TOTAL PRODUCTIVE MAINTENANCE IMPLEMENTATION IN THE NEWSPAPER PRINTING INDUSTRY: AN ACTION RESEARCH APPROACH

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ABSTRACT

The objective of Total Productive Maintenance (TPM) is to maximise plant and equipment effectiveness, to create a sense of ownership for operators, and promote continuous improvement through small group activities involving production, engineering and maintenance personnel. This paper describes and analyses a case study of TPM implementation at a newspaper printing house in Singapore. However, rather than adopting more conventional implementation methods such as employing consultants or through a project using external training, a unique approach was adopted based on Action Research using a spiral of cycles of planning, acting observing and reflecting. An Action Research team of company personnel was specially formed to undertake the necessary fieldwork. The team subsequently assisted with administering the resulting action plan. The main sources of maintenance and operational data were from interviews with shop floor workers, participative observation and reviews conducted with members of the team. Content analysis using appropriate statistical techniques was used to test the significance of changes in performance between the start and completion of the TPM programme. The paper identifies the characteristics associated with the Action Research method when used to implement TPM and discusses the applicability of the approach in related industries and processes.

INTRODUCTION

According to Kennedy (1995), Total Productive Maintenance (TPM) in manufacturing plants is as revolutionary in its approach to maintenance as the advent of the quartz-battery watch was to the watchmaking industry. The main point about TPM is that, in manufacturing in particular, it grows out of the Japanese-pioneered lean production approach. Its significance goes far beyond a limited view of maintenance because it is a part of a total approach to more productive manufacturing. The TPM concept addresses itself to the maximisation of overall plant and equipment effectiveness through the elimination or minimisation of the six machine losses, creating a sense of ownership for plant and equipment operators through a process consisting of training, involvement and promoting continuous improvement through small group activities involving production, engineering and materials personnel.

Many researchers have discussed the means of developing and implementing TPM within manufacturing (Nakajima, 1988, Maggard, 1992, and Karlsson & Ljungberg, 1993). It has been acknowledged that TPM cannot be successfully implemented by only a handful of people. It requires the cooperation and involvement of personnel at all levels of an organisation. Teamwork is, without doubt, of paramount importance. There have been a

number of approaches to implement TPM, but there has been no evidence previously of the use of Action Research.

THE NEWSPAPER PRINTING INDUSTRY

The newspaper printing industry is unique in that its products must be made "just-in-time" and have a very short shelf life. Moreover, editors will try to delay printing newspapers for as long as is deemed practical to enable the latest news to be included, while advertisement departments will also try to delay the presses from rolling until the last possible moment to enable inclusion of the greatest number of advertisements, since these are a top generator of revenue. Conversely, the circulation departments would like to get the newspapers out and distributed as early as possible. Production departments are therefore caught between the editorial and advertisement departments upstream and the circulation departments downstream.

Production personnel in newspaper plants have to work within very tight time frames, which in turn means they cannot afford to have any disruption of the machines during a production run, since each period of downtime will result in the completion time being delayed. The presses must, at all times, be in first class condition and in readiness to run when required without the occurrence of any major operational abnormalities. The operators must also be alert and attentive to respond to any abnormality during a print run.

Traditionally the maintenance department would arrange to undertake routine maintenance activities during the daytime when there are generally no production activities. A few key maintenance personnel would be left to attend to any necessary repair work or breakdowns during the night, which is the peak production period when the presses are running. However, nowadays there is ever-greater pressure for increasing press utilisation and reducing the maintenance window. A shortage of skilled maintenance manpower results in increases in work outside normal hours and a higher wage bill. The demarcation between operations and maintenance does not help, but only contributes to communication and coordination problems. TPM, therefore, provides an attractive way of creating a paradigm shift whereby a completely new approach can be taken to maintenance practice. This involves the operations personnel undertaking routine work within a closer working arrangement under the formal maintenance function. Likewise the maintenance personnel also become involved in routine operational tasks, thereby raising their productivity.

TPM IMPLEMENTATION

This paper describes and analyses a case study of TPM implementation at a newspaper printing house in Singapore where the origins of newspaper printing in the organisation date back to 1845. Following the amalgamation of several Singapore newspapers, the company is currently a large printing house undertaking work on behalf of a number of different publishers. During the early nineteen nineties the company streamlined both its organisational and operational structures within the group. Outsourcing of maintenance services was used as a stopgap measure but the practice was progressively reduced, especially when lead-time during critical hours was too long. Furthermore, faced with problems between the production and maintenance departments, the company saw the necessity to seek a practical solution to alleviate the problems it faced. TPM was accordingly identified as the means to achieve the solution. Management also took the decision to explore Action Research as a means of implementing TPM.

The implementation of TPM could have been carried out by employing specialised consultants. This would have had the advantage of imparting expertise from outside the organisation and allowing the internal personnel to learn from the consultant. Since hired consultants generally have wider experience gathered elsewhere on the development and implementation action plan they are usually able to complete the assigned task in a shorter time frame. However, they might have to grapple with the pitfalls arising from the environment and workplace culture.

The implementation of TPM could also be carried out through a project approach by selecting and sending out internal personnel for training, either locally or overseas. When this approach is used it is assumed that the company selects the correct people, usually with the recommendation from the user department. However, one shortcoming of this method is the possible inadvertent exclusion of key personnel from other relevant departments in the training programme. This can result in the withholding of support from those not recommended for training. The entire responsibility for implementing the programme and monitoring the outcome would therefore fall on the shoulder of only a small group of people.

The use of Action Research offers another approach to the development and implementation of a TPM programme. This method necessitates the formation of an Action Research Team into which participants are invited from a cross section of the departments of the plant. The most significant advantage of this approach is the "production of knowledge" from the shop floor. A minor disadvantage is the longer time taken due to the cyclic nature of this approach.

THE ACTION RESEARCH APPROACH

In the Action Research literature there have been many attempts made to distinguish between Action Research and other forms of applied social research. Lewin (1946), who pioneered research work on the subject, stressed the client problem-solving change characteristics of Action Research, while in a natural setting with conditions sufficiently amenable to scientific observation and control, it could lead to an understanding of "the law which governs the nature of the phenomena under study". Lewin did not discount pure research. In fact he argued that Action Research would lead to "pure research" However, he took cognisance of the fact that the freedom to continue with pure research would have to be earned by the change agency.

As a follow-up to Lewin's work, other contributors such as Hult & Lennung (1980) pursued the definition and scope of application of Action Research. This led to their observation that Action Research had not been clearly defined and a new definition was offered. According to Hult & Lennung "Action Research simultaneously assists in practical problem solving and expands scientific knowledge as well as enhances the competencies of respective action, being performed collaboratively in an immediate situation using data feedback in a cyclic process aiming at an increased understanding of a given social situation, primarily applicable for the understanding of change processes in social system and undertaken within a mutually acceptable ethical framework"

McKernan (1991) stated that "Action Research is both group and/ or self reflection solving by practitioners so that they can solve pressing day to day practical problems and improve the rationality and justice of their performance, while also improving their understanding of the

process involved." McKernan also stressed that both a moral and ethical dimension should be included in the process of critical reflection at the highest level.

Action Research has been demonstrated to be a useful mechanism to devise operational strategies and effect change. Whyte et al (1989) illustrate the use of Action Research in two different cases. The first was the Xerox Corporation in New York in which the problem of cost reduction and job preservation was the focus. The second case, the Mondragon Cooperative Complex in Spain, made use of Action Research to explain a range of problems, rethink them, and devise new feasible organisational strategies. Much light has also been thrown on the use of Action Research in areas such as education, natural and social services and health care. The extension of the use of Action Research process in the development and implementation of TPM within the newspaper printing industry was in line with the above cases.

To implement TPM the methodological approach using Action Research was particularly suitable, both from an organisational and personnel point of view. It could also result in the development of additional work-specific competences. Therefore Action Research not only investigated and improved management practice but also developed the managerial competences of those involved in the researcher. The implementation of the methodology at the site where the study was carried out consisted of a spiral of cycles of planning acting, observing and reflecting. A great deal of time was spent in the fieldwork as this formed an integral part of the research. It was through this fieldwork that the bulk of the primary data were collected. An Action Research team of organisation personnel was specially formed to undertake the necessary fieldwork. The team members who were specialists in their own area participated voluntarily in the study. Their satisfaction was the experience they gained from the project and the opportunity to work together as a team.

The main sources of operational and maintenance data were from open-ended interviews with shop floor workers, participative observation in the plant over a period of time, and reviews of the findings that were conducted with members of the Action Research Team. The field data were analysed by using content analysis. The purpose of content analysis was to establish the individual opinions of the evaluators, the members and the researchers from an analysis of the findings obtained. The patterns established from the content analysis were based on reports from various parties since each party provided separate and independent opinions.

Statistical techniques were used to test the data obtained from the interviews with the operations and maintenance personnel, the findings from participative observation and meetings with the Action Research Team. A check was made for any significant change in performance between the start and completion of the TPM programme. The triangulation method was then used to compare the deviation, if any, of the results obtained from the three sources of data.

FIELDWORK

The fieldwork was carried out at a newspaper printing plant located on the western side of Singapore. As mentioned earlier, it consisted of three cycles of the Action Research process of planning, acting, observing and reflecting.

In the First Cycle the background necessary for the development and implementation of TPM was studied, the state-of-the-art of TPM reviewed and a profile assessment of TPM carried out to identify the area where the TPM programme could be most successfully carried out. An action plan was developed and implemented incorporating the training programmes that were designed for the operations and maintenance personnel. A coordinator was appointed to liase with the operations and maintenance personnel to ensure that planned schedules were adhered to. The impact of the programme on work method, working relationship, cooperation, coordination and communication, house keeping and production downtime was evaluated from the data collected in this cycle.

The Second Cycle addressed the need for a formal equipment history recording system, which could function as a data bank for operations and maintenance information. This information could be retrieved from the system for use when needed. An index called the Operating Effectiveness of Equipment (OEE) was developed to measure the performance of the equipment over a period of time after TPM was introduced.

The Third Cycle addressed the improvement that could be made over the performance of the Second Cycle and the setting up of a realistic and practical benchmark for the OEE. Team members agreed that the benchmark to be set should be neither too high nor too low. An unrealistically high benchmark would cause enthusiasm to wane with passage of time while a comparatively low benchmark would not be challenging at all. The causes of variations in the OEE were analysed and an action plan incorporating reinforcement was worked out and implemented.

DATA ANALYSIS

Content analysis was the main tool employed to evaluate the data obtained from interviews with the operators and maintenance personnel, participative observation and a review with the Action Research Team members. Opinionative statements were placed in categories according to whether they referred to the team members before or after the TPM programme, which statements were negative and which statements referred to the application and understanding of the technique within the programme.

Statistical analysis of collected data was performed to ascertain if there was a difference in the population of positive and negative comments before and after the implementation of the TPM programme. A null hypothesis of "no change" and an alternative hypothesis of "a perceived change" were also tested. A 2 x 2 contingency table was used in the analysis.

In Cycle Two the OEE (a product of availability, performance rate and quality rate) was calculated for a period of time. The factors causing a reduction in availability in relation to the machines were investigated and identified. Unlike the component manufacturing industry where the OEE is normally calculated for each individual machine or item of equipment, the OEE for machines in the printing industry is calculated for an entire printing line, which can consist of a combination of mono units, colour units and folders. Therefore the OEE is for a process and not for individual machines or equipment. (Kennedy, 1995).

In Cycle Three the monthly variations of the OEE indices were checked. Analysis of the operators' performances showed that there were cases where the operators were not "risk taking" and would not venture to drive the machines faster. This had an adverse effect on the completion time of the production run as well as the performance rate. Availability, which

was influenced by make-ready and downtime, was evaluated. Quality, which was also an important component in the OEE formula, was checked for any abnormality in the OEE calculation process. In order to assess the impact of reinforcement on the OEE index the post reinforcement implementation analysis was checked to compare the performance before and after the implementation of reinforcement.

CONCLUSION

It was observed from the Action Research approach used that feedback existed between the Action Research Team members and the operations and maintenance personnel. Joint reflection between the researcher and members of the Action Research team - a very important parameter in the Action Research approach - helped to overcome the concern before the implementation of the TPM programme.

Apart from the experimental characteristic, eleven of the twelve characteristics of Action Research were identified in the TPM implementation project (problem solving, action oriented, cyclic process, collaborative, ethical, scientific, re-educative, emancipatory, naturalistic, normative and group dynamics).

The use of an Action Research approach for the development and implementation of TPM at the particular site was successfully tested in the study. In the Action Research process there was reflection beyond evaluation. The researcher and members of the Action Research Team assessed individually the impact of the implementation of the TPM programme. This made the findings more meaningful and accurate.

The immediate outcome of the study shows that it is possible to use Action Research as a tool to develop and implement TPM in the press department of a newspaper printing plant. The extension of TPM in the printing area to the pre-press and post-press areas is a logical development. Newspaper printing plants in countries within the region such as Malaysia, Thailand, Hong Kong and Taiwan are similar in their organisation and management to the Singapore plant studied. Therefore the approach could have wider applicability within similar production contexts. Additionally the drive for improved product quality is bringing about a paradigm shift in the maintenance management practices in these countries and therefore calls for the adoption of TPM as part of their maintenance policy.

Outside the newspaper printing industry there are a number of other industries that have been identified as having similar production characteristics. For example, commercial printing and typesetting, which are close to the newspaper printing industry in Singapore, could also benefit from the adoption of TPM in their operations. This is because management has decided on a maintenance policy that supports quality assurance in the light of increasing competition and the need to minimise rejects. The textile and similar industries in Singapore, which also have characteristics comparable to those in the newspaper printing industry, seem to be potential candidates to benefit from the implementation of TPM in their operations. Here, there could be increases in productivity if the operators treated the companies' machines as their own and take care of autonomous maintenance, during which process they would begin to better understand the machines and improve their availability.

The packaging industry has many characteristics similar to those of newspaper printing. To increase productivity, ensure a longer economic life span of the machines and deliver orders on time, management must have in place a maintenance system that supports production and

product quality. TPM also offers a solution in this case. Furthermore, the applicability of TPM in the paper mill industry, which currently is only based outside Singapore, follows the same rationale as that for the newspaper printing industry. As with the newspaper printing industry investment in plant and machinery is high and customers are becoming more quality conscious. To maintain the competitive edge production must be supported by an efficient maintenance system. TPM works towards this goal and its implementation in this industry is justified.

The findings detailed above should provide rich information to researchers who are interested in the adoption of the Action Research method to develop and implement TPM in other industries. There are still unexplored areas such as the long-term impact of reinforcement and frequency of application of reinforcement to achieve optimum performance in both equipment and people in manufacturing plants.

As a concluding comment, the use of Action Research as a method to develop and implement a TPM programme can be a longer and more arduous approach than using more conventional methods, but the overall benefits have been proved to far outweigh the extra effort involved. The approach used was unique and required dealing with people, which in turn demanded the application of management skill, operational experience and in-depth knowledge of the type only available in a well-selected Action Research team.

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