# **PRODUCTION AND OPERATION MANAGEMENT(3-0-0)**

- 1. Productivity : Importance, productivity ratio, productivity measurement, productivity index, awareness improvement maintenance (A.I.M) proceSs.
- 2. Production System Models of production system, Product Vs. Services, Process-focused & product focused systems, product strategies, product life cycle, production function.
- 3. Forecasting : Methods moving average, exponential smoothing, Regression analysis, coefficient of co-relation, Delphi, Market survey.
- 4. Facilities Planning : Site location, facilities layout and various types, planning using CRAFT work place design, working conditions noise illumination etc.
- 5. Motion study principles of motion economy, Time study-standard time.
- 6. Production Planning & Control : Aggregate planning. Sequencing, Line balancing, Flow control, Dispatching, expediting, Gantt chart, line of balance, learing curve.
- 7. Project Management Network scheduling, PERT. Critical path, Most likely time estimate, Resource leveling.
- Modern Trends in Manufacturing :Basic concepts of CAD,CAM,FMS, MM, ISO 9000, Quality circle, Kaizen, Kanbans, Poke Yoke' surply obain management.

# Text Books

- 1. Production Systems : Planning, Anaryli C. Sontrol : By Riggs, J.L.(4<sup>th</sup> Edn.) John Wiley & Sons
- 2. Modern Producting/Operation managements By Buffa, E.S. & Sarin, =,.K.(8)"-Eth.Conn Wiley & Serie
- 3. Pollution & Operation & Menadement : By Panneer saivem, R.(2<sup>1</sup> Edn.) PHI
- 4. Production & Operations Management : By Chary, S.N.(TMH)

# CHAPTER-II PRODUCTION SYSTEM

# 2.1 Introduction

A "Production System" is a system whose function is to transform an input into a desired output by means of a process (the production process) and of resources. The definition of a production system is thus based on four main elements: the input, the resources, the production process and the output.



Most of the organizations (including non-profit organization) can be described as production systems. These organizations transform (or convert) a set of inputs (such as materials, labour, equipment, energy etc.) in to one or useful outputs. The outputs of a production system are normally called products. These products may be:



Fig 2.1 A simple block diagram of a production system

Production system refers to manufacturing subsystem that includes all functions required to design, produce, distribute and service a manufactured product. So this system produces goods and/or services on a continuous and/or batch basis with or without profit as a primary objective.

- 3. **Determine** the optimal position for the product in regard to each attribute, taking into consideration the position occupied by existing brands.
- 4. Choose an overall position for the product (based on overall match between product attributes and their distribution in the population and the position of existing brands)

Product Positioning Strategy

- **Definition**: Placing a brand in that part of the market where it will have a favorable reception compared with competing brands.
- For Ex The marketers of "Liril" soap wants the people to think "Liril" when they think soap. The marketers of "Colgate" want the consumers to think "Colgate" when they think toothpaste etc.
- Objective
  - To position the product in the market so that it stands apart from competing brands. (b) To position the product so that it tells customer what you stand for, what you are, and how you would like customers to valuate you. In the case of positioning multiple brands:
    - (a) To seek go via by offering varied products in differing segments of Chemarket.

(b) To a plot out etitive threats to a single brand

- **Requirements**: Use of marketing mix variables, especially design and communication efforts.
  - Successful management of a single brand requires positioning the brand in the market so that it can stand competition from the toughest rival and maintaining its unique position by creating the aura of a distinctive product.
  - Successful management of multiple brands requires careful positioning in the market so that multiple brands do not compete with nor cannibalize each other. Thus it is important to be careful in segmenting the market and to position an individual product as uniquely suited to a particular segment through design and promotion.
  - Expected Results:
  - Short term success
  - Meet as much as possible the needs of specific segments of the market

to +1. An r value of exactly +1 indicates a perfect positive fit. Positive values indicate a relationship between x and y variables such that as values for x increases, values for y also increase.

- ✓ Negative correlation: If x and y have a strong negative linear correlation, r is close to -1. An r value of exactly -1 indicates a perfect negative fit. Negative values indicate a relationship between x and y such that as values for x increase, values for y decrease.
- ✓ No correlation: If there is no linear correlation or a weak linear correlation, r is Close to 0. A value near zero means that there is a random, nonlinear relationship between the two variables
- $\checkmark$  Note that r is a dimensionless quantity; that is, it does not depend on the units employed.
- ✓ A perfect correlation of  $\pm 1$  occurs only when the data points all lie exactly on a straight line. If r = +1, the slope of this line is positive. If r = -1, the slope of this line is negative.



Notice that in this example as the heights increase, the diameters of the trunks also tend to increase. If this were a perfect positive correlation all of the points would fall on a straight line. The more linear the data points, the closer the relationship between the two variables.

### **Negative Correlation**

among the opinions too much the report is sent to the same group for another round and the participants may choose to modify their previous responses. This process will be continuing until consensus is obtained. So Delphi method is a iterative process.

# **Market Research**

- It is systematic approach to determine external consumer interest in a service or product by creating and testing hypothesis through data-gathering surveys.
- It includes all research activities in marketing problem:
  - Gathering, recording and analyzing the utility and marketability of the product
  - The nature of the demand
  - The nature of competition
  - The methods of marketing
  - Other aspects of movements of product from the stage of to the point where they get consumed.
- Market research gathers records and analysis all facts about problem including to the transfer and sale of goods and services from producer to consumer.
- Market Research procedure Define the problem clearly Develop a clear set of restance objectives Supervise the estate collecting the data from the existing consumers.
  Extra remeaningful information row the collected data.
  Prepares a report presenting the major findings and recommendations coming from the study.
- It may be used to forecast demand for the short, medium and long-term. Accuracy is excellent for the short term, good for the medium term and only fair for the long term.

### **Forecast Error:**

### Forecast error

Difference between forecast and actual demand.

MAD (mean absolute deviation):

$$MAD = \frac{\sum_{t=1}^{n} |D_t - F_t|}{n}$$

where

- t = period number
- $D_t$  = demand in period t
- $F_t$  = forecast for period t

= total number of periods п

Month	Sales	Forecast
1	220	
2	250	255
3	210	205
4	300	320
5	325	315

Question: What is the MAD value given the forecast values in the table below?

Solution

	Month	Sales	Forecast	Abs Error
	1	220		
	2	250	255	5
	3	210	205	5
	4	300	320	20
	5	325	315	De
			Ne.	
		sintes.	1	40
$MAD = \frac{\sum_{t=1}^{n}  D_{t} - D_{t} ^{2}}{D_{t}  D_{t} ^{2}}$		from Not 9 page 44 of 9	8	

Note that by itself, the MAD only its as know the mean error in a set of forecasts

Mean absolute percent deviation (MAPE)

$$MAPE = \frac{1}{n} \frac{\sum_{t=1}^{n} |D_t - F_t|}{D_t} * 100$$

# **Demand Behavior:**

- Trend •
  - a gradual, long-term up or down movement of demand •
- Random variations
  - movements in demand that do not follow a pattern •
- Cycle

Existing facility (i)	1	2	3	4	5
Co-ordinates (ai,bi)	(5,10)	(20,5)	(15,20)	(30,25)	(25,5)
	(15,20)	(30,35)	(25,40)	(28,30)	(32,40)
No of trips of loads/years	100	300	200	300	100
(wi)	200	300	400	500	600

Find the optimal location of the new facilities based on giving location concept

# **SOLUTION**

$$X^{*} = \frac{\sum_{i=1}^{5} wiai}{\sum_{i=1}^{5} wi} = \frac{(100 \times 5 + 300 \times 20 + 200 \times 15 + 300 \times 30 + 100 \times 25)}{(100 + 300 + 200 + 300 + 100)} = 21$$
$$Y^{*} = \frac{\sum_{i=1}^{5} wibi}{\sum_{i=1}^{5} wi} = \frac{(100 \times 10 + 300 \times 5 + 200 \times 20 + 300 \times 25 + 100 \times 5)}{(100 + 300 + 200 + 300 + 100)} = 14.5$$

### **4.5.3 SINGLE FACILITY LOCATION PROBLEM**

co.uk **Objective** – To determine the optimal location for the new pickty by using the given set of existing facilities co-ordinates on X-Y plane and more sent of materials from a new facility to all existing facilities.

ecision. The rectilinear distance between any Generally we follow action lear distance for a and(X2,Y2) is given by the following formula two points weekse co-ordinates  $d_{12}=|X1-X2|+|Y1-Y2|$ 

some properties of an optimum solution to the rectilinear distance location problems are as follows:

- 1. The X-coordinate of the new facility will be same as the X-co-ordinate of some existing facility. Similarly the Y co-ordinate of the new facility will coincide with the Y coordinate of some existing facility. It is not necessary that both coordinates of the new facility
- 2. The optimum X or Y-co-ordinate location for new facility is a median location. A median location is defined to be a location such that no more than one half the item movement is to the left/below of the new facility location and no more than one half the item movement is to the right /above of the new facility location.

### **EXAMPLE**

Consider the location of a new plant which will supply raw materials to a set of existing plants in a group of companies, let there are 5 existing plants which have a materials movement

### (iv) Rules concerning Tools and Equipment Design

- 1. Jigs, fixtures and foot operated devices should be employed to reduce the work load on hand.
- 2. Tools should be multipurpose and easy to handle.
- 3. Foot-operated switches and controls should be designed as far as possible to reduce the workload on the hands.
- 4. Tools and materials should be properly arranged and located near the workpiece.
- 5. Tools and materials should be located in the order of their use.
- 6. There should be maximum surface contact between the tool handle and hand. It helps proper application of hand force and minimizes fatigue.
- 7. Gravity should be used for delivery of materials and finished goods.
- 8. Where the work is supposed to be carried out by fingers, the load distribution on each finger should be as per normal capacity of finger.
- 9. A worker should have the flexibility to stand or sit comfortably while working.
- 10. A worker should be able to operate levers and handles without changing the body position.
- 11. The workplace should have proper ergonomics in terms of illumination, proper conditions of heat, cold and humidity, reduced dust and noise, etc.

#### (v) Rules concerning time conservation

- 1. Even temporary ceasing of work by a man or m/c should not be encouraged.
- 2. Machine should not run idle as it leads to loss of production and power.
- 3. Two or more jobs should be done at the same time, or two or more operations hould be carried out on a job simultaneously.
- 4. Number of motions involved in completing a job should be in ratized.
- 5. The loading and unloading of the job and the syll one should be synchronized in such a manner that one operator can be in tranctional or an simultaneously operate a number of machiner.

# 6 Procedure il Potton Analysis DI CONTRACTION Analysis

The steps in motion analysis are as follows:

- a) Select: Select the work to be studied.
- b) Record: Record all the relevant facts of the proposed work by direct observation.
- c) Examine: Examine the facts critically in sequence, using special critical examination sheet.
- d) Develop: Develop the best method i.e. the most practical, economic and effective method under prevailing circumstances using the principle of motion economy.
- e) Install: install that method as standard practice.
- f) Maintain: maintain that standard practice by regular routine check.

### Recording

The recording may trace the movements of men, material or details of various processes. The principle is to use the simplest technique which will contain all relevant information needed for investigation.

The different recording techniques are charts, diagrams, models and photographic aids. The most commonly used recording techniques to cover most of the activities are shown in Table 5.1. The different symbols which are used in process charts are shown in Table 5.2.

### Explanation on each term

1. Forecasting: Estimation of type, quantity and quality of future work.

2. Order writing: Giving authority to one or more persons to undertake a particular job.

3. Product design: Collection of information regarding specification, bill of materials, drawing, etc.

4. Process planning and routing: Finding the most economical process of doing work and then deciding how and where the work will be done.

5. Material control: It involves determining the material requirement and control of materials.

6. Tool control: It involves determining the requirement and control of tools used.

7. Loading: Assignment of work to man power and machining etc.

8. Scheduling: It determines when and in what sequence the work will be carried out. It fixes the starting and finishing time for the job.

9. Dispatching: It is the transition from planning to action phase. In this phase the worker is ordered to start the actual work.

10.Progress reporting: Data regarding the job progress is collected. It is interpreted by comparison with the preset level of performance.

11.Corrective action: (i) Expediting means taking active if the progress reporting indicates a deviation of the plan from the original set tag. t. (d) Replanning of the whole affair becomes essential, in case expediting fails cobiling the deviation plan to a sight path.

# Objectives of PP?

1. To determine the sequent to operations to continue production.

2. To issue co-ordinated work schedule of production to the supervisor/foreman of various shops.

3. To plan out the plant capacity to provide sufficient facilities for future production programme.

- 4. To maintain sufficient raw materials for continuous production.
- 5. To follow up production schedule to ensure delivery promises.
- 6. To evaluate the performance of various shops and individuals.
- 7. To give authority to right person to do right job.

### **PPC and related functions**

The Fig. 6.1 shows the relation of PPC with other functional departments.



Fig. 6.1 Relation of PPC with other functional departments

6.2 Aggregate planning (AP)



**AP:** Production planning in the intermediate range of time is termed as Aggregate planning.

### **Explanation of AP**

The aggregate planning concentrates on scheduling production, personnel and inventory levels during intermediate term planning horizon such as 3-12 months. Aggregate plans act as an interface between strategic decision (which fixes the operating environment) and short term scheduling and control decision which guides firm's day-to-day operations. Aggregate planning typically focuses on manipulating several aspects of operations-aggregate production, inventory and personnel levels to minimize costs over some planning horizon while satisfying

Step 1: Find the minimum among  $t_{i1}$  and  $t_{i2}$ .

Step 2(a): If the minimum processing time requires m/c-1, place the associated job in the 1<sup>st</sup> available position in sequence.

Step 2(b): If the minimum processing time requires machine-2, place the associated job in the last available position in sequence.

Step 3: Remove the assigned job from the table and return to Step 1 until all positions in sequence are filled. (Ties may be considered randomly)

The above algorithm is illustrated with the following example.

Ex.1 Consider two machines and six jobs flow shop scheduling problem. Using Johnson's algorithm, obtain the optimal sequence which will minimize the makespan.

Job	Time taken by machines		
	1	2	
1	5	4	
2	2	3	
3	13	14	
4	10	1	
5	8	9	
6	12	11	
Sum	50	42	

sum 50 42 Solution: The working of the algorithm is sum arced in the form of a table which is shown below.

Stage	Unsche in leasy ob	Min	Assignment	Partial sequence/
	evi			Full sequence
1	123456		Job 4-[6]	$\times \times \times \times \times 4$
2	12356	t <sub>21</sub>	Job 2-[1]	$2 \times \times \times \times 4$
3	1356	t <sub>12</sub>	Job 1-[5]	$2 \times \times \times 14$
4	356	t <sub>51</sub>	Job 5-[2]	$25 \times 14$
5	36	t <sub>62</sub>	Job 6-[4]	$25 \times 614$
6	3	t <sub>31</sub>	Job 3-[3]	253614

Now the optimal sequence is 2-5-3-6-1-4.

The makespan is determined as shown below.

Job	Ν	И/С-1		M/C-1	Idle time on
	Time in	Time out	Time in	Time out	m/c-2
2	0	2	2	5	2
5	2	10	10	19	5
3	10	23	23	37	4
6	23	35	37	48	0
1	35	40	48	52	0
4	40	50	52	53	0

The makespan for this schedule is 53.

The chart shows that part V & W started on  $4^{th}$  day and the other parts on  $5^{th}$  day such that all the components become ready for subassembly on 6.5<sup>th</sup> day and all the subassembly become ready on 9<sup>th</sup> day for final assembly. The assembly is over on 10<sup>th</sup> day.

- (d) Control of parts subassemblies and Assembly: A supervisory function coupled with an appropriate information feedback system keeps a check whether the small parts arriving in lots and big parts coming continuously are available at right time, in proper quantities for making subassemblies as per scheduled plan.
- (e) Dispatching: Dispatching is nothing but issuing orders and instructions to start a particular work which has already been planned under routing and scheduling.

### **Functions of Dispatching**

- (i) Assignment of work to individual man, m/c or work place.
- (ii) Release necessary order and production firm.
- (iii) Authorize for issue of materials, tools, jigs, fixtures, gauges, dies for various jobs.
- (iv) Required materials are authorized to move from stores or from operation to operation.
- (v) Issue m/c loading and schedule chart, route sheet, etc.
- (vi) To fix up the responsibilities of guiding and controlling the materials and operation processes.
- (vii) To issue inspection order.
- (viii) Issue of time tickets, drawing, instruction cards.

#### **Dispatch procedure**

sale.co.uk The product is broken into different component Pr component, operations are mentioned in order as shown in Figure aside

<u>_</u>	
Route sheet for component C	7801
Material-	aplu
	au
Operation 2-	

The various steps of dispatch procedure for each operation are listed below:

- (a) Store issue order: Authorise store department to deliver required material.
- (b) Tool order: Authorise tool store to release the necessary tools. The tools can be collected by the tool room attendant.
- (c) Job order: Instruct the worker to proceed with operation.
- (d) Time tickets: It records the beginning and ending time of the operation and forms the basis for workers pay.
- (e) Inspection order: Notify the inspectors to carry out necessary inspections and report the quality of the component.
- (f) Move order: Authorise the movement of materials and components for one facility to another for further operation.

In addition, there are certain dispatch aspects such as:

- (1) All production information should be available beforehand.
- (2) Various order cards and drawing with specification should be ready.
- (3) Equipment should be ready for use.
- (4) Progress of various orders should be recorded.
- (5) All production records should be on Gantt chart.



The corresponding manpower requirement histogram is shown below.



From this figure, it is observed that the peak manpower requirement is 21 and it occurs from 0

to 6 weeks. The activities which are scheduled during the period are: (1-2), (1-3) and (1-4). The activity 1-2 is critical activity. So it should not be disturbed. Between activities (1-3) and (1-4), the activity (1-3) has high slack value of 6 weeks (whereas its only 4 weeks for (1-4)). Hence, it can be started at the end of 6 weeks. The corresponding modification is shown by the following histogram.

CAM tool includes the following three elements:

- (i) **CAD Tool**: The basic geometric information of the model is extracted from the geometric model created in the CAD phase of the product cycle. From the model necessary information regarding the shape, contour and sizes is extracted so as to implement in the manufacturing tool.
- (ii) Manufacturing tool: The fundamental of manufacturing process which are used defines the manufacturing tool. It describes the method in which the product can be manufactured. This includes generation of part programming and manufacturing and computer aided process planning (CAPP) and tool and cutter design, etc.
- (iii) Networking tools: The knowledge of networking and interfaces is required for communication capability between various machines and computers. e.g. transferring a part program from one computer to 04 different machines, controlling a robot from a computer etc. a communication or networking tool is a must for CAM to be operational effectively.

CAM employs computers for 02 basic purposes:

- (a) **Computer monitoring and control:** Where computers are used to control and monitor the applications. The major applications include in this category are: controlling machines and polytic.
- (b) **Manufacturing support applicit on** it includes those applications which are not controlled uncerty by computer but are used to support the primary and direct operation. Such applications include numeric many and direct operating computer aided schedules and all other kinds of pagends.
- (c) Flexible Manufacturing System (FMS): A FMA integrates all major elements of manufacturing into a highly automated system. FMS has born in the latter half of 1960's as a means to improve productivity of small and medium volume production.

organizations and can provide common standards of goods and services on international trades.

ISO9000 series has 5 numbers of international standards on quality management which are listed below with different objectives.

ISO 9000: Provides guide lines on selection and use of quality management and quality assurance standards.

ISO 9001: This is applicable for industries doing their own design and development, production, installation and servicing. It has 20 elements.

ISO 9002: It has 18 elements. It is same as ISO 9001 without the 1<sup>st</sup>two tasks i.e. design and development.

ISO 9003: It has 12 elements covering final inspection and testing for laboratories and warehouses.

ISO 9004: This provides guidelines to interpret the quality management and quality assurance. It also has suggestions which are not mandatory.

# **Benefits of ISO 9000 Series**

- 1. This gives competitive advantage in the global market.
- 2. Consistency in quality, as ISO helps in detecting non-conforming early which makes it possible to rectify.
- 3. Documentation of quality procedure adds clarity to quality system.
- 4. It ensures adequate and regular quality training for all members of the organization.
- 5. It helps in customers to have cost effective particulate procedure.
- 6. The customers during purphase from firm holding ISO certificate need not spend much on inspection and testing. Thi Over reduce quality cost and lead time.

7. **The will aid to improve metale and involvement of workers**.

- The level of the state ction will be more.
- This will help in increasing productivity.

### Steps in ISO 9000 Registration

- 1. Selection of appropriate standard from ISO 9001/9002/9003 using guidelines given in ISO 9000.
- 2. Preparation of quality manual to cover all the elements in the selected model.
- 3. Preparation of procedure and shop floor instruction which are used at the time of implementing the system. Also document these items.
- 4. Self-auditing to check compliance of the selected module.
- 5. Selection of a registrar (an independent body with knowledge and experience to evaluate any one of the three quality systems i.e. ISO 9001/ 9002/ 9003) and the application is to be submitted to obtain certificate for the selected quality system/ model.

- 5. A willingness to allow people to volunteer their time and effort for improvement of performance of organization.
- 6. The importance of each member's role in meeting organizational goal.



### Characteristics of quality circle

- 1. QCs are small primary groups of employees/workers whose lower limit is 3 and upper limit is 12.
- 2. Membership is voluntary. The interested employees in some areas may come together to form a quality circle.
- 3. Each quality circle is led by area supervisor.
- 4. The members meet regularly every week/ as per agreeable schedule.
- 5. The QC members are specially trained in technique of analysis and problem solving in order to play their role efficiently.
- 6. The basic role of quality circle is to identify work related problems for improving quality and productivity.
- 7. QC enables the members to exercise their hidden talents, creative skills, etc.
- 8. It promotes the mutual development of their member through cooperative participation.