Proposing Facility Layout Plan for Plastic Bag making Industries working in MSME segment

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In
Software Enterprise Management

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DECLARATION

I hereby declare that this Project Report entitled Proposing Facility Layout Plan for Plastic Bag making Industries working in MSME segment submitted by me to the GGSIPU Delhi is a bonafide work undertaken by me and it is not submitted to any other University or Institution for the award of any degree diploma / certificate or published any time before.

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ABSTRACT

Almost in all MSME Industries not much attention is given to the concept of facility planning and layout in spite of the fact that if a good facility plan or layout is implemented it would certainly ease out the operations being carried out in a company.

The project aims at studying the different types of facility layout plans and understanding the factors that would play an important role in the making of a facility layout plan. According a facility layout plan would be suggested.

Since a facility layout plan is always company specific therefore in this project a facility layout plan would be suggested for the plastic bag making industry.

To chalk out an implementable facility layout the constraints for a MSME have been studied with the dimensions of the machines as well as the material flow process. The study also includes the characteristics of the inventory goods as well as those of the machines so that their appropriate placement is suggested.

The ideal operating space for a workman is also calculated so that appropriate spacing can be created around the machines.

The result of the project is an ideal facility layout plan for a plastic bag making industry which also includes the dimensions of the plant in which this plan can be implemented.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

This project will propose an ideal facility layout plan after considering an industry's working process and the related aspects.

The introduction seeks to acquaint the reader with the manufacturing industry for which a facility layout plan would be suggested as well as the state of MSME industries present in India.

Following this the purpose of the project would be presented and constraints in the execution of the project would be identified.

The chapter would also define the delimitations of the project and give an outline of the report.

Background

The project would acquaint the reader with the different types of available facility layout plans, the factors affecting implementation of these layout plans as well as the constraints for a particular industry (example - machine type, machine dimensions, material types etc.). The project would also discuss the different factors or concepts that may be used to make a facility layout more effective.

Problem Introduction

In India there are around 26 million MSME industries that provide employment to approximately 60 million people. Majority of these MSMEs are either located in industrial estates set up many decades ago or are functioning within urban areas or have come up in an unorganized manner in either urban or rural areas.

The state of infrastructure including power, water, roads etc in such areas is poor and unreliable. Much cannot be done about such external problems but many internal problems like accidents, frequent labour illness, congestion, bad utilization of space, long distances in the work flow process, labour anxiety, discomfort and difficulty in controlling operation and personnel can be helped up to a certain extent with the help of an efficient and effective facility layout plan.

Purpose

The purpose of this project is to propose a facility layout plan for a plastic bag making industry working in the MSME segment.

Delimitations

In this project the study area is limited only to the Macro (Building Layout) level and Micro (Work cell / Department Layout) level of facility planning i.e. the Global (Site Location) level, Supra (Site planning) level and sub-micro (Workstation Design) level have not been covered.

It has been assumed during the execution of the project that the above mentioned five facility planning levels are not inter dependent and hence can be considered exclusively.

The government norms also place many restrictions for any plant layout. These restrictions are highly dependent on the government in power therefore the government norms have been considered to be out of scope of this project.

While designing this facility layout plan ergonomic aspects have been considered. The approach used for applying ergonomic aspects into this layout plan is a proactive approach i.e. the problems which were thought to be important and that might raise an issue at the later stage only those have been addressed now.

The application of ergonomics concepts into this facility layout plan leaves many a things at the discretion of the planner. Therefore the factors like clearance multiplier etc. can vary from researcher to researcher.

METHOD

The following chapter aims to describe how the study has been conducted, the literature studies, the data collection and the analysis of the collected data.

Approach

Since the project was on facility layout planning therefore, first of all the topic of facility layout planning was studied from various books of operations management. This study included studying what is facility layout planning, advantages of facility layout planning, different types of facility layout plans their features and the tools used for analysing these layout plans.

After this the constraints for a MSME were studied from the Report of Prime Minister's Task Force on Micro, Small and Medium Enterprises (MSME) published by Government of India in January 2010.

Subsequent to this the manufacturing process for a plastic bag making industry was studied with the help of the videos of the manufacturing processes available on the internet sites like youtube.com.

Then the most appropriate type of facility layout plan was chosen to suit the constraints of a MSME as well as those of the plastic bag making industry.

After this the tools for analysing the chosen layout plan were studied in detail from various research papers and the internet. In order to take the full advantage of the analysis tools the capacity of the plant was assumed with the capacity of the machines and the types of products being produced.

Dimensions of different machines involved in manufacturing of plastic bags were obtained from the website of one of the manufacturer of the plastic bag making machines. The anthropometric measurements were also collected from an Ergo-Handbook available on the internet.

By using the dimensions of different machines and applying ergonomic factors to their surroundings areas for various departments were decided.

The analysis tools were applied to the assumed data and then a final layout plan was proposed that complied with the analysis results as well as the MSME constraints. It also defined the ideal land dimensions needed for building up such a facility.

Empirical Data Collection

For designing a facility layout the first major requirement would be the department areas which highly depend on the dimensions of the machines being used in these departments. Therefore, the following dimensions of the different machines being used in the departments have been listed below.

Dimensions Of the mixing machine

Length = 2’

Width = 4’

Height of mixer = 3’

Dimensions of the mixing tub

Length = 20”

Width = 42”

Height of tub = 18”

Dimensions Of the extrusion machine

Length = 10’

Width = 11’

Height of machine = 14’

Dimensions Of the sealing cutting machine

Length = 11’

Width = 6’

Height of machine = 6’

Dimensions Of the punching machine

Length = 22”

Width = 28”

Height of machine = 67”

Dimensions Of the packing machine

Length = 40 cm

Width = 90 cm

Assumptions regarding the total required production and the production capacities of various machines are as follows

Production Volume	2400 Kg/24hr
RM Inventory held at any time	20 tonnes
Product Category I, Punched Bags	576 Kg/day
Product Category II, Un-punched Bags	864Kg/day
Product Category III, Rolls	960 Kg/day
Capacity of 1 Extrusion Machine	20Kg/hr
Capacity of 1 Sealing Cutting Machine	15Kg/hr
Capacity of 1 Punching Machine	24Kg/hr
Packing Capacity of 1 person	12 packet of 5Kg each

THEORETICAL FRAMEWORK

Facility Layout planning

DEFINITION OF FACILITY LAYOUT PLANNING

A *facility layout* is an arrangement of everything needed for production of goods or delivery of services. A *facility* is an entity that facilitates the performance of any job. It may be a machine tool, a work centre, a manufacturing cell, a machine shop, a department, a warehouse, etc. (Heragu, 1997).

The layout design generally depends on the products variety and the production volumes. Four types of organization are referred to, namely fixed product layout, process layout, product layout and cellular layout (Dilworth, 1996).

TYPES OF LAYOUT PLANS

<u>Product Layout</u>

Product layouts are found in flow shops (repetitive assembly and process or continuous flow industries). Flow shops produce high-volume, highly standardized products that require highly standardized, repetitive processes. In a product layout, resources are arranged sequentially, based on the routing of the products. In theory, this sequential layout allows the entire process to be laid out in a straight line, which at times may be totally dedicated to the production of only one product or product version. The flow of the line can then be subdivided so that labour and equipment are utilized smoothly throughout the operation.

Two types of lines are used in product layouts: paced and un-paced. Paced lines can use some sort of conveyor that moves output along at a continuous rate so that workers can perform operations on the product as it goes by. For longer operating times, the worker may have to walk alongside the work as it moves until he or she is finished and can walk back to the workstation to begin working on another part (this essentially is how automobile manufacturing works).

On an un-paced line, workers build up queues between workstations to allow a variable work pace. However, this type of line does not work well with large, bulky products because too much storage space may be required. Also, it is difficult to balance an extreme variety of output rates without significant idle time. A technique known as assembly-line balancing can be used to group the individual tasks performed into workstations so that there will be a reasonable balance of work among the workstations.

Product layout efficiency is often enhanced through the use of line balancing. Line balancing is the assignment of tasks to workstations in such a way that workstations have approximately equal time requirements. This minimizes the amount of time that some workstations are idle, due to waiting on parts from an upstream process or to avoid building up an inventory queue in front of a downstream process.

Advantages of product layouts include:

Output → Product layouts can generate a large volume of products in a short time.

Cost → Unit cost is low as a result of the high volume. Labour specialization results in reduced training time and cost. A wider span of supervision also reduces labour costs. Accounting, purchasing, and inventory control are routine. Because routing is fixed, less attention is required.

Utilization → There is a high degree of labour and equipment utilization.

Disadvantages of product layouts include:

Motivation → The system's inherent division of labour can result in dull, repetitive jobs that can prove to be quite stressful. Also, assembly-line layouts make it very hard to administer individual incentive plans.

Flexibility → Product layouts are inflexible and cannot easily respond to required system changes—especially changes in product or process design.

System protection → the system is at risk from equipment breakdown, absenteeism, and downtime due to preventive maintenance.

Fixed Position Layout

A fixed-position layout is appropriate for a product that is too large or too heavy to move. For example, battleships are not produced on an assembly line. For services, other reasons may dictate the fixed position (e.g., a hospital operating room where doctors, nurses, and medical equipment are brought to the patient). Other fixed-position layout examples include construction (e.g., buildings, dams, and electric or nuclear power plants), shipbuilding, aircraft, aerospace, farming, drilling for oil, home repair, and automated car washes. In order to make this work, required resources must be portable so that they can be taken to the job for "on the spot" performance.

Due to the nature of the product, the user has little choice in the use of a fixed-position layout.

Disadvantages include:

Space → For many fixed-position layouts, the work area may be crowded so that little storage space is available. This also can cause material handling problems.

Administration → Oftentimes, the administrative burden is higher for fixed-position layouts. The span of control can be narrow, and coordination difficult.

<u>Process Layout</u>

Process layouts are found primarily in job shops, or firms that produce customized, low-volume products that may require different processing requirements and sequences of operations. Process layouts are facility configurations in which operations of a similar nature or function are grouped together. As such, they occasionally are referred to as functional layouts. Their purpose is to process goods or provide services that involve a variety of processing requirements. A manufacturing example would be a machine shop. A machine shop generally has separate departments where general-purpose machines are grouped together by function (e.g., milling, grinding, drilling, hydraulic presses, and lathes). Therefore, facilities that are configured according to individual functions or processes have a process layout. This type of layout gives the firm the flexibility needed to handle a variety of routes and process requirements. Services that utilize process layouts include hospitals, banks, auto repair, libraries, and universities.

Improving process layouts involves the minimization of transportation cost, distance, or time. To accomplish this some firms use what is known as a Muther grid, where subjective information is summarized on a grid displaying various combinations of department, work group, or machine pairs. Each combination (pair), represented by an intersection on the grid, is assigned a letter indicating the importance of the closeness of the two (A = absolutely necessary; E = very important; I = important; O = ordinary importance; U = unimportant; X = undesirable). Importance generally is based on the shared use of facilities, equipment, workers or records, work flow, communication requirements, or safety requirements. The departments and other elements are then assigned to clusters in order of importance.

Advantages of process layouts include:

Flexibility → The firm has the ability to handle a variety of processing requirements.

Cost → Sometimes, the general-purpose equipment utilized may be less costly to purchase and less costly and easier to maintain than specialized equipment.

Motivation → Employees in this type of layout will probably be able to perform a variety of tasks on multiple machines, as opposed to the boredom of performing a repetitive task on an assembly line. A process layout also allows the employer to use some type of individual incentive system.

System protection → since there are multiple machines available, process layouts are not particularly vulnerable to equipment failures.

Disadvantages of process layouts include:

Utilization → Equipment utilization rates in process layout are frequently very low, because machine usage is dependent upon a variety of output requirements.

Cost → If batch processing is used, in-process inventory costs could be high. Lower volume means higher per-unit costs. More specialized attention is necessary for both products and customers. Setups are more frequent, hence higher setup costs. Material handling is slower and more inefficient. The span of supervision is small due to job complexities (routing, setups, etc.), so supervisory costs are higher. Additionally, in this type of layout accounting, inventory control, and purchasing usually are highly involved.

Confusion → Constantly changing schedules and routings make juggling process requirements more difficult.

Cellular Layout

Cellular manufacturing is a type of layout where machines are grouped according to the process requirements for a set of similar items (part families) that require similar processing. These groups are called cells. Therefore, a cellular layout is an equipment layout configured to support cellular manufacturing.

Processes are grouped into cells using a technique known as group technology (GT). Group technology involves identifying parts with similar design characteristics (size, shape, and function) and similar process characteristics (type of processing required, available machinery that performs this type of process, and processing sequence).

Workers in cellular layouts are cross-trained so that they can operate all the equipment within the cell and take responsibility for its output. Sometimes the cells feed into an assembly line that produces the final product. In some cases a cell is formed by dedicating certain equipment to the production of a family of parts without actually moving the equipment into a physical cell (these are called virtual or nominal cells). In this way, the firm avoids the burden of rearranging its current layout. However, physical cells are more common.

An automated version of cellular manufacturing is the flexible manufacturing system (FMS). With an FMS, a computer controls the transfer of parts to the various processes, enabling manufacturers to achieve some of the benefits of product layouts while maintaining the flexibility of small batch production.

Some of the advantages of cellular manufacturing include:

Cost → Cellular manufacturing provides for faster processing time, less material handling, less work-in-process inventory, and reduced setup time, all of which reduce costs.

Flexibility → Cellular manufacturing allows for the production of small batches, which provides some degree of increased flexibility. This aspect is greatly enhanced with FMSs.

Motivation → Since workers are cross-trained to run every machine in the cell, boredom is less of a factor. Also, since workers are responsible for their cells' output, more autonomy and job ownership is present.

Table 1 | Features of Different layout plans

FACTORS	FIXED LAYOUT	PRODUCT LAYOUT	PROCESS LAYOUT	CELLULAR LAYOUT
Product	Made to order, Low volume	Standardized Product, Large volume, stable rate of o/p	Diversified products using common operations, Varying volumes, Varying rate of o/p	Diversified Products, Varying volumes
Process	Large scale project	Continuous and repetitive	Job or small batch	Small to medium batch
Arrangement of facilities	Facilities move where the product is being implemented	Placed along the line of product flow in a specialized sequence of task for each unit	Grouped by specialty and by function	Similar parts are grouped in part-family; one machine cell is formed which contains all facilities needed by corresponding part family
Cost of Layout	General purpose equipment. Moderate to low.	Large investment in specialized equipment and processes.	General purpose equipment and processes. Moderate to high	Moderate to Low
Inventory	Variable inventories and frequent tie-ups because production cycle is generally long	High turnover of raw material and work in process	Low turnover of raw material and work in process, High raw material inventory	High turnover of raw material and lower work in process
Material Handling	Flow variable, often low. May require heavy duty handling equipment	Predictable, flow systemized and often automated	Flow variable, handling often duplicated.	Flow variable can be reasonably high.
Material Travel	Variable path	Fixed path	Often high	Fixed path

Ergonomics

DEFINATION OF ERGONOMICS

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and is used by applying theory, principles, data and methods to design elements of a system in order to optimize human well-being and overall system performance.

ERGONOMICS IMPORTANCE

Ergonomics literally means the science of work. Therefore ergonomics involves study of work, how work is done and how to work in a better way. This makes ergonomics capable of being used to make work more comfortable and efficient.

Ergonomics can be applied into the workplace of an employee working in any industry. Ergonomics in the workplace has to do largely with the safety of employees, both long and short-term. Ergonomics can help reduce costs by improving safety, this would decrease the money paid out in workers' compensation. For example, over five million workers sustain overextension injuries per year. Through ergonomics, workplaces can be designed so that workers do not have to overextend themselves and the manufacturing industry could save billions in workers' compensation as well as protect itself from frequent labour absenteeism.

Workplaces may either take the reactive or proactive approach when applying ergonomics practices. Reactive ergonomics is when something needs to be fixed, and corrective action is taken. Proactive ergonomics is the process of seeking areas that could be improved and fixing the issues before they become a large problem.

Problems may be fixed through equipment design, task design, or environmental design. Equipment design changes the actual, physical devices used by people. Task design changes what people do with the equipment. Environmental design changes the environment in which people work, but not the physical equipment they use.

USE OF ERGONOMCS

MSME's have a major constraint and that is the amount of space a MSME can afford for building up its facility. This constraint generally leads to problems like congestion and unsafe working distances for the labourers working with the machines. Mainly to prevent the eruption of these problems ergonomics is being used in this project.

For designing such a safe working environment certain anthropometric measurements are required which can help to design the place in such a way that labourers can be accommodated easily. These anthropometric measurements are shown in the figures and tables given below. These measurements have been taken from Business and Institutional furniture manufacturers association (BIFMA).

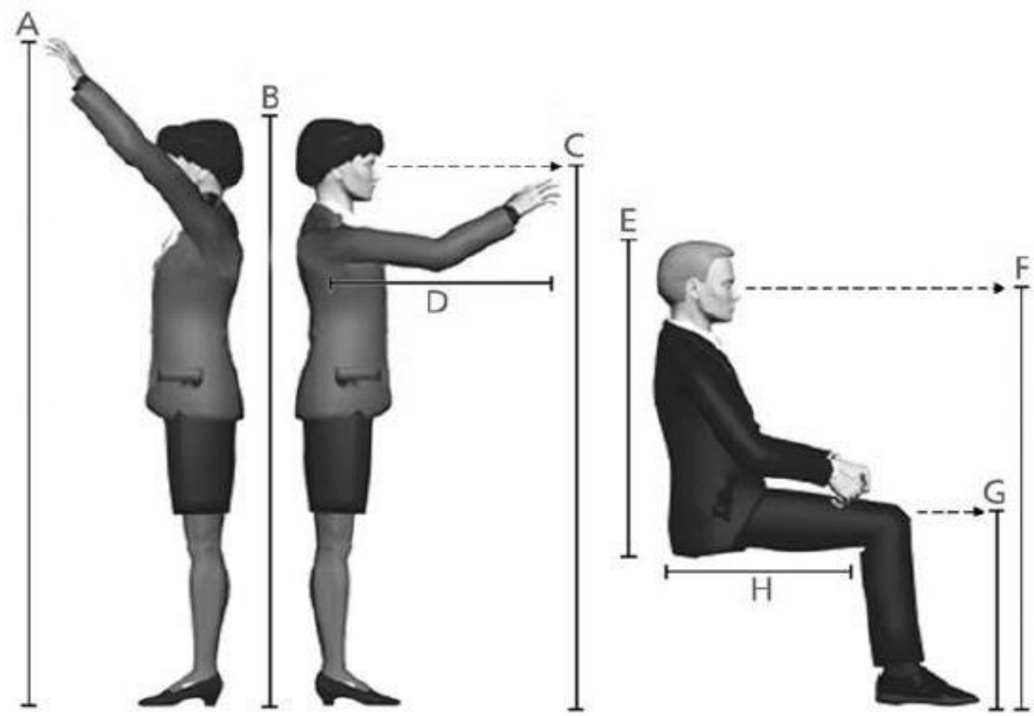


Figure 1 | Common working environment posture measurements

Table 2 | Working environment anthropometric measurements of small and large males and females, from BIFMA Ergonomics Guidelines, 2002

Measurement	Letter	Female	Male
Standing Overhead Reach	A	74.9″ – 86.8″	81.2″ – 93.7″
Standing Height	B	60.2″ – 68.4″	64.8″ – 73.5″
Standing Eye Height	C	56.9″ – 65.0″	61.4″ – 69.8″
Standing Forward Reach	D	30.8″ – 36.1″	33.8″ – 39.5″
Sitting Height	E	31.3″ – 35.8″	33.6″ – 38.3″
Sitting Eye Height	F	42.6″ – 48.8″	46.3″ – 52.6″
Sitting Knee Height	G	19.8″ – 23.2″	21.4″ – 25.0″
Seat Depth	H	16.9″ – 20.4″	17.7″ – 21.1″

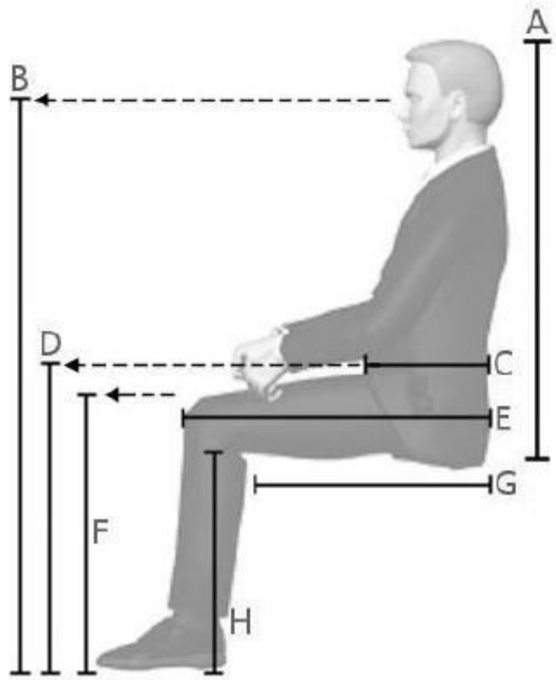


Figure 2 | Common anthropometric measurements for the seated position

Table 3 | Values for 5th to 95th percentile males and females in the seated position, from BIFMA Ergonomics Guidelines, 2002

Measurement	Letter	Female 5th – 95th%	Male 5th – 95th%	Overall Range 5th – 95th%
Sitting Height	A	31.3" – 35.8"	33.6" – 38.3"	31.3" – 38.3"
Sitting Eye Height	B	42.6" – 48.8"	46.3" – 52.6"	42.6" – 52.6"
Waist Depth	C	7.3" – 10.7"	7.8" – 11.4"	7.3" – 11.4"
Thigh Clearance	D	21.0" – 24.5"	23.0" – 26.8"	21.0" – 26.8"
Buttock-to-Knee	E	21.3" – 25.2"	22.4" – 26.3"	21.3 – 26.3"
Knee Height	F	19.8" – 23.2"	21.4" – 25.0"	19.8" – 28.0"
Seat Length/Depth	G	16.9" – 20.4"	17.7" – 21.1"	16.9" – 21.1"
Popliteal Height	H	15.0" – 18.1"	16.7" – 19.9"	15.0" – 19.9"
Seat Width	Not Shown	14.5" – 18.0"	13.9" – 17.2"	13.9" – 18.0"

Industry Analysis | Plastic Bag Making Industry

Plastic bag making Industries majorly produce for garment exporters and traders who supply it to all sorts of different industries. All of these customers have their own specified demands and quantities i.e. the product has to be largely customized according to the customer's requirements. Therefore the industry majorly follows shop based production.

The plastic bag manufacturing majorly consists of the following processes – mixing process, extrusion process, sealing-cutting process, punching process and packing.

The manufacturing of plastic bags involves use of various types of raw materials which have to be mixed evenly before being processed any further and hence are sent to the mixing process for even mixing in a mixture.

The mixture received after the mixing process then comes to the extrusion process which majorly involves use of extrusion machines which use this mixture to produce plastic tubes of different sizes which are adjusted by the operator of the machine. The rolls produced in the extrusion process are either sent to the sealing cutting process or directly to the finished goods inventory for fulfilling the requirement of rolls.

The sealing cutting process employees sealing cutting machines to perform the task of converting the plastic tubes into plastic bags by the act of sealing the tube and cutting it apart to give it the shape of a bag. The length of the bag is adjusted by the operator of the machine.

After the sealing and cutting process the un-punched bags are either sent to the punching department or are sent directly to the packing department for fulfilling the requirement of un-punched bags.

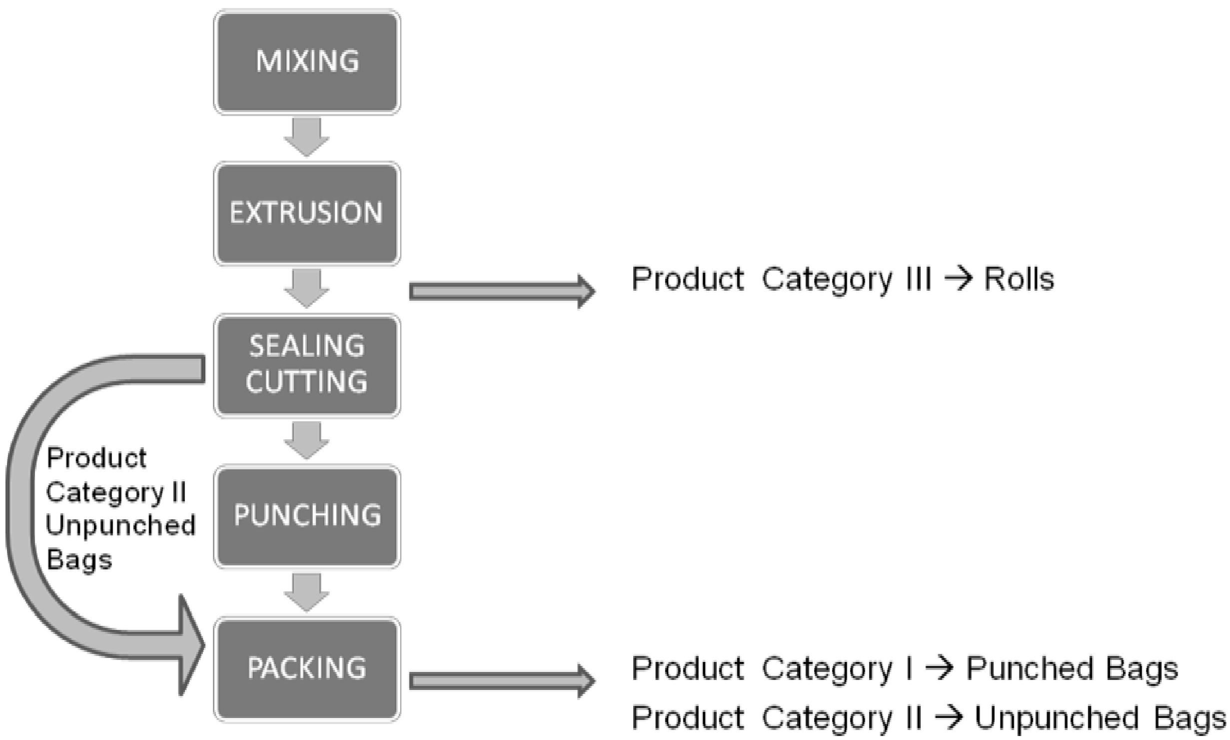


Figure 3 | Product flow

The plastic bag manufacturing industries need to invest large sums of money in their machine. Major amount of investment happens in the extrusion machines which contribute to most of the investment followed by the sealing cutting machines.

PROCESS LAYOUT – ANALYSING TOOLS

Spiral analysis

Mostly in MSME's there is not much data available on the inter departmental material handling cost as well as the size of the facility being small these values also tend to be negligible, therefore numerical flow of items between departments is impractical to obtain. This is why in these situations a semi quantitative technique like spiral analysis should be used.

The objective of the spiral analysis is to arrange the departments in such a manner that the transportation costs of material handling are minimized. The analysis tries to find an option that provides the most direct flow of material between different departments.

In spiral analysis the movement of all the variants of goods is studied between different departments only on the basis of the volumes moved and not on the basis of the cost for each movement.

Therefore in spiral analysis first of all the path of movement among different departments for all the product variants is chalked out along with their percentage share of the total goods produced.

Subsequent to this the inflow and outflow for each department is presented pictorially. The pictorial representation includes the source and destination of the material for each department. The inflows and outflows are in the form of percentages of the total goods movement.

On the left hand side of the department representation a line is used to represent the incoming material along which is mentioned the percentage of flow taking place. Similarly on the right hand side of the department representation a line is used to represent the outgoing material along which is mentioned the percentage of flow taking place.

The amount of total inflows for a department must be equal to the amount of total outflows for that department.

Space requirement also needs to be computed. Based on the size and number of machines to be installed and the space available for the layout, the minimum space required can be worked out. The solution is arrived at by hit and trial method.

The spiral method works under the following assumptions

1. The department shape is a combination of squares and rectangles.
2. The area of the department varies only slightly with peripheral changes in its shape.

Systematic Layout Planning Analysis

In certain layout problems, numerical flow of items between departments does not reveal the qualitative factors that may be crucial to the placement decision as well as these numerical flow values cannot be ascertained for non productive departments like offices, recreational centres and rest rooms. In these cases, the venerable technique known as **systematic layout planning (SLP)** is used.

The first step in performing a SLP analysis is to list down the reasons for which either a department should be placed close to another department or should be placed far away from another department. These reasons need to be summarised in a tabular form.

In the SLP analysis six priority rating are made namely A (Absolutely Important), E (Essential), I (Important), O (Ordinarily Important), U (Unimportant) and X (Undesirable). These ratings are given corresponding weights so that facility layout plans may be compared on the basis of the extent they satisfy priorities. Each priority rating is also given a line code for ease in pictorial representation.

Subsequent to this a relationship chart is developed showing the priority rating for having each department located adjacent to every other department. This chart also contains the reasons behind giving the mentioned priority.

Now the departments are linked with different line codes to signify the priorities given to them. This can be said to be a pictorial representation of the priority ratings.

For performing an SLP the number of departments in the facility should not be more than 20 because this may make the analysis much complicated to comprehend.

Now the placement of departments is done similar to the pictorial representation and the modifications are done department by department to obtain the best possible layout plan.

The SLP approach has been quantified for ease of evaluating alternative layouts. The assigned numerical weights to the priority rankings are checked for each layout plan suggested. The layout with the highest total closeness score is selected.

DECIDING DEPARTMENT AREAS

RM Inventory Area

Raw material inventory storage = 20 tonnes =20,000Kg

Weight in each sack = 25Kg

No. of sacks needed to store 20 tonnes = 20,000/25

= 800 sacks

DIMENSIONS OF A SINGLE RAW MATERIAL SACK

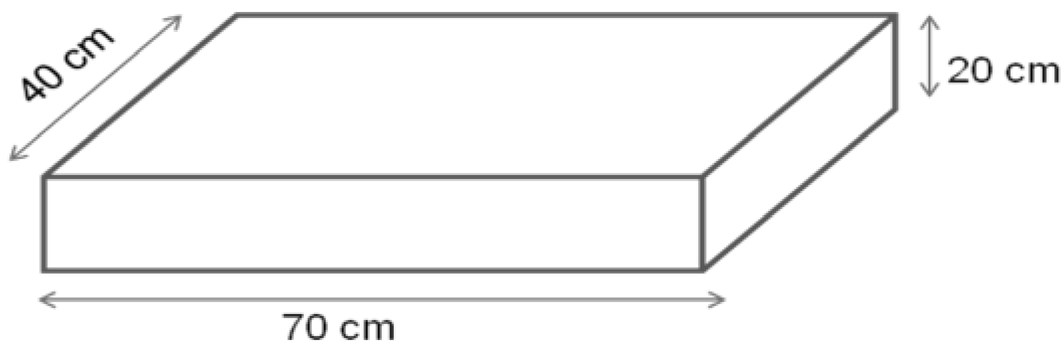


Figure 4 | Dimensions of a single Raw material sack

IDEAL PICKUP RANGE FOR A SACK OF 25Kg WEIGHT

Minimum storage height / level

= Sitting knee height

= G = 25”

= 0.635 m

Maximum storage height / level

= Standing eye height

= C = 69.8”

= 1.773 m

Height of Stack

= Maximum storage height / level - Minimum storage height / level

= 1.773 – 0.635

= 1.138 m

Height of department to store the stack

= Height of Stack + Minimum storage height / level

= 1.138 + 0.635

= 1.773 m

Height above floor

= Sitting knee height

= 0.635 m

Height of one sack = 0.2 m

No of sacks in one stack = Height of one stack / Height of one sack

= 1.138 / 0.2

= 5.69

≈ 5 sacks

DECIDING DEPARTMENT LENGTH AND BREADTH

No of stacks for storing 800 sacks = 800/5

= 160 stacks

= 2 * 2 * 2 * 2 * 2 * 5

= 16 * 10

i.e.

No. of rows for storing RM stock = 16

No. of columns for storing RM stock = 10

Length of Raw material warehouse

= {No. of stacks * Length of one sack} +

{Width of one sack + Seat length / depth}

= (10 * 40cm) + (70cm + 21.1")

= 4 + 1.236

= 5.236 m

Width of Raw material warehouse

= {No. of stacks * Width of one sack} +

{Clearance space * 2}

= (16 * 0.7) + (0.1 * 2)

= 11.4 m

Area required for storing 800 Raw Material Sacks = 5.236 * 11.4

= 59.6904 m^2

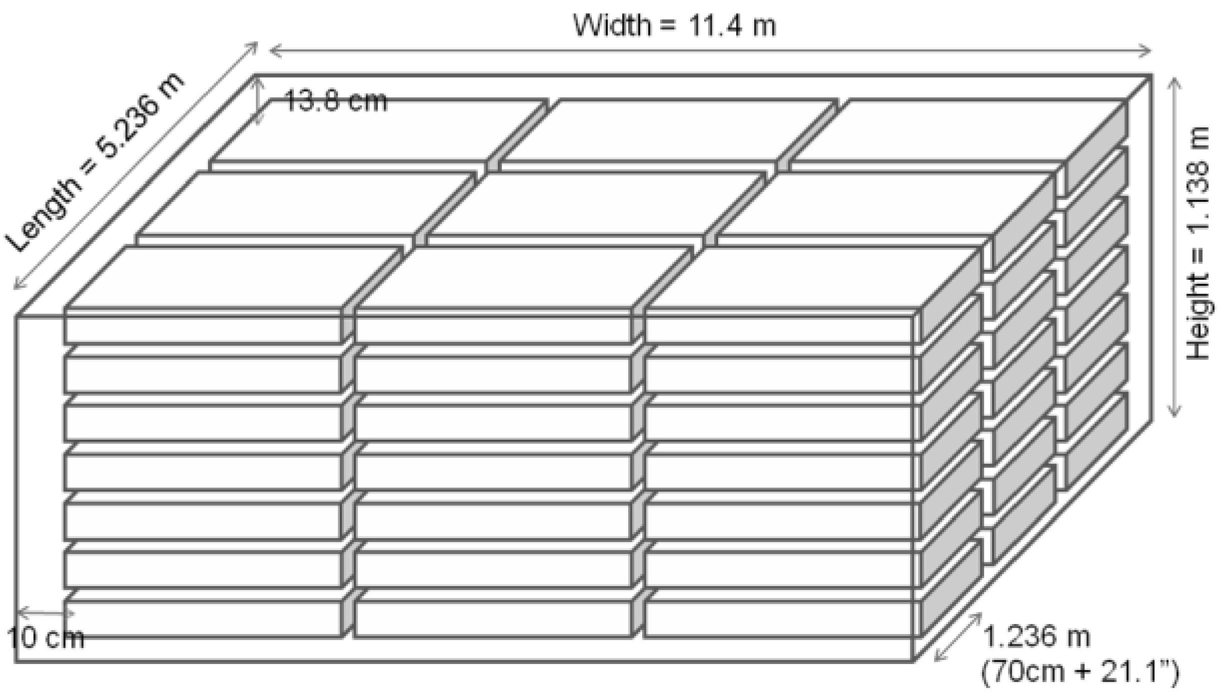


Figure 5 | Dimensions of the RM Inventory Department

Mixing Department

No of mixing machines = 1

No of mixing tubs = 5 (One for each extrusion machine)

DIMENSIONS OF THE MIXING MACHINE

Length = 2’

Width = 4’

Height of mixer = 3’

= 0.9144 m

AREA OCCUPIED BY ONE MIXER

= (L) 2’ * (W) 4’

= 0.6096 m * 1.2192 m

= 0.7432 m^2

DIMENSIONS OF THE MIXING TUB

Length = 20”

Width = 42”

Height of tub = 18”

= 0.4572 m

AREA OCCUPIED BY ONE MIXING TUB

= (L) 20” * (W) 42”

= 0.508 m * 1.0668 m

= 0.5419 m^2

Area occupied by five mixing tubs

= Five (no of mixing tubs) * area occupied by one mixing tub

= 5 * 0.5419 m^2

= 2.7096 m^2

AREA FOR PARALLEL ALLEY

= Largest length * (Standing forward reach * Clearance multiplier)

= (L) 2’ * (W) (39.5” * 1.5)

= 0.6096 m * 1.50495 m

= 0.9174 m^2

Area for four parallel alleys

= Four (no of Parallel Alleys) * area for one alley

= 4 * 0.9174

= 3.6696 m^2

HEIGHT OF PARALLEL ALLEY

= Standing Over head reach + Clearance space

= 93.7” + Clearance

≈ 100”

= 2.5 m

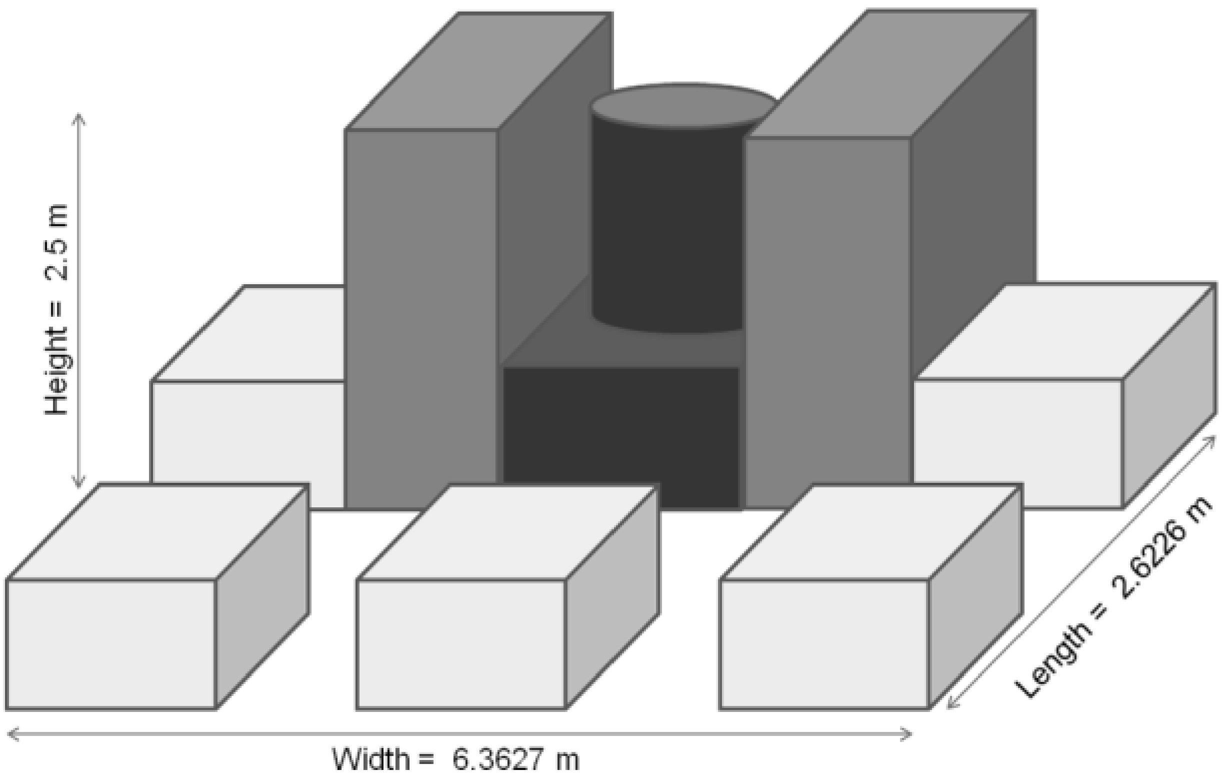


Figure 6 | Layout of mixing department

AREA FOR PERPENDICULAR ALLEY

= {Standing forward reach * Clearance multiplier} * {Mixer width + (Width of one tub * 2) + (Width of one parallel alley * 2)}

= (L) (39.5" * 1.5) * (W) (4' + (42" * 2) + ((39.5" * 1.5)*2))

= 1.505 m * 6.3627 m

= 9.5758 m^2

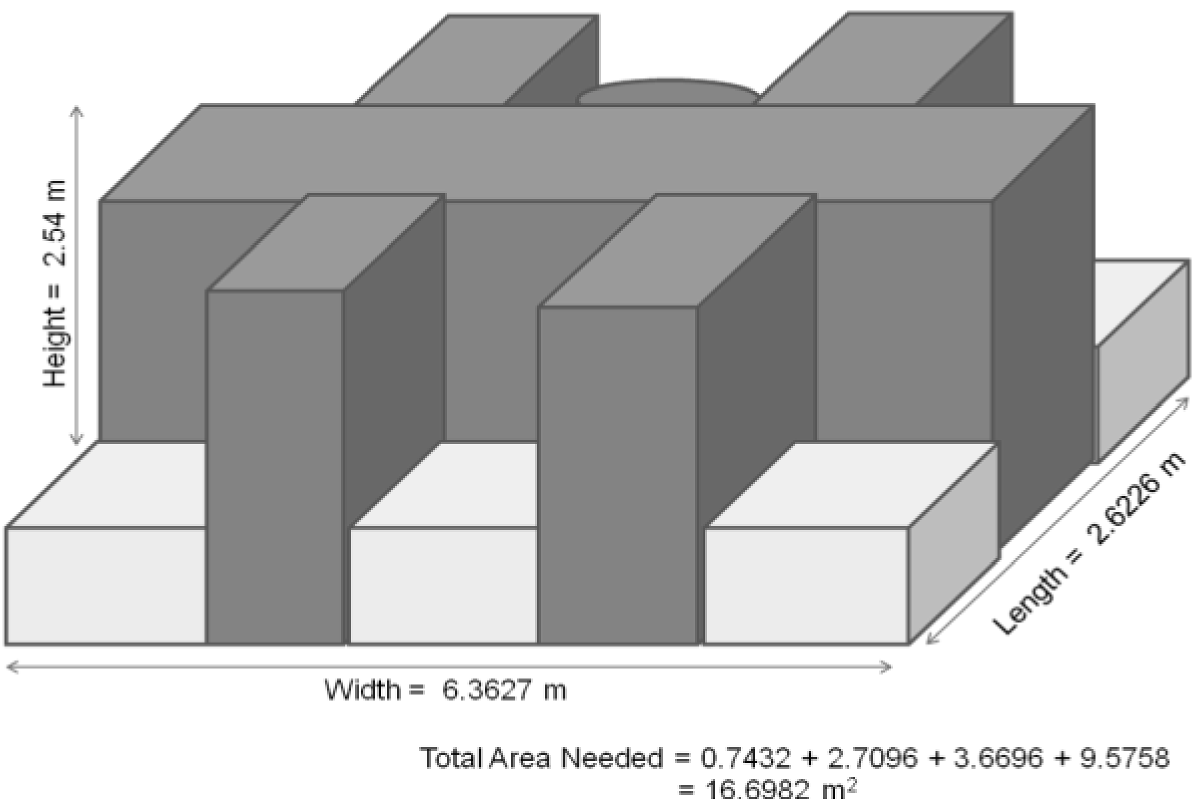
Height of Perpendicular Alley

= Standing Over head reach + Clearance space

= 93.7” + Clearance

≈ 100”

= 2.54 m



TOTAL AREA NEEDED FOR MIXING DEPARTMENT

= Area for mixing machine + Area for four mixing tubs + Area for four parallel alleys + Area for perpendicular alleys

= 0.7432 + 2.7096 + 3.6696 + 9.5758

= 16.6982 m^2

Extrusion Department

Total production requirement in a day = 2400 Kg

Production capacity for one Hr of one extrusion machine = 20 Kg/Hr.

Production capacity for 24 Hrs of one extrusion machine = 20 Kg/Hr. * 24

= 480 Kg/day

No. of machine needed to fulfil requirement = 2400/480

= 5 machines

Therefore no. of extrusion machines needed = 5

DIMENSIONS OF THE EXTRUSION MACHINE

Length = 10'

Width = 11'

Height of machine = 14'

= 4.3m

AREA OF ONE EXTRUSION MACHINE

= (L) 10' * (W) 11'

= 3.048 * 3.3528

= 10.22 m^2

Area of five machines

= Five (no of extrusion machines) * area occupied by one extrusion machine

= 5 * 10.22 m^2

= 51.1 m^2

AREA FOR ONE PARALLEL ALLEY

= Length of 1 extrusion machine * (Standing forward reach * Clearance multiplier)

= (L) 10’ * (W) (39.5” * 1.5)

= 3.048 * (1.0033 * 1.5)

= 4.587 m^2

Area for four parallel Alleys

= Four (no of Parallel Alleys) * area for one alley

= 4 * 4.587

= 18.35 m^2

Height of Alley

= Standing Over head reach + Clearance space

≈ 100”

= 2.54 m

AREA FOR ALL PERPENDICULAR ALLEYS

= {Standing forward reach * Clearance multiplier} *

{(Width of 1 machine * 3) + ((Width of 1 parallel alley) * 2)}

= (L) (39.5" * 2) * (W) {(11' * 3) + (39.5" * 1.5 *2)}

= (1.0033 * 2) * {(3.3528 * 3) + (1.0033 * 1.5 * 2)}

= 26.223 m^2

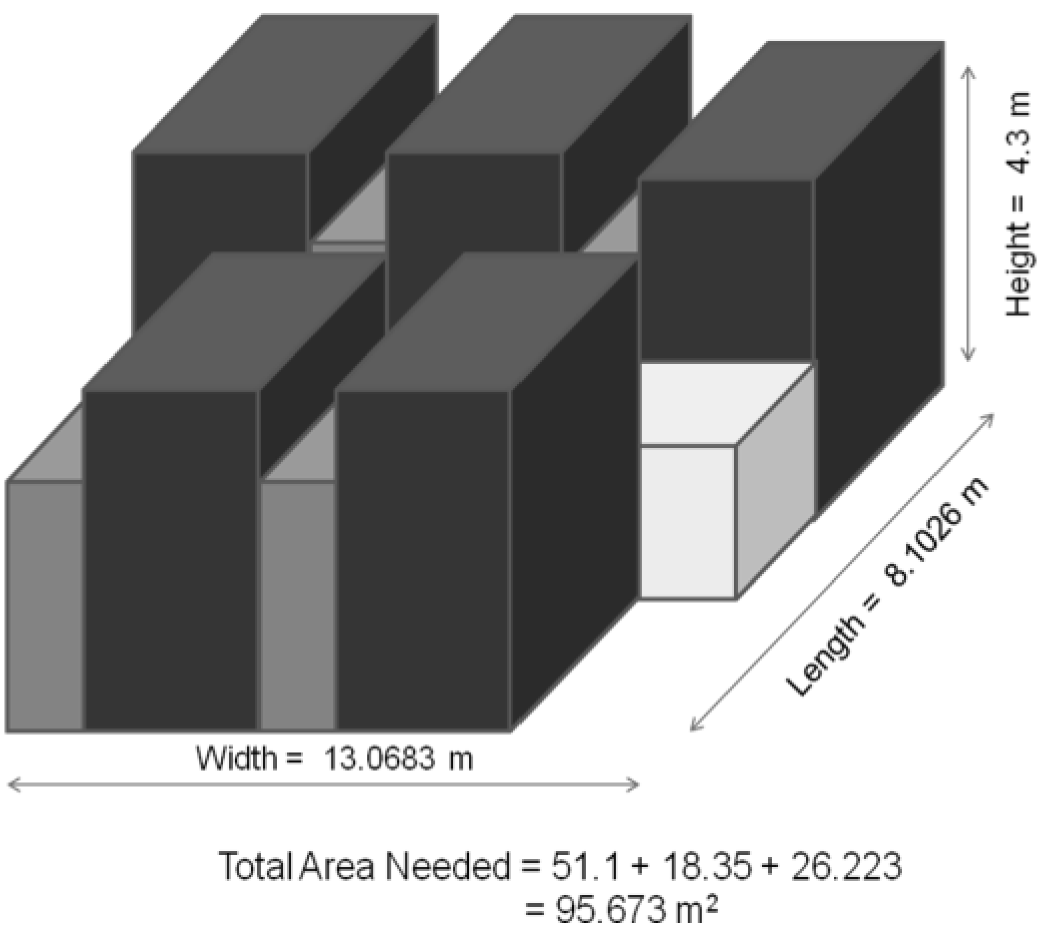


Figure 7 | Dimensions of extrusion department

Sealing Cutting

Total production requirement in a day = 1440 Kg

Production capacity for one Hr of one sealing cutting machine = 15 Kg/Hr.

Production capacity for 24 Hrs of one sealing cutting machine = 15 Kg/Hr. * 24

= 360 Kg/day

No. of machine needed to fulfil requirement = 1440/360

= 4 machines

Therefore no. of sealing cutting machines needed = 4

DIMENSIONS OF THE SEALING CUTTING MACHINE

Length = 11’

Width = 6’

Height of machine = 6’

= 1.8288 m

AREA OF ONE MACHINE

= (L) 11’ * (W) 6’

= 3.3528 m * 1.8288 m

= 6.1316 m^2

Area of four machines

= Four (No. of Sealing cutting machines) * area of single machine

= 4 * 6.1316 m^2

= 24.5264 m^2

AREA FOR ONE PARALLEL ALLEY

= Length of one machine * {Standing forward reach * Clearance multiplier}

= (L) 11' * (W) (39.5" * 1.5)

= 3.3528 * 1.505

= 5.046 m^2

Area for four parallel Alleys = No. of parallel alleys * Area of one parallel alley

= 4 * 5.046

= 20.1832 m^2

AREA FOR ONE PERPENDICULAR ALLEY

= {Standing forward reach * Clearance multiplier} *

{(Width of one machine * 2) + (Width of parallel alley * 2)}

= (L) (39.5" * 2) * (W) {(6' * 2) + (39.5" * 1.5 *2)}

= 2.0066 * (3.6576 + 3.0099)

= 13.3790 m2

Area for three perpendicular Alleys (last one taken half)

= No. of perpendicular alleys * area of perpendicular alleys

= 2.5 * 13.3790 m^2

= 33.4475 m^2

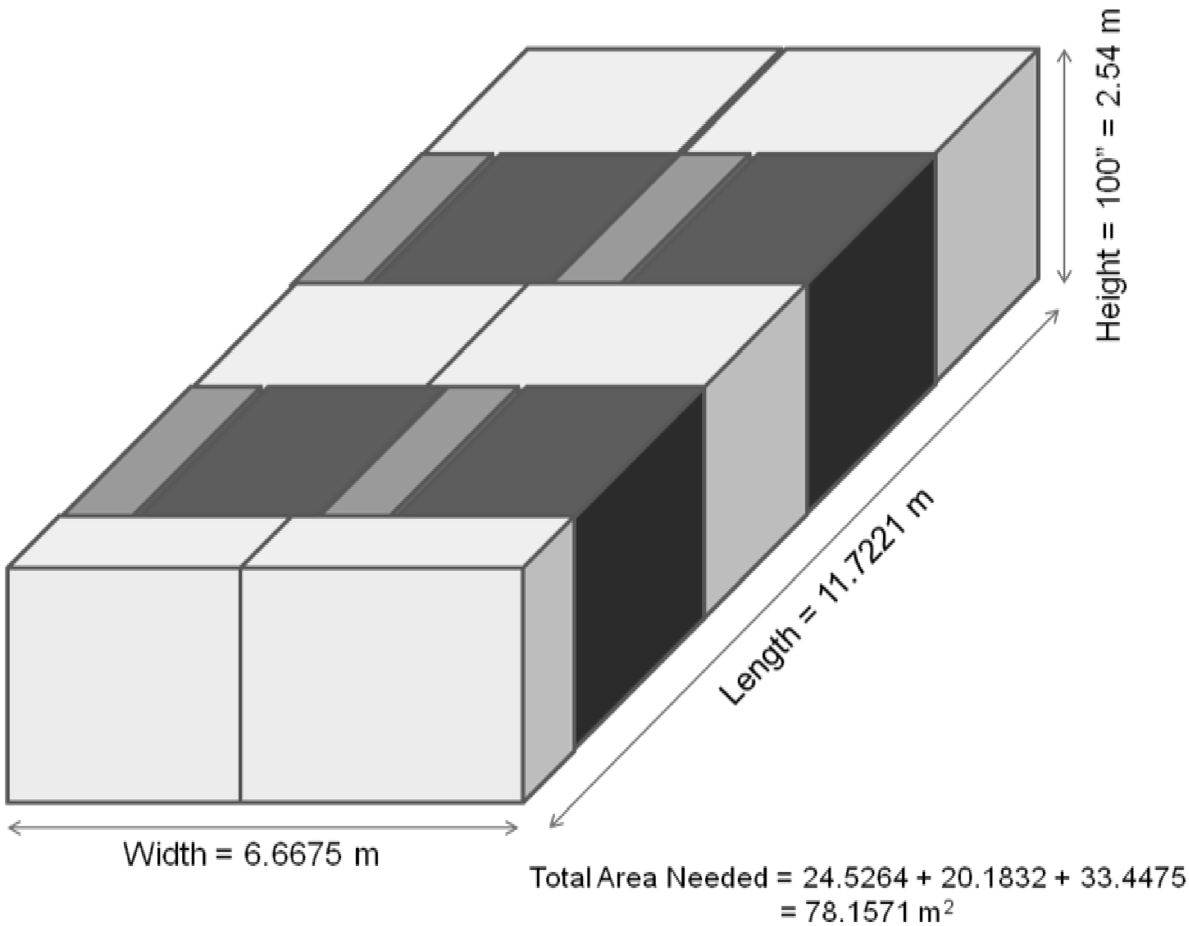


Figure 8 | Dimensions of sealing and cutting department

Punching Department

DIMENSIONS OF THE PUNCHING MACHINE

Length = 22”

Width = 28”

Height of machine = 67”

= 1.7 m

AREA OF PUNCHING MACHINE

= (L) 22” * (W) 28”

= 0.5588 * 0.7112

= 0.4 m^2

AREA FOR PARALLEL ALLEY

= Length of one sack * Width of one sack

= (L) (0.4 + 0.1) * (W) (0.2 + 0.1)

= (L) (0.5) * (W) (0.3)

= 0.15 m^2

HEIGHT OF ALLEY

= Height of one sack

= 0.7 m

AREA FOR PERPENDICULAR ALLEY

= {Standing forward reach * Clearance multiplier}

* {Seat depth * Clearance multiplier}

= (L) (39.5” * 1.5) * (W) (18” * 2)

= 1.3761 m^2

HEIGHT OF PERPENDICULAR ALLEY

= Standing Over head reach + Clearance space

≈ 100”

= 2.54 m

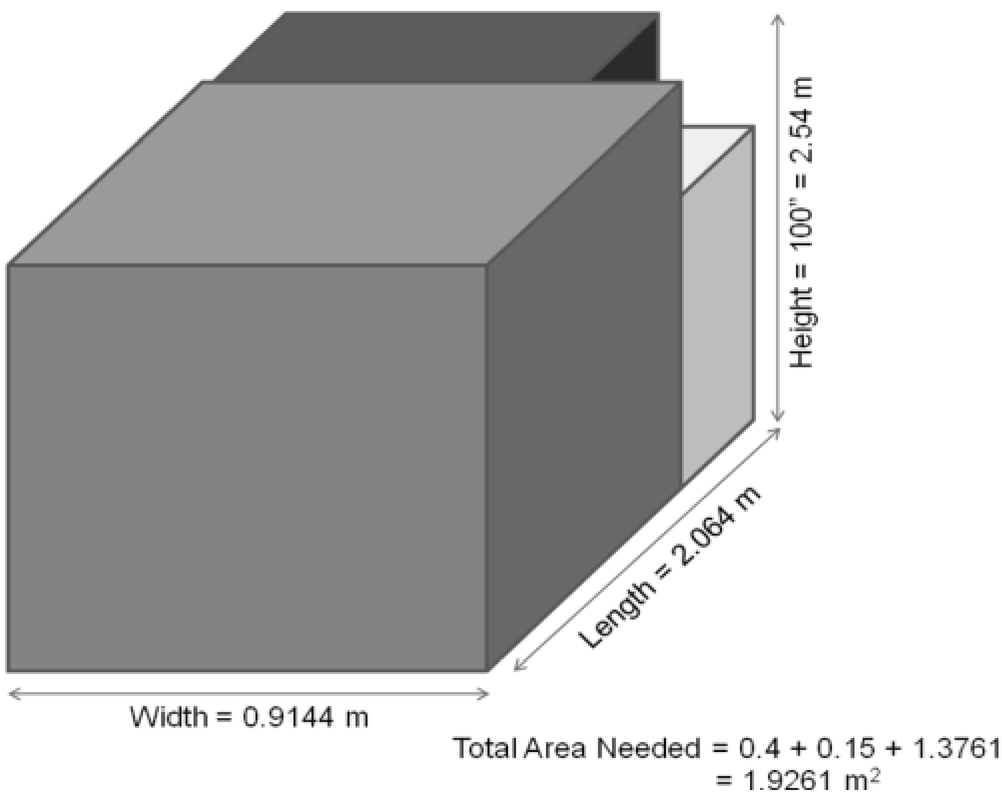


Figure 9 | Dimensions of punching department

Packing Department

DIMENSIONS OF THE PACKING MACHINE

Length = 40 cm

Width = 90 cm

Height of machine = Sitting Knee Height + Width of one sack + clearance space

= 25” + 1 m

= 1.635 m

AREA OF WEIGHING MACHINE CUM PACKING TABLE

= Length of one sack * {Width of one sack + Clearance space}

= (L) 0.40 * (W) {0.70 + (0.10 +0.10)}

= 0.36 m^2

Area for parallel Alley

= {Length of one sack * 3} * Width of one sack

= (L) (0.2 * 4) * (W) (0.4)

= (L) (0.8) * (W) (0.4)

= 0.32 m^2

HEIGHT OF ALLEY

= Height of one sack * clearance multiplier

= 1.4 m

AREA FOR PERPENDICULAR ALLEY

= {Standing forward reach * Clearance multiplier}

* {Seat depth * Clearance multiplier}

= (L) (39.5” * 1.5) * (W) (18” * 2)

= 1.50495 * 0.9144

= 1.3761 m^2

HEIGHT OF PERPENDICULAR ALLEY

= Standing Over head reach + Clearance space

≈ 100”

= 2.54 m

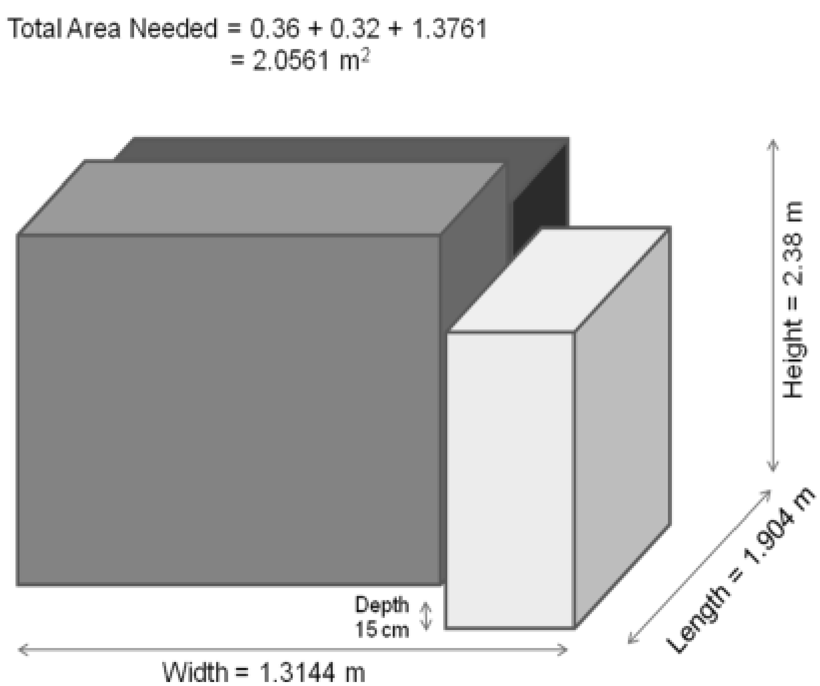


Figure 10 | Dimensions of packing department

FG Inventory Area

Finished Goods inventory storage = 1440 Kg * 2

= 2880 Kg

Weight in each sack = 25Kg

No. of sacks needed to store 2880 Kg = 2880/25

= 115.2

≈ 116 sacks

DIMENSIONS OF A SINGLE FINISHED GOODS SACK

Figure 11 | Dimensions of a finished goods sack

IDEAL PICKUP HEIGHT FOR A SACK OF 25KG WEIGHT

Minimum storage height / level

= Sitting knee height

= G = 25”

= 0.635 m

Maximum storage height / level

= Standing eye height

= C = 69.8”

= 1.773 m

Height of Stack

= Maximum storage height / level - Minimum storage height / level

= 1.773 – 0.635

= 1.138 m

Height of department to store the stack

= Height of Stack + Minimum storage height / level

= 1.138 + 0.635

= 1.773 m

Height above floor

= Sitting knee height

= 0.635 m

Height of one sack = 0.2 m

DECIDING DEPARTMENT LENGTH AND BREADTH

No of sacks in one stack = Height of one stack / Height of one sack

= 1.138 / 0.2

= 5.69

≈ 5 sacks

No of stacks for storing 116 sacks = 116/5

= 23.2

≈ 24 stacks

= 2 * 2 * 2 * 3

= 4 * 6

i.e.

No. of rows for storing FG Inventory = 4

No. of columns for storing FG Inventory = 6

Length of Finished Goods warehouse

= {No. of stacks * Length of one sack} +

{Width of one sack + Seat length / depth}

= (6 * 0.4) + (70cm + 21.1")

= 2.4 + 1.236

= 3.636 m

Width of Finished Goods warehouse

= {No. of stacks * Width of one sack} +

{Clearance space * 2}

= (4 * 0.7) + (0.1 * 2)

= 3 m

Area required for storing 116 Finished Good Sacks = 3.636 * 3

= 10.908 m^2

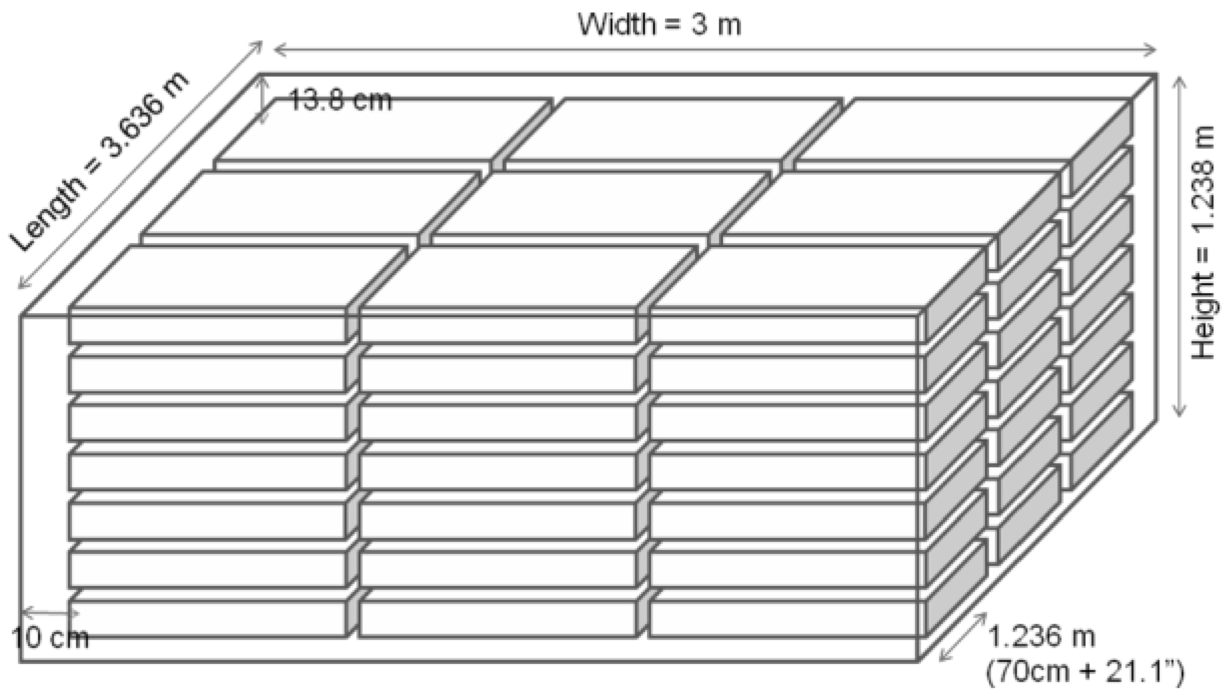


Figure 12 | Dimensions of FG Inventory

Area required for storing 116 Finished Goods Sacks = 3.636 * 3

= 10.908 m^2

DEPARTMENT AREAS

The area found appropriate for accommodating the above departments is as listed in the table below.

Table 4 | Consolidate Department Areas

DEPT. CODE	DEPARTMENT NAME	DEPARTMENT AREA (L X W)
S1	STOCK	59.6904
S2	MIXING	16.6982
S3	EXTRUSION	95.673
S4	SEALING CUTTING	78.1571
S5	PUNCHING	1.9261
S6	PACKING	2.0561
S7	FG INVENTORY	10.908

SPIRAL ANALYSIS

The industry analysis of plastic bag making industry shows that there exist three types of product variants which have been divided into Group I, Group II and Group III which stand for Punched bags, Un-punched bags and Rolls respectively.

From the assumptions regarding the volumes of production needed for the different product variants it can be seen that 576 Kg of the Product Group I needs to be manufactured in one day, 864 Kg of the Product Group II needs to be manufactured in one day and 960 Kg of the Product Group III needs to be manufactured in one day. The total production in a day needs to be 2400 Kg i.e. (576 + 960 + 864).

Now, the percentage volumes for the three product groups can be decided as given below

Percentage Volume Product Group I

= (Volume of Product Group I to be manufactured in one day / Total production in a day) * 100

= (576 / 2400) *100

= 24%

Percentage Volume Product Group II

= (Volume of Product Group II to be manufactured in one day / Total production in a day) * 100

= (864 / 2400) *100

= 36%

Percentage Volume Product Group III

= (Volume of Product Group III to be manufactured in one day / Total production in a day) * 100

= (960 / 2400) *100

= 40%

The whole of the plastic bag making industry can be divided into seven productive departments that are listed in the table below along with their department codes.

Table 5 | Department codes for spiral analysis

DEPT. CODE	DEPARTMENT NAME
S1	RM STOCK
S2	MIXING
S3	EXTRUSION
S4	SEALING CUTTING
S5	PUNCHING
S6	PACKING
S7	FG INVENTORY

Now the movement of different product groups through the different departments of the facility is listed in the following table. The percentage of produce needed for each product group is also listed along with the movement path.

Table 6 | Flow path through departments

PRODUCT GROUP	PERCENTAGE VOLUME	FLOW PATH THROUGH DEPARTMENTS
I → Punched bags	40%	S1,S2,S3,S4,S5,S6,S7
II → Un-punched bags	36%	S1,S2,S3,S4,S6,S7
III → Rolls	24%	S1,S2,S3,S7

The movement of goods through the different departments can be pictorially depicted as shown below

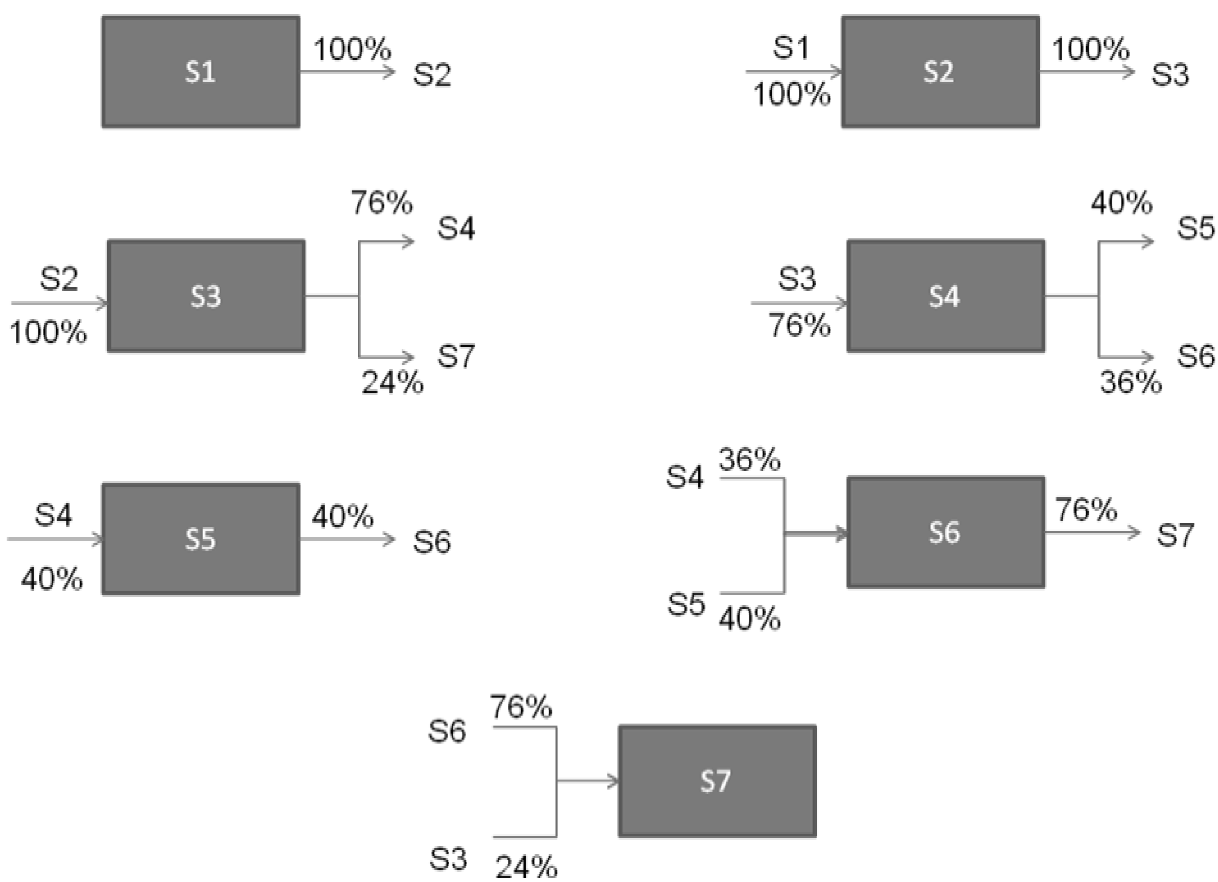


Figure 13 | Schematic representation of Spiral analysis

In the above pictorial representation it can be seen that the arrows to the left of the department under study indicates material inflow and the arrows to the right of the department under study indicates material outflow.

The department code given at the left of the department under study is the source department and the department code given at the right of the department under study is the destination department.

Now the proposed facility layout plan by spiral analysis is as shown below. The black arrow depicts the Product Group I, white arrow depicts the Product Group II and the grey arrow depicts the Product Group III.

This proposed facility layout doesn't take department areas into consideration.

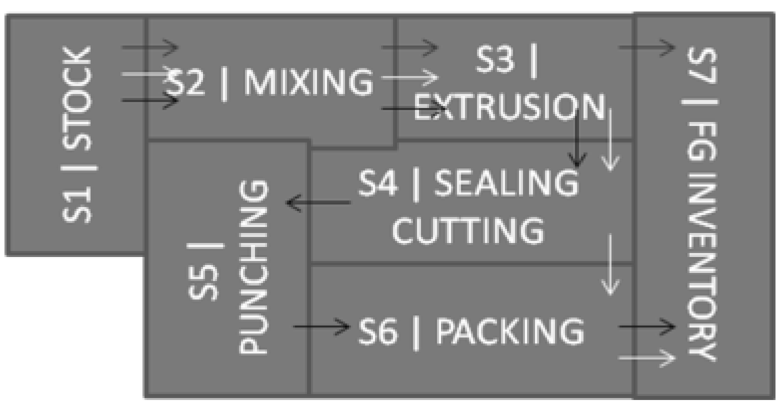


Figure 14 | Proposed Layout by Spiral Analysis

SYSTEMATIC LAYOUT ANALYSIS

The spiral analysis technique does not reveal the qualitative factors that may be crucial to the placement decision. These factors may be like avoidance from noise, fire and ease of supervision. The spiral analysis also doesn't provide plans for effective locations of offices, recreational centres, rest rooms etc. i.e. the non productive departments are not covered. This creates the need for systematic layout planning (SLP).

Before beginning the SLP we first of all list the departments of a plastic bag making industry with their corresponding department codes. This list of departments not only includes the productive department but also includes the unproductive as well as managerial departments. The list of departments and their corresponding code is given in the table below.

Table 7 | Department codes for SLP analysis

DEPT. CODE	DEPARTMENT NAME
S1	RM STOCK
S2	MIXING
S3	EXTRUSION
S4	SEALING CUTTING
S5	PUNCHING
S6	PACKING
S7	FG INVENTORY
S8	CONFERNCE CUM DINING HALL
S9	REST ROOM
S10	OFFICE
S11	RECREATION CENTRE

After preparing the list of department the priority ranking is done in the order A (Absolutely Important), E (Essential), I (Important), O (Ordinarily Important), U (Unimportant) and X (Undesirable). These ranks are provided with corresponding line codes for ease of pictorial representation. With this numerical weights are assigned to these priority ranks. The table containing the above mentioned aspects is as given below.

Table 8 | Codes for closeness priority and line coding

VALUE	CLOSENESS PRIORITY	LINE CODE	NUMERICAL WEIGHTS
A	Absolutely Important		16
E	Especially Important		8
I	Important		4
O	Ordinary Closeness OK		2
U	Unimportant		0
X	Undesirable	^^^^^^	-80

The concept behind these numerical weights is the priority given for the placement of departments close to each other. This means that if two departments A and B are marked with priority Absolutely Important (Weight = 16) and other two departments C and D are marked with priority Undesirable (Weight = -80) then placing C and D together is five times less desirable to the placement of A and B together.

Now, the reasons behind placement of two departments together are listed out in the form of a table with their respective reason codes. The reasons and their respective reason codes for this facility are listed in the table below.

Table 9 | Chart listing priority Reasons

CODE	REASON
1	Movement of material
2	Movement of personnel
3	Ease of Supervision
4	Common Personnel
5	Psychology
6	Share same space
7	Noise
8	Contamination
9	Safety

On the basis of the above reasons a relationship chart is prepared which gives the required relationship priority between different departments with the reasons for existence of such a relationship. The relationship chart for this facility layout plan is as given below.

Table 10 | SLP Relationship Chart

	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
RM STOCK	A	U	U	U	U	U	X	X	O	X
S 1	1						5,9	9	3	5,9
MIXING		A	U	U	U	U	X	X	U	X
S 2		1,4					5,8	8		5,8
EXTRUSION			E	X	X	I	X	U	X	X
S 3			1	7	7	1	5,7		7	5,7
SEALING CUTTING				E	E	U	X	U	U	X
S 4				1	1		5			5
PUNCHING					A	U	X	U	U	X
S 5					1,6		5			5
PACKING						A	X	U	I	X
S 6						1	5		3	5
FG INVENTORY							X	X	I	X
S 7							5,9	9	3	5,9
CONFERENCE CUM DINING								I	O	I
HALL (S 8)								2,5	2,3	2,5
REST ROOM									X	U
S 9									5	
OFFICE										O
S 10										3
RECREATION CENTRE										
S 11										

The above relationship chart is now presented in a pictorial form with the help of line codes. The pictorial representation of this layout plan is as shown below.

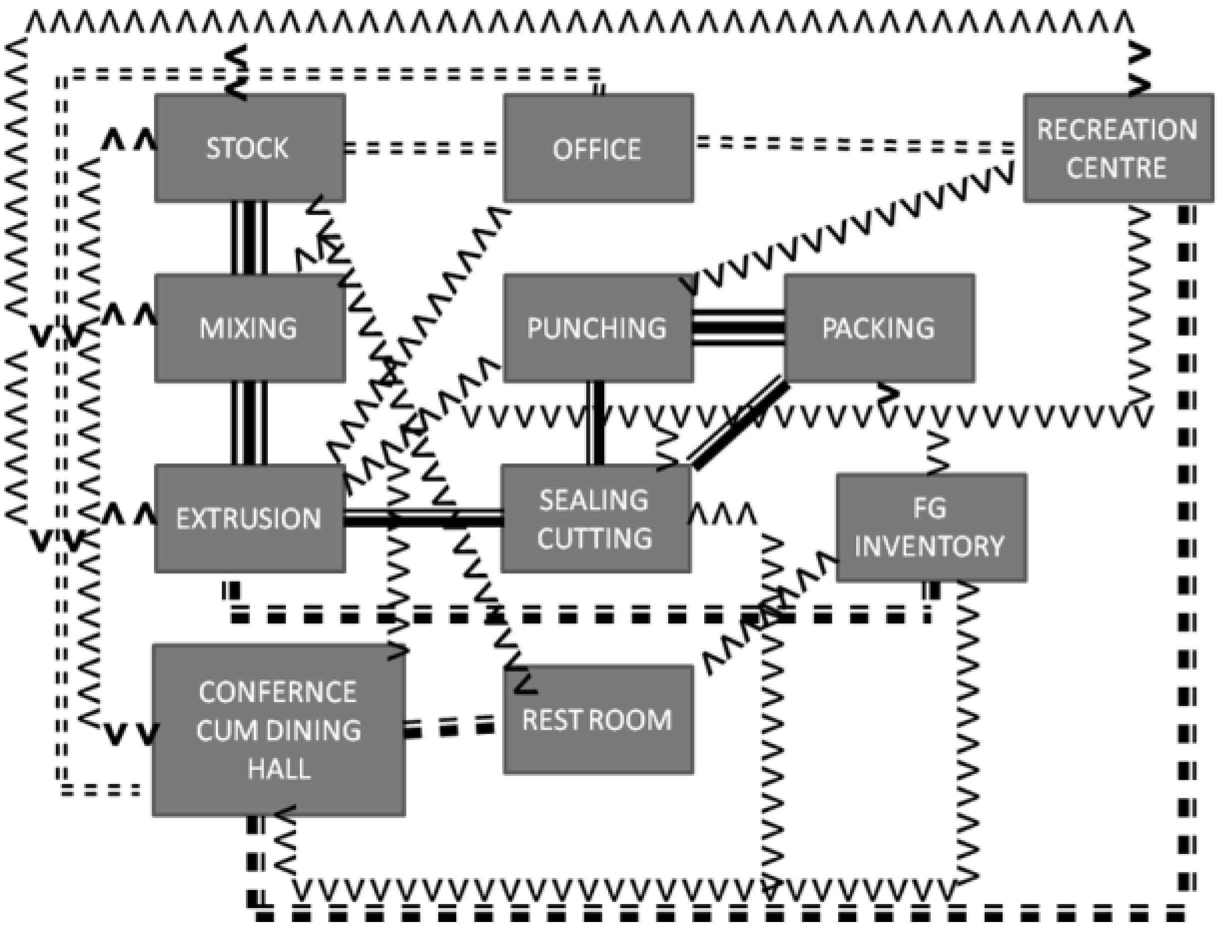


Figure 15 | Initial relationship diagram according to systematic layout planning

Hit and trial changes made to the above department placement would lead us to the final layout plan. The layout with the highest total weight is considered to be the most appropriate.

PROPOSED LAYOUT PLAN

With the help of the analysis tools above as well as keeping in mind the constraints of a MSME industry the following facility layout plan has been proposed for a plastic bag making industry.

According to the layout plan the building may be divided into three floors. This has been done keeping in mind the land constraints with the MSME's as well as the ease in material handling process.

The basement of the building would contain three departments i.e. RM Stock (S1), Mixing (S2) and Extrusion (S3).

The material flow process for the department S1 i.e. Raw Material stock would be facilitated with the help of a slide opening from the entrance of the Building to the RM stock department present in the basement. From the RM Stock the material can be easily moved to the mixing department as it is located just adjacent to it.

The material flow process for the Extrusion department (S3) i.e. movement of goods from the extrusion department to the sealing cutting department (S4) and the FG Inventory (S7) has been facilitated by moving the material from the extrusion department before it is converted into rolls in the form of plastic tubes to the Ist floor of the facility where the department S4 and S7 are located.

The ground floor of the facility would contain all the non productive department of the facility i.e. Conference cum Dining Hall (S8), Rest Room (S9), Office (S10) and Recreation Centre (S11).

The first floor of the building would be accommodating the rest of the departments i.e. Sealing Cutting Department (S4), Punching Department (S5), Packing Department (S6) and the FG Inventory (S7).

The material flow process for the department S7 i.e. FG Inventory would be facilitated with the help of a slide opening from the FG Inventory present on the Ist floor to the entrance of the building premises so that the material flowing from the slide directly lands into the vehicle where it has to be loaded.

The major drawback that can be seen in this layout is that the office and the packing as well as finished goods inventory department are placed at different floors where as they were needed adjacent to each other. The major reason for the need to place these departments together was that it would make easy for the manager to keep a check on the quantities being packed. This can still be achieved by providing an additional display of the weighing scale in the office so that the goods being dispatched can be checked for their weight.

According to the Systematic Layout Analysis performed above the proposed facility layout has a net weight of 104.

A pictorial representation of the proposed facility layout plan has been given below. The diagram doesn't contain the department present on the ground floor.

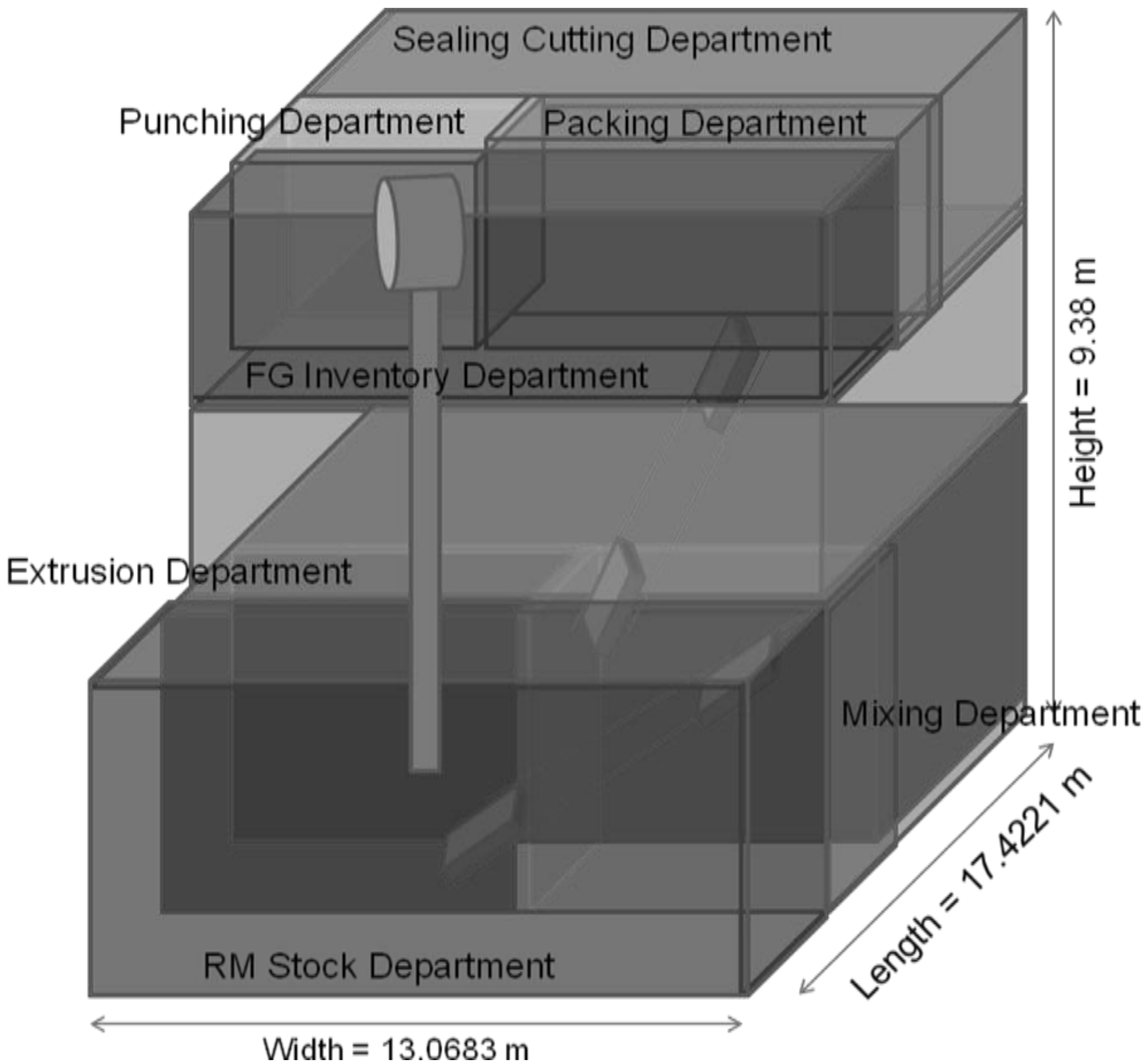


Figure 16 | Proposed Layout by SLP

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