



A Tactical Perspective to Reduce Major Losses in Manufacturing Sector through Total Productive Maintenance Technique

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ABSTRACT:

TPM is a forceful methodology centers around really working on the capability and plan of the creation gear. TPM expects to build the accessibility/viability of existing gear in a given circumstance, through the work of limiting information (improving and keeping up with hardware at ideal level to lessen its life cycle cost) and the interest in HR, which brings about better equipment use. TPM brings upkeep as a fundamental and imperatively significant piece of the business. The TPM drive is focused on as to upgrade seriousness of associations and it envelops a strong organized way to deal with change the mentality of representatives subsequently rolling out a noticeable improvement in the work culture of an association. Centered Improvement/Kobetsu Kaizen (KK) mainstay of TPM include exercises that expand the general viability of gear, cycle and plant through inflexible end of 16 sorts of misfortunes and improvement of execution. The group recognizes and plan exercises to wipe out/limit the 16 misfortunes, which are painstakingly estimated and assessed. In this proposition center is to concentrate on the substantial and immaterial advantages acquired after the execution of TPM in Caparo Maruti Limited (Bawal). TPM start off in Caparo Maruti Limited plant in August 2016. After start off the TPM organization has acquired the remarkable outcomes regarding Efficiency, Quality, Cost, Conveyance, Wellbeing, and Resolve. The organization has additionally accomplished unmistakable elusive advantages after start off the TPM.

Keywords: Pillars, Total Productive Maintenance, Improvement, Losses, 5S

Introduction:

Total Productive Maintenance (TPM) is a Japanese business concept practiced all over the world to exceed the production performance of an organization as understood from the books Zarreh et al., (2019). TPM in Process Industries and new execution Program in Fabrication and Assembly Industries Djabat et al., (2015). This concept is recognized by distinct industries in all parts of the world to improve the effectiveness of skills by reducing hindering factors and enhancing manufacturing performances Pandey et al., (2016). In the United States, in 1971, TPM was introduced and further extended by the Japan Institute of Plant Maintenance (JIPM), Japan. TPM concepts were initially executed mainly on the shop floor but later drifted to an industry-wide implementation Adesta et al., (2018). In 1989, company-wide, the concepts of TPM were applied. The new definition aims to establish a corporate culture to optimize production system effectiveness, thus organizing a practical shop floor to eliminate all losses before they appear on the production line Ahuja and Khamba (2008). TPM also targets on attaining zero accidents, zero defects, and zero breakdowns. This study is focused on the main objectives of "skill on factors," where the skill is taken as an independent variable and experiments with the dependent variable of availability, performance, and quality factors and how they influence the Overall Equipment Effectiveness (OEE) in the business Singh et al., (2013).

The JIPM definition of TPM is:

T = Total. Must involve all employees at all levels of the organization.

P = Productive Effective utilization of all resources.

M = Maintenance. Keeping the Man-Machine-Material system in optimum condition

TPM is a synergetic association between all organizational purposes, predominantly among production and maintenance. That targets for continuous enhancement of product quality, as well as effective efficacy and capacity word Vardhan and Gupta (2014). A well-organized TPM is contingent on both production and maintenance activities.

In TPM, maintenance is perceived as an important asset. In this method main target is to maximize the overall efficiency Jasiulewicz-Kaczmarek (2016). "The main business increasingly beneficial and the assembling framework progressively serious by persistently improving the capacity of the hardware, just as making the act of support increasingly proficient" with the way of thinking as "It is my machine I look after it" Yamashina (2020). To pick up the

full advantages of TPM, it must be applied in the best possible circumstances, and be coordinated with the assembling framework and other improvement activities Hooi and Leong (2017).

Pillars of TPM

There are eight columns on which the “TPM stands to accomplish zero accident, zero defect and zero failure”. The reference for pillars of TPM is (Djatna and Alitu 2015; Chlebus et al., 2023 & Shen (2015).

(1) Autonomous maintenance (JISHU HOZEN) (Khan et al., 2020)

Autonomous maintenance means maintenance of the equipment by the operator to avoid deterioration. It has basically three responsibilities to serve initial cleaning, lubrication and tightening bolts. Aim of autonomous maintenance is to safeguard from accelerated deterioration of the equipment, removal of hidden defects, maintenance prevention and increase in mean time between failures. This is the most important pillar of TPM that has been applied in the manufacturing sector to improve productivity of an organization. To pick up the full advantages of TPM, it must be applied in the best possible circumstances, and be coordinated with the assembling framework and other improvement activities

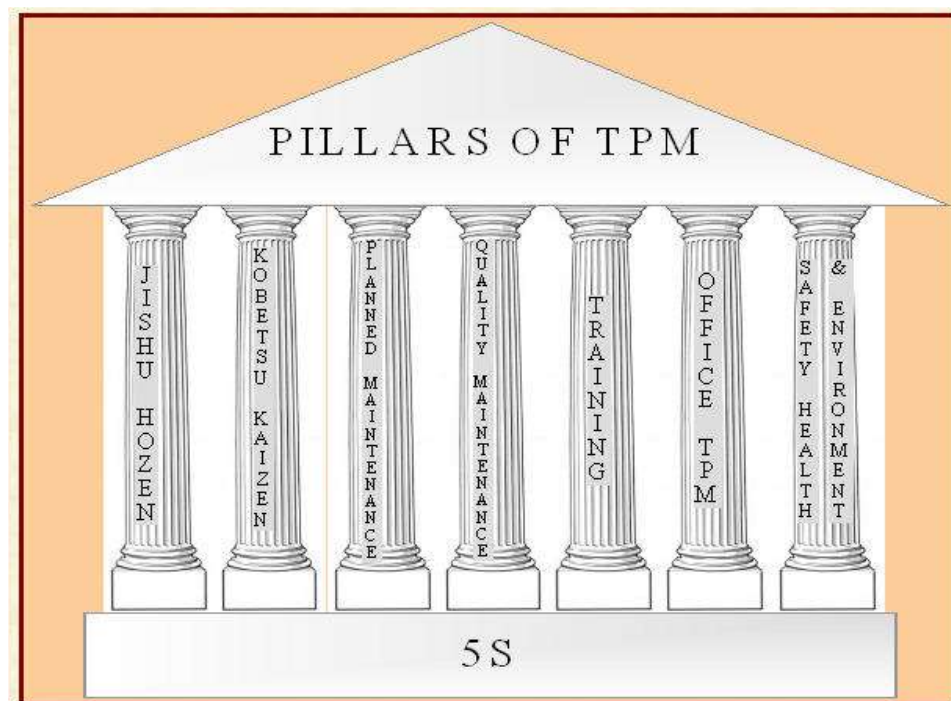


Figure 1.1: TPM Pillars

(2) Continous Improvement (Kobetsu Kaizen) (Gamer et al., 2020)

Kobetsu kaizen means continuous improvement Rosimah et al., (2015). It shows that many small improvements are better than a big improvement. Kobetsu kaizen aims to eliminate the major losses by improving the system continuously by countermeasures of the problems. It involves why why analysis to find the root cause of the failure and PDCA for countermeasure.

(3) Planned Maintenance (Liu et al., 2019)

Planned maintenance refers to the process of directing and organising resources in order to maintain a certain level of availability and performance of industrial equipment and to reduce the maintenance cost Azizi (2015). Typically, maintenance is viewed as a supporting process for the company's primary procedures, and it only works for one customer. It also deals with equipment modification and design-out-of-maintenance, estimation for maintenance activity time, skill level improvement, provision of insurance spare.

The planned maintenance has five basic approaches of implementation.

- ❖ Preventive maintenance system implementation
- ❖ Corrective maintenance system implementation
- ❖ Condition based maintenance (CBM) system implementation
- ❖ Implementation of maintenance prevention
- ❖ Maintainability improvement system

(a) Preventive maintenance system implementation: In this system a schedule of inspection or replacement is fixed on the equipment manufacturer's recommendation or past experience. Machine is stopped as per predefined schedule and scheduled jobs are performed as a result probability of failure reduces.

(b) Corrective maintenance system: In these system failures of failure prone component or sub assembly is analyzed in detail and changes in design are done to reduce the failure, as a result reliability of machine goes up. Corrective maintenance can also be used after a breakdown to restore an equipment.

(c) Condition based maintenance: In this system condition of the machine is monitored and the progress of wear is tracked, when it appears that after certain time span the wear might damage the equipment, the equipment is stopped and corrective action is taken to restore the wear. With implementation of condition based maintenance the need of shutdown reduces.

(d) Maintenance prevention system: Whenever a new equipment of similar type is procured, then all improvements incorporated in corrective maintenance system should be incorporated in the equipment, as a result from day one equipment operates at high reliability.

(e) Maintainability improvement system: It is used to correct the design of the equipment to provide ease to maintenance actively. It improves the effective maintenance and reduces the repair term of the equipment i.e. Mean Time to Repair [MTTR].

(4) Quality Maintenance System (Leoni et al., 2021)

- It aims to achieve customer satisfaction and no complain from customer.
- To detect defects and take corrective action before delivery to customer.
- To control the processes to get quality product.
- To continuous quality improvement to meet the need of customers.

(5) Maintenance Prevention (Denkena et al., 2019)

It is aimed to eliminate the maintenance by improving the equipment design and to attach the design improvement in the new machining same time to eliminate the maintenance in very new machine. It is a design-out-of maintenance activity. It also provides ease to maintenance activity for better maintainability and minimum maintenance cost.

(6) Efficient (Administration/Management) Vancampfort et al., (2016)

- It aims to eliminate losses to department of sales, support service and administration.
- It identifies the losses and takes corrective action by internal Jishu Hozen and Kobetsu Kaizen activity.

(7) Education and Training (Sindi and Woodman 2021)

The main objective of the education and training under TPM is:

- To bring up the talents in equipment maintenance and operation.
- To bring up talents to cope up with modernization and new technology.
- To develop abilities to discover malfunctions and analysis to improve equipment function.
- Skill upgradation for reliable maintenance.

LITERATURE REVIEW

TPM is intended to augment the general gear adequacy. It includes all offices that arrangement, use and keep up with gear, includes all representatives from top administration to bleeding edge laborers Chikwendu et al., (2020). The idea of TPM was created in Denso, A level one car provider in the Toyota gathering of providers, during 1960s and 70s in Japan. The main purpose of the program was the finished end of the "six significant gear misfortunes". The vital idea driving compelling enhancements was independent support. The idea of generally gear adequacy (OEE) and centered improvement were viewed as very uplifting for outcome of TPM. The point of the TPM is to further develop the work efficiency and to lessen the support cost. It means to carry gear to top working condition by disposing of the misfortunes that hamper plant viability. That is to accomplish zero breakdowns, zero imperfections and zero mishaps . TPM puts together support exercises by applying the accompanying activities:-

- Develop a feeling of pride in the administrator by presenting independent support - the administrator gets a sense of ownership with the essential consideration of his/her plant.
- Utilize cross-useful groups comprising of administrators, maintainers, specialists and supervisors to work on individual representative and hardware exhibitions.
- Lay out an ideal timetable of tidy up and PM to broaden the plant's life expectancy and boost its uptime

According to **Ahuja et al. (2007)** There is arising need for TPM execution in the Indian Business and have to foster TPM execution practice and techniques. The effective execution of TPM in the business is a component of capacity of an industry to approach and practice TPM backing and improvement, giving strengthening and impetuses, advancing cross usefulness and cooperation.

Ierace and Cavalieri (2008) highlighted on examination of the TPM and Upkeep program which infers that TPM can be areas of strength for a to the strength of the association which can further develop Support programs. Elite Assembling programs, like JIT, TQM, and TPM, ought not be assessed in separation. They are firmly related and in mix can assist with encouraging better Support programs.

There are two primary methodologies found in TPM writing for example Western Methodology and the Japanese Methodology, both having similitude. The Japanese methodology is advanced by Japanese Organization of Plant Support and portrayed while western methodology depicted Samatamba et al., (2020).

According to **Bevilacqua et al., (2010)** TPM is new support procedure created to meet the new upkeep needs, TPM is an American style of useful upkeep which has been adjusted and improved to fit in the Japanese modern climate. Presently it is well known in Japanese industry and in other western nations.

Niraj (2011) arranged support programs as responsive, preventive and prescient upkeep. Preventive and prescient upkeep address two proactive methodologies by which organizations can stay away from hardware breakdown.

As per **Niraj et al., (2012)** TPM is a synergistic relationship among every hierarchical capability, especially among creation and upkeep. This holds back nothing of item quality, as well as functional productivity and limit confirmation. A proficient TPM relies upon both creation and support exercises.

Kabir et al., (2013) expressed that regardless of how well plants are furnished with cutting edge fabricating methods, it is consistently the administrators, not supervisors or frameworks, who influence the plant's exhibition. TPM can be the support reasoning forestalls the disappointment of an association. It is a support program that works with TQM and lean administration **Ma et al., (2014)**.

As per **Peter (2015)** TPM is about correspondence. It commands that administrators, upkeep individuals and designers aggregately work together and see each other's language.

According to **Ervural et al., (2016)** TPM as a generally new and commonsense use of TQM and recommends that TPM plans to advance a culture in which administrators create "possession" of their machines, learn considerably more about them, and in the process acknowledge gifted exchanges to focus on issue demonstrative and gear improvement projects. As per **Rita et al., (2017)** TPM is an imaginative way to deal with plant support that is corresponding to Add up to Quality Administration (TQM), In the nick of time Assembling (JIT), Absolute Representative Contribution (TEI), Ceaseless Execution Improvement (CPI), and other a-list fabricating techniques. PM as the overall development with respect to organizations to attempt to accomplish more with less assets.

As per **Ferreira et al., (2018)** TPM assisted with keeping up with the ongoing plant and gear at its most noteworthy useful level through the collaboration of all practical region of an association.

Gallab et al., (2019) characterized Kaizen as 'It is a course of engaged and supported development all through the association that is as little gradual undertakings known as kaizen occasions'. It implies orderly method of little gradual changes toward improvement in each spot and every division who accepted that Kaizen depends on little gradual changes in routine working of the association, which further diminishes squander and further develop efficiency and nature of the item. As a nonstop improvement Kaizen gain ubiquity when it was considered as an overall idea for TQM.

Abaei et al., (2020) featured planned advantages of Kaizen, as authoritative execution improvement as decrease in squander, breakdowns, lead time, arrangement time, and as human asset advancement, as upgrade in ability level disposition, information, strengthening, and personal satisfaction of the laborer.

Bevilacqua et al., (2020) proposed a hypothetical structure by testing what the context oriented issues mean for company's upkeep frameworks while carrying out TPM. Their examinations show that the proposed three settings — ecological setting (country, industry), authoritative setting (hardware age, gear type, organization size, plant age, unionization), and administrative setting (in the nick of time, complete quality administration, representative contribution) do impact the organizations' TPM selections at various levels.

Ben-Daya and Duffuaa (2020) upkeep is a capability in an association that works in lined up with creation. The essential result of creation is the ideal item and its optional result is an interest for support, which is thus a contribution for the upkeep capability.

Bevilacqua et al., (2021) highlighted that TPM is predicated by the test of looking to improve thus managing change (frequently requiring quick modification) necessities to turn into a lifestyle inside assembling associations.

Khanlari et al., (2021) TPM is intended to expand hardware viability working on in general proficiency by laying out a complete useful support framework covering the whole existence of the gear, traversing all gear related fields arranging, use, upkeep, and so forth and with the cooperation of all representatives from top administration down to shop-floor laborers.

accepted that Kaizen depends on little gradual changes in routine working of the association, **Lillrank and Kano (2021)** which further diminishes squander and further develop efficiency and nature of the item and ceaseless improvement Kaizen gain ubiquity when it was considered as an overall idea for TQM.

Singh et al., (2022) arranged support programs as receptive, preventive and prescient upkeep. Preventive and prescient upkeep address two proactive systems by which organizations can keep away from hardware breakdowns. In receptive support the gear is permitted to run until disappointment, then, at that point, the bombed hardware is repaired or supplanted. However under receptive upkeep, brief fixes might be finished to return hardware to functional condition and long-lasting fixes made later time. Proactive upkeep is a technique for support by which breakdowns are stayed away from through exercises that screen hardware condition and embrace minor fixes to reestablish gear to functional condition (Pandey et al., 2016). TPM requires an uncommon really impact in the conventional mentality of work culture and support draws near. For this dynamic top administration support is urgent to conquer obstruction of representatives, particularly during the progress time frame (Fredendall L.D. Patterson J.W.1997). (Karlsson and Ahlstrom 1996)20 The idea of lean creation has become prevailing in most association and numerous associations are taking on it to keep their strategic advantage in both homegrown and worldwide market. Hence, an orderly and key upkeep the board, for example, TPM, in keeping up with the creation's hardware is truly importance to help the effective of lean creation.

As per **Salah et al. (2022)** Many organizations seek after either TPM or lean creation to further develop their business methodology. In any case, it is seen that the greater part of the execution of these drives been done independently. The different execution will require enormous size of assets also the related issues of running fighting undertaking in the organization.

According to **Niraj and Kumar (2023)** The importance job of TPM component as a significant corresponding to help the progress of lean creation was not been completely characterized in a lot of explores connected with lean creation.

The very broad writing looks at the job of TPM in lean creation was finished by Moayed and **Shell (2023)** and considered kaizen as a way of thinking which is broadly drilled in assembling cycle and quality circles. Kaizen depends on the idea that there is dependably opportunity to get better of the cycle and it tends to be improved through little gradual changes towards advancement likewise called kaizen occasions.

RESEARCH GAP

Basically research is done in the industry where TPM is not implemented& started from the base to implement it. After implementation it becomes difficult to maintain a continuously improving performance of the plant/ company. My research is based on the difficulties observed after implementing the TPM in the company in order to maintain the sustainable results. So I had chosen the company where TPM is already implemented & found some areas of improvement in that. The areas of improvement in this research which are focused is nothing but improving the current standing performance of selected performance parameters by improving the effectiveness of TPM intern improving performance parameters of the company like increasing the productivity, time efficiency, yield improvement, poka yoke implementation, reduction in consumables cost, Implementation of Autonomous maintenance with greater focus & at last the improvement of O.E.E. This research resulted towards a positive attitude providing a good result of the points of performance parameters which I selected for the company after the study.

FORMULATION OF RESEARCH PROBLEM

In this proposition focal point of exploration is to concentrate on the execution of one of the most effective to be specific center improvement TPM point of support in designing industry and hence concentrate on the substantial immaterial advantages acquired. Therefore, the title is selected as "To study on the execution of Intensive enhancement pillar in a manufacturing company: A case study"

OBJECTIVES OF PRESENT RESEARCH WORK

- To study the inclusive tangible and intangible benefits attained after the execution of TPM concept in manufacturing company in Caparo Maruti Limited (Bawal).
- To carry out the case study on comprehensive employment of one of the most significant TPM pillar namely focused enhancement pillar in Caparo Maruti Limited (Bawal) .
- To study the effect of KK pillar execution on the overall recital of the TPM employment

EXECUTION OF TPM CONCEPT

TPM alludes to an administration framework for enhancing the efficiency of assembling gear through efficient hardware upkeep including representatives at all levels. Under TPM, all representatives are engaged with keeping the gear all ready to limit Creation misfortunes from hardware fixes, helps, set-ups.

3.1 BASIC FUNDAMENTALS REQUIRED FOR TPM EXECUTION

1) The Topmost level of involvement:- The Execution of TPM is to enhance the shape and tough work of the apparatus. It includes the involvement of all workers from the shop floor to the high level management.

2) Advancement of Human Resource Divisions and have the uppermost level of provision:- To execute the strategy, creation and elevation of the human resource department in order to high up strength with unresolved aptitude. All divisions must identify the basic requirements of the TPM actions.

3) Training before start:- According to the production plant choose the suitable apparatus type as the model line. The apparatus may be the significant selection because larger the level of starting operative production facilities.

4) Starting and Execution:- Requirement higher involvement of the workers in order to kick-off or to encourage the TPM strategy. The Happenings to be dispatched on the company banner set up bill board and fascinate the full involvement of employees and workforces.

3.2 STAGES FOR EXECUTING TPM

The associations across the world have been attempting to develop the most ideal methodology for effective execution of TPM. The 12-step process intended to execute TPM and the different capabilities performed by these 12 stages are:-

- Execute TPM
- Achieve TPM acknowledgment
- Make TPM support from top administration and representatives
- Make excitement and positive assumptions for TPM.
- Foster the reasonable custom establishment plan
- Achieve the top notch brings about opportune way.

Executing steps are:-

Table 3.1: Steps for executing TPM Concept

Discrepancy	Phase
Introduction - Introductory Step	1) Topmost employee announcement in order to announce TPM
	2) To educate all employees about TPM activities
	3) TPM to encourage creation of rank system with overlaid small group.
	4) TPM basic set of impartial and goals.
	5) TPM preparation to initiate the key plan
Start of Introduction	6) Kick-off meeting
Introduction- Execution phase	7) Foundation of creation productivity of the framework.
	8) Foundation of new items, advancement of new gear the board framework.
	9) Foundation of the nature of protection of the framework.
	10) Making of framework for development of effectiveness of regulatory area.
Establishment phase	11) Making of the framework for the control of wellbeing, wellbeing, and climate, zero mishaps and zero contamination cases.
	12) Full Execution of TPM to improve the level

Step-1 Topmost level person’s announcement in order to announce TPM:-

The statement is made in an interior TPM address meeting and ought to be imprinted in an inner release and pamphlet. Top administration needs to establish a climate that upholds the execution of TPM. Legitimate comprehension, responsibility and dynamic inclusion of the top administration are required for initial step. Senior administration ought to have a mindfulness program, after which the declaration is made to all.

Step-2 To educate about TPM activities and education: -

Administrative staff, staff of a similar echelon is planned together for preparing general workers. Slide show meeting additionally happens. This step likewise comprises of assortment of data about TPM and to comprehend how TPM functions. TPM facilitator ought to comprehend what TPM precisely is, the way it works, its appropriate execution grouping, how much exertion expected for its execution, how it tends to be benefited for the plant, how long it will require to carry out.

Step-3 TPM to encourage creation of rank system with overlaid small group: -

Arrangement of TPM advancement association and formal association model advisory groups, particular sub-boards, advancement secretariat and so forth. In this stage a gathering/group is made. This group will advance and support TPM exercises once they start. Group based exercises are vital to a TPM exertion. The gathering needs to incorporate individuals from each level of the association from the board to the shop floor.

Step-4 TPM basic set of objective and targets: -

Setting of basic TPM principal and targets, benchmarks and targets, prediction of effects. In this step the councilors analyze the existing conditions and set the goals. These goals should be result oriented Specific, Measurable, Realistic and Attainable.

Step-5 TPM planning to start the master plan: -

Subsequent to laying out TPM strategies and objectives, a total proposed end-all strategy for execution of TPM is ready and proposition is introduced to the administration. This movement can be done by advisor or plant faculty or the two of them. Expert inclusion principally starts with a plant visit to notice creation tasks, find out about the hardware, concentrate on upkeep tasks, and converse with the workers to decide their inspiration and demeanor towards TPM. Then the expert creates and directs the TPM show to the executives, including questions and their responses. This show ought to end with a proposal to introduce TPM. This plan distinguishes what assets will be required and while for preparing, reclamation and upgrades of hardware, upkeep the board frameworks and new advances.

Step-6 Kick-off meeting: -

In Start up function of the TPM client, associated organizations, and agreeable organizations are welcomed. Each fruitful TPM establishment has been gone before by a decent possibility study. The consequences of this plausibility study lay out a standard against which TPM results and advance will be estimated and furthermore helps in putting forth the reasonable objectives that depend on the information got. The review assesses the states of these gear and the expected current and future support exercises. Abilities of plant staff, tidiness or efficiency of the endlessly plant culture (disposition, and the board style) will likewise be considered.

Step-7 Formation of production efficacy of the system:-

Foundation of framework for development the proficiency of the creation division. Various kinds of support points are utilized for working on the efficiency and in this way OEE of the framework. The Undertaking group to work on the exercises of little gathering and analysis further developed security.

The Pillars are:-

1. Kobestu- Kaizen
2. Jishu- Hozen
3. Planned maintenance
4. Quality maintenance

Step-8 Formation of new items, expansion of new apparatus management system:-

Items set up effectively and simple to use for advancement and the board of the hardware. Foundation of introductory stage the board framework for new items and new gear improvement.

Step-9 Formation of the quality of conservation of the system:-

Great circumstances for setting and keeping up with the executives. Foundation of value support framework, production of condition in which deformity doesn't happen and upkeep and the board of these circumstances.

Step-10 Formation of system for enhancement of efficacy of organizational sector:-

It worry with the creation support, Improvement of the productivity of the connected area and improvement of the effectiveness of the gear.

Step-11 Formation of the system for the control of safety, health, and environment, zero accidents and zero pollution cases: -

Foundation of zero contamination, zero mishap and makes preventive strides in regards to somewhere safe and ecological risks which prompts expansion in efficiency.

Step-12 Complete execution of TPM to improve the level: -

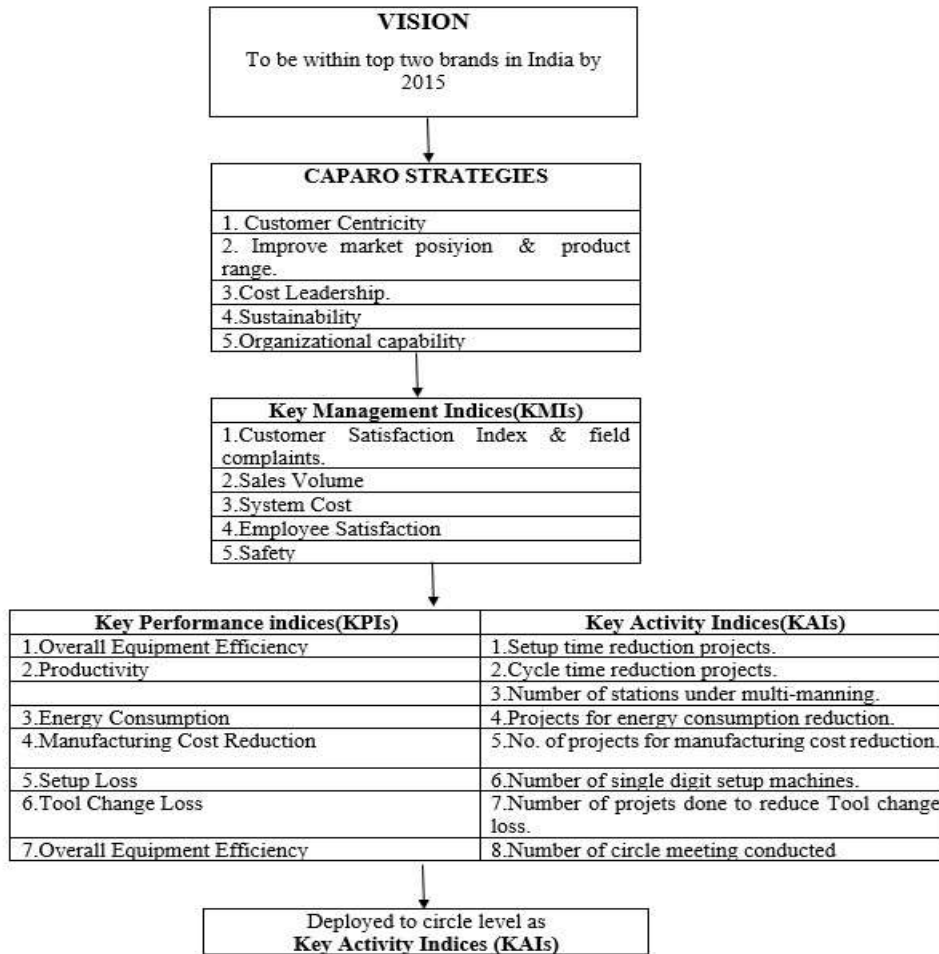
Complete fitting of TPM and level enhancement for enduring inspection for the acceptance of RS award. U, V, W, X, Y, Z attained.

4.7.3 PREPARATION OF KK PILLAR TEAM

To conquer the KK support point difficulties, the point of support group containing point of support head and other colleagues were planned. The colleagues did every one of the important exercises alongside an organized way to deal with conquer the misfortunes happening in KK point of support.

4.7.4 APPROACH ARRANGEMENT CAPARO

To accomplish organization's vision, the support point agents laid a few systems. According to these systems, KMIs, KPIs, KAIs are recognized which are shown by figure 4.2



4.7.6 BENCHMARK AND TARGET SETTING FOR KK PILLAR

The set targets are to be accomplished for the fruitful execution of a point of support. The significant objective boundaries recognized under KK point of support was Generally speaking Plant Proficiency (OPE), By and large Line Effectiveness (OLE), By and large Hardware Effectiveness (OEE), efficiency, fabricating cost, energy utilization, arrangement and apparatus change misfortune and so on to be gotten to the next level. In light of the past records, KK point of support group laid out the benchmark and target values as displayed in table 4.2.

Table No 4.2: Benchmark and Target Setting of KK Pillar Parameters

Sr. No	Constraints	Units of Measurement	Better	Benchmark 2015	Target
1.	Overall Plant Efficiency-OPE	%	↑	---	90
2.	Overall Line Efficiency-OLE	%	↑	---	90
3.	Overall Equipment Efficiency-OEE	%	↑	68	90
4.	Productivity	Tr/Man/Month	↑	3.4	4.1
5.	Energy Consumption	Units per tractor	↑	478	385
6.	Manufacturing Cost Reduction	% to total cost	↑	10.26	7.5
7.	Setup Loss	Hrs/Qtr.	↑	13120	3653
8.	Tool Change Loss	Hrs/Qtr.	↑	1470	510
9.	No. of Kaizen	No./Team/Year	↑	7	42

4.8 KK PILLAR EXECUTION STRATEGY

o complete KK point of support exercises, an efficient methodology was followed to accomplish the KK support point targets. The seven stage approach followed is portrayed as:

- 1) Information assortment and examination
- 2) ID of basic machines and focus on the misfortunes utilizing misfortune cost lattice
- 3) Work out the OEE previously and set the objective for focus on misfortunes.
- 4) Examination of issue
- 5) Execution of kaizen
- 6) Result accomplishment
- 7) Normalization and level organization

Overall Plant Efficiency (OPE), Overall Line Efficiency (OLE) and Overall Equipment Efficiency (OEE):

Machine shop, gathering shop, paint shop are the sub-segments of the plant. The General Gear Proficiency (OEE) of all machines in every one of the three shops was determined. Then, at that point, OEE of everything types of gear in a solitary line was ordered to get Generally speaking Line Effectiveness (OLE). The OLE of every one of the three shops was gathered to get the General Plant Proficiency (OPE) as displayed in figure 4.2.

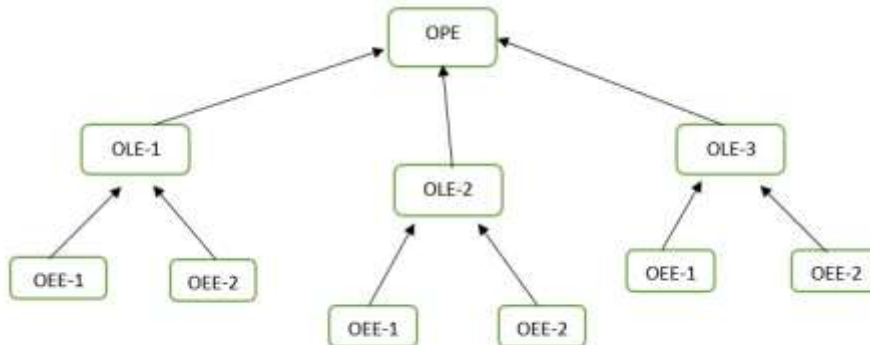


Fig.4.2 Overall Plant Efficiency

4.8.1 LOSS CAPTURING OF ALL MACHINE & DATA COLLECTION

In order to enhance the efficiency of the equipment, losses occurring on all the machines were captured. These losses were further characterized corresponding to the activity to be performed by individual pillars of TPM for the elimination of losses. The table 4.3 below shows the losses occurring at different stages during the operation.

Table No 4.3 Structure of Losses

Index		JIPM Loss Terminology	Terminology at SWARAJ Division	Responsible Pillar
OVERALL PLANT EFFICIENCY	AVAILABILITY	Shut Down	Arranged stoppages for preventive upkeep	OTPM
		Equipment failure	Misfortune because of gear breakdown	PM
		Setup Change	Time taken from halting m/c for model change from last alright to first part alright of the following model	KK
		Tool change Loss	Time taken to replace the tools	KK
		Startup Loss	Time taken by the gear to come to typical	KK
		Management Loss	Working condition. for example temp., pressure	OTPM
		Motion Loss	Man hour misfortune because of the development of administrator from the workstation to other spot for taking apparatus, bite the dust, material and so on.	KK
		Measurement and adjustment Loss	Time misfortune in regular estimation and Change in accordance with forestall	QM
	EFFICIENCY	Minor Stoppages and Idling Loss	Misfortune when gear is for a brief time. Halted for <10 min. e.g sensor activation, prattling in Parts, parts slippage, chip cleaning, profundity change by plug and so on.	KK
		Speed Loss	Misfortune cause by distinction between Planned speed and Real Working rate of Hardware	KK
		Line Organization loss	Misfortune for man and machine hanging tight for part from past machine	KK
	QUANTITY	Defect / Rework	Time loss in reworking defective components	QM
	COST	Energy Loss	Loss due to ineffective Utilization of Input energy in Processing eg. Elect, fuel, gas	PM
Die, jig and tool Loss		Loss in Repairs of jigs and fixtures	KK	
Yield Loss		Loss due to difference between input & output of material, paints	KK,DM	
Logistic Loss		Time and money involved in transportation of Material	OTPM	

4.8.2 LOSS TREE AND COST TREE MATRIX:

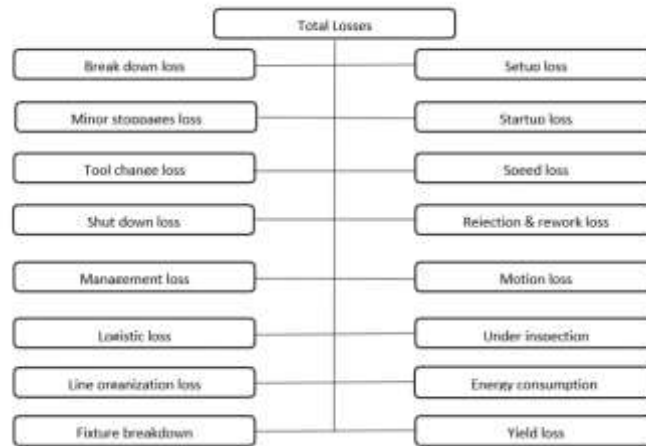


Fig. 4.3 Loss Tree

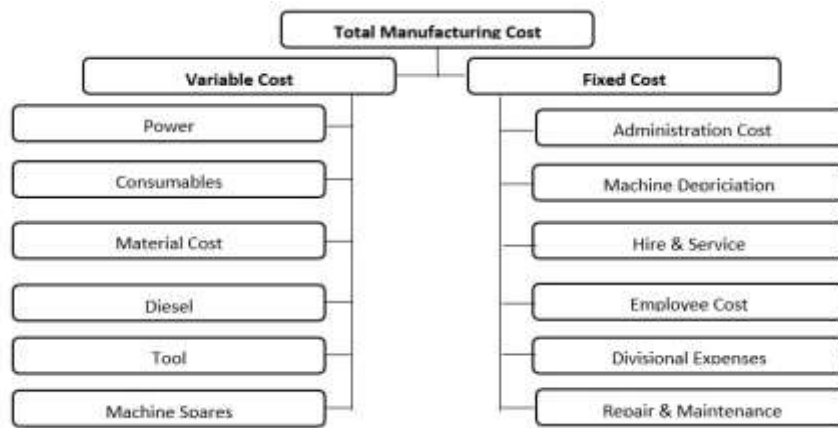


Fig. 4.4 Cost Tree

Results

TPM kick-off in Capora Maruti Limited (Bawal) plant in June 2004. After start off the TPM organization has acquired the phenomenal outcomes regarding Efficiency, Quality, Cost, Conveyance, Wellbeing, and Assurance. The organization has additionally accomplished unmistakable elusive advantages after start off the TPM.

5. OUTCOMES ATTAINED FOR SETUP LOSS

Figure 5.1 features the all out decrease in arrangement misfortune after kaizen execution. The arrangement misfortune was greatest in LMS division which was covering 85% of the arrangement misfortune. In LMS the subgroup barrel shaped crushing in crushing area division covering 55% of the arrangement time. In year 2005 the arrangement misfortune was 13152 min/arrangement and the objective was to accomplish 3742min/set up to year 2020. So after the execution of kaizen thought the genuine arrangement misfortune was 9800 mins/arrangement up to year 2010 and it was diminished to 3900 min/arrangement up to year 2020 for example up to 70% generally decrease in every one of the four jost.

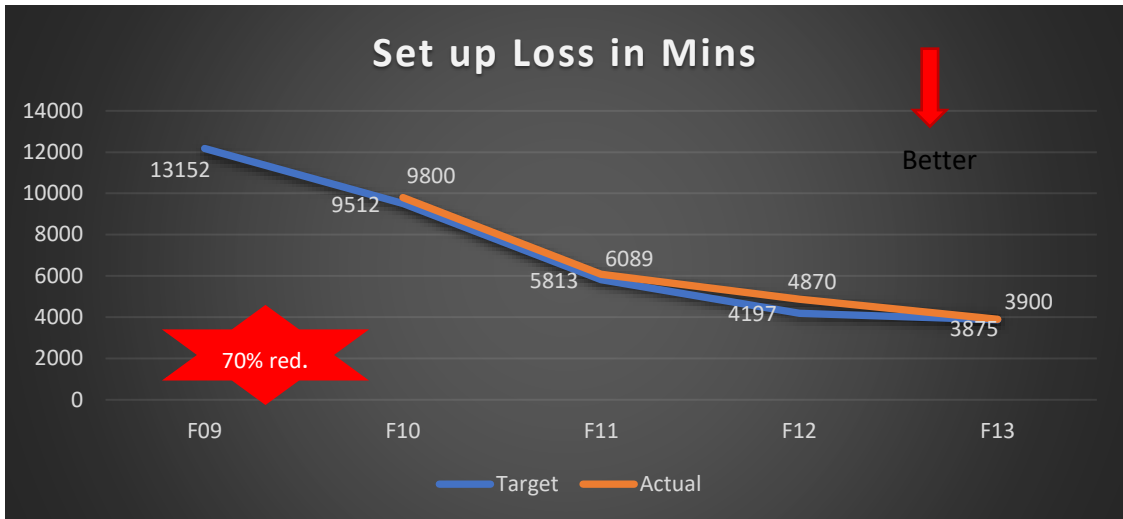


Fig. 5.1 Reduction in Setup Loss

Figure.5.3 features the absolute decrease in set up time after the execution of kaizen thought. The arrangement time on barrel shaped crushing machine was 93 min/arrangement before execution of kaizen thought. Presently it is diminished up to 75% by carrying out the kaizen thought for example To plan the part unambiguous tail stock focus.

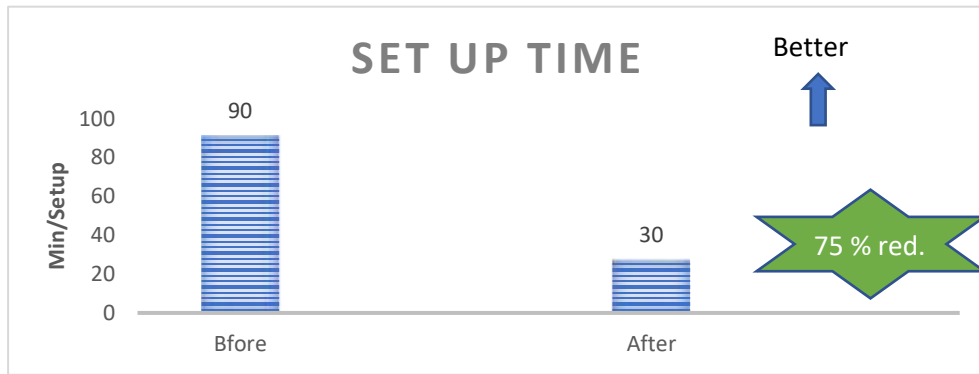


Fig. 5.2 Minimization in Set-up Time

The fig. 5.4 features the expansion underway limit by decreasing the arrangement misfortune after the execution of kaizen thought. Before execution the creation limit was 36 Units/hr and after execution it is expanded up to 43 Units/hr for example expanded up to 15%. With the expansion underway limit subsequently increment the creation.

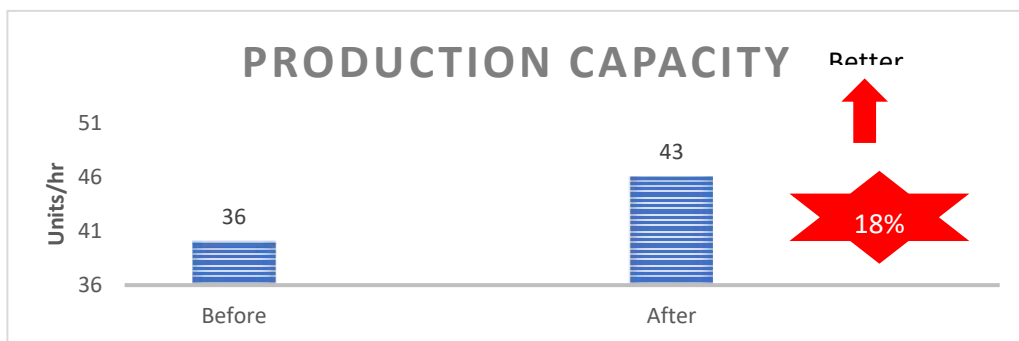


Fig. 5.3 Enhancement in Production capacity

Figure 5.5 features the reduction in normal time/arrangement by decreasing the arrangement misfortune after execution of kaizen thought. The typical time/arrangement in 2016 was 4.20 hr/arrangement and after execution of kaizen it was 2.15 hr/arrangement for example diminished practically up to 55%.

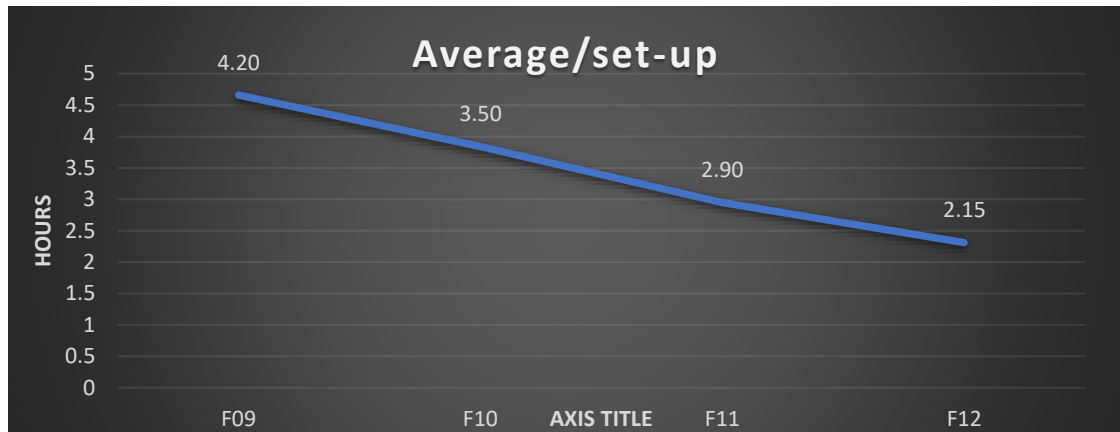


Fig. 5.4 Decrease in average time set-up

5.3 RESULTS OBTAINED FOR TOOL CHANGE LOSS

Figure 5.5 features the all out decrease in device change misfortune after the execution of kaizen thought. Device change misfortune was most extreme in HMS division i.e., 60%. In HMS the upward focus machine in differential lodging division covering 25% of hardware change misfortune. In the year 2020 the device change misfortune was 1340 min. furthermore, the objective was to accomplish 495 min. up to year 2019. So after the execution of kaizen thought the genuine apparatus change misfortune was 1012 min. up to year 2019 and it was decreased up to 550 min. to year 2019 for example 68%.

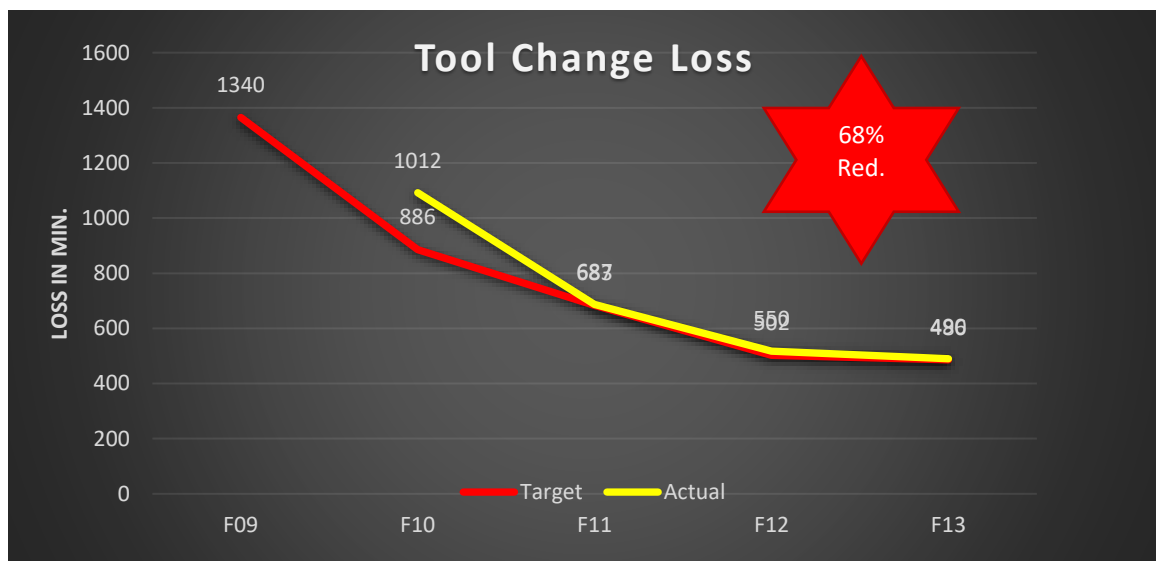


Fig. 5.5 Decrease in Tool change Loss

Figure 5.2 features the apparatus change time decrease after the execution of kaizen thought. The apparatus change misfortune was greatest on vertical place machine in differential lodging segment for example 43 min/arrangement before execution of kaizen thought. Presently the apparatus change time decreased up to 16 min/set after the execution of kaizen thought for example 60%.

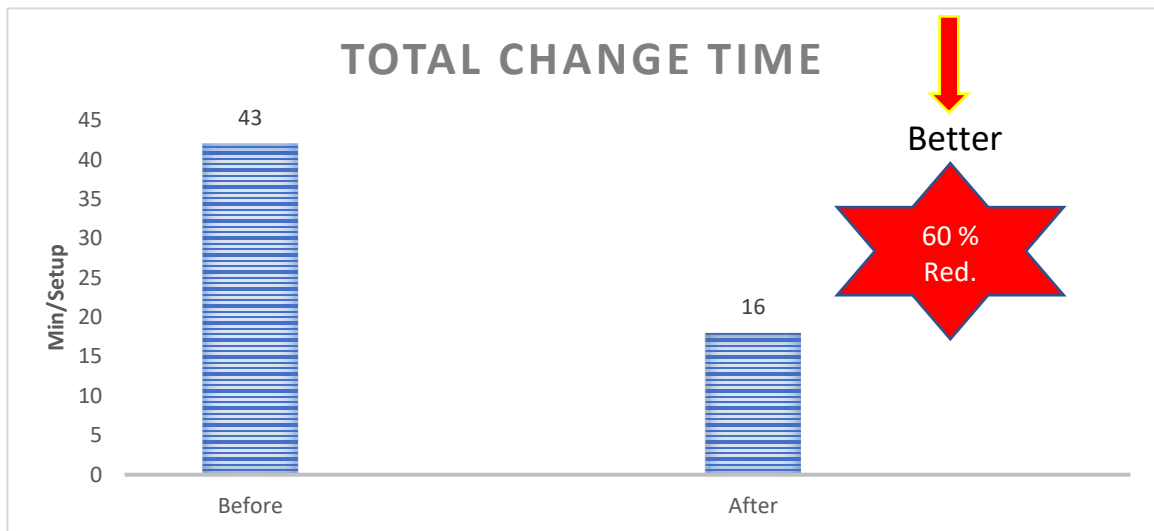


Fig. 5.6 Minimization in Tool change Time after TPM

Figure 5.7 highlights the increase in production capacity by reducing the tool change loss after the implementation of kaizen idea. Before implementation the production capacity was 63 units/hr and after implementation of kaizen idea the production was 69 units/hr i.e. increase up to 10% of the production capacity and hence increase the production.

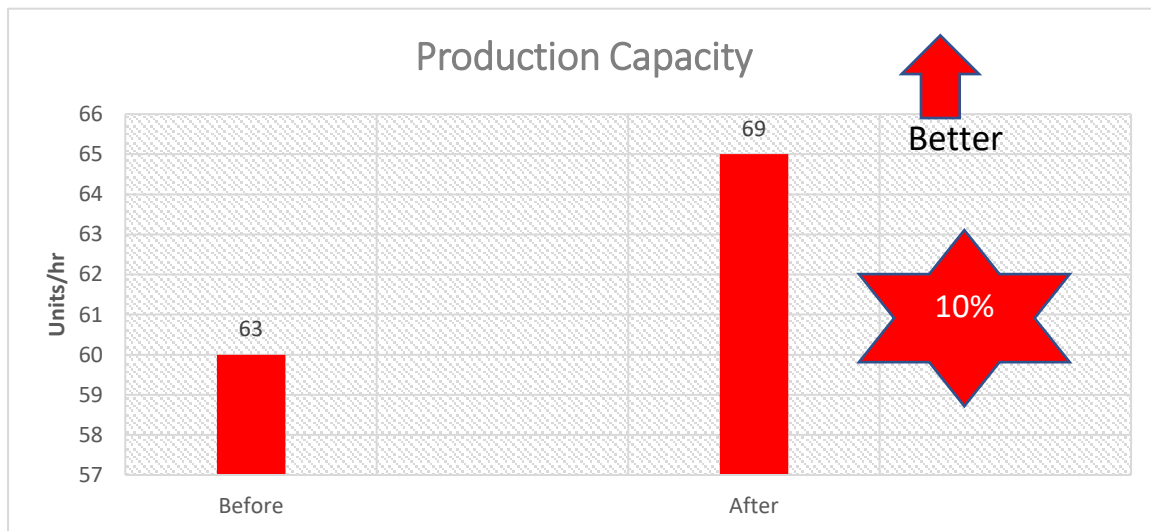


Fig.5.7 Enhancement in Production capacity

Figure 5.8 features the instrument change misfortune and number of kaizen performed for the time of 2016-20. The apparatus change misfortune was 1270 min in the time of 2016 and it was decreased to 400 min to the extended period of 2020 i.e.70% decrease. The quantity of kaizen acted in 2016 was 8 and it expanded up to 24 to the time of 2020 i.e.80% expansion.

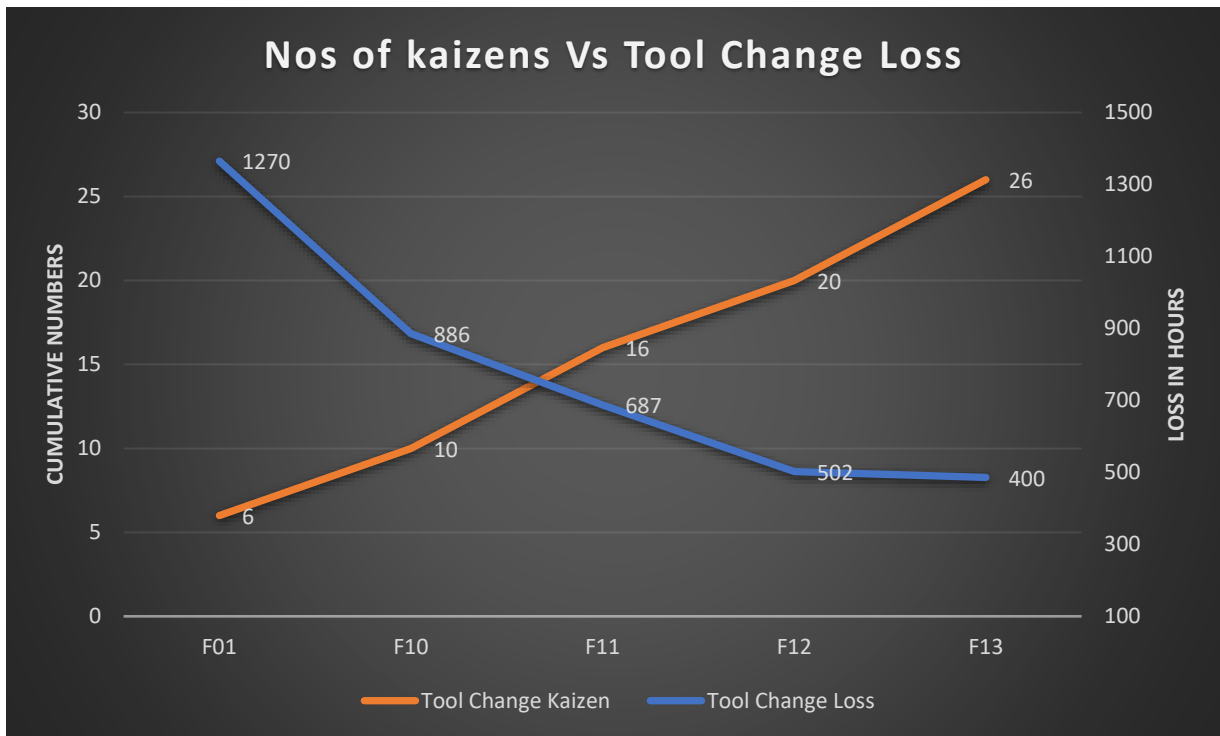


Fig. 5.8 Minimization in Tool change loss & Enhance no. of kaizen

5.4 RESULT ATTAINED FOR ENERGY LOSS

Figure 5.9 features the absolute energy decrease after the execution of kaizen thought. Energy misfortune was most extreme in paint shop which was covering 35% of energy. In 2016 energy utilization was 490 units and the objective was to accomplish 350 units up to 2020. So after the execution of kaizen thought genuine energy utilization was 420 units up to year 2009 and it is additionally diminished up to 370 units to year 2020 for example 20% decrease.

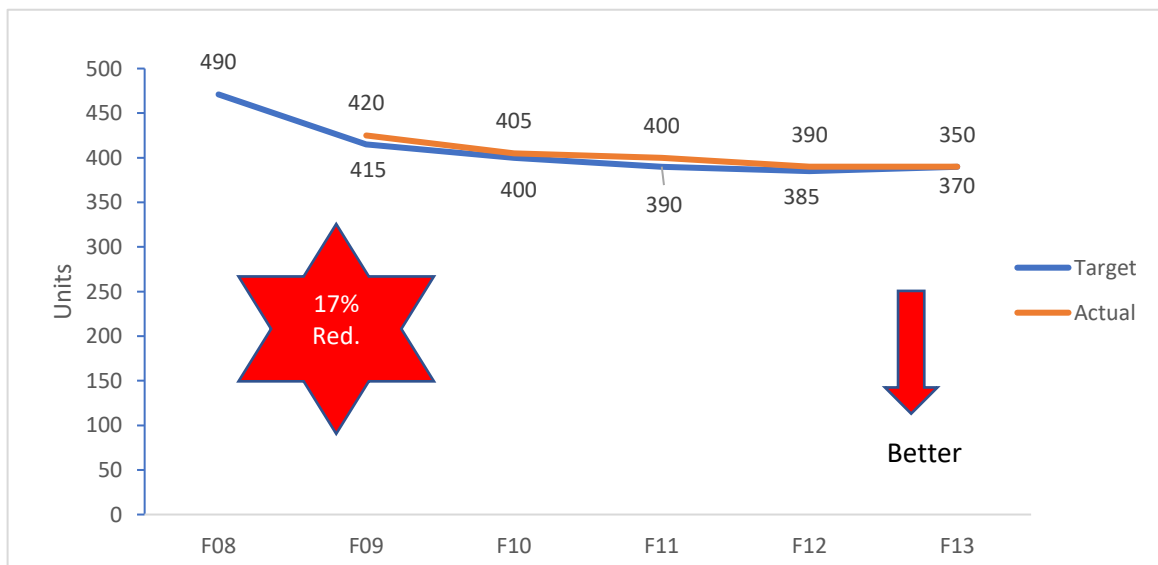


Fig. 5.9 Minimization in Energy Losses

Figure 5.10 features the decrease in power utilization after the execution of kaizen thought. Before execution power utilization was 55 units and it is decreased to 45 units after the execution of kaizen thought for example 19% decrease.

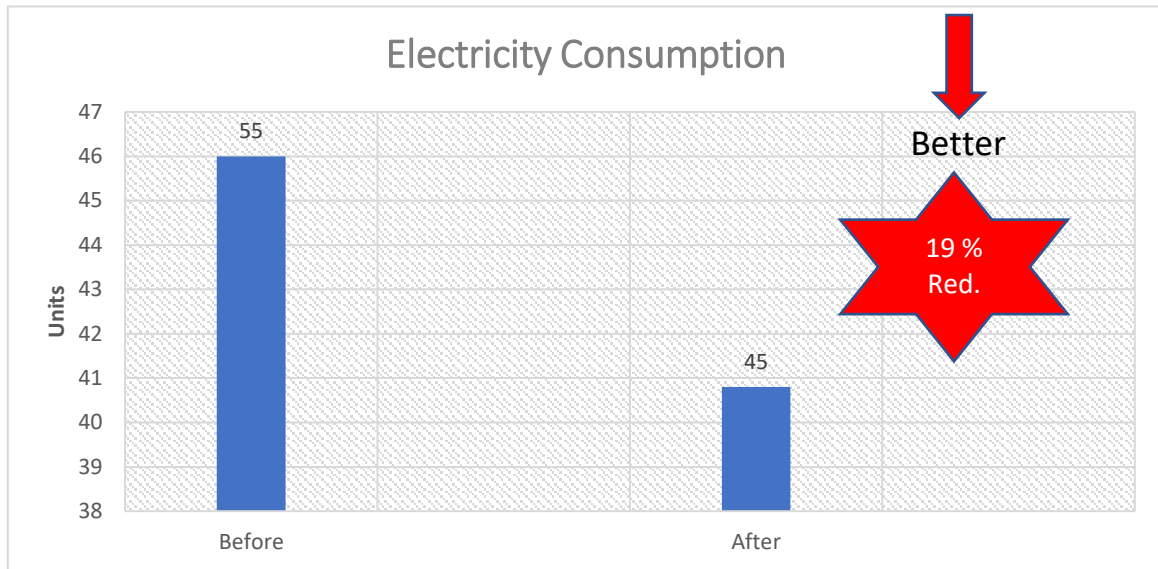


Fig. 5.10 Minimization in Electricity consumption

Figure 5.11 highlights the energy consumption and energy saving kaizen performed for the year of 2016-20. The energy consumption /tractor in 2016 was 471 units and is reduced to 390 units to the year 2020. The number of energy saving kaizen performed in 2016 was 4 and it further increase up to 45 to the year 2020

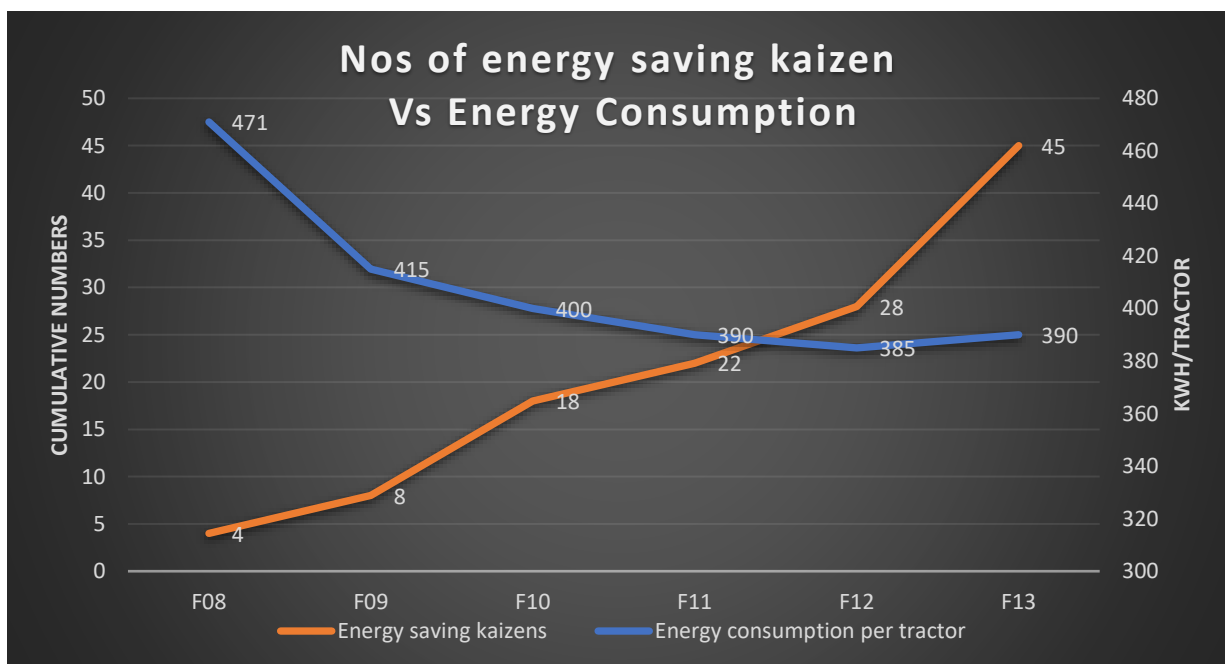


Fig. 5.11 Energy consumption & Energy saving kaizens

5.5 RESULTS FOR OBTAINED OEE

Figure 5.12 features the expansion in generally speaking hardware adequacy after the execution of kaizen thought. In 2010 the OEE was 59% and the objective was to accomplish 85% up to year 2020. So after the execution of kaizen thought the OEE was 75% up to 2016 and expanded to 88% up to 2020 for example 29% increment.

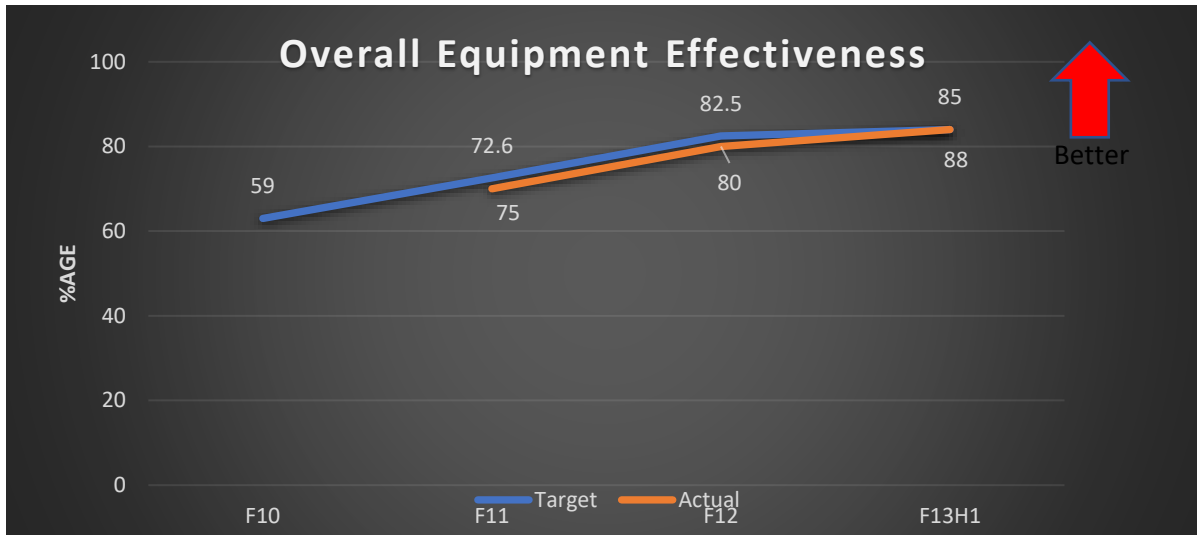


Fig. 5.12 Increase in Overall Equipment Effectiveness

5.6 CONCLUSIONS

The implementation of focused improvement pillar Caparo Limited, Bawal Division remained very successful and the overall result achieved after focused improvement pillar in terms of P, Q, C, D, S, M for the year of 2016-20 are conclude as:

Productivity

- 1) OEE Greater than 88%

Quality

- 1) Quality enhance by achieving zero losses and defects.
- 2) Reduce Rework

Cost

- 1) Manufacturing cost reduction.

Delivery

- 1) Faster delivery of the components by reducing the lead time
- 2) Reduction of product changeover time by 10 mins

Safety

- 1) Achieve up to 94%

Morale

- 1) Kaizen/ team/ year increase by 8 times.

1) 5.6.1 P, Q, C, D, S, M for TPM

- 2) The results of TPM achievement obtained after Implementation of KK pillar named as
- 3) focused improvement in swaraj for the year of 2016-20.

4) Productivity:-

- 5) 1) Increase in Tractors /man/month by 1.9 times
- 6) 2) Breakdown incidences/month reduced by 92%

7) Quality:-

- 8) 1) Field Quality improved by 30%
- 9) 2) Machine shop scrap and rework reduced by 85%

Cost:-

- 1) Manufacturing cost reduced by 35%
- 2) Tool cost reduced by 30%

Delivery:-

- 1) 100% schedule adherence
- 2) Equipment development lead time reduced by 55%

Safety:-

- 1) Zero Accidents
- 2) First Aid incidents improved by 94%

Morale:-

- 1) Kaizen /team/year increased by 8.7 times.

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