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REVOLUTIONIZING LEARNING AND DEVELOPMENT WITH TOTAL PRODUCTIVE MAINTENANCE (TPM): A CASE STUDY OF TPM IMPLEMENTATION AT SUNDARAM AUTO COMPONENTS

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ABSTRACT

Total productive maintenance (TPM) stands as an integral maintenance approach, meticulously tailored for upholding the operational integrity of plants and equipment, thereby ensuring optimal availability and efficiency (McKone& Weiss, 2000). This approach also fosters a culture of autonomous maintenance. This review aims to provide an examination of TPM Education and Training (ET) practices, predominantly embraced within the manufacturing sector. The core objective of this review is to illuminate the comprehensive framework employed for the seamless implementation of effective E&T. This study places a particular emphasis on apparent advantages garnered through the application of TPM's key performance indicators. The research findings underscore a pronounced positive impact stemming from methodical TPM interventions. In particular, the indicators undeniably showcase increased workforce motivation, along with heightened involvement in improvement initiatives following the implementation of TPM education and training programs. The application and the success rate of E&T Pillar is studied atSundaram Auto Components Limited and presented in this paper

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INTRODUCTION

Over the past three decades, the manufacturing sector has seen an unparalleled level of transformation that includes significant adjustments to supplier attitudes, customer expectations, product and process technology, management styles, and competitive behavior (Ahuja et al., 2006). The focus has switched from growing efficiency through internal specialization and economies of scale to satisfying market circumstances in terms of flexibility, delivery performance, and quality as a result of greater global competition (Yamashina, 1995). Manufacturing businesses need to integrate quality and performance improvement programs intoevery facet of their operations to enhance their competitiveness and overcome the difficulties

presented by the current competitive climate (Pintelon et al., 2006). To remain competitive in theever-expanding global economy, cost-effective manufacturing has become essential. In the past, management has focused a large portion of its attention on increasing industrial productivity through cost investigation, measurement, reporting, and analysis. It's long past time to make similar efforts with regard to the productivity of maintenance functions. It is noted that firms have generally neglected maintenance as a competitive strategy and that there has been a lack of synergy between quality improvement initiatives and maintenance management (Wireman, 1990b). Due to past maintenance practices' shortcomings, the organization's competitiveness has suffered, which has lowered production facilities' throughput and reliability and sped up their deterioration. Additionally, excessive system downtime has reduced equipment availability, decreased production quality, increased inventory, and resulted in inconsistentdelivery performance (Ahuja & Khamba, 2008).

In the manufacturing industries, equipment maintenance is a key component of operational costs.Maintenance has a significant potential impact on production performance. The maintenance department personnels are responsible for keeping people, materials, tools, and overhead costs under control (Pintelon and Gelders, 1992). It has been discovered that maintenance spending accounts for a significant 12 to 23% of overall factory operating costs for manufacturing industry(Cross, 1988; McKone& Weiss, 2000). Manufacturers are beginning to recognize that maintenance organization and management, as well as design for maintainability and dependability, are strategic determinants for success in the 1990s (Yoshida et al., 1990). Thus, theeffectiveness of the maintenance function adds greatly to the performance of equipment, manufacturing, and products (Macaulay, 1988; Teresko, 1992).

Faced with such realities, firms are under intense pressure to continuously develop their competences in order to provide value to customers while also improving the cost effectiveness of their operations. Companies must generate new knowledge in order to reduce maintenance costs, which are a critical contributor to the performance and profitability of production systems in a dynamic and highly difficult environment (Kutucuoglu et al., 2001). Hence, the Total Productive Maintenance (TPM) concept. Total Productive Maintenance (TPM) was first developed in 1969 in Japan at Nippon Denso Co., part of Toyota Motors, under the leadership ofMr. Seiichi Nakajima of the Japan Institute of Plant Maintenance (JIPM), Tokyo. TPM was further developed and refined in Japan during the following decade and reached America in the

mid-1980s. On April 11, 2015, Mr. Nakajima, the "Father of TPM," brought us his passionate vision and methods (Venkatesh, 2007). It underscored the significance of a leadership mindset that fosters collaboration among front-line teams engaged in small group improvement activities. This recognition became a cornerstone of effective operations (Venkatesh, 2015), particularly in an era of heightened industrial competition. In the face of today's intense competition, TPM can often be the sole factor distinguishing success from complete failure for manufacturing companies.

TPM is built upon eight pillars which are 1. Jishu Hozen, 2. Kobetsu Kaizen, 3. Planned Maintenance, 4. Quality Maintenance, 5. Development and Management, 6. Education Training, and 7. Safety Health and Environment, and 8. Office TPM encompassing various objectives (Jain, Bhatti, Singh, 2014). This review paper concentrates on the Education and Training pillar, highlighting its significance as numerous manufacturing companies face challenges such as breakdowns, accidents, and defects resulting from insufficient skills. These issues contribute to an escalation in costs and can significantly undermine employee morale. Of concern is the anticipated participation level in Total Employee Involvement (TEI), which currently stands at amere 3 percent, revealing a lack of a structured training approach (Necas, 2020).

In the manufacturing sector, TPM's role in education and training proves pivotal, yielding tangible improvements in multiple areas. Notably, it leads to reduced manufacturing cycle times, diminished inventory sizes, fewer customer complaints, while simultaneously fostering the development of cohesive, autonomous small-group teams. Furthermore, it bolsters the skills and confidence of individual employees (Ahmed, Hassan, & Taha, 2005), thereby contributing to an overall enhancement of operational efficiency and effectiveness.

Need for TPM

The necessity of implementing Total Productive Maintenance (TPM) within an organization is influenced by a combination of external and internal factors (Gupta & Sharma, 2006). A systematic approach, illustrated in Figure 1, has been devised to address both sets of factors. The TPM activities are overseen by the TPM steering committee, with clearly defined roles and responsibilities established through a thorough review of the following:

a. The corporate steering committee set the Goal for the company.
b. The plant level steering committee sets the KMI of the plant level, monitors and reviews the KPI of education and other pillars.
c. The department-level steering committee set the KPI, monitoring and reviewing the KAIof the TPM circle.
d. The TPM circle committee set various KAI parameters including training requirementsfor JH pillars and reviewed the KAI about the circle.

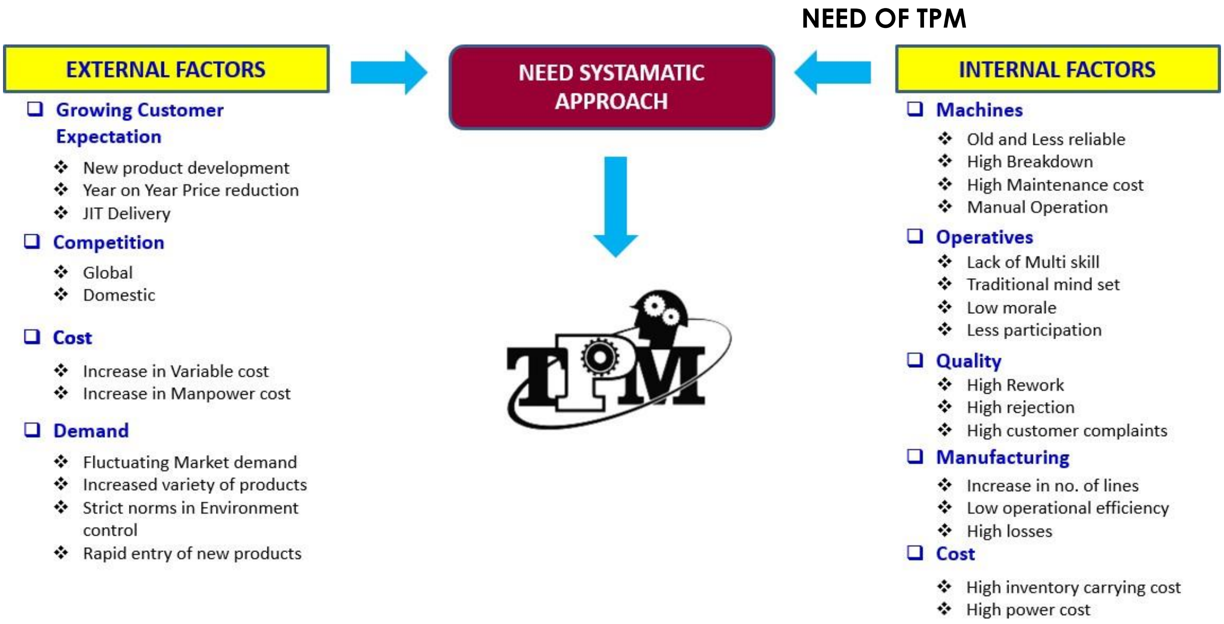


Figure 1: Systematic Approach

Need for Education and Training Pillar (E&T)

The primary purpose of implementing education and training is to ensure that staff members acquire essential skills, beneficial for both their personal development and the effective implementation of TPM in alignment with the organization's goals and objectives. Research conducted by Ajay in 2016 indicates that employees recognize the positive impact of TPM on skill enhancement and knowledge development through training, fostering a sense of job satisfaction. The study further revealed a consensus among respondents that safety performance improved following the implementation of TPM. These findings not only underscore the effectiveness of TPM in enhancing job performance but also highlight its role in controlling overhead costs by minimizing equipment breakdowns (Park & Han, 2001). The rationale behind the widespread adoption of Education and Training (E&T) by most organizations is illustrated in Figure 2.

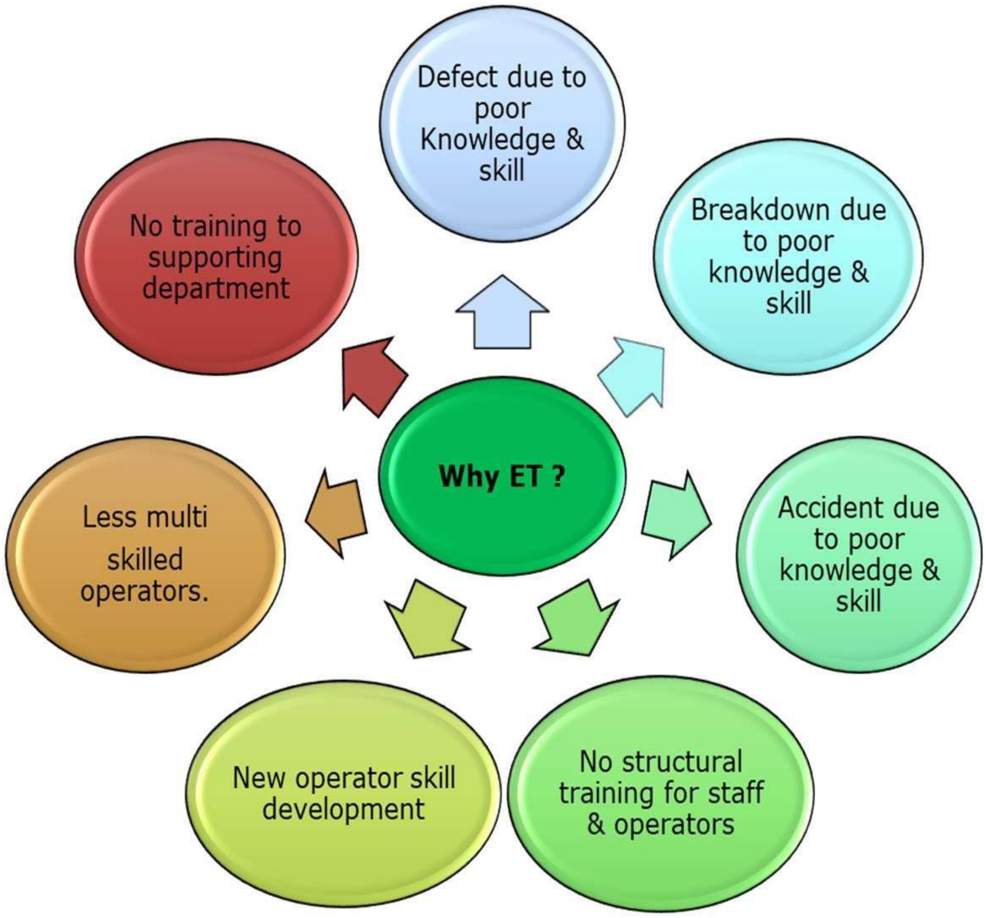


Figure 2: Rationale for Education and Training (ET) Adoption

Objectives of E&T Pillar

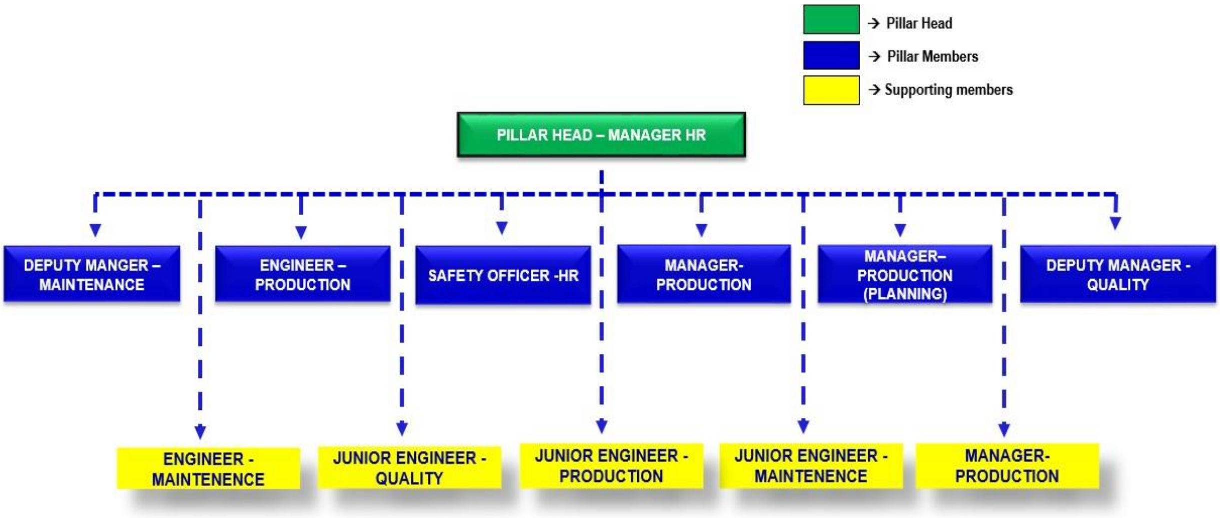
The primary goal of Education and Training (E&T) is to provide operators with essential education and training in maintenance engineering practices. The underlying concept emphasizesnot only acquiring practical knowledge ('know-how') but also understanding the underlying principles ('know-why'), enabling operators to effectively address routine challenges (Vardhan, 2014). The aim of this training is to foster specialized skills among employees, organizations typically implement an active program comprising (1) Knowledge & Skill Training, (2) Job Training, and (3) Self-development. This initiative involves:

a. Training staff and workers for enhanced skillfulness and effectiveness in their roles.
b. Upgrading skills of Production Operators and Maintenance Operators.
c. Enhancing Maintenance staff skills in specialized maintenance.
d. Providing skill-based training tailored to job requirements.
e. Developing Multi-skill Operators for quick changeovers.
f. Emphasizing skill development.
g. Addressing absenteeism through rewards and the implementation of flexible working arrangements.
h. Fostering the development of multi-skilled individuals.
i. Encouraging the self-development of employees.

Typical Organization Structure (OS) for E&T Pillar

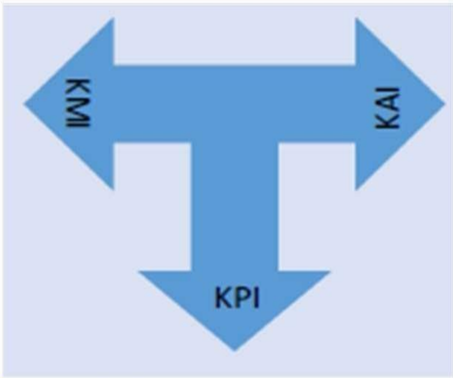
To implement Education and Training (ET), an organization should establish an Organizational Structure (OS) led by the HRD manager, with executives and employees from diverse functionaldepartments reporting to the HR head. This cross-functional team is designed to efficiently address and support all training-related needs and issues. An example of ET pillar OS given in Figure 3.

Figure 3: E&T Pillar Organization and StructureThe



Relationship between KMI, KPI and KAI in E&T Pillar

The Key Management Index (KMI), derived from the organization's Vision, Mission, and TPM Policy, assists top management in establishing objectives aligned with company goals. In contrast, the Key Performance Index (KPI), derived from the KMI determined by top management, aids Pillar leaders and team leaders in setting targets that align with group requirements. The Key Activity Index (KAI), derived from the KPI, predominantly focuses on the activities necessary to achieve the KPI and, ultimately, the KMI. This includes tangible, target-based improvement projects. The relation between KMI. KPI and KAI are described in Figure 4 below for an E&T TPM pillar. The chosen Key Performance Indicators (KPIs) are directly aligned with business objectives, ensuring that improvements in KPIs contribute to enhanced operational efficiency in the plant. Various Key Activity Indicators (KAI) related to achieving the Education and Training (E&T) goals are closely monitored and reviewed. Additionally, KPIs are subject to thorough monitoring and review. According to researchconducted by Katayama, Murata, & Lee (2019), it was determined that the transferability is quite high between Key Management Index (KMI), KPI, and KAI.



SAFETY & EH - Zero Accidents	Sustain EBDITA >21%	YOY Growth rate 10% Sales	Customer satisfaction- Improvement	Employee satisfaction - Improvement	Increase Revenue per Employee (Rs in Lakhs/Employee)		No. of No Why sheets developed	No. of OPL Created	No of training modules developed	No. of training classes for safety	No. of suggestions	No. of employees engagement conducted	No. of operator identified for multiskilling	No. of operator identified for multiskilling	No. of white tags cleared	No of reward and recognition schemes	No Poka Yoke developed	Promotional activities conducted
⊙	○	○	○	⊙	○	Eliminate Breakdown due to lack of skill & knoweldge	⊙	⊙	○	⊙	○	○	⊙	⊙	Δ	○	⊙	○
○	○	○	⊙	○	○	Eliminate Defect due to poor skill & knoweldge	⊙	⊙	○	○	○	○	⊙	⊙	Δ	○	⊙	○
⊙	○	○	○	⊙	○	Eliminate Accident due to lack of skill and knoweldge	⊙	⊙	○	⊙	○	○	⊙	⊙	⊙	○	⊙	○
○	⊙	○	⊙	○	⊙	Reduce Absceenteisim	Δ	Δ	Δ	○	Δ	⊙	○	Δ	○	⊙	○	⊙
⊙	○	Δ	○	⊙	⊙	Multi skilled operator developed (Cumulative)	○	○	⊙	○	Δ	○	○	○	○	⊙	○	○

Relationship
⊙ Strong ○ Meduim Δ Weak

Figure 4: Relationship between KMI, KPI and KAI in E&T PillarE&T Pillar

Implementation

To initiate TPM implementation in an organization, the management declares a roadmap for theTPM journey. Based on this roadmap, each pillar formulates its activities and master plans. The Education and Training (E&T) pillar also develops a master plan to support each pillar in achieving its results by implementing various educational and training programs. The following in Table 1 is some of the master plan activities for the E&T pillar.

Table 1: E&T Pillar Master Plan

S.No	ACTIVITY	2020-2021	2021-2022				2022-2023				2023-2024				2024-2025			
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Key milestones	TPM declration; TPM kickoff				Technical training center implementation						CII strong commitment award			CII significant achievement award			
1	TPM declaration																	
2	Selection of model machine																	
3	Setup organisation for TPM implementation																	
4	Implement step 1, 2, 3 in model machine																	
5	Company wide TPM kick-off																	
6	Implement JH step 1, 2, 3 (Initial cleaning , prevention of source of contamination and Standardization of CLIT)																	
7	CII certification for strong commitment																	
8	8.a TPM - Awareness training																	
	8.b E&T Pillar activity & Targets setting																	
	8.c Upgrading maintenance skills																	
	8.d Maintenance skill education curriculum																	
	8.e Develop training models																	
	8.f Inaguration of technical training center																	
	8.g Conducting training as per schedule																	
	8.h Operation skill education curriculum																	
	8.i Upgrading operation skill																	

Plan | Actual | In-Progress | Continual activity

E&T Roles in Other Pillars

To ensure successful implementation and the achievement of organizational objectives, the Education and Training (E&T) pillar should be implemented with the support of other key pillars.Below is Table 2, illustrating the relationship of the E&T pillar with other important pillars.

Table 2: Relation between E&T Pillar and other pillars (The Gives & Gets)

JH Pillar	PM Pillar	QM Pillar	SHE Pillar
• Training on various steps of Jishu Hozen.	• Reduction in breakdown due to inadequate skill	• Reduction in defect due to inadequate skill	• Training on PPE usage to operators
• Basic awareness training of operators	• Subject wise training material	• Training on defect identification	• Training on emergency response procedure
• Training on how to find abnormalities	• Technical training for operators	• 7 QC tools training	• Training on fire fighting
• OPL training to operators	• Training to do time based maintenance	• Training of 10 steps QM approach	• Training on danger prediction
• JH step 4 overall inspection training materials			• Training on First Aid
• Technical training center development			
• JH step 4 training			

The E&T Pillar serves as a facilitator, tasked with developing and managing systems to address losses arising from skill deficiencies across the organization and other relevant TPM pillars. Pil-lar heads and teams in other areas are responsible for identifying training requirements and con-tent, as well as allocating resources to deliver the necessary training within their respective pillars.The E&T pillar, in turn, utilizes these resources to develop and deliver training programs, aimingto eliminate losses and enhance the capabilities of team members and employees.

E&T responds to requests for assistance from other pillars, providing guidance on effective train-ing development, and disseminates training methods and processes to support the overall organ-izational objectives. The E&T pillar ensures that its systems are intricately designed to meet the skill requirements of each pillar. Individual skill matrices are prepared by the plant, and the E&Tpillar establishes development and improvement plans, addressing the crucial link between skill gaps and training needs.

E&T Pillar Approach

This pillar comprises eight essential steps, with detailed descriptions provided in Figure 6. Omitting any of these steps to expedite the process will not result in the desired outcomes intended by the organization. Therefore, the organization must meticulously plan and implement all these crucial steps for a successful outcome.

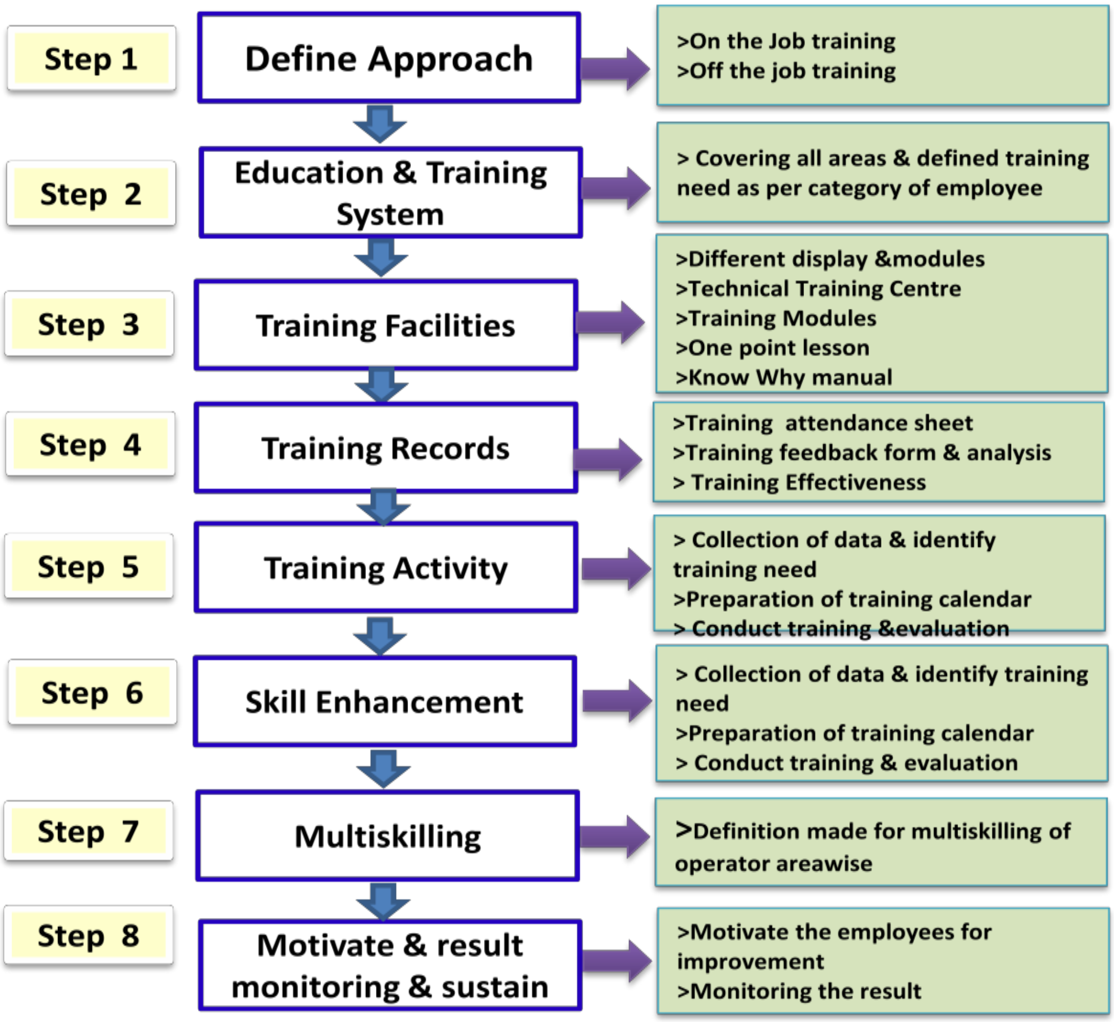


Figure 6: E&T Pillar 8 Steps

Sundaram Auto Components Limited Profile

Sundaram Auto Components Limited, a member of the $8.5 billion TVS Group, commenced operations in 1988. Since their inception, they have evolved into a comprehensive service provider of injection-molded plastic solutions for the automotive industry. Operating from six strategic locations — Hosur, Chennai, Himachal Pradesh, Mysore, Bhiwadi, and Sanand — theyserve a diversified portfolio, specializing in the design and manufacture of products for the two-wheeler, commercial vehicle, passenger vehicle, and three-wheeler segments within the automotive industry. Their emphasis is on delivering value-added products, services, and innovative solutions to elevate quality, reliability, and provide the optimum value proposition for their customers. To uphold this commitment, they adhere to Total Quality Management (TQM) practices at every level (https://www.sundaramautocomponents.com/about.html).

Training New Employees - Sundaram Auto Components Limited at Chennai Location

Newly hired employees in manufacturing firms typically undergo a rigorous training and certi-fication process, exemplified in Figure 7. Sundaram Auto Components Limited, for instance, mandates that their recruits successfully pass two SL certification procedures. It's a common practice for manufacturing companies to construct dexterity models in their skill development centres aimed at comprehending and elevating individual skill levels. These models are intri-cately linked to the entire process matrix, as depicted in Figure 8. The job assignment for each recruit is determined based on the outcomes of the dexterity assessment. To meticulously monitor employee performance, an employee qualification card is issued, which the respective trainer signs upon completion of training. Particularly, training's significance transcends individual skill development, extending to the enhancement of other fundamental pillars within the operational framework.

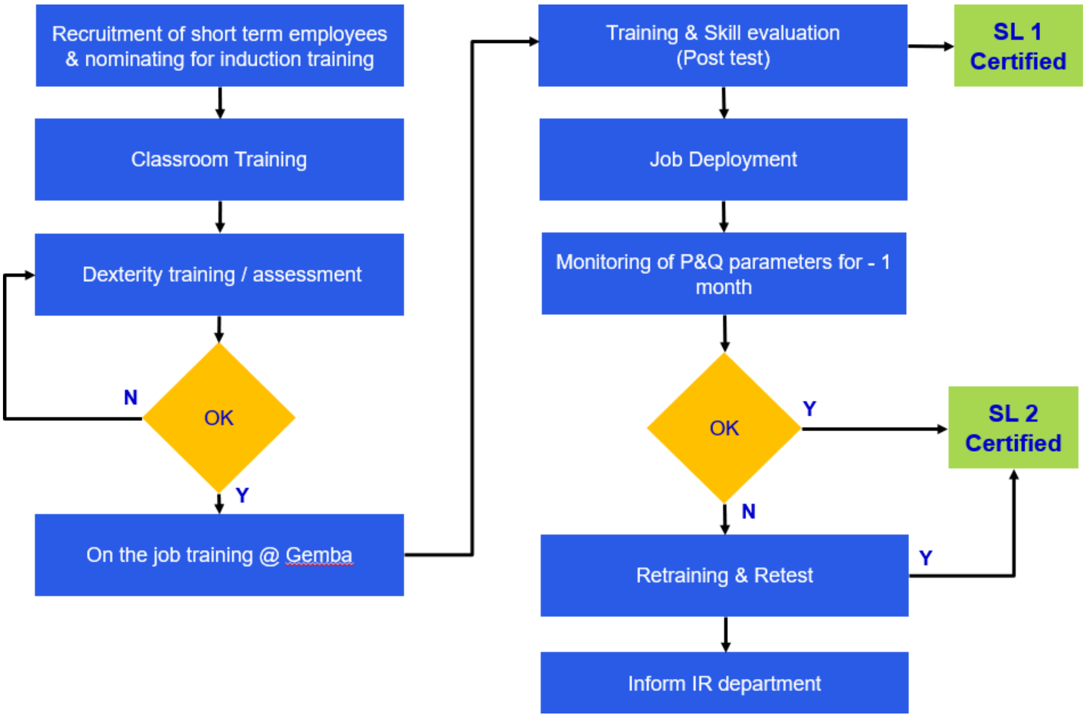


Figure 7: Training Flow Chart

Process \ Modules	Drop Ball Exercise (Safety)	1S & 2S	Memory Exercise	Mind & Hand Co-ordination	Nerves Exercise	Pick right Material right quantity	Soft ball Exercise	Visual Dexterity	golf ball exercise	Hand stretch Exercise	Pick and place material	Raw Material Identification
Stores	◎	◎	○	△	△	△	○	○	○	○	◎	◎
Raw materail feeding	◎	○	△	◎	○	△	○	◎	○	○	△	◎
Production	◎	◎	○	◎	◎	◎	○	◎	◎	◎	◎	◎
Quality	◎	◎	◎	◎	○	△	△	◎	△	△	△	○
Warehouse	◎	◎	◎	○	△	△	△	◎	△	△	◎	△
Maintainence	◎	◎	◎	◎	◎	△	○	○	○	○	○	△
Tool room	◎	◎	◎	◎	◎	△	○	○	○	○	○	△

◎ CLOSE RELATIONSHIP ○ MODERATE RELATIONSHIP △ NO RELATIONSHIP

Figure 8: Dexterity Mapping to Process Matrix

Newly hired employees undergo a selection process based on criteria such as age, qualifications,and knowledge, with an additional medical examination to ensure their fitness for the job. Once selected, candidates attend classroom sessions to acquire fundamental job knowledge. Training modules cover a range of topics, including 5S principles, safety procedures, environmental awareness, and comprehensive knowledge of products and processes. Training is delivered through presentations (PPT) and video sessions. Additionally, new employees are familiarized with the company's standing orders, culture, values, and the proper usage of tools and machines.

In addition to classroom training, new hires undergo job training to acquire the necessary skills and safety procedures, enabling them to perform their tasks effectively and safely. Following training in the skill development center (Dojo room) and on-the-job gemba training, new employ-ees undergo a skill level -1 test, and a Dexterity evaluation sheet is prepared. Upon successful completion, they are certified for skill level -1.

Certified SL-1 employees are then assigned responsibilities and deployed to their respective de- partments. Subsequently, these certified employees undergo further testing for skill level -2 overa period of 2 to 3 months, in accordance with the company's Education and Training (E&T) pol-icy. The employee's proficiency and quality (P&Q) knowledge are rigorously tested, and certifi-cation for skill level -2 is granted upon successful completion of the test.

Maintenance Skills Enhancement

The objective of enhancing employees' skills is to comprehensively identify their training needs,provide training, and assess their proficiency. The intricate nature of maintenance and assembly tasks demands that employees be trained to grasp the underlying sensorimotor and cognitive aspects essential for proficiently executing these operations (Webel, et al., 2013). Frequently, thereported root causes in manufacturing companies encompass factors such as forced deterioration, deficient skills, and suboptimal operating conditions. Sundaram Auto Components, for instance,documented 48 breakdown incidents attributed to inadequate skills.

When manufacturing companies formalize their training processes, they typically embark on a systematic approach. The initial phase involves data collection to pinpoint employees' shortcomings, encompassing required skills, necessary knowledge, and levels of awareness or exposure. The subsequent stage involves categorizing these findings into specific inspection subjects, accompanied by the development of an applicability matrix and a comprehensive training plan. To illustrate, if an employee is identified as struggling with cable and wiring routing, they would be categorized under the electrical subject inspection, leading to the implementation of planned maintenance training to address this deficiency. Nonetheless, the efficacy of personalized training within manufacturing companies tends to fluctuate owing to costconsiderations. Nevertheless, companies that manage to attain their desired outcomes often do soby closely tracking employees' progress throughout the training process. Notably, the outcomes achieved by Sundaram Auto Components Limited showcase a success rate, as depicted in Figure9 & 10.

In addition, the maintenance skills of JH members and PM pillar members (Figure 11) play a pivotal role in the success of TPM. Enhancing the skills of JH pillar members is essential for identifying abnormal conditions, sources of contamination affecting product quality, and recog-nizing areas of High-Technical Availability (HTA) that require corrections. Similarly, improvingthe skills of PM pillar members supports the immediate correction of Red tags, reduces various losses, and elevates equipment availability. Skill development for PM pillar technicians contrib-utes to a reduction in breakdowns, spare parts costs, increased Mean Time Between Failures (MTBF), and decreased Mean Time to Repair (MTTR). The methodology for skill enhancementinvolves the following steps:

1. Collecting data on machine breakdowns and analyzing them using the why-why analysis.
2. Classifying the root cause by understanding failure phenomena, causes, adequate operat-ing conditions, inadequate technician skills, and forced deterioration for each piece of equipment.
3. Identifying the required skills based on the breakdown phenomena.
4. Classifying the identified skills into inspection subjects, such as mechanical, electrical, hydraulic, and corresponding applicability to PM and JH pillars.

5. Conducting and monitoring training for PM and JH pillar members, which may take placeOn-the-Job Training (OJT), off the line, in the classroom, or at a Skill Development Cen-ter (DOJO center)

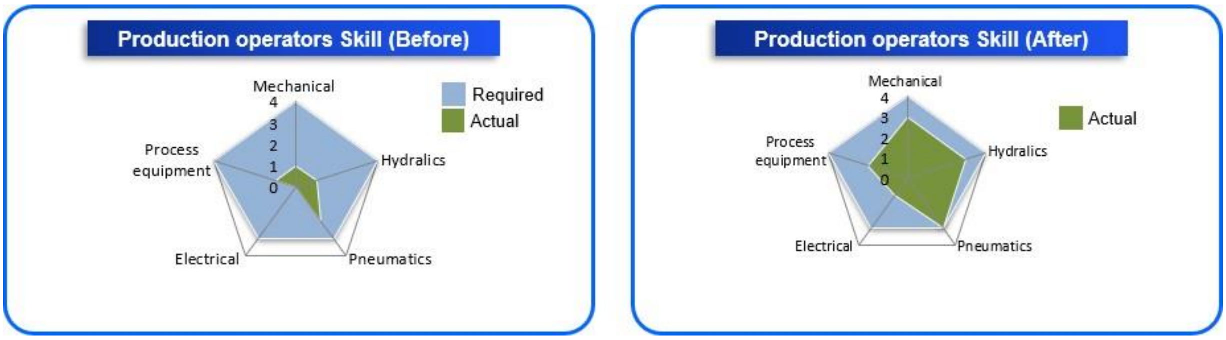


Figure 9: Success rate after implementation of personalized training ofproduction operator.

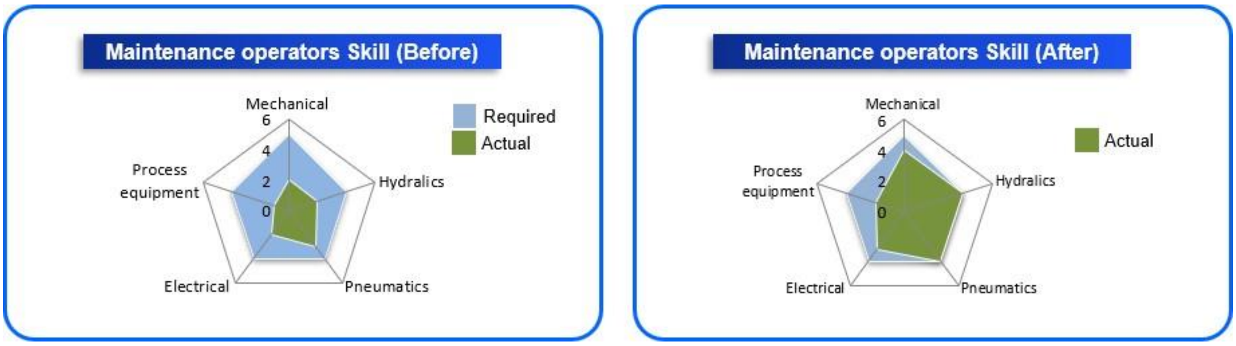


Figure 10: Success rate after implementation of personalized training of Maintenance operator.

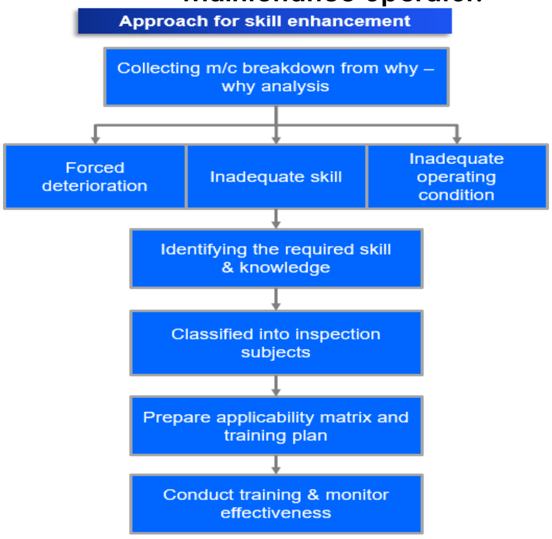


Figure 11: Maintenance Skill Enhancement of JH & PM Pillar MembersMulti-

Skill Approach

The performance outcomes of a specialized worker and a multi-skilled worker differ significantly,leading to variations in output or results that can subsequently impact the brand's market perception. This phenomenon arises due to escalating competition, causing skills to intersect andoverlap, while concurrently driving up the cost of skilled labor. This situation gives rise to two overarching viewpoints, denoted as flexibility and productivity (Chhabra, 2017). Encounters with multi-skilled employee scheduling are frequent, particularly in companies involved in diverse operations like maintenance, construction, and installation, where tasks are distributed across various physical locations. In such scenarios, it becomes prudent to consolidate a group of workers for a given workday. Pertinent information about technician availability is a crucial factor addressed in the problem-solving process (Fırat & Hurkens, 2012).

The multi-skill procedure typically commences by identifying the requisite multi-skills requiredfor the tasks at hand. Subsequently, the appropriate personnel possessing these skills are identified. The subsequent stages encompass the implementation of these skills, measuring their effectiveness, and ensuring sustainability by pinpointing trainers among the trainees. Throughout this process, employees often formulate successful recommendations and solutions, which concurrently aid in curbing absenteeism rates. The measurement framework revolves around four key levels: the employees' reaction, the learning process itself, observable changes in their behavior, and the ultimate outcomes achieved at the culmination of the training.

E& T Pillar Training Steps Implementation - Sundaram Auto Components Limited

The team follows a comprehensive seven-step process for autonomous maintenance, as outlinedin Table 3. Steps 1 to 3 primarily emphasize the detection of abnormalities through the use of thefive senses. Step 4, known as General Inspection, extends this focus by providing operators withan in-depth understanding of the functions and structure of their equipment. It aims to cultivate their capability to perform routine maintenance, supported by relevant logic and knowledge.

During equipment checks, particular emphasis is placed on meticulous observation of minor ab- normalities that could potentially lead to breakdowns, quality issues, and other persistent losses.Precise identification of these issues is crucial, and effective action is required to eliminate them.Operators, therefore, leverage the processes outlined in Step 4 to acquire the skills necessary formeasuring deterioration and predicting the likelihood of breakdowns and quality defects during inspections.

Table 3: 7 Steps of Autonomous Maintenance

Step 0	Initial Preparation
Step 1	Initial clean-up
Step 2	Countermeasures for the causes offorced deterioration and improvinghard-to-access areas
Step 3	Formulation of tentative standards
Step 4	Overall inspection
Step 5	Autonomous inspection
Step 6	Standardization
Step 7	All-out autonomous management

Dojo Room/Skill Development Centre - Sundaram Auto Components Limited

For the effective implementation of training, it is imperative to establish a skill development cen- ter, commonly known as the Dojo Room. In line with this requirement, Sundaram has establisheda Dojo Room, as depicted in Figure 12. The Dojo Room is equipped with various modules, show-casing practical examples such as a working Hydraulic powerpack with all accessories (Motor, coupling, pump, pressure relief valves, directional control valves, and cylinders), a functional
model of electrically and mechanically operated pneumatic cylinders, and models of Drive sys- tems with couplings and gearboxes. Additionally, numerous cut models of general items like hydraulic cylinders, pneumatic cylinders, gearboxes, and hydraulic valves are prominently dis- played.

These exhibits offer a comprehensive understanding of the components and their functionality, enabling operators to easily comprehend abnormalities on the shop floor within their respective machines. Moreover, this setup empowers operators to make minor adjustments, perform set- tings, and align pressure with confidence.

Figure 12: Dojo Room / Skill Development Centre

Know-WHY Sheets

Know-Why sheets are essential for summarizing the operational principles and abnormal condi-tions of machines slated for instruction. These sheets elucidate the nature of abnormalities, de- tailing what issues may arise, and provide guidance on the requisite checks and inspections to maintain the machines in optimal condition.

Preparation of Know-Why sheets extends to all fundamental components employed in the ma- chines, covering hydraulic systems, pneumatic systems, electrical drives, gearboxes, and more. These sheets offer operators a comprehensive understanding of parts and sub-parts, facilitating effective inspection of machine abnormalities and restoration to their basic operating conditions. An illustrative Know-Why sheet is attached, focusing on the air filter (refer to 'Typical Checklistand ‘Know-Why’ Explanation for Sundaram Company Filter). It is recommended to use such one-point lessons only when operators need to check and adjust air filters, making it unnecessaryif these actions are not part of their responsibilities.

TPM Training Triumph - Sundaram Auto Components Limited

The TPM training methodology employed at Sundaram Auto Components has resulted in a sig-nificant decrease in red tag failures linked to high abnormality incidents, necessitating interven-tion from the maintenance team. In contrast, white tags, indicative of less severe issues, can be effectively addressed by workers or operators themselves, as outlined in Figure 6.

Moreo- ver, there has been a noteworthy increase in the number of suggestions implemented for routinemaintenance over the past five months, as depicted in Figure 7.

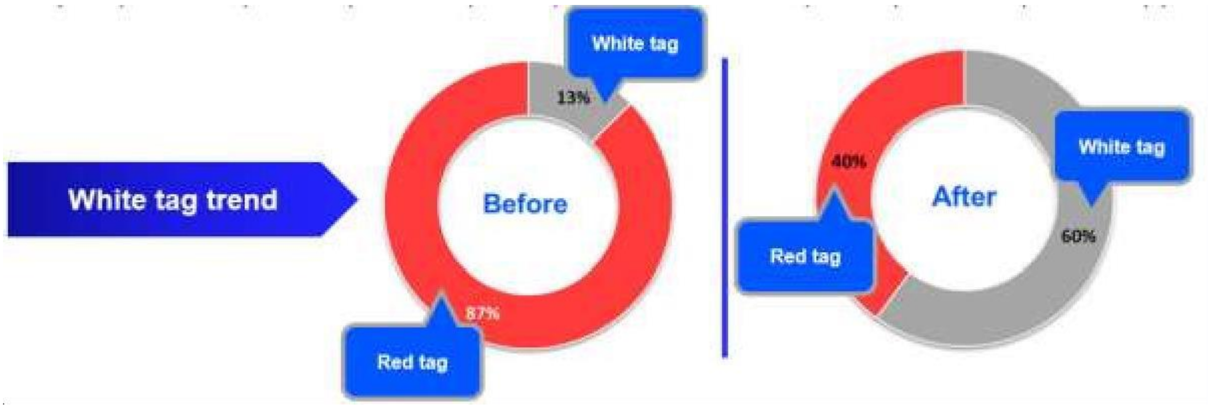


Figure 13: Red and White Tags Before and After TPM Education and Training

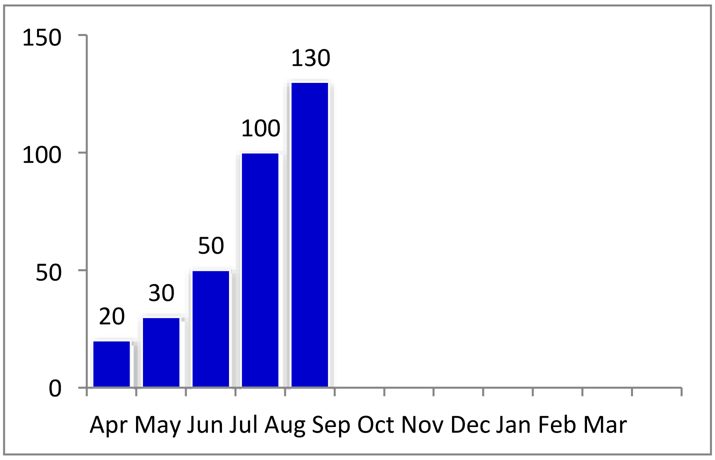


Figure 14: Number of Implemented Suggestion

The integration of TPM has yielded substantial outcomes for the organization. Breakdown inci- dents have witnessed a 100 per cent improvement, defects have seen a 50 per cent enhancement,accidents have been reduced to zero, employee participation has surged by 41 per cent, multi- skilling of employees has risen by 50 per cent, and the successful completion of JH S4 circles has grown by 45 per cent.

Beyond quantitative gains, the impact of TPM training extends to cultural transformation, foster ing a self-learning environment, and increasing workers' competency and awareness levels. Thisorientation equips organizations to navigate significant internal and external shifts by embracingadaptability—an approach that enables systems to efficiently and swiftly adjust to evolving de- mands. The term "adaptability" signifies a system's capacity to adeptly accommodate changes, making it an open and flexible entity. An adaptive learning system can adeptly modify its behav- iour in response to alterations within its environment or internal components (Fohrholz & Gro- nau, 2012).

Enhancing Work-Life Balance through TPM education and training is instrumental in address-ing employee engagement and retention, which have evolved into crucial tools in today's busi- ness landscape. To establish a suitable work-life equilibrium, TPM training allows for a com- prehensive understanding of job attributes. This entails designing jobs that are both stimulatingand challenging, ensuring that constructive feedback is provided periodically, and linking re- wards to the achievement of organizational objectives (Satpathy, et al., 2019).

Furthermore, augmenting organizational agility is imperative due to the mounting market pres-sures for growth. This context, combined with the potential rigidity that growth can entail, cre- ates an ongoing dilemma for many organizations. To resolve this potential disparity associated with growth's significance, prioritizing efficiency becomes vital to prevent an organization's sizefrom hindering its overall responsiveness (Harraf et al., 2015).

In conclusion, while intertwined with change management in the sense that the desire for inno- vation acts as the impetus for change, fostering a culture of innovation serves as a foundational, organization-wide approach to leveraging external changes to enhance the organization's internal dynamics. Some of the results of the E&T pillar achieved in a TPM company are listed below:

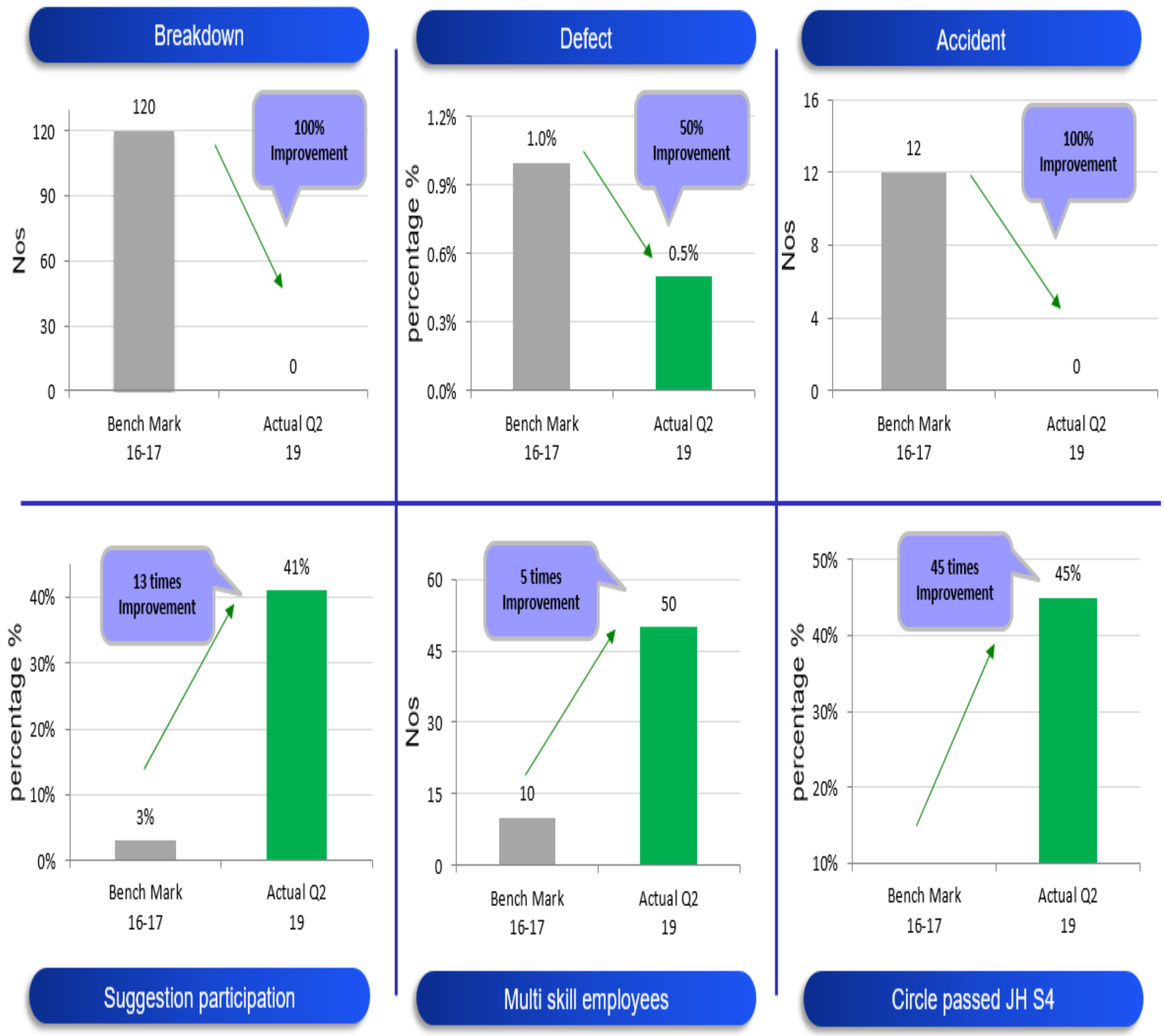
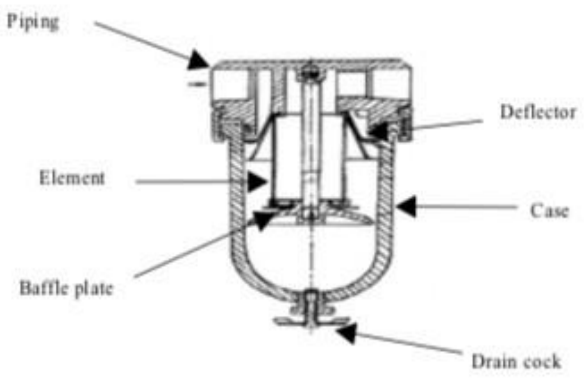


Figure 15: Results of E&T Pillar

Sample: 'Typical Checklist and 'Know-Why' Explanation for Sundaram Company Filter

Topic				No			
				Date Prep.			
OPL Type	Basic Knowledge ☐	Improvement ☐	Problem ☐	Area Manager	Line Leader	Team Leader	Author

Title: Air Filter



Checkpoints	Know-Why (Why is this check/restoration/improvement needed? What bad result would happen if the problem were left untreated?)
1. Drain water out of filter bowl	1. Water collects in bowl –> moisture gets into compressed air –> directional control valves, cylinders and actuators get rusty –> machine breaks down
2. Is bowl dirty inside, or damaged?	2. Inside is dirty –> centrifuging capacity declines –> damp air is discharged into air line Bowl is damaged –> bowl breaks –> someone gets injured
3. Is deflector damaged or distorted?	3. Deflector is damaged or distorted –> strong centrifugal force cannot be obtained –> damp air is discharged into air line
4. Is filter element blocked?	4. Filter is blocked –> pressure drops –> cylinder malfunctions
5. Is baffle plate damaged or distorted? 6. Is filter correctly installed?	5. Baffle plate is damaged or distorted –> damp air is discharged into air line 6. Filter is installed in a bent condition –> centrifuging capacity declines –> damp air is discharged into air line
7. Are there any leaks from piping joints? 8. Is bowl guard intact?	7. Piping joints leak –> pressure drops –> cylinder malfunctions 8. No bowl guard –> pieces fly around if bowl breaks –> someone gets hurt

Result	Date								
	Teacher								
	Student								

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