DEVELOPMENT OF ALGORITHM AND FLOWCHART FOR THE OPERATION OPTIMIZATION IN WAREHOUSE

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DEVELOPMENT OF ALGORITHM AND FLOWCHART FOR THE OPERATION OPTIMIZATION IN WAREHOUSE

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***Abstract*: A Supply chain or logistics network is a system of organization, people, technology, activities, information and resources involved in moving a product or services from supplier to customer. Supply chain activities transform natural resources, raw materials and components into finished products are delivered to end customer. The products are delivered at the minimum time. This time constraint has a direct impact on warehouse management. Warehousing is one of the stake holders in the supply chain management. Warehouse is the important link between producer and costumer.**

A warehouse is a location from where raw material, semi-product and finished products are received, transferred or put away, picked, sorted and accumulated, cross-docked and shipped in. Warehouse operation costs account for around 60% of the total cost of an organization. Various factors account for the cost such as labour, material, logistics, sub-costing, etc. In this Paper we aim to develop an algorithm which optimizes the operations and cost specifically taking into consideration space factor, time factor and cost factor. Following this algorithm and method of operation , the overall efficiency and costs could be optimized and thereby leading to profits and smooth of flow of the operations and activities in a warehouse.

***Index Terms*— Supply chain, Warehouse, Optimization**

I. INTRODUCTION

The manufacturing sector is seeing a new trend that is to make the supply chain (SC) more effective and efficient as it spans all the activities from material extraction stage to dispatching of finished goods in the manufacturing industry.

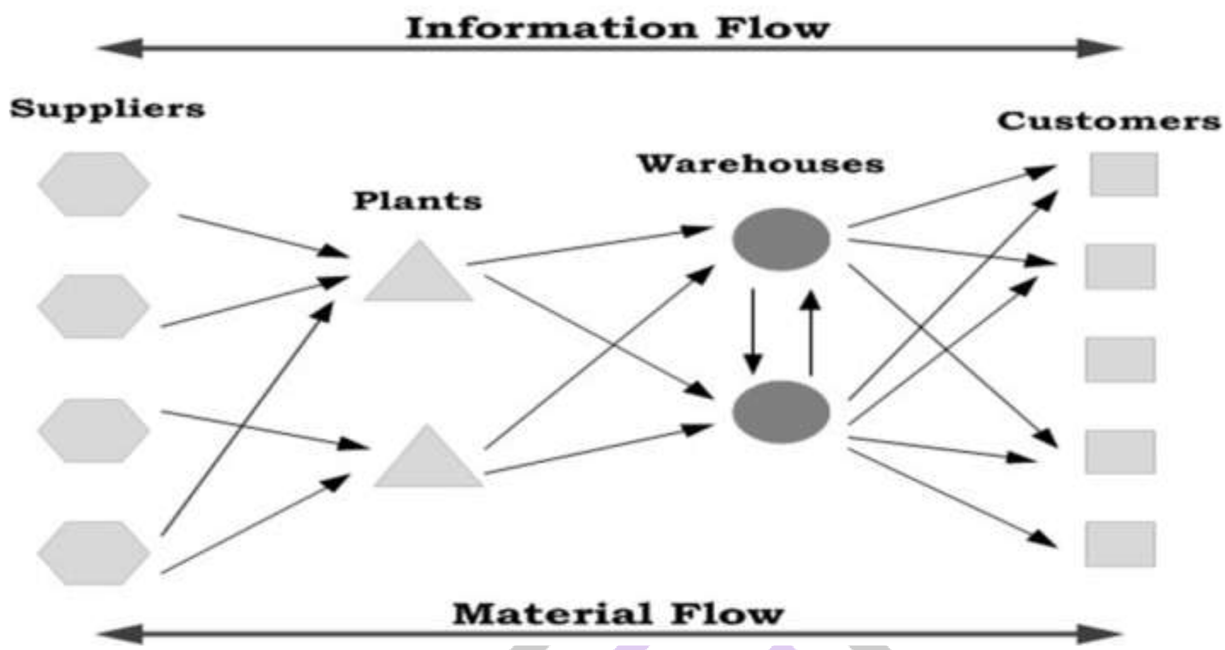
Among Supply Chain functions, Warehousing is one of the key factors in the supply chain management. Warehouse is the important link between producer and customer. A warehouse is a location from where raw material, semi-product and finished products are received, transferred or put away, picked, sorted and accumulated, cross-docked. Warehouses are essential constituents of logistics and supply chains. In a supply chain, a warehouse is an important factor that links the production and distribution units. The performance of these actions distresses productivity and operational costs. It is necessary to increase the productivity and reduce the operational cost through optimization.

The main role played in supply chain management is the warehouse operations. It ensures the safety of products from the shipping of goods from the plant to the customer during the process. The cost inculcated due to warehouse operations is comparatively high due compared to other operations due to the presence of many non-value added activities as implied by the present records.

The main requirement of the customer is getting the desired goods at a low price, in good condition and on time. Hence, the warehouse operations are optimized in order to meet with the manufacturer and customer perspectives. Generally, warehouse optimization objectives is tried to achieve through warehouse layout design models. Thus, to eliminate the inefficiencies in warehouse functions and make them consistent with respect to the cost, the importance of warehouse layout design arises.

In a supply chain network products need to be physically moved from one location to another. During this process, they may be stored or buffered at warehouses for a certain period of time for strategic or tactical reasons as shown in figure 1.

Figure 1: A Supply chain network



Within this context, warehouses play an important role in supply chain management and may be considered a key aspect in a very demanding, competitive and uncertain market. Modern supply chain ideologies compel organizations to eliminate inventory levels. Moreover warehouses require capital, labor, and information technologies, which are lavish resources.

In distribution logistic where market competition requires higher performances from the warehouses, organizations are bound to continuously improve the design and development of warehouses.

II. Proposed Scheme:

This paper proposes an algorithm for Optimization of warehouses to gain a competitive advantage and thus improves operation efficiency. Optimization of warehouses can occur for a variety of reasons. Management may want to optimize warehouses to reduce redundant labor cost, real estate and enable better control of requirements and standards. In an environment where real estate is becoming increasingly more expensive, optimizing the usage of real estate is necessary for companies to remain competitive.

III. LITERATURE REVIEW

The following section provides the brief overview of various literatures on warehouse operations and its routing scheduling policies.

a) Warehouse Operations [1]

Warehouse operation may be divided into different levels. Here Warehouse operations is classified into three functions

- receiving of goods from a source
- storing of goods until customers order
- The retrieving of goods.

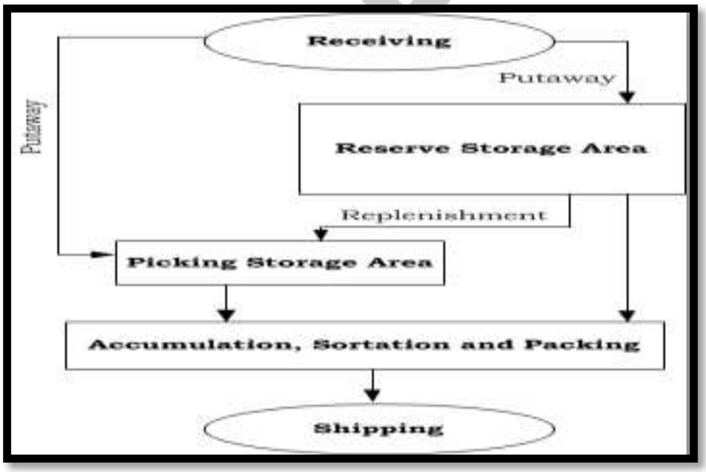


Figure 2: Typical Warehouse Functions and Flows.

Generally, the main warehouse activities are receiving, storage, order picking/selection, and shipping.

Receiving and shipping: The traditional activities of a storage process are receiving and shipping. Receiving operations move goods from dock door to storage locations within a warehouse. Shipping operations move items from the storage location to the acting area where they will be loaded into the freight. Both types of operations are significantly affected by the equipment selected and the movement pattern used to relocate the products.

Storage: Storage function concerns with the organization of goods with maximize resource utilization in the warehouse. The three storage policies that are used in the warehouse include,

- Random storage policy; It allows the storage location for a particular product to change or float over a period of time.
- Dedicated storage policy; It assigns each product to be stored at a permanent location.
- Class-based storage policy; It divides products into classes based demand rates. The area in the warehouse is divided and devoted to each class. Here the storage within an area is random.

Order picking: Order picking is the course of picking and retrieving specified items from a warehouse, in detailed quantities, to satisfy a client demand. Order picking systems may be classified into three groups:

- Picker-to-product systems
- Product-to-picker systems
- Picker-less systems.

b)Warehouse Design and Planning [2]

Warehouse design can be defined as an organised method of decision making at distinct decision levels in an attempt to meet a number of well-defined performance conditions. At each level, numerous decisions are interconnected and therefore it is necessary to group pertinent problems that are to be solved instantaneously.

According to Rouwenhorst, a warehouse design problem is a "coherent cluster of decisions" and they define decisions to be clear when a consecutive optimization does not promise a globally ideal solution.

More recently Strack and Pocket presented a strong approach that mixes aspects such as:

- The size of the functional areas
- The assignment and allocation of products to storage locations in the warehouse
- The replenishment decision in the inventory management.

c)Warehouse Optimization Activities [3]

Today's logistics and distributions canters are based on various optimization results. Warehouse Management System (WMS) is thus significant and becomes complex to manage.

The activities of the warehouse optimization can be divided into three groups:

- The technical structure of the warehouse
- Operational and organizational framework
- Coordinating and regulatory systems for warehouse operations.

Warehouse layouts

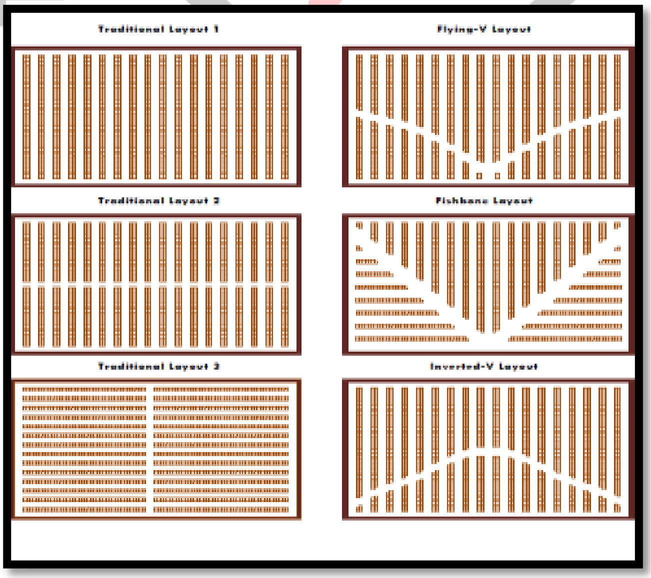


Figure 3: Types of warehouse layouts

The layout design of the warehouse is a crucial component of optimization tasks and has a significant influence on Order-picking and travelling distances in the warehouse. A few factors to be considered in the layout design, and are:

- The number of blocks; the length, the width of the rack
- The number of rack levels
- The positions of input and output gates in the warehouse.

The layouts of the warehouse can be classified as:

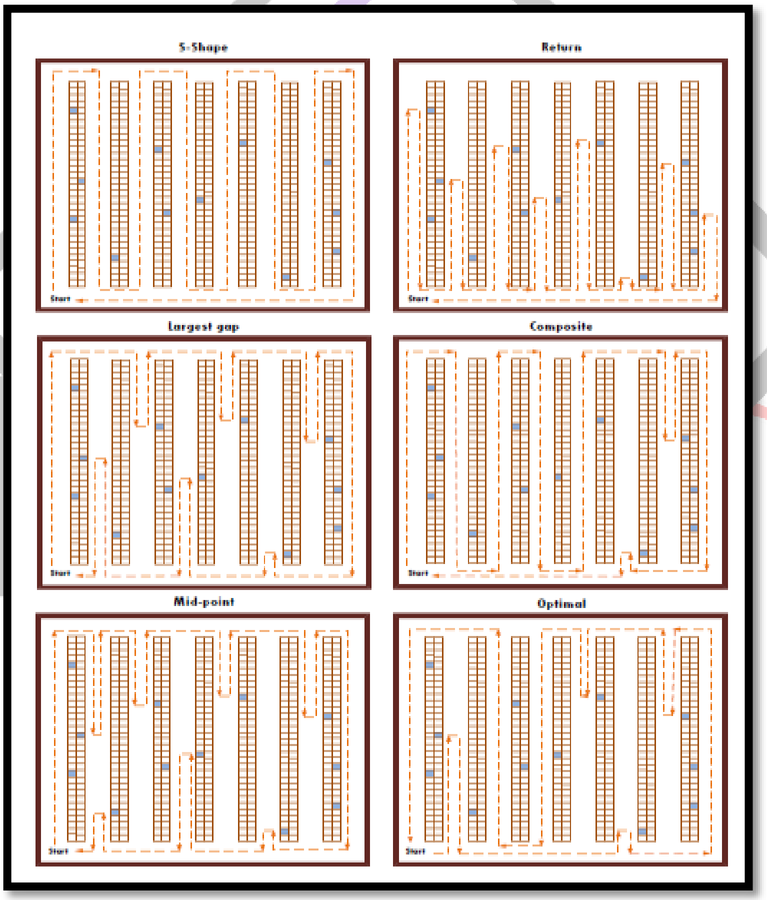
- Traditional layouts (1,2,3)
- Flying-V layouts
- Fishbone layout
- Inverted-V layout

Warehouse Routing

The common routing methods in these layouts may be:

- S-Shape
- Return
- Mid-point
- Largest gap
- Composite
- Optimal

Figure 4: Warehouse routing techniques



d)Static and dynamic policies with RFID for the scheduling of retrieval and storage warehouse operations' [4]

Warehouses are essential components of logistics and supply chains. The performance of warehouse operations significantly affects the efficiency of the operations. Most of the warehouse operations such as storing and retrieving are the most expensive operations because they tend to be either very labor intensive or very capital intensive. The performance of these operations affects the productivity and other operational costs. Radio frequency identification (RFID) is an emerging technology capable of providing real-time information about the location within the warehouse. This technology is effectively and increasingly used in all the business and industry particularly in logistics and supply chain management. RFID is intended to replace traditional barcodes in many ways. Its wireless tracking nature allows a reader to activate a transponder on a radio frequency tag attached in an item, allowing the reader to remotely read and write. The best routing and sequence is obtained by storage or retrieval operations in the warehouse for a given set of items. This emerging technology helps us to facilitate the accurate estimation of durations of the products; the time to fulfil an order is calculated as the sum of several main times: the travel time, the waiting time, the depot time and the Storage/retrieval time.

e) Addressing lot sizing and warehousing scheduling problem in manufacturing environment [5]

Lot sizing issues in the warehouses are gaining attention of the researchers all over. The explored formulation helps the manufacturer to decide the effective lot-size in order to meet the due dates while transferring the product from manufacturer to retailer through warehouse. The challenges such as uncertain demand pattern and customized product design are the key factors to remain competitive in current market. In order to meet the challenges warehouse management plays an important role.

f) Determining the size and design of flow type and u-type warehouses [6]

The fluctuations of costs and customers' demands make it harder for the firms to respond the market conditions. The modern supply chain process, aim in delivering the products to its costumer at the minimum possible time and procured with minimum of stocks. This time constraint has a direct impact on the distribution and warehouse management. Warehousing is the input factor in the supply chain management. The three important factors that are to be considered in the design of the flow types are:

- Warehouse layout plan includes storage area plan, shelf types and sizes.
- Warehouse material handling plans includes material handling equipment.
- Warehouse operations include placement / picking, categorization / sorting

The warehouse design can also be evaluated by:

- Assortment of material handling equipment
- Movement of materials
- Input and yield quantities

The objective is to suggest the models minimizing the total travel distance of picking in flow-type and u-type warehouses. Few assumptions are made. They are:

- Products that are regular outgoing exist near doors
- The number of arriving products are equal to yielding products

g) Developing Design Guidelines for a Case-Picking Warehouse [7]

A Warehouse can be characterized in many ways, that includes the number of items stored, the average number of cases per pallet, throughput and inventory requirements. It is a fact that there is no one-size-fits-all design for case –picking warehouses, and hundreds of designs are thus possible. Moreover the decision variables in warehouse design further complicates the design process. This paper provides a good configuration for a manual case-picking warehouse. Set of guiding principles are provided and the solutions are implemented. The decision variables include:

- The warehouse size and layout
- The rack height
- The availability of space in each rack
- The number of pallet locations

For a physical case- picking operations has a picking warehouse that employs selection from pallet rack, two decision variables are the shape of the pallet rack area and the number of levels of pallet rack.

IV. DESIGN METHODOLOGY

The proposed scheme provides an algorithm to optimize warehouses that reduce operating costs, optimize storage capacity and improve production activity. The objectives of the scheme are as follows;

1) Develop an algorithm - Algorithmic approach to warehouse optimization
2) Test the algorithm
3) Report Results
4) Recommend additional research.

PROBLEM DEFINITION

The manufacturing firm produces varieties of 'categories of products (n = 1, 2, 3….) where n belongs to a precise shelf (R), varies in features such as size, demand, weight (si, di, wi). Once it comes out from the manufacturing process it needs to be stored until the shipping stage. Meanwhile, numbers of sub-processes are running within the warehouse to transfer goods from plant to consumer. However, based on the stored place of the specific item, the storing, picking and shipping cost is determined.

This also includes some of the non-value adding events that also have to be taken into considerations while augmenting a warehouse.

The products that arrive at a warehouse are arranged in the racks and shelves for a storage purpose (figure 2). The warehouse optimization constraints are defined and an effort to make pertinent advancement in optimizing each constraint is made.

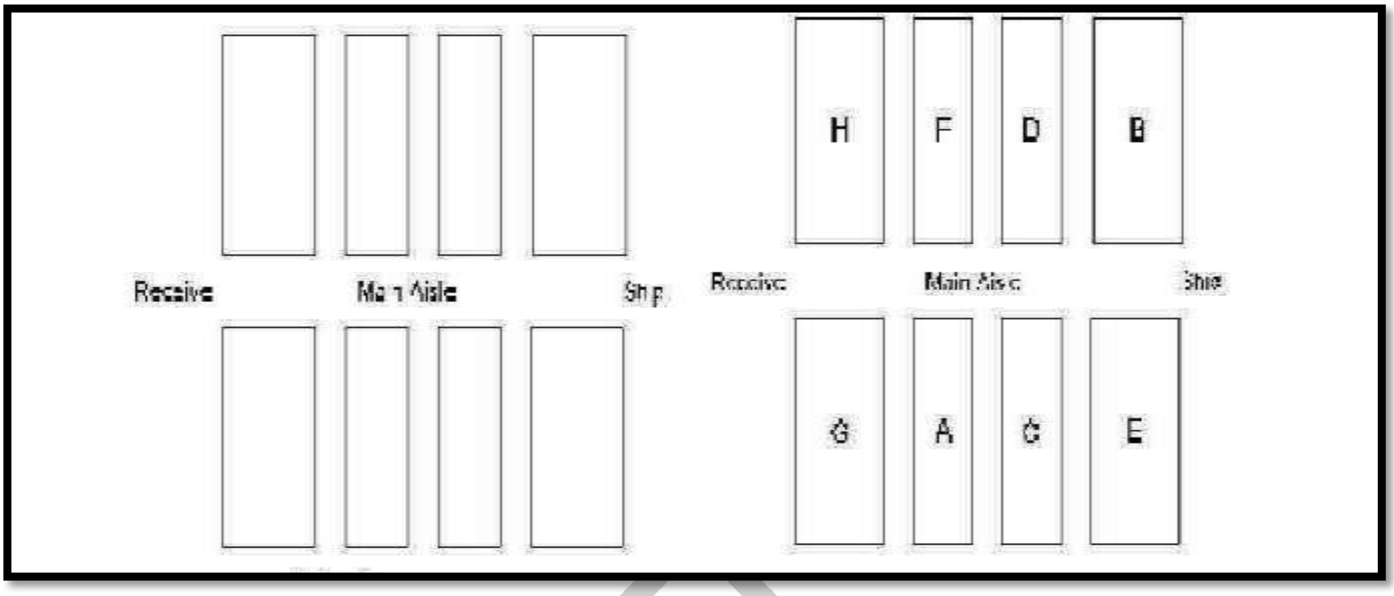


Figure 6: Racks or shelf's for the storage

The set of values to specify warehouse are the values accompanying with the design choices, and we refer to these as decision variables. The decision variables involve design decisions related to:

- The space available in the shell
- The pallet area shape
- The number of levels of pallet rack
- The dock door configuration
- Cost component

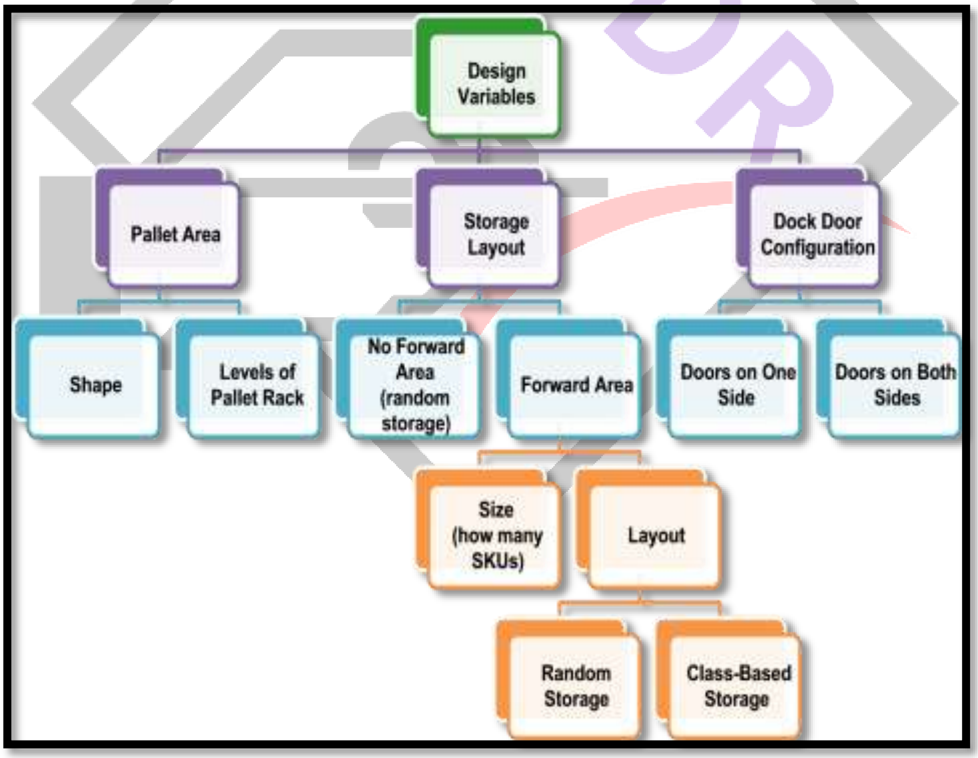


Figure 7: Design variables

METHODOLOGY

Postulating a warehouse involves two sets of values. We refer to the first set that describes a particular warehouse as the warehouse constraints. These constraints pertain to the features of the warehouse including the required number of pallet locations, the number of SKUs (stock keeping units), the average number of cases per pallet, through- put necessities, and activity profile. The warehouse constraints are fixed for a given problem and the steps involved in optimization process are:

1. Objective of warehouse optimization
2. Data collection
3. Defining the optimization Constraints/Parameters
4. Analysis of data collection

5. Application of Principles of Industrial Engineering for optimization
6. Accept the optimization values and Conclude.

1. OBJECTIVE OF WAREHOUSE OPTIMIZATION

The main objective of the ware house optimization is to
• Increase efficiency of the warehouse Operations.
•Reduce search time and time to take important decisions.
•Reduce Wastage of Industry resources.
•Reduce Cost of overall operations.

2. DATA COLLECTION

It involves all the data regarding the
•Product Description
•Product demand
•Product Price
•Product life (shelf life)

3. DEFINING OPTIMISATION PARAMETERS

The set of values to specify warehouse are the values related with the design choices, and we refer to these as decision variables. The decision variables involve design decisions related to

- Space optimization
- Cost component
- Shelf-life

4. ANALYSIS OF DATA COLLECTION

The data collected is examined by using statistical tools. They are required for a through and systematically valid analysis of study results. The basic element for proper implementation of analytical work is the statistical operation needed to control and verify the data. The critical analysis thus helps in increasing the performance of the operation.

5. PRINCIPLES OF INDUSTRIAL ENGINEERING FOR OPTIMISATION

- Concept of ABC analysis
- Technology management
- Saw tooth model
- S-Curve study.
- Space allocation

6. CONCEPTS OF INDUSTRIAL ENGINEERING & MANAGMENT

- Supply Chain And Logistics Management
- Just In Time Manufacturing
- Operations Research
- Enterprise Resource Planning
- Facilities Planning & Design
- Materials Management
- Concepts Of C
- Numerical Methods
- Financial Accounting And Costing

STEPS FOLLOWED

1. Collect the required data from a warehouse. Perform a literature review to determine common methods of optimization and research the topics of

- Warehouse Facilities Layout
- Space Optimization

2.Develop an algorithm to optimize warehouse.
3.Test the algorithm at a warehouse.
4.Analyse optimization results to show improvements.
5. Define areas for future research, and algorithm improvement

Assumptions:

Following assumptions were taken into account while designing the algorithm. A general warehouse configuration includes the following four functional areas: Receiving, reserve, forward or picking and shipping. Thus, the following pattern flows are possible:

1. Receiving → Reserve → Shipping
2. Receiving → Reserv → Forward → Shipping
3. Receiving → Forward → Shipping

Flow 1 refers to a pattern that describes a typical warehouse operation. Products are stored in standby area and picking operation is performed as required. Usually, it is assumed that only those products that remain for long periods of time or product volumes used for replenishment of the forward area will be assigned in this area.
Flow 2 is also a typical warehouse operation. Products with this pattern flow are initially stored in the reserve area and then moved to the forward area. This pattern flow is considered for fast picking operations, order consolidation or even to perform value-added operations.
Flow 3 refers to products that go directly to the forward area. This pattern flow is usually seen when there is a need to consolidate large orders.

I. OPTIMIZATIONS ALGORTHIMS & RESULTS

The two important parameters primarily need to be optimized are Space andcost.

SPACE OPTIMIZATION

Space in the warehouse is an important parameter and is vital for defining the appropriate space for the particular item. Space planning is necessary for the following reasons:

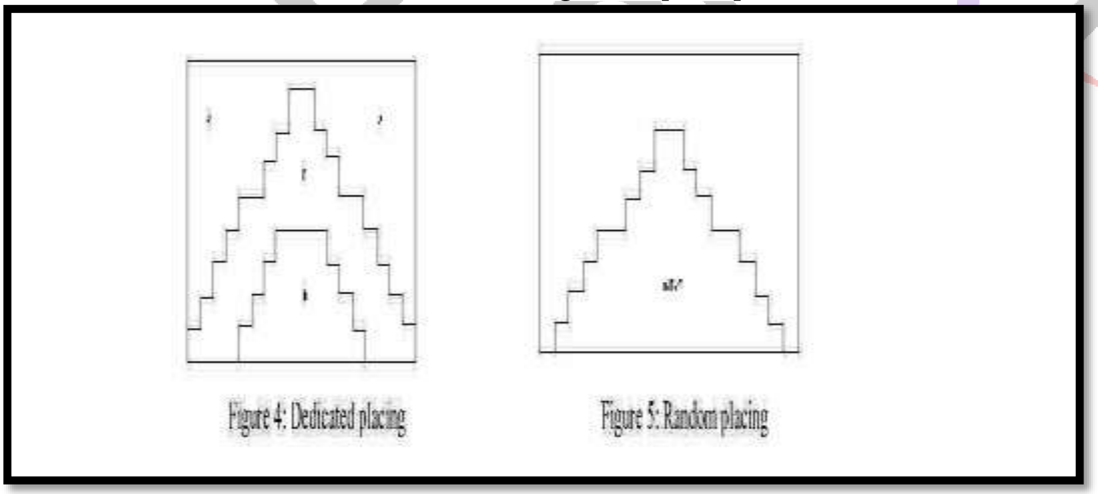
- The need for elasticity to adjust to change
- Accessibility and location of materials
- Safety of the products
- Increasing space budgets

Space planning is the part of the science of warehousing concerned with making a quantifiable calculation of warehouse space requirements. As is true of any science, space planning possesses a very specific procedure, and it follows a particular standard:

- Determine what is to be achieved
- Determine what activities will take place to achieve it.
- Determine space allowances for each element required to accomplish the activity.
- Calculate the total space requirements.

The space in a warehouse can be defined by the number of racks, dimensions of the racks, cubic space and so on.
The spacing can be categorized in two ways:
1. Dedicated placing
2. Random placing

Figure 8: Space optimization



An algorithm can be designed to know the total space prerequisite for placing the product in a particular rack. An algorithm is an effective method that can be expressed within a finite amount of space. Starting from an initial state and initial input the steps describe a computation proceeding through successive states eventually producing outputs and are deterministic.

OPTIMIZATION OF COST

Basically the ware house cost can be classified into eleven different types.

Fixed costs:

These are indirect costs or overheads of the business expenses that are not dependent on the level of goods or services produced by the business. They may include:

- Salaries of the worker
- Rent paid for the factors
- Overhead costs

Variable Costs:

These are the costs that differ depending on a company's production volume. They rise as production increases and fall as production decreases. The cost may include:

- Rent
- Advertising
- Insurance of the office
- Lighting in the office

Material cost:
Material costs include everything that is associated to materials that are acquired by the business. They may be:

- Raw materials,
- Parts and components,
- Manufacturing supplies
- Insurance
- Freight costs

Conversion costs:
Conversion costs cover any costs that are involved when processing raw materials to a finished product, such as manufacturing, utilities and maintenance costs.

The costs involved with logistics in a warehouse and these may be:

- Custom clearance,
- Transportation,
- Warehousing and distribution.

Subcontracting costs:
Subcontract costs involve all the expenses linked to commissioning, that is, the outsourcing of contract obligations to a third party. These costs are generally treated as direct costs to the business.

Overhead costs:
Overhead is an unending business expense which cannot directly be owed to a particular cost unit, they are so-called hidden costs. Despite not directly creating profits, they do still contribute to the constant business deeds.

Transportation cost:
In the cost break-down analysis, the major point is to examine the various costs drivers of the service or the product that is being analysed. When studied one can come across six types of drivers namely:

- Personnel (driver)
- Motor fuel (diesel, petrol)
- Tires
- Maintenance

Handling costs:
The cost of handling includes

- The cost of packaging
- The cost of order picking

Scrap costs:
Scrap costs are the worth of a physical asset's individual components when the asset itself is deemed no longer usable.

- Unused products in the shelf
- Long term unsealed products
- Excess daily outgoing products
- Too much of more products

Inventory costs:
The total economic cost of production made up of variable costs, which differ according to the quantity of a good produced and includes summation of inputs such as labour and raw materials, fixed costs, buildings and machinery. Therefore
Inventory cost = Fixed cost (FC) + Variable cost (VC)

ALGORITHM FOR SPACE AND COST OPTIMIZATION

Step1: Define Class Rack

Declare rack variables length (l), breadth (b), height (h), available length (al), available breadth (ab) and available height (ah).

Step2: Define x, y, z material cost

MC[xyz], handling cost HC[xyz], transportation cost TC[xyz], overhead cost OH[xyz], scrap cost SC[xyz], total cost TT[xyz], maximum cost MAXC[xyz], minimum cost MINC[xyz], Avgcost[xyz], sum SU[]

Step3: Define a Constructor Rack (l, b, h)

Step4: Initialize Length breadth, height of the rack equal to the original l, b, h.

```
Rack (l, b, h)
{
l=l;
b=b;
h=h;
al =l;
ab =b;
ah=h;
}
```

Step5: Define Check-Rack (l, b, h)

Step6: If either of l, b or h exceeds the available l, b, h of the rack

Then

Print "CANNOT FIT" and return 'false'

Else

Allot the product on the rack and reduce available l, b, and h with that of product's l, b & h.

```
Check-Rack (l, b, h)
{If (l>al || b>ab || h>ah)
        Print "Doesn't fit" return false
Else
        al = al-l;
        ab = ab-b;
        ah = ah-h;
}
```

Step7: Define remove from Rack (Product P)

Add product length breadth and height back to the rack l, b & h.

Delete Product or Object

```
{
        al = al + l;
        ab = ab + b;
        ah = ah + h;
        Destroy product;
}
```

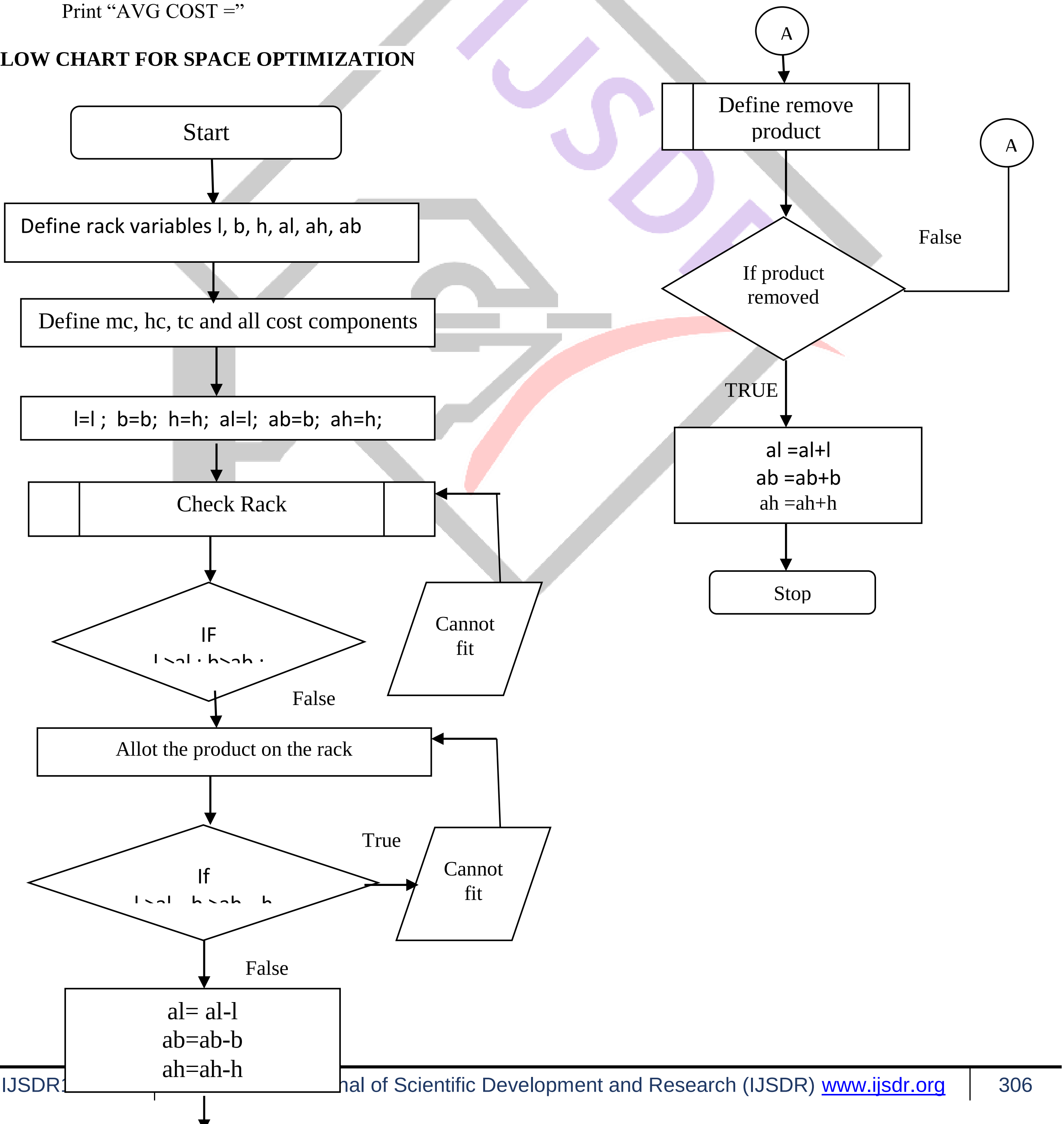
Step8: Rack cost (l, b, h, x, y, z)

```
{
        TT=0
        for (i=0; i<x ; i++)
        for (j=0; j<y; j++)
        for (k=0; k<z; k++)
        {
Read MC[xyz], HC[xyz], TC[xyz],OH[xyz], SC[xyz], TT[xyz], MAXC[xyz], MINC[xyz], Avgcost[xyz], sum SU[xyz]
SU [ijk] = MC [ijk] + HC [ijk] + TC [ijk] + OH [ijk] + SC [ijk];
TC = TC + SU [ijk];
}
HC = 0;
For ( i=0; i<x; i++)
For (j=0; j<y; j++)
For (k=0; k<z; k++)
{
If (SU [ijk] > HC)
{
Highest cost = SU[ijk];
```

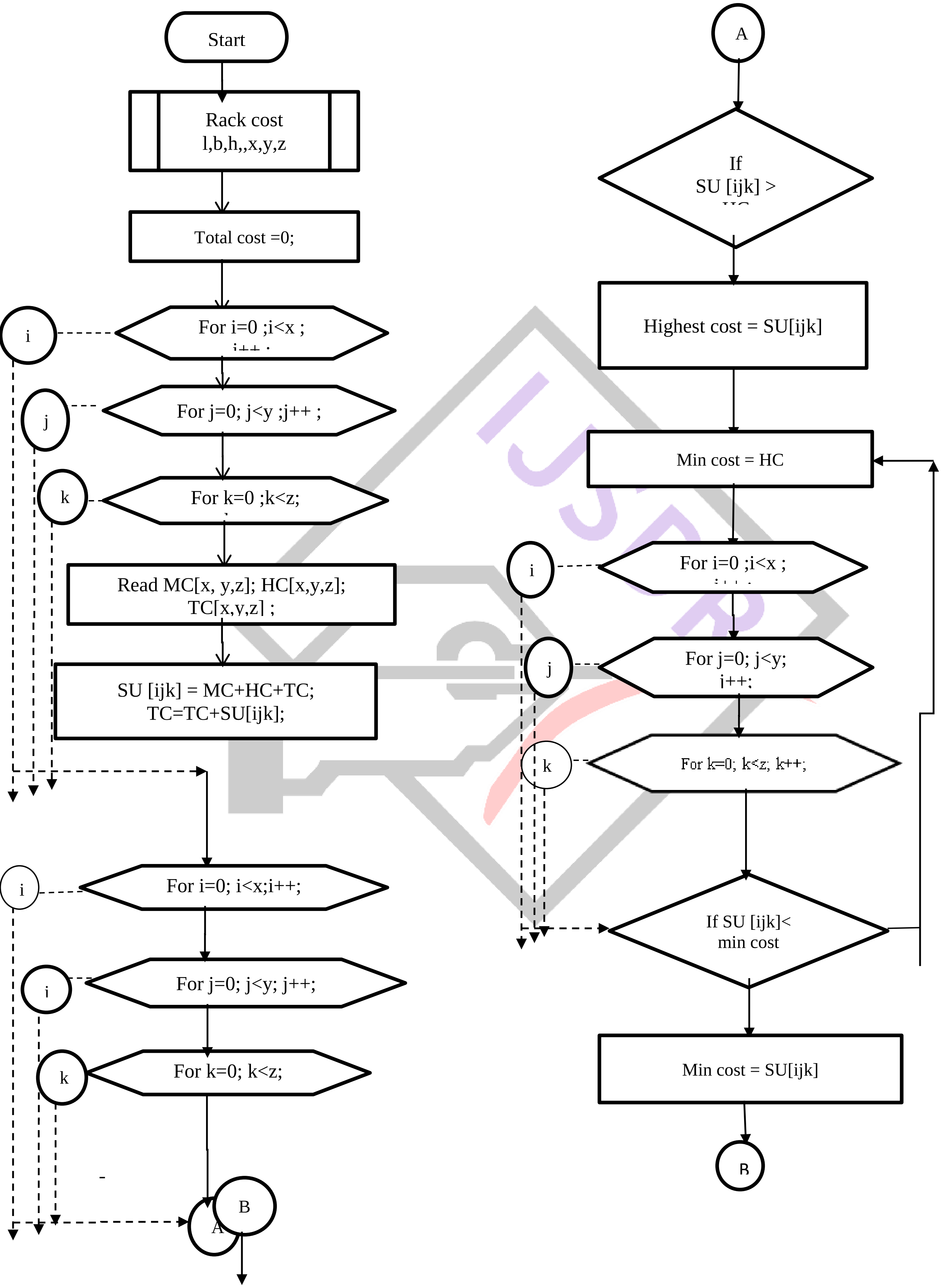
```
}
}
          }
                    Mini Cost = Highest cost
                    For (i=0; i<x; i++)
                    For (j= 0; j<y; j++)
                    For (k=0; k<z; k++)
                    {
                              If (SU [ijk] <Mincost)
                              {
                                        Mincost = SU [ijk]
                              }
                    }
          Avgcost = Total cost/ x*y*z;
```

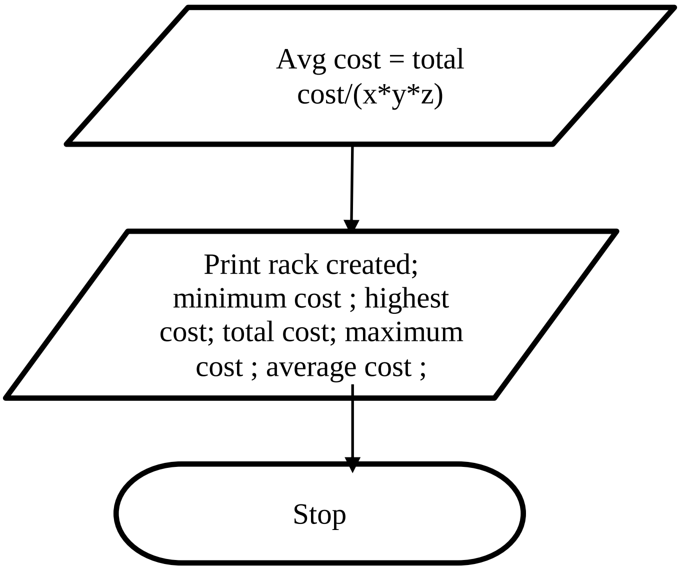
Step9: Display the required results
Print "RACK CREATED'
Print "HIGHEST COST ="
Print "MINIMUM COST ="
Print "TOTAL COST ="
Print "MAXIMUM COST ="
Print "AVG COST ="

FLOW CHART FOR SPACE OPTIMIZATION



Flow Chart for Cost Optimization





OPTIMIZATION WITH RESPECT TO SHELF LIFE

Shelf life is defined as the duration of time that a product may be stored without becoming unfit for use, sale or consumption. As in, it tells us whether a product should no longer be on a storage shelf i.e.: unfit for use, or just no more on a store shelf i.e. unfit for sale, but yet fit for use. This can be applied to beverages, cosmetics, foods, medicines, pharmaceutical drugs, car tires, chemicals, batteries, and so many other items which are perishable. In few regions, a recommended expiration test, mandatory use by, or best before date is required on perishable and packaged foods.

"Sell by date" is a vague term used to refer an "expiration date". Most perishable items are still edible after the expiration date. A commodity that has crossed its shelf life might be safe, but the quality can no longer certain. In many food shops, waste is reduced by using stock rotation, which involves moving commodities with the earliest "sell by date" from the warehouse to the sell location, and then in front of the shelf, so that most customers will pick them up first and hence they are most likely to be sold before their shelf life ends. This is of utmost importance, as customers enjoy newer goods, and still some stores can be fined for selling "out of date" i.e. expired items; most if not all would have to mark such commodities as waste, leading to financial loss.

The shelf life mainly depends on the degradation mechanism of the specific commodity. Most are influenced by several factors such as heat, exposure to light, transmission of gases, moisture, mechanical stresses, and contamination due to micro-organisms. Product quality is frequently displayed around a parameter such moisture content, a microbiological index, or concentration of a chemical compound.

Algorithm
The algorithm for shelf-life is designed and is as follows:
Step1: Define Class product
Declare product variables length, breadth, height, location, rack, rank, shelf life, max--shelf life, d1, d2, perishable and non-perishable.

Step 2: Define product constructor
Product (length breadth height, location, rack, rank, d1, d2, maxshelf-life)

Step 3: Calculate shelf-life using formula shelf-life = d1 – d2
If shelf -life returns 'FALSE'
And if Rack.checkrack returns 'FALSE'
Then
Do not insert the product into the rack and return to step9.
Else
Print "Product is inserted into the rack"

```
Product (P)
{
        Define l, b h, location, d1, d2, sl, maxsl, distance, rank;
        Product (l, b, h, location, d1, d2, sl, maxsl, distance, rank,)
        {
```

```
                    l=l, b=b, h=h, dist = dist;
                    r = rack.checkrack (l, b, h);
SL = d1 – d2;
                    if
r! = false
                    Else
SL= false
Print "Do not insert the product"
Else if
Print "Product is inserted in the rack"
                    }
          }
```

Step 4: Define Check Shelf-life;

```
          If
Shelf-life >maxshelf-life
                    Print "EXPIRED" and return false;
          Else if
Shelf-life >maxshelf-life – 14;
                    Print "WARNING" and return true;
```

Step 5: Read m number of racks

```
          For each i =1 to m create-racks () from step2
          Read 'n' number of products
          For each i= 1 to n create products ()
```

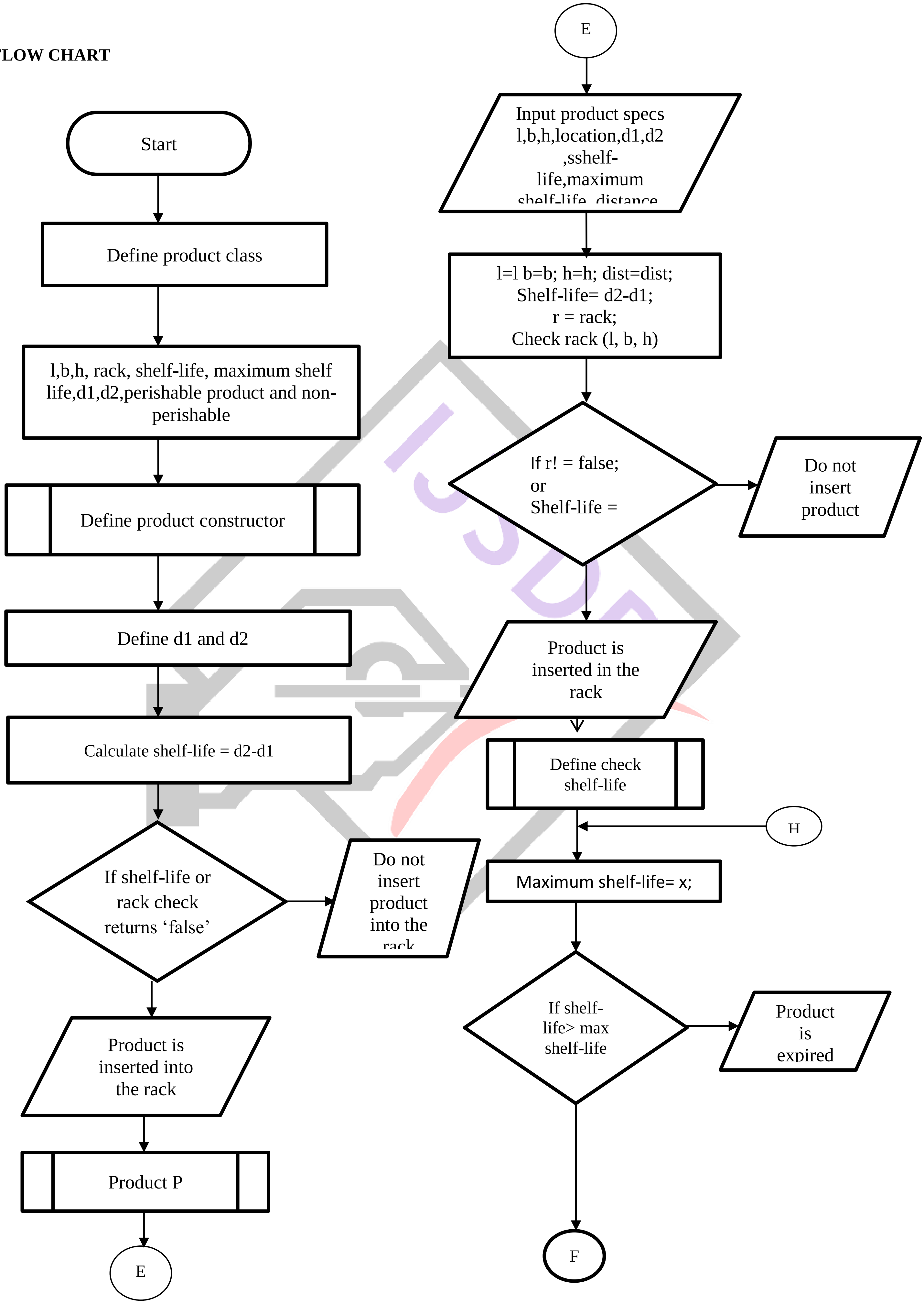
Step 6: Sort products based on location

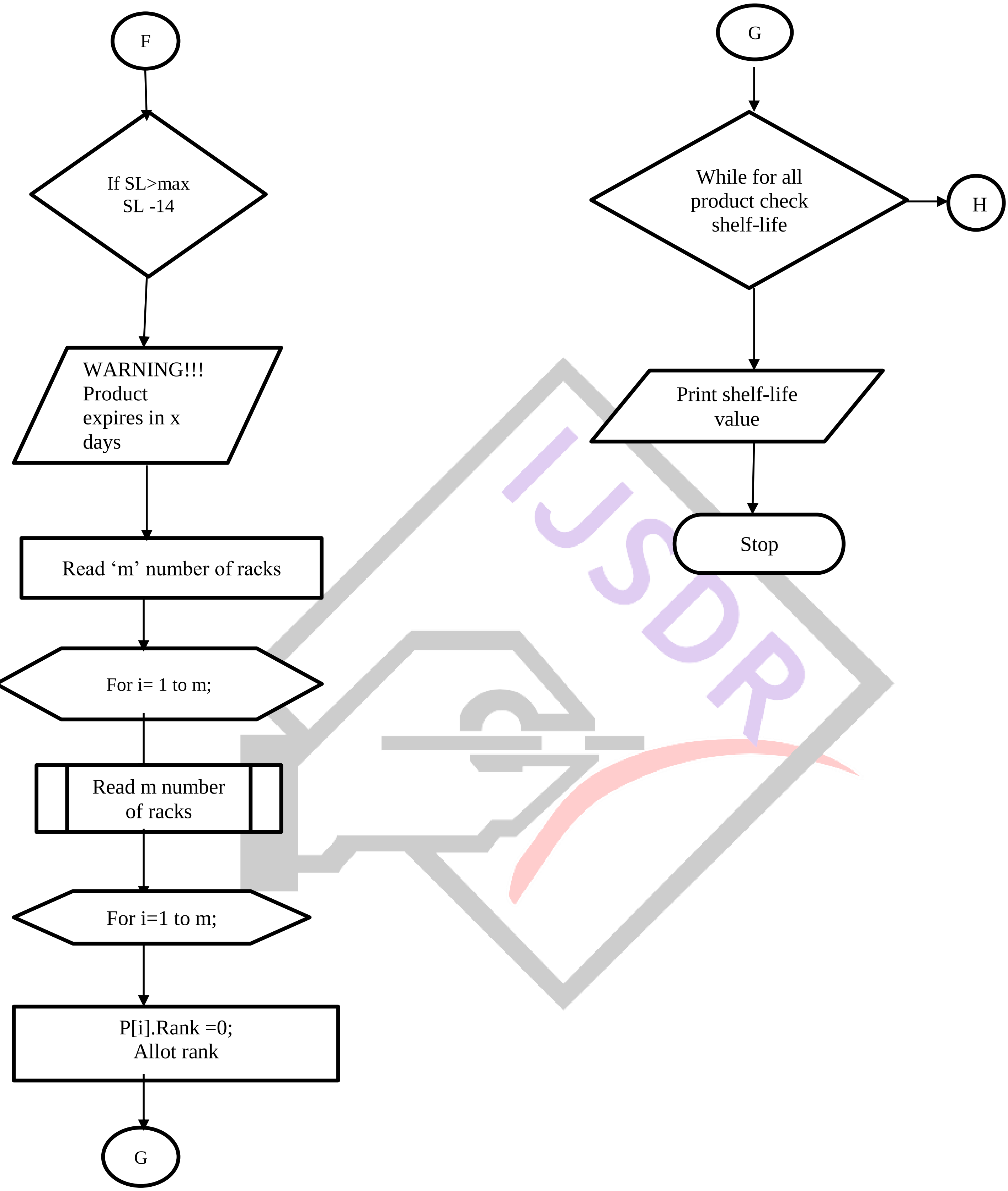
```
          For j = 1 to n;
           P[j].rank = j
           Allot rank

           While
                    For all products check shelf life () from step9.
```

Step 7: Print "SHELF LIFE ="

Step 8: EXIT

FLOW CHART


Start
Define product class
l,b,h, rack, shelf-life, maximum shelf life,d1,d2,perishable product and non-perishable
Define product constructor
Define d1 and d2
Calculate shelf-life = d2-d1
If shelf-life or rack check returns 'false'
Do not insert product into the rack
Product is inserted into the rack
Product P
E
E
Input product specs l,b,h,location,d1,d2 ,sshelf-life,maximum shelf-life, distance
l=l b=b; h=h; dist=dist; Shelf-life= d2-d1; r = rack; Check rack (l, b, h)
If r! = false; or Shelf-life =
Do not insert product
Product is inserted in the rack
Define check shelf-life
H
Maximum shelf-life= x;
If shelf-life> max shelf-life
Product is expired
F



RESULTS

Input

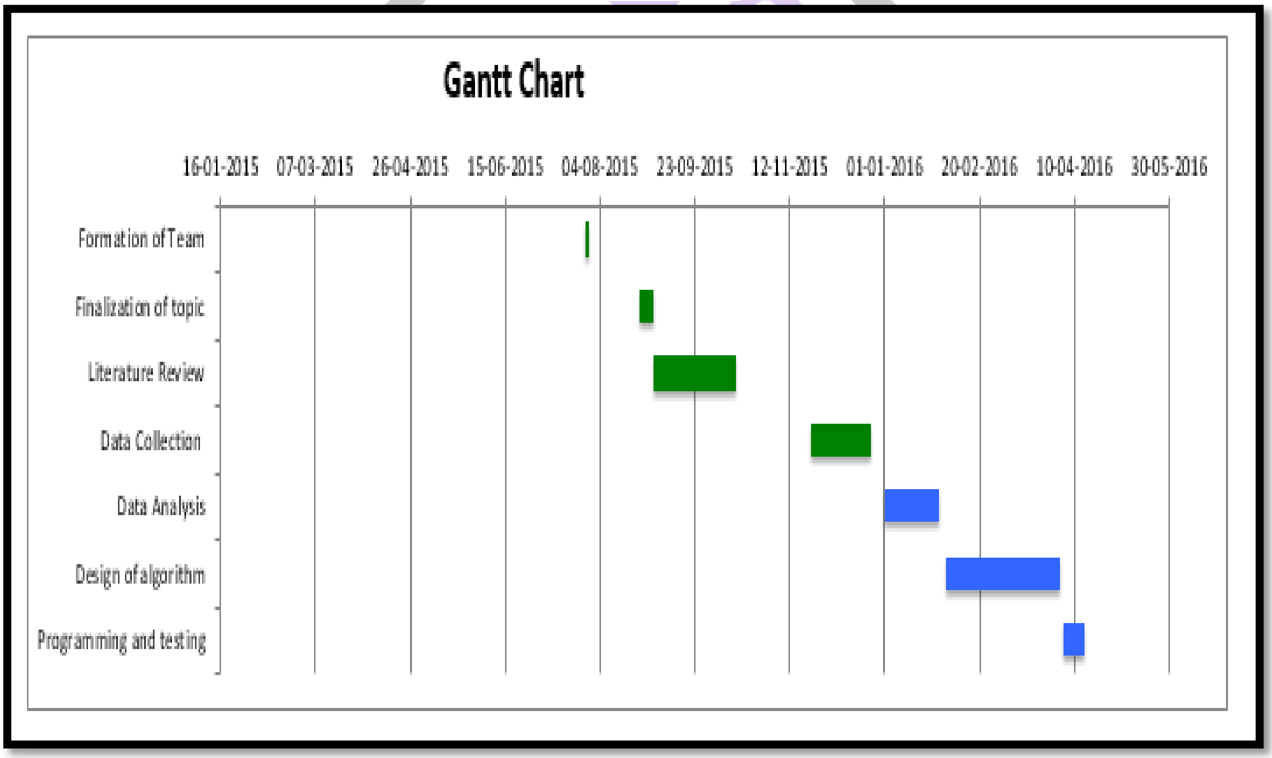
- Number of racks : 1
- Rack dimensions and number of cubes (l b h x y z) : 20 20 20 1 2 1
- Cube costs MC,HC,TC,OH,SC : 60 50 54 45 35
- Cube costs MC,HC,TC,OH,SC : 20 25 30 16 12
- Number of products in this rack : 1

- Product dimensions l, b, h ,d1 ,d2 ,maxshelflife distance : 5 5 5 2 65 100 20

Output

- Enter number of racks : 1
- Enter rack details l,b,h,x,y,z :20 20 20 1 2 1
- Rack created with length=20 ; breadth=20 ; height=20 ; x=1; y=2; z=1;
- Enter MC,HC,TC,OH,SC for rack[1,1,1] :60 50 54 45 35
- Enter MC,HC,TC,OH,SC for rack[1,2,1] :20 25 30 16 12
- Enter the number of products in rack:01
- Enter product details:
- Enter product l,b,h,rank,d1,d2,maxshelflife,dist: 5 5 5 2 65 100 20
- Creating product:01
- The product can fit in the rack
- Warning! Shelf life about to expire
- Insert the product on rack with l=5,b=5, h=5
- Rack no:01
- Available length on the rack=15
- Available breadth on the rack=15
- Available height on the rack=15
- Maxcost of the rack=244
- Mincost of the rack=103
- Average cost of the rack=173

GNATT CHART



V. CONCLUSION

Warehouse optimization is a discipline of vital importance for many organizations. Optimization and automation of a warehouse can help save time, space, and resources, reduce picking mistakes and manual handling, and improve flexibility, ergonomics, management, and communication.

Through this project we were able to develop an algorithm that could optimize the space factor, time factor and cost factor in a warehouse operation. These three factors constitute the major cost of a warehouse. Optimization in these three areas will lead to increase in efficiency, better records, lesser mistakes and faster processes. Also it will lead to higher profits and higher team morale among the employees.

Allocating the items with respect to the space available and its displacement rates and distributing the items in a warehouse is not an easy task especially due to the diversity of the products managed and the characteristics they may have been assigning inside the warehouse. Also due to the larger quantities managed everyday it is vital to allocate the products in a fast and efficient

manner. Algorithms for such kind of operations offer efficiency in space planning, effective utilization of shelves, thus optimizing the overall cost.
Finally it is interesting to analyze the warehouses that manage huge amounts heterogeneous sizes of products
With this project we would like to conclude that with the right use of technology and procedure, we can easily run the operations smoothly and efficiently.

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