

# Productivity in Manufacturing Industries

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**Abstract: Low productivity of workers is the most significant factor behind delivery slippages in manufacturing industries. As manufacturing is a laborer predominant industrial sector, this paper focuses on worker output and their efficiency in the manufacturing sector. It covers the definitions of productivity, efficiency of the workers, its perspectives and the factors influencing the productivity.**

**Objective of this article is to find out how the productivity of workers in a manufacturing industry is affected. The essential significance of this review is in identifying the key variables influencing efficiency of laborers in a manufacturing industry with special emphasis in machine tool industry. The study mainly focuses on two different manufacturing companies having its factories located in different locations in India.**

**Keywords:- Productivity, Manufacturing.**

## I. INTRODUCTION

➤ **Production:** In simple terms, 'Production' is the process of manufacturing or fabricating or producing certain type of goods, semi finished or finished, input being basic raw material or semi finished products or sub assemblies. Production is a measure of output only and not a measure of efficiency of the organization.

➤ **Productivity:** Biggest and most challenging task faced today by any organization is "PRODUCTIVITY". It is the measure of the combined efficiency or integrated efficiency of employees, machines and other devices and equipments, nature of raw material inputs, performance of the management, efficiency of the whole production system. Productivity can be computed and expressed as the ratio of average acceptable output per period by the total costs incurred through various resources ( Labor, Input material, consumables, power utilized, capital, energy, material, personnel) consumed in that period. It is nothing but a measure of efficiency of the integrated system consisting of resources like Money, Men, Materials, Machines (4 Ms of an industry) and time etc.

Peter F Drucker said "Productivity means a balance between all factors of production that will give the maximum output with the smallest effort." According to European Productivity Council, "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. International Labour Organization has defined Productivity as "the ratio between the volume of output as measured by production and the corresponding volume of labour input." Japanese holistic view is "Productivity is a comprehensive holistic phenomenon encompassing all elements required to improve products / services (output)".

The term 'Productivity' has to be understood differently from the term 'Efficiency'. Efficiency is a narrower concept about the performance level of a single element. Productivity is defined in a much broader sense. Adding more unnecessary work is not exactly productive. Productivity is a measure of effectiveness of a production system. Producing right type of products of right quality (as per the design requirements) is what is expected from the term productivity. Productivity is a product of rate of production and the quality of outputs and therefore it is rather outcome-oriented than output-oriented.

- **Partial Productivity:** When only one variety of inputs is considered for the measurement of productivity, then it is often referred as "Partial Productivity". For example, measurement in no of pieces of shirts produced from a fixed length of a cloth piece. In an organization, worker hours, materials or power used per unit of production are typical examples of partial productivity.
- **Multi Factor Productivity:** Productivity measures that consider more than one variable or factors are termed as "Multi Factor Productivity (MFP)".
- **Total Factor Productivity:** Productivity which is the measure of all the variables or factors influencing the production process (Men, Machines, Material and Money or capital employed, energy charges, overhead charges etc.,) is termed as "Total Factor Productivity (TFP)". Ratio of the total output of a chemical factory with respect to the installed capacity of the plant which considers all the inputs is the typical example of MFP.

$$\text{MFP} = \frac{\text{Output}}{\text{Men+ Machines + Material + Capital, Energy charges \& others}}$$

- **Profitability:** Profitability of any system or organization hint at how efficient the organization utilizes its resources and assets to produce the outputs. Productivity of different elements in the system ultimately decides the profitability of any organization. Output and profitability of different organizations in the Nation decides the progress of the Nation which is very

significant for its global status. For progress of the Nation what is most required is the highest productivity of different organizations engaged in production or service industry. But the astonishing factor is that there is not a single organization which does not face the problem regarding productivity since the factors affecting productivity are of confronting nature and large in number. Low productivity leads to reduced profitability of the organization, cumulative effect of which is the retarded growth of the Nation.

In the whole system or organization, there are a number of factors which decides the productivity of workers. For any organization, leave alone its growth, even its survival is dependent on the productivity of its workers. As such the most critical problem that any industrial organization shall address is how to identify the reasons behind the low productivity of its workers and what are the steps required to improve the same so as to improve the profitability of the whole organization.

➤ *Employee or Worker Productivity:* “Employee Productivity” or “Worker Productivity” is the efficiency at which he or she or a group of workers produces the required outputs at the specified quality acceptance level using the specified inputs made available to him for production. Most predominant factor behind success or

failure of any organization is the productivity of its workforce and as such employee productivity is an important consideration for any enterprise. “Worker Productivity” is a measure of several economic indicators, because it proposes a continuous measure of economic growth and living standards within an economy.

➤ *Measure of Worker Productivity:* Productivity can be computed in terms of the output of the employee during a specific period of time. For example, number of units produced per hour or the time required for completing the specified task with respect to the output expected or the time estimated and projected. An extension of this evaluation is the Standard hours earned or produced. The time estimated by the planners for every job is specified and intimated through job cards of every allocation of job. On completion of the job the standard hour earned is accounted against the respective employee and the total standard hours produced or earned by the particular employee for every pre-determined interval, say per week or per month, are computed. “Productivity” of the worker is then evaluated as the ratio of standard hours earned to the actual duty hours that the worker was present to perform the assigned tasks.

$$\text{Worker Productivity} = \frac{\text{Output per unit of time}}{\text{Estimated output per unit of time}}$$

OR

$$\text{Worker Productivity} = \frac{\text{Time taken for a specified work}}{\text{Estimated time for the specified work}}$$

OR

$$\text{Worker Productivity} = \frac{\text{Standard hours earned during a period}}{\text{Actual duty hours present for the assigned tasks}}$$

**II. PRODUCTIVITY IN DIFFERENT SEGMENTS**

- *Agriculture:* If the production of a paddy field is, say ‘X’ tons, and if through using better seeds, better fertilizers and better methods of cultivation, the yield is increased to 1.5 times ‘X’, then it can be stated that the productivity of that particular piece of paddy field is improved by 50%.
- *Labour productivity:* If a tailor takes ‘X’ hours to stitch a shirt where as another skilled tailor takes only half of that then the productivity of the former is only 50%.
- *Material:* If an ordinary tailor produces ‘X’ number of shirts from a particular size of cloth piece whereas another experienced tailor can produce 1.2 times ‘X’ number of shirts from the same piece of cloth then the productivity of the experience tailor is 1.2 times that of the ordinary tailor.

- *Machining:* Normal output from a machine tool is 10 pieces per hour and after reconditioning of the machine if the output can be increased to 12 pieces per hour by increasing the machining parameters, then it can be stated that the productivity of the machine is improved 20%. Similarly in a punching machine, if in place of producing 9 pieces from a sheet of material, using CAD if 12 pieces can be punched out then it can be stated that productivity has been increased 33%.
- *Process Planning:* If the output can be increased through using a better process plan, say more than one piece being machined simultaneously using a fixture or suggesting alternative raw material to produce more than one finished component in a cycle, then we can state that the productivity is improved based on the increased output.
- *Construction:* At a construction site where contract

workers are employed, where wage rate is different for different workers, ratio of the output produced by the worker to the wages he is given represents the productivity.

$$\text{Worker Productivity} = \frac{\text{Value of the output produced during a specified period}}{\text{Wages given for the specified period}}$$

*Capital productivity:* It is the ratio of output to the capital employed.

### III. SIGNIFICANCE OF PRODUCTIVITY

- Prosperity: Productivity is the key to prosperity and leads to
  - Higher production
  - Reduced cost per unit
  - Higher wages for workers
  - Higher profit for organization.
  - More employment opportunities.
  - Improvement in standard of living.
- Economic growth:
  - Products available at reduced rate.
  - Better customer acceptance for the products.
  - Increased sales for the organization
  - Increased export
  - Improvement in foreign exchange reserves
  - Leads to economic growth of the country
  - Increased share for the share holders of the company
- Scrap reduction.
  - Reduction in raw material requirement
  - Reduction in idle time of men and machines
  - Reduction in space requirements
- Reduction in poverty and unemployment.

### IV. FIELD SURVEY

It was decided to restrict the study to the permanent full-time employees of few CPSEs engaged in manufacturing sector. The principle was that permanent employees would have acquired sufficient amount of experience in the organization and would have come across many factors which had affected the productivity of workers.

Accordingly a number of discussions were held with employees and officers of a Rail coach factory and another leading Machine Tool factory having its factories at 5 different states. The spectrum covered was workers, direct workers and indirect workers, supervisors in manufacturing and assembly shops, executives in supporting departments like Planning, Design etc. Based on the personal interviews, different influencing factors affecting productivity of

workers were identified.

### V. FACTORS AFFECTING PRODUCTIVITY

➤ *Product design characteristics:* Product design is a knowledge-intensive and cross-functional work. It is the most critical factor for the success of any organizational since the design output controls the workers productivity to a very great extent. The design has to conform the available materials in their types, and specifications, nature and conditions of the machines and other equipments in the plant.

Most of the supervisors and officers interviewed were of the opinion that most of their designers are not aware of the production capabilities of their plant. Procedure for implementation of design alterations is another hurdle in achieving productivity, said many of the supervisors. There were cases of rejection of both finished and half-finished components and cases of mismatch of mating parts in assembly. Executives in process planning department commented that principles of DFMA and DFA were not being followed by their design department.

Improving manufacturability is an important point to be considered while designing a product or a component. A systematic approach to product design “Design for Manufacturability and Assembly (DFMA)” is a powerful tool to facilitate easy manufacturing and reduced cost of production. DFMA software identifies various concepts of design that would ensure the above requirements. It is reported that Texas Instruments could reduce assembly time for an infrared sighting mechanism from 2 hours to less than half an hour. IBM is another organization to take advantage of DFMA and has brought down the assembly time for its printers from half an hour to 3 minutes. Design for Assembly (DFA) is another strategy adopted for bringing down the varieties of components/standard parts in a product and to simplify and standardize the assembly methods thereby increasing the productivity. Modular design is another concept, a peculiar approach towards standardization in which assemblies are subdivided into modules which can be easily replaced or interchanged. Modular concepts facilitate to diagnose and remedy a problem easily and quickly, thereby ensuring productivity.

➤ *Process plans:* Workers and supervisors in plant have highlighted the cases of lack of clarity in process sheets provided to them such as absence of stage drawings, inefficient methods, lack of perceiving the requirements of special tools, jigs and fixtures etc. Stage drawings for at least critical operations would enable the operators to understand the process layouts in a better way.

Process Planning is the process of deciding in advance the type of raw material and various operations to be performed in sequence for converting the selected raw material from its initial form to the final component

conforming to the design specifications as per the drawing provided. The output document is generally known as process sheet or process layout or operation layout or Route sheet etc. Different factors considered by process planning engineers are size and shape of the final components, design accuracy requirements like tolerance on dimensions and surface finish, batch quantity of production, estimated value of the finished product, required date of completion (RDC), available manufacturing facilities in the plant, conditions of machines and other equipments etc. In process layouts, the work centre and proposed machines in which the operations are planned, different steps for machining, optimum cutting parameters to be set on machines, and the tooling requirements are usually specified. If required stage drawing is also included in the process layout. In few factories process planning is performed manually, in some other units Computer Aided Process Planning (CAPP) is adopted.

- *Available machines & other equipments and their condition:* Shop personnel are often constrained to produce components utilizing the available machines in their shop under their respective control. The conditions of machines may not produce the required accuracy and other features as per the design specifications. Machines may not perform with the parameters recommended in the process sheet. Non availability of standard work holding devices is another problem faced by them.
- *Scheduling:* Scheduling is the process of prioritizing different jobs and optimizing the production resources according to the priority of jobs. Effective scheduling of jobs in a manufacturing plant is essential for ensuring the availability of right component in right time in assembly. In assembly the same is about ensuring right people at right place on right time performing right task thereby ensuring that the product is assembled in least time reducing idling of various resources.

During the observation it has been noticed that productivity of the production shops were getting affected due to inefficient and non-logical scheduling.

- Both Cast iron and steel jobs being scheduled in the same machine without considering the machining requirements of the two different types of material.
- Roughing jobs and finishing jobs which call for accurate machining being scheduled without considering the capability of the operators and machines.
- Jobs scheduled without ensuring the availability of special tooling's (Jigs and Fixtures)
- Jobs being scheduled without considering the priority of requirements in the assembly shop.
- *Technology updation and Automation:* In a production shop new technology means introduction of CNC controlled machines provided with automated tool changer (ATC), automated pallet changer (APC), automated in process gauging system and other sensing devices, automated guided vehicles (AGV), Robotics etc.

Monitoring and controlling of the entire process with the support of central computer, usage of ERP system is integrated automation. Automation reduces the manual intervention in production, eliminates repetitive tasks, reduces cost of production; result in increased output of better quality, leading to improved productivity of the whole organization. Automation also provides sufficient data of the machines and other process factors which enables the organization to analyze the factors affecting the productivity.

It was observed that the organization under study has only few CNC controlled machines in their production shop which is one of the main factors behind their low productivity.

- *Working environment:* Working environment has a direct impact on employee productivity and morale in any organization. In north India, workers keep away from work spot during winter seasons due to low temperature. So also during summer conditions. In south India absenteeism is heavy during rainy seasons. Better temperature conditions, improved air circulation and quality, providing enough lighting, reduced noise level, availability of drinking water, providing tea and snacks in shop floor, etc. create a better harmonious working environment. This will motivate the employees to work harder and more effectively which can lead to improved productivity of the organization. It is an accepted fact that if the workers are kept happy and healthy, they will perform better.
- *Standard time estimated:* Standard time estimated by the planning personnel as indicated against the respective operations is the first thing which motivates or demotivates the workers to take up the work. There were many cases wherein the time indicated does not match with the reality. This has definitely affected the productivity of the workers.
- *Non availability of right material:* In manufacturing industries batch production is the system adopted. In this system if there is a delay in making the material available for few components, it can delay the whole production process even if the material is available for all other components. Another problem observed was that in few cases material provided was not as recommended in the process layout. Oversize material if issued can definitely affect the productivity. Similarly material of inferior quality like high hardness had also affected the productivity of workers.

In assembly shops non availability of bought out items has totally halted the assembly progress of machines and coaches. Scarcity of working capital was the most critical factor for the shortage of items, said the planning personnel. Inefficiency in materials planning and inventory control also had contributed to the problem.

Non conformities in quality of the bought out items including raw material have caused a lot of inconvenience

and loss of production hours in both manufacturing and assembly shops of all the factories under study.

- *Non availability of standard tooling's:* Workers are provided with few standards cutting tools and measuring instruments against tokens. They store these items in their cupboards. Sometimes they may require additional standard toolings and other devices for specific components which they have to collect from the tool counters. It was learnt that many times workers have to return without getting the required items and they would book 'idle' job card under "NO TOOL". This has affected the productivity of workers to the extent of 2% in the organization as a whole.
- *Non availability of jigs and fixtures:* Requirement of special tooling's like jigs and fixtures are identified by the process planning personnel and indicated in the process sheet. There were many cases observed during the study that these recommended tooling's were not made available. This will necessitates change of machines or number of setups or splitting the operations or it may lead to rejections of machined components. All these had led to low productivity of workers.
- *Inspection delay:* There are two stages of inspection, one after every operation and the other after the component is claimed as completed as per the drawing and submitted for inspection. Sometimes inspection had to be carried out on machine itself before the job is unloaded. Non availability of proper measuring devices, non-availability or heavy load on inspection personnel etc had also caused the delay. Any delay that occurs during the work in process can definitely lead to loss of time affecting the productivity of the workers. There were many cases came to the attention during the study.
- *Assembly problems:* Even after total inspection and acceptance of components against the design specifications, there were cases of components returned from assembly due to mismatching of components in assembly. Reasons for the same could be dimensional variations and also unscientific way of incorporating design alterations. This calls for unexpected and unaccounted reworks of finished components which may lead to low productivity of the manufacturing shops and workers. In few organizations there is a system of granting extra special time in the job card for such alterations. This is at the cost of total manufacturing capacity of the plant.
- *Workers related issues:* Absenteeism among employees is the main cause for reduction or underutilization of the plant capacity. Absenteeism results not only in loss of plant capacity, but it also causes delay in completion of projects and consequent effects. Absenteeism also leads to disturbance in scheduling there by affecting productivity. Low efficiency of certain workers, their mental and physical health, non-resolving individual worker's issues at the plant level, their day to day family problems etc. also do affect the productivity of the plant.

Their health condition is another factor. Medically unfit employees continue to be in the rolls which affect the productivity of the section. Lack of training is another significant contributing factor towards low productivity.

- *Lack of supervisory support:* During the discussion few machine operators were raising the complaints that their supervisors were not very effective in solving technical and section related problems.

Supervision is not just overseeing and managing employees in the workplace. Supervisors are primarily responsible for the productivity of workers under their control. Supervisors shall possess strong working knowledge of the jobs. Supervision if to be effective shall include problem solving, fast decision making, planning and organising materials and papers for production, co-ordination with other departments and meeting management and solving workers related problems, training new employees and ensuring conformance to personnel policies and other internal regulations.

- *Working hours:* In different manufacturing units of the organization under study, the shift timings were different. In few units the timings were A shift – 5.30 am to 1.30 pm followed by B and C shifts of 8 hours each. In some other units the timings were A shift – 8.00 am to 4.00 pm followed by B and C shifts. On an analysis of shift wise performance records of different units it was learnt that productivity was more in units where shift timings were A shift – 5.30 am to 1.30 pm. In the other factory it was 7 am to 3 pm which was more convenient to most of the workers. Productivity was also high. Regarding acceptance of shift timings, discussions were held with different trade unions of different units. It was noticed that shift timings of 7 am- 3 pm, 3 to 11, and 11 to 8 were preferred where most of the workers were staying in company provided quarters.
- *HR & IR related matters:* During an interaction with office bearers of recognized trade unions of all the 5 manufacturing units, it was noticed that there were a number of HR & IR related issues which were disturbing the minds of the workers. Delay in payment of regular wages and other financial benefits, promotion related issues, other personal oriented issues were there.

## VI. CONSOLIDATION

From the personal interviews conducted with employees of different factories, around 100 from six factories, following were identified as significant factors affecting Workers productivity:

- Product design characteristics
- Process plans
- Available machines & other equipments and their condition
- Scheduling
- Technology updation and Automation
- Working environment
- Standard time estimated

- Non availability of right material
- Non availability of standard cutting tools
- Non availability of jigs and fixtures
- Inspection delay
- Assembly problems
- Workers related issues
- Lack of supervisory support
- Working hours
- HR & IR related matters

## VII. INFERENCE

From the preliminary discussion held with employees of 6 factories it could be concluded that *delay in ensuring the availability of right material in right time in different production shops has affected the productivity of workers to the maximum extent.*

## VIII. DISCUSSIONS & CONCLUSIONS

For an organization to progress, it is very important to identify and understand various factors that influence the growth of the organization. Productivity of workers is the most important factor among them. Every organization shall have a special eye to monitor this performance factor. This study was concerned with identifying the significant factors concerning the same.

Study was conducted in six factories located in different states in the country manufacturing different types of equipments like rail coaches, lathes, milling machines, machining centres, special purpose machines, grinding machines, defence equipments etc. Therefore it is believed that the findings of the study also represent the population of manufacturing industries as a whole.

The findings of this study revealed that

- there are 16 significant factors affecting the workers productivity.
- based on the criticality of these factors, the same can be classified in to different groups.
- delay in ensuring the availability of right material in right time is the most significant factor affecting the productivity of workers in manufacturing industries.
- Highest proportion of idle time occurring in an organization is due to the fact that labour is available for production but is not engaged in active production due to shortage of material.

## SUGGESTIONS

This study has mainly focused on two different manufacturing companies, a Rail coach building factory and a Machine Tool manufacturing company. Former is a multiproduct multi variant company and the later is a single product unit. Batch production is the type of production followed in the former where as the later one is having continuous production. Machine Tool factory is having component centre type of lay out where as the Rail coach unit is having a process type flow line for rail coaches.

These distinct features of two manufacturing companies are reflected in the response to the questionnaire. These distinguishing characteristics of the companies can be still different for another group of companies. Therefore it is proposed that similar studies can be undertaken in other manufacturing industries too like automobile manufacturing companies, ship building companies, aeronautics manufacturing company etc.

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