17	11	5	4	27	24	13	10	5	2	26	19	12	6	3	1

Source Tompkins et al, 2010 P.494

Table 2.7 Coefficients of utilization for standard luminaries

Luminaries	Spacing Not to Exceed	RCR	ECR 80% WR 80%	ECR 80% WR 50%	ECR 80% WR 30%	ECR 80% WR 10%	ECR 50% WR 80%	ECR 50% WR 50%	ECR 50% WR 30%	ECR 50% WR 10%	ECR 10% WR 80%	ECR 10% WR 50%	ECR 10% WR 30%	ECR 10% WR 10%	ECR 0% WR 0%
Filament Reflector lamps	1.5 x Mounting Height	1	1.11	1.09	1.07	1.03	1.04	1.02	1.00	0.98	0.96	0.95	0.94	0.93	0.91
		2	1.04	1.00	0.95	0.92	0.99	0.95	0.92	0.88	0.92	0.90	0.87	0.85	0.83
		3	0.95	0.92	0.88	0.82	0.92	0.88	0.84	0.80	0.85	0.83	0.80	0.77	0.75
		4	0.90	0.85	0.79	0.73	0.86	0.81	0.76	0.71	0.79	0.77	0.73	0.70	0.68
		5	0.82	0.77	0.71	0.65	0.80	0.75	0.69	0.64	0.75	0.71	0.67	0.63	0.61
		10	0.58	0.50	0.43	0.38	0.54	0.49	0.43	0.38	0.51	0.47	0.42	0.38	0.36
High-intenstity discharge lamps	1.3 x Mounting Height	1	0.59	0.87	0.84	0.82	0.81	0.80	0.78	0.77	0.74	0.73	0.72	0.71	0.70
		2	0.82	0.79	0.75	0.72	0.70	0.74	0.71	0.68	0.70	0.68	0.66	0.64	0.63
		3	0.76	0.72	0.67	0.63	0.72	0.68	0.64	0.61	0.65	0.63	0.60	0.58	0.56
		4	0.70	0.66	0.61	0.57	0.67	0.63	0.58	0.55	0.57	0.55	0.51	0.53	0.51
		5	0.64	0.60	0.55	0.51	0.62	0.58	0.53	0.49	0.56	0.54	0.52	0.49	0.46
		10	0.45	0.40	0.34	0.30	0.42	0.38	0.34	0.30	0.40	0.36	0.41	0.20	0.28
Fluorescent lamp in uncovered fixtures	1.3 x Mounting Height	1	0.88	0.85	0.82	0.79	0.79	0.65	0.72	0.71	0.65	0.61	0.63	0.62	0.59
		2	0.78	0.75	0.70	0.65	0.71	0.67	0.63	0.59	0.60	0.57	0.55	0.52	0.50
		3	0.69	0.66	0.60	0.55	0.63	0.59	0.54	0.50	0.54	0.51	0.48	0.45	0.42
		4	0.61	0.59	0.52	0.46	0.60	0.52	0.47	0.43	0.48	0.45	0.41	0.38	0.36
		5	0.53	0.51	0.44	0.39	0.51	0.46	0.40	0.36	0.43	0.40	0.36	0.33	0.30
		10	0.35	0.30	0.23	0.19	0.32	0.27	0.21	0.18	0.26	0.23	0.19	0.16	0.14
Fluorescent lamps in prismatic lens fixtures	1.2 x Mounting Height	1	0.65	0.63	0.61	0.59	0.60	0.59	0.58	0.56	0.56	0.55	0.51	0.53	0.52
		2	0.60	0.57	0.54	0.51	0.56	0.54	0.51	0.49	0.10	0.50	0.49	.47+	0.46
		3	0.54	0.51	0.48	0.44	0.51	0.49	0.46	0.43	0.47	0.46	0.44	0.42	0.41
		4	0.49	0.46	0.42	0.39	0.48	0.44	0.41	0.38	0.44	0.42	0.39	0.37	0.63
		5	0.45	0.42	0.37	0.34	0.44	0.40	0.36	0.34	0.40	0.38	0.35	0.33	0.32
		10	0.31	0.26	0.21	0.18	0.29	0.25	0.21	0.18	0.27	0.24	0.20	0.18	0.17

Source Tompkins et al, 2010 P.495

Step 8. Determine the location of the luminaries

The number of luminaries calculated. Will result in the correct quantity of light. In addition to the quantity of light, the quality of light must be considered. The most important factors affecting the quality of light are glare and diffusion. Glare is defined as any brightness that causes discomfort, interference with vision, or eye fatigue

Table 2.8 Lamp Output at 70% of rated life

Lamp Type	Watts	lamp output at 70 % of rated life (Lumens)
Filament	100	1600
	150	2600
	300	5000
	500	10000
	750	15000
	1000	21000
High-intensity discharge	400	15000
	700	28000
	1000	38000
Fluorescent	40	2500
	60	3300
	60	3300
	85	5400
	110	7500

Source: Tompkins et al, 2010 P.496

Table 2.9 Lamp Luminary Dir Depreciation Factors

	Dirt Condition																			
	Clean-Offices, Light Assembly, or Inspection					Medium - Mill Offices Paper Processing or Light Machining					Dirty- Heat treating, High-Speed Printing or Medium Machining					Very Dirty-Foundry or Heavy Machining				
	Months Between Cleaning					Months Between Cleaning					Months Between Cleaning					Months Between Cleaning				
Luminaries	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48	0	12	24	36	48
Filament reflector lamps	0.95	0.93	0.89	0.86	0.83	0.94	0.89	0.85	0.81	0.78	0.87	0.84	0.79	0.74	0.70	0.83	0.74	0.60	0.56	0.52
High-Intensity discharge lamps	0.94	0.90	0.84	0.80	0.75	0.92	0.88	0.80	0.74	0.69	0.90	0.83	0.76	0.68	0.64	0.86	0.79	0.69	0.63	0.57
Fluorescent lamps in uncovered fixtures	0.97	0.94	0.89	0.87	0.85	0.93	0.90	0.85	0.83	0.79	0.93	0.87	0.80	0.73	0.70	0.88	0.83	0.75	0.70	0.64
Fluorescent lamps in prismatic lens fixtures	0.92	0.88	0.83	0.80	0.78	0.88	0.84	0.77	0.73	0.71	0.82	0.78	0.71	0.67	0.62	0.78	0.72	0.64	0.60	0.57

Source: Tompkins et al, 2010 P.498

2.11.3 Life safety Systems

Life safety systems are determined to deceive the emergency situations that will disrupt whole operations. These emergencies are created primarily by

- Fire
- Seismic Events
- Power Failures

The fire is the most pervasive of the accounts and three for the biggest of costs associated with disaster. Fire resistance is therefore critical in the design of any facility. Fire protection for buildings is governed by the uniform building code. UBC is a model building code that outlines the protection features that must be included in the building design. The features that are typically covered are fire ratings of walls, floors, and roofs as well as egress, sprinklers, and standpipe requirements.

2.11.3.1 Fire Protection and safety

The first objective of the facilities planner is to determine the building's function and construction type as defined by the occupancy classification. These occupacncy classifications are based on the International Building Code (IBC). In general, the following facility types typically account for all occupancy classifications in the United States.

Table 2.10 International Building Codeby

Group	Type
A	Assemblies, theaters
E	Educational facilities
I	Instituytional occupancies
H	Hazardous occupancies
B	Business, office, government buildings
R	Residential
M	Mercantile
F	Factories, manufacturers, and processing
S	Storage
U	Utility and miscellaneous

Source: Tompkins et al, 2010 P.500

Using the International building code for industries and maximum floor area allowances per occupant the equation will be:

(2-6)

$$Maximum\ population = \frac{Maximum\ floor\ area}{Allowance\ per\ Occupant}$$

$$The\ distance\ between\ exits = \frac{The\ diagonal\ dimension}{4} = \frac{d}{4}$$

Note: If the building does not have sprinklers, exits should be d/2

(2-7)

$$Capacity\ per\ exits = \frac{Occupants}{Minimum\ Number\ of\ exits}$$

$$Minimum\ width = Capacity\ per\ exits\ X\ 0.2"$$

Table 2.11(2003 IBC Table 1004.1.2) Maximum Floor Area Allowances per Occupantby

Use	Floor area per occupant (ft²)	
Agricultural building	300	Gross
Aircraft hanger	500	Gross
Airport terminal		
Baggage claim	20	Gross
Baggage handling	300	Gross
Concourse	100	Gross
Waiting areas	15	Gross
Assembly		
Gaming floors	11	Gross
Assembly with fixed seats		
Assembly without fixed seats		
Concentrated	7	Gross
Standing space	3	Gross
Unconcentrated	15	Gross
Bowling alleys allow five persons for each alley, including 15' of runway, and for additional areas	7	Gross
Business areas	100	Gross
Court Room-Other than fixed seating areas	40	Gross
Dormitories	50	Gross
Educational		
Classroom area	20	Gross
Shops and other vocational room areas	50	Gross
Exercise rooms	50	Gross
H-5 fabrication and manufactiromg areas	200	Gross
Industrial areas	100	Gross
Institional areas		
Inpatient treatment areas	240	Gross
Outpatient areas	100	Gross
Sleeping areas	120	Gross
Kitchen, commercial	200	Gross
Library		
Reading room	50	Gross
Stack areas	100	Gross
Mercantile		
Basement and grade floor areas	30	Gross
Areas on other floors	60	Gross
Storage, stock, shipping areas	300	Gross
Parking garages	200	Gross
Residential	200	Gross
Skating rinks, swimming pools		

Rink and pool	50	Gross
Decks	15	Gross
Stages and platform	15	net
Accesory storage areas, mechanichal		
Equipment room	300	Gross
Warehouse	500	Gross

Note: 1 ft = 304.8 mm; 1 ft² = 0.093 m

Source: Tompkins et al, 2010 P.502

Table 2.12(BOAC Table 809.2) Minimum Number of Exits for Occupant Loadby

Occupant Load	Maximum number of exits
500 or less	2
501-1000	3
Over 1000	4

Source: Tompkins et al, 2010 P.503

CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Methodology

This chapter consists of initial observation, problem identification, literature study, data collection and analysis, conclusion, and recommendation.

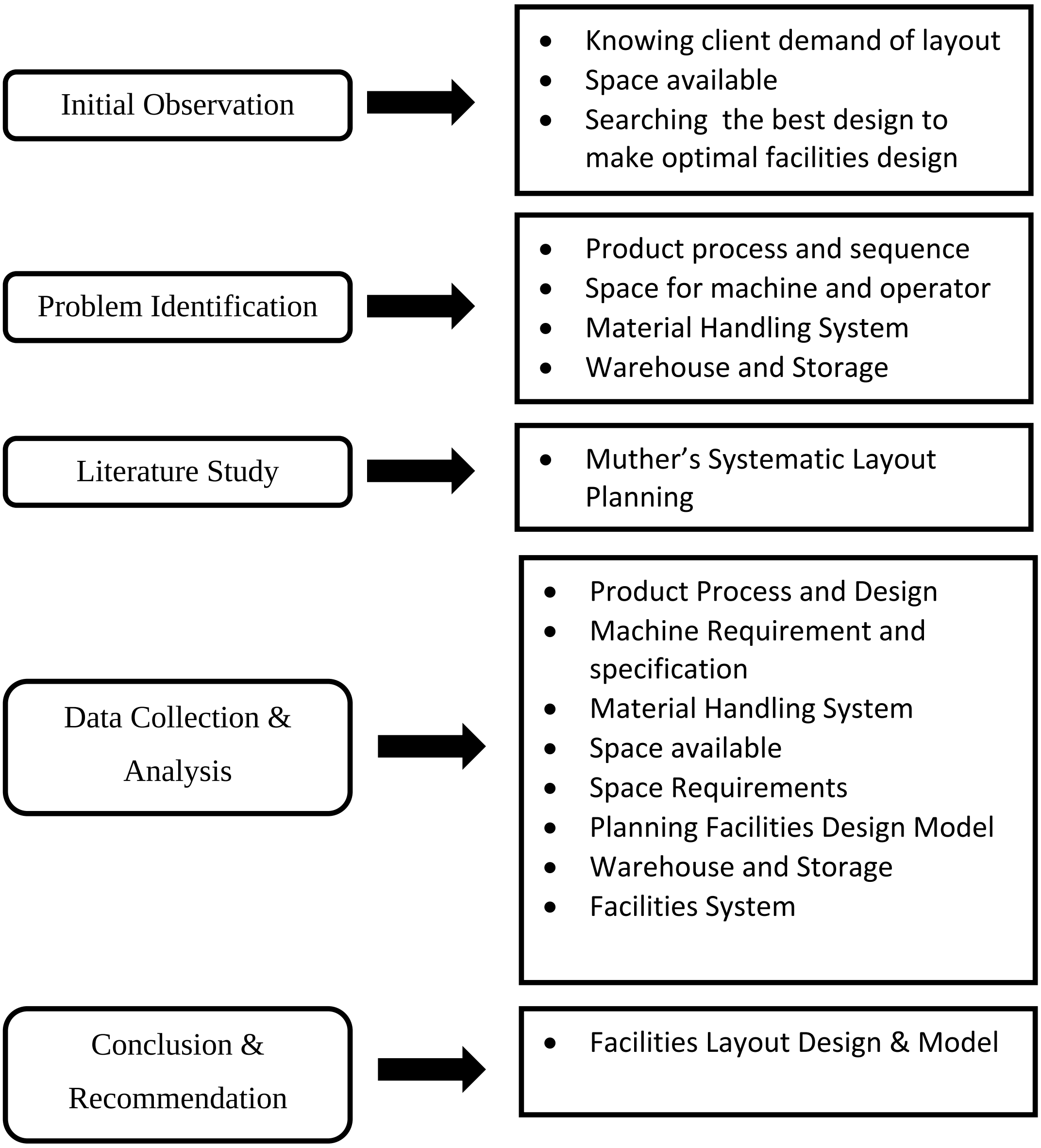


Figure 3.1 Research Framework

3.1.1 Initial Observation

This section will explained about the problem background to choose the topics of the research, by observing the usual problem that can happen in Paint Shop Industry extensively. After the observation, there are several things need to be prepared for optimal layout design. First the demand of the costumer which commonly has own his/her rough idea and determining the space available for optimal facilities design.

3.1.2 Problem Identification

This section is about explaining about the problem that found in designing the facilities and lay out design. Having little space available for quite big working process, because it will increase the productivity of the company by designing the optimal design for the layout problem, there are several things that required for this paint shop service manufacturing which are; Paint mixing, this process need high caution because of it need the right amount of mix proportion and the room for this process need to be clean (no-dust); Spray process, the process when the costumer's material are being sprayed with the spray booth and spray gun, this spray room need to be closed to the mixing room because there are cable that connected from the mixing room to the spray booth and spray gun; Oven room, the heat treatment process for the painted material so the painted material will coat well, this room requires heat control attention because the heat that comes out from the oven; Quality control, the process of checking the heated and painted material, if there is any defect the material should be repainted from all over again; Polishing and finish good quality control, this room are the final process for the material, the material will be polished for touch up the color of the paint, the room itself need special lighting for checking and polishing.

The paint job service manufacturing using hazardous and chemical material so it must have waste management and high safety attention for the operator and the layout, with the right design and calculation it will pressed the risk that will happening within the manufacturing.

Warehouse and storage needs to be right calculated because of the material that been processed are automotive part like car bumper, rack design and the right material handling are needed to be design carefully

3.1.3 Literature Study

In this chapter is industrial engineering theory that will explained that appropriate in order to solve the problem as the goal of the research. Using the Muther's method to determine the relation between the processes needed and determine the right layout. Every jobs requires each operation and several operation will be operated on a separate machine.

Product processes and analysis to determine how much space requirement needed for the layout, after that the machine specification for the machine requirement for each process. Material handling system will be determine to acquire the flow of the material and relation between process are also analyze so the facilities design and model can be determine. Warehouse and storage operation to get the right amount of how much demand can be handled. Facilities system for the right environmental for the worker to get comfortable and safety work environment. Waste disposal management for eco green company because paint job service require chemical process that need to be recycled.

3.1.4 Data collection and Analysis

In this part is describing about how the data will be calculated and analyzed. Thus, it will tell describe how the conclusion is in order to design the facilities. The first thing that will be done to get the data is to find the machine specification and requirement and the relationship between all of them. This step is really necessary to know the exact layout, because there is several location that need to be closed enough so didn't distrust any future processes. Also determining the sequence of process is necessary thing because the step will described about which one of the layout should be run first and what process should be run for the next

3.1.5 Conclusion and Recommendation

In this chapter is describing about the visualization and conclusion for future of the research about the design that have been gathered from the last sections. Also, the outcome will define whether the research objective can be achieved or not.

3.2 Detail of Research Framework

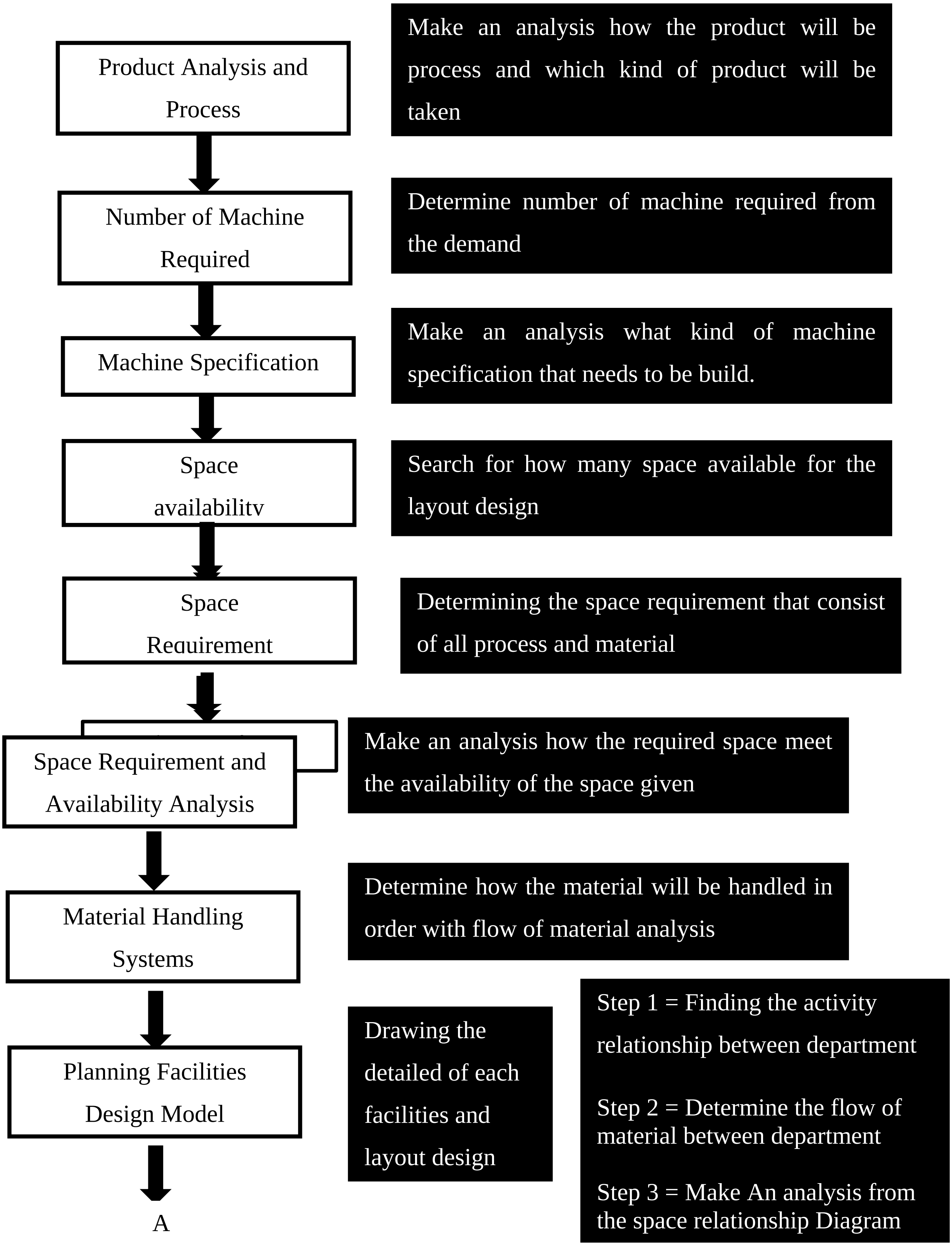


Figure 3.2 Continued on the next page

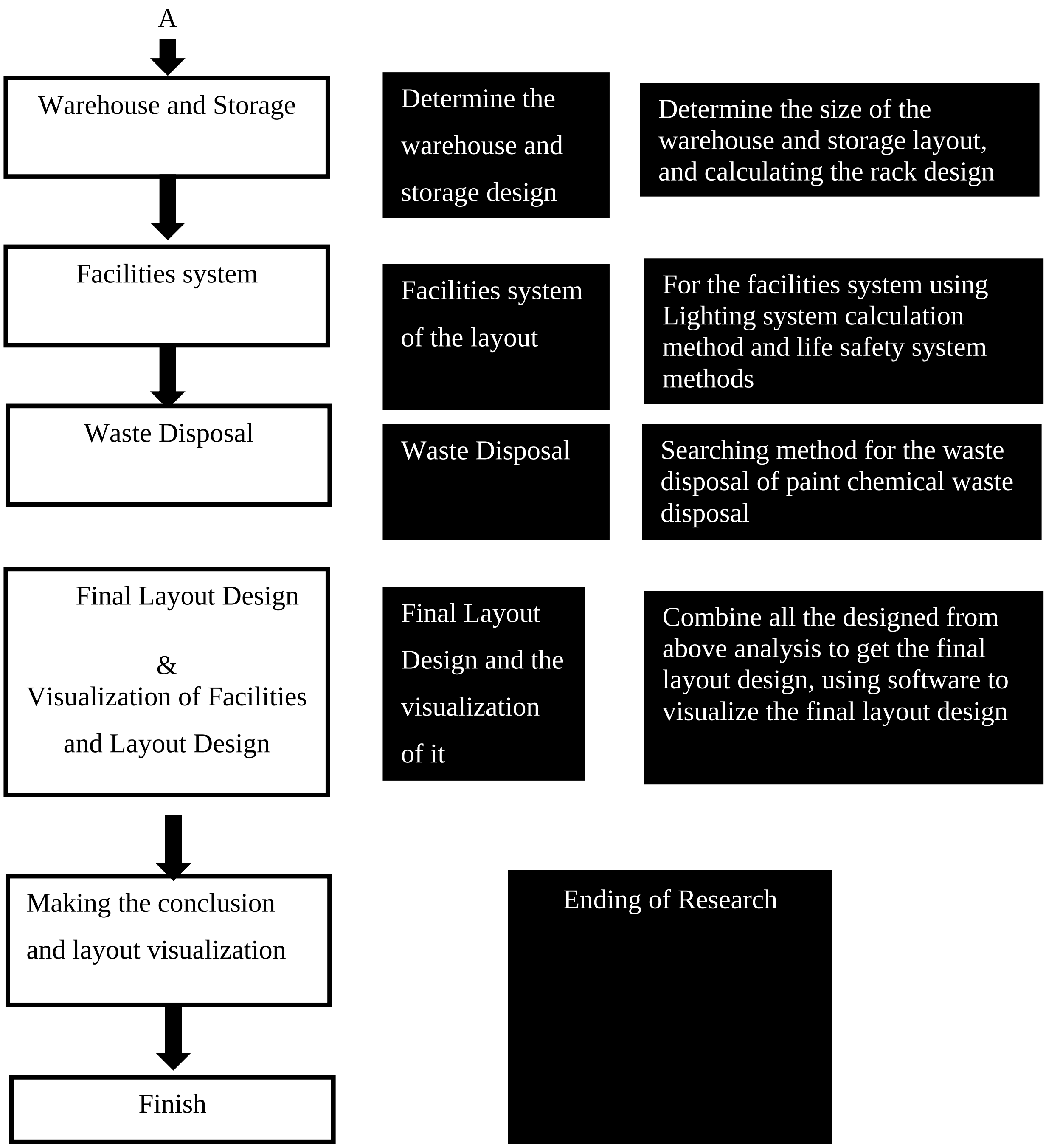


Figure 3.2 Detailed of Research Framework

As can be seen in Figure 3.2, the first step of doing this thesis is to find the product process and analysis, after that determining the machine requirement that come with the machine specification. After getting the product and machine requirement then do the analysis of space requirement and space availability, to get the space requirement first must define the material handling flow and equipment, with that develop the facilities and layout design with the SLP procedure and using two methods which are Block Layout and ALDEP Method.

After determining the layout do the design of warehouse and storage such as rack, placement of material handling equipment with the aisle and maneuver calculation. Then determine the facilities system such as ambiance and life safety system environment. Search option for waste disposal management, and then develop the final layout design for the manufacture. Do the evaluation for the final layout design and the conclusion.

CHAPTER IV
DATA CALCULATION AND ANALYSIS

4.1 Problem Identification

The future paint shop needs that need to be design required several things that need to be analyzed and calculated. This paint shop focused on automotive part, using three mainly generally paint types used in automotive paint which produce which are solvent-based, water-based, and powder. Solvent and water based types construct of two main components, the 'carrier' (water or solvent) and the 'solid' (color) and.

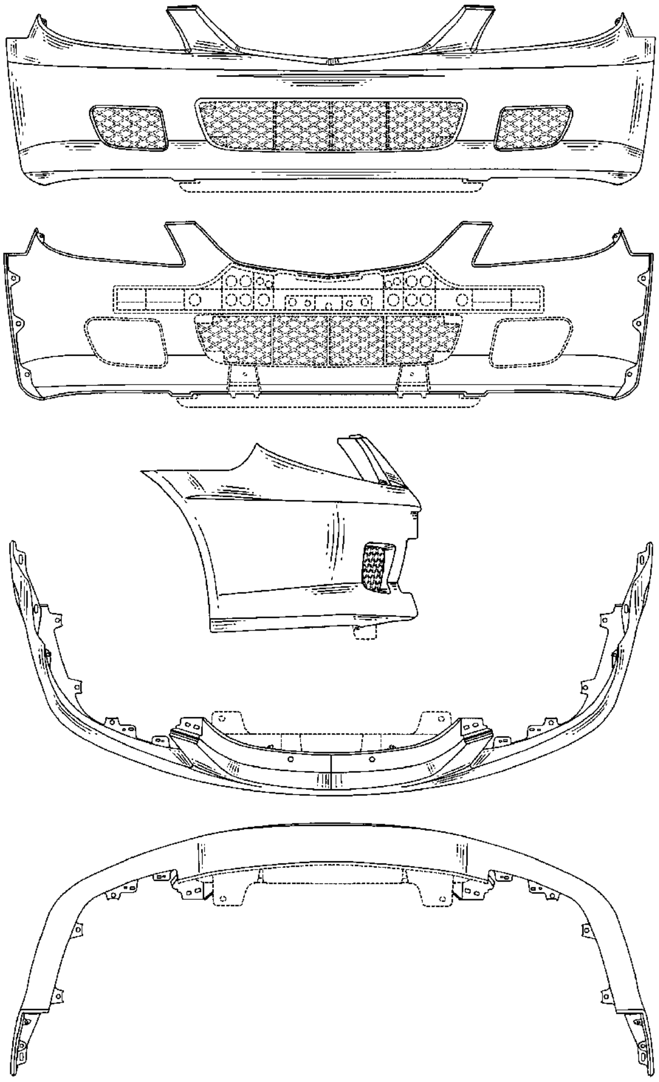
Table 4.1 Customer Demand

Name	Paint Service Layout	
Description	Amount of Demand	Unit Type
Car Bumper	**300 per Month**	**Automotive Parts**

Table 4.1 shows the amount of demand for the layout, from this data the calculation can be made for how much space requirements that needs to be added.

4.2 Product Analysis

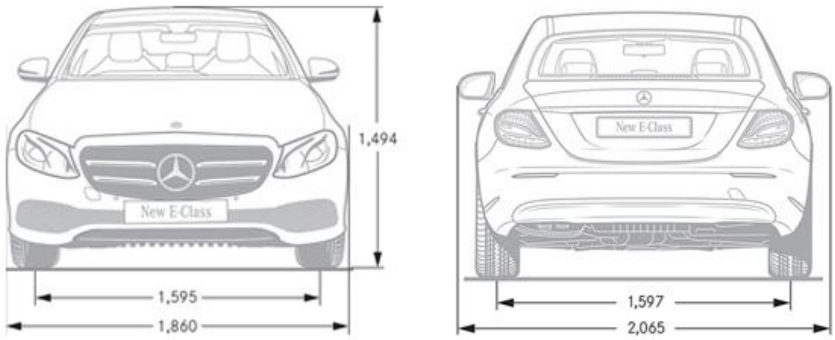
Discussed about the product that going to be made by the manufacture. The product will be automotive part of car with the given standard of car bumper that will be paint



By Mitsubishi Car Bumper

Figure 4.1 Product Design

It is shown from the figure 4.1, the four faces of car bumper the cross-section web in the picture show the no-painted part, the rest of the area must be paint with the precise demanded color. The dimension of bumper can be seen in Table 4.2.



By Mitsubishi Car Bumper

Figure 4.2 Front& Back Car Bumper Dimension

Table 4.2 Bumper Specification

Car dimension	
Height	**< 41 - 51**
Front Bumper	
Outer Length	**1,860 Cm**
Inside Length	**1,595 Cm**
Back Bumper	
Outer Length	**2,065 Cm**
Inside Length	**1,597 Cm**

4.3 Product Process

Process of painting with the product, automotive Paint act as buffer between the processes of the two main stages of vehicle production: Body and Paint. As every process has different processes requirements, car bodies can be re-process to pass through in the optimum order.

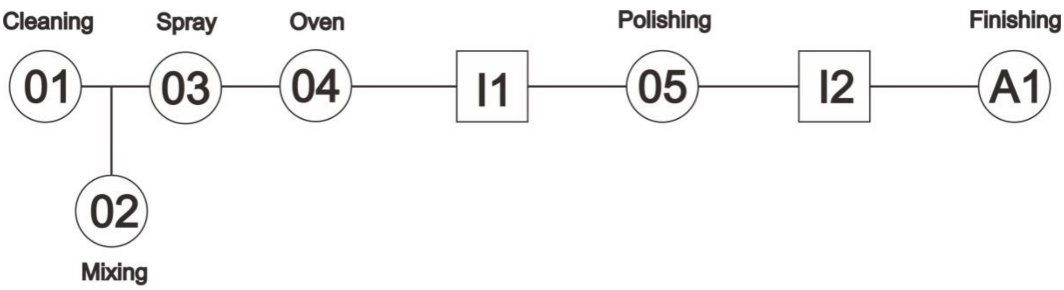


Figure 4.3Process Chart

The operation process chart as shown in Figure 4.3 describes how the product will be produced, cleaning the material is a must do preventing any defect in the product. The base material of the paint will be mixed in the mixing room and put in the sucking tank and delivered to the spray gun. After painting process the required product will be heated in the oven at temperature ranging from 130 to 150 degrees Celsius.

After the top-coat has been applied, a process known as ‘heated flash off’ allows vapour from the paint to evaporate and disperse. After the heat treatment process, there will be an inspection for the product if there is/are defect in the product it will be bring back in the cleaning process, if not the product will go to the polishing process for the touch up of the paint, and finally last inspection of the product, this last inspection process determine the product finish or not, if there is a defect all the process have to be restart from the cleaning process. The required flow process can be seen in the Figure 4.4.

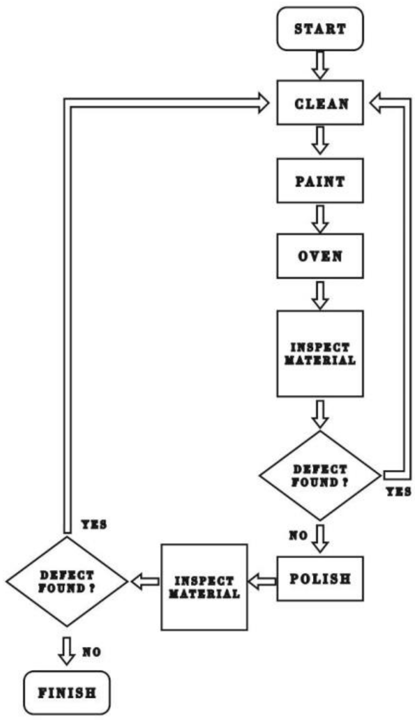


Figure 4.4 Flow Process Chart

4.4 Number of machine required

Each machine has its own calculation for how much the machine have to be will be present in table 4.3. The calculation of the data described in sub-title below

4.4.1 Spray Booth Machine Requirement

Spray booth had a standard processing time of 30 minutes per part on a spraying process. During an eight-hour shift, 15 units had to be made. In the determined production time, which is 480 minutes, the spray machine will be produce 90% of the time. During processes of the machine is operational, parts are manufactured at a rate equal to 99% of the rate standard. From the known data the required machine can be calculated using equation (2-1).

S = 30 Minutes per part

Q = 15 Units per shift

H = 480 Minutes

E = 0.95 R = 0.80

$$F = \frac{30\ (15)}{0.95\ (480)(0.8)} = \frac{450}{364.8} = 1.2\ machines\ per\ shift$$

4.4.2 Oven Machine Requirement

An oven has a standard machining time of 30 Minutes per part at 70 degrees to flesh on a heat treatment process. During an eight-hour shift, 15 units had to be made. In the determined production time, which is 480 minutes, the oven machine will be produce 90% of the time. During processes of the machine is operational, parts are manufactured at a rate equal to 95% of the rate standard. From the known data the required machine can be calculated using equation (2-1).

S = 30 Minutes per part

Q = 15 Units per shift

H = 480 Minutes

E = 0.95 R = 0.80

$$F = \frac{30\ (\ 15\ )}{0.95\ (\ 480\ )(\ 0.8\ )} = \frac{450}{364.8} = 1.2\ machines\ per\ shift$$

4.4.3 Polishing Machine Requirement

Polishing has a standard machining time of 90 on a polishing process. During an eight hour shift, 15 units had to be made. In the determined production time, which is 480 minutes, the polishing machine will be produce 85% of the time. During processes of the machine is operational, parts are manufactured at a rate equal to 95% of the rate standard. From the known data the required machine can be calculated using equation (2-1).

S = 90 Minutes per part

Q = 15 Units per shift

H = 480 Minutes

E = 0.95 R = 0.80

$$F = \frac{90\ (\ 15\ )}{0.95\ (\ 480\ )(\ 0.8\ )} = \frac{1350}{364.8} = 3.7\ machines\ per\ shift$$

4.4.4 Machine Requirement

It is shown from the calculation above that certain machine are required more than one, 15 units are the highest demand possible for one shift ,for the calculation more than 0.5 will not take more machine but will be taken by the over shift works (2nd Shift).

Table 4.3 Machines Requirement

Machine Name	Machines per Shift	Machine Need
Spray Booth	1,2	1
Oven	1,2	1
Polish	3,7	4

4.5 Machine Specification

There are some dimensions that needed to be concerned like the machine specification for calculating the space requirement that explained in the Table 4.4. Which explain how much space required for each machine.

Table 4.4 Machine Specification

Machine	Dimension (Cm)	Requirement
Spray Booth	300 x 175 x 270	1
Oven	150 x 200 x 170	1
Polish	100 x 100 x 120	4

4.5.1 Spray Booth

Spray booth is a machine for spraying process and taking the material and sprayed by the standard of spraying system (Spray Booth). Spray booth itself has to had ventilation for the paint waste after been sprayed to the material.

This spray booth calculation use the standard recommendation of National fire protection association which is the best rules and guidelines for determining spray booth specification

4.5.1.1 Air Circulation in booth

A spray booth required air circulation which are NFPA-33 and OSHA that have minimum of 100feet/min of airflow. For most common booth this calculation to requiring a volume from 8,000 to 10,000 Cubic feet/min, when spray booth didn't have the need of the air it needs then the air flow inside the booth is a lot less than the required 100 FPM. The painter is left standing in a cloud of over spray that eventually settles to the floor and the paint over spray can't be whisked away and. This is why booths become dusty and dirty as well as leaving a lingering smell of paint and solvent.

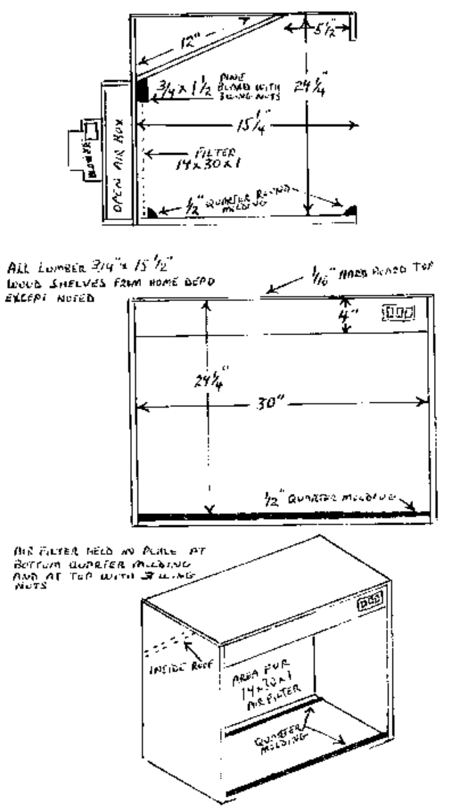
4.5.1.2 Exhaust

Exhaust chamber with a good steel that create with frames holding structure with steel filter are all need by NPFA-33. Considered a home build booth, the exhaust fan is determined by the needed air to set-up a min of 100FPM air flow inside the booth. The requirement size for the fan exhaust is calculated in CFM.

Try assembling the fan way up high in steel exhaust stack which is not against the exhaust chamber. Letting the fan to work quitter when one of the exhaust is inside, with the axial fan efficiently operates when there is few feet on each hand of exhaust stack.

How the making of the booth getting complicated, it can be simplify into three simple requirements which are :

1. Filters
2. Exhaust
3. Air



Spray paint booth tif

By Axelsson,2007 P.13

Figure 4.5 Spray Booth Blue Print

Wrong in addressing these areas will concern in the result of paint spray booth that will outcome not efficient and can be troublesome. But when it is fully made with the requirement the outcome will be efficient and rarely become troublesome.

4.5.2 Oven

Heat processing applications vary widely from industry to industry. Curing, drying, heat treating, sterilizing and bonding represent just a few of the many uses for ovens and furnaces. To some extent, all ovens and furnaces utilize the same basic principles of thermal transfer.

Selection of heat processing equipment is dependent on the type of application, but also on the specific needs of the products under manufacture. Described here are some of the general criteria you should consider and be aware of in order to succeed with your thermal application.

4.5.2.1 Basic Oven Consideration

Ovens generally are classified as heating equipment operating from ambient to 1000°F (538°C), while furnaces operate above 1000°F. Equipment may be designed for intermittent loadings (a batch at a time), or for a continuous flow of work using some form of conveyor. The source of heat is normally derived from combustion of fuel (gas, oil, etc.), electricity, hot water or from steam.

4.5.3 Spray Gun

From an environmental viewpoint, by reducing atomizing, air pressure (at gun handle) by 0.05MPa and surpassed atomizing performance. Can cope with environment complying paints (water based paint, etc.).

4.5.3.1 Lightweight and Compact Gun Body Design

Small type of gun 295g, with compact round gun body can fit easily to the operator hand. When fitting an air hose, container or cup to the gun will give the operator well balance sense of gravity

Figure 4.6 Spray Gun

4.6 Space Available

From the clients demand that the client company wants to make new facilities design with efficiency and low cost, for painting workshop with partition on the empty land that the company had.

Table 4.5 Space Available

Name	Description	Size
Land	Empty land	15 m x 6 m x 3 m

Thus, based on Table 4.5, the area for the partition layout for the painting workshop is 15m x 6m x 3m. The area will contain certain painting machine that used for the painting process

4.7 Space Requirements

Analyzing the data that already obtain using the knowledge of industrial engineering facilities design and layout planning, the require basic data can be seen in Table 4.4 will be described in sub-sub chapter below.

4.7.1 Activity Relationship

Flows are be measured qualitatively using the closeness relationship values developed by Muther and given in Table 4.6. The values may be recorded in conjunction with the reason for the closeness value using the relationship chart.

Table 4.6 Reason of closeness

No	Reason of closeness
1	Material Handling flow
2	Material in process queue
3	Machine flow within departments
4	Raw Material movement to department
5	Finish Good material from workstation
6	Inspected material queue storage

The activity relationships are gathered from interviewing the company client and engineer in charge. Mostly the closeness factor are explained by the engineer, how the spray room and mixing room had to be closed are because there will be pumping machine from the mixing room and spray room, the oven room and paint QC need to be close is because the designed oven machine had input and output mechanism, that the output will be directly headed to the QC Room.

Table 4.7 Value of Reason and Importance

Score	Closeness
A	Absolutely Necessary
E	Especially Necessary
I	Important
O	Ordinary Closeness OK
U	Unimportant
X	Unimportant

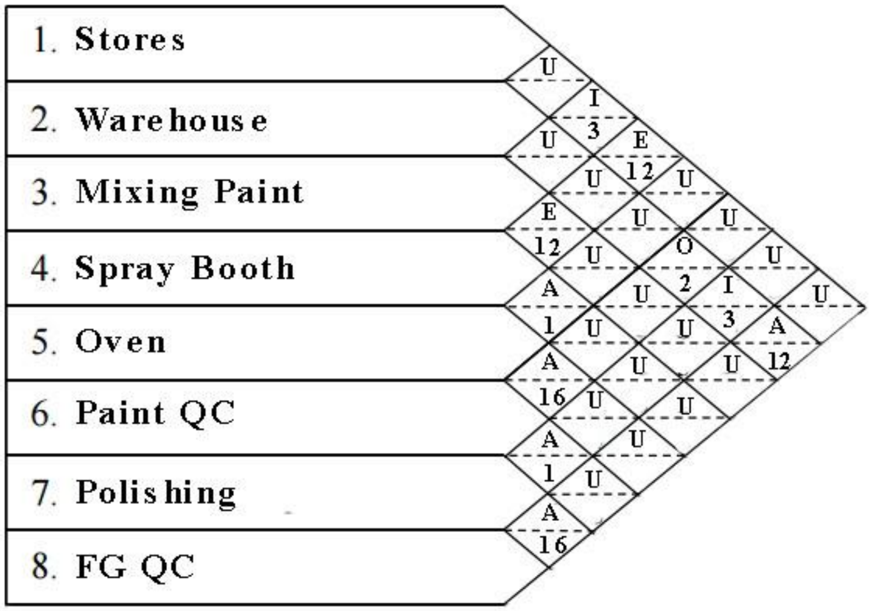


Figure 4.7 Relationship Chart with unreason closeness

Following procedure in creating a relationship chart, in the way of the facilities planner synchronizing the departments relationship as described, the allowed department heads have to assign the nearer of relationship with inconsistencies may develop and other departments. After creating the relationship chart then sketch the relationship diagram shown in Figure 4.7.

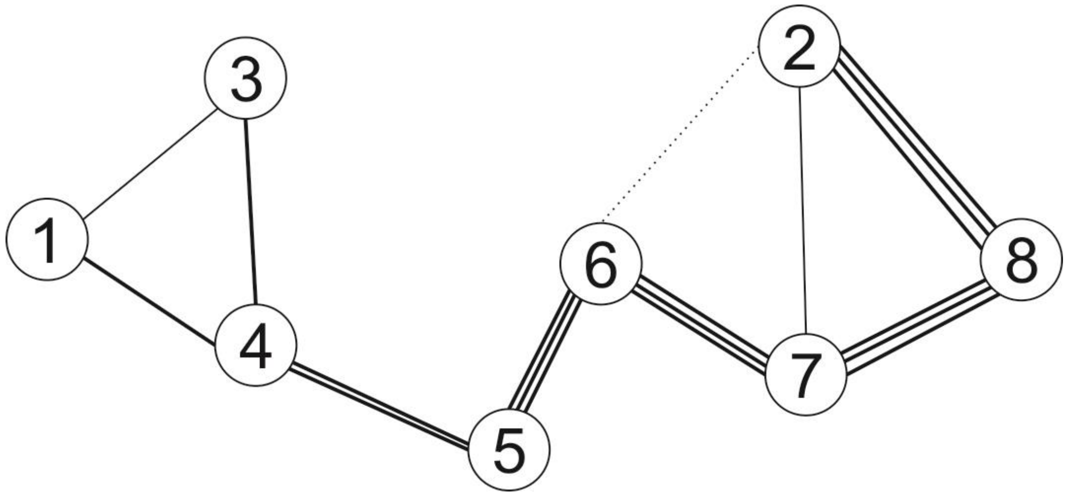


Figure 4.8 Relationship Diagram

It is showed Figures 4.8 displayed the closeness and importance between departments. When concluded with the relationship diagram, next will be described about space relationship diagram, but before got into that space relationship diagram need Department service and area requirements sheet.

Explaining how much a work station required a space specification Workstation Specification; define in 3 which are Equipment, Material, and Personnel. Also know the height required of each machine in each department. This area requirement is gate to the next calculation which is workstation specification for each department.

4.7.2 Flow of Material

Flow of material In Figures 4.9 you can see the flows of material between departments are showed. Flow of material describes are the process of material run to each departments

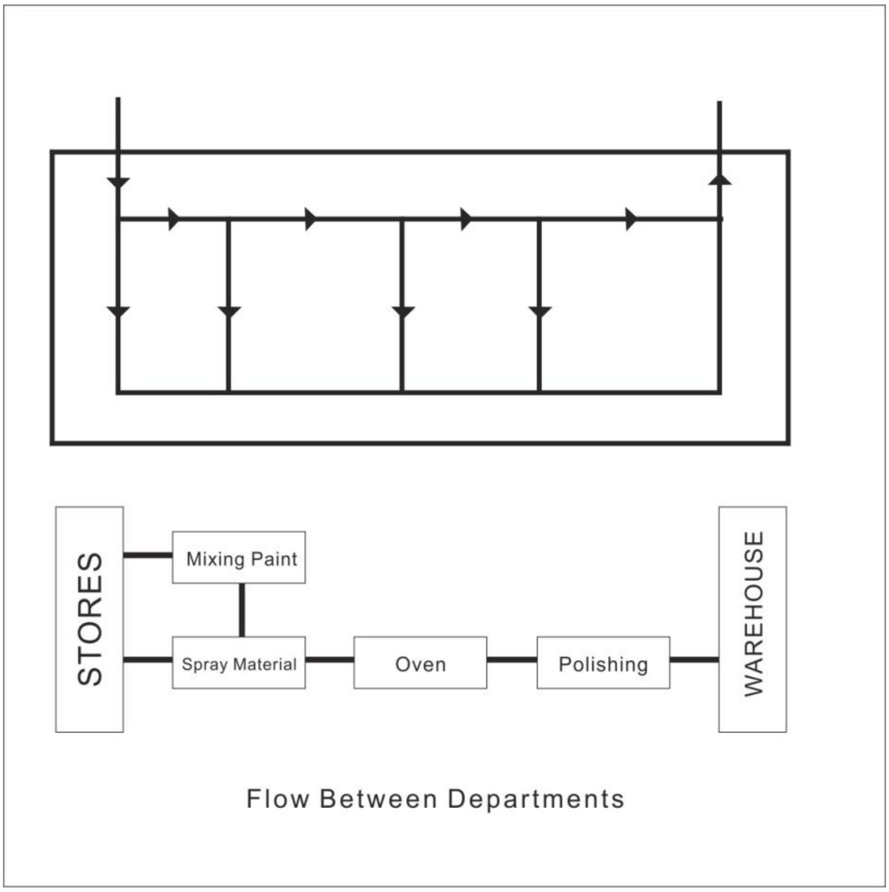


Figure 4.9 Flow of Material Between Departments

4.7.3 Space Relationship Diagram

From the input data and knowing of the relationship and roles between activities, activity relationship and a material flow analysis are performed. then a relationship diagram is developed.

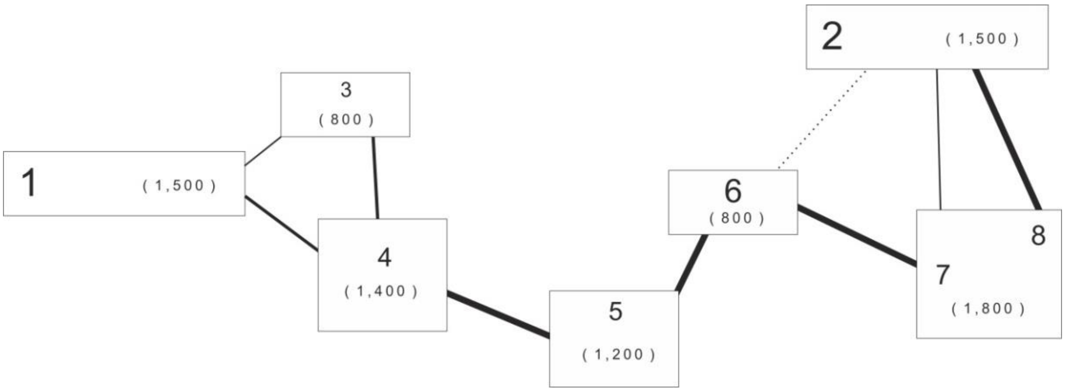


Figure 4.10 Space Relationship Diagram

Relationship diagram placing the activities spatially, take the nearest are typically used to conduct the relationship between activities pairs.

Table 4.8 Space Requirement

Name	Length	Width	Height	Area (LxW)
Storage	7.5 m	2 m	3 m	15
Warehouse	7.5 m	2 m	3 m	15
Mixing Room	2 m	4 m	3 m	8
Spray Room	3,5 m	4 m	3 m	14
Oven	3 m	4 m	3 m	12
QC	2 m	4 m	3 m	8
Polish / FGQC	4.5 m	4 m	3 m	18
				90

4.8 Space Requirement and Availability Analysis

As shown in Table 4.5 that this area will be used for the space requirement and Table 4.8 that shows the space requirement needed, therefore the result will calculated in Table 4.9

Table 4.9 Space Requirement and Availability Calculation

Name	Area (LxW)
Space Availability	90
Space Req	90

4.9 Material Handling Systems

Based on the requirement, a number of material handling checklist have been developed to facilitate the identification of opportunities to improve existing material.

4.9.1 Material Handling Chart

A material planning chart has been made and be function to gather information pertaining to provide preliminary examination and a specific material handling problem of the alternative solutions. The outcome from the analyses using this method can be used to further refine optional strategies using the steps such as the alternative solutions simulation.

Table 4.10Material Handling Chart

Step no	O	T	S	I	Description	Dept		Size	Material of Handling
1			x		Dye Stock in Storage	Aluminum can		80cm x37cm	Platform Hand Truck
2		x			Material Had to Spray			187cmx107cm	Fork lift
3	x				Material Lift up to Spray Booth			80cm x37cm	Platform Hand Truck
4	x				Material Lift Down from Spray Booth			80cm x37cm	Platform Hand Truck
5		x			Material to oven room			80cm x37cm	Platform Hand Truck
6	x				Material enter Oven			80cm x37cm	Platform Hand Truck
7	x				Material Exit Oven			80cm x37cm	Platform Hand Truck

8				x	Checking Material			80cm x37cm	Platform Hand Truck
9	x				From QC to Polish			80cm x37cm	Platform Hand Truck
10				x	From Polish to FGQC			80cm x37cm	Platform Hand Truck
11	x				Finished Material to warehouse			80cm x37cm	Platform Hand Truck
12				x	Finished material to rack			187cmx107cm	Fork Lift

4.9.2 Fork Lift Aisle

Fork lift designed to help warehouses maximize rack space. Forklift will be able to fit into aisles just larger than 4 and ½ feet wide. The length will vary depending on the capacity and frequency of use. Ultimately, forklift dimensions are specific to each individual truck and application. A mistake in calculation and measurements could mean a forklift won't be able to turn around or fit into an aisle. Specifications are determined during a complete site-survey, and should only be conducted by a trained forklift professional.

4.10 Material Handling Equipment Maneuvering

Within the factory, it has to considered the maneuvering and aisle of the material handling equipment, from the analysis above the recommended equipment are platform hand truck and fork lift are 5 to 12 Feet.

4.11 Planning Facilities Design Model

The board means of the facility terms that includes in the fixed assets important to specific finished production objectives. This part explain how workstation specification for each departments.

4.11.1 Block Layout

In modifying practical limitation and considerations, the block layout is displayed in figures 4.11

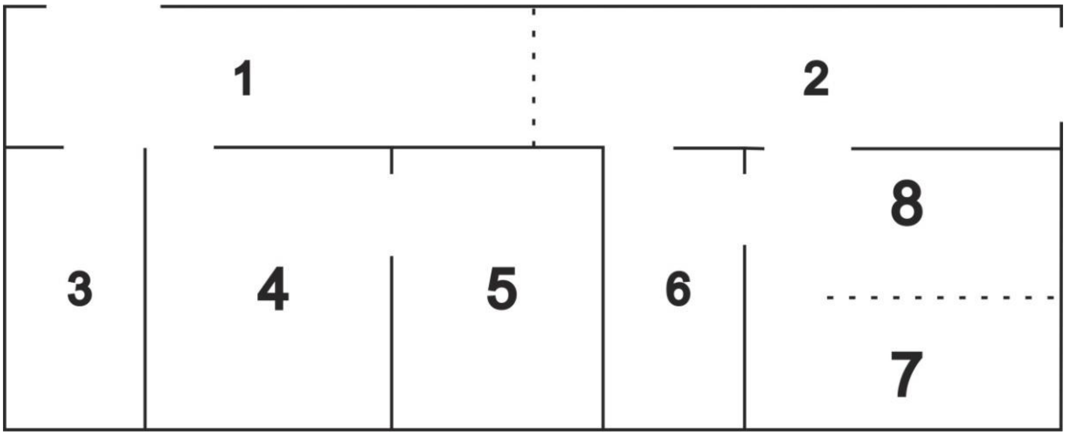


Figure 4.11Block Layout

4.11.2 ALDEP Layout

Using Automated Layout Design Program (ALDEP) to construct alternatives layout for the facility, In ALDEP there will be some calculation using the Space Relation Chart that can be seen in Figure 2.8, Calculate using 3 different options as described in Figure 4.12. The departments and the required number of blocks are:

- ❖ Stores (S) 15 Blocks
- ❖ Warehouse (W) 15 Blocks
- ❖ Mixing Room (M) 8 Blocks
- ❖ Spray Room (Sb) 15 Blocks
- ❖ Oven (O) 12 Blocks
- ❖ Paint QC (Qc) 8 Blocks

- ❖ Polish (P) 9 Blocks
- ❖ FGQC (Fg) 9 Blocks

Option 1

S	S	S	S	M	M	M	O	O	P	P	P	W	W	W
S	S	S	Sb	Sb	M	M	O	Qc	P	P	P	W	W	W
S	S	Sb	Sb	Sb	M	M	O	Qc	P	P	P	W	W	W
S	S	Sb	Sb	Sb	M	O	O	Qc	Qc	Fg	Fg	Fg	W	W
S	S	Sb	Sb	Sb	O	O	O	Qc	Qc	Fg	Fg	Fg	W	W
S	S	Sb	Sb	Sb	O	O	O	Qc	Qc	Fg	Fg	Fg	W	W

Option 2

M	M	M	S	S	S	S	S	P	P	P	Fg	Fg	W	W
M	M	M	S	S	S	S	S	P	P	P	Fg	Fg	W	W
M	M	Sb	S	S	S	S	S	P	P	P	Fg	Fg	W	W
Sb	Sb	Sb	Sb	Sb	O	O	O	O	Qc	Qc	Fg	Fg	W	W
Sb	Sb	Sb	Sb	Sb	O	O	O	O	Qc	Qc	Fg	Fg	W	W
Sb	Sb	Sb	Sb	Sb	O	O	O	O	Qc	Qc	Qc	Qc	W	W

Option 3

S	S	S	S	S	S	S	S	W	W	W	W	W	W	Fg
S	S	S	S	S	S	S	W	W	W	W	W	W	Fg	Fg
M	M	Sb	Sb	Sb	Sb	O	O	O	Qc	Qc	P	P	Fg	Fg
M	M	Sb	Sb	Sb	Sb	O	O	O	Qc	Qc	P	P	Fg	Fg
M	M	Sb	Sb	Sb	Sb	O	O	O	Qc	Qc	P	P	Fg	Fg
M	M	Sb	Sb	Sb	Sb	O	O	O	Qc	Qc	P	P	P	Fg

Figure 4.12 ALDEP Option

After determining the block placement with the proximity relationship, The layout options is obtained, a score for the layout is computed with the following conversion of proximity relationship

A = 64 E = 16 I = 4 O = 1 U = 0

X = -10254

Using the score that get from each option, proximity ratings from the closest and adjacent departments and the value from each score relation will be add to the score results, repeat the methods until the end of blocking and then sum the score. With the score the calculation will be described in Table 4.11 and the highest score will be choose for the designing the facilities layout,

Table 4.11 ALDEP Score

Option I		
AdjacentsDept	Proximity Ratings	Score
(S,Sb)	E	16
(S,M)	I	4
(Sb,M)	A	64
(Sb,O)	A	64
(M,O)	U	0
(O,Qc)	A	64
(O,P)	U	0
(Qc,P)	A	64
(Qc,Fg)	U	0
(P,Fg)	A	64
(P,W)	I	16
(Fg,W)	A	64
		420

Option II		
AdjacentsDept	Proximity Ratings	Score
(M,Sb)	A	64
(M,S)	I	4
(Sb,O)	A	64
(Sb,S)	E	16
(S,P)	U	0
(S,O)	U	0
(O,P)	U	0
(O,Qc)	U	0
(P,Qc)	A	64
(P,Fg)	A	64
(Qc,Fg)	U	0
(Qc,W)	U	0
(Fg,W)	A	64
		340

Option III		
AdjacentsDept	Proximity Ratings	Score
(S,M)	I	4
(S,Sb)	E	16
(S,O)	U	0
(S,W)	U	0
(M,Sb)	A	64
(Sb,O)	S	64
(O,W)	U	0
(O,Qc)	A	64
(W,Qc)	O	1
(W,P)	I	16
(W,Fg)	A	64
(Qc,P)	A	64
(P,Fg)	A	64
		421

As shown in Table 4.11 The highest score is Option III, Therefore the facilities planning will be designed based on the 3rd Option of ALDEP Method.

4.11.3 Layout Method Evaluation

Two methods are calculated in this analysis, BLOCK layout and ALDEP layout. The block layout using the Muther's procedure and also with the ALDEP and in conclusion of the method the result are the same layout output.

4.11.4 Mixing Room and Spray Room

Both of these room has to connect because of the spray room needed the material from the mixing room by overpass the machine that will be explained in the figure below.

There are certain connector from mixing room to spray room like described in Figures 4.13.That's why the importance closeness of these 2 rooms are especially important. After the material is sprayed it must be fast and bring it to the oven room.

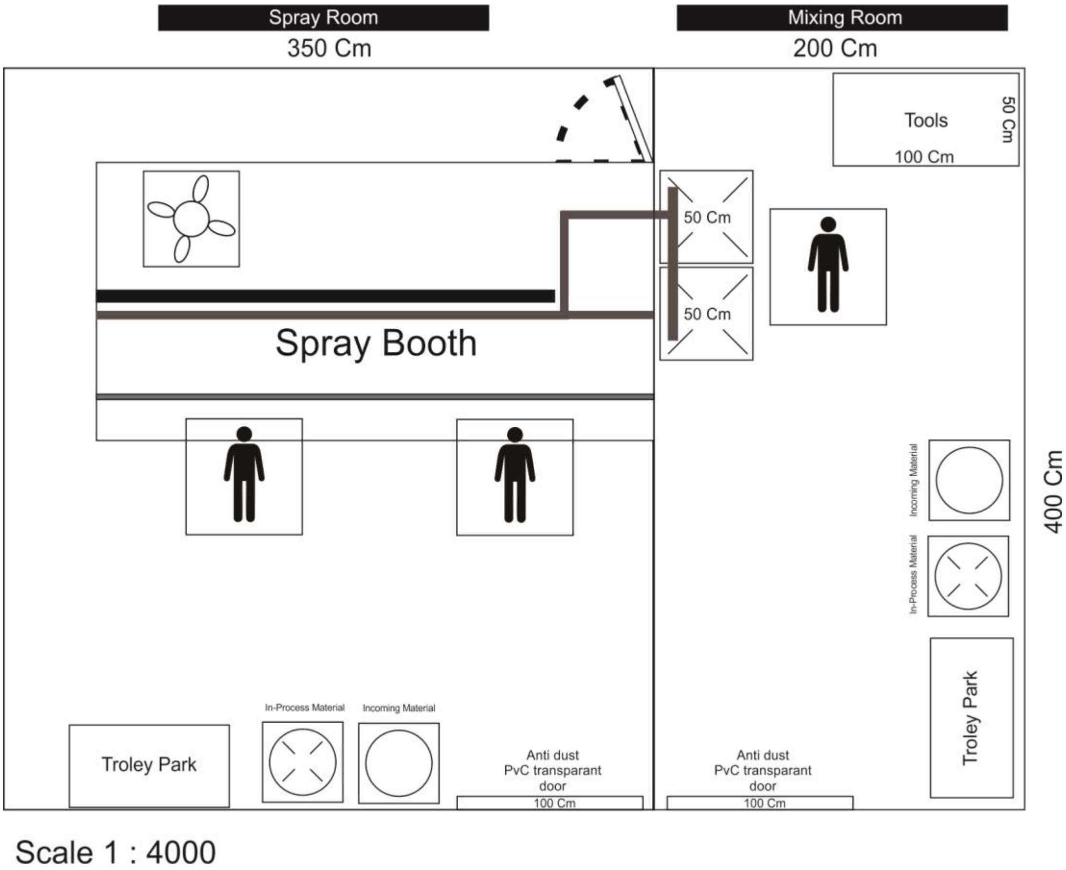


Figure 4.13 Spray Room and Mixing Room

4.11.5 Oven and Painting Quality Control Room

As you can see form Figure 4.14 the oven machine door is connecting through the paint QC room, this things design to take the efficiency of material flow so it not taking time to delivered from room to room, and the oven itself are designed to be open front and back. The operator in Oven Room are from the spray room operator, so after the operator finished spraying material the operator immediately delivered the painted material to the oven room. The importance closeness of oven room and spray room is absolute importance because the sprayed material has to be done quite fast after spraying process.

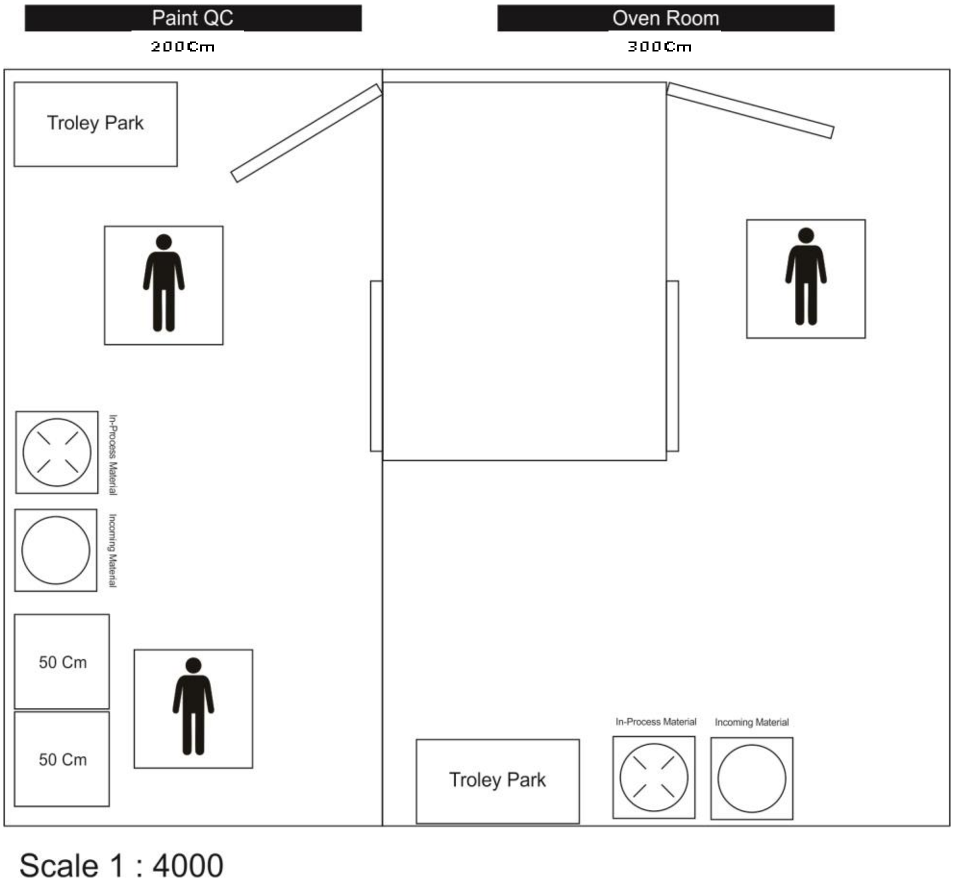


Figure 4.14 Paint QC and Oven Room

4.11.6 Polishing and Finish Good Quality Control Room

This room used for two different processes, where they are being blended together because the using same special requirement which is special lighting, this special lighting are used to reveal the true color of the painting and polishing so the result will be accurate as the demand coloured by costumer. How the workstation looks like will be described in figures below.

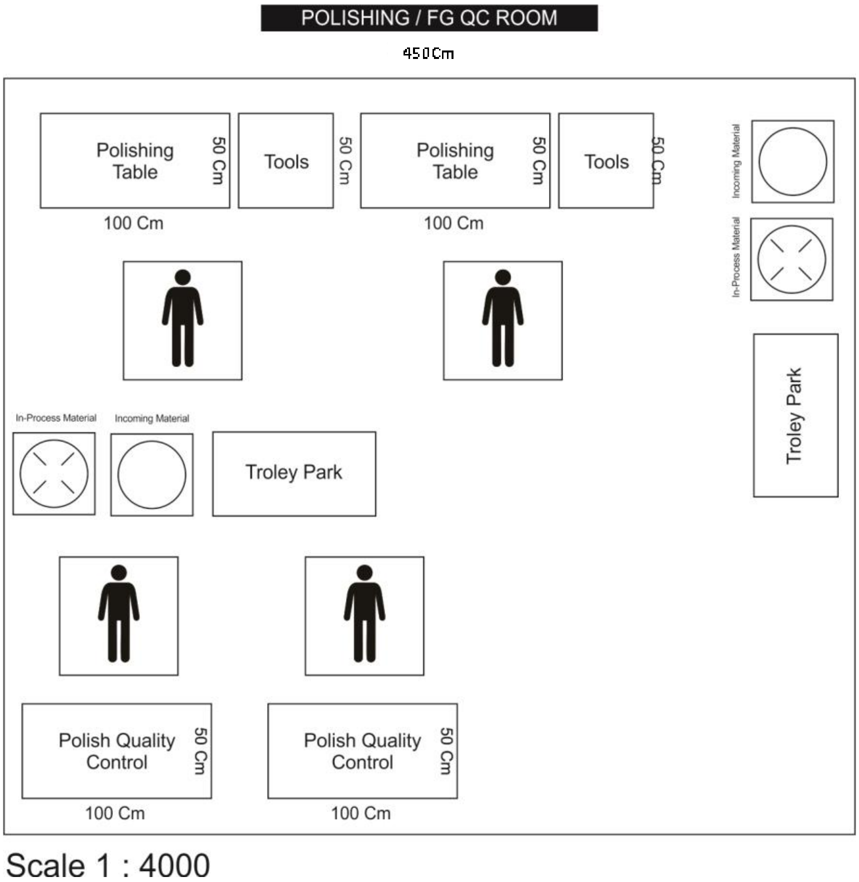


Figure 4.15 Polishing and Finish Good Quality Control Room

4.12 Warehouse and Storage

Paint job manufacturing must maintaining the warehouse to store in-process inventories or components received for the supplier. This warehouse must be maintain by the desired calculation method

4.12.1 Rack Design

For this particular manufacturing there are special design for the rack system, with approximate monthly demand 300 Item, the design will be consist 4 level of rack, with height of 270 cm and area of each rack 900 cm. Because the building layout height is 3 meter, the 4 level can be maintained

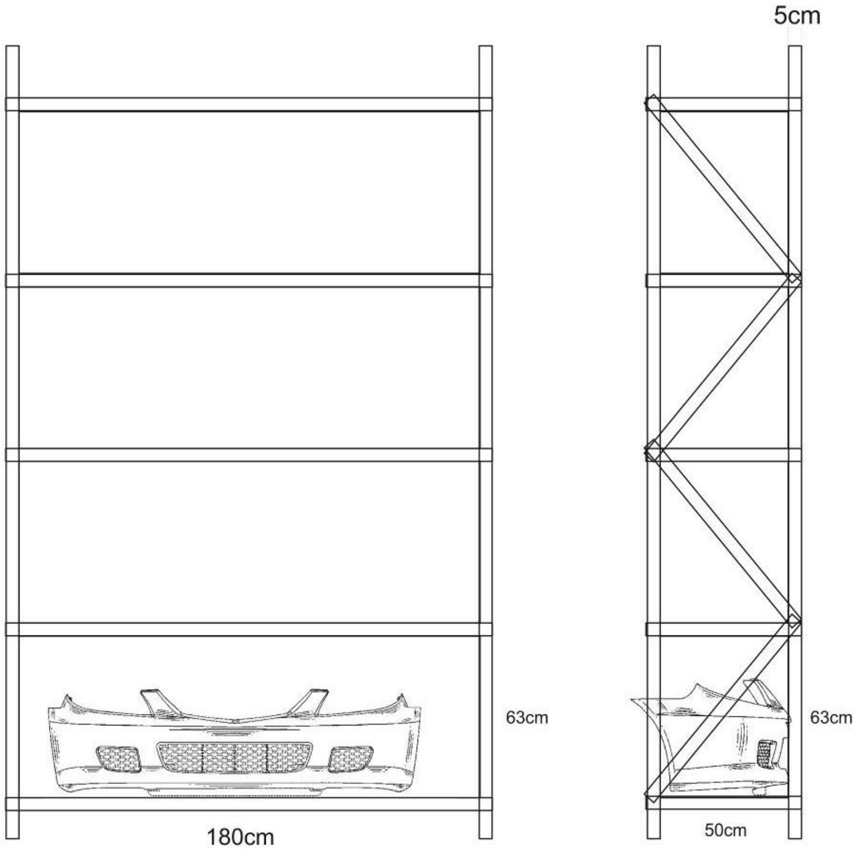


Figure 4.16 Rack Design

4.12.2 Rack Allocation for Warehouse and Storage

For the warehouse and storage rack system giving 1 meter for the aisle and material handling system which will be described in the Figure 4.16 below.

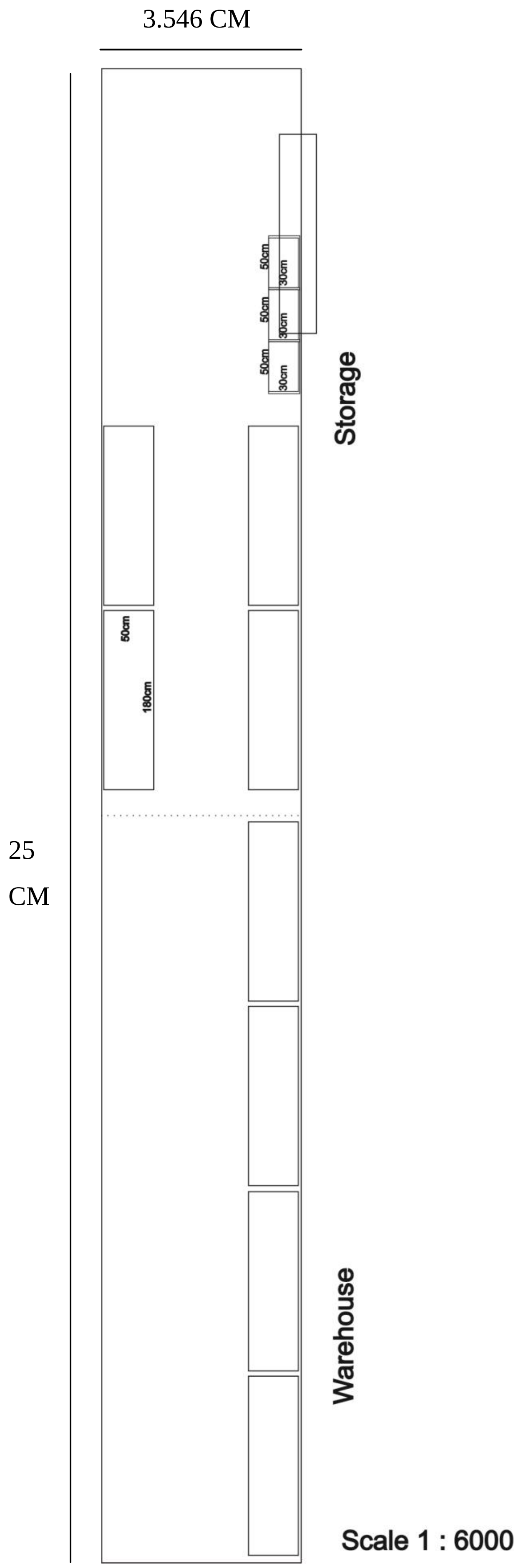


Figure 4.17 Rack Allocation

4.13 Facilities System

In this sub chapter will discuss the work environment and safety of the facilities layout included lighting and life safety system with detailed calculation that will be described below.

4.13.1 Lighting System

These are the calculation and analysis for each department. Each department has different lighting condition, because of not every area need particular lighting.

4.13.1.1 Mixing Room

With minimum levels of illumination for specific task is 1000 (Assembly; Extra Fine) mixing the require dye that have to be précises so the minimum illumination level. The height 3m, Length 2m and Width 4m.calculation can be determined. By using Equation (2-1),(2-2),and (2-3).

$\boldsymbol{H = 3m = 9.8'}$ Height of layout

Height for working surface luminance (Standard height for working table = 3')

$$\boldsymbol{H = 9.8' - 3' = 6,8'}$$

$$\boldsymbol{L = 2m = 6,6'}$$

$$\boldsymbol{W = 4m = 13.1'}$$

Determining the (RCR) room cavity ration, The RCR as an index of the shape of room to be lighted with equation (2-2)

$$\boldsymbol{RCR} = \frac{(5)(\boldsymbol{Height\ from\ the\ working\ surface\ to\ the\ luminaris})(\boldsymbol{room\ length} + \boldsymbol{Room\ Width})}{(\boldsymbol{Room\ Length})(\boldsymbol{Room\ Width})}$$

$$\boldsymbol{RCR = \frac{(5)(6,8)(6,6+13,1)}{(6,6)(13,1)} = 5.2}$$

CCR need not be considered, as the luminaries are ceiling mounted

Determining the wall reflections ant the effective ceiling reflectance. Using the approximate reflectance for wall and ceiling finishes the room will be painted with white paint **(Approximate Reflectance = 80 %)**. Refer to Table 2.3

Coefficient of utilization, using fluorescent lamps in uncovered fixtures are to be utilized, the CR may be interpolated in coefficients of utilization for standard luminaries is (CU) 0.53 that can be seen in Table 2.5.

CU = 0.53

The Light loss factors for fluorescent lamps (60watt) in uncovered fixtures in a "medium-dirty environment" that are cleaned every 24 months that can be seen in Table 2.7 and can be calculated using equation (2-5,2-6).

LLF = 0.80

Now the number of lamps and luminaries can be determined

$$\textit{Number of lamps} = \frac{(\textit{Required level of illumination})(\textit{area to be lit})}{(CU)(LLF)(\textit{Lamp output at } 70\% \textit{ of rated life})}$$

$$\textit{Number of Luminaries} = \frac{(\textit{Number of lamps})}{(\textit{Lamps per luminary})}$$

$$\textit{Number of lamps} = \frac{(1000)((6.6)(1.3))}{(0.53)(0.8)(3300)} = 6 \textit{ Lamps}$$

$$\textit{Number of Luminaries} = \frac{(6)}{(1)} = 6 \textit{ Luminaries}$$

Refers To Table 2.7 2.5 2.6 and 2.7

Take the lamp output at 70% in Table 2.6, with the lamp luminary dir depreciation factor (LLF) in Table 2.7 Dirty heating, medium machining with 24 months between cleaning the calculation can be calculated.

Location of the luminaries for mounting height 10’ above the work surface, the luminaries should be space no more than 13’ apart. Each fluorescent fixture is 4’ long. By placing 2 rows of 3 luminaries across the room, the illumination level within the room will be evenly distributed and will be adequate to perform tasks. This room requires high luminance to mixing the painting component.

4.13.1.2 Spray Room

With minimum levels of illumination for specific task is 1000 (Assembly; Extra Fine) mixing the require dye that have to be précises so the minimum illumination level. The height 3m, Length 2m and Width 4m.calculation can be determined. By using Equation (2-1),(2-2),and (2-3).

$$\boldsymbol{H = 3m = 9.8'}$$

Height for working surface luminance (Standard height for working table = 3’)

$$\boldsymbol{H = 9.8' - 3' = 6,8'}$$

$$\boldsymbol{L = 3,5m = 11,5'}$$

$$\boldsymbol{W = 4m = 13.1'}$$

Determining the room cavity ration (RCR), The RCR as an index of the shape of room to be lighted and can be calculated using equation (2-2).

$$\boldsymbol{RCR = \frac{(5)(Height\ from\ the\ working\ surface\ to\ the\ luminaris)(room\ length + Room\ Width)}{(Room\ Length)(Room\ Width)}}$$

$$\boldsymbol{RCR = \frac{(5)(6,8)(11,5 + 13,1)}{(11,5)(13,1)} = 3,03}$$

CCR need not be considered, as the luminaries are ceiling mounted

Determining the wall reflections ant the effective ceiling reflectance. Using the approximate reflectance for wall and ceiling finishes the room will be painted with white paint **(Approximate Reflectance = 80 %)**. Refer to Table 2.3

Coefficient of utilization, using fluorescent lamps in uncovered fixtures are to be utilized, the CR may be interpolated in coefficients of utilization for standard luminaries is (CU) 0.69 that can be seen in Table 2.5.

CU = 0.69

The Light loss factors for fluorescent lamps (60watt) in uncovered fixtures in a “medium-dirty environment” that are cleaned every 24 months that can be seen in Table 2.7 and can be calculated using equation (2-5,2-6)..

LLF = 0.80

Now the number of lampas and luminaries can be determined

$$Number\ of\ lamps = \frac{(Required\ level\ of\ illumination)\ (area\ to\ be\ lit)}{(CU)(LLF)(Lamp\ output\ at\ 70\%\ of\ rated\ life)}$$

$$Number\ of\ Luminaries = \frac{(Number\ of\ lamps)}{(Lamps\ per\ luminary)}$$

$$Number\ of\ lamps = \frac{(300)(11,5)(13,1)}{(0.69)(0.8)(3300)} = 20\ Lamps$$

$$Number\ of\ Luminaries = \frac{(20)}{(2)} = 10\ Luminaries$$

Refers To Table 2.7 2.5 2.6 and 2.7

Take the lamp output at 70% in Table 2.6, with the lamp luminary dir depreciation factor (LLF) in Table 2.7 Dirty heating, medium machining with 24 months between cleaning the calculation can be calculated.

Location of the luminaries for mounting height 10’ above the work surface, the luminaries should be space no more than 13’ apart. Each fluorescent fixture is 4’ long. By placing 2 rows of 3 luminaries across the room, the illumination level within the room will be evenly distributed and will be adequate to perform tasks. This room requires high luminance to spray material.

4.13.1.3 Oven Room

With minimum levels of illumination for specific task is 1000 (Assembly; Extra Fine) mixing the require dye that have to be précises so the minimum illumination level. The height 3m, Length 2m and Width 4m.calculation can be determined.By using Equation (2-1),(2-2),and (2-3).

$$H = 3m = 9.8'$$

Height for working surface luminance (Standard height for working table = 3')

$$H = 9.8' - 3' = 6,8'$$

$$L = 3m = 9,8'$$

$$W = 4m = 13.1'$$

Determining the room cavity ration (RCR), The RCR as an index of the shape of room to be lighted and can be calculated using (2-2).

$$RCR = \frac{(5)(Height\ from\ the\ working\ surface\ to\ the\ luminaris)(room\ length + Room\ Width\ )}{(Room\ Length\ )(Room\ Width)}$$

$$RCR = \frac{(5)(6,8)(9,8 + 13,1)}{(9,8)(13,1)} = 6,06$$

CCR need not be considered, as the luminaries are ceiling mounted

Determining the wall reflections ant the effective ceiling reflectance. Using the approximate reflectance for wall and ceiling finishes the room will be painted with white paint **(Approximate Reflectance = 80 %)** Refer to Table 2.3.

Coefficient of utilization, using fluorescent lamps in uncovered fixtures are to be utilized, the CR may be interpolated in coefficients of utilization for standard luminaries is (CU) 0.53 that can be seen in Table 2.5.

CU = 0.53

The Light loss factors for fluorescent lamps (60watt) in uncovered fixtures in a "medium-dirty environment" that are cleaned every 24 months that can be seen in Table 2.7.

LLF = 0.80

Now the number of lampas and luminaries can be determined by equation (2-5,2-6).

$$\textit{Number of lamps} = \frac{(\textit{Required level of illumination})(\textit{area to be lit})}{(CU)(LLF)(\textit{Lamp output at } 70\% \textit{ of rated life})}$$

$$\textit{Number of Luminaries} = \frac{(\textit{Number of lamps})}{(\textit{Lamps per luminary})}$$

$$\textit{Number of lamps} = \frac{(100)(9{,}8)(13{,}1)}{(0.53)(0.8)(3300)} = 9{,}2 = 10 \textit{ Lamps}$$

$$\textit{Number of Luminaries} = \frac{(10)}{(3)} = 3 \textit{ Luminaries}$$

Refers To Table 2.7 2.5 2.6 and 2.7

Take the lamp output at 70% in Table 2.6, with the lamp luminary dir depreciation factor (LLF) in Table 2.7 Dirty heating, medium machining with 24 months between cleaning the calculation can be calculated.

Location of the luminaries for mounting height 10' above the work surface, the luminaries should be space no more than 13' apart. Each fluorescent fixture is 4' long. By placing 2 rows of 3 luminaries across the room, the illumination level within the room will be evenly distributed and will be adequate to perform tasks. This room requires low-mid luminance to help operator in doing the task.

4.13.1.4 QC Room

With minimum levels of illumination for specific task is 1000 (Assembly; Extra Fine) mixing the require dye that have to be précises so the minimum illumination level. The height 3m, Length 2m and Width 4m.calculation can be determined. By using Equation (2-1),(2-2),and (2-3).

$$H = 3m = 9.8'$$

Height for working surface luminance (Standard height for working table = 3')

$$H = 9.8' - 3' = 6,8'$$

$$L = 2m = 6,6'$$

$$W = 4m = 13.1'$$

Determining the room cavity ration (RCR), The RCR as an index of the shape of room to be lighted and can be calculated by using equation (2-2).

$$RCR = \frac{(5)(Height\ from\ the\ working\ surface\ to\ the\ luminaris)(room\ length + Room\ Width)}{(Room\ Length)(Room\ Width)}$$

$$RCR = \frac{(5)(6,8)(6,6 + 13,1)}{(6,6)(13,1)} = 5.2$$

CCR need not be considered, as the luminaries are ceiling mounted

Determining the wall reflections ant the effective ceiling reflectance. Using the approximate reflectance for wall and ceiling finishes the room will be painted with white paint **(Approximate Reflectance = 80 %)** Refer to Table 2.3.

Coefficient of utilization, using fluorescent lamps in uncovered fixtures are to be utilized, the CR may be interpolated in coefficients of utilization for standard luminaries is (CU) 0.53 that can be seen in Table 2.5.

CU = 0.53

The Light loss factors for fluorescent lamps (60watt) in uncovered fixtures in a "medium-dirty environment" that are cleaned every 24 months that can be seen in Table 2.7.

LLF = 0.80

Now the number of lampas and luminaries can be determined equation (2-5,2-6)

$$\textit{Number of lamps} = \frac{(\textit{Required level of illumination})(\textit{area to be lit})}{(CU)(LLF)(\textit{Lamp output at } 70\% \textit{ of rated life})}$$

$$\textit{Number of Luminaries} = \frac{(\textit{Number of lamps})}{(\textit{Lamps per luminary})}$$

$$\textit{Number of lamps} = \frac{(1000)\big((6.6)(1.3)\big)}{(0.53)(0.8)(3300)} = 6\ \textit{Lamps}$$

$$\textit{Number of Luminaries} = \frac{(6)}{(1)} = 6\ \textit{Luminaries}$$

Refers To Table 2.7 2.5 2.6 and 2.7

Take the lamp output at 70% in Table 2.6, with the lamp luminary dir depreciation factor (LLF) in Table 2.7 Dirty heating, medium machining with 24 months between cleaning the calculation can be calculated.

Location of the luminaries for mounting height 10' above the work surface, the luminaries should be space no more than 13' apart. Each fluorescent fixture is 4' long. By placing 2 rows of 3 luminaries across the room, the illumination level within the room will be evenly distributed and will be adequate to perform tasks. This room requires high luminance to inspect the sprayed material.

4.13.1.5 Finish Good QC and Polishing Room

With minimum levels of illumination for specific task is 1000 (Assembly; Extra Fine) mixing the require dye that have to be précises so the minimum illumination level. The height 3m, Length 2m and Width 4m.calculation can be determined. By using Equation (2-1),(2-2),and (2-3), with references in Table 2.4, Table 2.5, Table 2.6, Table 2.7, Table 2.8 and Table 2.9.$\boldsymbol{H = 3m = 9.8'}$

Height for working surface luminance (Standard height for working table = 3')

$$\boldsymbol{H = 9.8' - 3' = 6,8'}$$

$$\boldsymbol{L = 4,5m = 14,76'}$$

$$\boldsymbol{W = 4m = 13.1'}$$

Determining the room cavity ration (RCR), The RCR as an index of the shape of room to be lighted and can be calculated using equation (2-2).

$$\boldsymbol{RCR = \frac{(5)(Height\ from\ the\ working\ surface\ to\ the\ luminaris)(room\ length + Room\ Width\ )}{(Room\ Length\ )(Room\ Width)}}$$

$$\boldsymbol{RCR = \frac{(5)(6,8)(14,76 + 13,1)}{(14,76)(13,1)} = 4,89}$$

CCR need not be considered, as the luminaries are ceiling mounted

Determining the wall reflections ant the effective ceiling reflectance. Using the approximate reflectance for wall and ceiling finishes the room will be painted with white paint **(Approximate Reflectance = 80 %)** Refer to Table 2.3.

Coefficient of utilization, using fluorescent lamps in uncovered fixtures are to be utilized, the CR may be interpolated in coefficients of utilization for standard luminaries is (CU) 0.53 that can be seen in Table 2.5.

CU = 0.53

The Light loss factors for fluorescent lamps (110 Watt) in uncovered fixtures in a "medium-dirty environment" that are cleaned every 24 months that can be seen in Table 2.7.

LLF = 0.80

Now the number of lampas and luminaries can be determined equation (2-5,2-6)

$$\boldsymbol{Number\ of\ lamps} = \frac{(Required\ level\ of\ illumination\ )\ (\ area\ to\ be\ lit\ )}{(CU)(LLF)(Lamp\ output\ at\ 70\%\ of\ rated\ life\ )}$$

$$Number\ of\ Luminaries = \frac{(Number\ of\ lamps)}{(Lamps\ per\ luminary)}$$

$$Number\ of\ lamps = \frac{(1000)(14{,}76)(13{,}1)}{(0.53)(0.8)(7500\ )} = 60\ Lamps$$

$$Number\ of\ Luminaries = \frac{(60)}{(8)} = 8\ Luminaries$$

Refers To Table 2.7 2.5 2.6 and 2.7

Take the lamp output at 70% in Table 2.6, with the lamp luminary dir depreciation factor (LLF) in Table 2.7 Dirty heating, medium machining with 24 months between cleaning the calculation can be calculated.

Location of the luminaries for mounting height 10' above the work surface, the luminaries should be space no more than 13' apart. Each fluorescent fixture is 4' long. By placing 2 rows of 3 luminaries across the room, the illumination level within the room will be evenly distributed and will be adequate to perform tasks. This room requires high luminance to polish and inspect the finished material.

4.13.1.6 Warehouse and Storage Room

With minimum levels of illumination for specific task is 1000 (Assembly; Extra Fine) mixing the require dye that have to be précises so the minimum illumination level. The height 3m, Length 2m and Width 4m.calculation can be determined. By using Equation (2-1),(2-2),and (2-3), with references in Table 2.4, Table 2.5, Table 2.6, Table 2.7, Table 2.8 and Table 2.9.

$$H = 3m = 9.8'$$

Height for working surface luminance (Standard height for working table = 3')

$$H = 9.8' - 3' = 6,8'$$

$$L = 15m = 49,2'$$

$$W = 2m = 6,6'$$

Determining the room cavity ration (RCR), The RCR as an index of the shape of room to be lighted and can be calculated using equation (2-2).

$$RCR = \frac{(5)(Height\ from\ the\ working\ surface\ to\ the\ luminaris)(room\ length + Room\ Width)}{(Room\ Length)(Room\ Width)}$$

$$RCR = \frac{(5)(6,8)(49,2 + 6,6)}{(49,2)(6,6)} = 5,8$$

CCR need not be considered, as the luminaries are ceiling mounted

Determining the wall reflections ant the effective ceiling reflectance. Using the approximate reflectance for wall and ceiling finishes the room will be painted with white paint **(Approximate Reflectance = 80 %)** Refer to Table 2.3.

Coefficient of utilization, using fluorescent lamps in uncovered fixtures are to be utilized, the CR may be interpolated in coefficients of utilization for standard luminaries is (CU) 0.53 that can be seen in Table 2.5.

CU = 0.53

The Light loss factors for fluorescent lamps (60watt) in uncovered fixtures in a "medium-dirty environment" that are cleaned every 24 months that can be seen in Table 2.7.

LLF = 0.80

Now the number of lampas and luminaries can be determined equation (2-5,2-6)

$$\textit{Number of lamps} = \frac{(\textit{Required level of illumination})\,(\textit{area to be lit})}{(CU)(LLF)(\textit{Lamp output at 70\% of rated life})}$$

$$\textit{Number of Luminaries} = \frac{(\textit{Number of lamps})}{(\textit{Lamps per luminary})}$$

$$\textit{Number of lamps} = \frac{(50)(49{,}2)(6{,}6)}{(0.53)(0.8)(3300)} = 11{,}6 = 12\ \textit{Lamps}$$

$$\textit{Number of Luminaries} = \frac{(12)}{(2)} = 6\ \textit{Luminaries}$$

Refers To Table 2.7 2.5 2.6 and 2.7

Take the lamp output at 70% in Table 2.6, with the lamp luminary dir depreciation factor (LLF) in Table 2.7 Dirty heating, medium machining with 24 months between cleaning the calculation can be calculated.

Location of the luminaries for mounting height 10' above the work surface, the luminaries should be space no more than 13' apart. Each fluorescent fixture is 4' long. By placing 2 rows of 3 luminaries across the room, the illumination level within the room will be evenly distributed and will be adequate to perform tasks. This room requires medium luminance to make the operator comfort in allocating the material to the rack.

4.13.1.7 Lighting Location of the Luminaries

The number of luminaries calculated will result in the correct quantity of light. In addition to the quantity of light, the quality of light must be considered.

Table 4.12 Luminaries

Name	Number of Luminaries	Type of Lamp	Environment
Mixing Room	6	Fluorescent	Med-Dirty
Spray Room	10	Fluorescent	Med-Dirty
Oven Room	3	Fluorescent	Med-Dirty
QC Room	6	Fluorescent	Med-Dirty
FG & Polish Room	8	Fluorescent	Med-Dirty
Warehouse & Storage	6	Fluorescent	Med-Dirty

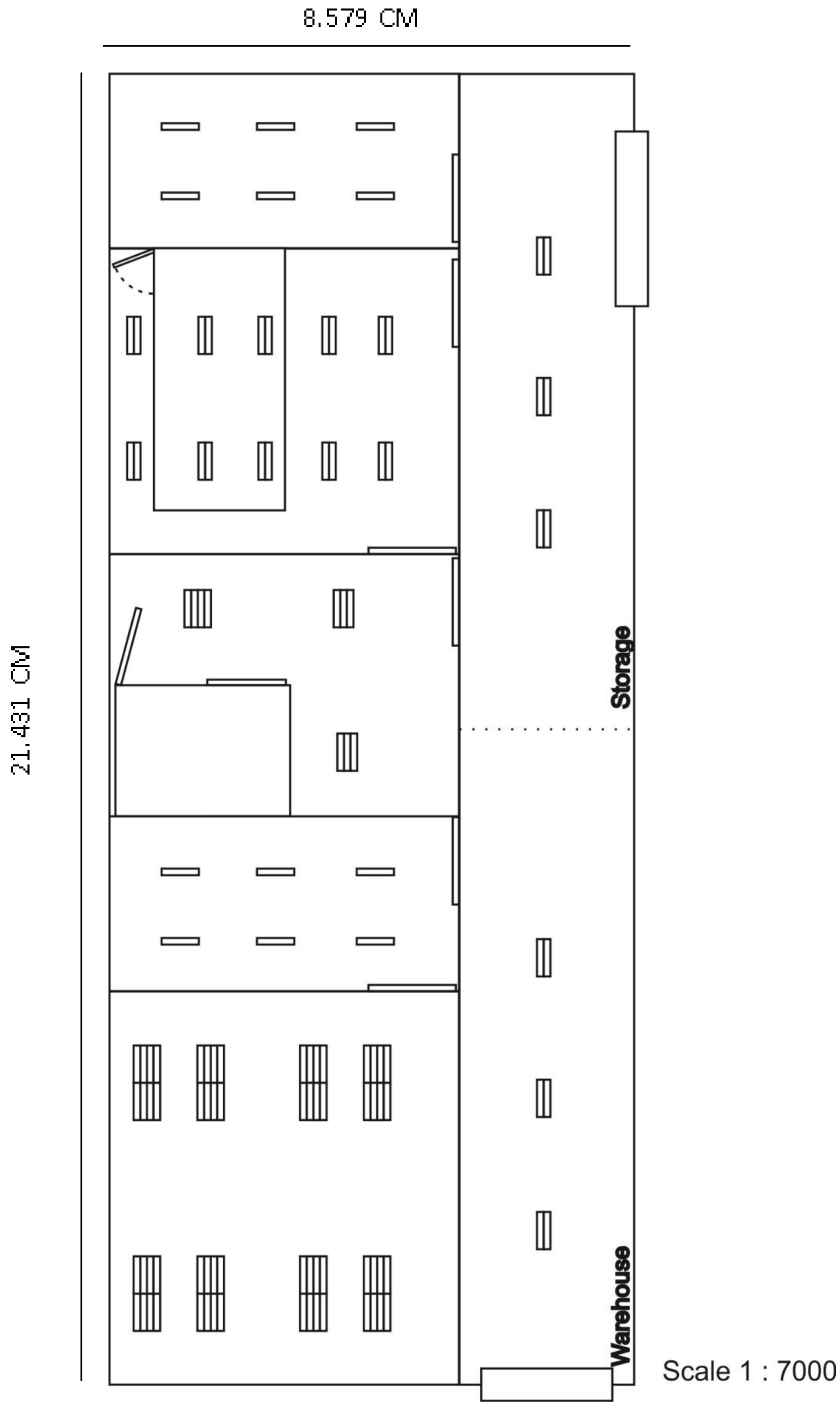


Figure 4.18Luminaries Configuration

4.13.2 Life Safety System

Analyzing life safety system for the paint manufacturing partition layout, In general, the following facility types typically account for all occupancy classifications in the United States:

Table 4.13 Occupancy classification

Class Group	Type
A	Assemblies, theaters
E	Educational facilities
I	Institutional occupancies
H	Hazardous Occupancies
B	Business, office, government buildings
R	Residential
M	Mercantile
F	Factories, Manufacturers, and processing
S	Storage
U	Utility

In this lay out there will be group taken which are; H, F, and S. The type of the structure also the degrees of fire resistance that have been govern. These construction type 1 (Nearly Fireproof) to Type D (Conventional wood-frame construction).

Using the international Building code (Maximum floor area allowances per occupant) for industrial areas, 100 ft^2 per occupant is the recommended area, by using Equation (2-6), and (2-7), with references in Table 2.10, Table 2.11, and Table 2.12.:

$$\boldsymbol{Maximum\ Population = \frac{19{,}7\ ft\ x\ 49{,}2\ ft}{100\frac{ft^2}{person}} = 10\ People}$$

From the calculation above the equation can be determined door ranged need to safely move occupants out of the facility.

$$\boldsymbol{The\ distance\ between\ exits = \frac{the\ diagonal\ dimension}{4} = \frac{d}{4}}$$

$$d = ((19,7)^2 + (49,2)^2)^{1/2} = 52,99 = 53'$$

$$Minimum\ distance\ between\ exits = \frac{53}{4} = 13,2'$$

Determining the allowable minimum width for each door

$$Capacity\ per\ exit = \frac{10People}{2} = 5\ people\ /exit$$

$$Minimum\ width = 5\ x\ 0.2'' = 2,5\ ''$$

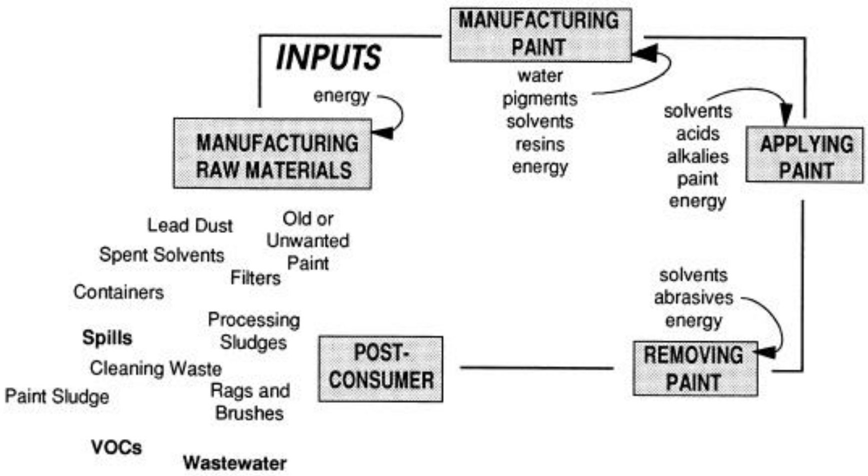
4.14 Waste Disposal

Paint job process using chemical that will generate chemical waste disposal which is pollution will be impacted to the air. Definitely, will be mixed by the air that inhaled by human being and impacted to their health.

Paint consists of a mixture of four basic components such are pigment, binder, solvent and additives. Pigments are small particles of solid materials that give the paint its color and opacity. Moreover, the pigments can be composed of toxic compounds such as cadmium and lead. Binders are composed of resins and give the thin layer of paint film is continuity and adhesion to the material being painted. They are the basic components that remains after the paint has finished. Most binders are nontoxic and insoluble in the water. So, can be greatly impacted to the surrounding environment or even can spread widely through the air and flow by the water.

Solvents are liquids that will volatile added to paints in order to disperse or dissolve the binder and to modify the viscosity of the coating. there are several application techniques that require the paint to have a narrow range of solvent-controlled physical and electrical properties. In this case, it is common practice to blend two or more solvents. Organic chemicals are used as solvent in paint. These solvents will lead to the chemical waste disposal and impacted to the water flow.

Solvent used in paints are released to the environment through evaporation in limited quantities during paint manufacturing and in larger quantities by design when paint dries or cures. The clean air act amendments of 1990 will require paint formulations which reduced amounts of many common organic solvents because they produce volatile organic compounds (VOCs) that contribute to the generation of atmospheric ozone.



By university of Illinois,1992 P.12

Figure 4.19 Paint Life Cycle and Associated Waste

Both the manufacture and the use of paint will generate the quantities of waste. These wastes can be form in solid, liquid, and gaseous form and, because of the nature of paint, they may be hazardous or toxic. Paint has impacts on the environment at all stages of its life cycle including manufacture of the paint itself; application of the paint; and removal of the paint, if required. These all paint processes will generate the chemical waste disposal.

Providing information to OEMs on technologies improve paint transfer efficiency and effectively is a first step to waste production. With providing an education program that requires; technologies demonstrations, distribution of vendor list, a tax credit for capital expenditures that result in waste reduction, publication of successful efforts through documentation of case studies, and news release on new developed technologies.

4.14.1 Waste Management Method

Several options are provided for paint waste management method. The detailed described can be as below:

- Use for paint preparation

Methods are developed by researchers for waste management in the set of recovery and preparation of new paint from used paint. This method requires pigment separation and use centrifugation technique, though it can also by adding chemicals. These methods which are the following:

❖ Use of use of waste Ferric Phosphate (FeP04) sludge obtained from metal pretreatment zinc phosphating process to provide different paint composition

❖ The paint sludge is soaked in the solvent mixture over 1 to 72 hours for preparation paint waste. Meanwhile, the solvent is grouped that consisting of toluene, xylene, benzene, acetone, isobutyl alcohol, n -butyl alcohol, isopropyl alcohol, methyl ethyl ketone and any another conventional solvent or any mixture of that

❖ The resin added is selected from the group consisting of maleic resins, ketonic resins, petroleum resins (cumran indene resins).

❖ The invention the solvent mixture comprises toluene or benzene in an amount of 28 to 40 %, xylene in an amount of 22 to 38 %, n-butyl alcohol or methyl isobutyl ketone or methyl cellosolve in an amount of 5 to 12 %, diacetone alcohol in an amount of 3 to 10 %, cellusolve acetate or amyl acetate in an amount of 2 to 5 % by weight expressed in terms of the amount of the paint sludge to be treated

❖ Drying and centrifugation then continued with addition of resins

❖ Use of paint waste disposal can be used as bitumen for the road construction

It is observed through literature that, use of paint waste is possible for build a road construction. This is either by replacing slag used for construction application or by adding resin to the heated sludge and bitumen mixture in the form of a solution in a solvent selected from the group consisting of toluene, toluene with butyl acetate, benzene with butyl acetate and benzene with xylene or any other conventional solvent used for paints.

- ❖ Use for colored concrete

In this method paint is dried and crushed. Centrifuges are used to separate pigments which then in turn are used along with concrete ingredients that give peculiar color to concrete. Or simply impurities from liquid paint are filtered out and liquid paint is applied along with concrete ingredients. This improves aesthetics of concrete.

- ❖ Use of paint waste in sealant Industry

A method for treating waste paint sludge in sealant industry makes use of water, uncured resin and liquid hydrocarbons. The waste material, typically in the form of sludge, is processed in a heating and resin curing procedure whereby water and VOCs, in the form of liquid hydrocarbons, are evaporated so that the solid discharged after heating is in a substantially dried particulate solid form. The heating step is also designed to cure the uncured polymeric paint resins.

- ❖ Use for charcoal preparation

One invention on paint recycling talks about pyrolysis process wherein paint sludge is mixed with potassium Hydroxide and is heated in controlled condition in absence of air at 600 0 c for preparation of char-coal particles.

4.14.1.1 Results for waste disposal

All above mentioned options are associated with pros and cons on various lines such as practical application, feasibility in implementation, economic viability and consequences of offering. Thus evaluation of alternatives is subject to various factors at specific sites. The analysis of the same can be given as below:

Table 4.14 Waste Management Method

Sr. no	Method of Recycling	Benefits	Constraints
1	Use for paint Preparation	Best example of rejuvenation of life cycle of product.	Quality of paint produced is limited to secondary applications. Limited facilities that make use of the technology. Costly. Prone to fire hazard
2	Use of paint waste as bitumen for road construction	Abounded application in road construction. Resource reuse. Financially viable. Simple technique	Limitations in use due to involvement of govt bodies that can sanction road projects. Scattered sources of generation. Generation of emissions
3	Use for colored concrete	Symbiotic association. Win-win solution. Environmentally friendly.	Difficulty in set up implementation. Limited use.
4	Use of paint waste in sealant Industry	Industrial application.	VOC emissions.
5	Use for charcoal preparation	Can be used for laboratory, medical, filtration and other purposes	Not possible for small quantum of waste. Scope limitations

By Kulkarni,2016 P.47

4.14.2 Paint Waste System

There is solution for technical for separating poisonous particles from the air. Australia's Warringah Council has in a report about common ways of process in spray painting. They split this into three main groups, such as the booth, the airflow and the filter (Kulkarni,2016).

4.14.2.1 Booth

From Warringah Council the most general used painting booths are (Kulkarni,2016):

- Booth with open faced can be described as a booth with three or two walls with a roof in a simple way. With an extractor together and an open front with a filtration system that setup in the booth wall backside.

- This example of booth is totally enclosed and sealed. The room airflow where the process of paint take place is generally cross draft, down draft or a combination of these is called enclosed booth.
- Production booth or tunnel. Roof with opening and booth with two walls in both ends. Cross draft and down draft are the most standard used methods for airflow the booth

4.14.2.2 Airflow

In the making the moving towards particle in the filter is an important. Warringah Council explain some airflow through the booth types(Kulkarni,2016):

- Cross draft.

  Moving airflow in parallel towards the rear of the booth and the filter system and to the floor
- Down draft.

  The system makes the air move in vertical way from the ceiling to floor filter. This solution is generally works with bigger products like vehicles and giving more than one worker at the same time from different sides.
- Semi-down draft.

  Two system design. The moving air is from the ceiling in the front of the booth into the bottom rear part. Second type is when two filtered extractors at the bottom of the side walls or the airflow goes from the center of the ceiling towards one or.

It is necessary to bring into option with what product kind that is going to be used up in booth in order to choose option of airflow solution. When a huge product need to be more in operating from more than one side it is better to use a semi down draft system or down draft system.

4.14.2.3 Filter

Based on good filter that depends on the spray rate I Warringah Council journal, two filter option that used in in combination and different ways. The basic way is use a dry filter. Another option is separating paint particles from air with wet filter. When spray rate is above four litres/hours it is the best option to waste the chemical waste

4.14.2.4 Spray Booth Concept (Water wash booth without pump)

Concept in booth is developed with three or roof and walls. The material will be the extract channel and placed in among the worker. When the material is sprayed the particles from the paint the water filter will going to works well. The spray booth will be given extract channel (exhaust) at the top of the spray booth. Below it there will be water tank and there will be a gap for the airflow, in this process

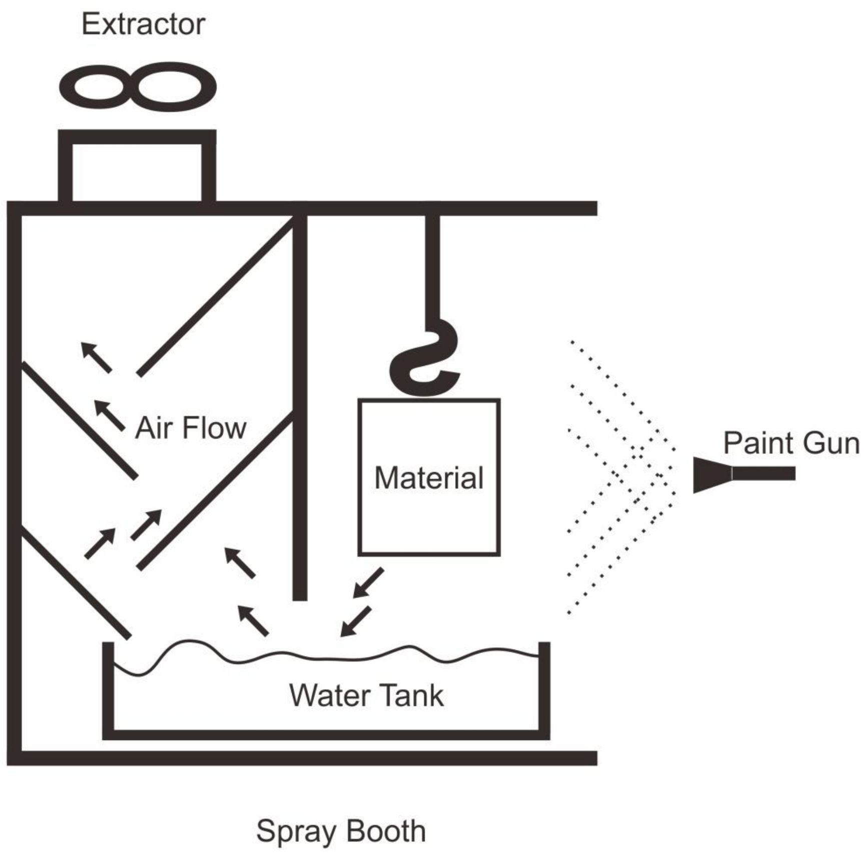


Figure 4.20 Spray Booth Systems

the paint and the air will be separated. The air will go to the exhaust and the paint will drop to the water tank (Kulkarni,2016).

4.15Final Layout Design

From the analysis of the data identification and data analysis section it can conclude how the layout will be looks like.

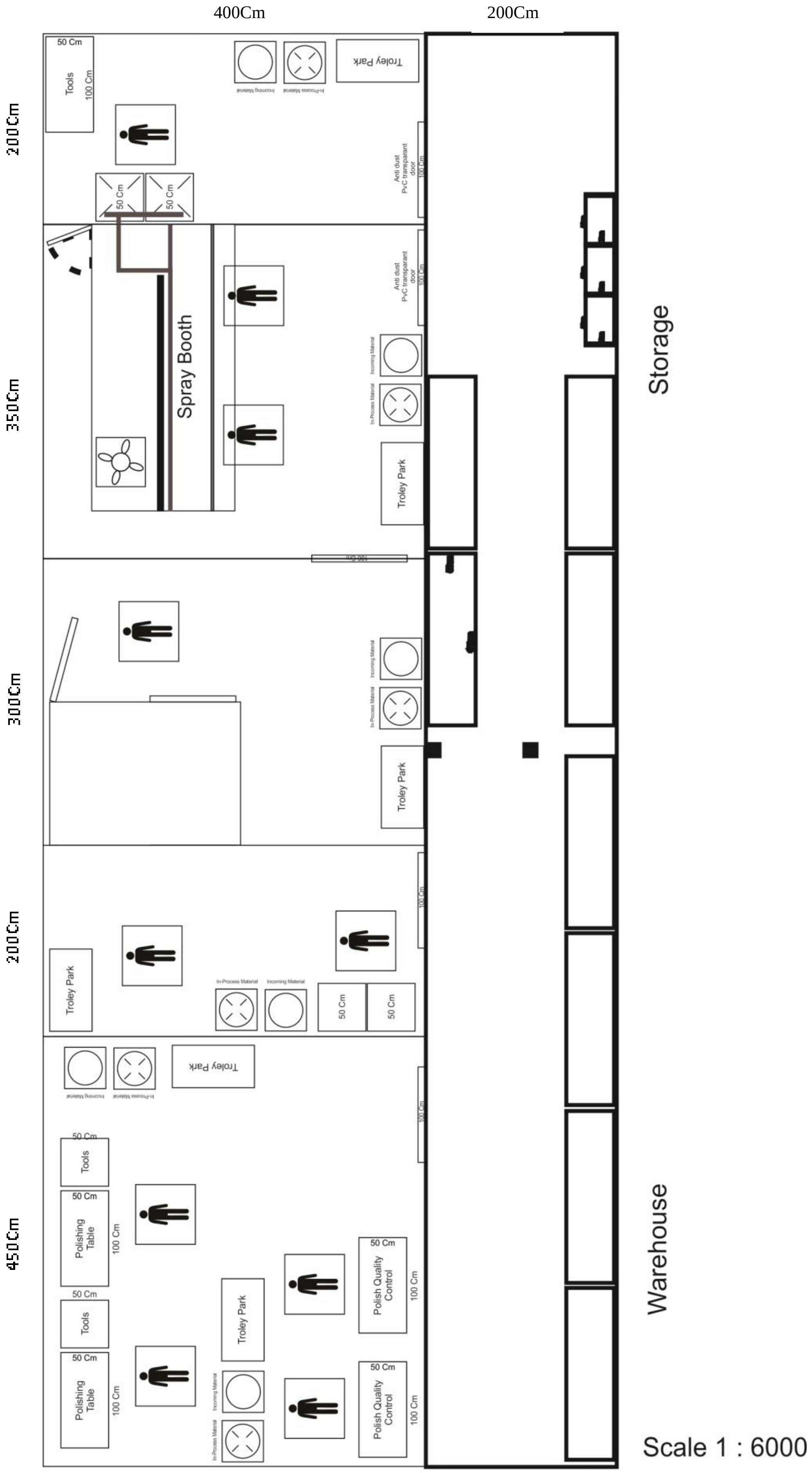


Figure 4.21 Final Layout Design

4.16 Visualization of Facilities and Layout Design

With the help of Autodesk software the designed layout design can be visualized to see the outcome of this study

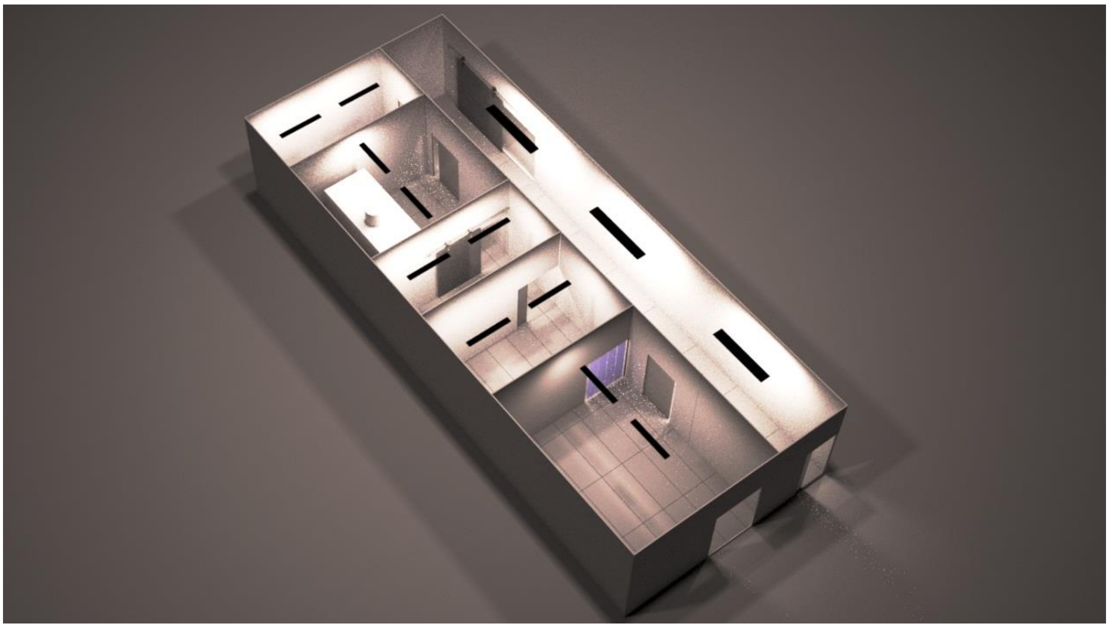


Figure 4.23 Factory Layout

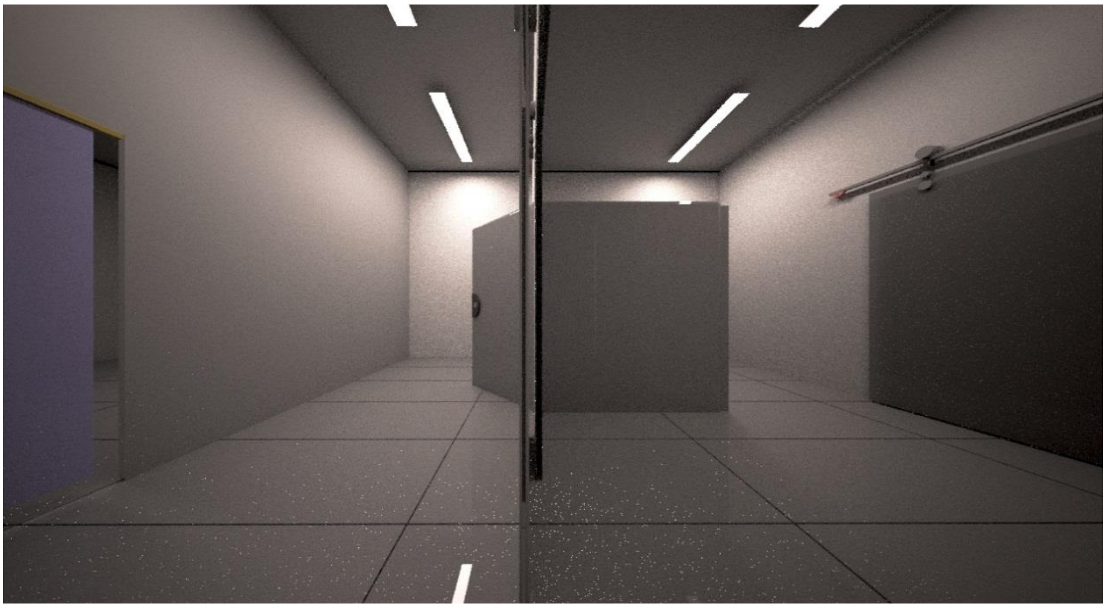


Figure 4.24 Oven& QC Room

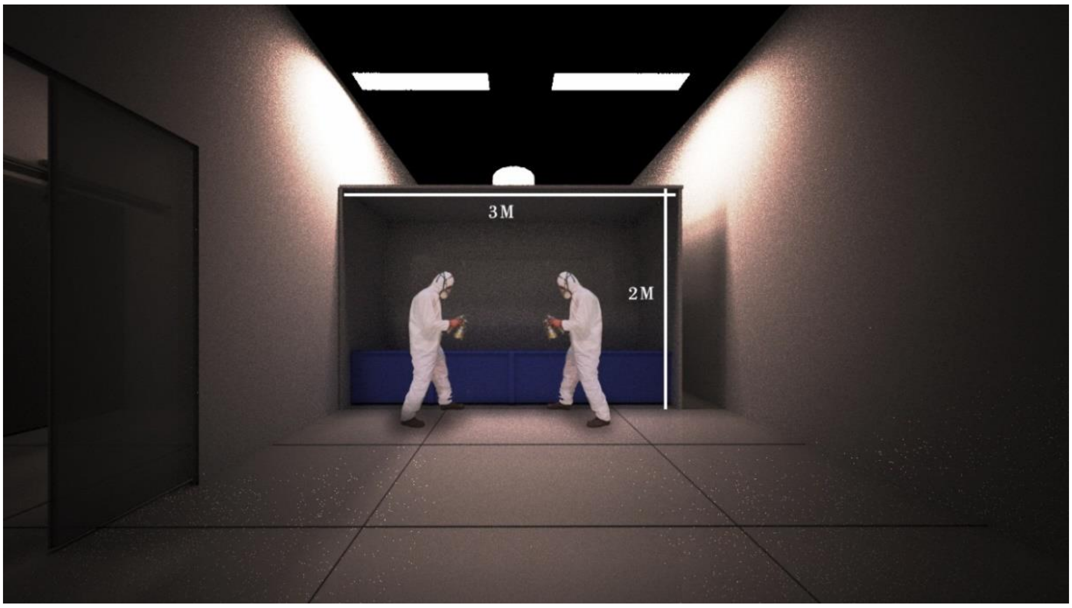


Figure 4.1 Spray Booth

CHAPTER V
CONCLUSION

5.1 Conclusion

This company want to enter new manufacturing department which is job paint manufacturing, the facilities design that consist in this department are mixing room, spray room, oven room and polish room. The design area already determined by the company and each department must fit to the reserved area.

Designing facilities and layout design is not only designing the building itself, health, safety and good work environment is also needed for the company. By analyzing the data given the output of process shown the how the layout is going to be, with high care attention of risk, safety and also ambience for the worker the layout will do good for the operator that will works in the area. The waste management method gives the company less cost for the paint material because the used paint will be re-used for the manufacturing.

Using facilities and layout planning design method, the process and product analysis can be known, then the machine that requires for the manufacturing are determined. With 2 optional of layout calculation using Block and ALDEP method the right layout is determine.

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