

CHAPTER 3
PRODUCTIVITY IMPROVEMENT TECHNIQUES AND
IT'S RELATIONSHIP WITH WORK STUDY

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CHAPTER 3

PRODUCTIVITY IMPROVEMENT TECHNIQUES AND IT'S RELATIONSHIP WITH WORK STUDY

3.1 Introduction:

Productivity improvement is to do the right things better and make it a part of continuous process. Therefore it is important to adopt efficient productivity improvement technique so as to ensure individuals and organization's growth in productivity. The aim of this chapter is to introduce and understand productivity improvement, various techniques of productivity improvement, work study and its relation with productivity improvement. To achieve this present chapter is arranged as follows:

3.1 Introduction

3.2 Productivity and Productivity Improvement: Concept

3.3 Importance of Higher or Improved Productivity

3.4 Factors of Productivity Improvement

3.5 Some Techniques for Measurement of Productivity Improvement

3.5.1 Factor Productivity Indices

3.5.2 Japanese Productivity Improvement Techniques

3.5.3 Work Study as a Productivity Improvement Technique

3.5.4 Work Measurement Techniques for Productivity Improvement

3.6 Techniques of Work Study and their Relationship with Productivity Improvement

3.2 Productivity and Productivity Improvement : Concept

Productivity is the ratio between output and input. It is quantitative relationship between what we produce and what we have spent to produce.

Productivity is nothing but reduction in wastage of resources like men, material, machine, time, space, capital etc. It can be expressed as human efforts to produce more and more with less and less inputs of resources so that there will be maximum distribution of benefits among maximum number of people. Productivity denotes relationship between output and one or all associated inputs. European Productivity Council states that 'Productivity is an attitude of mind. It is a mentality of progress of the constant improvement of that which exists. It is certainty of being able to do better than yesterday and continuously. It is constant adoption of economic and social life to changing conditions. It is continual effort to apply new techniques and methods. It is faith in human progress'. In the words of Peter Drucker productivity means a balance between all factors of production that will give the maximum output with the smallest effort¹. On the other hand, according to International Labour Organisation productivity is the ratio between the volume of output as measured by production indices and the corresponding volume of labour input' as measured by production indices and the corresponding volume of labour input as measured by employment indices². This definition applies to an enterprise, industry or an economy as a whole.

The productivity of a certain set of resources (input) is therefore the amount of goods or services (output) which is produced by them. Land and building materials, machines, manpower (labour), technology etc. are the resources at the disposal of a manufacturing company. Therefore higher (improved) productivity means that more is produced with the same expenditure of resource i.e. at the same cost in terms of land, materials, machine, time or labour, alternatively, it means same amount is produced at less cost in terms of land, materials, machine time or labour that is utilized.

In countries where capital and skill are short, while unskilled labour is plentiful and poorly paid, it is especially important that higher productivity (improved) should be looked for by increasing the output per machine or piece of plant or per skilled worker. Improving productivity means increasing or raising productivity with the help of using same amount of materials, machine time, land, labour or technology. The following examples of each type of productivity may make improved or higher productivity meaning clearer.

1. Improved productivity of land:

If by using better seed, better methods of cultivation and more fertilizer, the yield of corn from a particular hectare of land can be increased from 4 quintals to 6 quintals, the productivity of that land, in the agricultural sense is increased (improved) by 50 percent. The productivity of land used for industrial purposes is said to have been increased if the output of goods or services within that area of land is increased by whatever means.

2. Improved productivity of materials:

A skilled tailor is able to cut 12 suits from a bale of cloth where an unskilled labour is able to cut only 10 suits from a bale of cloth, then the productivity of the bale used by skilled worker is 16.6 percent greater than unskilled labour.

3. Improved productivity of machines:

A machine tool is producing 90 pieces per working day (i.e. 8 hours). Considering that through the use of improved cutting tools, the output is increased to 120 pieces, then the productivity of that machine will be increased by 33.33 percent.

4. Improved productivity of Men (Labour):

The worker is producing 32 plates per hour. Considering that with the improved methods of work, he will be able to produce 42 plates per hour, then productivity of worker will be improved by 31.25 percent.

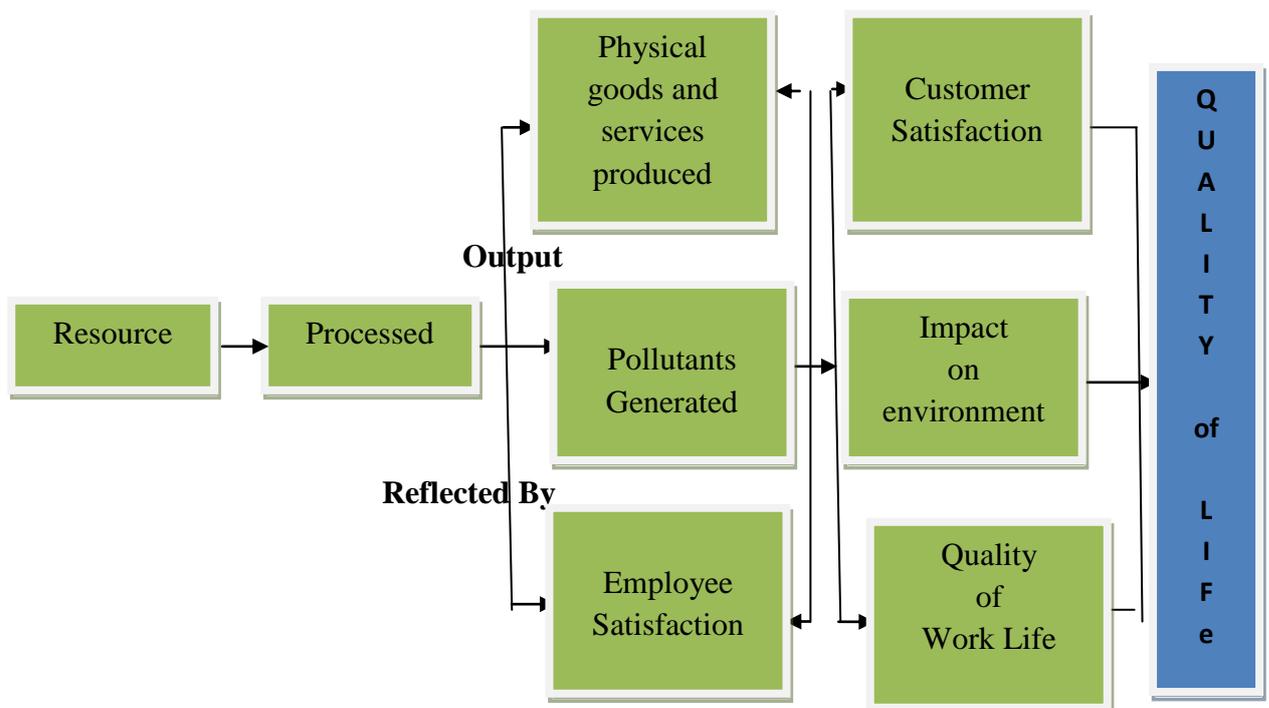
Thus it can be said that more output results into higher productivity or improvement from same amount of resources which means lower money costs and higher net money returns per unit of output.

Another productivity concept known as Japanese Holistic View of Productivity explains productivity as a comprehensive holistic phenomenon encompassing all elements required to improve products/ services (output). Productivity in the future must be concern itself with seeking affluence of a kind which will provide people with material wealth as well as spiritual satisfaction. Also

the outputs particularly in the form of physical pollution must be controlled in the context of increasing concern of society for clean environment and sustainable development. To improve productivity products must be designed to satisfy customer need with optimum consumption of resources without generation of waste in the manufacturing process. The following Figure 3.1 represents clearly Japanese Holistic View of Productivity.

Figure 3.1

Japanese Holistic View of Productivity Concept



Source: Shivalingaiah B.K., 'Labour Productivity through Method study', A project report, Industrial Engineering & Operations research, IIT Bombay, 1995.

On the basis of above discussion, productivity concept can be summarized as shown in Chart 3.1.

Chart: 3.1

Summary of Productivity Concept

Sr.No	Concept	Summary
1	Productivity as an objective concept	<ul style="list-style-type: none"> - It can be measured, ideally against a universal standard. - Organizations can monitor productivity for strategic reasons such as corporate planning, organization improvement, or comparison to competitors. - Can be used for tactical reasons such as project control or controlling performance to budget.
2	Productivity as a scientific concept	<ul style="list-style-type: none"> - Can be logically defined and empirically observed. - It can also be measured in quantitative terms, which qualifies it as a variable and therefore, it can be defined and measured in absolute or relative terms. - It is much more useful as a concept dealing with relative productivity or as a productivity factor.
3	Productivity as a measure concept	<ul style="list-style-type: none"> - Useful as a relative measure of actual output of production compared to the actual input of resources, measured across time or against common entities. - As output increases for a level of input, or as the amount of input decreases for a constant level of output, an increase in productivity occurs. - "productivity measure" describes how well the resources of an organization are being used to produce input.
4	Productivity as an efficiency concept	<ul style="list-style-type: none"> - Productivity is often confused with efficiency. Efficiency is generally seen as the ratio of the time needed to perform a task to some predetermined standard time. However, doing unnecessary work efficiently is not exactly being productive. - It would be more correct to interpret productivity as a measure of effectiveness (doing the right thing efficiently), which is outcome-oriented rather than output-oriented.
5	Productivity as an Factor concept	
5.1	partial Factor Productivity	<ul style="list-style-type: none"> - Considers a single input in the ratio. - Partial-factor productivity would be - the ratio of total output to a single input. - Output/labor, output/machine, output/capital, or output/energy.
5.2	Multi Factor Productivity	<ul style="list-style-type: none"> - Utilizes more than a single factor. - Multifactor productivity is the ratio of total output to a subset of inputs: - A subset of inputs might consist of only labor and materials or it could include capital
5.3	Total Factor productivity	<ul style="list-style-type: none"> - Measured by combining the effects of all the resources used in the production of goods and services (labor, capital, raw material, energy, etc.) and dividing it into the output

3.3 Importance of Higher Productivity:

Section 3.2 presents the conceptual framework of productivity and productivity improvement. This discussion shows that Productivity improvement can be achieved in a number of ways. If the level of output is increased faster than that of input, productivity will increase. Conversely, productivity will be increased if the level of input is decreased faster than that of output. Also, an organization may realize a productivity increase from producing more output with the same level of input. Finally, producing more output with a reduced level of input will result in increased productivity.

Any of these scenarios may be realized through improved methods, investment in machinery and technology, improved quality, and improvement techniques and philosophies such as just-in-time, total quality management, lean production, supply chain management principles, and theory of constraints.

A firm or department may undertake a number of key steps toward improving productivity. William J. Stevenson³ lists these steps to productivity improvement:

- Develop productivity measures for all operations; measurement is the first step in managing and controlling an organization.
- Look at the system as a whole in deciding which operations are most critical; it is over-all productivity that is important.
- Develop methods for achieving productivity improvement, such as soliciting ideas from workers (perhaps organizing teams of workers, engineers, and managers), studying how other firms have increased productivity, and reexamining the way work is done.
- Establish reasonable goals for improvement.
- Make it clear that management supports and encourages productivity improvement. Consider incentives to reward workers for contributions.
- Measure improvements and publicize them.

- Don't confuse productivity with efficiency. Efficiency is a narrower concept that pertains to getting the most out of a given set of resources; productivity is a broader concept that pertains to use of overall resources. For example, an efficiency perspective on mowing the lawn given a hand mower would focus on the best way to use the hand mower; a productivity perspective would include the possibility of using a power mower.

Therefore it is essential to know the importance of higher / improved productivity in manufacturing company/ organization. Thus importance of productivity can be summarized as follows:

i) **Productivity is a key to prosperity.** Rise in productivity results in higher production which has direct impact on standard of living. It reduces cost per unit and enables reduction in sale price. It increases wages for workers and increased profit for organisation. Higher demand creates more employment opportunities.

ii) **Higher productivity leads to economic growth and social progress.** Higher productivity helps to reduce cost per piece which make product available at cheaper rate. Thus it is beneficial for consumers. Low price increases demand of the product which in turn increases profit of the organisation. Higher profit enables organisation to offer higher dividend for shareholders. It increases export and increases foreign exchange reserves of a country.

iii) **Higher productivity requires elimination of waste in all forms.** It is necessary to eliminate wastage in raw material, wastage of time in case of men and machinery, wastage of space etc. to improve productivity. Several techniques like work study, statistical quality control, inventory control, operation research, value analysis etc. are used to minimise wastage of resources.

iv) **Improvement in productivity is important for country** like ours because it can minimise level of poverty and unemployment.

3.4 Factors of Productivity Improvements:

There are varieties of factors which can affect productivity, both positively and negatively as listed in Chart.3.2. Some factors can be controlled and some cannot be controlled due to natural limitations.

Chart 3.2 Factors of Productivity Improvement

Sr.No	Factors
1	capital investments in production
2	capital investments in technology
3	capital investments in equipment
4	capital investments in facilities
5	economies of scale
6	workforce knowledge and skill resulting from training and experience
7	technological changes
8	work methods
9	Procedures
10	Systems
11	quality of products
12	quality of processes
13	quality of management
14	legislative and regulatory environment
15	general levels of education
16	social environment
17	geographic factors

3.5 Some Techniques for Measurement of Productivity:

Productivity has been defined as the ratio of output to input⁴. An increase in productivity means an increase in output that is proportionally greater than increase in input.

Productivity may be measured either on an aggregate basis or individual basis. On aggregate basis, output is compared with all inputs taken (added) together. This is called as total productivity. On individual basis, output is compared with any one of the input factor and this is called as partial productivity or factor productivity.

$$\text{Total productivity index} = \frac{\text{Total output}}{\text{Total inputs}} = \frac{\text{Total production of goods and services}}{\text{Labour} + \text{Material} + \text{Capital} + \text{Energy}}$$

This index measures the productivity of the entire organisation with use of all resources. It is a way of evaluating efficiency of entire plant or firm.

It has been said that the challenge of productivity has become a challenge of measurement. Productivity is difficult to measure and can only be measured indirectly, that is, by measuring other variables and then calculating productivity from them. This difficulty in measurement stems from the fact that inputs and outputs are not only difficult to define but are also difficult to quantify.

Any productivity measurement system should produce some sort of overall index of productivity. A smart measurement program combines productivity measurements into an overall rating of performance. This type of system should be flexible in order to accommodate changes in goals and policies over time. It should also have the ability to aggregate the measurement systems of different units into a single system and be able to compare productivity across different units.

The ways in which input and output are measured can provide different productivity measures. Disadvantages of productivity measures have been the distortion of the measure by fixed expenses and also the inability of productivity measures to consider quality changes (e.g., output per hour might increase, but it may cause the defect rate to rise). It is easier to conceive of outputs as tangible units such as number of items produced, but other factors such as quality should be considered.

Experts have cited a need for a measurement program that gives an equal weight to quality as well as productivity. If quality is included in the ratio, output may have to be defined as something like the number of defect-free units of production or the number of units which meet customer expectations or requirements. Therefore, it is very much essential to understand different techniques of measuring the productivity and its improvement. In practice, there are multiple productivity improvement techniques. Section 3.5 explains some of the important techniques for measurement of productivity. They are discussed briefly as follows:

3.5.1 Productivity Improvement Indices:

Factor productivity or partial productivity indices are of following types:

- i) **Labour productivity:** The important function in any production set-up is that the budgeted quantity of work must be achieved over a period of time. Labour productivity depends upon how labours are utilised. Labour productivity can be higher or lower depending on factors like availability of work load, material, working tools, availability of power, work efficiency, level of motivation, level of training, level of working condition (comfortable or poor) etc. Labour productivity can be measured in terms of hours or money.

$$\text{Labour productivity} = \frac{\text{Total output}}{\text{Labour input}}$$

$$\text{Labour productivity (in terms of hours)} = \frac{\text{Total quantity produced}}{\text{Actual man hours required to produce that quantity}}$$

$$\text{Labour productivity (in terms of money)} = \frac{\text{Total cost (or sales value) of output produced}}{\text{Amount in terms of rupees spent on workers}}$$

The productivity of labour can be increased by increasing efficiency of labour and reducing labour time.

- ii) **Material productivity:** Production system converts raw material into finished product with the help of mechanical or chemical processes. Material productivity plays important role in cost of production. Material productivity depends upon how material is effectively utilised in its conversion into finished product. Material productivity depends upon percentage of rejection, creation of scrap, level of spoilage, obsolescence, work wastage etc. Material productivity is expressed as:

$$\text{Material productivity} = \frac{\text{Total output}}{\text{Material input}} \text{ or}$$

$$\text{Material productivity} = \frac{\text{Number of units produced}}{\text{Total material cost}}$$

Material productivity can be increased by using skilled workers, adequate machine tools, good design of product etc.

iii) Machine Productivity: Production system converts raw material into finished product through mechanical or chemical process with the help of machines and equipments. Machine productivity depends upon availability of raw material, power, skill of workers, machine layout etc.

$$\text{Material productivity} = \frac{\text{Total output}}{\text{Material input}} \text{ or}$$

$$\text{Material productivity} = \frac{\text{Output in standard hours}}{\text{Actual machine hours}}$$

iv) Capital productivity: For any production set-up, facilities of machines, tools, land etc. are required which are assets of organisation. Capital is needed for such assets. As huge capital is locked in assets, their effective utilization is absolutely necessary. Capital productivity depends on how effectively assets are utilised. Therefore decision is necessary to take about replacement of fixed assets. Early replacement of fixed assets brings down maintenance cost but requires capital expenses. On the other hand, late replacement of fixed assets improves ratio of production to capital expenditure, but it increases maintenance cost. Therefore proper balance is necessary. Organisation spent large amount (direct expenditure) for assets like direct material, direct wages, land, building, equipment etc. But a production system incurs a lot of direct expenditure like salaries of manpower employed in planning, store keeping, record keeping, inspection etc. Indirect labour is also used for material movement, good housekeeping, cleaning etc. Indirect expenditure is incurred on indirect material like tools, oils, lubricant etc.

$$\text{Capital productivity} = \frac{\text{Total output}}{\text{Capital input}} \quad \text{or} \quad \text{Capital productivity} = \frac{\text{Total output}}{\text{Capital employed}}$$

3.5.2 Japanese Productivity Improvement Techniques:

Productivity improvement techniques can be applied effectively in enterprises of any size, from one-person companies to corporations with thousands of staff. Japan developed number of productivity improvement techniques after World War II .The TPS comprises the following productivity improvements components. Toyota, a giant Japanese automobile company was pioneer in development and application of various productivity improvement techniques under Toyota Production System (TPS). Taiichi Ohno developed the Toyota Production System (TPS) after World War II. Some of the selected Japanese Productivity Improvement techniques are presented in this section as below⁵:

A) JIDOKA:

Jidoka is a Toyota concept aimed at describing the man-machine interface such that people remain free to exercise judgment while machines serve their purpose. The jidoka system shows faith in the worker as a thinker and allows all workers the right to stop the line on which they are working. Jidoka is often referred to as ‘automation with a human mind’. The jidoka way of working consists of following three principles- Do not make defects, Do not pass on defects, Do not accept defects.

B) HEIJUNKA

Heijunka focuses on achieving consistent levels of production. It is defined as ‘distributing the production of different [body types] evenly over the course of a day’ It incorporates the principles of line balancing by attempting to equate workloads, leveling demand out by creating an inventory buffer and replenishing that buffer. It believes in providing even work load for all employees. Heijunka has the capability of reducing lead times by minimizing time losses due to frequent process changeovers.

C) KAIZEN Techniques:

Kaizen (Continuous improvement) is a management supported employee driven process where, employees make a great number of continuous improvement efforts.

i) Five Ss of Housekeeping:

A structured approach to achieve clean and orderly work place by fixing place for everything. Five Ss is an abbreviation for the Japanese words: Seiri, Seiton, Seiso, Seiketsu and Shitsuke. It means:

Seiri- getting rid of unnecessary items

Seiton- Arranging items (materials, tools, gauges) systematically for easy retrievability.

Seiso- Keeping work place scrupulously clean.

Seiketsu - Scheduling regular cleaning and clearing out operations.

Shitsuke - Making all the above task meet agreed standards at agreed intervals.

(ii) Muda elimination:

Muda means 'Waste'. Here muda elimination implies an 'on going' and systematic reduction or elimination of waste. There are seven kinds of major waste: Overproduction Muda, Stock Muda, Transport Muda, Defects Muda, Delay Muda, Motion Muda, Over processing Muda. It helps to eliminate redundant processes or parts of processes, delete non-value added activities, simplify motions, minimize fatigue, reduce wait time, etc.

(iii) Poka-Yoke:

It is powerful and comprehensive method of 'error proofing'. A work process to eliminate inadvertent errors to ensure quality products and services. It helps in defect prevention and defect detection.

(iv) SMED:

Single Minute Exchange of Die (SMED) is a technique of performing a set up operation in lesser amount of time .It affects a machinery setup for change over from job to another in less than 10 minutes expressed as a single digit. It helps in reduced Work-in-progress, better average daily production, increased capacity and faster delivery to customers.

(v) Total Productive maintenance (TPM):

TPM is keeping machines in good working condition through systematic maintenance of equipment so that they fail less frequently and production process continues without interruption.

(vi) Just-In-Time:

JIT is a management philosophy aimed at eliminating waste from every aspect of manufacturing and its related activities. The term JIT refers to producing only what is needed, when it is needed and in needed quantity. The aim of JIT in a factory is to reduce lead times, minimise inventory, reduce the defect rate to zero and accomplish all of the above at minimum cost. There are three essential ingredients to effective manufacturing excellence through JIT: (i) JIT manufacturing techniques that aims to promote a rapid response to customer demand while minimising inventory (ii) a total quality culture to pursue excellence in both the product and every area of the business, including customer service, purchasing, order taking, accounting, maintenance, design, etc.; and (iii) people or employee involvement in the development of the organisation through its culture and its manufacturing and other business processes.

(vii) Kanban:

Kanban is a manual production scheduling technique controlled by a process or machine operator. Kanban means card in Japanese, ia attached to given number of parts or products in the production line instructing the delivery of given quantity. The kanban card after all parts/products have been used up is returned by the operator to

its origin. Production is controlled through demand originating from external customer.

(viii) Process Oriented Management (POM):

Traditional management focuses mainly on results and individuals on their ultimate achievement. Kaizen management emphasis on process of achieving the results. Managers in POM are judged by people centered skills as time management, education and training, inter-team participation, communication and morale boosting.

(ix) Visual management:

Visual management is the method of providing, in a clearly visible manner, to both workers and management, information on the current status including target of the various operations performed as well as various work pieces found at the work place.

(x) Work Standards:

Work standards represent the best way of doing a job and it consists of set of documented policies, rules, directives and procedures established by the management for all major operations to enable employees to perform their jobs without errors and to enable management to minimize variations in output, quality, work-in-progress and cost. Three elements of standardized work are takt time, work sequence and standard work-in-progress. The key steps in implementing work standards are (i) identify the key issues in the current process (ii) map the process (iii) improve the process (iv) implement the process and (v) sustain the process.

(xi) The PDCA/SDCA Cycle:

The PDCA (Plan-Do-Check-Act) cycle is an endless improvement cycle which demands that each team **Plans** (establish a target for improvement through action plan), **Does** (implement the plan), **Checks** (monitor and evaluate effects), **Acts** (Standardises new procedures or set goals for further improvement). Since every process is initially unstable, it must be stabilize using SDCA (Standardise-do-check-

act) cycle. Thus, a SDCA cycle must precede every PDCA cycle to consolidate gains into current process before raising the standard threshold.

(xii) Statistical Process Control (SPC):

Statistical Process Control is the application of statistical techniques to control a process and eliminate process variations due to assignable causes. Statistical process control requires operators to do periodically sampling of the quality of their own output, enter data into control charts, analyze the trend, and decide for themselves when to shut down the process and when to make adjustments / corrections to the process to prevent defects.

xiii) Suggestion Systems:

Suggestion Systems- the fundamental to the Kaizen philosophy is the process owned by employees through designed to benefit the company, inviting employees to suggest / implement any idea, large or small, novel or mundane concerning any aspect of the company life.

3.5.3 Work Study as a Productivity Improvement Technique:

Work study is an important management tool to achieve higher productivity. It is related to human work, method of doing work and standard of performance. The survival of any organization is dependent on use of latest technology and efficient methods of production. To improve efficiency of production it needs effective utilization of plant, equipment and labor. This can be achieved by using work study which studies method and evaluate the performance. It divides work into smaller elements, studies it, and rearranges it to get same or greater efficiency at reduced cost. International Labor Organization (ILO) defines work study as the technique of method study and work measurement employed to ensure the best possible use of human and material resources in carrying out a specified activity. It is also a management service based on method study and work measurement used in examination of human work leading to investigation of all the resources that effect efficiency and economy of situation to affect improvement. Further ILO states that

work study is to minimize cost either by designing the work for high productivity or by improving productivity in existing work through improvements in current methods by reducing ineffective and wasted time. Therefore, it can be said that it is a direct means of raising the productivity. It is most frequently used to increase the amount of production from a given quantity of resources with little or no further capital investment and hence work study has direct relation to productivity improvement. According to B.S Glossary, ' Work study is a generic term for those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contexts, and which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement'⁶. From this definition we can say that, work study is direct means of rising or improving the productivity as work study is used to examine human work that affects efficiency which in turn affects improvement. Work study therefore has direct relationship with the productivity. It is frequently used to increase the amount produced from a given quantity of resources with little or no further investment. Productivity of an enterprise is affected by various factors such as Labour, Material, Land, Machine, Capital, Technology, product and Management. One of the effective ways of raising productivity in the long run is the development of new process and installation of modern plant and equipment. But this approach requires heavy capital investment. Further, to improve the productivity using advanced technology may affect the efforts aimed at expanding employment opportunities. On the other hand, work study aims to improve productivity through the systematic analysis of existing operations, processes and work methods so as to improve their efficiency with little or no extra capital expenditure. To achieve this improvement it is extremely important to apply work study continuously and throughout the organization. Thus, International Labour organization has clearly shown to what extent there is direct relationship of work study in raising the productivity. This is represented in Chart.3.3

Chart: 3.3 Direct means of Raising Productivity

Sr. No	Approach	Type of Improvement	Means	Cost	Results obtained in terms of Time	Extent of Improvement in Productivity	Role of Work Study	
1	Capital Investment	1	Development of new basic process or fundamental improvement of existing ones	Basic research, Applied research, pilot plant	High	Years	No Limit	Method Study to improve ease of operation & maintenance at design stage
		2	Install more modern or higher-capacity plant or equipment or modernize existing one	Purchase, Process research	High	Immediate after Installation	No Limit	Method study in plant layout and to improve ease of operation when modernizing
2	Better Management	3	Reduce the work content of the product	Product research, Product development, Quality management, Method study , value analysis	Not High as compared to 1& 2	Months	Limited	Method Study to improve design for ease of production
		4	Reduce the work content of the process	Process Research, Pilot plant, process planning, Method study , operator training, value analysis	Low	Immediate	Limited	Method study to reduce wasted effort and time in operating the process by eliminating unnecessary movement
		5	Reduce ineffective time due to management or workers	Work Measurement: Marketing policy, standardisation, product development, production planning and control, material control, improved working conditions, operator training, Incentive Schemes	Low	May start slowly but effect grows quickly	Limited	Work Measurement to investigate existing practice, locate ineffective time and set standards of performance as basis for -Planning and control, Utilisation of plant, Labour cost control, Incentive schemes

Source: International Labour Organisation, 'Introduction to Work Study', Third edition, Universal Publishing Corporation, India, 1986, PP. 31.

The relationship of work study and productivity improvement can also be understood from the objectives of the work study. All objectives of the work study indicate that there is positive (direct) relationship between work study and productivity improvement. The objectives of the work study are as follows:

- i) Analysis of existing method
- ii) Finding weakness in existing production process
- iii) Most effective utilization of existing or proposed report and resources
- iv) Setting and measuring performance standard
- v) Use of performance standard to pay incentives
- vi) Standardize method, material and equipments used in the production process

3.5.3.1 Techniques of Work Study:

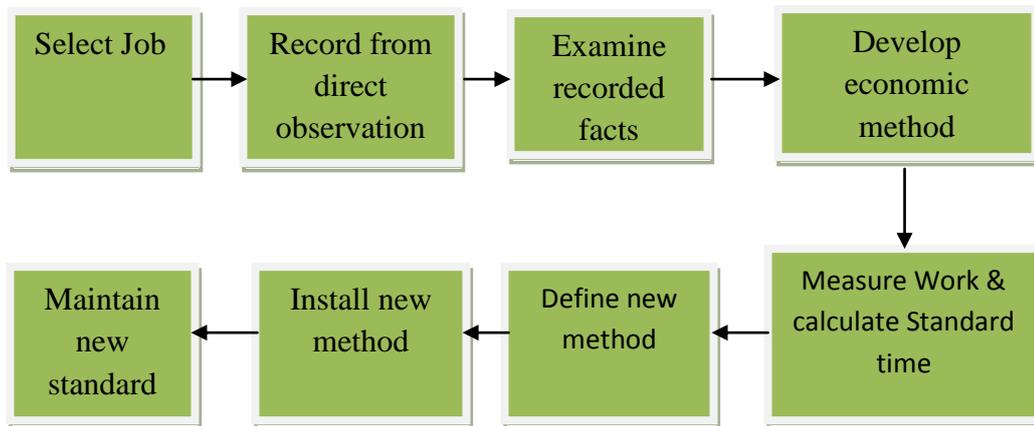
The amount of work in a given job is referred to as work content. The work study consists of two techniques:

- (a) Method Study:** Method study is the systematic recording and critical examination of existing and proposed ways of doing work. It is concerned with the reduction of work content of a job or operation.
- (b) Work Measurement:** Work Measurement is the application of techniques designed to establish the time for a qualified worker to carry out a specified job at defined level of performance. It is concerned with the investigation and reduction of any ineffective time associated with it.

3.5.3.2 Basic Procedure of Work Study:

Work study procedure consists of eight steps as shown in Figure. 3.2.

Figure 3.2
Work Study Procedure



3.5.4 Work Measurement Techniques for Productivity Improvement:

3.5.4.1 Meaning and objectives of Work Measurement:

Total manufacturing time of a product may be affected or delayed due to bad operations of the process, ineffective time added in production process, shortcomings on part of management or to actions of workers. All this factors tends to reduce the productivity of the enterprise. To eliminate or reduce these factors method study or work measurement can be used to improve productivity of the enterprise. As discussed earlier, work measurement is concerned with investing, reducing, and eliminating ineffective time. Work measurement provides management with a means of measuring the time taken in the performance of an operation by separating ineffective time from effective time. Work measurement is defined as ‘The application of a set of techniques intended to establish quantum of work to be done by an operator in a given time of a specified task, under specified conditions and at defined level of performance’⁷. Work measurement provides a scientific method of fixing production standards i.e. standard time for a job. Amount of time a particular task should take to accomplish is calculated to accomplish planning, determine performance, establish costs and improve productivity. According to ILO, ‘Work Measurement is the application of technique designed to establish the time for a

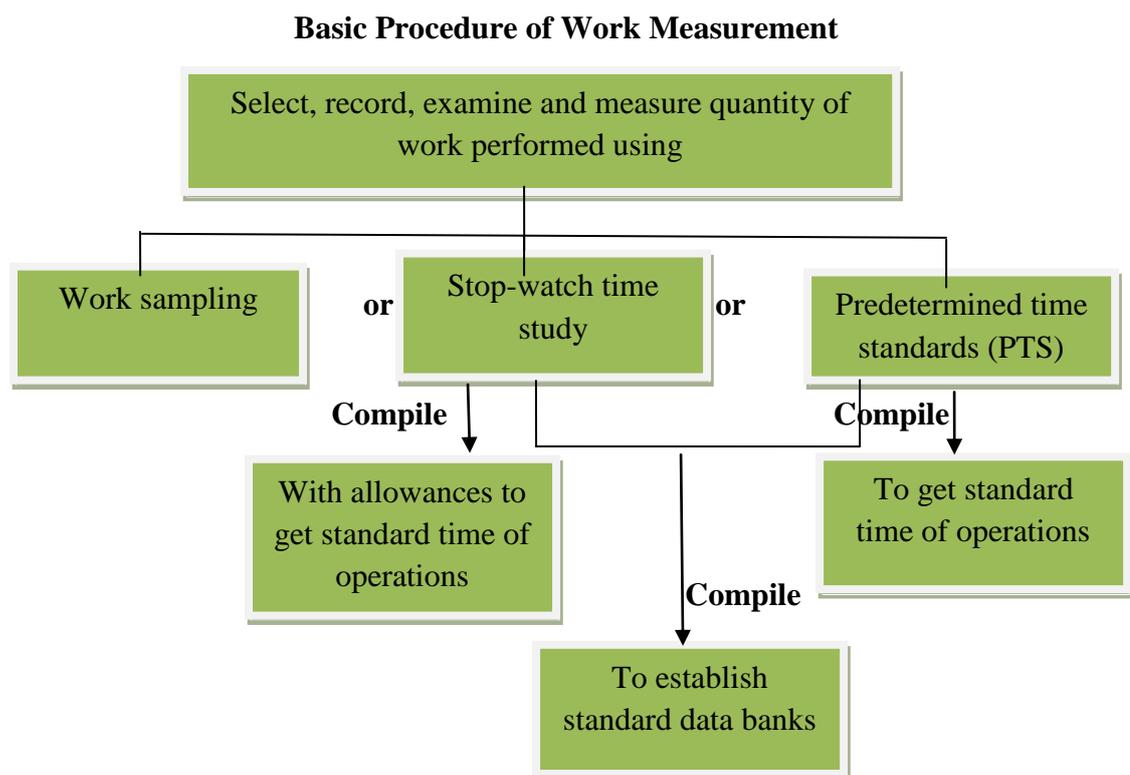
qualified worker to carry out a specified job at a defined level of performance'. Basically there are eight objectives of measurement as mentioned below:

- (i) **Planning:** Work measurement data enables management to determine manpower requirement, future requirements of equipments & machines as well as number of machines a worker can conveniently handle and to understand start and end time of a particular process.
- (ii) **Estimation of costs:** Manufacturing time is required to estimate labour cost. Similarly, indirect costs like depreciation, rent, power charges, fuel, salaries of staff and supervisors etc. depends on time.
- (iii) **Cost reduction and Cost control:** Work measurement data is helpful to reduce or control cost. Efficiency can be improved if information of men, machine utilization and time lost by men and machine is available. It provides labour costs standards which help to control labour costs.
- (iv) **Basis for incentive:** Work measurement data acts as basis for incentives to prepare for standards that needs to be achieved by worker.
- (v) **Improvement in existing methods:** Work measurement data helps to bring improvement in existing methods by eliminating unnecessary activities those results into waste of time.
- (vi) **Comparison of alternative methods:** When method study gives two or more alternatives which are equally advantageous, work measurement data helps to select one alternative.
- (vii) **Sub-standard Workers:** Work measurement data helps to set standards like production per hour or per shift by worker. Management needs to take decisions about workers like training, transfer of old workers to light jobs, action against workers who purposely work slow, etc.
- (viii) **Measuring employee performances:** Work measurement data is useful to check employee performance. It enables line management to find out if employee is making satisfactory progress, fully trained or training period should be extended or if worker is suitable for job offered.

3.5.4.2 Basic procedure of Work Measurement

The basic procedure needs to be understood to apply modified technique of work measurement. The basic procedure is divided into 6 steps namely selection, recording, examining, measuring, compiling and precisely defining methods. Full steps need to be performed only when standard time is to be calculated. These steps and the techniques necessary for measuring work are shown in Figure 3.3.

Figure 3.3

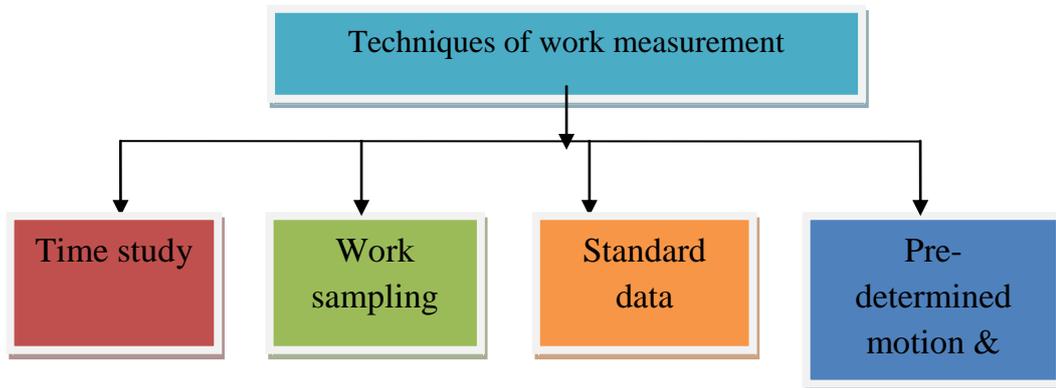


Source: International Labour Organisation, 'Introduction to Work Study', Universal Publishing Corporation, India, 1986, PP.192

3.5.4.3 Techniques of Work Measurement:

The work measurement is carried out by using following principle techniques as shown in Figure 3.4.

Figure 3.4
Techniques of Work Measurement



1. Time study:

Time study is the technique of work measurement to establish time for a qualified worker to carry out specified task under specified conditions and at defined level of performance. Basic time study equipment consists of – a stop-watch, a study-board and time study forms. The time study procedure consist of steps such as (i) Selection of Job (ii) Standardization of Method (iii) Select the operator for study (iv) Recording of details (v) Measure the duration of each element (vi) Calculating representative time of each element (vii) Convert observed time into normal time (viii) Calculate relaxation and other allowances (ix) Calculate Standard time. Time study can be performed depending on the accuracy of stopwatch method, time recording machine and motion picture camera. Time study and its application along with the procedure is discussed in chapter 7.

2. Work Sampling:

Work sampling was pioneered by L.H.C. Tippet in a British Textile Mill. It is defined as ‘A technique in which a statistically competent number of instantaneous observations are taken, over a period of time, of a group of machines, process or workers. Each observation records what is seen to happen and the percentage of observations recorded for a particular activity or delay is a measure of percentage of time observed by the occurrence’⁸. It is a method of finding the percentage occurrence of certain activity by statistical sampling and random observations. It is

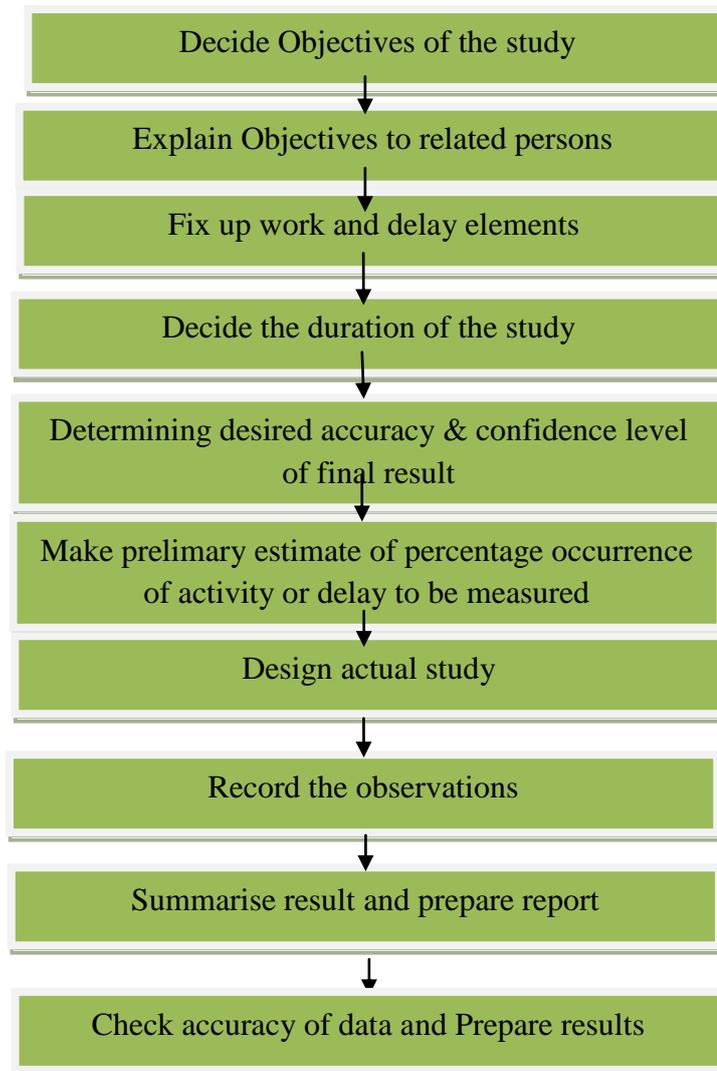
also known as ‘Activity Sampling’ , ‘Ratio-delay study’, ‘ Random observation method’, ‘Snap-reading method’ and ‘ Observation ratio study’. Work sampling can be applied and used for -

1. Work sampling data provides useful information on delays and interruptions in work process which helps to simplify work process.
2. Allowances that cannot be measured using time study method as they are small and infrequent can be economically measured by work sampling method.
3. Work sampling is used to measure the work load of heterogeneous work that involves long cycle jobs.
4. The information derived from work sampling can be used to compare the efficiency of two departments, to provide for a more equal distribution of work and reasons behind ineffective time.

Work Sampling Procedure:

Work sampling consists of following steps as shown in Figure 3.5.

Figure 3.5
Work Sampling Steps



3. Standard Data:

Large numbers of operations in a plant have several common elements. When similar elements and jobs are present throughout a plant, the standard data system of work measurement can be used. Standard data consist of tables, curves and charts built up from various basic job constituents called as elements. These elements along with the time are used to set output standards for new jobs for organization. Standard data elements must first be measured by any of the three work measurement systems: Time Study, PMTS or work sampling. Therefore, it is important to choose the elements

used in these methods that can be reused in standard data. The standardization of times and methods is critical using standard data. It is feasible under following conditions: (i) Identical elements recur consistently from job to job. (ii) The workload consists of similar operations, machines, products and methods. (iii) All similar elements have identical start and stop motions and are spread throughout the plant. Standard data helps to reduce or eliminate reproduction of work that is usually observed while performing time study as identical elements are timed over and over again. This results in reduced time studies, standard setting time and standard setting costs, thus increasing standard accuracy and consistency.

4. Predetermined Motion Time Study (PMTS):

These systems utilized the time study and micro motion techniques of the earlier techniques to determine and assign times to specified basic motions. It is a work measurement technique whereby time established for basic human motions are used to build up the time for a job at a defined level of performance. PMTS is also called as Predetermined Time Standards (PTS). The motions and associated times were catalogued. Work measurement then became a matter of establishing the best basic motion pattern to perform a certain task and, from the catalog or data card, assigning the appropriate predetermined time for each basic motion in that pattern. Since times for all motions are predetermined, it is possible to accurately predict future task times. The catalogs of predetermined times leveled to 100% of performance time. Of all the predetermined motion time systems, the most well known is Methods-Time Measurement (MTM), as developed by Harold B. Maynard, G. J. Stegemerten, and J. L. Schwab and published in 1948. Because it is a very detailed system and in the public domain, MTM has been recognized as the most accurate and widely accepted predetermined motion time system in use today. The MTM system has a detailed data card of basic motions (reach; Move; Grasp; Position; Release; body, leg, and foot motions; and so on), each concerned with particular variables. Basic motions are identified, and with the variables considered the appropriate times are chosen from the data card. Because of its detail, MTM can be a very exact system and also very slow to apply. Also, basic motion distances must be accurately measured and correctly classified because of the detail, applicator errors can be a problem. The times that

result from performing an MTM analysis reflect a 100% performance level, and times can be established for operations prior to production. MTM measures time in Time measurement Unit (TMU) and 1 TMU = 0.0006 minutes. MTM analyses an industrial job into basic human movements and standard time can be calculated by adding suitable allowances.

Synthesized versions or levels of MTM were developed to reduce applicator errors and the time of analysis known as MTM-1, MTM-2 and MTM-3. MTM-1 consists of basic components of motions such as RELEASE, REACH, GRASP, MOVE, and POSITION. MTM-2 consists of motions such as GET and PUT along with the basic motions. MTM-3 consist additional motion such as HANDLE. Higher level such as MTM-5 consists of combination of simple and complex elements. For example, the operator will reach to the washer, grasp the washer, move the washer to bolt, position it on the bolt and release it. These systems grouped or averaged together certain basic motions and/or variables to reduce the applicator effort required to apply the technique. The analysis of work using a predetermined motion time system today is performed by systematically breaking down work into very small and distinct units called basic motions. For highly repetitive, short-cycle operations, attention to detail is necessary and effective in generating valuable methods improvements.

Following are the available Predetermined Times and Motion systems:

1. Motion Time Analysis (MTA)
2. The Work Factor System (WOFAC)
3. Methods-Time-Measurement (MTM)
4. Basic Motion Time Study (BMT)
5. Dimensional Motion Times (DMT)
6. Maynard Operation Sequence Technique (MOST)
7. Modular Arrangement of Predetermined Time Standards (MODAPTS)
8. Master Standard Data (MSD)

As a matter of fact, these systems are available through consulting firms and associations. A survey of various PMTS systems is discussed in detail by Brisley⁹ in his article. In a subsequent article Brisley discusses the rules and principles for many of these systems¹⁰.

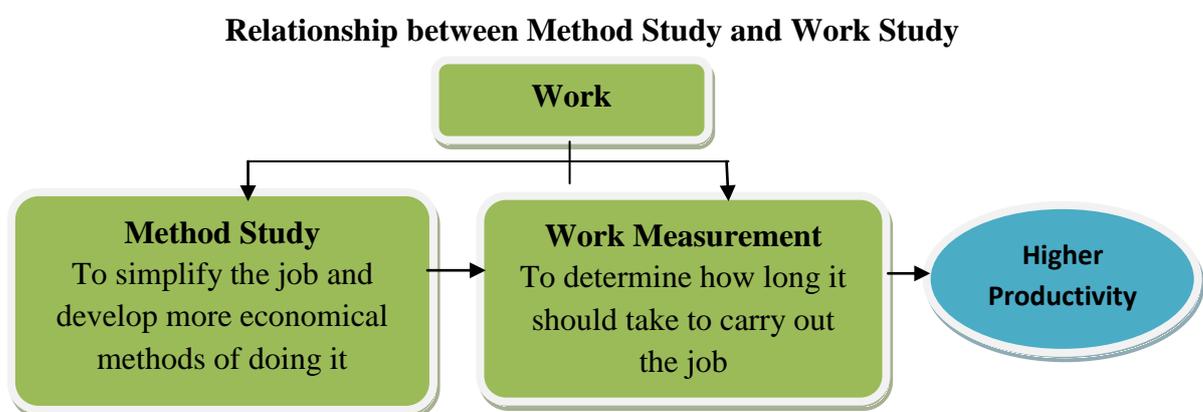
5. Maynard Operation Sequence Technique (MOST):

MOST was developed by H.B Maynard in 1970. It is one of the revolutionary predetermined Motion and Time Study techniques for work measurement. It allows the system to measure the work with the help of method steps and sequence models. MOST system comprises of (i) MOST Work Measurement Systems (ii) MOST application Systems (iii) MOST Computer Systems. Application of MOST results in accurate work standard, efficient capacity and manpower planning.

3.6 Techniques of Work Study and their relationship with productivity Improvement:

Method study and work measurement are closely linked to each other as both are associated with work study. Method study reduces the content of job and work measurement investigates and reduces ineffective time associated with job with establishment of standard time. This results into efficient working operations leading to increase in productivity of that process.

Figure 3.6



Source: ILO, Introduction to Work Study, Universal Publishing Corporation, India 1986, PP.34.

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