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Investigation of Human Aspect in Total Productive Maintenance (TPM): Literature Review

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Abstract:- Today in Indian industries total productive maintenance (TPM) has made significant impact on the managers, engineers, technicians and workers. Either with direct involvement in TPM implementation process or due to indirect awareness from employees of other nearby industries who have adopted or planned to adopt TPM concept; TPM has become part of concern for significant portion of employees of Indian manufacturing industries. Hence obviously it is important to investigate role of human in TPM concept and impact of TPM on the employees. For this purpose analysis of the link between TPM and employees is attempted herewith with exhaustive literature review focused on human accept of TPM.

Keywords:- Kaizen, TPM, Total productive maintenance, empowerment, participation, TQM, Industry, autonomous maintenance, SGA

I. INTRODUCTION

Globally each year billions of dollars are spent on engineering equipment maintenance shows that there is a definite need for effective asset management and maintenance [1].Maintenance function is ultimately responsible to human in many ways. Maintenance is responsible to the owners, the users of the system, and society as a whole. With adequate and continuing financial returns owners are fulfilled. Users want functioning of the equipment as per design. No failure should be threat to public health and safety is requirement of society [2]. From breakdown maintenance then concepts such as preventive, predictive, productive maintenance TPM concept was evolved initially at Nippon Denso co. Japan in 1971. A more rational approach is to consider maintenance as part of the company's continuous improvement program. Meaning of maintain is to keep in order. The total part of TPM is meaningful and gives deeper thought to maintenance process within an organization [3].

II. TOTAL PRODUCTIVE MAINTENANCE (TPM)

In the total productive maintenance total participation of all the employees is important feature along with total effectiveness and total maintenance system. Group activities such as autonomous maintenance are part of total participation [4]. In defining TPM majority of researchers have emphasised the human aspect in TPM along with effectiveness and maintenance aspects. TPM is a maintenance that is productive and done by all the employees [5]. Jostes and Helms [6] described TPM as a synergistic relationship among all the functions of the organization, but mainly between production and maintenance. Sun *et al.* [7] also describes this synergistic aspect of TPM. Yamashina [8] describes TPM starts right at the designing of new equipment to the daily autonomous maintenance by operators. TPM progress is based on human factors. Thus, TPM is rightly suitable for developing competent human resources. According to Witt [3] TPM is communication and collaboration According to Sharma *et al.* [9] TPM is combination of preventive maintenance (PM) and total quality through employee involvement (TQEI) and according to them autonomous maintenance group is a part of TQEI initiative. TPM underlines importance of people with positive approach and continuous improvement initiative; and harmonious work culture between production and maintenance people [2]. According to Ben-Daya [10] empowerment of employees is one of the basic features of the TPM. TPM aids organisations to explore its own potential and talent for achieving improvements. The fostering of a ‘‘can do’’ culture promotes the TPM [11]. According to *Eti et al.* [2] TPM combines the prominent aspects of productive and Preventive procedures with innovative strategies and encourages total employee participation. Product quality improvement, waste reduction, improvement in the state of maintenance and empowerment of employees are some of the TPM goals [10]. TPM is strategy to maximise equipment effectiveness, to improve quality, to increase safety, to reduce costs and more than that to raise moral of the team [2]. TPM is initiative for participation of all the departments,

involvement of every single employee, and promotion of autonomous maintenance culture [12]. TPM is a company-wide approach to plant, equipment or asset that involves the active participation of more than just the maintenance of equipment and improvement of the overall equipment effectiveness. This is a ``common thread" that runs through the many definitions of TPM [13].

2.1 Involvement and participation:

In literature relation of total quality management (TQM) and TPM is noted and common parameters related to human aspect is discussed. Involvement of workers is the key factor for the success of TPM and TQM. The true strength of both TQM and TPM is the use of knowledge and experience of all the workers to generate ideas and contribute to the goals and objectives of the company [6]. TPM possesses the prospective to be used in managing the people and improvement of resource-use [2]. The human resources (HR) related practices which are common for both TPM and TQM are encouragement of leadership in employees to make suggestions for performance improvement, cross-functional employee involvement, and multiple tasking and skill development [14]. TQM and to some extent TPM also, focus on achieving commitment and other intangible factors such as participation and engagement. Still, implementation often fails due to causes like lack of commitment [15]. If operators can make budgets, take decisions, interact with others at outside of company then they may be assigned similar responsibilities at work as well. However American industry often made mistake by treating operators like robots. On the contrary TPM and TQM explore operators' knowledge and abilities by their involvement at all phases of implementation [6]. Willmott [16] cautioned about implementing Japanese model of TPM as it is in European company. He further states that the Japanese workplace culture and European are very different, and even in Europe no two companies are alike in their methods to beat the competition, which is to be taken care while implementing TPM. Despite some common thread the literature studied shows two different approaches to defining TPM which are considered as the Western approach and the Japanese approach. In defining the Japanese style TPM is suggested as with an emphasis on the use of teamwork or small group activities working on a system of productive maintenance, while the Western style definitions incline toward placing the emphasis on overall effectiveness of equipment through an active involvement of equipment operators [13]. Ben-Daya [10] observed that, the implementation of TPM in non-Japanese companies shifts the focus from ``the total involvement of every employee" to the effectiveness of equipment. Labib [17] mentions that TPM is simple and obvious, and though philosophy of TPM is sound but implementation lacks focus and system approach that is suitable with different work cultures. Both the human and process oriented strategies lead TPM implementation in the organisation. The effect of human oriented strategy is more than process oriented Strategy in advancement of TPM execution as the changes and adoption in the organisation are much more related to human issues [18]. Focus of TPM is people and involvement and participation of people are the basic parameters for implementation and sustaining of TPM.

2.2 Empowerment:

TPM a people-oriented concept makes attempt to free the "minds of gold" generally hidden and unexploited in the employees. TPM an empowerment process aims to promote a culture of ownership in operators. TPM creates an environment where people are given the authority, resources and time to make sound decisions within established boundaries, and this makes those people more productive. TPM treats operators with respect and generates self-esteem to the workplace. TPM explores opinion and ideas from people about their equipment. Incorporation of some of these ideas makes the atmosphere supportive and cooperative. If concepts are imposed cooperation are fewer [19]. Practicing TPM is operators and maintenance technicians working together, as a team, to improve product-quality, improve the effectiveness of the equipment, reduce downtime and reduce waste. This may be achieved by focusing on those aspects that prevent a plant from running at its optimum condition. It requires empowerment of the team with the authority and responsibility for the equipment's long-term maintenance. TPM cuts considerably the operating and maintenance costs by concentrating on the causes of failure through the making of a sense of ownership (by the plant's operators, maintainers and support staff) that boosts the development of a ''prevention at source'' approach [11]. Fore and Zuze [20] presented in concluding remarks of case study mentioned that empowerment aid communication from both the sides. Lack of trust between management and the workforce is hurdle in empowerment. Empowerment requires action from management as empowerment in the company will go through denial, resistance, exploration and commitment phase. Closer look on PM shows that companies are focusing on technical aspects such as checklists and documentation rather than the empowerment of shop-floor employees. The objective of empowering the employees to solve workplace problems by themselves as well as understanding and working on the root causes is yet to be realized [21]. This case study showed that a high degree of team autonomy was an important contributor to success. Authors claimed that this aspect was not previously emphasized in the literature [22]. Empowerment is related to increase in morale of employees and job satisfaction as well.

2.3 Cultural aspect:

Focused implementation plan, supported by top management in organizational cultural improvement, over a substantial period of time is needed to recognise the true results from the holistic TPM [23]. Development of work culture, skill development and promotion of cross-functional team made an enthusiastic atmosphere [24]. According to Arca and Prado [25] apart from other reasons poor commitment and involvement of concerned persons are significant factors for the difficulties in implementation of TPM. Success of a TPM program is closely associated to the way of managing people, as the focus of this methodology is the human being. It is necessary to create indicators for the evaluation of performance of the program. In this context the following indicators used to verify and control TPM are: Productivity (P), Costs (C), Delivery, Supply, levels and circulation (D), Quality can achieve zero defects (Q), Safety, almost total eliminating of violations (S), Morale, suggestions and participation of all employees in the small group meetings (M) [26],[27]. Out of these morale and safety has direct link with human accepts and other indicators will lead indirectly to human issues. Kwon and Lee [28] suggested new methodology for obtaining estimating the quantitative monetary managerial effects by application of TPM activities. They have identified education and morale and also safety, health and environment among the TPM measurement indices. Cooke [29] reported the finding of a study of the production and maintenance function of four processing/manufacturing companies and noted difficulties in implementing TPM because of political, financial, departmental and inter-occupational barriers. They also observed team working because of informal and sound personal relationship and empathy and not due to formal initiatives. TPM is introduced as a ‘‘top-down’’ approach, but for successful implementation you need ‘‘bottom-up’’ participation [2]. Lawrence proposed [30] mathematical modelling to help bring about the cultural change necessary to make TPM work. He observed that Workers are anxious about how the new changes will affect them and whether they will be really fruitful. Vital element in TPM is total involvement of all the employees including top management and operators [31]. TPM is to bring together management, supervisors and trade union members to take speedy corrective actions as and when required [2]. According to Ljungberg [32] the implementation of TPM is a difficult process of corporate change. Among all success stories described, there also exist cases of failures that are never reported. Feeling that there is no time for TPM, absence of openness and absence of willingness to learn are some of the obstacles standing in the way of implementation of TPM [15]. Almeanazel [33] mentioned that with TPM effect there will not be “his or my fault” approach but the efforts will be directed to solve the problems at earliest. A change in the traditional syndrome “I make-you fix”, was observed and implementation team members accepted the responsibility for equipment condition [34].

2.4 Communication:

The proper communication skill and the thoughtfulness towards criticism are required for the employees [35]. Better communication and team-work are needed to promote autonomous maintenance teams [24]. Strong focus on communication by awareness campaign, emphasis on training for all employees is needed for successful implementation of TPM [36]. Kheng and Yusof [37] believed that operators should be taken in confidence so that they can understand TPM would not increase their load but will provide a better work culture. Because of unfortunate poor horizontal communication and coordination between between equipment planning, operations, and maintenance departments prevents the use of technical data for improvement in design. Maintenance engineers are reluctant to share data relating to maintainability and reliability that could be important at the design and fabrication stages; and design engineers are not able standardize the technical data or use the data at design stage [4].

2.5 Attitude and skill development:

TPM necessitates changes in employees’ attitudes and their behaviour, which takes a long time to accomplish [38]. The knowledge base about an organization's machine taskforce may be expanded through education. Maintenance and education are always neglected. In economic hard times the first things that managers do is to cut maintenance and education and in good times there is no time for maintenance and education. But smart companies will use economic recessions to improve the productivity of humans and machines [3]. Workers should be trained properly as human assets are invaluable. It was observed that operators were trained and provided with first-hand experience and job knowledge by the supervisors or team leaders to get better understanding of the equipment at their work place. New workers were given induction training about basic such as safety procedures, daily operations requirements, and work place management. On the job training was also being carried out especially to get acquainted to the processes and machines involved [39]. Ferrari *et al.* [40] concluded that for success of TPM participation of workers was key element and stated the need of good training programs while discussing ceramics sector and packaging systems in Italy. Ahmed *et al.* [41] reported general problems specific to SMIs (small and medium industries) in Malaysia deficiency of human resources both in quantity and skill, inadequate in-house training facilities. A centralized TPM steering committee was constituted for training the workers in different functional areas and for catering to multi-skilling requirements

in the various organizational areas [42]. TPM enhances the problem-solving skills of individuals and facilitates learning across various functional areas and thus improve the organization's capabilities [43]. In addition to the Kaizen, one point lesson (OPL) is used to standardise the working procedures and acts as a training tool to train the operators. Generally they are written by the technicians and engineers. The draft is be discussed in the meeting and agreed upon by all parties. These OPL are not only used to train the operators, but also to improve their interpersonal skills as they are needed to train as trainers to the other operator [7]. OPL type training by model machine operators helped to meet high training needs in the company [24]. A special guidance from supervisors with the support from co-workers, together with proper training are required to change the mind-set of workers. The educational background of the members selected will really upset the speed of the implementation of TPM hence more training and practicing may be needed [7]. Ireland and Dale [44] in case study of implementation of TPM reported that the managers were trained in TPM to provide the strong TPM drive from top management down to the shop floor. TPM system should be internally strong to integrate different departments for improvement of the organization's performances; the most important part is equipment improvement. Harmonious and safe working atmosphere is required. There is need that all technician should be trained for why-why and PM analyses [45]. Blanchard [46] suggested that managers, engineers, and technicians should overcome educational barriers and should start using some of the tools like Life cycle cost analysis (LCCA), Reliability and maintainability predictions/estimation, Failure mode, effects, and criticality analysis (FMECA), Maintenance task analysis (MTA), Level of repair analysis (LORA) so as to realize significant gain in the implementation of the TPM concept. Misunderstanding regarding TPM and fear of job security was disappeared due to training [24]. Job security is serious threat felt by maintenance technicians. Obviously training to overcome this fear and understanding the TPM is needed to them [15]. Training initiatives is not restricted to understand TPM pillars and other details but more importantly to raise morale and soften resistance to change [47]. TPM helps to develop the organization's capabilities by improving the problem-solving skills of individuals and facilitating learning across different functional areas [20]. Sharma and Trikha [48] stated the need of training to enables a person to understand the reason for and purpose of his efforts. Due to moderate education level of operators (some of them had done only primary schooling) TPM implementation was bit slow as more time needed to digest TPM concepts [24]. To change employees' attitude and values takes time to realise hence TPM cannot be a quick solution [49]. Management has to be patient as employees require some time to adopt TPM [50]. Lycke [51] in Swedish medium sized company experienced problems to make the operators understand that team meetings are also part of work. It was tough for them to stop the machine and go to a meeting instead. It was also difficult getting the operators to talk. It required some time before operators started to cooperate. Training and skill development nurtured necessary maintenance skills in the operators for solving the problems without causing any further delays [34]. In pillar approach of TPM one pillar is devoted to education and training to take care of all relevant needs of attitude and skill development.

2.6 Ownership of Machine:

Empowerment process leads to concept of ownership of machines approach by operators. TPM incorporates the strategies of operator ownership and preventive maintenance activities to keep machines away from failure or malfunctioning during production. [12]. Corporation between production and maintenance has promotes the participation of operators in autonomous maintenance develops a sense of responsibility, pride, and ownership; enhancement of teamwork between productions and maintenance [10]. Cultivating a sense of ownership among operators promotes caring culture for the cleanliness and condition of their machines becomes a way of life [49]. TPM implementation creates sense of individual responsibility for equipment and importance for basic equipment conditions; development of ''Can-Do'' attitude and ownership concept [24]. The main objectives of TPM are to achieve zero breakdowns, zero defects and improved outputs by increasing operator participation and inculcating ownership concept [2]. Daily preventive maintenance check sheets can aid, responsibility orientation, quality consciousness, and self-discipline. The procedure was expected to encourage ownership of the machines, to observe abnormalities, for removal of accumulated dusts from the machines, to ensure the process conditions and parameters and hence to develop discipline among the operators [39].

2.7 Workplace Cleanliness:

As ownership concept exists operators are enthusiastic to care for equipment and workplace and care starts from cleanliness. It was observed that the operators were responsible for the housekeeping of their workplace [24]. Five housekeeping principles popularly known as 5s's, come from the first five letters of the five Japanese terms, namely Seiri, Seiton, Seiso, Seiketsu, and Shitsuke. In English may be written as respectively, sort, set in order, shine, standardise, sustain [27], [44]. 5s is also referred as CAN DO philosophy based on first five letters of cleanliness, arrangement, neatness, discipline, order [16]. The concept of 5s is necessary for TPM .In fact implementation of all the pillars of TPM is on this sound base of 5s. Workplace should be clean, neat and organised then it helps to identify the problems. First important step of improvement is

to make the problems visible or uncover the problems. Seiri means sorting the items in the categories such as critical, important, frequently used items, useless, or items that are not needed as of now. Worth of item is decided on utility and not cost so they can be kept accordingly. Seiton is setting in order with concept "each item has a place and only one place". Some considerations in this step are name plates and tags may be used for identification, item should be placed where they are required, items should be returned to the place after usage. Seiso is sweeping that includes cleaning the work place free of burrs, grease, oil, waste, scrap etc. there should be no loose hanging wires or oil leakage from machines. Key point of maintaining cleanliness is that it should be part of daily activity. Seiketsu means standardizing work practices, operating in consistent way. Employees will discuss and decide together standard procedure for keeping work place, machines, and work area neat and clean and will implement it. Sitsuke is self-discipline includes maintaining and reviewing standards. Once 4s is established now it is new way of operating. Sittsuke helps to maintain this focus [52].

2.8 Autonomous maintenance:

Autonomous maintenance consists of preventive, predictive and occasionally breakdown maintenance activities which are done on daily basis by operators themselves. The CLAIR means operators Clean, Lube, Adjust, Inspect, and Repair their equipment had been attempted before; but, it was supposed as too dictatorial from management. The justification for the change in division of labour is that operators know their equipment better than anybody. They can do regular inspection, which consists of looking, feeling, listening, Smelling, and testing. They know best how the equipment should operate and can quickly detect potential or actual problems [53]. Autonomous maintenance involves visual things like checking a sight glass or pressure gauge, and making sure gearbox oil is within the appropriate limits. Operators can be trained to respond to these irregularities. However a TPM approach will teach operators to identify the root cause of why a machine's pressure is low, or why hydraulic fluid is dripping. Operators have to be trained to do something more than to treat the indications of a problem [3]. As the technology of production equipment becomes more advanced, it is crucial that operators and maintenance technicians are provided with the tools and training as per new requirements of the equipment. It is also important that production operators should be made available new maintenance technologies, such as vibration analysis and infrared thermography that have become useful means for predictions and diagnosis of equipment problems. These trends make companies to maintain equipment in order to attain the new performance benchmarks, obtain maximum returns, and compete aggressively in global scenario [54]. In spite of all the hard work by maintenance personnel very little progress in maintenance and equipment improvement they can make as long as "I operate-you fix." Is the operator's attitude towards maintenance exists. On the other hand, operators can participate in the maintenance function by becoming responsible for the prevention of deterioration to help to achieve competitive manufacturing [8].

TPM ensures that operators, maintenance people and engineers collectively collaborate and understand each other's language. Autonomous maintenance, a pillar of TPM, guides operators in the day-to-day activities of keeping equipment in order. It may be understood as first line of defence. There are always more machine operators in a shop than maintenance people. It's the operators who hear or smell something out of the ordinary, and we have to tap this into that knowledge base [3]. TPM drives for zero breakdowns through a greater emphasis on condition monitoring, involving operators. In TPM operators act as the ears, eyes, nose, mouth and common sense of their maintenance colleagues [19]. According to Japan institute of plant maintenance (JIPM) both operators and maintenance technicians are responsible for up-keeping of equipment. No matter whatever may be level of sophisticated automation in the plant ultimately people are responsible for operation and maintenance. Machine performance can be ultimately correlated with human act. Operator's role is crucial in elimination of waste and hidden losses [55]. In TPM a cooperative relationship between maintenance and production is inculcated through small group activities. Production workers are involved in performing maintenance work through equipment monitoring and upkeep. This nurtures the skill of operators and makes them more effective in maintaining equipment in decent condition [56]. Development of sense of importance for maintaining basic equipment conditions with operator involvement by performing AM (oiling, lubrication, and inspection) and 5S housekeeping activities was observed [34]. Corporation between production and maintenance has several benefits such as operators and technicians become multi-skilled, leading to job enhancement and improved flexibility of workforces; delay times are reduced and productivity is improved [10].

Operators should do the following activities as part of autonomous maintenance (AM) [24].

- maintain elementary equipment conditions by cleaning, lubrication, bolting etc.,
- maintain functional conditions by proper operation and visual check-up,
- discover deterioration and early identification of indications of abnormalities during operation through visual check-up,
- improve skills such as equipment operation, set-up, and adjustment, visual check-up,

Consequently maintenance technicians should do the following:

- provide technical support and guidance for the AM activities;

- restore deterioration comprehensively and precisely, using inspections, condition monitoring and overhaul;
- clarify operating standards by identifying design weaknesses and making suitable improvements;
- improve maintenance talents and skills for check-ups, condition monitoring, inspections, and overhaul

Arca and Prado [25] presented a case study on implementation of TPM in Spanish group of timber companies. The major objective of this study is to investigate effectiveness of an electronics manufacturing company during its TPM implementation. TPM is a synergistic association among all organisational functions, particularly between production and maintenance. This aims for continuous improvement of product quality, as well as operational efficiency and capability assurance. An efficient TPM depends on both production and maintenance activities. TPM implementation benefits improvement in problem solving skill [24]. TPM unites the preventive and predictive maintenance aspects with an emphasis on employee involvement [31]. TPM helped improving the synergy between the maintenance and rest of the manufacturing functions [42].

2.9 Teamwork and coordination:

The ownership of machines concept need to be enhanced to ownership of company as final goal is collective performance in any organisation. Teamwork and coordination are basic elements in enhancing ownership of machine concept to ownership of plant concept. Activities like quality circles or TPM circles, kaizen, focused improvement groups, self-directed teams encourage teamwork and coordination. The small group activities (SGA) being driving force in TPM implementation operators and executives at different levels were encouraged to form kaizen teams [42]. Kaizen is an important factor of TPM activities aids contribution of operators. Kaizen is aimed at small improvements on a constant basis with participation of all people in the organization to achieve the best returns for the company. In fact Nippon Denso Co. in Japan was the first company who implemented successful TPM in year 1971 had promoted quality circles involving employee's participation and teamwork [52]. Cigolini and Turco [57] and Dogra *et al.* [50] observed contribution of all the employees to improve effectiveness through the kaizens. Ahmed *et al.* [45] observed in his study the formation of self-directed work teams which were given problem solving responsibility, in addition to their regular job responsibilities. Lazim *et al.* [39] observed numbers of improvement activities were executed to create an on-going autonomous management atmosphere. This was done through the activities such as quality circle (QC), 5'S. The TPM plan includes cross-functional teams which work out on training to lowest levels, machine uptime, preventive maintenance, and other similar assignments [30]. After the choice of the model machines team members were selected to form two core teams the Autonomous Maintenance team (AM) and the Focus Improvement team (FI). The AM team consists of operators who do routine maintenance tasks and contribute in improvement activities that stop accelerated deterioration, control contamination and maintain optimum conditions. The FI team is a cross-functional project team comprised of people including engineers, maintenance personnel, and operators to participate in actions focused to minimise targeted losses [7]. TPM small group activities (SGA) aids better communication at all levels across all the departments and hence develops team working spirit healthy organizational requirements [50]. There are other measurable checks for the TPM accomplishments, such as the number of One-Point Lessons (OPLs), the number of suggestions and the number of 'Kaizen'. These kinds of activities are to promote the contributions of the team members. Both operators and technicians express their ideas through the brainstorming session in order to solve all the recorded problems. Hence, there can be many suggestions for improving the equipment. From all the suggestions few of them contribute significantly to the improvement of the performance of the equipment can be classified as Kaizen [7]. Setting up of cross-functional teams helped operators to identify and resolve many basic equipment problems with in short period of time [34]. Encouragement to group activities and 5s were recommended by Bamber *et al.* [13] in case study on UK SMEs (small to medium size enterprise). Teamwork is needed to eliminate potential breakdowns and stoppages through total commitment [47]. According to Pinjala *et al.* [58] TPM is people oriented maintenance concept and teamwork is important aspect in TPM. Establishment of cross-functional teams helps improved coordination on the shop [24].

2.10 Motivation and recognition:

For stimulating and enthusiasm and positive focus and maintaining it over the period motivation and recognition are necessary. Banners, signs, flags and notice boards that bear TPM slogans were displayed to create a positive environment and promote enthusiasm [31]. The teams cleaned and improved their work place accordingly. Quality personnel will go around assessing the cleanliness of each line and team with the highest mark will be announced as the winner. Rewards in terms of monetary and certification will be given [39]. Graisa and Al-Habaibeh [35] observed that motivation awards to individuals and to shifts were given based on the criteria. An effective recognition and reward programme for employees who were actively involved in the process was observed [6]. Efforts were done to boost operators' morale and the commitment towards company's goals [31]. Promotion awareness and motivation of employees was done by putting up TPM posters at strategic

locations, writing songs and designing slogans and displaying them, publishing TPM newsletters to propagate TPM news, policies, concepts, cases. Recognition to departments and awards to contributing employees are given in meetings or company events [49]. To create positive approach and to promote enthusiastic approach for TPM banners, signs, flags and notice boards that bear TPM slogans were created. Banners, posters, streamers and flyers helped to create awareness [47].

2.11 Safe and Healthy:

In pillar approach of TPM one pillar itself is Safety, health, and environment (SHE) shows clearly importance of safety aspect in TPM implementation [26], [43]. Number of accidents on model machines has been reduced and approaching zero accidents status [50].Tsarouhas [36] presented case study of implementation of TPM in food industry. According to them a healthy and safe work environment due to the participation of operators in adjustment and maintenance of the equipment can be analysed. TPM improves business performance in many facets including safety and cleanliness [59]. TPM implementation aims for zero accidents, zero health damage and zero fires. Actually this focus starts at design stage only. Operators are given safety training. In fact without appropriate safety training they are not allowed to operate the machines. Workers are required to use appropriate safety measures such as helmets, shoes, gloves, glasses. In health aspect side effects on health are considered. Appropriate measures such as smoke extraction, ventilation etc. is considered as per requirement at workplace. Through safety slogans, quizzes, dramas, posters awareness for safety is created [52]. One purpose of 5s philosophy for cleanliness is to improve safety at workplace [35]. In training programs operators were firstly inspired to learn for their own safety. SHE pillar focus on issues such as noise level, radiation level, air pollution, unsafe practices, waste treatment, fire-prevention, fire-fighting, first-aid, emergency drill, smoking policy [45]. Ireland and Dale [44] in there study in a company observed safety objective linked with TPM were to create safe work environment, to fulfil legal aspects related to safety and to reduce number of accident hence related cost. Bohoris and Vamvalis [60] in their case study at Land-Rover observed that in TPM training team one member was a health and safety representative. TPM had considerably contributed toward improving the safety aspect as well in manufacturing system [42]. In briefing before starting autonomous maintenance safety cautions about the machine were mentioned to avoid any accidents during initial cleaning [24].

2.12 Demoralizing parameters:

However there are always some aspects which are to be considered and efforts are needed to overcome them or eliminate them. In some cases activity such as autonomous maintenance or improvement gets diminished due to overload of production operator gets professionally frustrated. Similar thing happens when ideas or suggestions are not heard or considered. If suggestion is not considered operator should be taken in confidence and constraint or reason for not accounting for suggestion should be explained to him. This will help to avoid weakening this important channel of improvement [26]. High turnover of manpower, lack of commitment, lack of follow-up, work stress, focus only on production and negligence towards maintenance, no allocation of time for autonomous maintenance, hurried implementation by omitting the steps, lack of training, not conducting reviews are some of the typical factors influencing failure of TPM [61]. Tsang and Chan [49] in a case study of TPM implementation in China observed that while implementing TPM additional responsibilities are given to workers without any extra incentive may be viewed as exploitation. Anxiety, misunderstanding, lack of confidence to acquire new skills are some problems encountered in implementation. With proper communication atmosphere of trust can be developed. An important part of TPM is its focus on eliminating major losses to production; reducing downtime and changeover time, and reduction in rework and scrap generation. If a machine goes down, the first thing that happens is that the operator is assigned another job. However the operator is in the best position to tell the maintenance worker what went wrong. Traditionally preventive maintenance relies on personnel trained for definite jobs. TPM is more inclusive makes use of the machine operator's relationship with the machinery for routine and simple maintenance activities and also includes input from managers, engineers and QC experts as well. The best process engineers listen to operators and maintenance people [3]. A model machine and related TPM team members were selected for pilot implementation. Differences were observed in TPM and non-TPM members. General feeling of non-TPM members was workload was increased due to TPM and also some sort of resistance to TPM members due their efforts for model machine. Non-TPM members believed that management wanted maintenance to run by fewer people hence was insisting production people to maintenance work [24]. TPM is an excellent work philosophy delivering results in the productive process .But the question is: “Does my company think it has TPM, or does it really have it?” [26].

2.13 Role of management:

The status consciousness and hierarchy bound mind-set of middle level officials particularly in public sectors is hurdle in the improvement process. Approach of frontline managers is limited to implement whatever comes from the top. Strong leadership is needed to overcome these barriers [62]. Senior management must devote time and allocate resources and show its commitment to TPM to create and sustain the cultural change. Management leadership is important to give a clear-cut signal that TPM is an integral part of the company. Otherwise there is a possibility that employees may think TPM as another 'flavour of the month" that will not last long [49]. Patra *et al.* [63] concluded that understanding, commitment and involvement of top management are needed for effective implementation of officeTPM. Senior management must show their commitments to TPM by devoting and allocating adequate resources (such as training) to create and sustain cultural changes [38]. Top management motivates the contribution of operators to achieve zero breakdowns, zero stoppages and a safer working environment [31].

III. CONCLUSIONS

Though main objective of TPM is availability, overall equipment effectiveness (OEE), and overall efficiency and hence cost effectiveness the focus of TPM is people. TPM is based on enhancing, exploring, and using of capabilities of people but in doing so TPM recognizes and attempts to realize needs of people such as self-esteem, morale, safety, job satisfaction. Hence TPM has strong impact on the people involved. The response of employees to the TPM is also important. Study and investigations of all these human aspects of TPM will help to develop more sustainable and with less lead time to implementation; model of TPM implementation. More exhaustive research efforts are needed in this regard.

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