Productivity Improvement by use of Time Study, Motion Study, Lean Tool's and Different Strategy for Assembly of Automobile Vehicles

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Abstract— Now a day's cut throat competition is going on so if you want to sustain in market then give best product quality with minimum cost, minimum delivery time, customer satisfaction and ultimate increase the rate of production for industry profit. This paper identified how simple methods can be used to improve the rate of production in vehicle assembly. By making simple changes to the process, it can reduce the time taken for each operation to improve the production rate. Productivity improvement is achieved through analyzing the current method by eliminating un-necessary movements by use of standard operating procedure, reducing cycle time and providing appropriate solutions to various problems during the assembly of components to improve productivity.

Key words: Productivity, Quality, Lead Time, Cost, Customer Satisfaction, Eliminating Wastes

I. INTRODUCTION

Day to day changing economic conditions such as global competition, declining profit margin, customer demand for high quality product, product variety and reduced lead–time etc. this factor are major impact on manufacturing industries. The demand for higher value at lower price is increasing so survive in global market's need to improve different operations through-Producing right first time quality and waste reduction [7].

Researchers are actively engaged in related to productivity improvement, quality improvement, profit improvement and minimize the rate of rejection. So full fill this requirement by use of select best method for performing various operations and calculate time taken for each operation and select the best method for material movement, and at the last stage find the bottleneck operation and minimize the total manufacturing lead time so ultimate increase the productivity and quality of different products. The following are main part of rate of production [7].

The productivity improvement is basically depends upon company process analysis. After process analysis for the current process plan of the company, identified some spaces where we were having chance for improvement. From that we reach to the conclusion, some modifications are required in the process plan, current plant layout with the help of which we can improve the productivity up to satisfactory requirement. Main part of the study are methodologies used currently, working conditions with which staff is working as well as the material handling map for the jobs inside the premises of company which is used for the job from raw material to finished goods [6].

To improve the productivity in a manufacturing company by putting light on some specific areas of manufacturing like plant layout, material movement, waste of materials, poor workmanship by using cellular manufacturing and work-study techniques. Cellular manufacturing is mainly based on group technology which utilizes the method of standardization and similarity of parts. In this process the machines are grouped according to similar parts no. Improving productivity through time and motion study is used in the manufacturing sector. Work study consists of two aspects method study and work measurement which when applied effectively results to higher productivity. In this method average time is calculated as according to new machine layout for completing a job at different work stations [8].

II. PRODUCTIVITY IMPROVEMENT METHODS, LEAN TOOLS AND STRATEGY

A. Khalid S. Al-Saleh [1] Motion and Time Study Method:

When a new product is being put into production or the improvement of a method already in effect, is a very important part of motion and time study.

The elimination of unnecessary work and the design of methods and procedures are the most important objectives of motion and time study.

It is expected that the productivity, profit, and comfort of customers will increase while the flow time, cost, and labor requirement will decrease. Eliminate all unnecessary work, combine operations or elements, change the sequence of operations, and simplify the necessary operations. The standard time for each inspection point was calculated by using the following formula.

Standard Time= Normal Time*100/(100-Allowance Time).

OR

Standard Time=Normal time + Allowances.
Normal Time= Observed time*Rating factor.
Observed time= Direct stop watch time in seconds.

Two types of time study are employed where the initial time study conducted was the direct stopwatch time study used to validate the current OEE standard. Maynard's Operation Sequencing Technique (MOST) is then adopted to conduct the secondary time study. Motion and time study consists of four parts and two parts:

- Motion study or work methods design—to find the preferred method of conducting work.
- Time study or work measurement— to obtain the standard time to perform a specific task.

1) Stopwatch: A conventional method to record and rate the work elements of a specified job done under specific condition and the data are further analyzed to determine the standard time for a particular job.

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2) Work sampling: A large number of observations are made over a period of time for one or group of machines, processes or workers. This technique aims to measure the percentage of time during
3) Predetermine motion time system (PMTS): A work measurement technique which develops the time for a job using previously established time for the basic human motions in time measurement units (TMU).
4) MOST: A complete study of an operation or a sub-operation typically where appropriate parameter time values are assigned, resulting in a total normal time for the operation or sub-operation. The difference between time study and MOST is that time study is used as a direct measurement tool.

B. Mr. Pramandra Kumar Gupta [2]. Effective Utilization of Workforce:

Effective utilization of workforce is a primary objective for any manufacturing organization is no exception to this. In-fact, considering the significant environmental and safety risks associated, it becomes imperative to deploy the right number of associates in the plant and at appropriate locations.

C. T. K. Lien [3]. Parallel Arrangement of Stations:

The two basic principles for the manual assembly the parallel arrangement of stations, and the sequential arrangement. A theoretical model for the possible output as function of production volume, number of assembly operations, number of product variants, and station operation time imbalance is presented. This model enables prediction of the performance and selection of the optimal system for a given set of conditions.

This would seem to be an inefficient solution since individual workers operational speed will determine the overall output. But experience with the system has shown that it will not necessarily give a lower overall efficiency. It is true that individual worker speed will determine the overall production rate. But provided that the workstations are laid out properly according to ergonomic principles and good assembly technology standards, normal workers will perform just as well as in machine-paced operations. So parallel operation is best instead of sequential operation.

D. Rohan Kulkarni [4]. Automation Method:

Automation is a broad field among other engineering disciplines. The major activities of Automation stem from manufacturing industries and include cycle time improvement, productivity improvement, cost reduction, efficiency improvement, materials handling, analyze and improve the work methods, to eliminate waste and proper allocation and utilization of resources. Automation in a manufacturing shop is one of the most challenging tasks, as it has an impact of many interrelated variables and parameters. A detailed study by large data acquisition and analysis is essential for understanding the trends in productivity improvement. Productivity improvement is achieved through analyzing the current method by eliminating un-necessary movements, reducing cycle time and providing appropriate solutions to various problems during the machining of components to improve productivity.

E. Priti Mandwe [5]. Process Analysis:

The productivity improvement is basically depends upon company process analysis. After process analysis for the current process plan of the company, identified some spaces where we were having chance for improvement. From that we reach to the conclusion, some modifications are required in the process plan, current plant layout with the help of which we can improve the productivity up to satisfactory requirement. Main part of the study are methodologies used currently, working conditions with which staff is working as well as the material handling map for the jobs inside the premises of company which is used for the job from raw material to finished goods.

F. Md. Mazedul Islam[6]. Eliminating nonproductive activities:

The study clearly indicates that by eliminating non-productive activities like reworks in industries time as well as cost are saved by ensuring quality production which have an important impact on overall factory economy.

G. Gyanendra Prasad [7]. Cellular Manufacturing:

To improve the productivity in a manufacturing company by putting light on some specific areas of manufacturing like plant layout, material movement, waste of materials, poor workmanship by using cellular manufacturing and work-study techniques. Cellular manufacturing is mainly based on group technology which utilizes the method of standardization and similarity of parts. In this process the machines are grouped according to similar parts no. Improving productivity through time and motion study is used in the manufacturing sector. Work study consists of two aspects method study and work measurement which when applied effectively results to higher productivity. In this method average time is calculated as according to new machine layout for completing a job at different work stations.

Method Study is defined as a systematic and critical study of the existing method of doing a task, with a view to evolve the most efficient and economic method of doing it. Work Measurement is very important. It is a technique of establishing the proper time required in performing a job or work. Since it is concerned with measurement of time so it is also called time study.

H. Md. Rezaul Hasan Shumon [8]. Balancing Method:

The effective layout model where to hit upon the bottleneck process through benchmark capacity and led us to use balancing process using two separate concept of manufacturing processes- modular line and Traditional system both together. Balancing method is very essential to make the production flow almost smoother compare to the previous layout. Considering working distance, type of machines and efficiency, workers who have extra time to work after completing their works, have been shared their work to complete the bottleneck processes.

I. Wan Faizul Bin [9]. Direct Observation Method:

Other than that, direct observation method, archival data and self collecting data are used. Live experiments are conducted on production lines. Four problems are identified such as reworked, not enough manpower, delayed process, high waiting time, and low production which are not in the

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target for one day production. Interventions are made to rectify the problems such as to reduce waiting time in problem's section by adding buffer which for temporarily storage for finished part in order to minimize waiting time for finished section sent the finish part without have to wait. As a result, the production productivity for the trim line production is increased.

J. Sandip K. Kumbhar[10]. Kaizen Method:

Kaizen means Continuous Improvement, This requirement is focusing on optimization of cycle time, reduction non value added work (3M-Muda, Muri, Mura), Kaizen: Continuous Improvement. In Japanese Kaizen is for continuous automated improvement designed to eliminate waste on resources of manufacturing system i.e. machinery, material, worker and production methods. Improvement in the productivity achieved and elimination of non value added activities has been done. The cost of operation is reduced considerably. Optimization of cycle time study is helpful for low cost automation and bench marking activity at industry Production improvement level.

K. Hazri M. Rusli[11]. Supplier Kaizen Framework:

steps and methodology to implement the lean manufacturing, This resulted in substantial improvements in quality, timely delivery and cost saving which in total improves the bottom line. Kaizen can be roughly translated as continuous incremental improvement and it is most suitable when applied tactically to a product line or to an entire organization that is relatively mature and stable. On the other hand, Kaikaku, which can be roughly translated as radical improvement is more of a holistic transformational process.

L. Saurabh Tiwari[12]. 6S Method:

The extension of 5S method is called a 6S method. The safety is most important parameter I organization. the basic and easy tool to implement for an approach to create an orderly and safe workplace. The detail study of 6S and its successful implementation in workplaces like in production line and its extension to other work environments such as health care, construction, etc.

6S becomes the powerful tool to provide a starting point. 6S allows managers to better understand the work environment using different Visual signs and also set the starting baseline for Lean Six Sigma.

M. Michal Leporis[13]. Bottleneck Analysis Method:

The term "bottleneck" is used to describe a point of congestion in any system from computer networks to a factory assembly line. In such a system, there is always some process, task, machine, etc. that is the limiting factor preventing a greater throughput and thus determines the capacity of the entire system. Knowing the bottleneck allows increasing the flow by improving just one process in the system rather than all its remaining parts. Vice versa, if there is a bottleneck, nothing done elsewhere in the value stream can improve the throughput Both theory and practice of production management pay great attention to the bottleneck analysis in order to increase throughput of a production system, i.e. the rate at which the system generates money through sales of its products. The bottleneck in production system occurs when workloads arrive at a given point more quickly than that point can handle them. The bottleneck situation causes unneeded inventory and prolongs manufacturing lead times. In a wider sense of the word, any element of a production system (machine, conveyor, AGV, buffer, labor etc.) can turn to a bottleneck.

N. P. M. Rojasra[14] 5S method:

The efficient implementation of 5S technique leads to subsequent improvement in productivity of the manufacturing plant. The 5S improves environmental performance and thus relate primarily in reduction of wastes in manufacturing. It promotes neatness in storage of raw material and finished products.

The 5S is a set of straight forward steps towards continual improvement. Implementation of the 5S can improve the quality, productivity and working conditions in the organizations. The 5S is an effective management tool which can improve housekeeping, environmental conditions and health and safety standards. 5S sort stage eliminates unused, unwanted material from the shop floor which reduces clutter.

In the path of implementation of the Total Quality Management on the operational level, 5S will become the first step. 5S is a Japanese concept for increasing quality and productivity. 5S will become the essential tool for acquiring continuous Improvement in the organization. In any organization improvement begins with 5S. 5S is a Lean Tool which is implemented for obtaining a clean, effective and pleasant work environment. 5S is the first step of approaching the Lean Manufacturing. 5S is a strategy that delivers results by a systematic approach of planning and organizing the activities.

- SEIRI [Sort]
- SEIRON [Set in order]
- SEISO [Shine]
- SEIKETSU [Standardize]
- SHITSUKE [Sustain]

Lean Tool and Methods	**What Is It?**	**How Does It Help?**
Time study	Standard Time= Normal Time*100/(100-Allowance Time). OR Standard Time=Normal time + Allowances. Normal Time= Observed time*Rating factor. Observed time= Direct stop watch time in seconds.	Time study is the most important method for productivity improvement, before implement any lean tool first time study should be conducted.
5S	Organize the work area: Sort (eliminate that which is not needed) Set In Order (organize remaining items)	Eliminates waste that results from a poorly organized work area (e.g. wasting time looking for a tool).

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	Shine (clean and inspect work area) Standardize (write standards for above) Sustain (regularly apply the standards)	
Bottleneck Analysis	Identify which part of the manufacturing process limits the overall throughput and improve the performance of that part of the process.	Improves throughput by strengthening the weakest link in the manufacturing process.
Andon	Visual feedback system for the plant floor that indicates production status, alerts when assistance is needed, and empowers operators to stop the production process.	Acts as a real-time communication tool for the plant floor that brings immediate attention to problems as they occur – so they can be instantly addressed.
Continuous Flow	Manufacturing where work-in-process smoothly flows through production with minimal (or no) buffers between steps of the manufacturing process.	Eliminates many forms of waste (e.g. inventory, waiting time, and transport).
Heijunka (Level Scheduling)	A form of production scheduling that purposely manufactures in much smaller batches by sequencing (mixing) product variants within the same process.	Reduces lead times (since each product or variant is manufactured more frequently) and inventory (since batches are smaller).
jidoka (Autonomation)	Design equipment to partially automate the manufacturing process (partial automation is typically much less expensive than full automation) and to automatically stop when defects are detected.	After Jidoka, workers can frequently monitor multiple stations (reducing labor costs) and many quality issues can be detected immediately (improving quality).
Hoshin Kanri (Policy Deployment)	Align the goals of the company (Strategy), with the plans of middle management (Tactics) and the work performed on the plant floor (Action).	Ensures that progress towards strategic goals is consistent and thorough – eliminating the waste that comes from poor communication and inconsistent direction.
Just-In-Time (JIT)	Pull parts through production based on customer demand instead of pushing parts through production based on projected demand. Relies	Highly effective in reducing inventory levels. Improves cash flow and reduces space requirement
Kaizen (Continuous Improvement)	A strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing process.	Combines the collective talents of a company to create an engine for continually eliminating waste from manufacturing processes.
Kanban (Pull System)	A method of regulating the flow of goods both within the factory and with outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed.	Eliminates waste from inventory and overproduction. Can eliminate the need for physical inventories (instead relying on signal cards to indicate when more goods need to be ordered).
KPI (Key Performance Indicator)	Metrics designed to track and encourage progress towards critical goals of the organization. Strongly promoted KPIs can be extremely powerful drivers of behavior – so it is important to carefully select KPIs that will drive desired behavior.	The best manufacturing KPIs: Are aligned with top-level strategic goals (thus helping to achieve those goals) Are effective at exposing and quantifying waste (OEE is a good example)
Muda (Waste)	Anything in the manufacturing process that does not add value from the customer''s perspective.	Eliminating muda (waste) is the primary focus of lean manufacturing.
Overall Equipment Effectiveness (OEE)	Framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked: Availability (e.g. down time) Performance (e.g. slow cycles) Quality (e.g. rejects)	Provides a benchmark/baseline and a means to track progress in eliminating waste from a manufacturing process. 100% OEE means perfect production (manufacturing only good parts, as fast as possible, with no down time).
PDCA (Plan, Do, Check, Act)	An iterative methodology for implementing improvements: Plan (establish plan and expected results) Do (implement plan) Check (verify expected results achieved) Act (review and assess; do it again)	Applies a scientific approach to making improvements: Plan (develop a hypothesis) Do (run experiment) Check (evaluate results) Act (refine your experiment; try again)
Poka-Yoke (Error Proofing)	Design error detection and prevention into production processes with the goal of achieving zero defects.	It is difficult (and expensive) to find all defects through inspection, and correcting defects typically gets significantly more expensive at each stage of production.

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Root Cause Analysis	A problem solving methodology that focuses on resolving the underlying problem instead of applying quick fixes that only treat immediate symptoms of the problem. A common approach is to ask why five times – each time moving a step	Helps to ensure that a problem is truly eliminated by applying corrective action to the "root cause" of the problem.
Single Minute Exchange of Die (SMED)	Reduce setup (changeover) time to less than 10 minutes. Techniques include: Convert setup steps to be external (performed while the process is running) Simplify internal setup (e.g. replace bolts with knobs and levers) Eliminate non-essential operations Create standardized work instructions	Enables manufacturing in smaller lots, reduces inventory, and improves customer responsiveness.
Six Big Losses	Six categories of productivity loss that are almost universally experienced in manufacturing: Breakdowns Setup/Adjustments Small Stops Reduced Speed Startup Rejects Production Rejects	Provides a framework for attacking the most common causes of waste in manufacturing.
SMART Goals	Goals that are: Specific, Measurable, Attainable, Relevant, and Time-Specific.	Helps to ensure that goals are effective.
Standardized Work	Documented procedures for manufacturing that capture best practices (including the time to complete each task). Must be "living" documentation that is easy to change.	Eliminates waste by consistently applying best practices. Forms a baseline for future improvement activities.
Takt Time	The pace of production (e.g. manufacturing one piece every 34 seconds) that aligns production with customer demand. Calculated as Planned Production Time / Customer Demand.	Provides a simple, consistent and intuitive method of pacing production. Is easily extended to provide an efficiency goal for the plant floor (Actual Pieces / Target Pieces).
Total Productive Maintenance (TPM)	A holistic approach to maintenance that focuses on proactive and preventative maintenance to maximize the operational time of equipment. TPM blurs the distinction between maintenance and production by placing a strong emphasis on empowering operators to help maintain their equipment.	Creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity (increasing up time, reducing cycle times, and eliminating defects).
Value Stream Mapping	A tool used to visually map the flow of production. Shows the current and future state of processes in a way that highlights opportunities for improvement.	Exposes waste in the current processes and provides a roadmap for improvement through the future state.
Visual Factory	Visual indicators, displays and controls used throughout manufacturing plants to improve communication of information.	Makes the state and condition of manufacturing processes easily accessible and very clear – to everyone.

Table 1:

III. Conclusion

This paper identified how simple methods can be used to improve productivity in assembly line. By making simple changes to the process, it can reduce the time taken for each operation to improve the flow and speed up the process. Importantly, the costs and benefits of an additional process have also been calculated which predict by making those changes that output can be increased dramatically. Here by use of different methods and simple strategy we can increase the rate of production, quality and minimize the rejection rate.

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