PRODUCTIVITY IMPROVEMENT ON ASSEMBLY LINE THROUGH REDUCTION OF DOWN TIME USING AUTONOMOUS MAINTENANCE

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Abstract

Autonomous Maintenance (AM) is a team-based approach to maintenance activities and part of a Total Productive Maintenance (TPM) process. The process is a partnership between operators, maintenance technicians, engineers and leaders in the operation and maintenance of the equipment. The goal of autonomous maintenance is to prepare operators to do some basic daily equipment care independently of the maintenance staff. It is not an awareness course, but a hands-on training for the successful implementation of an autonomous maintenance effort. The steps necessary to involve operators in maintaining their own equipment through daily inspections, lubrications, detection of abnormalities, and precision checks. The result is restoration of equipment to its ideal state, establishment of basic conditions for maintaining it, and prevention of equipment deterioration. Properly implemented, AM eliminates the causes of 40-60% of unplanned downtime, freeing skilled trades for more specialized activities, like major overhauls, upgrades, predictive programs and new equipment planning and design. It is an applied methodology of scientific, objective technique that cause work tasks in a process to be performed with a minimum of non-value adding activities resulting in greatly reduced wait time, queue time, move time, administrative time, and other delays. The prime objective is to evolve and test few strategies to eliminate waste on the shop floor. This work is focused on improving the Productivity of the seat welding and assembly plant by reducing the down time using lean tools. The non-value added activities which are identified in the assembly line will be eliminated using lean tools. The paper addresses the productivity improvement of a seat welding and assembly line. The goal of this paper is to identify and reduce the downtimes. An attempt has been made in this paper to present some experiences of implementing new productivity improvement strategies in a small company. In this paper experiences with implementation of productivity improvement strategies are presented.
Keywords: Productivity improvement, line balancing, Autonomous maintenance

1. Introduction

In the past a lot of effort has been put to reducing the cycle time and speeding up the output rate whilst totally ignoring the change overtime from one product to another. This has led to the Economic batch quantity Concept and has resulted in small batches appearing to be uneconomical to run. In the past a lot of effort has been put to reducing the cycle time and speeding up the output rate whilst totally ignoring the change overtime from one product to another. This has led to the Economic batch quantity concept and has resulted in small batches appearing to be Uneconomical to run. Reducing Setup times (Which we rarely Concentrate on) can give the Equivalent of huge increase in process speed (Which we almost and always concentrate on).

TPM is designed to maximize the overall equipment effectiveness. It involves all departments that plan, use and maintain equipment, involves all employees from top management to front line workers [1]. The concept of TPM was developed in Denso, A tier one automotive supplier in the Toyota group of suppliers, during 1960s and 70s in Japan. The central thrust of the programme was the complete elimination of the —six major equipment lossesl. The key concept behind effective improvements was autonomous maintenance. The concept of overall equipment effectiveness (OEE) and focused improvement were found to be quite encouraging for success of TPM [2]. The aim of the TPM is to improve the labour productivity and to reduce the maintenance cost. The work of the Japanese consultant Koichi in Nissan Motors were acknowledged as 10% reduction in maintenance cost, 30% reduction in manpower and 140% increase in 46 labour productivity were reported. Author reported that labour productivity increases by 140%-150% and maintenance cost decreases by 15%. Customers claim that poor quality reduces by 20%-25% and machine breakdowns by 98% [3]. TPM aims to develop both the company and its employees individually. It aims to bring equipment to peak operating condition by eliminating the losses that hamper plant effectiveness. That is to achieve zero breakdowns, zero defects and zero accidents .TPM concepts involve commitments to long-range planning, especially on the part of senior management. Typically, TPM is initiated as a—top-down exercise, but only implemented successfully via —bottom-up participation. However, consensus building may take about three years, from the planning phase, for sustainability to be achieved in a large organization . TPM is a manufacturing-led initiative that emphasizes the importance of (i) people with a ‘can do‘ and continual improvement attitude and (ii) production and maintenance personnel working together in unison. TPM combines the best features of productive and preventive maintenance (PM) procedures with innovative management strategies and
encourages total employee involvement. TPM does not provide a quick or easy solution. It usually requires changes in employee’s attitudes and values, which take time to imbibe. Quick and company-wide performance gains should not be expected during the initial phase. TPM helps organize maintenance activities by applying the following actions:

- Cultivate a sense of ownership in the operator by introducing autonomous maintenance—the operator takes responsibility for the primary care of his/her plant.
- Use cross-functional teams consisting of operators, maintainers, engineers and managers to improve individual employee and equipment performances.
- Establish an optimal schedule of clean-up and PM to extend the plant’s lifespan and maximize its uptime.

TPM brings maintenance into focus as a necessary and vitally important part of the business: maintenance should no longer be regarded as a non-profit-making activity. The goal is to minimize the frequency and magnitudes of emergency and unscheduled maintenance interruptions. In all, TPM implementation will involve design, operation, maintenance, engineering and sales activities, and may require hiring or appointing a TPM coordinator whose responsibility is to advocate through an educational programme the TPM concepts to the workforce, and check that they are being implemented. Each person becomes a stakeholder in the process and is encouraged to do his or her best to contribute to the success of the team. TPM requires a drastic change in the traditional mindset of work culture and maintenance approaches. For this active top management support is crucial to overcome resistance of employees, especially during the transition period. A positive strategic outcome of TPM implementations is the reduced occurrence of unexpected machine breakdowns, which ultimately results in enhanced profits in the organization [4].

The results of the analyses indicate that TPM controls manufacturing cost, quality, and delivery time. TPM can be a strong contributor to the strength of the organization and has the ability to improve MP (Manufacturing performance) [5]. With competition in manufacturing industries rising relentlessly, TPM can be the maintenance philosophy preventing the failure of an organization. It is a maintenance programme that works with TQM and lean management. Manufacturing is considered to be an important element in a firm’s endeavour to improve firm performance. Superior manufacturing performance leads to competitiveness. TPM is a highly structured approach, which uses a number of tools and techniques to achieve highly effective plants and machinery. With competition in manufacturing industries rising relentlessly, TPM has proved to be the maintenance improvement philosophy preventing the failure of an organization. Today, an effective TPM strategy and programs are needed, which can cope with the dynamic needs and discover the hidden but unused or underutilized resources (human brainpower, man-hours, machine-hours). TPM
methodology has the potential to meet the current demands. A well conceived TPM implementation program not only improve the equipment efficiency and effectiveness but also brings appreciable improvements in other areas of the manufacturing enterprise.

Authors [6] have investigated the strategic implications of TQM and TPM in an Indian manufacturing set-up. Author[7] has described the dynamic implications of TPM by working out inter relations between various pillars of TPM to analyze the fundamental structures and identifies the most appropriate strategy for the implementation of TPM considering the interplay of different pillars of this 48 maintenance approach.

Authors[8] have stated that equipment is the major contributor to the performance and profitability of manufacturing systems.

Author [9] have investigated the significant contributions of TPM implementation success factors like top management leadership and involvement, traditional maintenance practices and holistic TPM implementation initiatives, towards affecting improvements in manufacturing.

**Pillars of TPM**

The basic practices of TPM are often called the pillars or elements of TPM. The entire edifice of TPM is built and stands, on eight pillars (Sangameshwran & Jagannathan, 2002). TPM paves way for excellent planning, organizing, monitoring and controlling practices through its unique eight-pillar methodology. TPM initiatives, as suggested and promoted by Japan Institute of Plant Maintenance (JIPM), involve an eight pillar implementation plan that results in substantial increase in labour productivity through controlled maintenance, reduction in maintenance costs, and reduced production stoppages and downtimes. The core TPM initiatives classified into eight TPM pillars or activities for accomplishing the manufacturing performance improvements include autonomous maintenance; focused maintenance; planned maintenance; quality maintenance; education and training; office TPM; development management. The detailed maintenance and organizational improvement initiatives and activities associated with the respective TPM pillars are as follows: Pillar 1-5S: TPM starts with 5S. It is a systematic process of housekeeping to achieve a serene environment in the work place involving the employees with a commitment to sincerely implement and practice house -keeping. Problems cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of
5S is a foundation program before the implementation of TPM. If this 5S is not taken up seriously, then it leads to 5D (delays, defects, dissatisfied customers, declining profits, and demoralized employees).

This 5S implementation has to be carried out in-phased manner. First the current situation of the workplace has to be studied by conducting a 5S audit. This audit uses check sheets to evaluate the current situation. This check sheet consists of various 49 parameters to be rated say on a 5-point basis for each ‘S’. The ratings give the current situation. The each of the above-mentioned 5S is implemented and audit is conducted at regular intervals to monitor the progress and evaluate the success of implementation. After the completion of implementation of 5S random audits could be conducted using company check sheets to ensure that it is observed in true spirits by every one in the workplace.

Pillar 2-Autonomous maintenance
This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating. By use of this pillar, the aim is to maintain the machine in new condition. The activities involved are very simple nature. This includes cleaning, lubricating, visual inspection, tightening of loosened bolts etc. Maintenance policy are uninterrupted operation of equipments, flexible operators to operate and maintain other equipments, and eliminating the defects at source through active employee participation. Steps in are Autonomous maintenance preparation of employees, initial cleanup of machines, take counter measures, fix tentative Autonomous maintenance (JISHU HOZEN) standards, general inspection, autonomous inspection, and standardization.

Pillar 3-Kaizen:
—Kai means change, and —Zenl means good (for the better). Basically kaizen is for small Improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that —a very large number of small improvements are more effective in an organizational environment than a few improvements of large value. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well. Kaizen policy are practice concepts of zero losses in every sphere of activity, relentless pursuit to achieve cost reduction targets in all resources, relentless pursuit to improve over all plant equipment effectiveness, extensive use of PM analysis as a tool for eliminating losses, and focus of easy handling of operators. Kaizen target are achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost
reduction. Tools used in kaizen are Why-Why analysis, Poka-Yoke (Poka-Yoke is Japanese term, which in English means ‘mistake proofing’ or ‘error prevention’), summary of losses, kaizen register, and kaizen summary sheet. The objective of TPM is maximization of equipment effectiveness. TPM aims at maximization of machine utilization and not merely machine availability maximization. As one of the pillars of TPM activities, kaizen pursues efficient equipment, operator and material and energy utilization that is extremes of productivity and aims at achieving substantial effects. Kaizen activities try to thoroughly eliminate losses. Six major losses that were identified are: equipment failure, set-up and adjustments, small stops, speed losses during production and losses during warm-up (Nakajima, 1988). Pillar 4-Planned maintenance It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into four—families or groups, viz., preventive maintenance, breakdown maintenance, corrective maintenance, and maintenance prevention. With this we evolve our efforts from a reactive to a proactive method and use trained maintenance staff to help train the operators to better maintain their equipment. In Planned maintenance policy are achieve and sustain availability of machines, optimum maintenance cost, reduces spares inventory, and improve reliability and maintainability of machines. Pillar 5-Quality maintenance

It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like focused improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, and then move to potential quality concerns. Transition is from reactive to proactive (quality control to quality assurance). Quality Maintenance activities are to set 51 equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The condition is checked and measure in time series to very that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand. Pillar 6-Training: It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill. It is not sufficient know Byexperience they gain, —Know-How to overcome a problem what to be done. This they do train them on knowing —Know-why. The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills is phase 1-do not know, phase 2-know the theory but cannot do, phase 3-can do but cannot teach, and phase 4-can do and also teach. Pillar 7: Office TPM Office TPM
should be started after activating four other pillars of TPM (AM, Kaizen, PM, and QM). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation. Office TPM addresses twelve major losses, they are processing loss; cost loss including in areas such as procurement, accounts, marketing, sales leading to high inventories; communication loss; idle loss; set-up loss; accuracy loss; office equipment breakdown; communication channel breakdown, telephone and fax-lines; time spent on retrieval of information; non availability of correct on line stock status; customer complaints due to logistics; and expenses on emergency dispatches/purchases, reduced manpower, and clean and pleasant work environment. Pillar 8-Safety, health and environment: In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis. 52.

**Basic Concept of Autonomous Maintenance**

Implementing Autonomous Maintenance is a dramatic organizational change that can affect organizational structures, work floor management system, employee responsibilities, performance incentive system, skill development, and the use of information technology. Usually difficulties faced in Autonomous Maintenance implementation include people showing strong resistance to change, people treat Autonomous Maintenance just as another programme of the month without any focus and also doubt its effectiveness, not having sufficient resources (people, money, and time) and assistance to back up Autonomous Maintenance, insufficient understanding of the methodology and philosophy by middle management. Autonomous Maintenance is also not a quick fix approach, it involves a cultural change to the way things are done. Departmental barriers existing within the business unit can cause a major setback to Autonomous Maintenance implementation. Lastly many people consider Autonomous Maintenance activities as additional work. It is not the big investments and changes which are secret to TPM, which have transformed the workplace at the Japanese firms, but the encouragement of production workers who fix many small defects and do minor changes. When implemented fully, Autonomous Maintenance could dramatically improve productivity, quality and reduce costs. Autonomous Maintenance is an approach to eliminate/reduce losses in the plant (time & cost) and equipment management that involves all employees (officers, supervisors & operators) from production, maintenance and administration departments. When Autonomous Maintenance is implemented together with Reliability Centred Maintenance, a comprehensive data base of maintenance requirements, skills required, and stocks that should be held is developed.
The main objective of this paper is to present attitude of the production department in case of machine breakdowns is to avail the maintenance for help thereby the maintenance personnel is not able to concentrate on more value added activities. On this observation a thought arose to bridge the gap between the production operators and maintenance personnel. Employee involvement in case of machine breakdown was found to be less. The goal is to change operators from being reactive to working in a more proactive way, to achieve optimal conditions that eliminate minor equipment stops as well as reducing defects and breakdowns.

Figure 1: Autonomous maintenance goal.

Methodology

The principal way in which the production department participates in TPM is through autonomous maintenance-cleaning, inspection, and simple adjustments performed by operators systematically trained through a step-by-step programme. It is very difficult to do several things at the same time. That’s why autonomous maintenance training takes a step-by-step approach, making sure each key skill is thoroughly learned before going on to the next.

Autonomous maintenance was implemented in seven steps:

Step 1 : Conducted initial cleaning and inspection workshops Goal was to eliminate environmental causes of deterioration such as dust and dirt; prevent accelerated deterioration Eliminate dust and dirt; improve quality of inspection and repairs and reduce time required. Developed curiosity, interest, pride and care for equipment through frequent contact of the equipments by the operators.

Step 2: Eliminated sources of contamination and inaccessible areas. Eliminate the sources of dirt and debris; improve accessibility of areas that are hard to clean and lubricate; reduce time required for lubrication and cleaning. The goal was to increase the reliability of the equipment by preventing dust and other contaminants from adhering and accumulating
Step 3: Developed provisional cleaning, inspection and lubrication standards. Set clear cleaning, lubrication and inspection standards that can be easily maintained over short intervals; the time allowed for daily/periodic work was clearly specified.

Step 4: Conducted general inspection training and develop inspection procedures. Conducted training by maintenance and production personnel on inspection skills in accordance with inspection manuals; find and correct minor defects through general inspections; modify equipment to facilitate inspection.

Step 5: To Conduct general inspections autonomously. Develop and use autonomous maintenance check sheet (standardize cleaning, lubrication, and inspection standards for ease of application). Operators trained and maintained optimal equipment conditions once deterioration is restored through general inspection.

Figure 2 Check sheet for a welding cell.
Step 6: Organise and manage the workplace. Implemented visual control systems and also proper zoning throughout the plant.

Existing condition: Difficult to Identify which material to use on Picking Zone Rack A, Because of two row of same material

Step 7: On-going autonomous maintenance and advanced improvement activities. Pinpoint weaknesses in equipment based on analysis of data, implement improvement plans to lengthen equipment life span.

**Results and Discussion**

1. The production and maintenance people together to accomplish a common goal –to stabilize equipment conditions and halt accelerated deterioration. Operators learn to carry out important daily tasks that maintenance personnel rarely have time for. These tasks include cleaning and inspection, lubrication, precision checks, and other light maintenance tasks, including simple replacements and repairs in some environments.

2. Operators learnt more about how their equipment functions, what common problems can occur and why and how those problems can be prevented by the early detection and treatment of abnormal conditions. 3. Operators became active partners with maintenance and engineering personnel in improving the overall performance and reliability of equipment.
Conclusion

After the implementation of autonomous maintenance in the plant in the month of January there has been significant decrease in downtime over a period of 4 months according to the data collected. An average of 15 minutes has been saved per shift which has lead to an additional production of 15 seats adding to the profit of the firm.

References


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