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A Study on Total Productive Maintenance at Vishal Precision Products Private Limited

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INTRODUCTION

1.1 Introduction to TPM

Getting operators involved in maintaining their own equipment, and emphasizing proactive and preventive maintenance will lay a foundation for improved production (fewer breakdowns, stops, and defects).

TPM (Total Productive Maintenance) is a holistic approach to equipment maintenance that strives to achieve perfect production:

- No Breakdowns
- No Small Stops or Slow Running
- No Defects

In addition it values a safe working environment:

- ***No Accidents***

TPM emphasizes proactive and preventative maintenance to maximize the operational efficiency of equipment. It blurs the distinction between the roles of production and maintenance by placing a strong emphasis on empowering operators to help maintain their equipment.

The implementation of a TPM program creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity (increasing up time, reducing cycle times, and eliminating defects).

The 5S Foundation

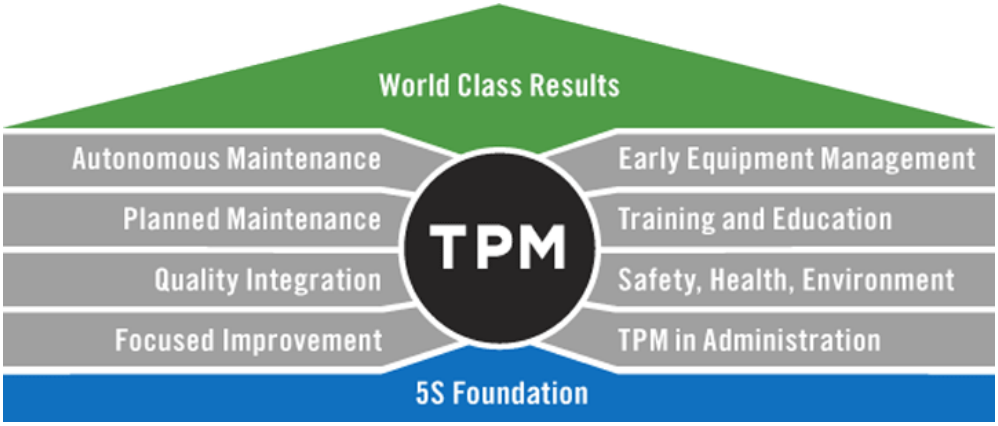
The goal of 5S is to create a work environment that is clean and well-organized. It consists of five elements:

- Sort (eliminate anything that is not truly needed in the work area)
- Set in Order (organize the remaining items)
- Shine (clean and inspect the work area)
- Standardize (create standards for performing the above three activities)
- Sustain (ensure the standards are regularly applied)

It should be reasonably intuitive how 5S creates a foundation for well-running equipment. For example, in a clean and well-organized work environment, tools and parts are much easier to find, and

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it is much easier to spot emerging issues such as fluid leaks, material spills, metal shavings from unexpected wear, hairline cracks in mechanisms, etc.



The traditional TPM model

1.2 The Eight Pillars

The eight pillars of TPM are mostly focused on proactive and preventative techniques for improving equipment reliability.

PILLAR	WHAT IT IS	HOW DOES IT HELP
Autonomous Maintenance	Places responsibility for routine maintenance, such as cleaning, lubricating, and inspection, in the hands of operators.	• Gives operators greater "ownership" of their equipment. • Increases operators' knowledge of their equipment. • Ensures equipment is well-cleaned and lubricated. • Identifies emergent issues before they become failures. • Frees maintenance personnel for higher-level tasks.
Planned Maintenance	Schedules maintenance tasks based on predicted and/or measured failure rates.	• Significantly reduces instances of unplanned stop time. • Enables most maintenance to be planned for times when equipment is not scheduled for production. • Reduces inventory through better control of wear-prone and failure-prone parts.
Quality Maintenance	Design error detection and prevention into production processes. Apply Root Cause Analysis to eliminate recurring sources of quality defects.	• Specifically targets quality issues with improvement projects focused on removing root sources of defects. • Reduces number of defects. • Reduces cost by catching defects early (it is expensive and unreliable to find defects through inspection).
Focused Improvement	Have small groups of employees work together proactively to achieve	• Recurring problems are identified and resolved by cross-functional teams. • Combines the collective talents of a company

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	regular, incremental improvements in equipment operation	to create an engine for continuous improvement.
Early Equipment Management	Directs practical knowledge and understanding of manufacturing equipment gained through TPM towards improving the design of new equipment.	• New equipment reaches planned performance levels much faster due to fewer start up issues. • Maintenance is simpler and more robust due to practical review and employee involvement prior to installation.
Training and Education	Fill in knowledge gaps necessary to achieve TPM goals. Applies to operators, maintenance personnel and managers.	• Operators develop skills to routinely maintain equipment and identify emerging problems. • Maintenance personnel learn techniques for proactive and preventative maintenance. • Managers are trained on TPM principles as well as on employee coaching and development.
Safety, Health, Environment	Maintain a safe and healthy working environment.	• Eliminates potential health and safety risks, resulting in a safer workplace. • Specifically targets the goal of an accident-free workplace.
TPM in Administration	Apply TPM techniques to administrative functions.	• Extends TPM benefits beyond the plant floor by addressing waste in administrative functions. • Supports production through improved administrative operations (e.g. order processing, procurement, and scheduling).

1.3 OEE (OVERALL EQUIPMENT EFFECTIVENESS)

OEE is a metric that identifies the percentage of planned production time that is truly productive. It was developed to support TPM initiatives by accurately tracking progress towards achieving "perfect production".

- An OEE score of 100% is perfect production.
- An OEE score of 85% is world class for discrete manufacturers.
- An OEE score of 60% is fairly typical for discrete manufacturers.
- An OEE score of 40% is not uncommon for manufacturers without TPM and/or lean programs.

OEE consists of three underlying components, each of which maps to one of the TPM goals set out at the beginning of this topic, and each of which takes into account a different type of productivity loss.

OEE = Performance × Availability × Quality

COMPONENT	TPM GOAL	TYPE OF PRODUCTIVITY LOSS
Availability	No Stops	Availability takes into account **Availability Loss**, which includes all events that stop planned production for an appreciable length of time (typically several minutes or longer). Examples

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		include Unplanned Stops (such as breakdowns and other down events) and Planned Stops (such as changeovers).
Performance	No Small Stops or Slow Running	Performance takes into account **Performance Loss**, which includes all factors that cause production to operate at less than the maximum possible speed when running. Examples include both Slow Cycles, and Small Stops.
Quality	No Defects	Quality takes into account **Quality Loss**, which factors out manufactured pieces that do not meet quality standards, including pieces that require rework. Examples include Production Rejects and Reduced Yield on start up.
OEE	Perfect Production	OEE takes into account all losses (Availability Loss, Performance Loss, and Quality Loss), resulting in a measure of truly productive manufacturing time.

OEE is tightly coupled to the TPM goals of No Breakdowns (measured by Availability), No Small Stops or Slow Running (measured by Performance), and No Defects (measured by Quality).

It is extremely important to measure OEE in order to expose and quantify productivity losses, and in order to measure and track improvements resulting from TPM initiatives.

1.4 Company Profile

Vishal Precision Product Pvt. Ltd. has started in the year of 1987 as Vishal engineering company. This operates as a partnership concern up to 1993. It becomes a registered private Ltd organization from 1.12.1993. The managerial board comprised of Mr. Jayaseelan as managing director and Mrs. Mercy Jayaseelan hold the post of director.

Today Vishal changed the name as Vishal Precision Products Private Ltd situated in Peelameda, Coimbatore. This company a well-equipped engineering industry processing special purpose CNC machinery and other general purpose machine. It includes machine for jig boring made of OERCIKON (Swiss) WMWE (Germany) etc.

Primarily engaged in the manufacture of standard mould base of plastic moulds, die housing for pressure die casting and plate die sets for press tools and precision components to suit their client requirement. The manufacturing is done as per customers drawing specification. This includes all drawing on pockets side opening. Side core opening, jig boring which are undertaken to fit the 'INSERT' in the mould base, bores to slide figure cams/pins, auxiliary pillar bush for ejector system, length red, support pillar tubular dewless for spigot type mould and all other arrangement are as per the given drawing and specification.

On account of this communication to a self-certified quality standards productivity and reliability in service. It has over the year developed a commendable list of its proud and satisfied clients. These include Mitsubishi (Japan), national dewatering and land drainage (Dubai), BPL Ltd (Cochin), Eagle flash industries (Pune), Roots industries (Coimbatore), Bajaj Auto Ltd (Pune, etc. Vishal adopts the national standards ISO 9001:2000. It was proving a quality management system to demonstrate its ability to provide consistent products that meet customer satisfaction through the effective Planning. It

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presently ranked among the best in the category of the engineering industry in India. To specified Vishal ranks three among the mould base products in India

Their reputation is built on the foundation of Precision, Reliability and On-Time Delivery. The strategic focus is to deliver increasing value to our customers. Continuous up-gradation of human resource machinery and infrastructure helps us to achieve the goal while staying ahead of competition as well.

Vishal Precision Products Private Limited have three division specialized in three different aspects;

1.4.1 Fine Product Division

Vishal manufacture standard mould bases for plastic injection moulds die housing for pressure die casting dies, and plate die set for press Tools & precision components suit the requirement. They manufacture as per customer drawing specification, including pocket opening, side core opining, fig boring to fit insert in the mould base, bores to suit finger cams/pins, auxiliary pillar bush for ejector system, length red, support pillars, cooling holes, tubular dowels for spigot type mould and many other arrangements.

1.4.2. Fine Machining Division

They are engaged in manufacture and supply of Jigs & Fixtures and Precision machined components, sub-assemblies & exports.

1.4.3. Fine Assembly Division

Vishal assemble sub-assemblies as part of OE with hydraulic, pneumatic accessories along with required gears, cams & motors to the customer's requirements.

1.4.5 Mission and Vision Statement

Mission

To deliver Excellence in Engineering, by meeting every customer requirement as a matter of habit

Vision

To be a Global Player in Engineering Excellence by exploring new frontiers of challenges to delight the customer.

Values

• Our employees, and their professional and personal growth
• Teamwork that ensures success when faced with challenges
• Providing superior client service and achieving total satisfaction.
• Professionalism and integrity. Being honest, fair, and ethical
• Being entrepreneurial. Rewarding performance Accepting noble failures

1.4.6 Product Profile

Fine Production Division

• Mould Base for Plastic Injection Moulds.
• Die-Housing for Pressure Die Casting Die.
• Plate Die set for Press Tools

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Fine Assembly Division
• Special Purpose Machineries.
• Sub-Assemblies.

Fine Machining Division
• Export components.
• Press Tools.
• Jigs.
• Fixtures for CNC Machines.
• Gauges.
• Precision Components Machining.

1.5 Functional Departments
1.5.1. Marketing Department
This department takes care of the activities of sales, export and customer interaction. The marketing department receives the customer requirement and designs the mould base and it allocates the work to purchase department and design department. Vishal has very good fame and name in the country because it is existing since two decades in the services of mould base jigs and fixtures.

Function of the marketing manager:
• Customer relationship marketing.
• Receive the enquiry.
• Prepare the quotation with terms and condition
• Quotation means = material cost + process cost + machine cost + labour cost + transport + packing cost + bought out items + over heads & profitable margin.
• Send the quotation to the customer.
• Keep in touch with the customer to convert the quotation into order.
• Receive the confirmation order.
• Design the product.
• Purchase raw materials.
• Products process
• Clarification from customer.
• Arrange dispatching the mould base.
• Feedback from customer.
• Maintain the goad relationship to the customer.

1.5.2 Purchase Department
This department takes care of procuring raw materials as well as stores and cutting tools, for the company such as steel tools of various grades have been produced manager heads the purchase department. He is sole person responsible for all the requirement process.

Purchase department carries the functioning of both purchasing and processing. Hence it is called C. P.P.D. (Centralized Purchase and Process Department).

Purchase Department Function
• Purchasing department gets purchase requirement from along with work order from marketing department.

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• They are having production software in which they prepare material planning as per specification of the customer.
• They prepare a plan to make purchase.
• They purchase the materials according to work order supplied by marketing department.

Vishal precision products Pvt Ltd, maintain a good relationship with vendors, which help them to procure the quality materials at reasonable price.

The process of purchasing is as follows:
• The potential supplier selected based on ability to supply quality products at competitive price in time.
• They are having approved suppliers list on the basis of that list they select the vendor.
• All the purchase materials are listed in three groups which are intimated to supplier through purchase order, delivery Chelan, and excise Chelan.
• The general Consumable and regular items are identified forms work order form are informed to CPPD through materials requisition and purchase requisition.
• The purchase order is raised.
• In case of any changes required in the term mentioned in the purchase order details must inform to consumer.
• In any of the supplies rejected from the suppliers list and after some time if they join the list then they may be considered as new suppliers.
• In case of emergency of materials it can be procured from any supplier other than the approved supplier.
• Assistant manager is the person who measures the supplier's satisfaction with help of the survey check list.

There are two types of purchase
• Cash purchase.
• Credit purchase.

Cash purchases are comparatively low. Credit purchases are usually more. Credit period is 90-100 period. Mode of payment to suppliers is made by cheque, DD, cash for special raw materials are from the places via Chennai, Bangalore, Mumbai, Pune etc.,

Materials suppliers list:
• National steel agency, Coimbatore,
• Andavar steel, Coimbatore.
• Universal steel, Coimbatore.
• Karpagam steel, Coimbatore.
• Ferro trading company, Coimbatore.
• Anand steel and alloys, Coimbatore.

The potential suppliers are selected based on ability to ensure quality products at competitive price in time.

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1.5.3 Production Department

Production department is taking care of all the manufacturing activities in the machine shop and with sub-contractors and the process is strictly planned and controlled by the production manager to attain total productivity.

Raw material purchased and roughing is done in conventional machine. If required stress reliving is done.

Proof machining is done & sent for heat treatment, if it is case hardening steel, 0.3 to 0.6mm stock is kept on all sides before hardening for further machining process.

The components undergo fine machining like CNC milling, Jig boring, wire cutting, fine milling, surface & cylindrical grinding, then sent for inspection & then sent for assembly.

Test certificate of Raw materials can be given on demand.

Delivery will be within 3 to 4 weeks after firm purchase order & as per terms in our Quotation. In case of urgency, delivery period can be reduced.

1.5.4 Machine Shop

Vishal machine has the capacity to produce standard housing from 120 - 125 mm to 1000 - 1500 mm for plastic moulds, dye housing for pressure die casting dyes, plate dye for press tools.

This dies and moulds are made with different spares, like cavity plate, core plate, other plate, pillar bushes etc. This spares are semi-finished in the machine shop. The plate is equipped with various machines such as.

- Grinding machine
- Lagun CNC milling machine
- Batliboi machine.
- Lathe machine.
- Jig boring machine.
- Radical drilling machine.
- Internal and external grinding machine.
- Surface grinding machine.

1.5.5 CNC MACHINE CENTRE

Computer numerical control (CNC) system is a computer obtains information from a computer store and controls the machine. CNC is a numerical control system in which a dedicated stored program computer is used to perform some or all the basic numerical control programs stored in the read write memory of the computer.

The CNC machine is mainly used for finishing the plates of the mould base. Magazines are available regarding CNC machines, which also help in increasing the production rate.

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1.5.6 Quality Control Department

The duty of the quality control department is to determine the quality of the products. This analysis is done for both in house and vendor products. They check for accuracy, in case of an error a non-conformity report is given by this department. If an error occurs in the vendor's product, the calculated amount is debited from their account. If it is an in house product the respective operator is warned about it. If it is repeated then IPRR- in process reason report is received from the operator. This may also lead to salary deduction. Thus based on the consistency of the product manufactured the quality check is done as periodic intervals.

The quality control department makes use of some computer controlled machines such as the CMM to check the accuracy of the product.

1.5.7 Design Department

On receiving the work order from the marketing department along with the entire drawing of the product, part drawings are drawn by them as per the requirement of each machine section and are given to the purchase and production department. They mainly use Auto CAD, Pro-E software for this designing purpose. Mainly engineers study the drawing of the customer. After the clear study of the drawing. Then part drawings are made. They are divided into parts based on the availability of the machines: operators and some of the drawings should also be completed by the vendors. Thus these part drawings help to do the work more efficiently when compared to the whole drawing process.

Software's used:

• *Auto CAD*

This is highly professional software where all the needs of a designer are met completely.

• *Pro-E*

This is also designing software which highly facilitates 3D drawings.

• *Master CAM*

This software enables clear layering of the drawings by which in turn part drawings can be drawn.

1.6 SCOPE OF STUDY

The particular study about TPM is limited within the organisation. The study is conducted on the shop floor of the organisation. In this study, the status of implementation of TPM in Vishal Precision Products Pvt. Ltd. is measured. The machines in the organization and their history are intensely studied and the breakdown ration is measured. The appropriate types of maintenance is identified and implemented to bring perfect production. TPM checklist is generated for all the 8 pillars of TPM and the process is evaluated and TPM Audit is conducted for machines in order to identify the reason for rework. Employees are given necessary training follow the process to achieve the perfect production. All the three underlying elements of OEE are measured and OEE is measured in order to expose and quantify the productivity losses and in order to measure and tract improvements resulting from TPM initiatives.

1.7 OBJECTIVE

Primary Objective

To study on Total Productive Maintenance at Vishal Precision Products Private Limited.

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Secondary Objective

• To Study the factors that are causing breakdown and rectifying those factors.
• Enhancing the productivity by improving OEE.
• To identify the training needs of the employee.

1.8 Problem Statement

According to the study, the major problem in Vishal Precision Products Pvt Ltd is caused by the SRT (Spindle Run Time). The major reason for less SRT is caused by the carelessness of the employees.

REVIEW OF LITERATURE

Kaur, Mandeep Singh, Kanwarpreet Ahuja, Inderpreet Singh (2013)

In this study, a large number of manufacturing organisations have been extensively surveyed, to ascertain contributions made by TQM-TPM paradigms in the Indian manufacturing organisations towards realizing business performance improvements and highlights the strong potential of synergic TPM implementation initiatives in affecting business performance improvements. The correlations between various organisational initiatives towards TQM-TPM implementation and business performance improvements have been evaluated and validated by employing various statistical tools. Findings – The research focuses upon the significant contributions of TQM-TPM organisational initiatives like quality related queries; top level support and level of total employee involvement; culture of continuous improvement; TQM and TPM core strategies; and transfusion of TQM and TPM, towards affecting improvements in business performance.

Binti Aminuddin, N. A., Garza-Reyes, J. A., Kumar, V., Antony, J., & Rocha-Lona, L. (2016).

The study on "An analysis of managerial factors affecting the implementation and use of overall equipment effectiveness" is the foundation of these two business improvement strategies as it tackles the underlying losses that impede equipment efficiency. This study presents the prevalence of managerial issues related to the implementation and use of OEE in the manufacturing industry. To do this, five hypotheses and four research questions were formulated and tested using a combination of descriptive statistics and cross-tabulation, chi-square, analysis of variance, Tukey's pairwise comparison, Z-test and correlation tests. The study identifies how manufacturing organisations employ the information provided by OEE and how the data for its computation are collected.

Gupta, Pradeep, Vardhan, Sachit (2016)

The study on "Optimizing OEE, productivity and production cost for improving sales volume in an automobile industry through TPM" is to investigate how increase in sales volume has evolved by improving overall equipment effectiveness (OEE) of) initiatives in a reputed tractors manufacturing industry in India. In this study, evaluation and analysis of the methodology adopted for improving sales volume through TPM initiatives was carried out using an interactive research approach. The industrial example on the application of OEE tool demonstrates that it has a remarkable potential to enhance the equipment effectiveness. The empirical findings of the study reveal that augmented OEE and productivity, and reduced production cost resulted to double the sales revenue and triple the profit within a period of three years. The industry also achieved notably tangible and intangible benefits with the TPM implementation.

Kumar, Jitendra, Soni, Vimlesh Kumar, & Agnihotri, Geeta (2014)

The study on "Impact of TPM implementation on Indian manufacturing industry" is to identify the relationship between TPM programme and manufacturing performance in Indian manufacturing industries and to identify common indicators; and to explore the common expectation while TPM implementation. A semi-structured questionnaire survey approach has been adopted for the justification of TPM implementation and benefits gained by it in Indian context. Survey has covered mainly automobile and machinery sector throughout India. The paper establishes the impact of successful TPM implementation on manufacturing performance. TPM initiatives provide regular OEE

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measure, performance monitoring and improvements, and developing guidelines for achieving enhanced manufacturing productivity.

Tyagi, A. S., Baag, D., Jailkhani, H., Poulose, J., & Patel, J. (2013)
The study is about "Identification of the Success Factors for the Implementation of Total Productive Maintenance in an Organisation Using Interpretive Structural Modeling (ISM)" and its aim to study the factors that affect the successful implementation of TPM in an organisation. The study have derived relationships among the various factors using the ISM modeling approach and topped it off by applying MICMAC analysis on the result to obtain a comprehensive relationship among the variables. The study here tells us that the top management's commitment is the major force behind the successful implementation of TPM in any organisation.

Wickramasinghe, G. D., & Perera, Asanka (2016)
The study on "Effect of total productive maintenance practices on manufacturing performance" is to investigate the effect of total productive maintenance (TPM) practices on manufacturing of textile and apparel manufacturing firms. A self-administered survey questionnaire was used for data collection. A total of 236 usable responses resulted in a 78 percent response rate from 30 textile and apparel firms. The results show that all the TPM practices have positive and significant relationship with manufacturing performance and significantly improve cost effectiveness, product quality, on-time delivery and volume flexibility. Correlation and regression analysis was performed using SPSS software to identify the effect of TPM on manufacturing performance.

S.Vigneshwaran, M.Maran, G.Manikandan (2015)
The study on "Impact of TPM Implementation is to review the review the literature on impact of Total Productive Maintenance (TPM). The paper explicates the tangible and the intangible benefits achieved as a result of TPM implementation. In the end some concluding observations and directions for future research are stated. The review was done by studying the Total Productive Maintenance papers and identifying the tangible and intangible benefits of Total Productive Maintenance This literature highlights the Total Productive Maintenance involvement in improving the Overall Equipment Effectiveness as well as employee's morale.

Fu-Kwun, Wang (2006)
The study on "Evaluating the efficiency of implementing total productive maintenance" can assist factories in improving their operations across a variety of dimensions. In particular, it aids factories in monitoring their performance in comparison with other factories. Effective benchmarks of high performance and efficient cluster are identified for improving the factories in the other groups. Data Envelopment Analysis (DEA) is used to evaluate the efficiency score for when the utility function considers its many attributes. A prediction model by the multiple regression method is obtained. This regression equation can be used to obtain the expected efficiency score for checking the performance of implementing TPM. The actual improvement process may involve identifying the operating practices and procedures of the benchmark factories and engaging in re-engineering programs.

Jusko, Jill (2009)
The article "OEE: The Heart of the Matter" discusses how the overall equipment effectiveness (OEE) improves equipment performance and gauges total productive maintenance (TPM) benefits. It cites several uses of OEE, which include providing insights into where losses are occurring via the three sub metrics, helping the people look at key components of opportunity in a balanced way, and OEE's ability to drive continuous improvement activities. Moreover, Stroud Consulting's Ryan Hale offers tips on implementing OEE.

P Machini. L Pntelen. (2006)
The study "Performance measurement using overall equipment effectiveness" (OEE) is the quest for improving productivity in the current global competitive environment has led to a need for rigorously

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defined performance measurement systems for manufacturing processes. In this paper, overall equipment effectiveness (OEE) is described as one such performance measurement tool that measures different types of production losses and indicates areas of process improvement. Analysis is done on how OEE has evolved leading to other tools like total equipment effectiveness performance, production equipment effectiveness, overall factory effectiveness, overall plant effectiveness, and overall asset effectiveness. Two industrial examples of OEE application are discussed, and the differences between theory and practice analysed. Finally, a framework for classifying and measuring production losses for overall production effectiveness is proposed. The framework harmonizes the differences between theory and practice and makes possible the presentation of overall production/asset effectiveness that can be customized with the manufacturers needs to improve productivity.

3. RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is a way to systematically solve the research problem, as to how research is done scientifically. It consist of the different methods that generally adopted by researcher to study his research problem along with logic behind them. It is necessary for the researcher to develop certain tests. Marketing research specifies the information required to address these issues; designs the method for collection information manages and implements the data collection process; analysis the results and communication the findings and their implication.

3.2 Research Design

"Research design is the plan, structure and strategy of investigation conceived so as to obtain answer to research question and to control variance." - **By Kerlinger**

The researcher after choosing the subject, company and the area to conduct his research, decided to establish the theme or the important factor upon which the entire project is to base.
At the outset, the objectives of the project were identified. Thereupon, the conclusive research was undertaken upon consideration, the researcher chose the statistical design as it suited the project's requirements. This method was warranted as he had decided to embark upon a survey and the analysis and interpretation of the findings of the surveys can only be done properly only if he chose the statistical design.

1. Exploratory

2. Descriptive

Exploratory research is focus on the discovery of ideas. Exploratory research is carried out to define problems and developed hypothesis to test later. An exploratory study is generally based on the secondary data that are reading available. It does not have to change his focus of direction, depending on the availability of new ideas and relationship among variables.

Descriptive studies are undertaken in many circumstances. Descriptive studies can be complex, determining a high degree of scientific skill on the part of the researcher.

3.3 Method & Source Of Data Collection

The sources of data collection methods are as follows:-

a) Primary data:-

The primary data is that which details we collect first time from the market and also used first time in the research. The Researcher says that the information is first time in the research decision. To collect

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the primary data questionnaire is prepared structure non-disguise 2questionnaire is prepared. The researchers followed a primary data for the research.

Primary data: Questionnaire

b) Secondary data:-
Secondary data are those data which are already collected by someone for some purpose and are available for the present study; secondary data are already collected by the company's records and other library's books. When the secondary data are sufficient, the researcher has to be satisfied with the primary sources of data.

Secondary data can be used as bases for comparison with primary data have been -collected by questionnaire.

Secondary data: Magazines, Newspapers, Websites, Books, E-Journals.

3.4 Data Collection
The questionnaire was the main tool used for collecting the first hand information from the respondents. Hence, great attention was given to construct the questionnaire. The possible answer to every question was provided so that the respondents can put a tick mark wherever applicable.

The questionnaire method is used for data collection. The questionnaire framed for the research study is a structured questionnaire in which all the questions are pre-determined before conducting the survey. The form of question is both closed and open type. The questionnaire for the research was framed in a clear manner such that it enable the respondents to understand and answer the question easily. The questionnaire was designed in such a way that the questions are short and simple and is arranged in a logical manner. The Secondary Data are collected from company records for number and cost of errors and reworks.

3.5 Sampling Design
3.5.1 Population
The population consists of 120 employees in Vishal Precision Products Pvt Ltd.

3.5.2 Sample Design
A sample design is a define plan for obtaining a sample from a given population. It is the procedure used by the researcher in selecting items for the sample.

3.5.3 Sampling Method And Techniques
The sampling method used for the study is simple random sampling. In statistics, a simple random sample is a subset of individuals (a sample) chosen from a larger set (population). Each individual is chosen randomly and entirely by chance, such that each individual has the same probability of being chosen at any stage during the sampling process, and each subset of K individuals. The sample selected from every second name of the employees in alphabetic order their names.

3.5.4 Instrument for Data Collection
A Structured questionnaire was designed and using that questionnaire data was collected and some secondary data are collected from record of company.

3.6 Reliability Analysis
• Reliability Analysis is done using data collected through pilot study.
• The Pilot study was conducted with 20 respondents.
• The collected data was fed into SPSS software to test reliability of the questionnaire and response.

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• The data was then tested for reliability using the steps.

Analyze -> Scale -> Reliability Analysis.

• All the scale data were selected for testing. Then the results were obtained.

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Table 3.1 Reliability Test

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.782	.786	22

• The Case Processing Summary table shows that there are 20 valid entries provided for analysis.
• The reliability statistics table depicts the Cronbach's alpha value as 0.786 which is >0.6
• For the questionnaire to be reliable or valid, the value of alpha should be greater than 0.6 and in this case the questionnaire is found to be valid. Therefore further analysis can be performed using SPSS. So we performed further analysis.

Cronbach‟s alpha is a measure of internal consistency, that is, how closely related a set of items are as group. It is considered to be measure of scale reliability. A "high" value of alpha does not imply that the measure is one dimensional. If, in addition to measuring internal consistency, you wish to provide evidence that the scale in question is one-dimensional, additional analysis can be performed. Exploratory factor analysis is one method of checking dimensionality. Technically speaking, Cronbach‟s alpha is not a statistical test- it is a co-efficient of reliability or consistency. Cronbach‟s alpha can be return as a function of the number of test items and the average inter correlation among the items. Below, for conceptual purpose we show the formula for the standardized Cronbach‟s alpha.

3.7 Tools Used

3.7.1 Percentage Method

In this study, Percentage analysis is used. Percentage is used for making comparison between two or more series of data.

$$\text{Percentage} = \frac{No.\ of\ Respondents}{Total\ No.\ of\ Respondents} \times 100$$

3.7.2 ANalysis Of VAriance (ANOVA)

The purpose of analysis of variance (ANOVA) is to test for significant differences between means. Elementary Concepts provides a brief introduction to the basics of statistical significance testing. If

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we are only comparing two means, ANOVA will produce the same results as the t test for independent samples (if we are comparing two different groups of cases or observations) or the t test for dependent samples (if we are comparing two variables in one set of cases or observations).

3.7.3 Regression

Regression In statistics, dependence is any statistical relationship between two random variables or two sets of data. Correlation refers to any of a broad class of statistical relationships involving dependence.

3.7.4 Correlation

The bivariate Pearson Correlation produces a sample correlation coefficient, r, which measures the strength and direction of linear relationships between pairs of continuous variables. By extension, the Pearson Correlation evaluates whether there is statistical evidence for a linear relationship among the same pairs of variables in the population, represented by a population correlation coefficient.

3.7.5 OEE

OEE is a metric that identifies the percentage of planned production time that is truly productive. It was developed to support TPM initiatives by accurately tracking progress towards achieving "perfect production".

WORLD CLASS OEE

Table 3.1 World Class Oee

OEE FACTOR	WORLD CLASS
Availability	90%
Performance	95%
Quality	99%
OEE	85%

3.8 Limitations of the Study

- The study is not a longitudinal study.
- Time constraint.
- The study is restricted to 120 employees.

DATA ANALYSIS AND INTERPRETATION

4.1 Percentage Analysis

I. Autonomous Maintenance

1. Substantial Efforts Obtained in Accordance with the Steps

TABLE 4.1: Substantial Efforts Obtained in Accordance with the Steps

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	92	92
No	8	8
Total	100	100

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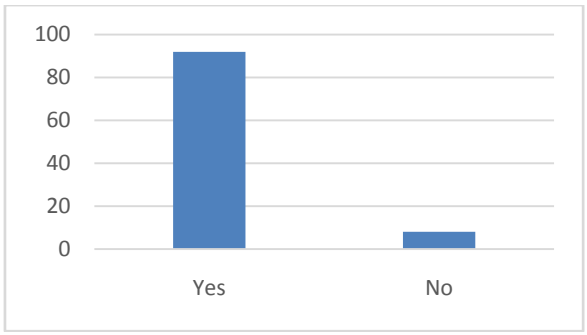


CHART 4.1: Substantial Efforts Obtained in Accordance with the Steps

INTERPRETATION
The above table and chart shows that the majority of the respondents 92% agree that there is substantial efforts obtained in accordance with the steps and 8% of the respondents disagree that there is no substantial efforts obtained in accordance with the steps.

2. Instead of Insisting on Forms and Theory are People Learning from Experience

TABLE 4.2: Instead of Insisting on Forms and Theory are People Learning from Experience

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	82	82
No	18	18
Total	100	100

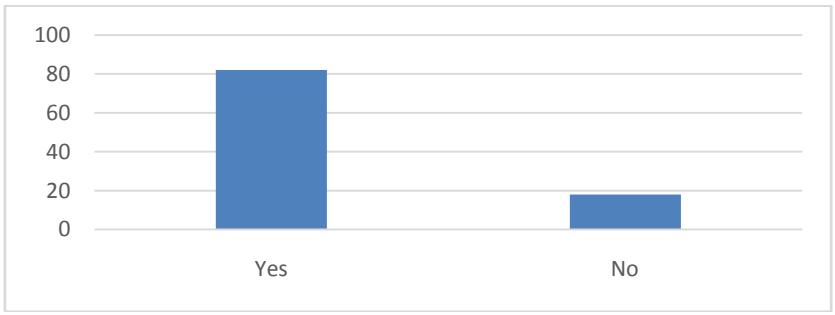


CHART 4.2: Instead of Insisting on Forms and Theory are People Learning from Experience

INTERPRETATION
The above table and chart shows that the majority of the respondents 82% agree that instead of insisting on forms and theory are people learning from experience and 18% of the respondents disagree that there is no learning from experience.

3. The Diagnosis and Guidance of the Supervisor Adequate

TABLE 4.3: The Diagnosis and Guidance of the Supervisor Adequate

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	75	75
No	25	25
Total	100	100

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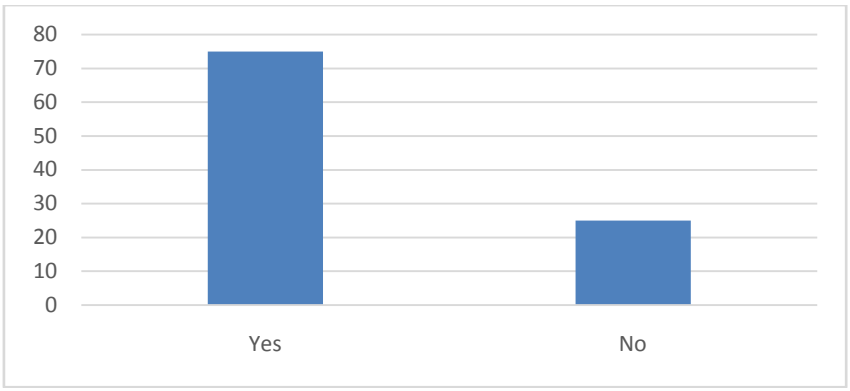


CHART 4.3: The Diagnosis and Guidance of the Supervisor Adequate

INTERPRETATION

The above table and chart shows that the majority of the respondents 75% agree that there is diagnosis and guidance of the supervisor adequate and 25% of the respondents disagree that there is no proper diagnosis and guidance of the supervisor.

4. The Assistance and Cooperation of Other Divisions towards the Production is Satisfactory

TABLE 4.4: The Assistance and Cooperation of Other Divisions towards the Production is Satisfactory

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	84	84
No	16	16
Total	**100**	**100**

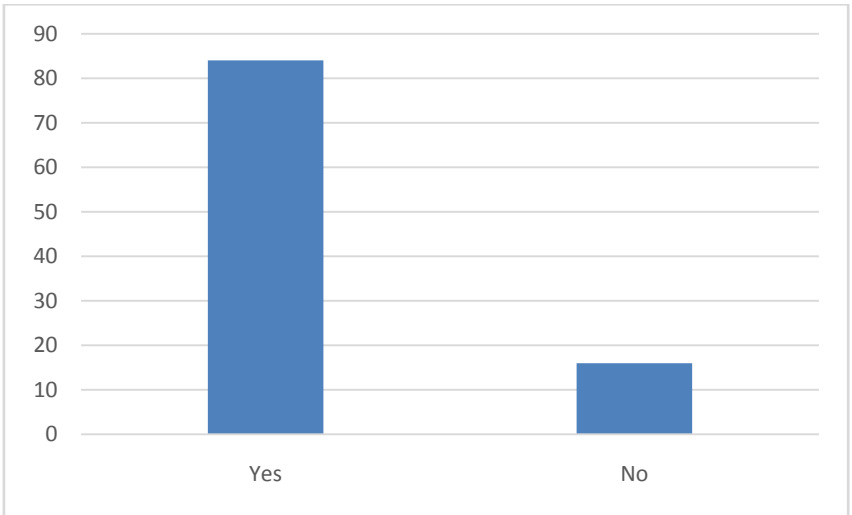


CHART 4.4: The Assistance and Cooperation of Other Divisions towards the Production is Satisfactory

INTERPRETATION

The above table and chart shows that the majority of the respondents 84% agree that there is the assistance and cooperation of other divisions towards the production is satisfactory and 16% of the respondents disagree that there is no proper assistance and cooperation.

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5. The Capability to Decide by Oneself

TABLE 4.5: The Capability to Decide by Oneself

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	64	64
No	36	36
Total	100	100

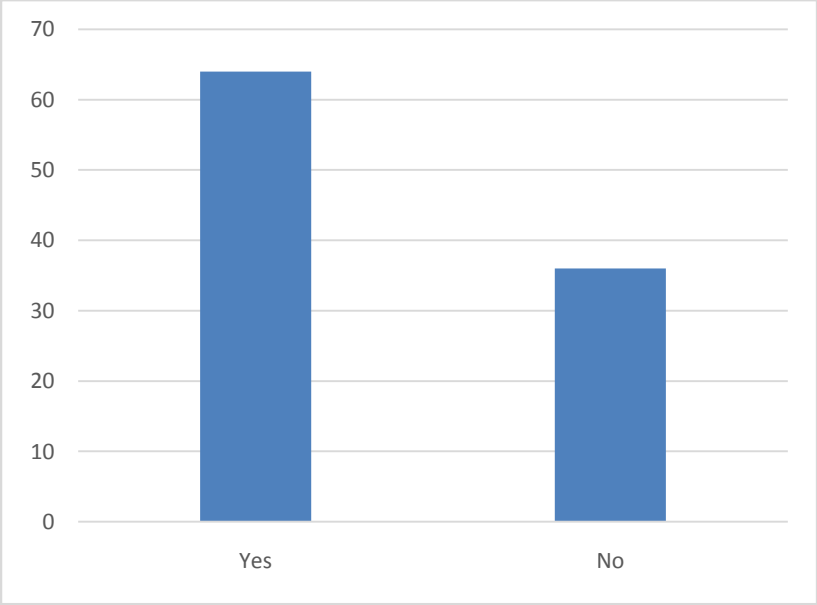


CHART 4.5: The Capability to Decide by Oneself

INTERPRETATION

The above table and chart shows that the majority of the respondents 64% agree that there is the capability to decide by oneself and 36% of the respondents disagree that there is no capability to decide by oneself.

II. PLANNED MAINTENANCE

1. Quantitative Grasping of Equipment Reliability, Maintainability and Availability Adequate

TABLE 4.6: Quantitative Grasping of Equipment Reliability, Maintainability and Availability Adequate

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	86	86
No	14	14
Total	100	100

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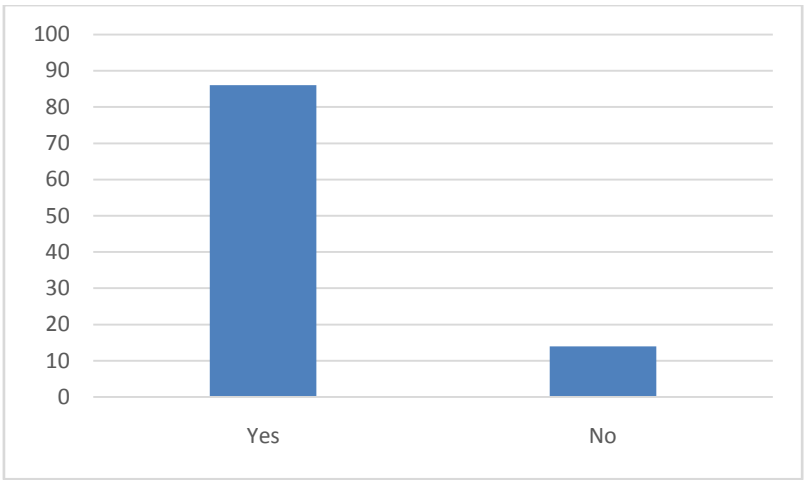


CHART 4.6: Quantitative Grasping of Equipment Reliability, Maintainability and Availability Adequate

INTERPRETATION

The above table and chart shows that the majority of the respondents 86% agree that there is quantitative grasping of equipment reliability, maintainability and availability adequate and 14% of the respondents disagree that there is no quantitative grasping.

2. Systematized Maintenance Information Management Employed

TABLE 4.7: Systematized Maintenance Information Management Employed

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	91	91
No	9	9
Total	100	100

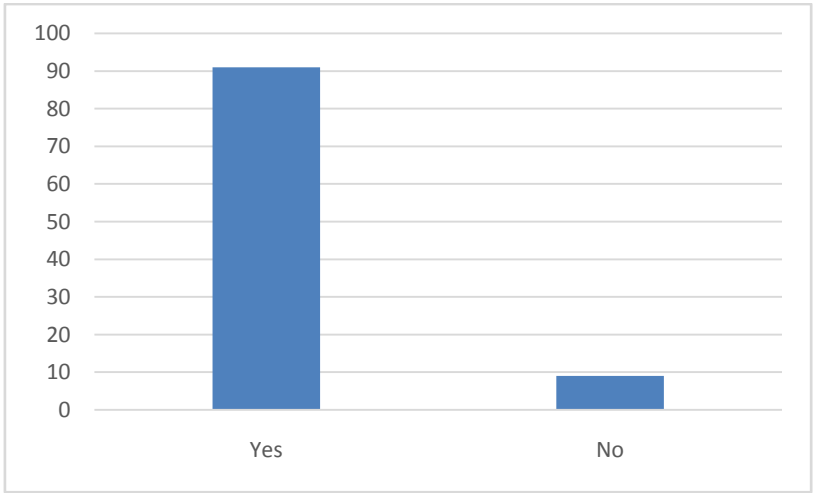


CHART 4.7: Systematized Maintenance Information Management Employed

INTERPRETATION

The above table and chart shows that the majority of the respondents 91% agree that there is systematized maintenance information management employed and only 9% of the respondents disagree that there is no systematized maintenance information.

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3. Good Management of Tools, Spare Parts, Jigs, Drawings, Moulds, Etc.,

TABLE 4.8: Good Management of Tools, Spare Parts, Jigs, Drawings, AND Moulds

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	95	95
No	5	5
Total	100	100

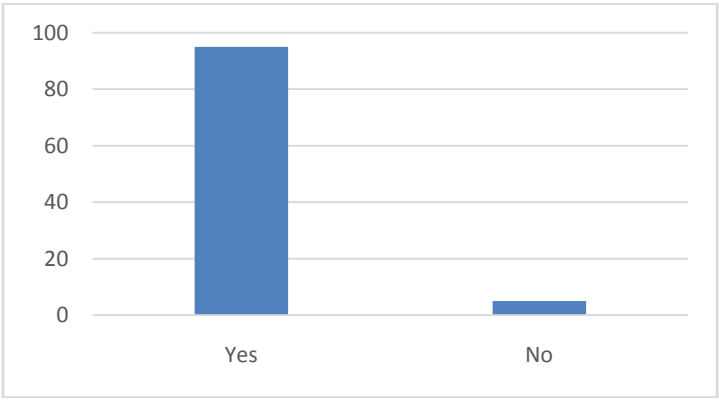


CHART 4.8: Good Management of Tools, Spare Parts, Jigs, Drawings, and Moulds

INTERPRETATION

The above table and chart shows that the majority of the respondents 95% agree that there is good management of tools, spare parts, Jigs, Drawings, moulds and only 5% of the respondents disagree that there is no good management of tools, spare parts, Jigs, Drawings, moulds.

4. Appropriate Utilization of Equipment Audit Technology

TABLE 4.9: Appropriate Utilization of Equipment Audit Technology

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	87	87
No	13	13
Total	100	100

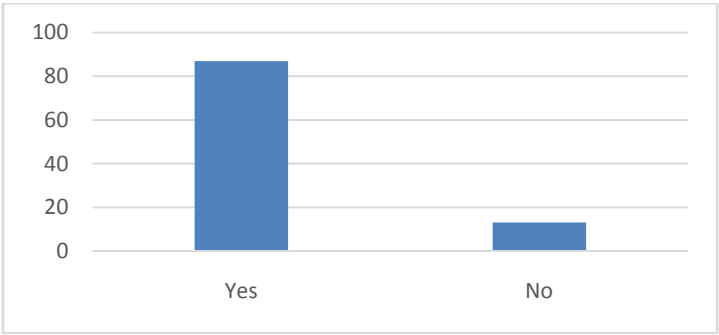


CHART 4.9: Appropriate Utilization of Equipment Audit Technology

INTERPRETATION

The above table and chart shows that the majority of the respondents 87% agree that there is appropriate utilization of equipment audit technology and 13% of the respondents disagree that there is no appropriate utilization of equipment audit technology.

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5. Appropriate Gathering and Utilization of Maintenance Data Such as Maintenance Man-Hour, Equipment Downtime, Failures, Etc.,

TABLE 4.10: Appropriate Gathering and Utilization of Maintenance Data Such as Maintenance Man-Hour, Equipment Downtime, Failures, Etc.

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	78	78
No	22	22
Total	100	100

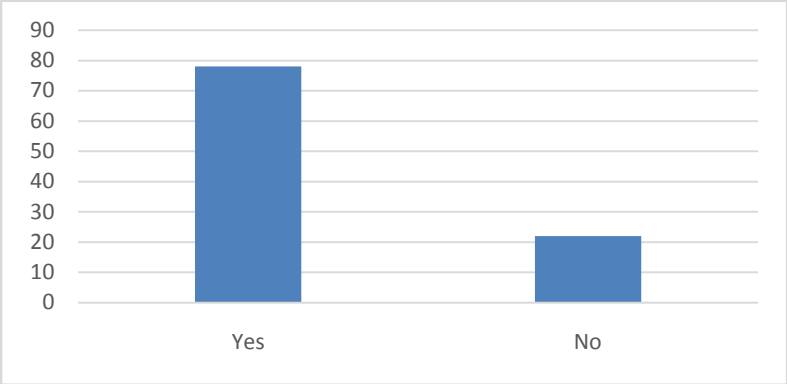


CHART 4.10: Appropriate Gathering and Utilization of Maintenance Data Such as Maintenance Man-Hour, Equipment Downtime, Failures, Etc.

INTERPRETATION

The above table and chart shows that the majority of the respondents 78% agree that there is appropriate gathering and utilization of maintenance data such as maintenance man-hour, equipment downtime, failures and 22% of the respondents disagree that there is no appropriate gathering and utilization of maintenance data.

III. FOCUSED IMPROVEMENT

1. Grasping of Present Status of Production Department Losses Adequate

TABLE 4.11: Grasping of Present Status of Production Department Losses Adequate

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	46	46
No	54	54
Total	100	100

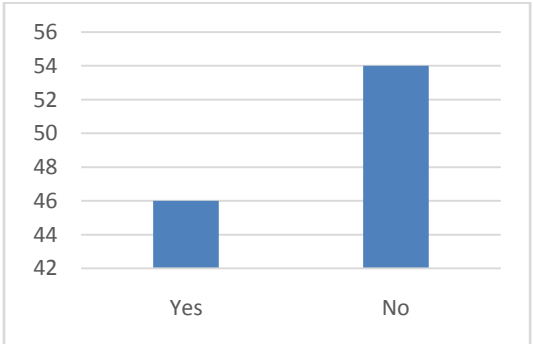


CHART 4.11: Grasping of Present Status of Production Department Losses Adequate

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INTERPRETATION
The above table and chart shows 46% of the respondents agree that the grasping of present status of production department losses adequate but 54% of the respondents disagree the grasping of present status of production department losses adequate.

2. Standardized of Fix Improvement Result Necessary

TABLE 4.12: Standardized of Fix Improvement Result Necessary

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	72	72
No-	28	28
Total	100	100

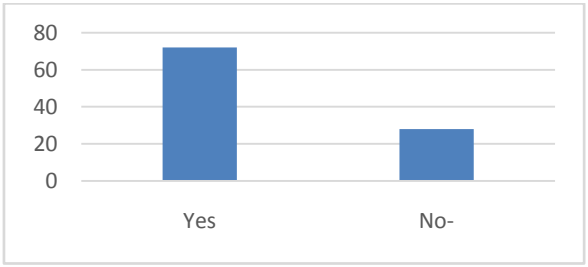


CHART 4.12: Standardized of Fix Improvement Result Necessary

INTERPRETATION
The above table and chart shows that the majority 72% of the respondents agree that standardized of fix improvement result necessary and 28% of the respondents disagree that standardized of fix improvement result necessary.

3. Clear Terminology and Definition Used on Production Department Losses

TABLE 4.13: Clear Terminology and Definition Used on Production Department Losses

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	72	72
No	28	28
Total	100	100

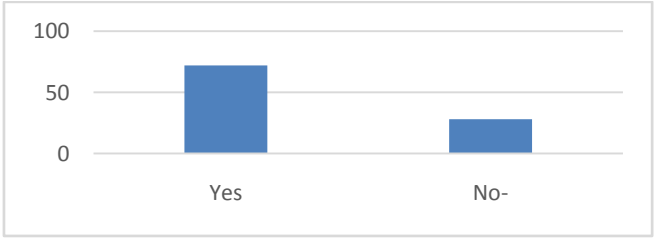


CHART 4.13: Clear Terminology and Definition Used on Production Department Losses

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INTERPRETATION
The above table and chart shows that the majority 72% of the respondents agree that there is clear terminology and definition used on production department losses and 28% of the respondents disagree that there is no clear terminology and definition used on production department losses.

4. Focussed Improvement Tasks Decided Preferentially

TABLE 4.14: Focussed Improvement Tasks Decided Preferentially

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	79	79
No	21	21
Total	100	100

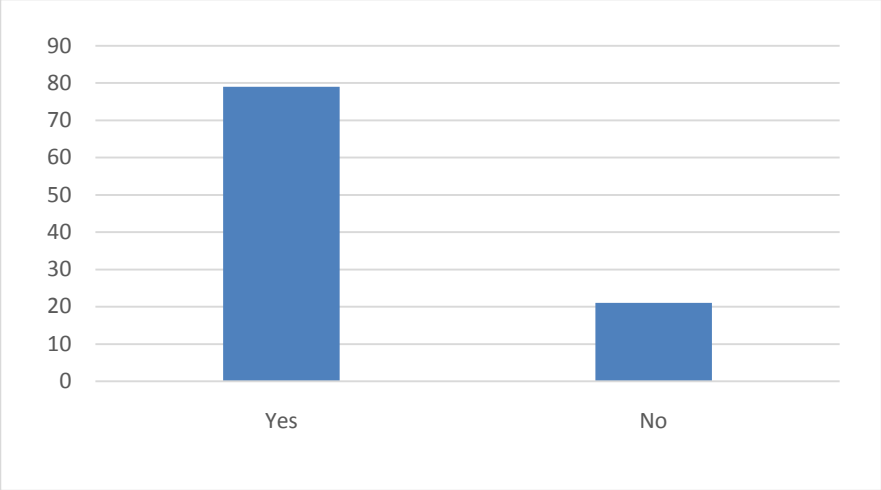


CHART 4.14: Focussed Improvement Tasks Decided Preferentially

INTERPRETATION
The above table and chart shows that the majority 79% of the respondents agree that there is focussed improvement tasks decided preferentially and 21% of the respondents disagree that there is no focussed improvement tasks decided preferentially.

5. Focuses Improvement Project Teams Joined by Managers and Supervisors as Leaders, Mixed With Staff and Experts, for Greater Accomplishments

TABLE 4.15: Focuses Improvement Project Teams Joined by Managers and Supervisors as Leaders, Mixed With Staff and Experts, for Greater Accomplishments

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	80	80
No	20	20
Total	100	100

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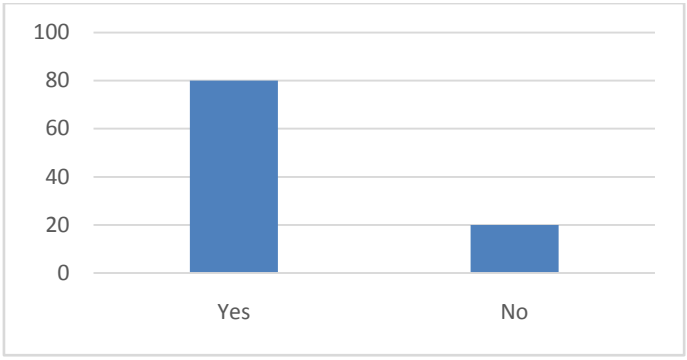


CHART 4.15: Focuses Improvement Project Teams Joined by Managers and Supervisors as Leaders, Mixed With Staff and Experts, for Greater Accomplishments

INTERPRETATION

The above table and chart shows that the majority 80% of the respondents agree that there is focuses improvement project teams joined by managers and supervisors as leaders, mixed with staff and experts, for greater accomplishments and 20% of the respondents disagree that there is no focussed improvement project teams.

IV. EDUCATION AND TRAINING

1. Grasping of Knowledge and Skills Needed for Managers, Supervisors, Staff, Operators and Maintenance Personnel

TABLE 4.16: Grasping of Knowledge and Skills Needed for Managers, Supervisors, Staff, Operators and Maintenance Personnel

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	74	74
No	26	26
Total	100	100

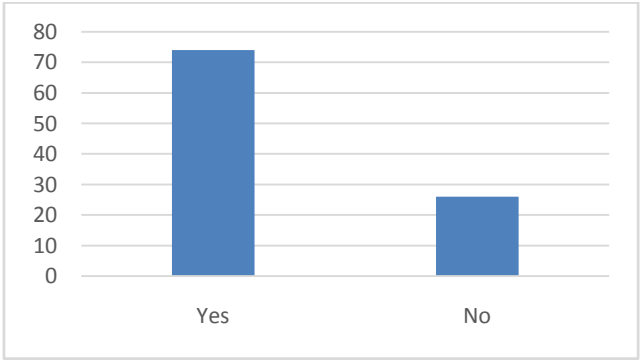


CHART 4.16: Grasping of Knowledge and Skills Needed for Managers, Supervisors, Staff, Operators and Maintenance Personnel

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INTERPRETATION
The above table and chart shows that the majority 74% of the respondents agree that there is grasping of knowledge and skills needed for managers, supervisors, staff, operators and maintenance personnel and 26% of the respondents disagree that there is no grasping of knowledge and skills.

2. Precise Grasping of Weakness and Strengths of Individual Operators Concerning Equipment

TABLE 4.17: Precise Grasping of Weakness and Strengths of Individual Operators Concerning Equipment

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	69	69
No	31	31
Total	100	100

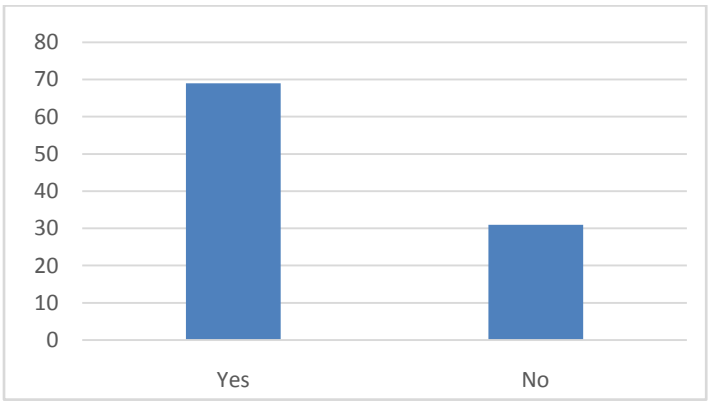


CHART 4.17: Precise Grasping of Weakness and Strengths of Individual Operators Concerning Equipment

INTERPRETATION
The above table and chart shows that the majority 69% of the respondents agree that there is precise grasping of weakness and strengths of individual operators concerning equipment and 31% of the respondents disagree that there is no precise grasping of weakness and strengths of individual operators concerning equipment.

3. Coupling of Important Education Themes to Further Plans of the Company

TABLE 4.18: Coupling of Important Education Themes to Further Plans of the Company

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	51	51
No	49	49
Total	100	100

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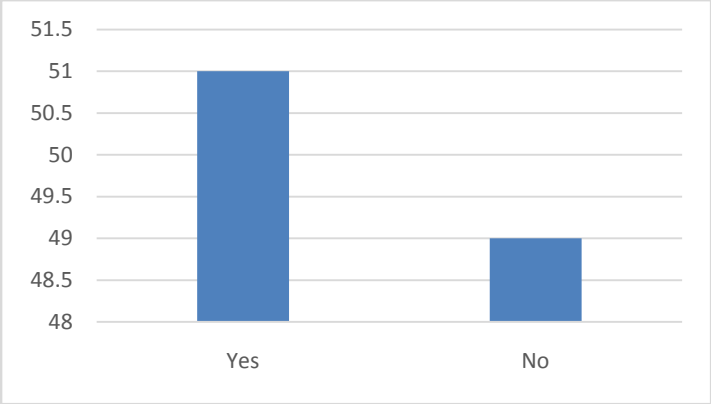


CHART 4.18: Coupling of Important Education Themes to Further Plans of the Company

INTERPRETATION

The above table and chart shows that the majority 51% of the respondents agree that there is coupling of important education themes to further plans of the company but 49% of the respondents disagree that there is no coupling of important education themes to further plans of the company.

4. Effective Education for Managers, Supervisors, Staff, Operators and Maintenance Personnel Given

TABLE 4.19: Effective Education for Managers, Supervisors, Staff, Operators and Maintenance Personnel Given

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	69	69
No	31	31
Total	100	100

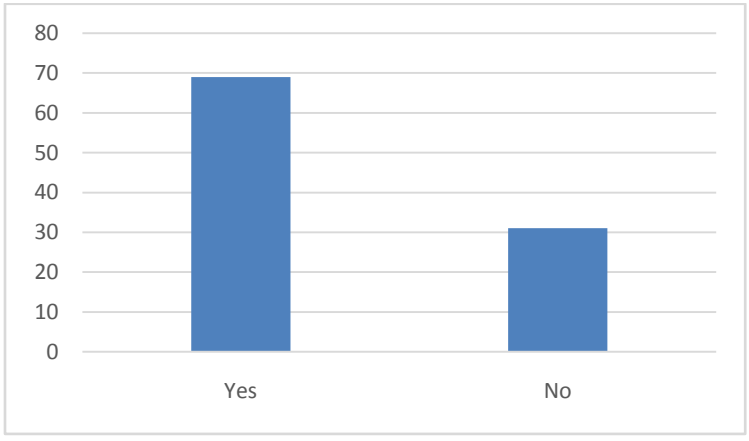


CHART 4.19: Effective Education for Managers, Supervisors, Staff, Operators and Maintenance Personnel Given

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INTERPRETATION
The above table and chart shows that the majority 69% of the respondents agree that there is effective education for managers, supervisors, staff, operators and maintenance personnel given and 31% of the respondents disagree that there is no effective education.

5. Skill Upgrading Curricula for Operators and Maintenance Personnel Implemented and Improved

TABLE 4.20: Skill Upgrading Curricula for Operators and Maintenance Personnel Implemented and Improved

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	82	82
No	18	18
Total	100	100

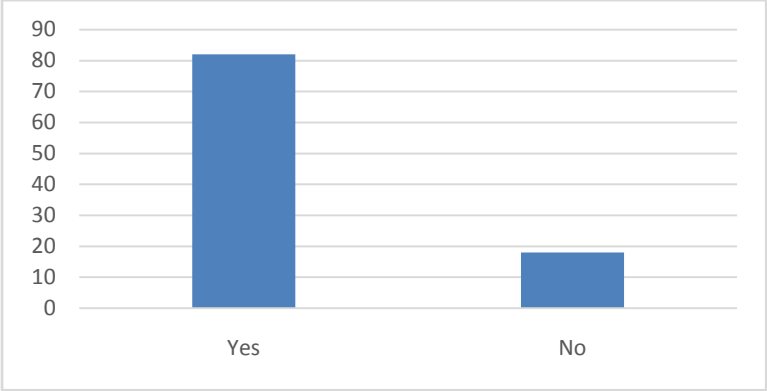


CHART 4.20: Skill Upgrading Curricula for Operators and Maintenance Personnel Implemented and Improved

INTERPRETATION
The above table and chart shows that the majority 82% of the respondents agree that there is skill upgrading curricula for operators and maintenance personnel implemented & improved and 18% of the respondents disagree that there is no skill upgrading curricula.

V. EARLY MANAGEMENT

1. Clear Relationship between Quality and Equipment

TABLE 4.21: Clear Relationship between Quality and Equipment

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	84	84
No	16	16
Total	100	100

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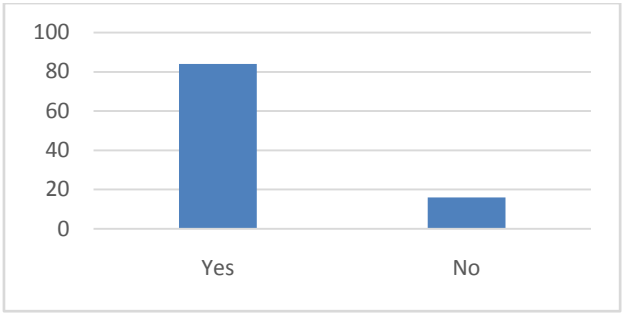


CHART 4.21: Clear Relationship between Quality and Equipment

INTERPRETATION

The above table and chart shows that the majority 84% of the respondents agree that there is clear relationship between quality and equipment and 16% of the respondents disagree that there is no clear relationship between quality and equipment.

2. Actions Taken to Prevent Recurrence of Causes for Quality Defects

TABLE 4.22: Actions Taken to Prevent Recurrence of Causes for Quality Defects

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	85	85
No	15	15
Total	100	100

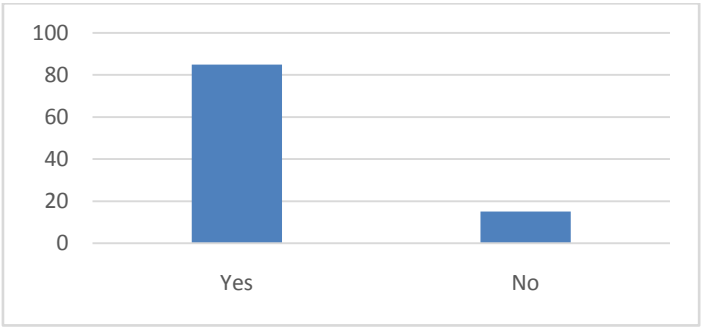


CHART 4.22: Actions Taken to Prevent Recurrence of Causes for Quality Defects

INTERPRETATION

The above table and chart shows that the majority 85% of the respondents agree that there are actions taken to prevent recurrence of causes for quality defects and 15% of the respondents disagree that there are no actions taken to prevent recurrence of causes for quality defects.

3. Defect Rates Caused by Equipment is lowering

TABLE 4.23: Defect Rates Caused by Equipment is lowering

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	84	84
No	16	16
Total	100	100

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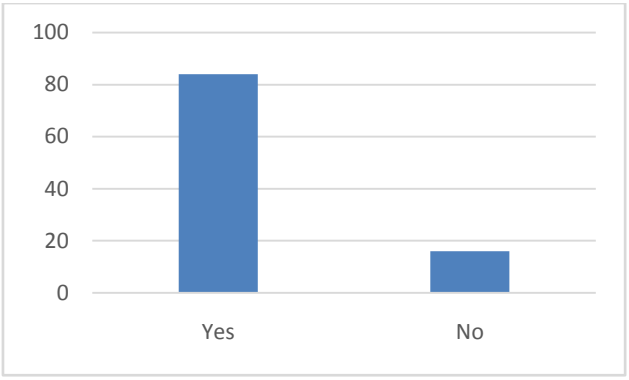


CHART 4.23: Defect Rates Caused by Equipment is lowering

INTERPRETATION

The above table and chart shows that the majority 84% of the respondents agree that there is defect rates caused by equipment is lowering and 16% of the respondents disagree that there is no defect rates caused by equipment is lowering.

4. Analysis of Relationship among Quality Characteristics, Machining Conditions, Equipment Precision, Etc., are Done Habitually

TABLE 4.24: Analysis of Relationship among Quality Characteristics, Machining Conditions, and Equipment Precision are Done Habitually

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	84	84
No	16	16
Total	100	100

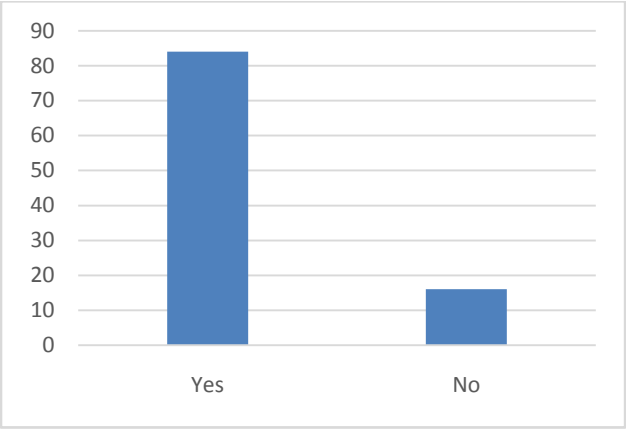


CHART 4.24: Analysis of Relationship among Quality Characteristics, Machining Conditions, and Equipment Precision are Done Habitually

INTERPRETATION

The above table and chart shows that the majority 84% of the respondents agree that there is analysis of relationship among quality characteristics, machining conditions, equipment precision, etc., are done habitually and 16% of the respondents disagree that there is no analysis of relationship among quality characteristics, machining conditions, equipment precision, etc., are done habitually.

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5. Repetitive Defects are Controlled

TABLE 4.25: Repetitive Defects are Controlled

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	79	79
No	21	21
Total	100	100

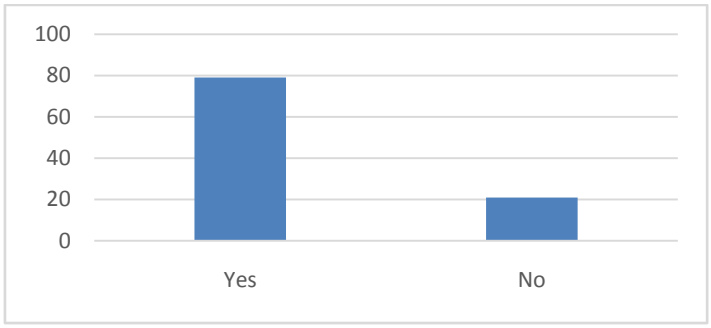


CHART 4.25: Repetitive Defects are Controlled

INTERPRETATION

The above table and chart shows that the majority 79% of the respondents agree that there is repetitive defects are controlled and 21% of the respondents disagree that there is no repetitive defects are controlled.

VI QUALITY MAINTENANCE

1. The Product and Equipment Initial Control Implemented With Result Accomplished

TABLE 4.26: The Product and Equipment Initial Control Implemented With Result Accomplished

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	87	87
No	13	13
Total	100	100

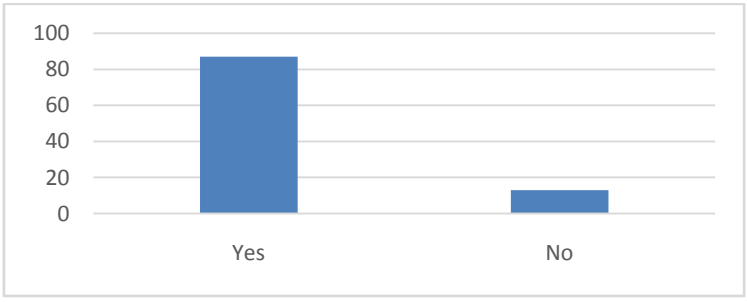


CHART 4.26: The Product and Equipment Initial Control Implemented With Result Accomplished

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INTERPRETATION

The above table and chart shows that the majority 87% of the respondents agree that the product and equipment initial control implemented with result accomplished and 13% of the respondents disagree that the product and equipment initial control implemented with result accomplished.

2. Clear Control Items and Criteria for Products and Equipment Initial Control

TABLE 4.27: Clear Control Items and Criteria for Products and Equipment Initial Control

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	87	87
No	13	13
Total	100	100

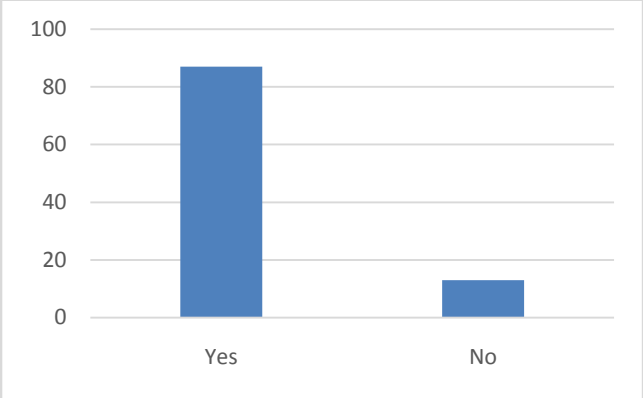


CHART 4.27: Clear Control Items and Criteria for Products and Equipment Initial Control

INTERPRETATION

The above table and chart shows that the majority 87% of the respondents agree that the product and equipment initial control implemented with result accomplished and 13% of the respondents disagree that the product and equipment initial control implemented with result accomplished.

3. Appropriate Relationship between Products and Process Development and Equipment Planning

TABLE 4.28: Appropriate Relationship between Products and Process Development and Equipment Planning

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	86	86
No	14	14
Total	100	100

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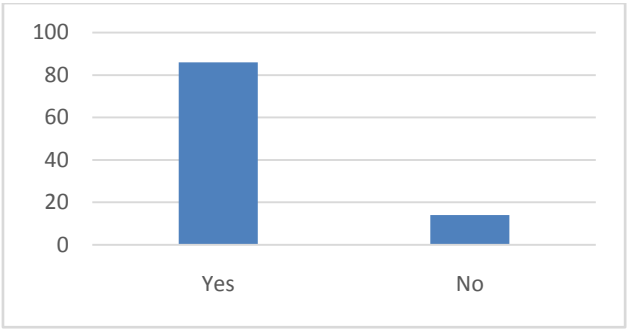


CHART 4.28: Appropriate Relationship between Products and Process Development and Equipment Planning

INTERPRETATION

The above table and chart shows that the majority 86% of the respondents agree that there is a clear control items and criteria for products and equipment initial control and 14% of the respondents disagree that that there is no clear control items and criteria for products and equipment initial control.

4. Appropriate Initial Control of Products and Equipment

TABLE 4.29: Appropriate Initial Control of Products and Equipment

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	88	88
No	12	12
Total	100	100

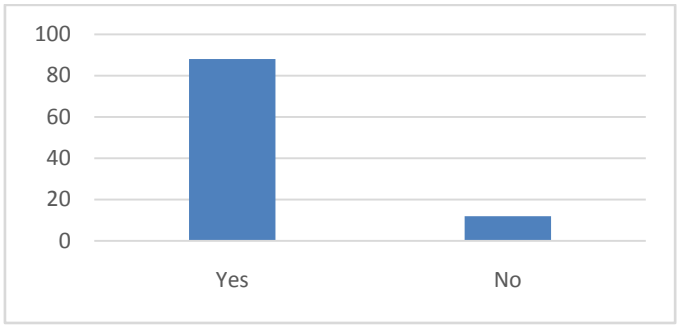


CHART 4.29: Appropriate Initial Control of Products and Equipment

INTERPRETATION

The above table and chart shows that the majority 88% of the respondents agree that there is appropriate relationship between products and process development and equipment planning and 12% of the respondents disagree that that there is no appropriate relationship between products and process development and equipment planning.

5. The Study of Uncertainty Factors in Equipment are Planned

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TABLE 4.30: The Study of Uncertainty Factors in Equipment are Planned

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	73	73
No	17	17
Total	100	100

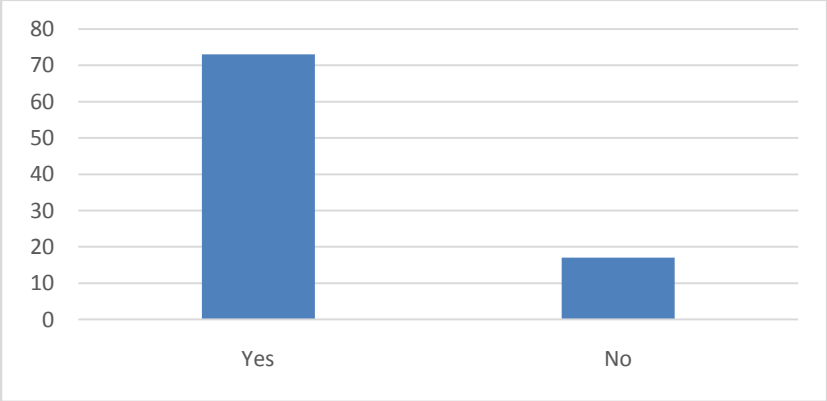


CHART 4.30: The Study of Uncertainty Factors in Equipment are Planned

INTERPRETATION

The above table and chart shows that the majority 73% of the respondents agree that the study of uncertainty factors in equipment is planned and 17% of the respondents disagree that that study of uncertainty factors in equipment is not planned**.**

VII TPM IN ADMINISTRATION

1. Activities Support Efficient Production

TABLE 4.31: Activities Support Efficient Production

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	89	89
No	11	11
Total	100	100

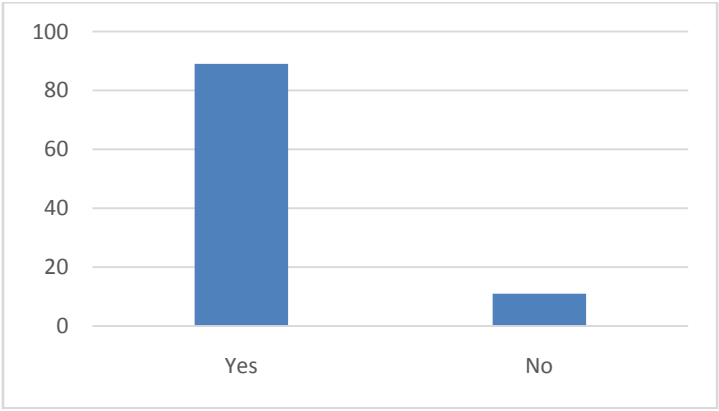


CHART 4.31: Activities Support Efficient Production

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INTERPRETATION
The above table and chart shows that the majority 89% of the respondents agree that there is activities support efficient production and 11% of the respondents disagree that there is no activities support efficient production.

2. Quick and Accurate Information Transmission

TABLE 4.32: Quick and Accurate Information Transmission

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	80	80
No	20	20
Total	100	100

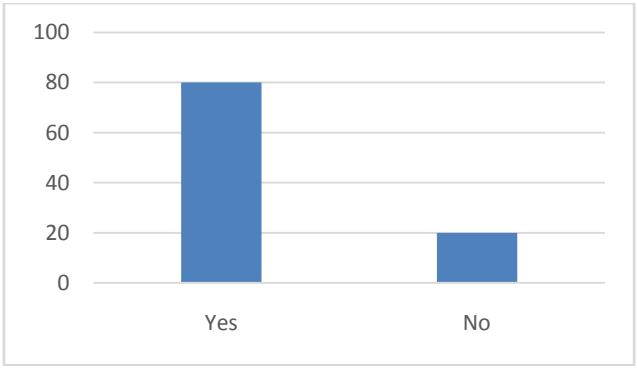


CHART 4.32: Quick and Accurate Information Transmission

INTERPRETATION
The above table and chart shows that the majority 80% of the respondents agree that there is quick and accurate information transmission and 20% of the respondents disagree that there is no quick and accurate information transmission.

3. The Needed Information Obtained Immediately

TABLE 4.33: The Needed Information Obtained Immediately

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	84	84
No	16	16
Total	100	100

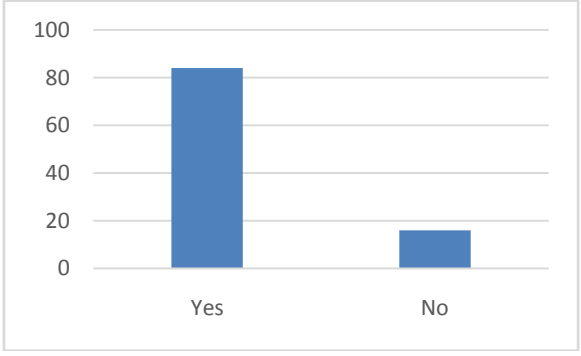


CHART 4.33: The Needed Information Obtained Immediately

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INTERPRETATION
The above table and chart shows that the majority 84% of the respondents agree that the needed information obtained immediately and 16% of the respondents disagree that the needed information is not obtained immediately.

4. Efficient Utilization of Storage Equipment

TABLE 4.34: Efficient Utilization of Storage Equipment

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	83	83
No	17	17
Total	100	100

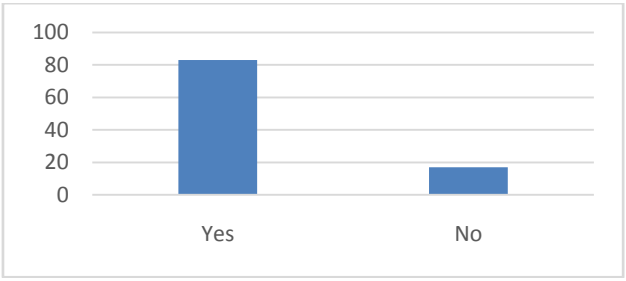


CHART 4.34: Efficient Utilization of Storage Equipment

INTERPRETATION
The above table and chart shows that the majority 83% of the respondents agree that there is efficient utilization of storage equipment and 17% of the respondents disagree that there is no efficient utilization of storage equipment.

5. The Important Information Safeguarded Against Loss

TABLE 4.35: The Important Information Safeguarded Against Loss

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	65	65
No	35	35
Total	100	100

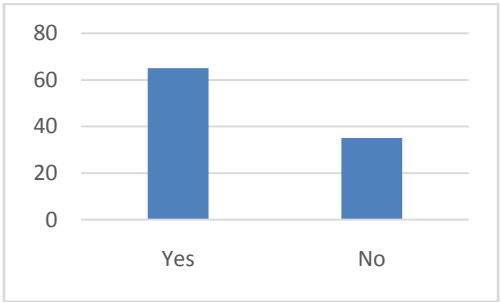


CHART 4.35: The Important Information Safeguarded Against Loss

INTERPRETATION
The above table and chart shows that the majority 65% of the respondents agree that the important information are safeguarded against loss and 35% of the respondents disagree that the important information are not safeguarded against loss.

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VIII SAFETY, HEALTH AND ENVIRONMENT

1. The Policies and Leadership in Safety, Hygiene and Environment Control Established

TABLE 4.36: The Policies and Leadership in Safety, Hygiene and Environment Control Established

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	64	64
No	36	36
Total	100	100

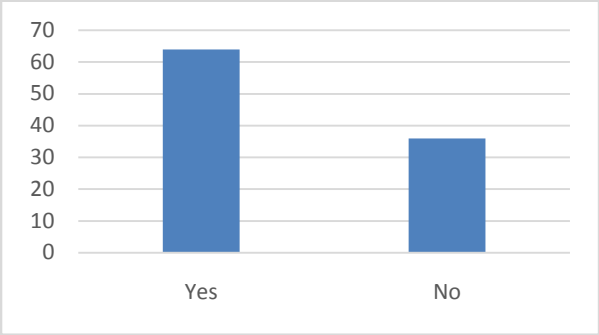


CHART 4.36: The Policies and Leadership in Safety, Hygiene and Environment Control Established

INTERPRETATION

The above table and chart shows that the majority 64% of the respondents agree that the policies and leadership in safety, hygiene and environment control is established and 36% of the respondents disagree that the policies and leadership in safety, hygiene and environment control is not established.

2. Good Health Management and Hygiene Facilities

TABLE 4.37: Good Health Management and Hygiene Facilities

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	71	71
No	29	29
Total	100	100

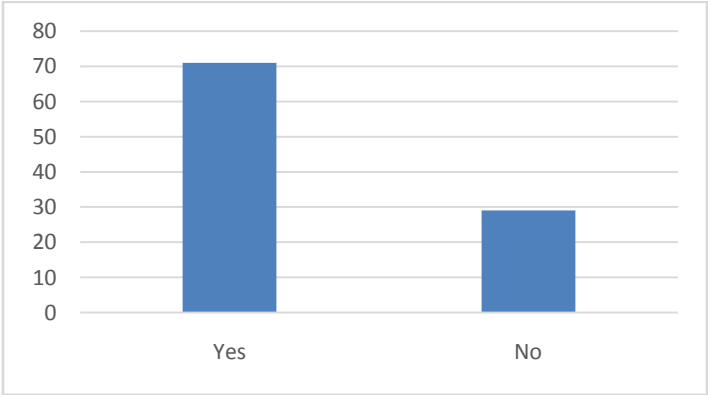


CHART 4.37: Good Health Management and Hygiene Facilities

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INTERPRETATION
The above table and chart shows that the majority 71% of the respondents agree that there is good health management and hygiene facilities and 29% of the respondents disagree that there is no good health management and hygiene facilities.

3. Good Safety Facilities Such as Safety Covers, Safety Fences, Safety Signs, Fool Proofing, and Measure to Prevent Damage Spreading

TABLE 4.38: Good Safety Facilities Such as Safety Covers, Safety Fences, Safety Signs, Fool Proofing, and Measure to Prevent Damage Spreading

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	74	74
No	26	26
Total	100	100

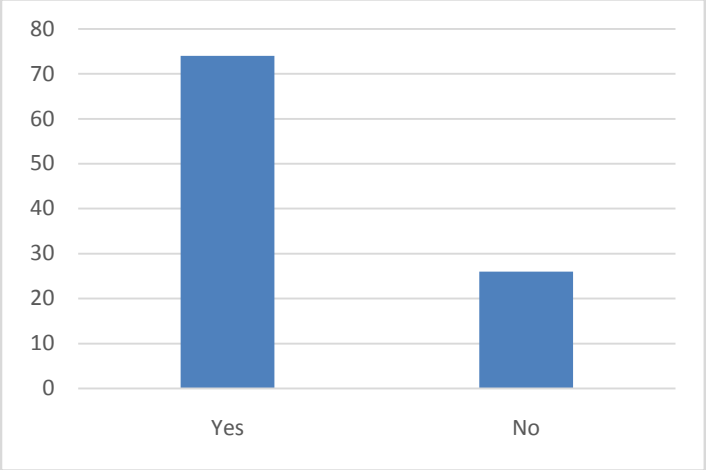


CHART 4.38: Good Safety Facilities Such as Safety Covers, Safety Fences, Safety Signs, Fool Proofing, and Measure to Prevent Damage Spreading

INTERPRETATION
The above table and chart shows that the majority 74% of the respondents agree that there is good safety facilities such as safety covers, safety fences, safety signs, fool proofing, and measure to prevent damage spreading and 26% of the respondents disagree that there is no good safety facilities such as safety covers, safety fences, safety signs, fool proofing, and measure to prevent damage spreading.

4. Safety Assessed Before Introducing New Technology and Equipment

TABLE 4.39: Safety Assessed Before Introducing New Technology and Equipment

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	82	82
No	18	18
Total	100	100

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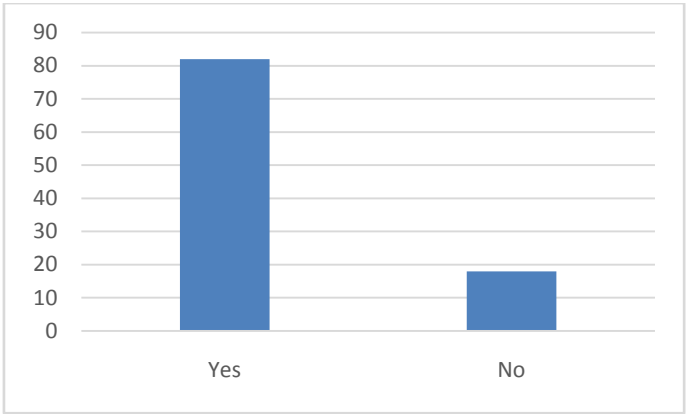


CHART 4.39: Safety Assessed Before Introducing New Technology and Equipment

INTERPRETATION

The above table and chart shows that the majority 82% of the respondents agree that there is safety assessed before introducing new technology and equipment and 18% of the respondents disagree that there is no safety assessed before introducing new technology and equipment.

5. Good Pollution Control Such as Waste Water Management, Anti-Air Pollution, Noise Control and Vibration Control

TABLE 4.40: Good Pollution Control Such as Waste Water Management, Anti-Air Pollution, Noise Control and Vibration Control

PREFERENCE	NO. OF RESPONDENTS	PERCENTAGE
Yes	72	72
No	28	28
Total	100	100

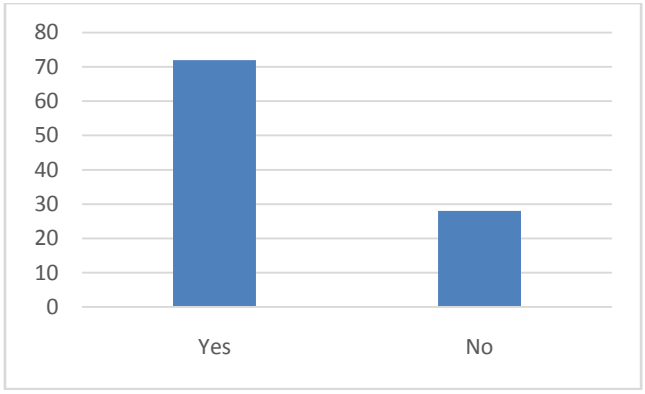


CHART 4.40: Good Pollution Control Such as Waste Water Management, Anti-Air Pollution, Noise Control and Vibration Control

INTERPRETATION

The above table and chart shows that the majority 72% of the respondents agree that there is good pollution control such as waste water management, anti-air pollution, noise control and vibration control and 28% of the respondents disagree that there is no good pollution control such as waste water management, anti-air pollution, noise control and vibration control.

4.2 REGRESSION

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TABLE 4.41 REGRESSION

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.937[a]	.878	.229	.662

INTERPRETATION

The R value of 0.937 indicates the positive correlation between the dependent and independent variables. The R square value of 0.878 can be interpreted as 87.8% of the variance in the dependent variable (No. of reworks) can be explained by independent variable machinery condition (Vibration, set-up adjustments, proper cleaning, cutting oil splashed, etc.,).

TABLE 4.42 ANOVA TABLE - REGRESSION

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.485	16	.593	1.353	.456[b]
	Residual	1.315	3	.438		
	Total	10.800	19			
a. Dependent Variable: No. of rework recorded						

From the ANOVA table, the p value 0.456 indicates that the regression model is statistically significant. Since the p value is greater than 0.05, null hypothesis is accepted. Hence, it is concluded that the errors and rework from machines is not depends on machinery condition.

TABLE 4.43 COEFFICIENTS

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.728	2.157		.337	.758	-6.137	7.592
	The machinery leaks lubricants.	.561	.299	.944	1.879	.157	-.389	1.511
	The machinery leaks hydraulic fluid.	.174	.342	.223	.508	.647	-.914	1.262
	Cutting oil is splashed on and around the machinery.	-.912	.512	-1.632	-1.782	.173	-2.542	.717
	The machinery and equipment generally dirty.	-.422	.415	-.790	-1.018	.384	-1.742	.897
	Motors are coated with a layer of	.621	.501	1.203	1.239	.303	-.974	2.216

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	oil/grime							
	Oil pans are full, Often to overflowing	.395	.146	.789	2.702	.074	-.070	.861
	Drains and filters are clogged	-.531	.841	-.666	-.632	.572	-3.209	2.146
	Machinery is positioned so that access for routine maintenance is difficult	.801	.795	1.122	1.007	.388	-1.730	3.332
	Wires and pipes are left in an untidy mess, making it hard to tell which goes where	-.166	.420	-.205	-.395	.719	-1.501	1.169
	Motors are allowed to get hot or make strange noises without it being detected	-.636	.631	-1.268	-1.007	.388	-2.645	1.373
	Machinery parts are rattle and vibrate	.115	.204	.207	.563	.613	-.534	.764
	Limit switches on machinery are covered with oil/grimes	.690	1.033	1.205	.667	.552	-2.599	3.978
	Oil cans are left around, often empty and dirty	.221	.386	.431	.574	.606	-1.007	1.449
	Minor problems occur more quite frequently and often repair is only temporary	-.429	.716	-.525	-.599	.592	-2.706	1.849
	There are no procedures for cleaning, lubricating, etc.,	.333	.431	.711	.774	.496	-1.037	1.704
	Minor stoppages happen very often, Automated machinery needs a minder	-.710	.842	-.890	-.844	.461	-3.389	1.968
a. Dependent Variable: No. of rework recorded								

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The un-standardized Coefficients B represents the coefficients of independent variables. The regression equation with independent variables is expressed as

$$\mathbf{Y = 0.728 + 0.561\ X_1 + 0.174\ X_2 - 0.912\ X_3 - 0.422\ X_4 + 0.621\ X_5 + 0.395\ X_6 - 0.531\ X_7 + 0.801\ X_8 - 0.166\ X_9 - 0.636\ X_{10} + 0.115\ X_{11} + 0.690\ X_{12} + 0.221\ X_{13} - 0.429\ X_{14} + 0.333\ X_{15} - 0.710\ X_{16}}$$

Where,

X_1= Lubricants leaking
X_2 = Hydraulic fluid leaking
X_3 = Cutting oil splashed
X_4 = Machinery generally dirty
X_5 = Coated with a layer of oil/grim
X_6 = Oil pans overflowing
X_7 = Drains are clogged
X_8 = Routine maintenance is difficult
X_9 = Wires in a untidy position
X_{10} = Motors are getting hot
X_{11} = Parts are Vibrate
X_{12} = Limit switches are covered with oil
X_{13} = Oil cans left around
X_{14} = Minor problems occur frequently
X_{15} = No procedure for cleaning
X_{16} = Machinery needs a minder

The standardized coefficient beta value is the average amount the dependent variable increases when the independent variable increases by one standard deviation. Hence, the highest influence is Limit switches on machinery are covered with oil (1.205) followed by machinery coated with a layer of oil/grim (1.203).

4.3 CORRELATION

TABLE 4.44 CORRELATION

		No. of rework recorded	Cutting oil is splashed on and around the machinery.	The machinery and equipment generally dirty.	Machinery parts are rattle and vibrate	There are no procedures for cleaning, lubricating, etc.,	Changeover and set-up adjustments take a lot of time
No. of rework recorded	Pearson Correlation	1		.			
Cutting oil is splashed on and around the machinery.	Pearson Correlation	.114	1				
The machinery and equipment generally	Pearson Correlation	.188	.185	1			

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dirty.							
Machinery parts are rattle and vibrate	Pearson Correlation	-.278	-.212	.140	1		
There are no procedures for cleaning, lubricating, etc.,	Pearson Correlation	-.200	.160	-.014	-.005	1	
Changeover and set-up adjustments take a lot of time	Pearson Correlation	-.031	-.004	.135	-.213	-.477*	1
**. Correlation is significant at the 0.01 level (2-tailed).							

INTERPRETATION

- The machinery and equipment generally dirty is weekly positive correlated to Number of rework recorded. Since the pearson coefficient value less than 0.5.
- The Changeover and set-up adjustments take a lot of time is weakly negative correlated to There are no procedures for cleaning, lubricating, Since the pearson coefficient correlation value is far less than 0.5.

4.4 ANOVA

***1. Formulation of hypothesis*:**

Null hypothesis H0: There is no significant difference between machinery condition and No. of reworks.

Alternative hypothesis H1: There is no significant difference between machinery condition and No. of reworks.

TABLE 4.45 ANOVA BASED ON NO. OF REWORK

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Cutting oil is splashed on and around the machinery.	Between Groups	.489	2	.245	.122	.886
	Within Groups	34.061	17	2.004		
	Total	34.550	19			
The machinery and equipment generally dirty.	Between Groups	6.724	2	3.362	1.839	.189
	Within Groups	31.076	17	1.828		
	Total	37.800	19			
Motors are coated	Between	5.823	2	2.911	1.425	.268

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with a layer of oil/grime	Groups					
	Within Groups	34.727	17	2.043		
	Total	40.550	19			
Motors are allowed to get hot or make strange noises without it being detected	Between Groups	.223	2	.111	.044	.957
	Within Groups	42.727	17	2.513		
	Total	42.950	19			
Machinery parts are rattle and vibrate	Between Groups	6.041	2	3.020	1.776	.199
	Within Groups	28.909	17	1.701		
	Total	34.950	19			
There are no procedures for cleaning, lubricating, etc.,	Between Groups	2.367	2	1.183	.430	.658
	Within Groups	46.833	17	2.755		
	Total	49.200	19			
Product specific standard cycle time have not been established	Between Groups	10.618	2	5.309	2.990	.077
	Within Groups	30.182	17	1.775		
	Total	40.800	19			
Changeover and set-up adjustments take a lot of time	Between Groups	.405	2	.202	.100	.906
	Within Groups	34.545	17	2.032		
	Total	34.950	19			

INTERPRETATION

The significance value was greater than the p value 0.05; therefore we accept the null hypothesis. So there is no significant difference between machinery condition and No. of reworks. Hence it is concluded that number of rework products from machines in future is not depends on machine condition such as vibration, set up adjustments, proper cleaning and cutting oil splashed.

1. ***Formulation of hypothesis:***

Null hypothesis H0: There is no significant difference between machinery condition and cost of rejection and reworks.

Alternative hypothesis H1: There is no significant difference between machinery condition and cost of rejection and reworks.

TABLE 4.46 ANOVA BASED ON COST OF REJECTION AND REWORK

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Cutting oil is splashed on and around the machinery.	Between Groups	1.526	3	.509	.246	.863
	Within Groups	33.024	16	2.064		

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	Total	34.550	19			
The machinery and equipment generally dirty.	Between Groups	2.871	3	.957	.438	.729
	Within Groups	34.929	16	2.183		
	Total	37.800	19			
Motors are coated with a layer of oil/grime	Between Groups	4.455	3	1.485	.658	.590
	Within Groups	36.095	16	2.256		
	Total	40.550	19			
Motors are allowed to get hot or make strange noises without it being detected	Between Groups	11.188	3	3.729	1.879	.174
	Within Groups	31.762	16	1.985		
	Total	42.950	19			
Machinery parts are rattle and vibrate	Between Groups	6.117	3	2.039	1.131	.366
	Within Groups	28.833	16	1.802		
	Total	34.950	19			
There are no procedures for cleaning, lubricating, etc.,	Between Groups	5.105	3	1.702	.617	.614
	Within Groups	44.095	16	2.756		
	Total	49.200	19			
Product specific standard cycle time have not been established	Between Groups	9.133	3	3.044	1.538	.243
	Within Groups	31.667	16	1.979		
	Total	40.800	19			
Changeover and set-up adjustments take a lot of time	Between Groups	9.355	3	3.118	1.949	.162
	Within Groups	25.595	16	1.600		
	Total	34.950	19			

INTERPRETATION

The significance value was greater than the p value 0.05; therefore we accept the null hypothesis. So there is no significant difference between machinery condition and cost of rejection and reworks. Hence it is concluded cost of rejection and reworks products from machines in future is not depends on machine condition such as vibration, set up adjustments, proper cleaning and cutting oil splashed.

4.3 OEE CALCULATION

1. Batliboi -4

TABLE 4.48 OEE OF BATLIBOI - 4

Day	Shift Length	Breaks	Downtime	Ideal Run Time	Total Pieces	Reject Pieces
	min	min	min	PPM	pieces	pieces
5/02/18	480	30	20	0.07	31	0
6/02/18	480	30	30	0.08	36	0

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7/02/18	480	30	22.5	0.07	32	0
8/02/18	480	30	20	0.09	41	0
9/02/18	480	30	32	0.08	39	0
10/02/18	480	30	25	0.08	36	0
Total	2400	150	149.5	0.47	217	0

Variables	Calculation	Calculated Data	
Planned Production Time	Shift - Breaks	2250	Min
Operating Time	Planned Production Time – Down Time	21005.5	Min
Good Pieces	Total Pieces – Rejected Pieces	217	Pieces

Availability	Operating Time/Planned Production time	93.35 %
Performance	(Ideal cycle time × Total Pieces)/operating time	48 %
Quality	Good pieces / Total Pieces	100 %
OEE	Availability × Performance × Quality	44.80 %

INTERPRETATION

The availability and quality are 93.35% and 100% better than world class percentage but performance of the machines is 48% which is low they have to be improved on ideal cycle time. The accepted world-class goals for each factor are different from each other, in this OEE is 44.80% but they have to improve in certain factor such as ideal cycle time, product produced, spindle run time to obtain 85%.

2. Takumi – 7

TABLE 4.49 OEE OF TAKUMI - 7

Day	Shift Length	Breaks	Downtime	Ideal Run Time	Total Pieces	Reject Pieces
	min	min	min	PPM	pieces	pieces
12/02/18	480	30	40	0.09	43	0
13/02/18	480	30	30	0.08	39	0
14/02/18	480	30	35	0.08	40	0
15/02/18	480	30	47	0.1	45	0
16/02/18	480	30	32	0.07	33	0
17/02/18	480	30	28	0.08	36	0
Total	2400	150	212	0.5	236	0

Variables	Calculation	Calculated Data	
Planned Production Time	Shift - Breaks	2250	Min
Operating Time	Planned Production Time – Down Time	2038	Min
Good Pieces	Total Pieces – Rejected Pieces	236	Pieces

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Availability	Operating Time/Planned Production time	90.57 %
Performance	(Ideal cycle time × Total Pieces)/operating time	57.89 %
Quality	Good pieces / Total Pieces	100 %
OEE	Availability × Performance × Quality	52.43 %

INTERPRETATION

The availability and quality are 90.57% and 100% better than world class percentage but performance of the machines is 57.89% which is low they have to be improved on ideal cycle time. The accepted world-class goals for each factor are different from each other, in this OEE is 52.43% but they have to improve in certain factor such as ideal cycle time, product produced, spindle run time to obtain 85%.

3. **Makino – 2**

TABLE 4.50 OEE OF MAKINO - 2

Day	Shift Length	Breaks	Downtime	Ideal Run Time	Total Pieces	Reject Pieces
	min	min	min	PPM	pieces	pieces
12/02/18	480	30	34	0.06	27	0
13/02/18	480	30	31	0.08	36	0
14/02/18	480	30	39	0.07	35	0
15/02/18	480	30	23	0.09	41	0
16/02/18	480	30	15	0.08	37	0
17/02/18	480	30	25	0.11	47	0
Total	2400	150	167	0.49	221	0

Variables	Calculation	Calculated Data	
Planned Production Time	Shift - Breaks	2250	Min
Operating Time	Planned Production Time – Down Time	2083	Min
Good Pieces	Total Pieces – Rejected Pieces	221	Pieces

Availability	Operating Time/Planned Production time	92.57 %
Performance	(Ideal cycle time × Total Pieces)/operating time	51.98 %
Quality	Good pieces / Total Pieces	100 %
OEE	Availability × Performance × Quality	48.11 %

INTERPRETATION

The availability and quality are 92.57% and 100% better than world class percentage but performance of the machines is 51.98% which is low they have to be improved on ideal cycle time. The accepted world-class goals for each factor are different from each other, in this OEE is 48.11% but they have to improve in certain factor such as ideal cycle time, product produced, spindle run time to obtain 85%.

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4. **YSM – 3**

TABLE 4.51 OEE OF YSM - 3

Day	Shift Length	Breaks	Downtime	Ideal Run Time	Total Pieces	Reject Pieces
	min	min	min	PPM	pieces	pieces
19/02/18	480	30	22	0.08	39	0
20/02/18	480	30	31	0.10	45	1
21/02/18	480	30	22	0.12	51	0
22/02/18	480	30	29	0.11	46	0
23/02/18	480	30	20	0.07	34	0
24/02/18	480	30	30	0.10	45	0
Total	2400	150	154	0.58	265	1

Variables	Calculation	Calculated Data	
Planned Production Time	Shift - Breaks	2250	Min
Operating Time	Planned Production Time – Down Time	2096	Min
Good Pieces	Total Pieces – Rejected Pieces	264	Pieces

Availability	Operating Time/Planned Production time	93.15 %
Performance	(Ideal cycle time × Total Pieces)/operating time	73.33 %
Quality	Good pieces / Total Pieces	99.62 %
OEE	Availability × Performance × Quality	68.04 %

INTERPRETATION

The availability and quality are 93.15% and 99.62% better than world class percentage but performance of the machines is 73.33% which is better but they have to be improved on ideal cycle time. The accepted world-class goals for each factor are different from each other, in this OEE is 68.04% but they have to improve in certain factor such as ideal cycle time, product produced, spindle run time to obtain 85%.

FINDINGS, SUGGESTIONS AND CONCLUSION

6.1 FINDINGS

6.1.1 PERCENTAGE ANALYSIS

- The most selected option by the respondents is yes with 79.4% in terms of Autonomous maintenance. While the least selected option is no with 20.6%
- The most selected option by the respondents is yes with 87.4% in terms of planned maintenance. While the least selected option is no with 12.6%
- The most selected option by the respondents is no with 69.8% in terms of focused improvement. While the least selected option is yes with 30.2%
- The most selected option by the respondents is no with 69% in terms of education and training. While the least selected option is yes with 31%
- The most selected option by the respondents is no with 83.2% in terms of early management. While the least selected option is yes with 16.8%
- The most selected option by the respondents is yes with 84.2% in terms of quality maintenance. While the least selected option is no with 15.8%

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- The most selected option by the respondents is yes with 84.2% in terms of TPM in administration. While the least selected option is no with 19.8%
- The most selected option by the respondents is yes with 72.6% in terms of safety, health and environment. While the least selected option is no with 27.4%

6.1.2 FINDINGS FOR REGRESSION

- The multiple linear regression was carried to analyse the influence of various factor on the machinery condition. The R value of 0.937 indicates the positive correlation between the dependent and independent variables. The R square value of 0.878 can be interpreted as 87.8% of the variance in the dependent variable (No. of reworks) can be explained by independent variable machinery condition (Vibration, set-up adjustments, proper cleaning, cutting oil splashed, etc.,).

- The regression equation is formed with the independent factors. The highest influence is limit switches on machinery are covered with oil followed by reliability and Machinery coated with a layer of oil/grim.

6.1.2 FINDINGS FOR CORRELATION

- The correlation test is carried out for all the factors and the machinery and equipment generally dirty factor is weekly positive correlated to number of rework recorded.
- The Changeover and set-up adjustments take a lot of time is weakly negative correlated to There are no procedures for cleaning, lubricating,

6.1.4. FINDINGS FOR ANOVA

ANOVA BASED ON NO. OF REWORKS

- There is no significant difference in the means between machinery condition and No. of reworks.
- It shows that the number of rework products from machines in future is not depends on machine condition such as vibration, set up adjustments, proper cleaning and cutting oil splashed.

ANOVA BASED ON COST AND REJECTION OF REWORKS

- There is no significant difference in the means between machinery condition and No. of reworks.
- It shows that the number of rework products from machines in future is not depends on machine condition such as vibration, set up adjustments, proper cleaning and cutting oil splashed.

6.1.5 FINDINGS FOR OEE

- Badliboi - 4 resulted in availability and quality are 93.35% and 100% but performance of the machines is 48% which is low and it is resulted in OEE of 44.80%
- Takumi – 7 resulted in availability and quality are 90.57% and 100% but performance of the machines is 57.89% which is low and it is resulted in OEE of 52.43%
- Makino – 2 is resulted in availability and quality are 92.57% and 100% but performance of the machines is 51.98% which is low and it is resulted in OEE of 48.11%
- YSM – 3 resulted in availability and quality are 93.15% and 99.62% but performance of the machines is 48% which is low and it is resulted in OEE of 68.04%

SUGGESTIONS

The suggestions for this study is as follows,

Implement a set-up reduction project on the machine or process causing the biggest bottleneck. Your initial goal is to reduce set-up time by 50 percent without spending money.

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- **AUTONOMOUS MAINTENANCE:** From the findings and the analysis from the questionnaire, the shop floor workers should be given more training and the capability to decide by oneself should be increased. The relationship between the operators and the supervisors should be improved.
- **PLANNED MAINTENANCE:** From the analysis of the questionnaire, it is clear that the employees should be lot more responsible in what they do. The proper maintenance for the tools and spare parts and etc., are needed. The utilization of maintenance data should be more appropriate.
- **FOCUSED MAINTENANCE:** Based on the analysis, the focused improvement team should be formed with the managers and supervisors as leaders and the mixture of staff and experts should be included.
- **EDUCATION AND TRAINING:** The employees should be given proper training and education. More than theoretical session's experimental learning should be employed to get better results.
- **EARLY MANAGEMENT:** From the findings of the study, the relationship between the quality and equipment should be increased. The repetitive defects should be reduced to become more efficient.
- **QUALITY MAINTENANCE:** There should be clear control over the product and the equipment. The relationship between the product and the process development and equipment planning should be appropriate.
- **OFFICE TPM:** The unnecessary expenses in the office such as office supplies, inventory holding cost should be reduced. The transmission of the information should be faster and adequate.
- **SAFETY, HEALTH AND ENVIRONMENT:** The pollution from the organization should be emitted in proper way. The employees should be provided with all the safety equipment. The environment should be kept clean.
- The regression was carried out and it has the highest influence factor in Limit switches on machinery are covered with oil (1.205) followed by machinery coated with a layer of oil/grim (1.203) and they we have to concentrate on this factors.
- The Pearson coefficient Correlation method was used to find out the correlation between the various factors. There were fair relationships between different factors and the machinery and equipment generally dirty is weekly positive correlated to number of rework recorded and the Changeover and set-up adjustments take a lot of time is weakly negative correlated to There are no procedures for cleaning, lubricating
- Number of errors and rework and cost of rejection and reworks of products from machines in future is not depends on machine condition such as vibration, set up adjustments, proper cleaning and cutting oil splashed.
- The accepted world-class goals for each factor are different from each other, in this OEE for Badliboi, Takumi, Makino and YSM is 44.80%, 52.43%, 48.11% and 68.04%, but they have to improve in certain factor such as ideal cycle time, product produced, spindle run time to obtain 85% which is a world class.

CONCLUSION

From the study, the status of the implementation of TPM in Vishal Precision Products Pvt Ltd is analysed using the eight pillars in TPM. The 8 pillars in the TPM has played a major role in studying the whole process. Based on the 8 pillars, questionnaire is prepared and analysis is done accordingly. Keeping the analysis as the base, improvements is made. The OEE calculation made it easy to find the current impact of the TPM implementation. TPM Audit of individual machines with five point scale helps to identify the lacking of individual machines in particular area and to find reason for reworks and to improve performance of machinery. Based on the analysis suggestions are made to improve the OEE of the machines in Vishal Precision Products Private Limited.

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REFERENCE

I. Kaur, M., Singh, K., & Ahuja, I. S. (2013). An evaluation of the synergic implementation of TQM and TPM paradigms on business performance. International Journal of Productivity & Performance Management, 62(1), 66-84. doi:10.1108/17410401311285309
II. BintiAminuddin, N. A., Garza-Reyes, J. A., Kumar, V., Antony, J., & Rocha-Lona, L. (2016). An analysis of managerial factors affecting the implementation and use of overall equipment effectiveness. International Journal of Production Research, 54(15), 4430-4447. doi:10.1080/00207543.2015.1055849
III. Gupta, P., &Vardhan, S. (2016). Optimizing OEE, productivity and production cost for improving sales volume in an automobile industry through TPM: a case study. International Journal of Production Research, 54(10), 2976-2988. doi:10.1080/00207543.2016.1145817
IV. Kumar, J., Soni, V. K., &Agnihotri, G. (2014). Impact of TPM implementation on Indian manufacturing industry. International Journal of Productivity & Performance Management, 63(1), 44-56. doi:10.1108/IJPPM-06-2012-0051
V. Tyagi, A. S., Baag, D., Jailkhani, H., Poulose, J., & Patel, J. (2013). Identification of the Success Factors for the Implementation of Total Productive Maintenance in an Organisation Using Interpretive Structural Modeling(ISM). Journal of Supply Chain Management Systems, 2(4), 20-36.
VI. Wickramasinghe, G. D., &Perera, A. (2016). Effect of total productive maintenance practices on manufacturing performance. Journal of Manufacturing Technology Management, 27(5), 713-729. doi:10.1108/JMTM-09-2015-0074.
VII. S. Vigneshwaran, M.Maran, G.Manikandan (2015) Impact of TPM Implementation: Literature Review and Direction, Vol. 2 Issue 12, Dec. 2015.
VIII. Fu-Kwun, W. (2006). Evaluating the efficiency of implementing total productive maintenance. Total Quality Management & Business Excellence, 17(5), 655-667. doi:10.1080/14783360600588232.
IX. Jusko, J. (2009). OEE: The Heart of the Matter. Industry Week, 258(2), 30-32.
X. P. Muchiri, L. Pintelon, (2006) Performance measurement using overall equipment effectiveness (OEE), Pages 3517-3535
XI. http://dx.doi.org/10.1080/00207540601142645

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