

TPM Implementation in a Food Industry-A PDCA Approach

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Abstract- Liberalization of global economy has resulted tough competition in global market and for the sustainability in market for any product or service, the optimization of resources and costs in all sorts is required. The global competition is based on the innovation of advanced products, processes etc. and technology support is the essential requirement for any advancement in product or process. The advancement in technology had lead to the industrial revolution and higher level competition for survival.

In today's situation, the importance of the upkeep of equipment has its own importance since the condition and performance of the equipment have large role in the quality and availability of the products.

So the concept of 'Total productive maintenance '(TPM) has very much relevance today. This concept was introduced by Mr. Seiji Nakajima, a Japanese Engineer in 1971.

TPM focus on improvement in equipment availability, performance and quality with assuring health and safety of employees and protection of environment.

The study is conducted in a food industry in South India which is engaged in the manufacture of egg related products. The implementation factors and performance are compared with that in TPM awarded industry and the correlation is found significant. This study will help the management team to focus on the areas for improvement to improve the system level.

The company already started some TPM initiatives by making awareness and training to operators for engaging in routine maintenance activities.

A Plan-Do-Check-Act concept is introduced for the further steps.

Plan-It includes the leadership role and their strategic decisions to fix the objectives, assigning the responsibilities, providing the resources etc.

Do -It is the efforts of utilizing all the inputs like plant/equipment /process inputs, utilization of human resources by giving proper training, motivation, availing the necessary methods and information with the support of computerized maintenance management system etc..for achieving the planned objectives and targets.

Check & act-It includes the measurement, analysis and implementation system for monitoring the processes and as well as the results, doing proper analysis and taking the improvement steps etc.

The employee attitude change or the organizations cultural change is the hurdles in TPM implementation and it need a time period. The implementation of these P.D.C.A approach will make results definitely and the time period for getting results will

depends upon how fast the organization is adopting the changes as well as the effectiveness of this implementation.

Index Terms- TPM, P.D.C.A approach, implementation factors, TPM pillars, Correlation

I. INTRODUCTION

Importance of TPM (Total Productive maintenance)

Liberalization of global economy has resulted tough competition in global market and for the sustainability in market for any product or service, the optimization of resources and costs in all sorts is required. The global competition is based on the innovation of advanced products, processes etc. and technology support is the essential requirement for any advancement in product or process. The advancement in technology had lead to the industrial revolution and higher level competition for survival. For sustainability in the market, the factors like product quality, availability, costs etc. are the some of the basic parameters considered. Technological advancements resulted sophisticated, automated equipment's by which the operations can be perform by even semi skilled or unskilled operators. Also the liberalization of economy supports the industries for the availability of high quality raw materials with competitive prize.

In today's situation, the importance of the upkeep of equipment has its own importance since the condition and performance of the equipment have large role in the quality and availability of the products.

So the concept of 'Total productive maintenance '(TPM) has very much relevance today. This concept was introduced by Mr. Seiji Nakajima, a Japanese Engineer in 1971.

TPM focus on improvement in equipment availability, performance and quality with assuring health and safety of employees and protection of environment.

TPM helps for eliminating equipment breakdown and improving quality performance of equipment, thus the achievement in TPM strongly supports in attaining the lean concepts which includes the elimination of waiting time, defects in process etc.

II. PILLARS OF TPM

TPM is stands on its 8- eight pillars

1. Autonomous Maintenance- This pillar is geared towards developing operators to be able to take care of small maintenance

activities, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs.

2. Planned maintenance-It is aimed to have trouble free machines and equipments, producing defect free products for total customer satisfaction. It breaks maintenance down into 4 families or groups as

a. Preventive Maintenance b. Breakdown Maintenance c. Corrective Maintenance d. Maintenance Prevention.

3. Quality Maintenance-Quality maintenance activities are to set equipment condition that preclude quality defects, based on the basic concept of maintaining perfect equipments to perfect quality products.

4. Focussed improvements-Target is to achieve and sustain zero losses with respect to minor stops, measurement and adjustments, defects and un avoided down times.

5. Development management-Planning project strategies, analyzing the factors influencing project decision, design new products with customer focus, reduce lead time from design to production to market.

6. Education and Training-It is aimed to have multi skilled revitalized employees, whose morale is high and who has eager to work and perform all required functions effectively and independently.

7. Safety, Health &Environment- Focus on targets, actual data, and gaps in implementation of systems for ensuring safety, occupational health and clean and safe environment.

8. Administrative Improvements- To improve productivity, and efficiency of administrative functions and to eliminate the losses.

III. INTRODUCTION OF TPM

Stage-A :Preliminary or Preparation stage;

Step-1; Announcement by management about TPM introduction: This includes the organizing awareness programme for the senior management..Then give wide publicity through various modes like notice boards,meetings etc.

Step 2: Some selected persons who will be playing important role can be given intensive training. Besides awareness the selected important people can be taken to an organization which is successfully practicing TPM and show it to them.

Before going to a full scale implementation ,select an area for trial implementation. Once an organization is convinced ,best way will be to carryout a trial to avoid any misunderstanding among workers and union leaders.

Step-3- Setting up TPM and departmental committee

Step-4: Establishing the TPM working system: Analyzing the present level of functioning and setting up of realistic objectives based on the bench marking etc. While setting objectives ,the present conditions of plant and other situations to be considered for making it realistic.

Step-5 –Generating a master plan- This is the final stage of the planning stage and this is the integrated plan to institutionalize the concept

Stage-B :Initial implementation stage:

Step-6: Starting TPM

This is the ceremony of the starting programme by associating all the people from all departments, vendors, customers and other important people to communicate the message

Stage-C: Full implementation or full development stage:

These are the implementation of all TPM pillars effectively

Stage-D Maturity stage-This is the stage of getting TPM awards.

Success factors of Management systems:

As per the researchers of quality management systems like TQM,TPM , etc, the success of any quality management system is depends upon 1. Awareness and commitment from top management and strategic planning 2. Process management including plant and equipments 3. Education,training and motivation of employees 4.Information architecture 5. Measurement , Analysis and Improvement systems.

IV. MEASURE OF TPM PERFORMANCE

TPM can be measured on the basis of 1.Productivity 2.Quality 3. Delivery 4. Cost 5.Safety &Health 6.Environment. To attain these results through TPM, the each pillars have its own contributions. According to the book ‘TPM Reloaded ‘ by Joel Levitt, the each pillars have its own objectives .This includes

1. Autonomous Maintenance Pillar: 1.Reduction of scheduled down time 2.Reduction of unscheduled down time 3. Increase in speed of the machine 4. Decrease in product/process variability 5. Increase in the number of flexible operators to operate and maintain the equipment 6. Reduction in lubrication oil consumption 7. Increase in small group activities etc.

2. Planned maintenance pillar: 1.Reduction in scheduled down time 2. Reduction in schedule miss due to operations 3. Reduction in breakdown 4. Increase in zero breakdown areas etc

3. Quality Maintenance; 1. Reduction in process defects 2. Reduction in final defects 3.Zero defects areas/zero customer complaint areas identified etc.

4. Focussed improvements- 1. Increase number of lean/kaizen projects 2.No. of waste areas identified 3.Easiness of operation achieved 4.Reduction in incidents of fire/explosions 5. Plant/Machine flexibility achieved for new product manufacturing /small volume of production of multiple items etc.

5. Development management 1. Intellectual property rights/patent applications being obtained, 2.Innovative products/processes/equipments etc.

6. Education and Training 1. Reduction in absenteeism of employees 2. Increase in suggestions per employee 3.Increase in quality circle participation 4. Improvements in skills per persons etc.

7. Safety, Health &Environment 1.Reduction in pollution level 2. Reduction in discharges 3. Reduction in accidents 4. Increase in recycling 5. Number of audit failures per total findings etc.

8. Administrative Improvements: 1.Reduction in overtime job 2. Reduction in inventory, 3. Reduction in holiday work 4.Improvements in equalizing of work load 5. Improvement of information processing etc.

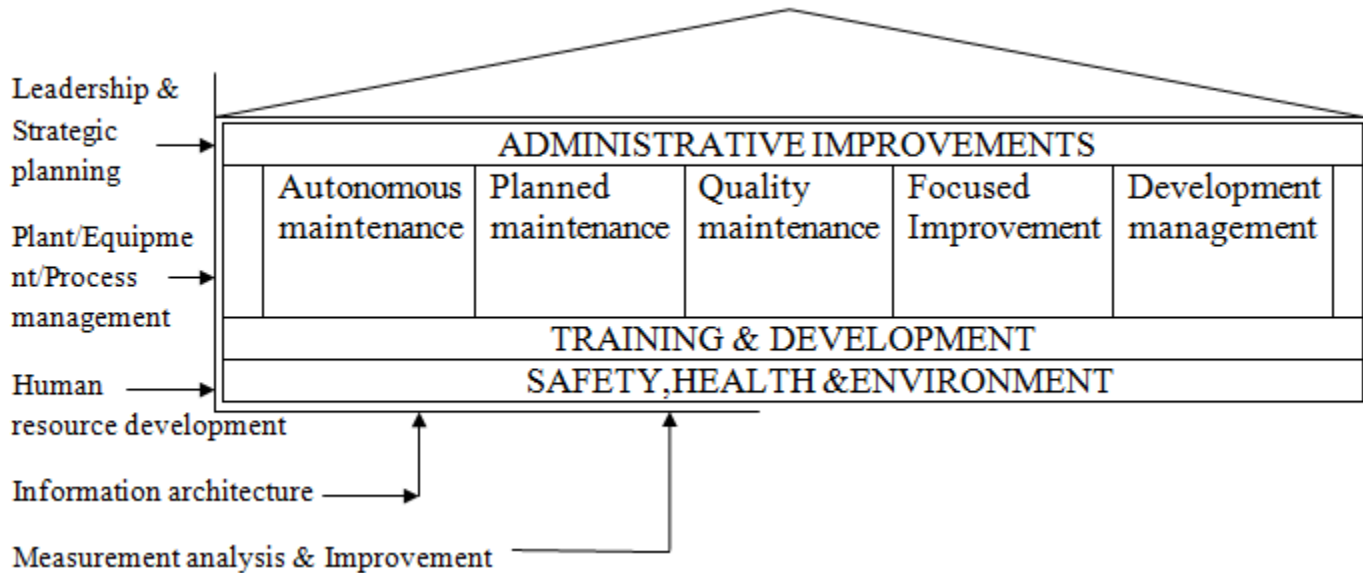
As per the recommendations of the book ‘TPM Reloaded ‘ by Joel Levitt, Education and training , Safety,health and

environment, and administrative improvements are considered as the plinths of TPM and in this study the administrative improvements are considered as an achievement of overall results.

As per the below diagram, the five implementation factors are influencing the two plinths and five pillars. The administrative improvement is the overall result from the plinths and pillars.

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V. PRESENT STUDY

The study is conducted in a food industry in South India which is engaged in the manufacture of egg related products. The company has already introduced the quality standards like ISO 22000 and other food quality related certifications etc. and the management has the vision to implement the TPM level system in the organization for further performance improvement.

A checklist is prepared from the inputs from the questionnaire of ‘Japan Institute of Plant Maintenance’ for various TPM award criteria’s, previous research papers, and as well as the inputs from articles and books related with the effective implementation of TPM. The study is conducted by visiting the plant, and interviewing the relevant officials and by direct observation of the systems etc. The study objective is to identify, the relationship between the implementation factors and performance based on each pillar of TPM and how much gap exists in the present system with that TPM level and how much gap the present results with that in the proposed TPM level etc. The implementation factors and performance are compared with that in TPM awarded industry. This study will help the management team to focus on the areas for improvement to improve the system level.

Correlation between the implementation factors and performance:

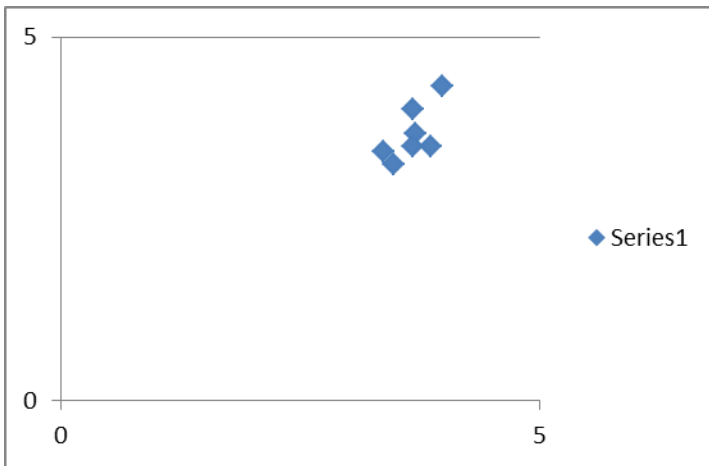
Calculation of Correlation Co-efficient: X-Implementation factors, Y- Performance levels

X	Value	Y	Value
3.37		3.42	
3.67		4	
3.70		3.67	
3.48		3.25	
3.67		3.5	
3.86		3.5	
3.98		4.33	

Results:

Total	
Numbers :	7
Correlation :	0.701086249288

The correlation coefficient is 0.70 it can be considered as significant.



The correlation coefficient is 0.70 so it can be considered as significant and the graphical presentation also supports the correlation.

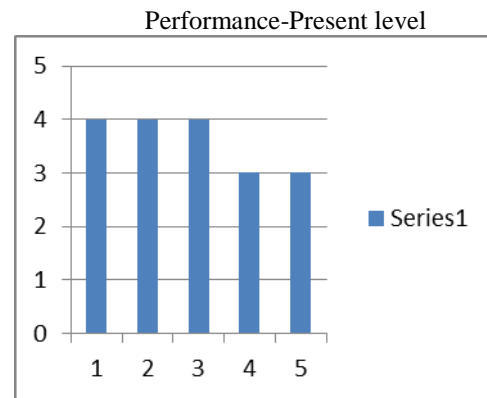
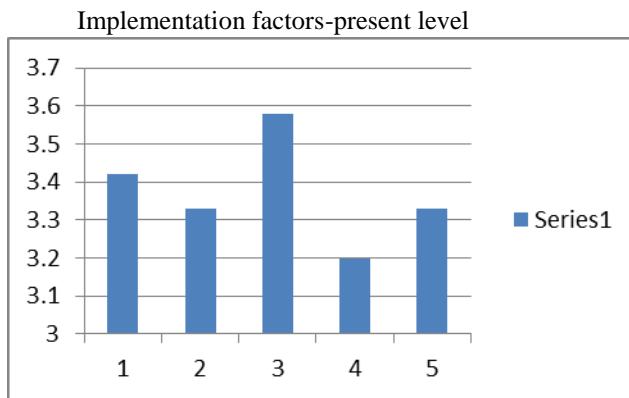
VI. THE RESULTS OF GAP STUDY

As a result of this study the following are the gaps related to each pillar in implementation and performance. The level 5 is considered as the full TPM level in implementation and performance.

In this graph the level 5 is the full stage implementation with results 4 is the implementation stage, 3 is the planning stage 2 is only with primary awareness stage 1 is even with out awareness stage.

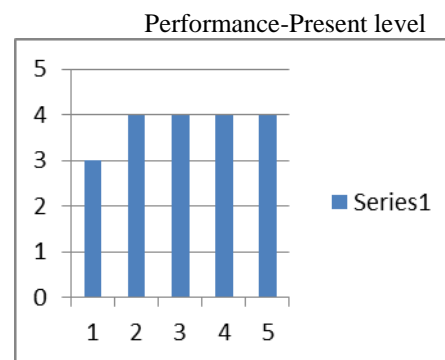
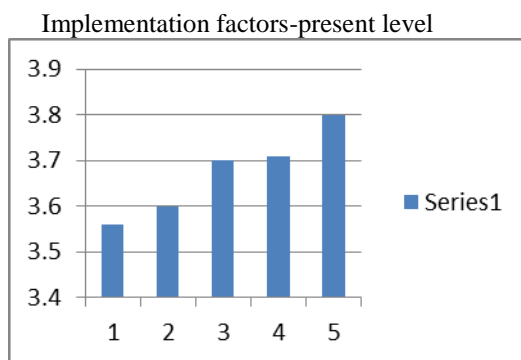
The results categorisation are 5 is 80-100%, 4 is 60-79% 3 is 40-59% 2 is 20 -39 % and 1 is 0-19%.

Autonomous maintenance



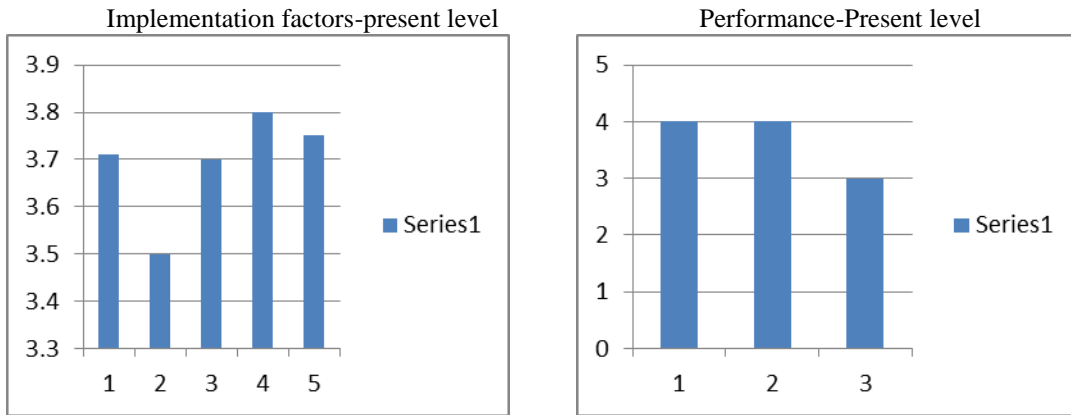
Performance 1. Reduction in scheduled down time 2. Reduction in unscheduled down time 3. Decrease in product/process variability 4. Increase in number of flexible operators to operate and maintain the equipment 5. Reduction in oil consumption

Planned maintenance



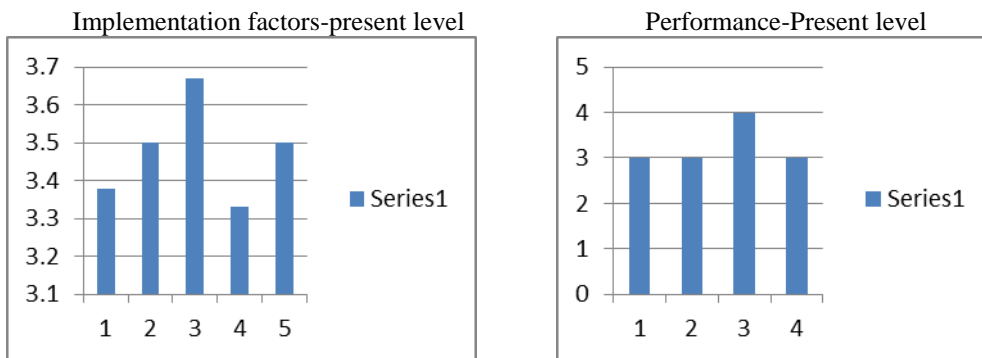
Performance: 1. Zero break down areas 2. Reduction in schedule miss due to operations 3. Reduction in breakdown 4. Zero breakdown areas 5. Reduction in scheduled down time.

Quality maintenance



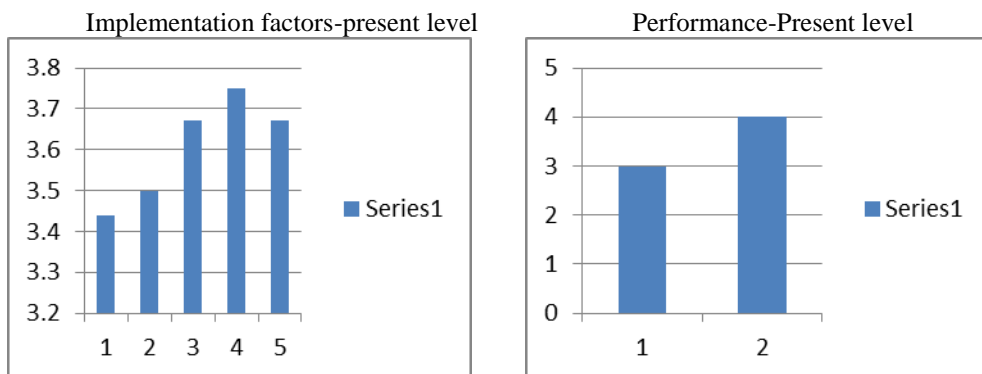
Performance: 1. Reduction in process defects 2. Reduction in final products 3. Zero defect areas/zero customer complaint areas.

Focused Improvement pillar



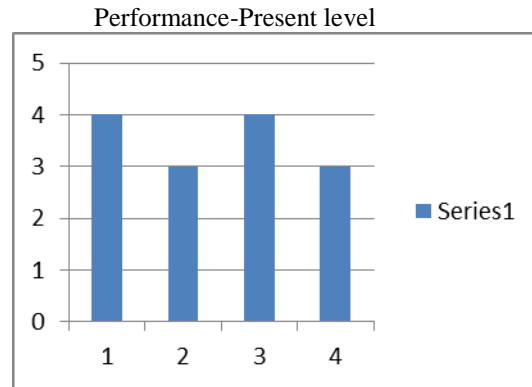
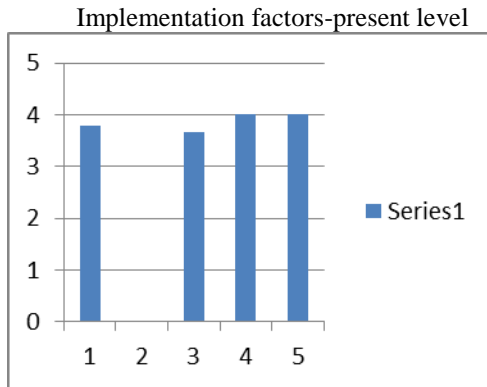
Performance: 1. Number of lean./kaizen projects 2. Number of waste areas identified 3. Easiness of operation identified 4. Plant /machine flexibility achieved for new product manufacturing

Development management pillar



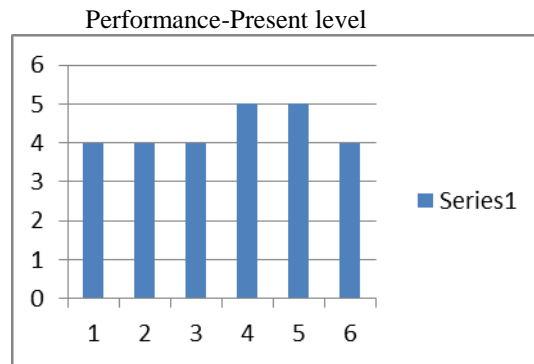
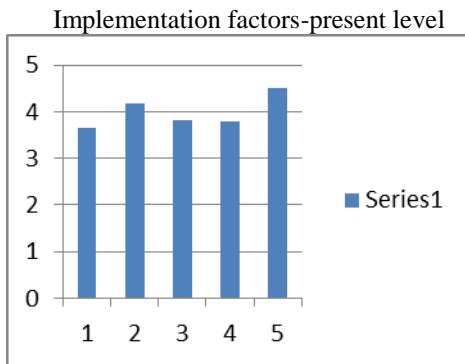
Performance: 1. Intellectual property rights/patent applications being obtained 2. Innovative products/processes/equipments

HRD plinth



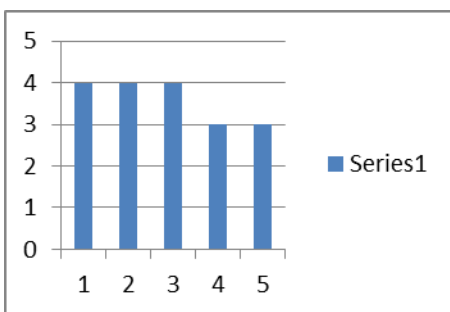
Performance: Reduction in absenteeism of employees 2. Increase in suggestions/employee 3. Increase in quality circle participation 4. Improvements in skills/person

Environment Safety plinth



Performance: 1. Increase in recycling 2. Reduction in discharges 3. Number of audit failures per total findings 4. Reduction in pollution level 5. Reduction in accidents 6.Reduction in discharges

Administrative improvements-Present level



Performance: 1. Reduction in inventory 2. Reduction in overtime job 3. Reduction in holiday work 4. Improvements in equalizing of work load 5. Improvements of information processing

Based on various implementation factors, the following observations identified through each pillar:

The company already started some TPM initiatives by making awareness and training to operators for engaging in routine maintenance activities.

Here introducing the Plan-Do-Check-Act concept for the further steps.

Plan-It includes the leadership role and their strategic decisions to fix the objectives, assigning the responsibilities ,providing the resources etc.

Do -It is the efforts of utilizing all the inputs like plant/equipment /process inputs ,utilization of human resources by giving proper training, motivation ,availing the necessary methods and information with the support of computerized

maintenance management system etc..for achieving the planned objectives and targets.

Check & act-It includes the measurement, analysis and implementation system for monitoring the processes and as well as the results, doing proper analysis and taking the improvement steps etc.

a. Leadership & Strategic planning: The company already have objectives related with quality on the base of ISO 22000 system and an internal audit system and a system for review meetings.

Top management have to implement a master plan for achieving TPM with a TPM policy and related objectives. The TPM targets can include the reduction of scheduled and unscheduled down time ,develop flexible operators for operating and maintaining equipments, reduction of consumable on equipments like lubricants etc.,by effective monitoring etc. as the Autonomous maintenance pillar and develop zero break down areas and eliminate preventive maintenance miss on the base of preventive maintenance pillar.

As the quality maintenance pillar ,the organization presently have the target of eliminating defective or inferior quality products at the processing and final stage and presently the achievement is in a positive level. However the organization can keep the objective to keep the achieved level and to identify any possibility for further improvements.

In the pillar of focused improvement ,the organization can keep the objective to identify the maximum possible kaizen projects and to eliminate all possible waste areas. Similarly keep target for smoothening of operations wherever possible. The possibility of flexibility of operations by improvement actions on equipment also to keep as targets.

In the development pillar ,presently the organization have attained some in house development of equipments. The organization can further develop by keeping targets for advanced equipments ,based on the inputs from the present equipments performance or with the latest technology developments in the environment. This development can be done on innovative equipments ,innovative products etc.

For attaining the above pillars ,the organization need a base called plinths which include the training and development of employees and to keep the plant and surroundings in a satisfactory level for the safety and health of employees. Presently the organization have a training system based on the implementation of the quality standard and this can be further improved by targeting to increase the quality circle participation or employee suggestions, improving the skills per persons, to reduce the absenteeism level of employees etc. The organizations operations are generally environmental friendly as food processing unit and only limited operations have influence on environment ,like generator operations etc. So the organization can targets for reducing the pollution level to the optimum level and to target for the possibilities for saving of resources like water, electricity etc. The discharge from the operations are limited and the organization can keep this in a optimum level. Similarly the safety related issues are also not significant with the present level that the incidents of accidents or the incident of fire or explosions are very negligible or in zero level. So this achievement can be keep as a target.

As an overall target, the organization can aim for the reduction of administrative improvements like reduction of inventory to a optimum level, reduction of overtime jobs or holiday jobs and equalizing work load which can achieved by a stabilized plant and equipment and competent and motivated work force.

The present review system to be further improved with including all these TPM related objectives and the responsibility and authorities to be suitably assigned to the staff. TPM recommends Production head for autonomous maintenance pillar and maintenance head for preventive maintenance pillar. This organization have the advantage that, both the production and maintenance is handled by the same head. Similarly for the updation of technology or innovation, the responsibility of development management pillar may be assigned to the top executive like GM or CEO. The responsibility of quality maintenance must be given to the quality head as usual. The suitable person for focused improvement pillar is the maintenance head. The HR head can take the responsibility of training and development pillar and the safety officer can take the responsibility of safety, health and environment pillar.

Top management can assign the duties including the maintenance jobs to be done by both operators and maintenance people. By suitable motivating methods like incentives, etc the mind set of employees to be changed. This generally need some time period, but a simple starting with selecting some sample equipments or plants this can bring to reality. The selection of these sample equipments must be on the basis that where there is big scope for improvements. Similarly other supporting systems like proper training resources, and allotting some percentage of sale value for innovation activities etc. also to be done from top management.

Plant/Equipment/Process management;

For autonomous maintenance implementation the operator level actions to be taken for removing the dirt, stains, scattered raw materials and oil leakages etc and to eliminate the causes. Measures have to be taken for difficult to handle areas. Cleaning materials and tools to be kept nearer to the machines as possible for smooth handling , considering the limitation in food industry. Lubrications can be monitored with the help of sensors for its optimum usage. Work place and onsite boards will help for knowing the status of activities , goals etc.

For Preventive maintenance pillar implementation, appropriate diagnostic technologies are being put to use for predictive maintenance and time based and condition based strategy can be adopted. Spares can be stored on SQC basis. Calibration of all equipments to be done periodically. By improving the maintenance technology, facility to be improved for ease of autonomous maintenance.

For attaining the quality maintenance pillar the raw material defects to be identified and the equipment to be keep in standard that it will not turnout defects. Presently the quality rejection in minimum level and a system is already established on the base of ISO implementation to verify the raw material, in process and final defects.

For focused improvement the usage of sensors visual images etc will support the monitoring the core production.

Maintenance free projects will improve the performance of equipment.

For development management, the existing equipment may be run at over speed to identify the failing parts for modification, and the equipments are to be developed with the development of new products. The introduction of computerized engineering design will support the process. The organization presently done some development activities on equipment and it to be further improved and a validation system for equipment can be done.

For environment and safety presently the organization have no critical issues since as a food industry. A system exists for to keep the work places neat and clean. The waste of processing is effectively used in farming. The organization kept all the fuel and storage tanks in separate areas. Work place is developed with good work environment like lighting etc. However any further improvements the areas like reduction of odor, noise etc if any can be considered. If any physically demanding labor is existing in the company, a programme for reducing it can be considered. The system to be developed for monitoring and reducing the resources like energy, water etc.

Presently the company has accident level in very minimum level. For TPM implementation, a risk analysis hazard map can be generated based on all processes. A safety audit system can be implemented and emergency drill can be frequently done. The organization already have the system for keeping the personnel protective equipments, safety devices, safety covers, safety nets, safety signage etc. The safety system can be documented including operational control procedure for all identified environment and safety related aspects.

Human resources management:

The organization has established a well human resource development system on the basis of ISO system implementation. So a system for identifying the training requirements, training plan, verifying the training effectiveness etc, and on job training system is already available. However the system to be further developed for training the internal TPM instructors and the training can be conducted by professional associations, personnel from other TPM companies, lubricant vendors, consultants, equipment manufactures etc. Similarly the tour training to other TPM companies can also be done. The training disciples can include both mechanical and electrical etc which may include the areas like hydraulics, pneumatics, electrical, lubrication, coolants, bolts and nuts, software systems, measuring instruments, safety etc. Similarly training can be organized on environment and resource saving also.

Information architecture:

The information system is the lifeblood of any system. For the successful implementation of each TPM pillar, the relevant information to be provided to the concerned people. In autonomous maintenance pillar, the operators need the necessary information on the shop floor level regarding the working system of each machine with pictorial support, standard operating procedures, abnormal conditions and action to be taken, lubrication types and methods and frequencies, quantity of lubricants to be applied, and methods, etc. So for operators a mini manual can be provided and TPM -1 point lessons also to be provided. These manuals to be reviewed frequently for assuring

its adequacy. The problem areas can tagged for identification and it can be recorded in log books.

In preventive maintenance pillar, the information on the storage of spares, moulds, measuring instruments, its calibration frequencies are to be kept. The maintenance information like machine history etc. to be kept which may include the deterioration status of equipments, shut down hours, man hours spent for maintenance, maintenance costs, spares replaced and the jobs done etc. The maintenance requirements are to be published in advance for proper production planning, suitable work instructions also to be provided. Presently the company has not introduced any software system for computerized maintenance management system and its implementation will strongly support the TPM activities.

Information system to be needed for identifying the in process and final products defects for taking the immediate corrective actions. Similarly the information on the required materials specifications, etc. to be needed in the quality maintenance pillar.

The internal information system to be strengthened to communicate the achievements horizontally in the organization. The contribution to these achievement are also to be communicated. This is required for the focused improvement pillar.

For the development management pillar, the information on the technology advancements, market information on products, and the inputs from the operators and maintenance people are to be collected as an input for further development. The losses on product development management to be kept for further analysis and for any development the cost saving benefits, operability, environmental impacts etc to be collected.

In training and development pillar, the training curricular to be developed. Pictorial representation etc. will give good information support.

In safety and environment pillar, an emergency manual is to be prepared, all environment aspects and impacts to be assessed, inspection manuals for safety etc. to be prepared. Similarly the information on the emission areas and hazard storage areas to be provided. For all identified hazards, operation control procedure to be developed for managing the risks.

Monitoring, Analysis and Improvements:

The monitoring and analysis can be done both on the system and on the equipments. Presently the company has an internal audit system available. So this system can be extended for monitoring the TPM performance also. The objectives are to be reviewed frequently and the future goals are to be set. Maintenance costs are to be evaluated. In preventive maintenance the failure analysis to be done on the equipments for improved maintenance practices. The preventive maintenance system can be modified based on the age, life stage and performance of the equipments. For the product, process defects in quality maintenance as well as the failure of equipments in planned maintenance, the analysis tools like why-why analysis, pareto analysis, etc can be widely used.

For improvement in the focused improvement, all the losses are to be analyzed and to identify the relation between the loss and the cost by using loss map or loss tree analysis. This is

for recurring the problems of defects, minor stoppages, speed losses etc.

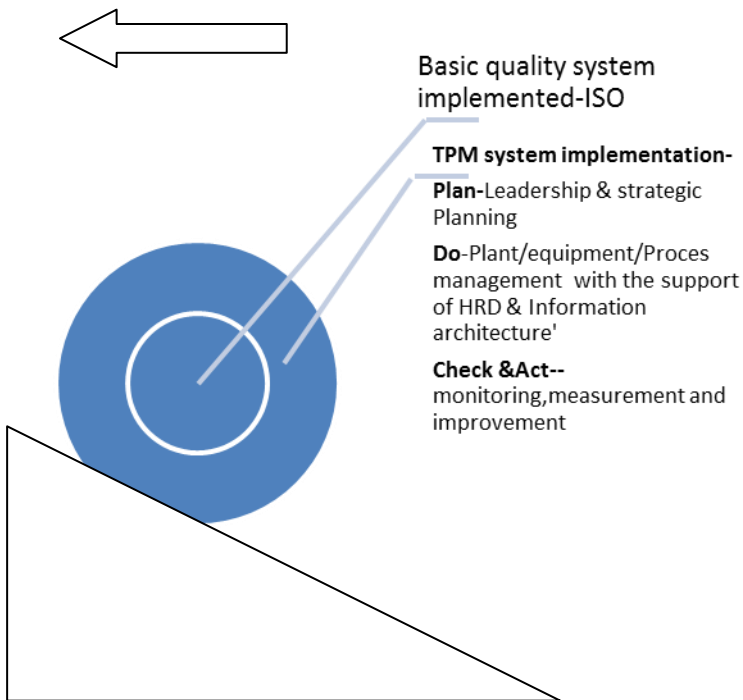
For development management, for any development the evaluation to be done on product cost saving benefit, operability, safety, environmental impacts, economic comparisons, etc. In the development management, the problem's are to be extracted and review and debugging to be done in product and plant development management. A feedback system is required in the development process.

In training and development pillar, a system for analyzing the employee satisfaction is to be required. Training feedback and effectiveness to be measured. Training faculty evaluation can also done.

In safety, health and environment pillar, a system to be developed for analyzing all the labor accidents, plant disasters etc and proper action plan to be developed for preventing the reoccurrences. The emissions, discharges etc to be analyzed frequently for effective monitoring and taking proper actions.

VII. PRACTICABILITY IN IMPLEMENTATION

TPM achievements



The P.D.C.A approach in TPM implementation starts from the initiatives from the top management. The strategic decision making and planning by fixing objectives and targets and by assigning responsibilities etc. Implementing the necessary steps for plant/process management and by providing necessary supports by providing necessary information and by proper training to employees. Top management have to review the progress of implementation at frequent intervals and to take proper corrective measures for overcoming the hurdles. Similarly the monitoring and analysis system to be improved for TPM process improvement as well for the improvement of plant and equipments.

The employee attitude change or the organizations cultural change is the hurdles in TPM implementation and it need a time period. So simple solution is available for this attitude/cultural change and it depend upon several factors. So the management can take suitable tactics for overcoming these issues by providing the necessary awareness, incentive systems, motivational actions etc.

The implementation of these P.D.C.A approach will make results definitely and the time period for getting results will depends upon how fast the organization is adopting the changes as well as the effectiveness of this implementation.

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