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Implementation of Total Productive Maintenance- a case study

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Abstract – Now a day's the term productivity plays crucial role in any manufacturing organization. Total Productive Maintenance is the advance tool in manufacturing era which was developed in Japan help to increase the OEE (Overall equipment effectiveness). Being the advance tool, the information related to the same is not cleared especially in Indian manufacturing industry. This paper deals with the concept, introduction and implementation approach of Total Productive Maintenance (TPM) in detail. TPM is a maintenance program which involves a newly defined concept for maintaining plants and equipment. This paper will define TPM benefits, its strengths as a maintenance philosophy, its implementation approach. In this paper experience of implementing Total Productive Maintenance is shared and investigated for a company manufacturing files which are used in mechanical workshop. Concept is implemented in the manufacturing firm. This also deals with the organization structure required for TPM implementation and shows that how the organization structure affects by the results of TPM. The goal of the TPM program is to increase production while, at the same time, increasing employee morale and job satisfaction. Overall Equipment Efficiency (OEE) and Value Stream mapping are used as the measure of success of TPM implementation. The losses, wastages are successfully identified. All the pillars of TPM are implemented. The results of implementing TPM program in terms of increased plant efficiency and productivity are outstanding. The paper concludes that the implementation of TPM is definitely not an easy task, which is considerably burdened by organizational, behavioral and other barriers, and necessitates the difficult mission to change people mindset from a traditional Maintenance approach.

Key Words: OEE, TPM.

1. Introduction

In today's manufacturing era, the waste due to operators, maintenance personal, process, tooling problem and non-availability of components in term etc. results in huge losses/wastages occur in manufacturing shop floor. In this situation, a concept TPM plays important role to eliminate the waste. TPM stands for Total Productive Maintenance. It is an innovative Japanese concept developed by Seiichi Nakajima in 1951. Nippodenso was the first company to introduce TPM in 1960. It focuses on keeping all the equipment in top working condition and builds a close relationship between Maintenance and Productivity. TPM is a philosophy of continuous improvement that creates a sense of ownership in the operators of each machine as well as in their supervisor. It is a process of maintenance management that empowers the organization with a progressive, continuous philosophy of enabling all manpower resources to work together to accomplish the mutual goal of manufacturing efficiency. Modern manufacturing requires that the organizations that want to be successful and to achieve world-class manufacturing, must possess both effective and efficient maintenance. One approach to improve the performance of maintenance activities is to implement a Total Productive Maintenance (TPM) system. The strategic TPM initiative can contribute to the improvement of manufacturing process. Today, the competition has increased dramatically. Customers focus on product quality, delivery time and cost of product. Because of these, the company should introduce a quality system to improve and increase both quality and productivity continuously. Total productive maintenance (TPM) is a methodology that aims to increase the availability of existing equipment, hence reducing the need for further capital investment. Investment in human resources can further result in better hardware utilization, higher product quality and reduced labor costs. TPM brings maintenance into focus as necessary and vital important as part of the business. TPM lead to zero breakdown and zero defect as possible. TPM involves everyone in the organization from top level to bottom level, it is based on team work and reduces the unaccepted breakdown. The five key elements or pillars of TPM include.

1. Improving equipment effectiveness by targeting the major losses.
2. Involving operators in the daily, routine maintenance of the equipment.
3. Improving maintenance efficiency and effectiveness.
4. Training for everyone involved.
5. Life cycle equipment management and maintenance prevention design.

1.1 Total Productive Maintenance

Total Productive maintenance (TPM) is System of maintaining and improving the integrity of production, safety and quality. Focuses on keeping all equipment in top working condition. Eliminate Breakdowns and Delays in Manufacturing Process. To implement the TPM concept we must follow the pillars of the TPM and adopt the technique like 5s and the tool used to implement the TPM is OEE (Overall Equipment Effectiveness) and for the result to be display numerically the concept of Value stream mapping is clubbed into this paper.

Eight pillars of TPM:

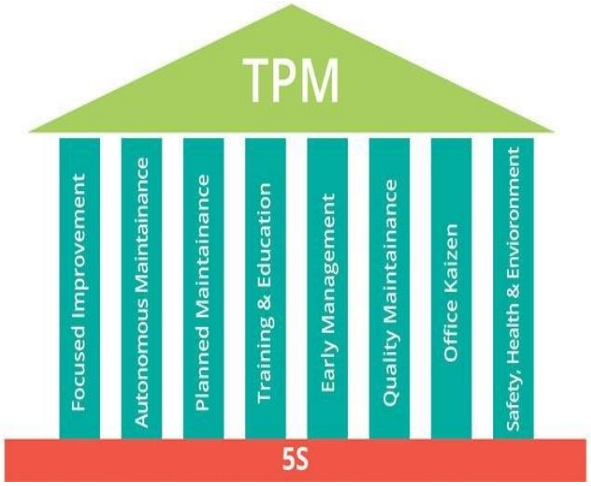

Fig 1: Eight pillars of TPM

The above Eight pillars of the TPM are self-explanatory. They deal with the autonomous Maintenance by the operator without waiting for the Maintenance person, continuous improvement of the processes, the Maintenance must be periodic and well planned within the organization. Education and training must provide in order to perform the given task effectively. Importance regarding the safety and health must be given to all the employees. The office TPM resembles that the data must be maintain periodically and in proper manner. TPM last pillars says that by implementation of the seven pillars, the development must monitor and further managerial actions must be done for developing the management.

1.2 Overall Equipment Effectiveness

TPM employs overall equipment effectiveness (OEE) as a quantitative metric for measuring the performance of a productive system. OEE is the core metric for measuring the success of TPM implementation program. This metric has become widely accepted as a quantitative tool essential for measurement of productivity in manufacturing operations. The role of OEE goes far beyond the task of just monitoring and controlling the manufacturing system performance. The OEE measure is central to the formulation and execution of a TPM improvement strategy. It provides a systematic method for establishing production targets, and incorporates practical management tools and techniques in order to achieve a balanced view of process availability, performance efficiency and rate of quality. OEE is calculated by obtaining the product of availability of the equipment, performance efficiency of the process and rate of quality product.

OEE =Availability (A)*Performance (P)* Quality
Where,

$$\text{Availability (A)} = \frac{\text{Available time - Downtime}}{\text{Available time}}$$

Available time= Total time - Planned downtime

Downtime is related to time associated with breakdown, setup, changeover, repairs, waiting time, etc.

$$\text{Performance(P)} = \frac{\text{Std cycle time * qty of products produce}}{\text{Operating time}}$$

Operating time=Total time - (Planned down time + Downtime)

$$\text{Rate of Quality} = \frac{\text{Good unit produce}}{\text{Total unit produces}}$$

TPM seeks to improve the OEE, which is an important indicator, deployed measure success of TPM program in an organization. TPM has the standards of 90 percent availability, 95 percent performance efficiency and 99 percent rate of quality. An overall 85 percent benchmark OEE is considered as world-class performance.

1.3 Value stream mapping

Value-stream mapping, also known as "material- and information-flow mapping", is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from the beginning of the specific process until it reaches the customer. A value stream map is a visual tool that displays all critical steps in a specific process and quantifies easily the time and volume taken at each stage. Value stream maps show the flow of both materials and information as they progress through the process. There are two kinds of value stream maps, current state and future state. The current state value stream map is used to determine what the process currently looks like, the future state value stream map focuses on what the process will ideally look like after process improvements have occurred to the value stream. The current state value stream map must be created before the future state map and is created by observing the process and tracking the information and material flow. The value stream map is then created using the following symbols. Value-stream mapping is a recognized method used as part of Lean Six Sigma methodologies.

2. Literature review

Every day the new technology is developing specially after industrial revolution in 19th century manufacturing sector improve continuously in the production systems and developing of world-class products and services (Chandra and Krishna, 1998). TPM is also emerging techniques which changed the industrial approach to a great extent. "TPM leading to realization of core competencies for meeting global challenges"(By IPS Ahuja and Prakash Kumar,2009) elaborate the concept of TPM, it's basic pillars and related terms which by taking in care can make a great change in organization. Some steps to implement i.e. how to start and what to focus get clear through this paper because in this paper case study regarding manufacturing firm of tube mill had focused Further, the organization has taken up major modernization and expansion plans, effectively catering to improvement in quality, production capacity and reduction in cycle time, for sustaining its market leadership and gaining international recognition in stainless steel manufacturing after the implementation of TPM. The idea of the paper TPM get strong by the paper "Evaluation of the TPM implementation initiative in an Indian manufacturing firm"(By IPS Ahuja and J.S.Khama,2009). From the paper the ideas about 5s, Availability criterion, rate of quality, etc. had cleared and steps regarding the implementation get cleared for this paper. The paper finds and helps to understand the TPM contribution to system, productivity, quality, safety and morale. "TPM implementation in machine shop"(By- Ashish Gohil and Dhaval B. Shah,2007) focus on overall equipment efficiency (OEE) calculation which helps in finding the formulae, terminologies related to the OEE and its relationship with the Total productive maintenance. Hence the OEE
Became the first tool for this case study. Success of the manufacturing firm depends upon the various pillars of TPM, 5s, planned maintenance, quality maintenance were the findings of this paper. From this the idea that TPM concept can bring a drastic change in Indian manufacturing firm. It is the simple concept but not well known to everyone and by implementing the basics things which are neglected during daily works can leads to effective production of the units to be produce with great accuracy and having great environment nearby in the manufacturing firm hence leads to increase the productivity and ultimately the overall efficiency of the plant. Lastly
the paper "critical review and analysis of 5s and value stream mapping"(By- Balkrishna E. Narkheda,2008) cleared the idea about the concept of the value stream mapping and its fundamentals and importance. The way of critical thinking gets emerged in order to tackle the problems which were coming in front of the selected case study so that the proper management leads to proper management. Similarly, we see the Indian companies has large potential which is tapped due to various technical and non-technical reasons. Since India is a developing country it has a tremendous potential to explore at and to unlock that potential, we need to implement TPM in our industries.

We see that industries of japan and Germany are far advance due to such practices. And as a citizens and engineering student we decided to implement this technique in our country too, so because of this, the selection of this topic has done which is definitely going to help and strengthen the nation's economy.

3. Research Methodology

The study was carried out in a manufacturing organization in India that has successfully implemented TPM. In this study manufacturing firm was critically examined. The approach was directed towards the justification of TPM implementation for its support to competitive manufacturing in Indian industries.
The methodology employed in the study is presented in Figure.

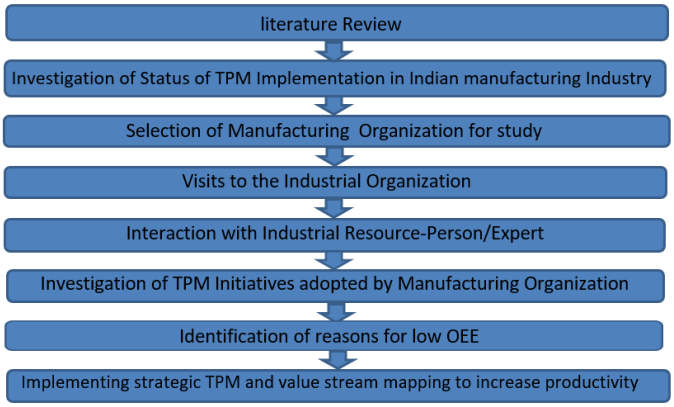

Fig 2: Methodology of project

To conduct the survey effectively, the exploits of the manufacturing organization regarding strategic TPM initiatives were explored through extensive plant visits, interviews/discussions with TPM practitioners.

3.1 Case study

For the execution of the project Total productive maintenance, the selection of the manufacturing organization had done. The product which is considered for the study is 6-inch triangular file and major focus is given on two process only i.e. tang forging process and annealing process. This selected manufacturing firm has the basic methods of operations for manufacturing a file. The process starts from the cropping process where the raw material which is stored in material room is brought for the cutting process and in Cropping process, out of raw material a required size files are cut by implementation of gauges of required length and the proper cut files are send for tang making process where with the application of the heat, the

hammering is to be done and tang making takes place. After this the next process i.e. annealing is carried out where the file become soften and gets ready for the work i.e. for sustaining against various further process so that the machinability becomes easy. The annealed file now sends for tang cutting process and there the extra length of the file was cut and inspection has done for the further work. After successfully pass through the inspection, the files are placed between the grinders and there the file get grind properly and take accurate shape. At the ground surface the teeth's are plotted at the time of up cutting process. This is the crucial step at this step proper setting of the machine is important. The files with teeth to be carved are again inspected by the team and after the inspection proper files are went for the hardening process where in furnace the files are deep to relieve the internal stresses and makes the file hardened so that they will sustain the stresses without fail of the teeth's.

The layer of oxide has been formed after hardening process which is removed in acid treatment. Here all the impurities are removed from the files. The scouring process is after this is applied where the files get clean and after drying, the inspection of the files are done and the well checked files are only permit for the packing purpose.

The inspection is done based on the experience of the worker.

Fig 3: process chart

3.2 TPM implementation

1. Focused improvement:

It is believed that small improvements of large numbers have more effect than large improvements of small numbers in any organization. This pillar aims to reduce losses in the workplace that are bottlenecks to plant efficiencies. Using a systematic procedure loss are eliminated in a phased manner. These activities can be implemented in both production as well as administrative areas.

Approach:

- The proper sorting arrangements like trolley and containers earlier was absent and the modified design trolley has implemented in order to save the time after tang forging process.

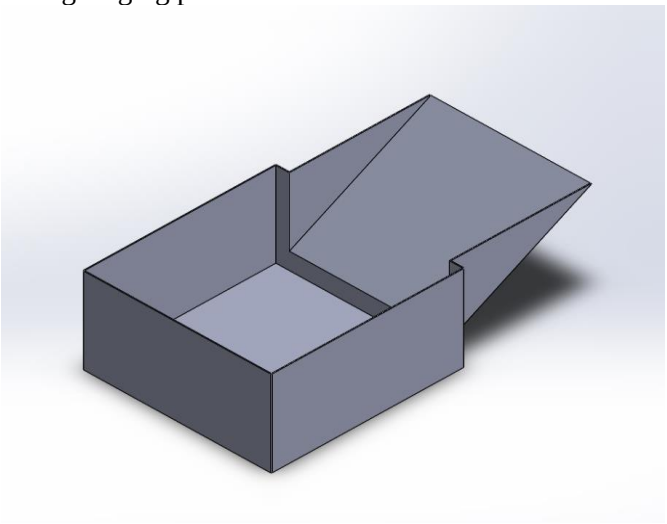

Fig 4: Before Trolley

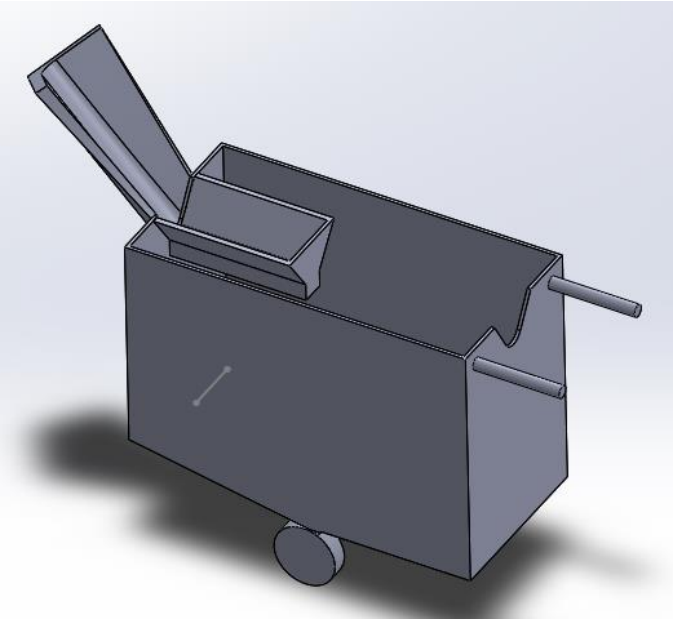

Fig 5: Modified Trolley

2. Autonomous Maintenance:

This is done by operator of machine and operator is same responsible for daily cleaning and minor maintenance activities. Operator must train for general maintenance.

Approach:

- Operators are given training by shop floor in charge about daily Maintenance.
- Operators are responsible to upkeep the machine on which they are working.
- Autonomous Maintenance check list is prepared and following the checklist is mandatory for the operators.

3. Planned Maintenance:

It happens before the machine breakdown. this is planned maintenance considering various factors like the machine failure rate, age of the machine etc.

Approach:

- Operators of the machine are train to identify the areas which are more likely to fail during manufacturing, so that they can inform Maintenance department in advance and take corrective actions before any major breakdown.
- Regular schedule of the Maintenance must follow by electric and mechanical maintenance department and data regarding the Maintenance must be recorded carefully.
- Proper ferment of the oil has done and more focus is given on leakage of oil in order to view the indicator level of the machine properly.

4. Education and training:

Employees having high morale and knowledge do wonders for a company. Aimed at developing employees into multi-skilled dynamic work forces wherein everyone who is enthusiastic about his work and does all the given functions effectively and more independently. This is imparted by engaging the operators in various ways of education in order to upgrade their skills.

Approach:

- The improvement is possible only through improvement in knowledge and skill of the worker.
- The defects are reduced by providing adequate training to all staff for increasing their skill regarding the field in which are they working to do work effectively.
- By training the imperfections regarding the edge cutting during up cutting process can be eliminated.

5. Quality Maintenance:

This TPM pillar address and improves quality by ensuring equipment is able to detect and present error during production. This helps detecting error during production hence we get best product in first time.

Approach:

- The temperature sensor is implemented at the time of tang forging process so that the waste which is in term of extra length of the tang can be removed.
- This also results in elimination of the tang cutting process from the manufacturing firm hence it's the huge change in any form to eliminate one full process.

Fig 6. Inductive Sensor

6. Office kaizen:

Office TPM aims at improving productivity and efficiency of the administrative functions by identifying and eliminating losses. It includes activities such as analyzing the procedures and processes for increased office automation. It targets several major losses in administrative work such as cost and processing loss in the areas of accounts, procurements, and sales and marketing that leads to high inventories.

Approach:

- Employee details are displayed on the notice board having information like their names, designation, phone numbers.
- Operators are writing daily Rejected quantities, records are properly maintaining based on training of the man force, so that the time required in getting data for daily rejection from quality department is reduced.
- Proper labeling are done on scrap Material, inventory, waste material and material in use.

7. Safety, health and Environment:

This pillar focuses on developing safer workplace and surroundings without getting damaged by the process or procedures.

Approach:

- Any accident in industry is loss to industry. Therefore, it is important to avoid accident and this will also keep away to industry and operators from any losses.
- The workers are given the safety equipment's and noise reducing equipment and the managerial staff take care that all workers must wear all equipment.
- Workers are advised to maintain cleanliness of toilets; regular cleaning of toilets is also done.
- Management is also given suggestions to start a scheme where the staff who gives new suggestions which helps in industry productivity uplifting must be credited by some incentives or awards.

3.3 Value stream mapping

* Value stream mapping before the implementation of the TPM:

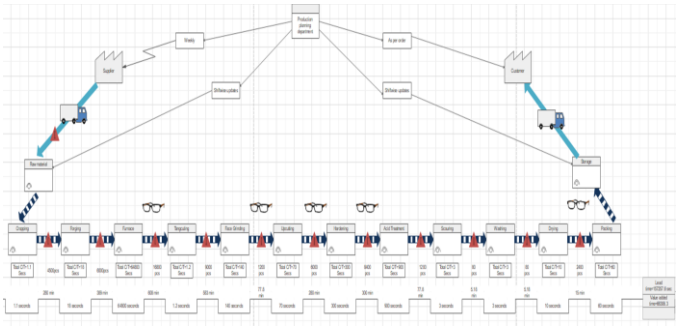

Fig 7. Value Stream mapping with tang cutting.

Calculation

- Value Added (%):
  Value added = Total cycle time / Total lead time
  = 66306.3 / 157257.6
  = 42.16%
- Non-value Added (%) {waste}:
  Non-Value added = 100-Value added
  = 57.83%

* Value stream mapping after the implementation of the TPM:

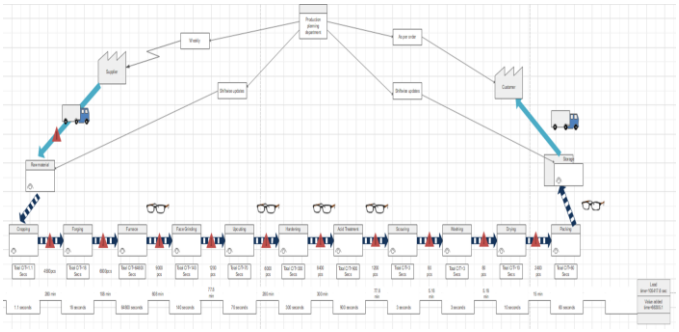

Fig 7. Value Stream mapping without tang cutting process.

Calculation

- Value Added (%):
  Value added = Total cycle time / Total lead time
  = 66305.1 / 105401.4
  = 62.90%
- Non-value Added (%) {waste}:
  Non-Value added = 100-Value added
  = 37.09%

- Process chart after implementation

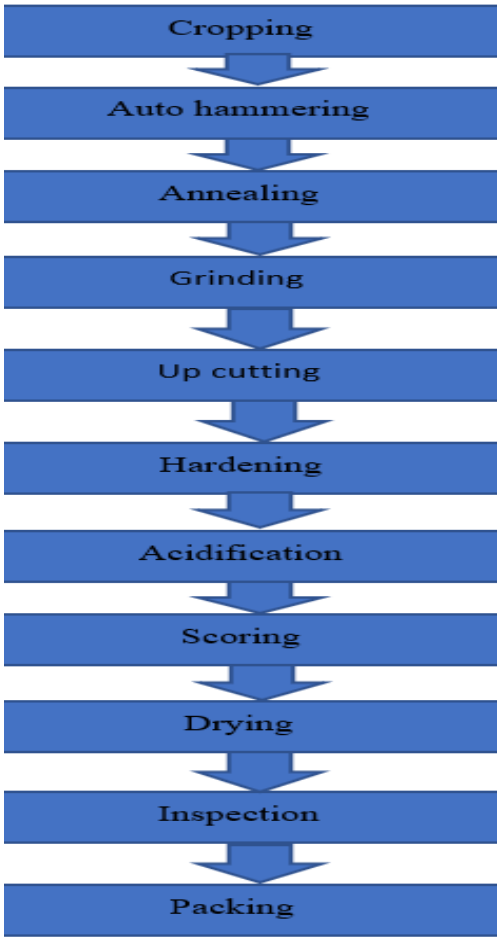

Fig 8: Future process chart

4. Result

Before implementation of TPM	After implementation of TPM
1.The value-added percentage was 42.16%	The value-added percentage becomes 62.90%.
2. Tang cutting process is present	Tang cutting process eliminated.
3. Scrap generation is more after tang forging process	No scrap generation after tang forging process due to implementation of sensor at the time of tang making
4.Holding time for annealing purpose earlier was approximately 4 hours for each tray of set of files and 2 manpower were required for setting of the file in proper arrangement in that trays.	Holding time reduced to 1.8 hours and only one manpower can operate and fill up the tray without any fatigue after the implementation of the modified trolley.
5. Existing trolley do not arrange the file in orderly fashion	Designed trolley have specific arrangement for sorting the files

5. Conclusion

The Indian manufacturing organizations has been studied through various literature and analyzed to study TPM implementation issues, the study reported in this work has revealed that there is an emerging need for TPM implementation in the Indian manufacturing industry. By implementing TPM in industry get many benefits from all the company areas. TPM implementation needs workers involvement and high authority support with the help of these two factors industry growth rapidly increases. TPM is not only related to productivity of industry it also creates safe and clean environment in industry and reduced unacceptable machine breakdowns. By implementing TPM project successfully implement in the company which will results the value-added percentage increases from 42.16 to 62.90%. By implementation of proximity sensor in tang forging process every time the length of tang formed is of perfect length, also it eliminates rework of tang cutting process. Along with that a trolley (file collector) is designed such that it collects the file in orderly fashion simultaneously after forging which will reduce the manpower by 1 along with that the efforts were reduced. Hence by using the tool OEE and value stream mapping the modified data can be easily seen and the solutions which are segregated under the pillars of TPM also were solved.

6. Future scope

In this paper, consideration is given on the selective process i.e. only on tang forging and annealing out of all the process due to lack of time. Further by analyzing all the process thoroughly, further increase in the productivity can observe and since it is irregular production firm the calculation of the overall equipment effectiveness becomes difficult due to lack of uniformity of the process plans because here the work is done on target basis. The target is given to all workers of individual process of finish the task and the target is based on past experience of the company. So, it can also change so that the company must adopt the new things and can sustain in this competitive world.

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