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ANNAMALAI UNIVERSITY

DIRECTORATE OF DISTANCE EDUCATION

M.Sc. PLANT AND MACHINERY VALUATION

First Year

INDUSTRIAL PROCESS AND PRACTICES

LESSONS: 1 – 15

M.Sc. PLANT AND MACHINERY VALUATION

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INDUSTRIAL PROCESS AND PRACTICES

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M.Sc. PLANT AND MACHINERY VALUATION

First Year

INDUSTRIAL PROCESSES AND PRACTICES

SYLLABUS

Introduction: Types of Manufacturing process – engineering equipment. Small. Medium & large scale industries. Types of ownership – Proprietary / Partnership / Pvt. Ltd. & Public Limited companies. Service & manufacturing – companies.

Class of Industry: Discrete / continuous production / Process units. Shifts in operation / ageing / useful life Maintenance / refurbishment / modernisation – aspects.

Manpower, Safety & Productivity: Manpower, Safety & Productivity : Categories / classification / measurement. Human Resources – categories –workmen (skilled / unskilled) , knowledge workers (technical / administrative), management , vendors & contractors.

Safety in the workplace: hazards in the work place – use of PPE (personal protective equipment), safety in operation

Productivity – measurement – KPI (key performance indicators) – production in qty / weight per employee, output of plant / equipment per hour or day or year , uptime of equipment (capability – hours / year – continuous / intermittent) , specific energy consumption per unit of production etc.

Instrumentation & Measurement: Purpose of instrumentation: Typical instruments for measurement of power, flow, pressure, temperature – types analog / digital – real time – intermittent – spontaneous. Management of data from multiple sources – real time monitoring & control. Numerical control / automation / DCS based management.

References

1) Telsang M T, Industrial Engineering and Production Management, S. Chand Publication, 2nd Edition, 1999.
2) Khan M I, Industrial Engineering, New Age International Publication, 2nd Edition, Reprint 2012.
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4) Avraham Shtub, Yuval Cohen, Introduction to Industrial Engineering, CRC Press, 2nd Edition, 2016.
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M.Sc.PLANT AND MACHINERY VALUATION

First Year

INDUSTRIAL PROCESSES AND PRACTICES

CONTENTS

PRODUCTION - TYPES OF MATERIAL PROCESS

1.1. INTRODUCTION

Industrial processes can be classified in many categories. This lesson deals with production methods based on type of process.

1.2. OBJECTIVE

Study of various processes that take place in a manufacturing unit.

1.3. CONTENT

1.3.1. PRODUCTION PROCESS

Production process is defined as: Mechanical or chemical steps used to create an object, usually repeated to create multiple units of the same item. The process generally involves the use of raw materials, machinery and manpower to create a product.

1.3.2. TYPES OF PRODUCTION PROCESS

There are many kinds of production process

1) Casting – ferrous, non-ferrous – types molding – gravity, die-cast, lost-in-wax, shell.
2) Molding & Forming – cold & hot process – pressing, hammer, rolling, shearing, extrusion, injection molding.
3) Machining – turning, shaping, welding, milling, drilling, grinding, cutting, swaging, drawing.
4) Continuous process plants – refinery, distillery, brewery, melting, chemical compounding, extraction, etc.

1.3.2.1. Casting process

In this process metals are heated beyond their melting point to a liquid form. Liquid metal is then poured into pre-formed molds and allowed to cool. Solidified metal parts are called castings. Castings are then processed to remove runners & risers and other excess material. This process is called fettling. Typically fettling can include cutting, grinding, shot blasting.

When metals are first melted and then poured into a mold the process is called gravity casting.

Metals/solids can be heated to melting & molded under pressure. This process is called pressure die-casting. This process results in better dimension control & good finish. Mostly non-ferrous metals like Aluminum amenable for pressure die-casting. Lost in wax castings & shell molding are special types of gravity casting which produce castings to closer tolerances and thin walled castings.

For example, in the secondary steel industry billets are cast from molten steel. In a foundry, steel or alloy castings are made using a blast furnace or induction furnace to melt metal.

1.3.2.2. Forming

The process of changing the shape of a work-piece by use of force without any material removal is called forming. There are 2 types of forming: Hot forming and Cold forming.

1.3.2.2.1 Hot forming

In this process solid work-piece is heated to a specified temperature. In this state it is possible to change it to a desired shape.

1.3.2.2.2. Cold forming

In this process shape of the work-piece is changed by use of force only. Work-piece is not heated. All ductile material can be cold formed to some extent.

Ductile materials like iron, copper & aluminum can be hot-formed to increase length. For example, in the secondary steel industry – wire rods are rolled from hot billets. Generally, ductility of a metal increases with temperature. Energy required to roll or draw (change shape) reduces with temperature.

1.3.2.3 Molding

Plastic granules are heated and molded in-situ in plastic injection molding machines. In extrusion process plastic granules are heated and extruded into yarn or sheets as required.

1.3.2.4 Machining

In this process the shape of the work-piece is changed by cutting/chipping away the material to a desired shape. Castings, sheets, rods require to be converted to components. Components are parts that:

a) have a defined shape
b) are precisely sized – dimensional tolerances are defined
c) should have specified characteristics in terms of hardness, surface finish etc.

To meet these requirements parts (Castings, sheets, rods) undergo machining. Depending on the specification of the component, parts can pass thru multiple machines & in-process treatments like heat-treatment. Machining operations are typically - turning, shaping, welding, milling, drilling, grinding, cutting, swaging, drawing. Machine tools have been developed to meet the “part” machining requirement.

Sometimes one machine can undertake multiple types of operations. They can be special purpose machines or flexible machining centers. They can have different types of control systems like manual, semi-automatic, PLC logic control, Computerized Numerical Control etc. Choice of machine tool(s) and complexity depends on viability of the requirement.

1.4. REVISION POINT

1) Manufacturing process, Machining, Casting process ,Forming, Molding

1.5. INTEXT QUESTIONS

1) What is production process? Name any 3 types of production processes.
2) How is a component or part made thru casting process.

1.6. SUMMARY

The basic methods used in manufacturing are Casting, forming, molding and machining. We discussed what is meant each type of method. Most manufacturing processes use a combination of these methods to produce a product.

1.7. TERMINAL EXERCISES

1) Define forming.
2) What do we mean by Machining?

1.8. SUPPLEMENTARY MATERIALS

1) *https://en.wikipedia.org/wiki/List_of_manufacturing_processes.*
2) *http://machinedesign.com/contributing-technical-experts/5-types-manufacturing-processes.*
3) *http://blog.mechguru.com/how-products-are-made/applications-merits-and-demerits-of-most-popular-manufacturing-processes/*

1.9. ASSIGNMENTS

1) Give two examples for formed parts and cast product.
2) Give two examples for molded parts and machined parts.

1.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication .
3) GavrielSalvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

1.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- Casting process
- Forming
- Molding
- Machining

1.12. KEY WORDS

Casting process, Forming, Molding, Machining

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LESSON - 2

TYPES OF PRODUCTION METHODS

2.1 INTRODUCTION

In this lesson we study about production methods based on quantity & function. There are four main types of industrial production methods based on quantity produced - One-off production, batch production, mass production & continuous production. Manufacturing units can be classified by function also -as Repetitive, Discrete, Job Shop, Process (batch), and Process (continuous). Any given manufacturing facility is likely to have a combination of different type of process by volume and function.

2.2. OBJECTIVE

- Study of various methods of production in a manufacturing unit.

2.3. CONTENT

2.3.1. Production Process by Quantity/volume

2.3.1.1. One-off production

2.3.1.2. Batch production

2.3.1.3. Mass production

2.3.1.4. Continuous flow production

2.3.2. Types of Industrial Processes by function

2.3.2.1 Repetitive

2.3.2.2. Discrete

2.3.2.3. Job Shop

2.3.2.4 Continuous Process

2.3.2.5. Batch Process

2.3.1. PRODUCTION PROCESS BY QUANTITY / VOLUME

2.3.1.1. One-off production

One-off production is when only one product is made at a time. Every product is different, so it is labour intensive. Products may be made by hand or a combination of hand and machine methods.

Examples: Dies & Tools, Special Purpose Machines, Pilot process equipment etc.

2.3.1.2. Batch production

Batch production is when a small quantity of identical products are made at a time. Batch production may also be labour intensive. However, many times jigs and templates are used to aid production. Modern equipment like CNC Flexible Machining Centers are employed. Batches of the product can be made as often as required. The machines can be easily changed to produce a batch of a different product.

Examples: machine tools & industrial machinery.

2.3.1.3. Mass production

Mass production is when hundreds of identical products are made, usually on a production line. Mass production often involves the assembly of a number of sub-assemblies of individual components. Parts may be outsourced. Some tasks are automated with the use of SPM s & CNC machines.

Examples: Multi-axle heavy vehicles, large capacity diesel engines, locomotives etc,

2.3.1.4. Continuous flow production

Continuous flow production is when many thousands of identical products are made. The difference between this and mass production is that the production line is kept running 24 hours a day, seven days a week to maximize production and eliminate the extra costs of starting and stopping the production process. The process is highly automated and only few workers are required.

Examples: Consumer goods like Air-conditioners, refrigerators, appliances, motor-cycles, cars etc.

2.3.2. TYPES OF INDUSTRIAL PROCESSES BY FUNCTION

Manufacturing units can be classified by function as - Repetitive, Discrete, Job Shop, Process (batch), and Process (continuous).

2.3.2.1 Repetitive

This type of process generally adopts line production – and produce the same product(of similar functions in different sizes). Production line is dedicated and changeover to another product line is time consuming & expensive. This may involve large capital expenditure. Advantage – high productivity & low per unit cost. Requires large volumes.

Example: Manufacturing of Gears, axles and other such automotive components, motors, pumps etc.

2.3.2.2. Discrete

This type of process is very versatile and can easily be adopted for different type of products. Usually equipment are arranged in functional layout. Most equipment are general purpose and allow frequent setups and changeovers. Advantage – adaptable to different market requirements – product & process flexibility. Usually low volumes – high value addition

Example: Manufacturing of Machine tools & Industrial machinery

2.3.2.3. Job Shop

Here the Unit offers only value addition services. Raw material(s) and drawing are provided by the client. The unit utilizes equipment in their unit selectively to convert raw material into the desired product. Revenue is from services provided. Usually such units tend to specialize in certain areas and offer their services to different clients.

Example: Heat Treatment, Foundry, powder coating, electro-plating etc.

2.3.2.4 Continuous Process

These plants are designed & required to operate on 24 x 7 basis. Typical feature of these plants is: raw material(s) are fed at one end and finished product(s) are produced at final / intermediate words. In a continuous process plant any breakdown

typically results in shut down of the process. In process, inventory can be very difficult or expensive to store or dispose of

Example: Petro-chemical units, cement plants, Power plants etc.

2.3.2.5. Batch Process

Batch-process operations are similar to continuous process plants and are designed & required to operate on 24 x 7 basis. However, the process is such that – different individual process in the course of production are required to be handled in batches of specified quantity. This can be due to size / time / speed limitations. It is very common to see batch process sub-plants in a continuous operation plant.

Example: Tyre manufacturing, API Pharma plants etc.

2.4. REVISION POINT

1) One-off production, Batch production, Mass production, Repetitive, Discrete, Job Shop.

2.5. INTEXT QUESTIONS

1) What are types of production methods by volume?
2) What are types of production methods by function?
3) What is the difference between repetitive process & mass production?
4) What is the difference between continuous process & batch process?

2.6. SUMMARY

Types of production based on quantity / volume are One-off production, batch production, mass production & continuous production. Manufacturing units can be classified by function also - as Repetitive, Discrete, Job Shop, Process (batch), and Process (continuous). Any given manufacturing facility is likely to have a combination of different type of process by volume and function.

2.7. TERMINAL EXERCISES

1) Discuss production process in an Automobile manufacturing unit
2) Discuss production method in a petro-chemical plant

2.8. SUPPLEMENTARY MATERIALS

1) *https://en.wikipedia.org/wiki/List_of_manufacturing_processes*
2) *http://machinedesign.com/contributing-technical-experts/5-types-manufacturing-processes*
3) *http://blog.mechguru.com/how-products-are-made/applications-merits-and-demerits-of-most-popular-manufacturing-processes/*

2.9. ASSIGNMENTS

1) What is the difference between repetitive process & mass production?
2) What is the difference between continuous process & batch process?

2.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, Industrial Engineering and Production Management, S. Chand Publication
2) Khan M I, Industrial Engineering, New Age International Publication
3) GavrielSalvendy, Handbook of Industrial Engineering: Technology and Operations Management

4) Avraham Shtub, Yuval Cohen, Introduction to Industrial Engineering, CRC Press

5) K. Krishnaswamy, Industrial Instrumentation, Amazon

6) S. Mukhopadhyay, Industrial Instrumentation, Control and Automation, Amazon

2.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- One-off production
- Batch production
- Mass production
- Repetitive
- Discrete
- Job Shop
- Continuous Process, Batch Process

2.12. KEY WORDS

One-off production ,Batch production ,Mass production ,Repetitive ,Discrete, Job Shop, Continuous Process, Batch Process

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LESSON – 3

MAINTENANCE

3.1. INTRODUCTION

The dictionary defines maintenance as follows: "the work of keeping something in proper condition; upkeep." This means that maintenance shall include all actions taken to prevent a device or component from failing or to repair normal equipment degradation experienced with the operation of the device to keep it in proper working order. In this lesson we learn various methods of maintenance & best practices.

3.2. OBJECTIVE

- To understand various maintenance aspects of a manufacturing unit. Plant & Machinery are subject to wear & tear and usually require continual maintenance. Usually life of different sub-components of equipment are specified based on measureable parameters. It is very common for a given plant / equipment to have different life. Life of sub-components can be specified in operational hours / gross duration / number of operations / vibration or noise limits / noticeable damage or leaks. Plant is expected to develop standards for measurement & action to be taken for these events. Wear is also dependent on quality of use of equipment – human resources / load pattern / adherence to design operational requirements / use of requisite quality of raw material, spares & consumables.

3.3. CONTENT

3.3.1. Types of Maintenance

3.3.1.1. Reactive maintenance

3.3.1.2. Preventive maintenance

3.3.1.3. Predictive Maintenance

3.3.2. Reliability Centered Maintenance

3.3.3. Training of Human resource

3.3.4. Load pattern

3.3.1. TYPES OF MAINTENANCE

Maintenance can be divided into three major categories

1. Reactive,
2. Preventive
3. Predictive maintenance

3.3.1.1. Reactive maintenance (Break-down maintenance)

This is the most common form of maintenance. Since break-down cannot be avoided totally all organizations have to follow break-down maintenance to some extent or another. Reactive maintenance is basically the "repair on breakdown" maintenance mode. Action is initiated after an equipment breaks down. Studies indicate this is still the predominant mode of maintenance. A study indicated the prevalence of maintenance by category as follows.

- >55% Reactive
- 31% Preventive

- 12% Predictive

Reactive maintenance has its advantages & disadvantages.

Advantages

- Low cost.
- Less staff.

Disadvantages

- Increased cost due to unplanned downtime of equipment.
- Increased labor cost, especially if overtime is needed.
- Cost involved with repair or replacement of equipment.
- Possible secondary equipment or process damage from equipment failure.
- Inefficient use of staff resources.

3.3.1.2. Preventive maintenance (Routine maintenance)

Preventive maintenance can be defined as follows: Actions performed on a time- or machine-run-based schedule that detect, preclude, or mitigate degradation of a component or system with the aim of sustaining or extending its useful life through controlling degradation to an acceptable level.

By performing maintenance activities intended by the equipment designer /manufacturer, equipment life is extended and its reliability increased. In addition to increased reliability, money is saved from increased time between failures & reduced loss of production. Studies indicate that savings of 12% to 18% can be achieved by adopting recommended preventive maintenance procedures. Advantages & disadvantages of Preventive Maintenance:

Advantages

- Cost effective in many capital-intensive processes.
- Flexibility allows for the adjustment of maintenance periodicity.
- Increased component life cycle.
- Energy savings.
- Reduced equipment or process failure.
- Estimated 12% to 18% cost savings over reactive maintenance program.

Disadvantages

- Catastrophic failures still likely to occur.
- Labor intensive.
- Includes performance of unneeded maintenance.
- Potential for incidental damage to components in conducting unneeded maintenance.

3.3.1.3. Predictive Maintenance

Predictive maintenance can be defined as follows: Measurements that detect the onset of system degradation (lower functional state), thereby allowing causal stressors to be eliminated or controlled prior to any significant deterioration in the component physical state.

Measurement &Results indicate current and future functional capability. Basically, predictive maintenance differs from preventive maintenance by basing maintenance need on the actual condition of the machine rather than on some preset schedule.

Example: We change engine oil in our cars every 10,000 kms or 6 months based on manufacturer's recommendation. This is effectively basing the oil change needs on equipment run time / time lapsed. No concern is given to the actual condition and performance capability of the oil. It is changed because it is time. This is as per preventive maintenance.

If, on the other hand, we test the oil quality at given intervals of time, say once a month, to determine its actual condition and lubrication properties, it may be possible to extend the oil change – say till 9 months or even 12,000 kms. Oil change is now determined by its actual quality and not based on time.

This is the fundamental difference between predictive maintenance and preventive maintenance. Predictive maintenance tasks are based on quantified material/equipment condition tests &measurements.

A good well designed predictive maintenance program can reduce or eliminate catastrophic equipment failures. More maintenance activities can be undertaken based on planned schedules. It is possible to reduce inventory and order parts, as required, just in time to support maintenance needs.

It is possible to optimize equipment operation, save energy and improve plant reliability.

Studies indicate that a properly functioning predictive maintenance program can provide a savings of 8% to 12% over a program utilizing preventive maintenance alone. Advantages from instituting a Predictive maintenance program:

- Reduction in maintenance costs: 25% to 30%
- Elimination of breakdowns: 70% to 75%
- Reduction in downtime: 35% to 45%
- Increase in production: 20% to 25%.

3.3.2. RELIABILITY CENTERED MAINTENANCE

A predictive maintenance program is very effective. However, its universal application to all equipment may be very costly. Hence cost versus benefit analysis may be needed to decide which equipment may be put on Predictive Maintenance & which others on Preventive maintenance. A Reliability centered maintenance (RCM) is a maintenance program that recognizes the importance & effect of the asset in the context of its contribution to production process and assigns suitable priority.

RCM recognizes that all equipment in a facility is not of equal importance to either the process or facility safety. It recognizes that equipment design and operation differs and that different equipment will have a higher probability to undergo failures from different degradation mechanisms than others. RCM maintenance program

recognizes that a facility has limitations on finance & skill sets and that the use of both need to be prioritized and optimized.

RCM is a systematic approach to maximize reliability and cost-effectiveness of a manufacturing facility – based on a focused study of equipment and available resources. RCM is highly reliant on predictive maintenance but also recognizes that maintenance activities on equipment that is inexpensive and unimportant to facility reliability may best be left to a reactive maintenance approach. A typical mix of the best use of maintenance programs is:

- <10% Reactive
- 25% to 35% Preventive
- 45% to 55% Predictive.

Of course the best mix pattern should be based on a study of the process, equipment & skill-set available.

3.3.3. TRAINING OF HUMAN RESOURCE

Plant & Machinery are designed with specified Standard Operation Procedure for – startup / loading / operation / shut down & emergency shutdown. It is necessary for the operators of the plant / equipment to be well trained on these issues. Any human error can cause severe damage to equipment and in certain cases can affect safety.

3.3.4. LOAD PATTERN

Plant & equipment are designed with certain specified parameters for operation. It is necessary to limit the use to within the design specifications of the machine. Hence it is necessary for the operator - to understand the limitations of the plant / equipment.

Adherence to Design operational requirements: Although these are also part of SOP, in many cases the limitation imposed by this criteria is not well understood. A typical example is sustained operation at low load (< 40 % of rated capacity). In process plants a typical example is use of fuel of different quality than as per design. In all such cases plant / equipment suffers – exceptional wear & tear although operating within size / load patterns.

- Use of requisite quality of raw material, spares & consumables.

Variations in quality of input raw material beyond the design capability of plant / machinery can cause long term damage. Typical case in thermal power stations is quality of coal. Stones / sand & ash beyond certain limits can cause damage to crushing equipment & boiler. Water / heavier compounds in liquid fuel can cause damage to engines.

It is necessary to use proper specified size & quality of spares and consumables in the course of maintenance. This needs to be part of SOP. Any laxity on this can cause accelerating ageing of the plant / equipment.

- Use of proper tools: Quality of maintenance depends on the quality of tools used in the process of maintenance.

3.4. REVISION POINT

Reactive, Preventive, Predictive maintenance

3.5. INTEXT QUESTIONS

1) Why do we need maintenance?
2) What are factors influencing wear & tear?
3) What are the 3 basic types of maintenance?
4) What do you understand by Reactive (break-down) Maintenance?
5) What do you understand by Predictive maintenance?
6) What is the difference between preventive maintenance & predictive maintenance?

3.6. SUMMARY

Three basic types of maintenance are Break-down maintenance, preventive maintenance & predictive maintenance. Approach & methodology are different. Cost of maintenance depends on choice of type. RCM is a good blend of different types of maintenance optimizing the cost of maintenance considering its impact on production.

3.7. TERMINAL EXERCISES

1) What are the 3 basic types of maintenance?
2) What do you understand by Reactive (break-down) Maintenance?

3.8. SUPPLEMENTARY MATERIALS

1) *http://www.worksafemt.com/safety/safety-important/the-importance-of-safety/*

3.9. ASSIGNMENTS

1) Take a typical manufacturing unit
   a. Automotive ancillary unit, b. Assembly line, c. Power plant
2) Discuss impact of adopting each type of maintenance on single approach basis in each plant.

3.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management*, S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication .
3) GavrielSalvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

3.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- Reactive
- Preventive
- Predictive maintenance

3.12. KEY WORDS

Reactive, Preventive, Predictive maintenance

LESSON - 4

HUMAN RESOURCES

4.1. INTRODUCTION

Successful corporate leaders recognize that their competitive edge in today's market place is their people. They also acknowledge that few organizations knowhow to manage their human resources effectively, primarily because traditional management models are inappropriate in our dynamic work environment. – John Bratton.

Human Resource has come to stay as the most valuable asset in any organization. It is up to the individual organization to give the necessary inputs to ensure that the resource is utilized to the optimum levels as deemed necessary to meet the market demands by way of output of quality products.

Human resources require action on the part of management to obtain the best results. In this lesson we study different aspects of managing human resource.

4.2. OBJECTIVE

- To understand human resource management in an industrial environment

4.3. CONTENT

4.3.1. Human Resource Planning

4.3.2. Selection and Recruitment

4.3.2.1. Job Analysis

4.3.2.2. Training

4.3.3. Statistical Data on Human Resources

4.3.1. HUMAN RESOURCE PLANNING

This is the first step in identifying the requirements of an organization. The planning has to take into consideration the skill levels that may be required to fulfill the total production as planned. The levels of skill can be categorized as follows.

4.3.2. SELECTION AND RECRUITMENT

The selection of the proper person for the right job is a stupendous task bestowed with any HR Manager. Unless we have the right man for the right job the qualitative output is compromised. It is for this reason that considerable effort is taken in identifying the right persons for recruitment. The selection process consists of one or more of the following.

1 Written Tests.

2 Skill oriented practical tests.

3 Oral Interview

4 Psychometric tests.

4.3.2.1. Job Analysis

Every job in the present day industrial context has to be analyzed to identify the specifics of the job and to fit the right person to carry out the job. This is often referred to as job evaluation. This exercise fixes the level of skills apart from identifying the

content of the job to be performed. The data required for evaluation may be detailed as follows.

1) Job identification.
2) Nature of the job.
3) Operations involved in doing the job.
4) Materials and equipment to be used in the job.
5) Personal attributes required to carry out the job ie education,training, physical strength, mental capabilities etc.
6) Relation with other jobs.

4.3.2.2. Training

Training has come to stay as an integral part of human resources development which is crucial for the growth of the individual and the organization. Forwardlooking companies stress the need for training their employees periodically to:

1) Improve their skills.
2) Keep abreast of latest developments.
3) Grow with the growth of the organization.

4.3.3. STATISTICAL DATA ON HUMAN RESOURCES

As per the Census 2001, the Indian workforce is over 400 million strong, which constitutes 39.1 % of the total population of the country. The workers comprise 312 million main workers and 88 million marginal workers (i.e., those who did not work for at least 183 days in the preceding 12 months to the census taking) Sex differential among the number of male and female worker in the total workforce is significant. Of the total 402 million workers, 275 million are males and 127 million females. This would mean that 51.7 percent of the total males and 25.6 percent of the total females are workers. The number of female workers is about less than half the number of male workers. In terms of proportion, 68.4 percent of the workers are males and 31.6 percent females as per the census taking.

Main workers constitute 77.8 percent of the total workers. The remaining are marginal workers. Among the main workers, female workers, are only 23.3 % and 76.7% are male workers. Majority of female workers (87.3 percent) are from rural areas. This is also twice that of male workers, which may be due to their being employed predominantly in activities like cultivation and agricultural labour. In the urban areas, majority of female workers are engaged in Households industry and other work.

Interestingly, among marginal workers, females outnumber the males. In three of the four categories, viz. cultivators, agricultural labourers and household industries, female marginal workers outnumber male workers.

Number of workers('000s)

Category	*Persons*	*Males*
Total population	1,028,610	532,157
Total workers	402,235	275,015

Main workers	313,005	240,148
Marginal workers	89,230	34,867
Non-workers	626,376	257,142
Cultivation	127,313	85,417
Agricultural laborers'	106,957	57,329
Household industry workers	16,957	8,744
Other workers	151,190	123,525

The workers have been classified by the type of economic activity into broad the type of economic activity into nine broad categories as per National Industrial Classification, 1998. Distribution of main workers by industrial category shows that agriculture sector still employs largest number of workers. The dependence on agriculture is brought out by the fact that of the 313 million main workers in the country, 166 million (56.6%) has been engaged in 'Agricultural and allied activities'. This is followed by 'Manufacturing Industries', which employed about 42 million (13.4%). There are 31.1 million workers in the services sector forming 10 % of the total main workers with similar number engaged in 'Wholesale retail trade and repair work, Hotel and restaurant.

Table 20: Distribution of main worker by Different Industrial Categories, India 2001

Industrial category	*Main Workers ('000s)*	*Percentage (%)*
Total main workers *	312,972	100.0
Agricultural & allied activities	176,979	56.6
Mining & quarrying	1,908	0.6
Manufacturing	41,848	13.4
Electricity, gas and water supply	1,546	0.5
Construction	11,583	3.7
Wholesale, retail trade & repair work, Hotel and restaurants	29,333	9.4
Transport, storage & communications	12,535	4.0
Financial intermediation, Real estate, business activities	6,109	2.0
Other services	31,131	10.0

Manufacturing sector employs about 13 % of the total workforce. This group can be further subdivided as - workmen (skilled / unskilled), knowledge workers (technical / administrative), management, vendors & contractors.

4.4. REVISION POINT

1) Human Resource Planning, Selection and Recruitment ,Job Analysis, Training, Statistical Data on Human Resources

4.5. INTEXT QUESTIONS

1) What is the role of human resource management in modern day production process?
2) Why is selection process important?

4.6. SUMMARY

Productivity, quality and sustainable management requires that a good organization is sensitive to the needs of the personnel – in terms of job satisfaction, growth prospects, security and emotional aspects on the one hand and – continual change aspects In terms of training. Job requirements, skill sets needed and qualifications of the suitable persons need to be clearly defined and monitored from time to time. Industry today is facing multitude of challenges imposed by rapid changes in technology, demography, globalization, and government policy. Human resources require continuous attention.

4.7. TERMINAL EXERCISES

1) What is the need for training in modern production practices?
2) Write a few lines on India's work force availability & quantity?

4.8. SUPPLEMENTARY MATERIALS

1) https://nonprofitrisk.org/tools/workplace-safety/nonprofit/c1/wkplcsafety.htm
2) http://www.safetyandhealthmagazine.com/articles/12470-tips-for-effective-workplace-

4.9. ASSIGNMENTS

1) Case study: Take any organization or company, Discuss how human resource management can help improve productivity & profitability.

4.10. SUGGESTED READING/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering,* New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

4.11.LEARNING ACTIVITIES

1) Group discussion on during PCP day
   - Human Resource Planning,
   - Selection and Recruitment
   - Job Analysis,
   - Training
   - Statistical Data on Human Resources

4.12. KEY WORDS

Human Resource Planning, Selection and Recruitment, Job Analysis, Training Statistical, Data on Human Resources

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WORKPLACE SAFETY

5.1. INTRODUCTION

Work place safety is a very important aspect of running an industry. An organization is responsible for the health and safety of its workers, contractors and volunteers while at work. Every country including India have laid out procedures & enacted Laws to ensure & monitor safe working practices in all activities. In this lesson we learn about the meaning of safety & safe working practices.

5.2. OBJECTIVE

- To familiarize students with safety & safe working practices in the work place.

5.3. CONTENT

5.3.1. Safety
5.3.2. Hazard Analysis Methodology
5.3.2.1. Assessment Measures
5.2.2.2. Activity Evaluation
5.3.2.2.1 Safety Survey and Inspection
5.3.2.2.2. Safety Sampling
5.3.2.2.3 Safety Audits
5.3.3. Predictive Models
5.3.4. Hazard Control
5.3.5.Control Measures
5.3.6. Providing training and instruction
5.3.7. Personal protective equipment
5.3.8. Work permits
5.3.10. Emergency plans

5.3.1. SAFETY

Safety has come to play an important role in everyone's daily life whether they be at home, travelling or in an office or industrial unit. It has to be understood that the human life is quite precious and it should be the endeavour of one and all to create an environment where people of all walks of life go about their work without any physical or mental harm or endangering their individual lives. With the advancement of Technology, Safety has come to stay in whatever activity we are involved in our daily life.

Let us look at different aspects of safety, what they are termed as & what is meant by them.

a) **Safety:** A process of creating a situation conducive to activity and avoidance of accidents.
b) **Accident:** Accident is an unplanned, unforeseen, unexpected occurrence.
c) **Injury:** Any immediate or delayed dis-comfort or condition – physical or mental – caused or inflicted on the human system, by the activity.
d) **Hazard:** Hazard is a dangerous or potentially unsafe situation attributable to the activity.

e) **Near miss**: A potential issue / incident that may have resulted in an injury – even though the accident did not happen .

f) Safety highlights the improvement of the situation around us to make the place safe for whatever activity it is meant for. For an activity to be safe it is necessary to identify, understand the hazards associated with the activity. So we have,

1) Hazard Recognition
2) Hazard analysis
3) Hazard Control.

Hazard Recognition

Many theories and postulates have been formulated based on a research on accidents and how they had taken place. Hazard recognition exercise is based on past experiences across industry and related environment. The exercise is a formal structured procedure that analyses each & every activity / function – to identify possible situations or conditions – even if hypothetical – that may lead to unsafe conditions.

Hazard Analysis

Cause & effect analysis is carried out for each identified hazard and mitigation measures are identified for each condition. A detailed document is prepared listing the Hazards, causes and effects.

Hazard Control

Based on Hazard Analysis Document - corrective action taken as suitable to eliminate / reduce identified Hazard.

5.3.2. HAZARD ANALYSIS METHODOLOGY

Hazard analysis is classified into three heads namely:

- Assessment Measures.
- Activity Evaluation.
- Predictive models.

5.3.2.1. Assessment Measures

This is an analysis carried out based on statistical data on accidents. All occurrences are analyzed to find out the root cause. Many a time it could be repetitive and the injury also could be sustained in the hand or leg. A deeper analysis of such situations leads to finding solutions in the work place which could help in avoiding such occurrences. The common parameters in assessing the performance on accidents are:

- Frequency rate.
- Severity rate.
- Million hours of accident free operation.

Generally, efforts are made by industrial establishments to improve their overall performance by initiating steps to achieve the third parameter which definitely highlights a very conducive atmosphere on accident free performance.

5.2.2.2. Activity Evaluation

The first aspect as described above could be considered a post mortem on what has happened. The activity evaluation is a means of prevention. Some of the methods adopted are

- Safety Survey and Inspection.
- Safety Sampling.
- Safety Audits.

5.3.2.2.1 Safety Survey and Inspection

This is one of the basic methods adopted in accident prevention in the industry. The practice is to undertake periodic inspection on the safety aspects in an operating plant and identify the sources of hazards for rectification. Such a practice gradually helps in the improvement of the working conditions on the shop floor for the benefit of those employed.

5.3.2.2.2. Safety Sampling

This is a simple method of conducting a tour of different shops simultaneously to identify unsafe acts and conditions. The sampling has two definitive words for adoption namely the time for the sampling is fixed and the route is also fixed to be covered within the stipulated time.

The sampling done is reflected in chart form which also indicates the periodicity over which the sampling is done. It is the responsibility of the operating departments to ensure that the number of words come down over a period of time reflecting a drooping curve.

5.3.2.2.3 Safety Audits

This is a process of checking all types of failures conducted as an audit to elicit information on possible hazards that could occur in the event of such failures. This is an extensive exercise in analyzing each and every failure on the shop floor more specifically on machines and operating plant and machinery, to identify vulnerable words in operation which could pose a hazard. This is very much required in chemical industries to eliminate the first degree hazards which could be the cause for the second degree hazards such as explosions, implosions, fire etc.

5.3.3 PREDICTIVE MODELS

This is a concept of prevention of hazardous conditions starting from the design stage itself. Hazard identification & analysis is incorporated at the design stage itself and at every stage of revision experimentation & execution. Thus HAZOP or Hazards & Operability Analysis forms part of system at all levels.

5.3.4. HAZARD CONTROL

Classification of Hazards

1. Mechanical

The mechanical hazard includes not only the machines but also all manual operations of material handling. The principles of ergonomics are to be adopted in deciding the most comfortable positions in which the human effort is to be expended.

2. Electrical Hazard

The electrical safety is governed by the electricity rules as are inforce in the country. The design of electrical equipment, installation and operation are governed by the said rules. Strict adherence is expected from all users of electrical energy.

3. Noise

Statutory limits on the Threshold limit value (TLV) are in vogue. It is mandatory on the part of industrial establishments to adhere to the norms laid down in such cases.

4. Thermal Hazard

This arises out of the conditions in operation where heat and high temperatures are involved namely in Thermal power plants, Steel plants, Foundries etc.

5. Chemical Hazard

The chemical hazard can be classified as first degree hazard and second degree hazard. The first degree hazard consists of conditions of abnormal pressure, temperature and similar factors which could be a cause for a dangerous situation. The second degree hazards are the culmination of the first degree hazard resulting in fires, explosions, implosions etc.

6. Fire Hazard

This is a second degree hazard under chemical hazard but this is classified separately due to the importance it carries in society.

5.3.5. CONTROL MEASURES

Different kinds of hazard control measures are

1. Elimination

This is a process of completely removing a hazardous situation from the work place. Example: Introduction of bag filters or scrubbers to eliminate dust hazard.

2. Reduction

Some situations are such that it is not possible to totally eliminate the Hazard. Mitigation measures are designed to reduce the probability of occurrence or reduce the severity of the Hazard in the event of an occurrence Example 1: Reduce occurrence: Explosion risk: Additional back-up safety valves, by-pass arrangements for excess pressure

Example 2: Reduce severity: provide water showers in specified locations for eye / skin protection, in case of accidental contact

- **Isolation:** This is a method of isolating the hazard in the work place.
- Example.: belt guard: fixing a physical barrier like a screen guard, covering the belt drive, to eliminate accidental contact.
- **Lock In:** This is a method of shutting off the hazard from the work situation.
- Example: In Nuclear power plants, lead covered doors & canopy automatically engage when radiation beyond a level is detected. Radiation Hazard is contained within the system. killing of the active material Eg.: Sliding Doors provided in buildings in case of fire.

- **Lock Out:** This is an arrangement prevalent in all automatic machines used in production of goods wherein the machine will not start until and unless the shutters are brought down keeping the operator out of the machine.
- **Interlock:** The interlocking system is prevalent in all continuous operation processes wherein the equipment are started in a sequence and any tripping of one equipment brings all the related equipment to a halt.
- **Monitoring:** Monitoring systems oversee the deviations as and when such deviations occur. When there is a deviation in the established parameters a siren goes off or red light indicators start blinking giving a warning of the situation.

5.3.6. PROVIDING TRAINING AND INSTRUCTION

The organization should provide information, training and supervision to keep all people safe from any risks that might arise from the work being undertaken in the premises.

First aid

The organization must make first-aid arrangements for their workplace so workers can get immediate help if they are injured at work.

5.3.7. PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is anything used or worn by a person to minimise a risk to health or safety. If PPE is needed, then it's the responsibility of the employer or person conducting the business or undertaking to provide it.

Typical PPE s are – eye protection like – goggles, safety spectacles, foot protection like safety shoes, hand protection like appropriate gloves, head protection like hard hats and ear muffs for protection from excessive sound.

5.3.8. WORK PERMITS

Safety at the workplace includes a work permit program that categorises different types of work that are likely to be undertaken at the workplace, and specifies the appropriate PPE to be used while attempting such work. The organization must ensure that all safety requirements are strictly enforced and must accept responsibility for any lapses on the part of the workmen.

5.3.9. WORKPLACE FACILITIES

Facilities in the workplace should conform to Health & Safety requirements as specified in Factories Act, Environment Protection Act and other such Acts in force from time to time.

5.3.10. EMERGENCY PLANS

Businesses and employers must have plans in place to respond effectively to health and safety incidents and other emergencies that might occur in the workplace.

5.4. REVISION POINT

1) Safety, Hazard Analysis Methodology, Assessment Measures, Activity Evaluation, Safety Survey and Inspection, Safety Sampling, Safety Audits, Predictive Models, Hazard Control, Control Measures, Providing training and instruction, Personal protective equipment, Work permits, Emergency plans

5.5. INTEXT QUESTIONS

1) What is meant by safety?
2) What is an accident?
3) What is a “near miss”?
4) How do we improve safety – what is meant by hazard management?
5) Name a few types of hazard?
6) Name a few types of control measures to improve safety

5.6. SUMMARY

Safety has come to play an important role in everyone’s daily life whether they be at home, travelling or in an office or industrial unit. Human life is precious. It is necessary & required by law to create an environment where people can work without any physical or mental harm or endangering their individual lives. Hazard recognition, analysis & control require to applied in a scientific manner to achieve safe working conditions. With the advancement of Technology, Safety aspects require serious attention to ensure zero / low accident rates.

5.7. TERMINAL EXERCISES

1) How do we improve safety – what is meant by hazard management?
2) Name a few types of hazard?
3) Name a few types of control measures to improve safety

5.8. SUPPLEMENTARY MATERIALS

1) *http://www.labour.gc.ca/eng/health_safety/workplace/index.shtml*
2) *http://www.safetyworksmaine.gov/safe_workplace/*
3) *https://nonprofitrisk.org/tools/workplace-safety/nonprofit/c1/wkplcsafety.htm*
4) *http://www.safetyandhealthmagazine.com/articles/12470-tips-for-effective-workplace-*
5) *http://www.worksafemt.com/safety/safety-important/the-importance-of-safety/*

5.9. ASSIGNMENTS

1) Discuss Safe working practices in
   1. Construction area
   2. Engineering manufacturing unit
   3. Petro-chemical plant

5.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S.Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

5.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- Safety
- Hazard Analysis Methodology
- Assessment Measures
- Activity Evaluation
- Safety Survey and Inspection
- Safety Sampling
- Safety Audits
- Predictive Models
- Hazard Control
- Control Measures
- Providing training and instruction
- Personal protective equipment
- Work permits, Emergency plans

5.12. KEY WORDS

Safety, Hazard Analysis Methodology ,Assessment Measures ,Activity Evaluation ,Safety Survey and Inspection, Safety Sampling, Safety Audits, Predictive Models, Hazard Control, Control Measures, Providing training and instruction, Personal protective equipment, Work permits, Emergency plans.

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FEATURES OF A GOOD WORKPLACE

6.1. INTRODUCTION

In this lesson we learn about the features of a good work-place. We look at aspects influencing morale, productivity and safety.

6.2. OBJECTIVE

- To explore different aspects of a good & efficient work-place and factors that contribute to it and its direct relation to productivity.

6.3. CONTENT

6.3.1. THE FEATURES OF A GOOD WORKPLACE

A safe workplace shall have the following features

- buildings are well maintained
- Equipment are safe and work efficiently
- Reduce / eliminate defects, or take steps to protect anyone at risk
- fence or cover floor openings, when not in use
- have enough space for safe movement and access
- floors, corridors and stairs etc are free of obstructions, eg trailing cables
- have good drainage in wet processes
- All doors &windows (that require to opened) can be opened, closed or adjusted safely
- all windows and skylights are designed and constructed so that they may be cleaned safely

6.3.2. LIGHTING

Industrial research has proved that adequate lighting improves productivity. Eye strain can cause human discomfort and migraine. Prolonged work in poorly lit workplaces can lead to impairment of vision.

Lighting intensity is measured in Lumens & lux. Standards have been developed defining lighting levels (lux levels) for different types of activity.

- good light – use natural light where possible but try to avoid glare
- a good level of local lighting at workstations where necessary
- suitable forms of emergency lighting
- well-lit stairs and corridors
- well-lit outside areas – for pedestrians and to help with work activities such as loading/unloading at night

6.3.3. MOVING AROUND THE PREMISES

Ensuring safe movement is very important aspect of design of work area. People & goods require to be moved from place to place as part of production process. There is a need to demarcate separate path ways for movement. Here are a few aspects for safe movement.

- safe passage for pedestrians and vehicles – separate routes as may be necessary
- level, even floors and surfaces without holes or broken boards
- hand-rails on stairs and ramps where necessary
- safely constructed doors and gates
- floors and surfaces which are not slippery

A well designed work area with clearly demarcated movement pathways & practices can result in better productivity and reduce accidents.

6.3.4. CLEANLINESS

Cleanliness is part of human sensibility. A clean work-place improves morale and greater sense of participation. Research has shown that clean work-place ensures better quality of product and reduces rejects.

- provide clean floors and stairs, with effective drainage where necessary
- provide clean premises, furniture and fittings
- provide containers for waste materials
- remove dirt, refuse and trade waste regularly
- clear up spillages promptly
- keep internal walls or ceilings clean

6.3.5. HYGIENE AND WELFARE

These are part of statutory minimum requirements and need to be adhered to by all manufacturing units where applicable.

- clean toilets and hand basins, with running water & soap
- drinking water
- A place to rest and eat meals
- showers for dirty work or emergencies
- accommodation or hanging space for personal clothing not worn at work (and somewhere to change if special clothing is worn for work)
- rest facilities for pregnant women and nursing mothers (where applicable)

6.3.6. COMFORTABLE CONDITIONS

These are part of statutory minimum requirements and need to be adhered to by all manufacturing units where applicable.

- a reasonable working temperature within workplaces inside buildings
- local heating or cooling where a comfortable temperature cannot be maintained throughout each workroom (eg .hot and cold processes)
- good ventilation – a sufficient supply of fresh, clean air drawn from outside or a ventilation system
- Odor free safe environment
- enough workspace, including suitable workstations and seating

6.4. REVISION POINT

1) The features of a good workplace, lighting, moving around the premises, Cleanliness, hygiene and welfare, comfortable conditions

6.5. INTEXT QUESTIONS

1) What are the aspects that contribute to safe workplace?
2) Why is lighting important in a workplace?

6.6. SUMMARY

A safe work place leads to minimal accidents and best productivity. Safe workplace requires good design and implementation. Lighting, cleanliness, hygiene, pathways and comfort at work are very important in production management.

6.7. TERMINAL EXERCISES

1) How does cleanliness contribute to profitability?
2) What is the need for demarcating pathway?

6.8. SUPPLEMENTARY MATERIALS

1) http://www.worksafemt.com/safety/safety-important/the-importance-of-safety/

6.9. ASSIGNMENTS

1) Take a typical work-place
2) Class room: discuss the impact of– lighting / cleanliness / hygiene / pathways / comfortable condition – in a class room environment.

6.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

6.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day
   - The features of a good workplace
   - lighting
   - moving around the premises
   - Cleanliness, hygiene and welfare
   - comfortable conditions

6.12. KEY WORDS

The Features of a Good Workplace, Lighting, Moving around the premises, Cleanliness, Hygiene and welfare, Comfortable conditions

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LESSON - 7

PERSONNEL PROTECTION EQUIPMENT (PPE)

7.1. INTRODUCTION

Safety practices are monitored by Directorate of Health & Safety (formerly known as Inspectorate of Factories). Rules governing use of Safe practices and use of PPE are framed under Factories Act & Rules, Environment Protection Act, Indian Electricity Act & Rules etc.

In Plant & Machinery Valuation practice, visit to the plant often involves a tour of the plant to personally verify, observe the condition, O & M practices first hand. Plant will be usually in working condition and in operation. It is necessary for the Valuer to understand the safety requirements and hazards in undertaking this work. It is very important to check the quality of the PPE before wearing the same.

7.2. OBJECTIVE

- To understand need for PPE, types of PPE and their use.

7.3. CONTENT

7.3.1. Personal protective equipment

7.3.2. How to ensure proper use of personal protective equipment

7.3.3. Types of PPE you can use

7.3.1. PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause/can cause workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.

7.3.2. HOW TO ENSURE PROPER USE OF PERSONAL PROTECTIVE EQUIPMENT

All personal protective equipment should be safely designed and constructed, and should be maintained in a clean and reliable fashion. It should fit comfortably, encouraging worker use. If the personal protective equipment does not fit properly, it can make the difference between being safely covered or dangerously exposed. When engineering, work practice, and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment to their workers and ensure its proper use. Employers are also required to train each worker required to use personal protective equipment to know

- When it is necessary
- What kind is necessary
- How to properly put it on, adjust, wear and take it off
- The limitations of the equipment
- Proper care, maintenance, useful life, and disposal of the equipment

7.3.3. TYPES OF PPE YOU CAN USE

1. **Eye protection:** Hazards that may be present in the workplace can be from Chemical or metal splash, dust, projectiles, gas and vapour, radiation.

PPE s recommended can include Safety spectacles, goggles, face screens, face shields, visors.

It is necessary to make sure that eye protection chosen has the right combination of impact/dust/splash/molten metal eye protection for the task and fits the user properly

2. **Head and neck protection:** Hazards that may be present include impact from falling or flying objects, risk of head bumping, hair getting tangled in machinery, chemical drips or splash, climate or temperature. Recommended PPE are industrial safety helmets, bump caps, hairnets and firefighters' helmets.

3. **Ear protection:** Hazards are noise producing equipment. A combination of sound level and duration of exposure can cause damage to ears, even with short duration exposure. Appropriate PPE are Earplugs& earmuffs. Ear protectors should reduce noise to an acceptable level, while allowing for safety and communication

It is necessary that right hearing protectors based on the source & noise level is used. We must know how to wear them also.

4. **Hands and arms protection:** Danger to hands & arms can arise from Abrasion, temperature extremes, cuts and punctures, impact, chemicals, electric shock, radiation, vibration, biological agents and prolonged immersion in water. PEE to be used are Gloves&sleeve that covers part or all of the arm.

Hand gloves come many types & material of construction. We must use the right type of gloves for the hazard at work. For example, for electrical work, rubber gloves are used. For handling chemicals special non-corrosive gloves need to be used. For handling, iron filings & machined parts that may have burr, the correct type of tear protected-gloves should be used. e

5**. Feet and legs protection:** Hazards are -Wet, hot and cold conditions, electrostatic build-up, slipping, cuts and punctures, falling objects, heavy loads, metal and chemical splash, vehicles Solution is to wear safety boots and shoes with protective toecaps and penetration-resistant, mid-sole wellington boots.

Footwear can have a variety of sole patterns and materials to help prevent slips in different conditions, including oil - or chemical-resistant soles. It can also be anti-static, electrically conductive or thermally insulating. Appropriate footwear should be selected for the risks identified

6**. Lungs& nose – respiratory hazards:** Dust, gases and vapours, pungent odors.

This can be simple filtering face pieces. Where hazardous gases are possible, assisted respirators with oxygen cylinders may be required. It is very important to make sure it fits properly, eg for tight-fitting respirators (filtering face pieces, half and full masks)

7.4. REVISION POINT

1) PPE

7.5. INDEX QUESTIONS

1) What is meant by PPE & why is it necessary?
2) How do you ensure proper use of PPE?

7.6. SUMMARY

Personal Protective Equipment is very important aspect of work-place safety. There are different types of PPE for each portion of the human body designed for specific application. It is necessary to wear the right PPE in the right manner.

7.7. TERMINAL EXERCISES

1) Name some PPE for eye protection & where it is to be used?
2) Name some PPE for head protection & where it is to be used?

7.8. SUPPLEMENTARY MATERIALS

1) https://en.wikipedia.org/wiki/Personal_protective_equipment
2) http://www.hse.gov.uk/toolbox/ppe.htm

3) http://www.hse.gov.uk/pubns/indg174.pdf

4) https://www.osha.gov/Publications/osha3151.html

7.9. ASSIGNMENTS

1) Name a PPE for

a. Hand protection - discuss its use, how it is to be checked and what are the hazards if they are not properly worn.

b. Head protection - discuss its use, how it is to be checked and what are the hazards if they are not properly worn.

7.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

7.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day
2) Personal Protective Equipment

7.12. KEY WORD

Personal Protective Equipment (PPE)

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LESSON - 8

PRODUCTIVITY & PRODUCTIVITY MEASUREMENT

8.1. INTRODUCTION

Productivity determines profitability and viability of a manufacturing unit. Metrics have been developed for measuring productivity. Productivity is the result of a combination of factors. In this lesson we study the factors & metrics for productivity.

8.2. OBJECTIVE

- To understand what is meant by productivity, metrics for measurement and factors influencing productivity.
- The purpose of manufacturing is to produce goods & services economically to meet market requirement.

8.3. CONTENT

8.3.1. PRODUCTION AND PRODUCTIVITY

Production and Productivity are two distinct aspects of a manufacturing process. These are parameters to measure the performance of a manufacturing facility.

8.3.1.1. Production

Production refers to the quantum of output in a manufacturing facility. The measurement of the quantum varies from industry to industry. The units of measurement can be listed as follows

8.3.1.2. Productivity

Expressing the quantum of production alone does not reflect efficiencies involved in production. Production involves various costs like - raw materials,labour, maintenance, energy, finance and other inputs for achieving production. Therefore, we need to compare the output as against the inputs that have gone into the production.

This is called productivity. Productivity is defined as a ratio between output volume and volume of inputs. In other words, it measures how efficiently production inputs, such as raw material, energy, labour and capital, are used in a manufacturing unit, to produce a given level of output.

Productivity is a key to growth and competitiveness. It allows analysts to determine & compare capacity utilization & efficiency of use of resources. There are different measures of productivity and the choice between them depends either on the purpose of the productivity measurement and/or data availability

8.3.2. PRODUCTIVITY MEASUREMENT

Productivity is usually measured in numbers as a ratio. Quantity produced per in unit of time, finished product / raw material, energy consumed / product, quantity produced / employee etc.

These are usually called KPI (key performance indicator). Even though many manufacturing processes are diverse with different types of materials – most organizations use similar Key Performance Indicators (KPIs) to assess, analyze and track manufacturing processes.

Everyone can benefit by monitoring & employing continuous improvement initiatives.

8.3.3. WHAT ARE KEY PERFORMANCE INDICATORS (KPIS)

KPIs are assorted variables that organizations use to assess, analyze and track manufacturing processes. These performance measurements are commonly used to evaluate success in relation to goals and objectives.

8.3.4. SOME COMMON KPIS USED IN MANUFACTURING

1. **Quantity produced**: number of pieces, weight, volume per shift / day / month / employee

An essential factory floor metric relates to the amount of product produced. This is a measure of the quantity of saleable goods produced.

2. **Quality:** Production processes produce rejects / scrap - which is measured in terms of reject ratio. Minimizing rejection / scrap helps improve reliability & profitability. So it is important to monitor rejects / scrap.

3. **Ratings & rate of production:** Machines and processes are designed to produce optimally at specified rates. Very often in actual practice, goods are produced at variable rates. Lower rate of production can be due to different reasons. When it is not market driven and is caused by equipment limitation, it typically results in lower profitability. Hence it is important to monitor rate of production.

4. **Target:** Many organizations display target values for output, rate and quality. This KPI helps motivate employees to meet specific performance targets.

5. **Cycle time / process time:** This refers to the time lag from start of initial process to final finished product moving into storage / dispatch. This determines the speed of response and in-process inventory. Monitoring of this parameter helps in optimizing production costs.

6. **Equipment Effectiveness:** This parameter is a measure of efficiency & productivity of individual equipment that participate in the process of manufacture. Optimizing this parameter on a system basis results in the best of use of equipment, thus optimizing cost of production.

7. **Downtime:** Whether the result of a breakdown or simply a machine changeover, downtime is considered one of the most important KPI metrics to track. An useful metric is MTBF, mean time between failures. It should the constant endeavor of all manufacturing systems to increase MTBF and preferably synchronize the timing with overall Plant scheduled shut down time.

8.3.5. DRIVING PRODUCTIVITY

Managing productivity and profitability is a key role of plant managers and engineers in world-class manufacturing operations. The amount of increased productivity and profit an organization stands to gain depends quite largely on the company and its existing processes.

Management has to coordinate in the proper use of these materials for obtaining the required output. Therefore, management plays an important role in the combination of all the rest of the inputs to obtain the required output.

It has been found from various studies that the labour productivity determines the overall productivity of the manufacturing facility because it is the workers who put the various inputs to use and convert them into output.

Even in fully automated systems of manufacture the man behind the machine plays a key role towards productivity. Thus it would be prudent to understand the factors affecting labour productivity as detailed below:

1) Training.
2) Commitment.
3) Discipline.
4) Absenteeism.
5) Morale.
6) Labour relations.
7) Safety

It is the responsibility of the management and the shop floor supervisors to strive to eliminate the factors hindering productivity to create an atmosphere of cohesiveness and team work to achieve the desired results to improve productivity. Some of the motivators for higher productivity are as given below:

1. Better understanding
2. Good relationship.
3 Care for the individual.
4. Free communication and information sharing.
5. Higher participation.
6. Job enrichment.
7. Incentives – monetary and non-monetary.
8. Encouraging feedback/suggestions and whole hearted participation.

There are various techniques for improving productivity. Some of the important techniques are as given below

1) Work Study.
2) Value Engineering.
3) Cost reduction.
4) Waste reduction
5) Inventory management
6) Production Planning and Control.

8.4. REVISION POINT

1) Production and Productivity, Production, Productivity, Productivity Measurement, Key Performance Indicators (Kpis), Driving Productivity

8.5. INTEXT QUESTIONS

1) Why do we need to measure productivity?
2) What is the difference between production & productivity?
3) Name some methods of improving productivity.

8.6. SUMMARY

Productivity determines profitability and viability of a manufacturing unit. Productivity is the result of a combination of factors. Metrics like KPI are used to measure productivity. Different KPI s are discussed. Methods to improve productivity are discussed.

8.7. TERMINAL EXERCISES

1) What is the difference between production & productivity?
2) Name some methods of improving productivity.

8.8. SUPPLEMENTARY MATERIALS

1) https://www.oecd.org/std/productivity-stats/2352458.pdf
2) http://www.pc.gov.au/news-media/pc-news/pc-news-may-2015/productivity-and-how-measured
3) https://hbr.org/1988/01/no-nonsense-guide-to-measuring-productivity
4) https://en.wikipedia.org/wiki/Productivity
5) https://www.spring.gov.sg/resources/documents/guidebook_productivity_measurement.pdf
6) http://www.referenceforbusiness.com/management/Pr-Sa/Productivity-Concepts-and-Measures.html

8.9. ASSIGNMENTS

1) Take the case of an Automobile ancillary plant.
2) Discuss production aspects and productivity aspects based on parameters:
   a. Value addition
   b. Quantity produced
   c. Number of employees

8.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.

2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

8.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- Production and Productivity,
- Production, Productivity,
- Productivity Measurement,
- Key Performance Indicators (Kpis)
- Driving Productivity

8.12. KEY WORDS

Production and Productivity, Production, Productivity, Productivity measurement, Key Performance Indicators (KPIs), Driving Productivity

LESSON - 9

INSTRUMENTATION, CONTROL & MEASUREMENT

9.1. INTRODUCTION

Production process & machinery are controlled by actuators, feedback systems and measuring devices. Feedback loops can be open or closed. Multiple parameters may need to be monitored and managed. Degree of automation may be different. Systems that measure, manage & control production equipment comprise Instrumentation, Control & Measurement. In this lesson we learn the fundamentals of Instrumentation, control and some basic measurement devices.

9.2. OBJECTIVE

- To familiarize students with fundamentals of Instrumentation, control & measuring instruments.

9.3. CONTENT

9.3.1. Instrumentation &Control
9.3.2. Types of automation
9.3.3. Measurement
9.3.4. Purpose of Instruments
9.3.5. Types of Instruments
9.3.5.1. Digital Instruments
9.3.5.2. Advantages of the digital instruments
9.3.5.3. Disadvantages of digital instruments.
9.3.5.4. Instruments used in Electrical power distribution
9.3.5.5. Mechanical Energy measurement
9.3.6. Process Automation
9.3.7. Types of Automation Systems
9.3.7.1. Fixed Automation
9.3.7.2. Programmable Automation
9.3.7.3. Flexible Automation
9.3.7.4. Integrated Automation

9.3.1. INSTRUMENTATION &CONTROL

Purpose of instrumentation: From Wikipedia, the free encyclopedia Instrumentation is defined as the art and science of measurement and control of process variables within a production or manufacturing area.The process variables used in industries are Level, Pressure, Temperature, Humidity, Flow, pH, Force, Speed etc. Typical instruments are valves, levers, actuators etc. These are used to govern the operating characteristic like speed, flow, pressure or temperature of a given process.

Control systems use sensors to measure the output performance of the device being controlled and those measurements are used to give feedback to instruments that can make corrections toward desired performance. When a device is designed to

perform without the need of human inputs for correction it is called automatic control.

Management of data from multiple sources – real time monitoring & control. Real-time data monitoring (RTDM) is a process through which the equipment or process can reviewed / modified from a remote control location. This is usually done with use of data & software. It enables managers to view & manage the overall processes and functions performed by the system in real time Numerical control / automation / DCS based management

Courtesy Wikipedia:

9.3.2. TYPES OF AUTOMATION

1. Discrete control (on/off)

One of the simplest types of control is on-off control. An example is the thermostats used on household appliances. Electromechanical thermostats used in HVAC may only have provision for on/off control of heating or cooling systems. Electronic controllers may add multiple stages of heating and variable fan speed control.

2. Sequence control,

In which a programmed sequence of discrete operations is performed, often based on system logic that involves system states. An elevator control system is an example of sequence control.

3. Continuous control

The advanced type of automation that revolutionized manufacturing, aircraft, communications and other industries, is feedback control, which is usually continuous and involves taking measurements using a sensor and making calculated adjustments to keep the measured variable within a set range.

4. Open and closed loop

All the elements constituting the measurement and control of a single variable are called a control loop. Control that uses a measured signal, feeds the signal back and compares it to a set point, calculates and sends a return signal to make a correction, is called closed loop control. If the controller does not incorporate feedback to make a correction, then it is open loop.

Loop control is normally accomplished with a controller. Sequential control may be either to a fixed sequence or to a logical one that will perform different actions depending on various system states. An example of an adjustable but otherwise fixed sequence is a timer on a lawn sprinkler.

5. States

Refer to the various conditions that can occur in a use or sequence scenario of the system. An example is an elevator, which uses logic based on the system state to perform certain actions in response to its state and operator input. For example, if the operator presses the floor n button, the system will respond depending on whether the elevator is stopped or moving, going up or down, or if the door is open or closed, and other conditions.

An early development of sequential control was relay logic, by which electrical relays engage electrical contacts which either start or interrupt power to a device. Relays were first used in telegraph networks before being developed for controlling other devices, such as when starting and stopping industrial-sized electric motors or opening and closing solenoid valves. Using relays for control purposes allowed event-driven control, where actions could be triggered out of sequence, in response to external events. These were more flexible in their response than the rigid single-sequence cam timers. More complicated examples involved maintaining safe sequences for devices such as swing bridge controls, where a lock bolt needed to be disengaged before the bridge could be moved, and the lock bolt could not be released until the safety gates had already been closed.

The total number of relays, cam timers and drum sequencers can number into the hundreds or even thousands in some factories. Early programming techniques and languages were needed to make such systems manageable, one of the first being ladder logic, where diagrams of the interconnected relays resembled the rungs of a ladder. Special computers called programmable logic controllers were later designed to replace these collections of hardware with a single, more easily re-programmed unit.

In a typical hard wired motor start and stop circuit (called a control circuit) a motor is started by pushing a "Start" or "Run" button that activates a pair of electrical relays. The "lock-in" relay locks in contacts that keep the control circuit energized when the push button is released. (The start button is a normally open contact and the stop button is normally closed contact) Another relay energizes a switch that powers the device that throws the motor starter switch (three sets of contacts for three phase industrial power) in the main power circuit. Large motors use high voltage and experience high in-rush current, making speed important in making and breaking contact. This can be dangerous for personnel and property with manual switches. The "lock in" contacts in the start circuit and the main power contacts for the motor are held engaged by their respective electromagnets until a "stop" or "off" button is pressed, which de-energizes the lock in relay.

Commonly interlocks are added to a control circuit. Suppose that the motor in the example is powering machinery that has a critical need for lubrication. In this case an interlock could be added to insure that the oil pump is running before the motor starts. Timers, limit switches and electric eyes are other common elements in control circuits.

Solenoid valves are widely used on compressed air or hydraulic fluid for powering actuators on mechanical components. While motors are used to supply continuous rotary motion, actuators are typically a better choice for intermittently creating a limited range of movement for a mechanical component, such as moving various mechanical arms, opening or closing valves, raising heavy press rolls, applying pressure to presses.

6. Computer control

Computers can perform both sequential control and feedback control, and typically a single computer will do both in an industrial application. Programmable logic controllers (PLCs) are a type of special purpose microprocessor that replaced many hardware components such as timers and drum sequencers used in relay logic type systems. General purpose process control computers have increasingly replaced stand-alone controllers, with a single computer able to perform the operations of hundreds of controllers. Process control computers can process data from a network of PLCs, instruments and controllers in order to implement typical (such as PID) control of many individual variables or, in some cases, to implement complex control algorithms using multiple inputs and mathematical manipulations. They can also analyze data and create real time graphical displays for operators and run reports for operators, engineers and management.

9.3.3. MEASUREMENT

Courtesy Wikipedia, the free encyclopedia

Measurement is the assignment of a number to a characteristic of an object or event, which can be compared with other objects or events. The scope and application of a measurement is dependent on the context and discipline. In the natural sciences and engineering, measurements do not apply to nominal properties of objects or events, which is consistent with the guidelines of the International vocabulary of metrology published by the International Bureau of Weights and Measures. However, in other fields such as statistics as well as the social and behavioral sciences, measurements can have multiple levels, which would include nominal, ordinal, interval, and ratio scales.

Measurement is a cornerstone of trade, science, technology, and quantitative research in many disciplines. Historically, many measurement systems existed. Since the 18th century, developments progressed towards unifying, widely accepted standards that resulted in the modern International System of Units (SI). This system reduces all physical measurements to a mathematical combination of seven base units. The science of measurement is pursued in the field of metrology.

Basic units of measurement in the SI system:

Base quantity	*Base unit*	*Symbol*
time	second	*s*
length	metre	*m*
mass	kilogram	*kg*
electric current	Ampere	*A*
temperature	Kelvin	*K*
Amount of substance	mole	*mol*
luminous intensity	candela	*cd*

All other units of measurement are derived units. For example:

a) Speed = meters per second
b) Area = length x width = sq.M
c) Volume = length x width x height = cubic meter

d) Pressure = kg / area (sq.m)

e) Volts (electrical) = $kgm^2/s^3/A$

f) Power = Current x volts

Common Electrical Measurements

Quantity	*Measurement*	*Symbol*	*Instrument*
Current	current	*A*	Ammeter
Voltage	volts	*V*	Voltmeter
Power	watts	*W*	Power meter
Energy	unit	*kWh*	Energy meter
Vector difference between current & voltage (AC)	Cos phi	*PF*	PF meter

Common Industry Manufacturing Measurements

quantity	*units*	*Instrument*
Power consumption Energy	KWh & Demand	Energy meter/Trivector meter
Pressure (bar / atmosphere / water level / mercury)	Pascal - Kg/sq.cm	Pressure gage
Weight (mass)	Kg / grams / Tons	Weighing Balance / scale
Liquid flow	CuM/sec or CuM/hr	Flowmeter
Gas flow (at normal temperature & pressure)	NM3/hr	Flow meter
Solids flow	Kg / hour or Tons / day	Weighing Balance / scale
Temperature	Degree Celsius	Thermometer

9.3.4. PURPOSE OF INSTRUMENTS

Measuring Instruments are devices used for measurement of certain physical quantity or parameter. We use measuring instruments in everyday life to measure parameters like length, weight, temperature, pressure, current, voltage etc.

9.3.5. TYPES OF INSTRUMENTS

There are two main types of the measuring instruments: analog and digital. Analog instruments indicate the magnitude by means of a pointer or needle mounted on a dial. Dial is calibrated in units of the parameter to be measured. Position of the needle corresponds to the reading. Needle position needs to be read by human eye and is subject to error.

Analog instruments utilize some intrinsic property (chemical or physical) of a component or material or a specific combination of materials. The chosen property should linearly respond to the measured parameter.

Examples;

a) Temperature: Mercury in glass: here the expansion of mercury up the tube is dependent on temperature. This property is used to mark the tube in deg C. In the case of K type thermocouple –chomel/alumel bimetal junction develops a

voltage (thermic junction) that is proportional to temperature. This voltage is measured & calibrated in deg C.

b) Electric Current: Moving iron meters (MI): Here the magnetic field generated by current deflects a moving iron coil and this deflection is an indication ofcurrent.

c) Pressure: Bourdon gage: The property of a curved tube to straighten when under pressure is used to measure pressure. Deflection of the tube is proportional to pressure.

d) Flow: Liquid: Turbine wheel meters: Liquid flow thru the meter makes the wheel rotate and rotational speed is proportional to the flow.

e) Flow: Gas: Orifice plate type: The pressure drop across the orifice increases when the rate of flow increases. When there is no flow there is no differential. The differential pressure is proportional to the square of the velocity. Hence if all other factors remain constant, then the differential is proportional to the square of the rate of flow. Here the differential pressure across the orifice is calibrated with flow to indicate fluid flow.

9.3.5.1. Digital Instruments

Digital instruments usually consist of 3 parts. Sensor, transducer & display unit. The sensor can have a basic unit similar to that used in Analog instruments. However the similarity ends here. For example, digital instrument may also use a orifice plate or a current transformer or K type thermocouple. Property of the sensor is then converted to a analog signal – 5 to 20 mA or 1 to 7 Volts. This signal is then processed as a binary digital and is displayed.Digital measuring instruments display values numbers, that can be easily read, without any human error while reading.

9.3.5.2. Advantages of the Digital Instruments

1) They are very easy to read.
2) Since there are fewer moving parts in the electronic instruments, they are usually more accurate than the analogue instruments.
3) Technological progress has made electronic products & software cheaper, better & more versatile over the years. Digital instruments can be more accurate, have diagnostic features and can be easily adapted for feedback circuits.
4) The data from the instruments can be recorded for future reference.
5) The output of the digital devices can be obtained in the computer

There are also come disadvantages of the digital instruments.

9.3.5.3. Disadvantages of digital instruments.

1) They are sensitive to temperature & dust. They can show erratic values when affected by moisture / heat or dust.
2) Any error in the sensor or the transducer results in wrong indication. Increasingly self-diagnostic features are built into digital instruments to validate/ monitor these issues.

Typical instruments for measurement of power, flow, pressure, temperature – types analog / digital – real time – intermittent – spontaneous.

Measuring instruments can be mechanical deflection type or electronic type. Electronic instruments can be simple analog instruments or software driven

numerical control digital instruments. Present trend is towards increasing digital instrumentation with communication facilities.

9.3.5.4. Instruments used in Electrical power distribution

Typical instruments used are Ammeters for measurement of current, Voltmeter for measurement of voltage, KW, KVA & KVAR meters for measurement of power, PF meter for measurement of power factor, Trivector& KWh meters for measurement of energy consumed etc. These instruments can be mechanical or electronic or numerical type with communication facility.

9.3.5.5. Mechanical Energy measurement

Pressure gages are expensively used for indicating operating pressure of air, gases, steam & liquids. Flow meters are used for measurement of flow of liquids and gases. Flow meters can be differential pressure type, turbine type or by using Doppler effect.

1. Temperature measurement

The most common type of temperature measurement is by use of thermocouples.

2. Measuring instruments used as the controllers

Often measuring instruments perform additional functions in addition to display. This is especially true for digital instruments. They can be used to set bands for safe / optimal operation, set alarms, for logic controls in multi-parameter systems and so on. For instance, when a certain value of the pressure is reached, the measuring instrument can break the electrical circuit, which can stop a motor or drive operating a pump / compressor / fan etc.

3) Digital instruments can be easily adapted for recording the data on real time basis. They can have independent on board storage or communicate with a Computer program.

4) Transmitting the data

Measuring instruments can be used for remote monitoring. Only the sensorunit needs to be located near the measurement point. Transducer and processor canbe conveniently located. This feature is very critical in many hazardous locations

5) Software programmable solutions

Since the data can be fed on real time basis to computers, it is possible to monitor simultaneously hundreds of parameters, make complex calculations with software and offer program based operating solutions. With Distributed Digital Computerized Control Systems (DCS or DDCS), entire process plant operations can be monitored & controlled from a remote place of choice.

9.3.6. PROCESS AUTOMATION

Industries today face multiple challenges imposed on it by forces from not only, within the factory environment but also from volatile state of the domestic & global economy. Demands on process control system have gone beyond simple operation dependent & regulatory functions. Today Process Automation is a tool to manage the

plant, decrease energy consumption, reduce costs, cut emissions and provide quick and precise information from the field to support production and business decisions.

Process Automation is different from Information Technology. Process Automation may use IT, but is more than that. Industrial information systems are generally reactive – they are expected to react to certain set of events / parameters in a specified manner that results in an acceptable course correction.

Most of industrial information systems have to be real-time – collection processing & reaction has to be on real time basis. System has to respond within stipulated time period based on information available (even if inadequate). Hence systems have to be designed with stated explicit considerations of meeting computing time deadlines.

Many industrial information systems are critical – any malfunction can lead to shut down or sometimes can cause even catastrophic consequences in terms of loss of life and/or property. Redundancy & default decisions need to be built into the design, to take care of unforeseen circumstances. Extraordinary care must be exercised during their design.

9.3.7. TYPES OF AUTOMATION SYSTEMS

Automation systems can be categorized based on the flexibility and level of integration in manufacturing process operations. Various automation systems can be classified as follows

9.3.7.1. Fixed Automation

This type is used for high volume production with dedicated equipment, which has a fixed set of operations specifically designed for a given series of parts / components / product. Continuous flow and Discrete Mass Production systems use this automation. e.g. Distillation Process, Conveyors, Paint Shops, Transfer lines etc.

A process using mechanized machinery to perform fixed and repetitive operations in order to produce a high volume of similar parts.

9.3.7.2. Programmable Automation

This set up has variable sequence of operation and configuration of the machines using electronic controls. Some discrete programming may be needed to reprogram individual machines or sequence of operations.

This method is used where the basic product / production line is relatively stable on medium term basis. Investment on programmable equipment is less, as production process is not changed frequently. It is typically used in Batch process where job variety is low and product volume is medium to high, and sometimes in mass production also. e.g. in Steel Rolling Mills, Paper Mills etc.

9.3.7.3. Flexible Automation

It is used in Flexible Manufacturing Systems (FMS) which is invariably computer controlled. Human operators give high-level commands in the form of codes entered into computer identifying product and its location in the sequence and the lower level changes are done automatically. Each production machine receives

settings/instructions from computer. These automatically loads/unloads required tools and carries out their processing instructions. After processing, products are automatically transferred to next machine. It is typically used in job shops and batch processes where product varieties are high and job volumes are medium to low. Such systems typically use Multi-purpose CNC machines, Automated Guided Vehicles (AGV) etc.

9.3.7.4. Integrated Automation

This process denotes complete automation of a manufacturing plant, with all processes functioning under computer control and under coordination through digital information processing. It includes technologies such as computer-aided design and manufacturing, computer-aided process planning, computer numerical control machine tools, flexible machining systems, automated storage and retrieval systems, automated material handling systems such as robots and automated cranes and conveyors, computerized scheduling and production control. It may also integrate a business system through a common database.

This process integrates demand management, supply chain & production systems. They manage process and management actions using information and communication technologies.

9.4. REVISION POINTS

1) Instrumentation &Control
2) Automation, Measurement
3) Purpose of Instruments, Digital Instruments, Electrical power distribution
4) Mechanical Energy measurement
5) Process Automation
6) Fixed Automation
7) Programmable Automation
8) Flexible Automation
9) Integrated Automation

9.5. INTEXT QUESTIONS

1) What is instrumentation?
2) What is control system?
3) What are measuring instruments?

9.6. SUMMARY

Production process & machinery are controlled by actuators, feedback systems and measuring devices. Systems that measure, manage & control production equipment comprise Instrumentation, Control & Measurement. Feedback loops can be open or closed. Multiple parameters may need to be monitored and managed. Degree of automation may be different.

Control loops can be mechanical, electrical or electronic. Digital computer based control systems are very common.

Measuring instruments display a control parameter. There are various types of measuring instruments based on technology and purpose. They can be broadly classified as mechanical or electronic.

Increasingly computer based systems offer, control & display and are software based.

9.7. TERMINAL EXERCISES

1) What is the difference between open loop & closed loop control?
2) What is the difference between analog & digital control?
3) Give an example of process automation

9.8. SUPPLEMENTARY MATERIALS

1) http://www.electrical4u.com/electrical-measuring-instruments-types-accuracy-precision-resolution-speed/
2) http://www.industrial-needs.com/measuring-instruments.htm
3) https://en.wikipedia.org/wiki/Measuring_instrument
4) http://www.surecontrols.com/why-calibration-of-your-measuring-instruments-is-important/
5) management of data from multiple sources
6) https://en.wikipedia.org/wiki/Data_integration

9.9. ASSIGNMENTS

1) Discuss instrumentation control & measuring systems in a modern automobile

9.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

9.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day
2) Instrumentation & Control, automation, Measurement, Purpose of Instruments, Digital Instruments, Electrical power distribution, Mechanical Energy measurement, Process Automation, Fixed Automation, Programmable Automation, Flexible Automation, Integrated Automation

9.12. KEY WORDS

Instrumentation &Control, automation, Measurement, Purpose of Instruments, Digital Instruments, Electrical power distribution, Mechanical Energy measurement, Process Automation, Fixed Automation, Programmable Automation, Flexible Automation, Integrated Automation

LESSON - 10

TYPES OF ORGANIZATIONS

10.1. INTRODUCTION

An organization is an entity – comprising people & physical assets that is structured and managed to meet a need or to pursue collective goals. Objective of the organization can be to provide service or produce goods or distribute goods. Organization can be for profit or not-for-profit. Organizations can also be classified based on their structure & ownership pattern .In this lesson we look at some basic forms of organizations.

10.2. OBJECTIVE

- To familiarize the student with different types of organizations based on objective of profit / not for profit and different types of for profit organizations based on type of value addition.

10.3. CONTENT

10.3.1. Organization

10.3.1.1. For-Profit (Business) Organizations

10.3.1.2. Not-For-Profit Organizations

10.3.2. Ownership

10.3.1. ORGANIZATION

An organization is an entity - comprising people & physical assets that is structured and managed to meet a need or to pursue collective goals. Objective of the organization and the results expected should be clearly defined and understood by all concerned. Hence all organizations must have a structure that determines relationships between activities and members. Roles & responsibilities must be clearly defined.

Organizations influence the society in which they operate and similarly Society influences the aspects of function of the organization. This symbiotic relationship defines the operation & constraints of an organization. In this lesson we look at various types of organizations. An Organization could be For Profit or not for Profit.

10.3.1.1. For-Profit (Business) Organizations

Primary objective of a for-profit organization is to generate a profit (surplus), that is, to make more money than it spends. Owners can decide to retain entire surplus for reinvestment in the business or apportion surplus towards cash benefits for owners or employees in any manner.

A For-Profit Organization does not have any obligation to society except to meet rules of the land. Any direct activity towards benefits to Society is at the discretion of the owners.

10.3.1.2. Not-For-Profit Organizations

Nonprofit Organizations are formed to provide a specific set of services to the community. Hence the objective of a Not-for-Profit organization is to provide a "Service" to Society, in the manner & methods compatible to its objective.

The term "Not for Profit" needs to be understood clearly. A "Not for Profit" organization is one that expressly forbids the distribution of profits or Surplus to owners. Hence there is no restriction on running a "not for profit" organization in a profitable manner (create surplus).

However, there are restrictions on how the amount of surplus can be spent or invested. Usually Society considers "not for profit" organizations as benevolent and Government extends tax & other concessions to encourage their activity and reach.

For Profit Organizations can be divided into 3 categories, by their activity. They are organization that primarily offer:

a. Manufacturing of products
b. Trading of products
c. providing specialized/skilled services that are needed by Society or business.

a. Manufacturing Business

A manufacturing business produces a new product different from the product that it purchases. Value addition as perceived by Government / Society takes place. Value addition provides the source of income and generates profit. Investment, employment and all related issues in manufacturing business arise from the process of value addition.

For a manufacturing business to generate profit & sustain itself, there are many variables – availability of raw materials, infrastructure, technology, skilled labor– all at an economical rate, and access to market where the product manufactured, can be exchanged for cash.

b. Trading Business

In trading the value addition is by making goods available at the right place & time. There is no change in the product handled. What is purchased is what is sold. Essentially they are "buy and sell" businesses.

Examples are: grocery stores, convenience stores, distributors, and other resellers.

c. Service Business

A service organization provides services to meet the needs of the market. Value addition is by empowerment / transfer of knowledge / improvement in status. The service organization may use many equipment in the process of rendering the service.

However, the primary output of the organization is service. Service provided can cover a wide range - service to individuals in the sphere of – education, health, beauty,home improvement, travel, leisure, entertainment etc. Services can be provided to organizations – consultancy, design, inspection, training, etc

Examples of service businesses are: schools, repair shops, hair salons, banks, accounting firms, Engineering design & consultancy, Valuation practice, health-care, hospitality, legal practice etc.

10.3.2. OWNERSHIP

Organizations can be classified base on ownership – Privately owned or Government owned. Private organizations can be further classified as Proprietary, partnership, Private Limited, and Public Limited Companies. Government organizations can be Govt. departments, quasi-government organizations or Government Owned / controlled Companies.

A proprietary organization is the simplest form of business. A Public Limited Company with its shares listed in a stock exchange is the most complicated form of Organization.

10.4. REVISION POINTS

1) Organization
2) For-Profit (Business) Organizations
3) Not-For-Profit Organizations
4) Ownership

10.5. INTEXT QUESTIONS

1) What is a not-for-profit organization?
2) What is the objective of a business organization?
3) What is a service organization?
4) How does a manufacturing organization differ from a trading organization?

10.6. SUMMARY

An organization is an entity – comprising people & physical assets that is structured and managed to meet a need or to pursue collective goals. Organization can be for profit or not-for-profit. All businesses are for-profit organizations. Business of the organization can be to provide service or produce goods or distribute goods. Organizations can also be classified based on their structure & ownership pattern.

10.7. TERMINAL EXERCISES

1) What is a service organization?
2) How does a manufacturing organization differ from a trading organization?

10.8. SUPPLEMENTARY MATERIALS

1) https://www.boundless.com/business/textbooks/boundless-business-textbook/small-business-and-entrepreneurship-7/starting-a-small-business-58/types-of-ownership-280-7209/
2) https://www.boundless.com/business/textbooks/boundless-business-textbook/types-of-business-ownership-6/

10.9. ASSIGNMENTS

1) Discuss the objective, structure & nature of an educational organization.
2) Discuss the nature of a Hospital Organization?

10.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.

3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

10.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day
2) Organization, For-Profit (Business) Organizations, Not-For-Profit Organizations, Ownership

10.12. KEY WORDS

Organization, For-Profit (Business) Organizations, Not-For-Profit Organizations, Ownership

LESSON - 11

ORGANIZATION – OWNERSHIP MODELS

11.1. INTRODUCTION

Industrial & Commercial Organizations can be classified based on ownership & liability as: Sole Proprietorship, Partnership and Limited Liability Companies. Limited Liability Companies are further classified as Private Limited Companies, closely held Public Limited Companies & listed Public Limited Companies whose shares are traded in a Stock Exchange. In this lesson we look at some basic features of Organizations based on ownership pattern.

11.2. OBJECTIVE

- To understand different types of business ownership patterns and their features. In Plant & Machinery Valuation we shall come across many different types of companies. A basic understanding of ownership pattern helps in establishing the role & responsibility of individuals we meet as part of valuation.

11.3. CONTENT

11.3.1 ORGANIZATION – OWNERSHIP MODELS

A business organization can be classified based on ownership as:

- Proprietary
- Partnership
- Private Limited Company
- Public Limited Company (Listed & unlisted)

All types of organizations have to comply with statutory requirements for conduct of business, like registration with State & Central Taxes (VAT, Service Tax, Excise Duty), Labor Welfare Acts like Factories Act, Shops & establishments Act, Provident Fund Act and ESI Act & Social Welfare Acts like Environment Protection Act, have to be adhered to. All activities of Industrial & Commercial Organizations must conform to Zoning regulations regarding land use. Buildings must conform to Metropolitan Development Authority / Directorate of Town & Country planning rules & regulations.

11.3.2. PROPRIETARY FIRM

A proprietary business is one where one individual owns all the assets & liabilities of the company for purposes of accountability, liability & taxation. All decisions are taken in the name of the individual. Generally Proprietary concerns tend to be small with low capitalization. They tend to be in sectors that are

unorganized or poorly organized. Growth prospects are constrained. Usually these tend to be either first generation ventures or family businesses handed over from one generation to the next.

The sole proprietorship is a business owned by a single individual. For tax and legal liability purpose, the owner and the business are one and the same. The proprietorship is not taxed as separate entity. Earnings of the business are taxed at the individual level.For liability purposes, the individual and the business are also one and the same. Thus, legal claimants can pursue the personal property of the proprietor and not simply the assets used in the business.

Advantages of a Sole Proprietorship

Perhaps the greatest advantage of this form of business is its simplicity and low cost. You are not required to file with the government, nor are any legal charter required. The sole proprietorship form of business has other advantages:

- The owner or proprietor is in complete control of business decisions.
- The income generated through operations can be directed into the proprietor's pocket or reinvested as he or she sees fit.
- Profits flow directly to the proprietor's personal tax return; they are not subject to a second level of taxation. In others words, profits from the business will not be taxed at the business level.
- The business can be dissolved as easily and informally as it was begun.

Disadvantages of the Sole Proprietorship:

- The amount of capital available to the business is limited to the owner's personal funds and whatever funds can be borrowed. This disadvantages limits the potential size of the business, no matter how attractive or popular its product or service
- Sole proprietors have unlimited liability for all debts and legal judgments incurred in the course of business. Thus, a product liability lawsuit by a customer will not be made against the business but rather against the owner.
- The business may not be able to attract high-caliber employees whose goals include a share of business ownership. Sharing the benefits of ownership, other than simple profit-sharing, would require a change in the legal form of the business.
- Some employee benefits, such as owner's life, disability, and medical insurance premiums, may not be deductible, or may be only partially deductible from taxable income.
- The entity has a limited life; it exists only as long as the owner is alive. Upon the owner's death, the assets of the business go to his or her estate.

11.3.3. PARTNERSHIP FIRMS

Partnership Firms evolved from proprietorship firms. Expansion in business requires more capital and managerial skills and also involves more risk. This calls for more persons to come together, with different skill sets and start / do business together. When these persons come together, pool their capital and skills and organize a business, it is called **Partnership**. A partnership by definition recognizes

the value of teamwork. In general Partnerships have good growth potential. They tend to be converted to Limited Liability companies over time.

Definitions on partnership:

The Indian Partnership Act, 1932, Section 4, defines partnership as "the relation between persons who have agreed to share the profits of business carried on by all or any of them acting for all". The Uniform Partnership Act of the USA defined a partnership "as an association of two or more persons to carry on as co-owners a business for profit".

According to J. L. Hanson, "a partnership is a form of business organization in which two or more persons up to a maximum of twenty join together to undertake some form of business activity". So a partnership is an "association of two or more persons" who have agreed to share the profits of a business which they run together. This business may be carried on by all or some or anyone of them acting for all.

The persons who own the partnership business are individually called 'partners' and collectively they are called as 'Firm' or 'Partnership Firm'. The name underwhich partnership business is carried on is called 'Firm Name'.

Partnership Firm Features:

1. **More Persons**: As against proprietorship, there should be at least two persons subject to a maximum of ten persons for banking business and twenty for non-banking business to form a partnership firm.

2. **Profit and Loss Sharing:** There has to be an agreement among the partners to share the profits earned and losses incurred in partnership business, in a pre-agreed manner. When no basis for sharing of profit/loss is stated, all partners shall be deemed as equal partners for this purpose.

3. **Contractual Relationship**: Partnership is formed by an agreement-oral or written-among the partners.

4. **Existence of Lawful Business**: Partnership is formed to carry on some lawful business and share its profits or losses. If the purpose is to carry some charitable works, for example, it is not regarded as partnership.

5. **Utmost Good Faith and Honesty**: A partnership business solely rests on utmost good faith and trust among the partners.

6. **Unlimited Liability**: Like proprietorship, each partner has unlimited liability in the firm. This means that if the assets of the partnership firm fall short to meet the firm's obligations, the partners' private assets will also be used for the purpose.

7. **Restrictions on Transfer of Share**: No partner can transfer his share to any outside person without seeking the consent of all other partners.

8. **Principal-Agent Relationship**: The partnership firm may be carried on by all partners or any of them acting for all. While dealing with firm's transactions, each partner is entitled to represent the firm and other partners. In this way, a partner is an agent of the firm and of the other partners. A partner's decision & actions are binding on the Firm.

Advantages of Partnership Firm:

1. **Easy Formation**: Partnership is a contractual agreement between the partners to run an enterprise. Hence, it is relatively ease to form. Legal formalities associated with formation are minimal. Though, the registration of a partnership is desirable, but not obligatory.

2. **More Capital Available**: With more persons to provide funds, more capital is available to the enterprise. It also increases the borrowing capacity of the firm. Lending institutions perceive less risk in granting credit to a partnership than to a proprietorship because the risk of loss is spread over a number of partners rather than one individual.

3. **Combined Talent, Judgement and Skill:** All the partners are involved in decision making and there is collective leadership. Usually, partners are pooled from different specialized areas to complement each other. For example, if there are three partners, one partner might be a specialist in production, another in finance and the third in marketing. This gives the firm an advantage of collective expertise for taking better decisions.

4**. Sharing of Risk**: in a partnership, losses of the firm are shared by all the partners as per their agreed profit-sharing ratios. Thus, the share of loss in case of each partner will be less than that in case of proprietorship.

Similarly, in case of a personal accident or loss of one partner – survival ability of the Firm is still good. Surviving Partners can still continue to lead the Firm. This is major risk for Proprietary Firms.

5. **Flexibility**: Like proprietorship, the partnership response times can be very quick. The partners can easily appreciate and quickly react to changing market opportunities, demands & situations. Decision making is based on mutual trust & domain based skill sets. Hence Partnership Firms can react much faster than say a Corporate Organization with Professionals.

Disadvantages of Partnership Firms:

1. **Unlimited Liability**: In partnership firm, the liability of partners is unlimited. Just as in proprietorship, the partners' personal assets may be at risk if the business cannot pay its debts.

2**. Divided Authority**: Conflicts & distrust between Partners can ruin the Firm. A partner's decision is binding on the Firm. Business is all about risk taking. Sometimes even decision based on Good Faith can turn out to be sour in the long run. This can lead to conflicts & affect the operation of the firm.

3**. Lack of Continuity**: Partnership is based on pooling of skill sets. Death or withdrawal of one partner can sometimes severely affect the Firm.

4**. Risk of devolution of Liability**: Implied Authority: Partners in a partnership business, have unlimited liability for all debts and liabilities that occur while operating the business. This means partners and sole proprietors may lose their homes, cars and other personal assets, if the company's assets are insufficient to cover the company's debts.

But the partnership firm is an independent entity like other individuals. The accounts of partnership firm are maintained like other business firms. All the expenses relating to the partnership firms are booked as per standard accounting practices, within the ambit of law.

Therefore, the income of the partnership firm is calculated separately. Income of partners does not have any relation with the income of partnership firm.

It means that the income tax liability is calculated separately for income of partners and partnership firm. Partnership Concerns have to pay income tax on the earnings at flat rate at the maximum of the Income Tax.

However, in the hands of Partners, share of profit from partnership firm is tax free and no tax shall be paid on it. The logic is that the firm has already paid income tax at the highest income tax slab.

11.3.4. LIMITED LIABILITY COMPANIES – PRIVATE LIMITED & PUBLIC LIMITED COMPANIES

Rapid growth of trade, commerce and industry in modern times have resulted in significant changes in the size of a firm. Business undertakings, enterprises organized on the basis of sole proprietorship, or partnership could not raise & meet capital requirements of modern day large scale business. Hence, a new form of business organization came into existence. These entities are known as 'Joint Stock Company' or simply a 'Company' or 'Corporation'.

The Indian Companies Act 1956 section 3(1) defines a company as "a company formed and registered under this act or under other previous Acts". A popular definition is given by the Lord Justice Lindley. According to him a Company is "an association of many persons who contribute money or money's worth to a common stock and employed it in some trade or business and who share the profit or loss arising there from. The common stock so contributed is denoted in money and is the capital of the company. The persons who contributed it or to whom it belongs are members. The portion of capital to which each member is entitled is his share. The shares are always transferable although the right to transfer them may be restricted".

From the above definition it is clear that, a company is an incorporated association, which is an artificial person created by law, having an independent legal entity, with capital divisible into transferable shares carrying limited liability, having a common seal and perpetual succession.

Corporations provide owners of the company with liability protection against business losses and obligations. This means owners of a corporation may not lose their home, if the company goes bankrupt. Liability of Owners of a corporation, in case of liquidation, is limited to the extent of their investment in the company.

Corporations are subject to double taxation. This occurs when the corporation pays taxes on the company's profits at the business level, and shareholders pay taxes on income received from the corporation on their personal tax return.

11.3.4.1 Private Limited Company

A private limited company, or LTD, is a type of privately held business entity. This type of business entity limits owner liability to their shares, limits the number of shareholders to 50, and restricts shareholders from publicly trading shares.

Restriction on sale of shares: Private Limited Company. Shares of a Private Limited Company cannot be freely sold in the market. A sale of share can happen only with the consent of Board.

This restriction on sale or transfer of shares may be an advantage or disadvantage, depending on the circumstances & outlook.

Continued Existence: The Company is an independent entity conforming to mandatory set of rules regulations & reporting systems. So The entity survives the major shareholder. Private limited companies are incorporated as an independent legal entity, meaning it is able to sue or own assets separate from the company owner.

Tax Breaks: Private limited companies also enjoy tax advantages. For example, their corporate taxes may be lower than those paid by other types of businesses. Financial statements for private limited companies must be filed no later than nine months after the fiscal year ends. The first accounting period begins the same day that the business is incorporated. When pursuing tax advantages, private limited companies must keep accurate records.

Structure: Corporations have a structure consisting of shareholders, directors, officers and employees. Every corporation must have specified number of persons at any given time, serving on its board of directors. The board of directors is responsible for allocating the company's resources and increasing the shareholders' profits. Officers are required to manage the day-to-day activities of the company and implement the decisions made by the company's shareholders and directors.

Formalities: Corporations are required to hold at least one annual meeting. A corporation must keep strict financial records and keep a ledger detailing how the company reached certain decisions.

11.3.4.2. Public Limited Companies

As a company grows in size & complexity, capital requirement increases significantly. As they grow in size, they consider accessing the equity market for financing or ownership transfer through the sale of shares. The first offering, called an initial public offering (IPO), signifies the transition of a private company into a publicly-traded company.

In some cases, the process of becoming a publicly-traded company is subsequently reversed through the process of privatization. This occurs when a group of investors, or a private company, purchases all of the shares in a public company that is looking to become private. Once the purchase is complete, the company can be deemed private by officially removing itself from the stock market and eliminating the option for the public trading of the associated stocks.

In India one can incorporate two types of companies, Pvt. Ltd. Co. and Public Ltd. Co. (also called Ltd. Co.). For naming a company as a Ltd. Or Pvt. Ltd., one must adhere to the rules and guidelines as per Company Law.

Some differences between the 2 are listed:

- Paid up capital, for a Pvt. Ltd. co. it is Rs. 1,00,000 minimum whereas for Ltd. co. it is minimum Rs. 5,00,000.
- No. of shareholders minimum: Pvt. Ltd. 3 :: Ltd. Co.(Public Ltd. Co.) 7
- Maximum shareholders: Pvt. Ltd. co. are 50. There is no restriction on number of shareholders Ltd. Co.
- Directors: Pvt. Ltd. Co. minimum 2 :: Public Ltd. Co. 3
- Only a public limited company can invite public for subscription of shares.
- Public Limited Company with traded shares must hold Annual General Meeting, with prior notice.
- All Listed companies must conform to regulations as laid down by SEBI.

11.3.5. ANNUAL REPORTS - BALANCE SHEETS – AUDITED STATEMENTS

The Companies Act, 2013 brought in key changes in manner of preparation of financial statements and new definitions and provisions relating to related party disclosures, deposits inter corporate loans, dividends etc. CEO/MD/WTD/CFO/ independent directors are personally accountable of the correctness of the statements made. Changes in the New Act have increased the accountability and duties of auditors.

Every company is required to prepare financial statements – that includes a balance sheet as at the end of the financial year, profit and loss account for the year, cash flow statement for the financial year, a statement of changes in equity, if applicable and any explanatory note annexed to, or forming part of, any document referred to above.

Familiarity with balance sheets & Annual Reports is necessary to understand the operations of a company and its net worth.

11.4. REVISION POINT

1) Organization – Ownership Models, Proprietary Firm, Partnership Firms ,Private Limited Company, Public Limited Companies , Annual Reports - Balance Sheets – Audited Statements

11.5. INTEXT QUESTIONS

1) What are different types of businesses by ownership model?
2) Give any two advantages & disadvantages of Proprietary model of ownership

11.6. SUMMARY

Industrial & Commercial Organizations can be classified based on ownership & liability as: Sole Proprietorship, Partnership and Limited Liability Companies. Limited Liability Companies are further classified as Private Limited Companies, closely held Public Limited Companies & listed Public Limited Companies. Generally, as the size of the organization grows there is a need to raise capital & borrowed funds from third parties. This defines the need to become more accountable and at the same time

restrict liability. We have studied the features of each type of organization and its advantages & disadvantages.

11.7. TERMINAL EXERCISES

1) Discuss performance of Public Limited Company (listed) with the help of its last published balance sheet.
2) Give any two advantages & disadvantages of Partnership model of ownership

11.8. SUPPLEMENTARY MATERIALS

1) https://www.nolo.com/legal-encyclopedia/learn-about-business-ownership-structures-29785.html
2) http://oneal.research.ucf.edu/Class/GEB5516_4152/Business%20Structure/Business%20Formation-Ownership%20Structures.pdf
3) https://www.livecareer.com/quintessential/business-plan-tutorial/business-ownership

11.9. ASSIGNMENTS

1) Discuss limitations of proprietary & partnership model based on practical experience.
2) Discuss performance of Public Limited Company (listed) with the help of its last published balance sheet.

11.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

11.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- Organization – Ownership Models
- Proprietary Firm
- Partnership Firms
- Private Limited Company
- Public Limited Companies
- Annual Reports - Balance Sheets – Audited Statements

11.12. KEY WORDS

Organization – Ownership Models, Proprietary Firm, Partnership Firms ,Private Limited Company, Public Limited Companies , Annual Reports - Balance Sheets – Audited Statements

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LESSON - 12

MICRO, SMALL& MEDIUM SCALE INDUSTRIES (MSME)

12.1. INTRODUCTION

Micro, Small & medium scale industries play a very important role in creating employment in India. Many large companies started off as small or medium scale industries. Government of India has recognized the vital role played by MSME and has formulated many schemes to promote such ventures. In this lesson we study some features & aspects of MSME industries.

12.2. OBJECTIVES

- A very large part of P & M Valuation practice involves valuation of assets belonging to MSME industries. It is very essential to understand the features of the industry and motive of the Government of India in promoting these industries.
- In the context of Indian Industrial Scene, small & medium scale industries need special mention. The segment contributes to maximum new job opportunities. Small and medium enterprises (SMEs) have been the backbone of the Indian economy.
- Based on published statistics (2015), SME s are employing close to 40% of India's workforce and contributing 45% to India's manufacturing output. SMEs play a critical role in generating millions of jobs, especially at the low-skill level. The country's 1.3 million SMEs account for 40% of India's total exports.
- SME s, provide employment to over 80 million persons. The Sector produces more than 6,000 products & contributes about 17 % to GDP. The SME sector has the highest potential to spread industrial growth across the country, with least capital investment and can be a major partner in the process of inclusive growth.
- SMEs also play a significant role in Nation development through high contribution to Domestic Production, Significant Export Earnings, Low Investment Requirements. They are entrepreneur driven organizations with, Operational Flexibility, Location Wise Mobility, Low Intensive Imports.
- Their achievements in developing Appropriate Indigenous Technology, Import Substitution, is commendable. SME tend to form clusters, specializing in offering particular skill-sets. This segment generates new entrepreneurs by providing on-the-job knowledge and training& family succession practices.
- Recognizing the importance of SME s, Government of India has enacted the Micro, Small and Medium Enterprises Development (MSMED) Act, 2006 to encourage micro, small and medium enterprises.

12.3. CONTENT

12.3.1. Definition of MSME s

12.3.2. Credit Linked Capital Subsidy Scheme for Technology Upgradation

12.3.3. The Credit Guarantee Fund Scheme

12.3.1. DEFINITION OF MSMES

Enterprises engaged in the manufacture or production, processing or preservation of goods as specified below:

- A micro enterprise is an enterprise where investment in plant and machinery does not exceed Rs.25 lakhs.
- A small enterprise is an enterprise where the investment in plant and machinery is more than Rs.25 lakhs but does not exceed Rs. 5 crores.
- A medium enterprise is an enterprise where the investment in plant and machinery is more than Rs.5 crores but does not exceed Rs.10 crores. In case of the above enterprises, investment in plant and machinery is the original cost excluding land and building and the items specified by the Ministry of Small Scale Industries vide its notification No.S.O.1722(E) dated October 5, 2006.
- Enterprises engaged in providing or rendering of services and whose investment in equipment (original cost excluding land and building and furniture, fittings and other items not directly related to the service rendered or as may be notified under the MSMED Act, 2006 are specified below.
- A micro enterprise is an enterprise where the investment in equipment doesnot exceed Rs.10 lakhs.
- A small enterprise is an enterprise where the investment in equipment is more than Rs.10 lakhs but does not exceed Rs.2 crores.
- A medium enterprise is an enterprise where the investment in equipment is more than Rs.2 crores but does not exceed Rs.5 crores.

Indian Small and Medium Enterprises (SME) sector has emerged as a highly vibrant and dynamic sector of the Indian economy over the last five decades. SMEs not only play crucial role in providing large employment opportunities at comparatively lower capital cost than large industries but also help in industrialization of rural areas. SMEs are complementary to large industries as ancillary units and this sector contributes enormously to the socio-economic development of the country.

Govt. India has instituted special finance schemes to support new ventures floated by first time entrepreneurs & entrepreneurs with technical expertise. Special support is available for technology upgradation in the form of subsidies.

12.3.2. CREDIT LINKED CAPITAL SUBSIDY SCHEME FOR TECHNOLOGY UPGRADATION:

The Scheme was launched in October, 2000 and revised w.e.f. 29.09.2005. The revised scheme aims at facilitating Technology Upgradation of Micro and Small Enterprises by providing 15% capital subsidy on institutional finance availed by them for induction of well established and improved technology in approved sub-sectors/products.

The admissible capital subsidy under the revised scheme is calculated with reference to purchase price of Plant and Machinery. Maximum limit of eligible loan for calculation of subsidy under the revised scheme is also been raised to Rs.100 lakh.

12.3.3. THE CREDIT GUARANTEE FUND SCHEME

The credit guarantee fund schemE for Micro and Small Enterprises (CGS) was launched by the Government of India (GoI) to make available collateral-free credit to the micro and small enterprise sector.

Both the existing and the new enterprises are eligible to be covered under the scheme. The Ministry of Micro, Small and Medium Enterprises, GoI and Small Industries Development Bank of India (SIDBI), established a Trust named Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) to implement the Credit Guarantee Fund Scheme for Micro and Small Enterprises. The scheme was formally launched on August 30, 2000.

Coverage of Collateral Free Loans under Credit Guarantee Fund Trust Scheme for Micro & Small Enterprises (CGTMSE):

Purpose: To provide collateral free loans upto Rs.100/- lakhs to Micro & Small Enterprises, as defined under MSMED Act, 2006.

Eligibility: The coverage of the Scheme is extended to all new and existing Micro and Small Enterprises (both in the Manufacturing Sector as well as in the Service Sector) as defined under MSMED Act, 2006.

Limit: The eligible loan limit under the Scheme is Rs.100 lacs. A borrower, who has availed certain credit facilities secured by collaterals and/or third party guarantees and is sanctioned distinct/separate credit facility without collateral security/third party guarantee, can be covered under CGTMSE scheme.

Security: "Primary security" in respect of a credit facility shall mean the assets created out of the credit facility so extended and/or existing unencumbered assets which are directly associated with the project or business for which the credit facility has been extended. This means if a borrower is sanctioned working capital facility only, a charge can be created on the fixed assets of the unit even though the same are not financed by the Bank and the same will not be treated as collateral security. In case of sanction of Term/Demand loan on standalone basis, charge taken on current assets will not be treated as collateral security.

Margin: The credit guarantee cover is available up to 75% of the amount in default in respect of credit facilities up to Rs.50/- lakhs extended by the Lending Institution to an eligible borrower subject to maximum guarantee cover of Rs.37.50 lakhs and 50% for the facilities over Rs.50/- lacs and up to a limit of Rs.100/-, i.e. maximum of Rs.62.50 lakhs.

In case of following categories of borrowers, guarantee cover is available up to 80% of the amount in default. a)Loans to Micro enterprises up to Rs.5 lakhs (85%). b)Loans to Micro and Small enterprises operated and/ or owned by women. c)All loans in North East Region including the State of Sikkim.

12.4. REVISION POINT

1) MSME - Credit Guarantee Fund Scheme

12.5. INTEXT QUESTIONS

1) What does MSME stand for?
2) Why is MSME sector very important to India's progress?

12.6. SUMMARY

SMEs are employing close to 40% of India's workforce and contributing 45% to India's manufacturing output. SMEs play a critical role in generating millions of jobs, especially at the low-skill level. The country's 1.3 million SMEs account for 40% of India's total exports. GOI has come out with special support schemes for encouraging entrepreneurs and upgradation of technology. 2 special schemes namely TDF capital subsidy scheme and CGTMSE scheme are discussed.

12.7. TERMINAL EXERCISES

1) What is the definition of a Small Scale Industry?
2) Write short notes on:
   a. Technology development fund – capital subsidy
   b. CGTMSE loans – features & protection for lending institutions

12.8. SUPPLEMENTARY MATERIALS

1) https://www.smartsheet.com/blog/how-calculate-productivity-all-levels-organization-employee-and-software
2) https://en.wikipedia.org/wiki/Capacity_factor

12.9. ASSIGNMENTS

1) Discuss the likely impact of 2 special schemes offered by GOI in achieving the objective.

12.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

12.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- MSME
- Credit Guarantee Fund Scheme

12.12. KEY WORDS

MSME, Credit Guarantee Fund Scheme

LESSON - 13

INDUSTRIAL ESTATES

13.1 INTRODUCTION

Industrial estates are promoted by various State Governments to provide a stimulus for growth and encourage entrepreneurship. In this lesson we look at some features of industrial estates.

13.2 OBJECTIVE

- To understand the role of Industrial estates in encouraging Entrepreneurship & MSME ventures

13.3 CONTENT.

13.3.1 Industrial Estates

13.3.2. Objectives of Industrial Estates

13.3.3 General Type Industrial Estate

13.3.4. Special Industrial Estate

13.3.1 INDUSTRIAL ESTATES

An industrial estate is a group of factories, designed &constructed on an economic scale in suitable sites with basic infrastructural facilities like roads, water and electricity. Government of India & various State Governments promote Industrial Estates to expedite, stimulate industrial growth.

There are some private ventures in promoting Industrial estates also. However, the number & contribution is relatively small.

13.3.2. OBJECTIVES OF INDUSTRIAL ESTATES

The main objectives of the establishment of industrial estates are to:

1) Encourage the development of entrepreneurs &SME s
2) Provide infrastructure & ready to occupy factory shed facility with power & water to entrepreneurs
3) Encourage industries in the rural and backward areas
4) Encourage ancillary industry in the proximity of major industrial units asfeeder units.

In India, industrial estates have been utilized as an effective tool for the promotion and growth of small-scale industries. They have also been used as an effective tool to decentralize industrial activity to rural and backward areas. Industrial estates are also known by different names, e.g. industrial region, industrial park, industrial area, industrial zone, etc.

The United Nations (1963) has defined an industrial estate as “a planned clustering of enterprises, offering standard factory buildings erected in advance of demand and variety of services and facilities to the occupants.”

Industrial Estates are classified by Govt., on various bases. The purpose of the specific Industrial Estate can be:

(i) General type industrial estates, or

(ii) Special type industrial estates.

13.3.3 GENERAL TYPE INDUSTRIAL ESTATE

When an Industrial Estate is promoted as a General Industrial Estate, allotment of sheds are made to a wide variety of Industries. There are no particular restrictions, except for zoning regulations & effluent issues.

13.3.4. SPECIAL INDUSTRIAL ESTATE

In this case the Govt., has a specific motive in promoting the Industrial Estate. The Govt. wishes to develop a cluster of Industries in that area, that in its opinion will result in maximum job creation & most conducive for that area.

In this kind of Industrial Estate, allotments are made only for establishing certain type of Industries. It is not open to the allotted or his assign to undertake any other kind of activity other than as specified in the original allotment.

Example 1: Pharma Industrial estate: In this case only pharmaceutical & related industries can be set up. Other Industries like engineering or fabrication units are not allowed.

Example 2: Electronics Industrial Estate: In this area only electronics & related companies are allowed to function. No other type of industry is allowed.

Example 3: Apparels & garments Industrial Estate: In this area only apparels & garments units are allowed to function. No other type of industry is allowed

Example 4: Petro-chemicals Estate: In this area only petro-chemical units are allowed to function. No other type of industry is allowed

Example 5: Ancillary Industrial Estates: In such industrial estates, only those small- scale units are housed which are ancillary to a particular large industry

Similarly, State Governments Promote Industrial Parks for promoting large industries. In this case the Govt., department allots land only. Usually land parcels relatively large in size. Area allotted ranges from 5 acres to 100 or more acres. Land is usually given on renewable in 33 years / 99 years lease. Purpose & style of business are specified and usually end use restrictions & conditions of sub-lease are also specified.

Here also the motive of the Govt., in promoting the Park is clearly stated. Only industries falling within the ambit of the declared intention are allowed to operate in the Industrial park.

13.4. REVISION POINT

1) Industrial Estates, Objectives of Industrial Estates, General Type Industrial Estate, Special Industrial Estate

13.5. INTEXT QUESTIONS

1) What is an “industrial estate”?
2) How Industrial Estate concept helps an entrepreneur?

13.6. SUMMARY

An industrial estate is a group of factories, designed & constructed on an economic scale in suitable sites with basic infrastructural facilities like roads, water and electricity. Government of India & various State Governments promote

Industrial Estates to expedite, stimulate industrial growth. In India, industrial estates have been utilized as an effective tool for the promotion and growth of small-scale industries. They have also been used as an effective tool to decentralize industrial activity to rural and backward areas. Industrial estates are also known by different names, e.g. industrial region, industrial park, industrial area, industrial zone, etc.

13.7. TERMINAL EXERCISES

1) What are the restrictions in an Industrial estate?

13.8. SUPPLEMENTARY MATERIALS

1) https://www.smartsheet.com/blog/how-calculate-productivity-all-levels-organization-employee-and-software
2) https://en.wikipedia.org/wiki/Capacity_factor

13.9. ASSIGNMENTS

Name an Industrial estate nearby.

Discuss the nature of the types of industry in the estate and list the facilities or support entrepreneurs have received that they otherwise may not have received in the absence of the "industrial estate".

13.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

13.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day

- Industrial estates,
- Objectives of industrial estates
- general type industrial estate,
- Special industrial estate

13.12. KEY WORDS

Industrial Estates, Objectives of Industrial Estates ,General Type Industrial Estate ,Special Industrial Estate

LESSON - 14

SPECIAL ECONOMIC ZONES

14.1 INTRODUCTION

In this lesson we study another initiative by Govt. of India – Special Economic Zones - to promote export oriented industries.

14.2 OBJECTIVES

- To understand what is a SEZ, its features & facilities.

14.3. CONTENT

14.3.1 .History of Economic Zones

14.3.2. The SEZ Rules provide for

14.3.3. Incentives and facilities offered to the SEZs

14.3.1. HISTORY OF ECONOMIC ZONES

India was one of the first in Asia to recognize the effectiveness of the Export Processing Zone (EPZ) model in promoting exports, with Asia's first EPZ set up in Kandla in 1965. With a view to overcome the shortcomings experienced on account of the multiplicity of controls and clearances; absence of world-class infrastructure, and an unstable fiscal regime and with a view to attract larger foreign investments in India, the Special Economic Zones (SEZs) Policy was announced in April 2000.

This policy intended to make SEZs an engine for economic growth supported by quality infrastructure complemented by an attractive fiscal package, both at the Centre and the State level, with the minimum possible regulations. SEZs in India functioned from 1.11.2000 to 09.02.2006 under the provisions of the Foreign Trade Policy and fiscal incentives were made effective through the provisions of relevant statutes.

The Special Economic Zones Act, 2005, came into effect on 10th February, 2006, providing for drastic simplification of procedures and for single window clearance on matters relating to central as well as state governments. The main objectives of the SEZ Act are:

(a) generation of additional economic activity

(b) promotion of exports of goods and services;

(c) promotion of investment from domestic and foreign sources;

(d) creation of employment opportunities;

(e) development of infrastructure facilities;

The SEZ Rules provide for different minimum land requirement for different class of SEZs. Every SEZ is divided into a processing area where alone the SEZ units would come up and the non-processing area where the supporting infrastructure is to be created.

14.3.2. THE SEZ RULES PROVIDE FOR:

Simplified procedures for development, operation, and maintenance of the Special Economic Zones and for setting up units and conducting business in SEZs.

- Single window clearance for setting up of an SEZ.
- Single window clearance for setting up a unit in a Special Economic Zone;
- Single Window clearance on matters relating to Central as well as State Governments;
- Simplified compliance procedures and documentation with an emphasis on self-certification

14.3.3. INCENTIVES AND FACILITIES OFFERED TO THE SEZS

The incentives and facilities offered to the units in SEZs for attracting investments into the SEZs, including foreign investment include.

1) Duty free import/domestic procurement of goods for development, operation and maintenance of SEZ units.
2) 100% Income Tax exemption on export income for SEZ units under Section 10AA of the Income Tax Act for first 5 years, 50% for next 5 years thereafter and 50% of the ploughed back export profit for next 5 years.
3) Exemption from minimum alternate tax under section 115JB of the Income Tax Act.
4) External commercial borrowing by SEZ units upto US $ 500 million in a year without any maturity restriction through recognized banking channels.
5) Exemption from Central Sales Tax.
6) Exemption from Service Tax.
7) Single window clearance for Central and State level approvals.
8) Exemption from State sales tax and other levies as extended by the respective State Governments.
9) The major incentives and facilities available to SEZ developers include:-
10) Exemption from customs/excise duties for development of SEZs for authorized operations approved by the BOA.
11) Income Tax exemption on income derived from the business of development of the SEZ in a block of 10 years in 15 years under Section 80-IAB of the Income Tax Act.
12) Exemption from minimum alternate tax under Section 115 JB of the Income Tax Act.
13) Exemption from dividend distribution tax under Section 115O of the Income Tax Act.
14) Exemption from Central Sales Tax (CST).
15) Exemption from Service Tax (Section 7, 26 and Second Schedule of the SEZ Act).

14.4. REVISION POINT

1) Economic Zones,-SEZ

14.5. INTEXT QUESTIONS

2) What is the objective of GOI in setting up of SEZ?
3) How is it advantageous to start an export oriented unit in an SEZ?

14.6. SUMMARY

SEZs have been set up to promote export oriented businesses. Many conditions on investment, ownership, registrations & clearances have been relaxed or issued on single window basis for companies established in SEZ s. They enjoy many concessions in import / export regulations. Income tax& service taxbenefits are also available.

14.7. TERMINAL EXERCISES

1) What are the benefits available to Companies operating in SEZ?

14.8. SUPPLEMENTARY MATERIALS

1) www.nic.in.microeconomics%20class%20xii.pd

14.9. ASSIGNMENTS

1) Name an SEZ.
2) Discuss the nature of organizations in the SEZ and employment potential generated by the presence of the SEZ.

14.10. SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

14.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day
    - Economic Zones
    - SEZ

14.12. KEY WORDS

Economic Zones, SEZ

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LESSON - 15

SERVICES SECTOR

15.1. INTRODUCTION

Services sector is generally very labour intensive and offers excellent growth potential. Information Technology, Hospitality& entertainment, Communication and Healthcare are some of the main segments of services sector. In this lesson we study some aspect of this sector.

15.2. OBJECTIVE

The services sector needs to invest significant amounts in Plant & Machinery, like DG sets, HVAC equipment, transformers, pumps etc. P & M valuation practice requires an understanding of the role & structure of service industry.

The services sector has emerged as the most dynamic sector of the world economy, contributing almost one-third of world gross value added, half of world employment, one-fifth of global trade and more than half of the world foreign direct investment flows.

It is one of the key driver of India's economic growth, contributing almost 66.1 per cent of its gross value added growth in 2015-16, important net foreign exchange earner and the most attractive sector for foreign direct investment inflows.

The services sector has attracted significant foreign investment flows, contributed significantly to exports as well as provided large-scale employment. India's services sector covers a wide variety of activities such as trade, hotel and restaurants, transport, storage and communication, financing, insurance, real estate, business services, community, social and personal services, and services associated with construction.

15.3. CONTENT

15.3.1. MARKET SIZE

Services sector contributed around 66.1 per cent of its Gross Value Added growth in 2015-16, thereby becoming an important net foreign exchange earner and the most attractive sector for FDI (Foreign Direct Investment) inflows.!

The Indian telecommunication services market is expected to grow by 10.3 per cent year-on-year to reach US$ 103.9 billion by 2020.

India is the eighth largest services exporter in the world. The services exports have in 2014 stood at US$ 155.6 billion, which constitutes 7.5 per cent of the GDP. The services imports increased at a rate of 3.3 per cent to US$ 81.1 billion in 2014-15.

Out of overall services sector, the sub-sector comprising financial services, real estate and professional services contributed 21.6 per cent to the GDP, and grew the fastest among all sub-segments at 10.3 per cent year-on-year in 2015-16.

The sub-sector of trade, hotels, transport, communication and services related to broadcasting contributed 12.6 per cent to the GDP. The third-largest sub-segment comprising public administration, defence and other services contributed nearly 12.6 per cent to the GDP.

15.3.2. INVESTMENTS

The Indian services sector has attracted the highest amount of FDI equity inflows in the period April 2000-March 2016, amounting to about US$ 50.79 billion which is about 18 per cent of the total foreign inflows, according to the Department of Industrial Policy and Promotion (DIPP). Looking ahead, the government's focus on infrastructure development, favourable regulatory policies like liberalization of FDI norms, increasing number of multimodal logistics service providers, growing trend of outsourcing logistics to third party service providers and entry of global players are expected to provide impetus to logistics services. Though shipping services are expected to grow, with increased imports of POL (petroleum, oil and lubricants), containerization of export and import cargo, modernization of ports, and establishment of coastal shipping routes.

15.3.3. ROAD AHEAD

Services sector growth is governed by both domestic and global factors. The sector is expected to perform well in FY16. Some improvement in global growth and recovery in industrial growth will drive the services sector to grow 7.4 per cent in FY16 (FY15: 7.3 per cent). The Indian facilities management market is expected to grow at 17 per cent CAGR between 2015 and 2020 and surpass the $19 billion mark supported by booming real estate, retail, and hospitality sectors. The performance of trade, hotels and restaurants, and transport, storage and communication sectors are expected to improve in FY16 and beyond.

15.3.4. PLANT & MACHINERY IN SERVICES SECTOR:

Any modern commercial or office space today is air-conditioned. IT sector requires uninterrupted power and air-conditioned environment. Hotels, restaurants invest a lot of money in equipment to improve comfort and provide an ambience to their clients. Medical equipment in Hospitals & diagnostic centers are very expensive. Thus it is common to see utility equipment like, Transformers, DG sets, HVAC equipment, passenger lifts & specialized equipment like – electronic equipment, kitchen equipment, medical diagnostic & therapeutic equipment in these organizations.

15.4. REVISION POINT

1) Market Size, Investments, Road Ahead, Plant & Machinery In Services Sector

15.5. INTEX QUESTIONS

1) Name a few activities covered under the Services sector
2) What is the contribution of services sector to the Indian economy?

15.6. SUMMARY

Services sector is generally very labour intensive and offers excellent growth potential. Information Technology, Hospitality & entertainment, Communication and Healthcare are some of the main segments of services sector.Services sector contributed around 66.1 per cent of its Gross Value Added growth in 2015-16. The services exports have in 2014 stood at US$ 155.6 billion, which constitutes 7.5 per cent of the GDP. It is common to see utility equipment like, Transformers, DG sets, HVAC equipment, passenger lifts & specialized equipment like – electronic equipment, kitchen equipment, medical diagnostic & therapeutic equipmentin these organizations.

15.7. TERMINAL EXERCISES

1) What are the common plant & machinery used in the services sector?

15.8. SUPPLEMENTARY MATERIALS

1) https://en.wikipedia.org/wiki/sericesect.org
2) http://www.businessdictionary.com/definition/serivce-secetor.html

15.9. ASSIGNMENTS

1) List the Plant & machinery likely to be used in:
   - Hotel
   - Hospital
   - IT Park
   - Commercial Mall

15.10.SUGGESTED READINGS/REFERENCE BOOKS

1) Telsang M T, I*ndustrial Engineering and Production Management,* S. Chand Publication.
2) Khan M I, *Industrial Engineering*, New Age International Publication.
3) Gavriel Salvendy, *Handbook of Industrial Engineering: Technology and Operations Management.*
4) Avraham Shtub, Yuval Cohen, *Introduction to Industrial Engineering*, CRC Press.
5) K. Krishnaswamy, *Industrial Instrumentation,* Amazon.
6) S. Mukhopadhyay, *Industrial Instrumentation, Control and Automation,* Amazon.

15.11. LEARNING ACTIVITIES

1) Group discussion on during PCP day
   - Market Size
   - Investments
   - Road Ahead
   - Plant & Machinery In Services Sector

15.12. KEY WORDS

Market Size, .Investments, Road Ahead, Plant & Machinery In Services Sector