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Total Productive Maintenance, Affective Commitment and Employee Retention in Apparel Production

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Abstract: The success of the implementation of advanced manufacturing systems, such as total productive maintenance (TPM), depends on employee commitment and retention. This study investigated total productive maintenance (TPM) practices implemented by apparel production firms, and the effect of these practices on affective commitment (AC), and employee retention (ER) of operators on the production floor. The study adopted the survey research methodology. In total, 411 operators from apparel production firms responded to the study. The responses were analyzed using statistical methods. Four hundred and eleven responses were received for the survey and data were analyzed using statistical methods. The findings suggest that TPM practices significantly positively affect AC. Affective commitment mediates between TPM and ER. The success and sustainability of TPM implementations depend on the firm's ability to retain trained operators and keep their AC high. The study has several implications for theory and practice.

Keywords: total productive maintenance; affective commitment; employee retention; apparel production

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1. Introduction

Total productive maintenance (TPM)is a lean manufacturing philosophy with the aim of achieving high quality and productivity by eliminating machine breakdowns, small stops, slow running and accidents to minimize defects in products manufactured [1–4]. The maximization of machine and equipment performance is at the heart of TPM philosophy through the optimization of machine and equipment maintenance [3,4]. Organizations worldwide implement TPM to gain the benefits it offers [5]. For example, Xiang [5] showed the importance of TPM for small and medium enterprises. Several studies have shown the importance of TPM with the advent of Industry 4.0 [6,7].

The successful operation of TPM requires meticulous planning, careful implementation, and follow-up to sustain TPM in organizations [5,8]. However, planning and implementation to sustaining the practices demand high involvement of employees, especially by taking equipment ownership [7,9]. Total productive maintenance requires employees to accept ownership of their machinery and makes all operators responsible for the maintenance of machinery and equipment while operating the same [7,9,10]. In other words, operators in firms that have implemented TPM carry out cleaning, inspecting, and lubricating work as well as executing corrective work involving machinery and equipment in addition to typical production job tasks. Furthermore, operators are expected to maintain a proactive attitude toward identifying all machine-related issues. These changes in TPM implementation suggest a shift from traditional maintenance systems to a new system that needs higher levels of involvement of employees. Hence, TPM requires changes in attitudes and values of production and maintenance personnel and any changes to these take time. Furthermore, employees should attain new capabilities, attitudes, and behavior appropriate for the TPM implementation [11]. Training [9], employee empowerment [12], work

teams [12] and preventive maintenance [3,4] can be identified as important contributors to the success and sustainability of TPM implementations.

Although the literature provides evidence for significant positive relationship between TPM practices and organizational performance in terms of cost, quality of products manufactured, flexibility in the volume produced and on-time delivery of orders in apparel manufacturing [13–19]. However, TPM implementations are also met by employee resistance due to cultural incompatibility, overly optimistic expectations, failures in establishing well-defined routines, and due to issues in organizational communications [9,12,20–22]. There are important questions about employee work-related attitudes toward TPM, especially in highly labor-intensive industries such as apparel production. What are the employee-related implications when machine maintenance responsibilities were delegated from maintenance employees to the operators? These areas are rarely addressed in previous research. Furthermore, in addition finding that TPM implementation brings substantial new job responsibilities, employees may experience higher levels of pressure and psychological tensions at work suggesting burdens rather than challenges [23,24]. Changes to workplace policies on re-skilling, job re-structuring and job enlargements need to ensure that worker commitment to both current job role and enlarged job roles can be strengthened. When employees from all levels or departments in the manufacturing fail to recognize the benefiting outcomes of TPM implementations for both the organization and employees, failures in TPM implementations are unavoidable. However, the literature suggests that only a few studies investigated relationships between TPM practices and employee outcomes in the apparel production [25–27]. Overall, although numerous empirical studies pertaining to the TPM have been published, relatively little is known about the effects of TPM practices on employees in the apparel production context. Furthermore, many elements of the present consensus developed from studies in Western countries may not be directly applicable to underdeveloped countries. It is likely that differences in macro-environmental factors may render the commonly accepted Western notions less appropriate for the Asian developing nations. Furthermore, research on TPM practices in more labor-intensive industries such as apparel production is limited. This is because the TPM principles are adapted from low labor-intensive industries to more labor-intensive industries such as apparel production. Hence, the best practices are yet to be established in the labor-intensive TPM environment in apparel production.

In this context, we investigated TPM practices implemented by apparel production firms, and the effect of these practices on affective commitment (AC), and employee retention (ER) of operators on the production floor. Although previous research concentrated more on the mechanics of TPM implementations [28,29], few studies have been conducted on employee-related aspects. This suggests the importance of research on employee-related aspects in TPM-implemented organizations. Concerning global apparel production, high concentrations of production houses are evident in the South Asian region, which includes India, Sri Lanka, and Bangladesh. However, studies in this region are very limited on apparel production. Therefore, an understanding of relationships between TPM practices, AC, and ER in a highly labor-intensive and low-tech manufacturing sector such as apparel is important and adds value to the literature and practice.

2. Literature Review

2.1. Total Productive Maintenance

Total productive maintenance is defined as an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous maintenance by operators through day-to-day activities involving total workforce [1–4]. It describes a synergistic relationship among functions, particularly between production and maintenance, for continuous improvements in product quality, operational efficiency, capacity assurance and safety [29–31]. Willmott [29] states TPM to be maintaining and improving the integration of production systems through machines, equipment, processes and people, which add value. The TPM implementations are supported by the 5S foun-

dation that results in clean and good working condition machines and equipment that are less likely to have loose moving parts, minor stops and delays, lubricant leakage, and reduced engine speed. Furthermore, production floor incidents due to disorderliness, such as tools in the wrong places, incorrect machine and equipment setups and messy stations are reduced [7,9,30]. As untidy and dirty work environments present risk of injuries in industrial settings, the TPM implementation results in a safer workplace where employees are happier to work [32,33].

In TPM, operators' commitment and ownership are paramount; they should be empowered with the responsibility to take care of their machinery and equipment. Hence, the main aim of TPM is to maximize machine and equipment effectiveness with the involvement of production workers. Total productive maintenance optimizes preventive maintenance, corrective maintenance, and predictive maintenance while promoting autonomous small groups to conduct planned maintenance on the production floor [34,35]. Therefore, machine and equipment effectiveness are highly related to autonomous maintenance and teamwork.

Concerning apparel production, researchers [24] found that employee empowerment increases AC. Employees who recognize their employer to be supportive are more likely to remain with the organization [36]. Higher levels of job involvement were reported to significantly reduce employees' turnover intention [37]. Previous research also reports that the gender of workers has no influence on their work attitudes in lean production [38]. Masud et al. [25] reported that equipment losses were reduced, and overall equipment efficiency was maximized in apparel production firms that implemented TPM practices. When considering previous research on TPM and firm-level outcomes, Senthilkumar and Sampath [26] showed that the implementation of TPM practices significantly reduces the down time of sewing machines. Furthermore, Senthilkumar and Thavaraj [39] showed the importance of TPM for improving operational performance and reducing lead-time in apparel production.

2.2. Affective Commitment

Organizational commitment has three definable dimensions—affective commitment (AC), continuance commitment (CC), and normative commitment (NC). Affective commitment is the emotional attachment of an employee to organizational values—how much an employee likes the organization. Continuance commitment is a measure of the willingness of an employee to continue working for the same organization. Normative commitment deals with the feelings of obligation, or sense of responsibility an employee feels towards the organization [40]. Researchers such as Wickramasinghe and Wickramasinghe [37] showed that the AC is the most important component in the context of the implementation of advanced manufacturing technologies, such as lean manufacturing and TPM, in labor-intensive industries such as apparel production in Sri Lanka. Therefore, this research was confined to investigating the AC of employees.

The term AC is used to describe employees' sense of belonging and emotional attachment to the organization, identification with problems of the organization, and feeling that the organization has a personal meaning to him or herself [40,41]. Employees' affective response and attachment to the organization are important organization considerations [42,43]. Dixit and Bhati [44] state that employees' commitment decides the extent to which they are willing to identify with the organization and committed to its goals, and willing to go for the organization. Studies [45] showed that employees' commitment predicts their work performance, absenteeism, turnover intention and several other attitudes and behaviors.

Previous research also provides evidence that managerial commitment [46] and employee empowerment [47] increase employees' AC. The success of TPM implementation depends on bottom-up participation [48], managerial commitment [49] and employee participation and commitment [50,51]. Previous research also showed evidence for positive

effect of employee empowerment practices in increasing AC in the context of apparel production [36]. Therefore, it is hypothesized for the study:

Hypothesis 1 (H1). *Total productive maintenance practices significantly positively predict affective commitment.*

2.3. Employee Retention

Employee retention is referred to the intention of an employee to remain for a long period in the current place of employment [52,53]. Researchers reported a strong positive relationship between employee commitment and ER [40,54,55]. The employees who have effective participation in decision-making within their job roles, are more likely to remain with the organization [56]. The literature identifies the intention to remain with the organization is the most important, the strongest and the immediate predictor of employee turnover [57,58]. The physical form of lower intention to remain is higher turnover. However, not all employees are likely to turnover even though they have lower level of intention to remain. Previous research also showed that employees who identify their employer as supportive are more likely to remain with the organization [59,60].

Employees with higher levels of job involvement exhibit characteristic positive moods at work and maintain regular attendance and punctuality at work and can be identified as satisfied with their jobs [61]. Furthermore, such employees find compatibility in personal and organizational goals and expect to engage with the organization for the foreseeable future [62]. Such evidence suggests higher levels of job involvement increase employees' intention to retain. Some research showed a significant negative relationship between job involvement and turnover intention [24]. In addition, researchers reported a strong positive relationship between employee commitment and ER [40,52,53]. The employees who have effective participation in decision making within their job roles can have higher levels of intention to remain with the organization [36,38,57]. Therefore, it is hypothesized for the study:

Hypothesis 2 (H2). *Total productive maintenance practices significantly positively predict employee retention.*

Hypothesis 3 (H3). *Affective commitment significantly positively predicts employee retention.*

Hypothesis 4 (H4). *Affective commitment mediates the relationship between Total productive maintenance practices and employee retention.*

The proposed model is shown in Figure 1 with the paths relating to H1 to H4.

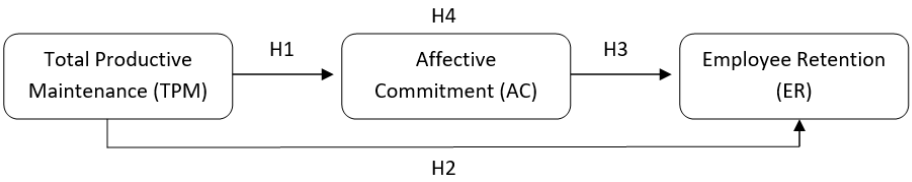


Figure 1. Proposed model.

3. Research Methodology

3.1. Sample

The samples of machine operators were pooled from apparel production firms operating in Sri Lanka. These firms export at least 90 percent of their production; employ at least 100 employees on the production floor [23]; implemented TPM practices in the production floor; and TPM is considered as the standard of operation; TPM practices are in operation for at least one year by the time of the study. We identified 30 firms that fulfill these criteria, and these firms are included as firms of the population frame. Of these, 25 firms

agreed to take part in the study. Using convenience sampling method, we distributed the survey questionnaire targeting machine operators in these firms. A survey questionnaire was developed for the study targeting machine operators. This was pre-tested before administration. Furthermore, before administering the survey, the target respondents were briefed about the study; their responses were anonymous. We distributed 500 survey questionnaires for which 411 valid responses were received: 68.5% valid response rate.

Of the respondents, 57% were female and 43% were male: 42% were between 18 years and 27 years of age, 53% were between 28 and 37 years of age, and 5% were above the age of 37 years. Of the respondents, 6% reported having a diploma or above level education qualifications, 25% reported having 13 years of schooling, 69% reported having 10 years of schooling. Prior to data analysis, we tested Wilks' Lambda statistics to identify any significant differences ($p > 0.05$) between the 25 firms. Furthermore, results of independent sample *t*-test suggested non-existence of significant differences ($p > 0.05$) by the sex of the respondents. Furthermore, the results of one-way ANOVA suggested non-existence of significant differences ($p > 0.05$) in respondents' education level.

3.2. Measures

The measure for TPM practices was developed based on previous research [16,17,27,33,34], and insight gained from our preliminary investigations in Sri Lanka. The measure covered areas of autonomous, planned and quality maintenance, focused improvement, health, safety and environment; education and training; development management; office TPM. An example items include "Operators are given specific training to improve their ma-chine maintenance skills", "Operators are empowered to attend machine cleaning, routine maintenance and minor adjustments", "Systems are implemented for identification and elimination of loses", and "Safety initiatives and devices are in place on the machines to ensure safety of the employees". Employee retention was measured using the scale adopted from Hui et al. [55]; Example items include "I often think of leaving the organization" and "it is very possible that I will look for a new job next year". AC was measured using the scale adopted from Meyer et al. [41]. An example item includes "I feel a strong sense of belonging to the organization".

3.3. Methods of Data Analysis

Exploratory factor analysis was conducted using Principal component factor analysis Varimax rotation on each measure. For confirmatory factor analysis, AMOS was used. We followed the statistical procedures recommended by Arbuckle [63] and Byrne [64]. The results of AMOS for the structural relationships between TPM, AC and ER were interpreted using normed chi-square statistic ($\chi 2/df$), comparative fit index (CFI), Tucker–Lewis index (TLI) and root mean square error of approximation (RMSEA) [63,64].

4. Results

Table 1 shows Cronbach's Alpha reliability values and the summary of results of factor analysis for TPM, AC and ER. Correlation table with means and standard deviations are shown in Table 2. Correlations suggest that the TPM practices have significant positive association with AC ($p < 0.01$) and ER ($p < 0.01$).

Table 1. Cronbach's Alpha and summary of results of factor analysis.

	Cronbach's Alpha	Eigenvalue	Explained Variation
TPM	0.884	4.045	50.558
AC	0.873	3.237	53.948
ER	0.797	2.496	62.407

Table 2. Correlation.

	Mean	SD	AC	ER
AC	3.7749	0.6399	-	
ER	3.3029	0.8873	0.641 **	-
TPM	3.4767	0.5482	0.564 **	0.457 **

** $p < 0.01$.

Confirmatory factor analysis was conducted using AMOS to identify structural relationships between TPM, AC and ER. The study predicted that AC mediates the relationship between TPM and ER. The initial analysis of the model shown in Figure 1 has not yielded satisfactory fit indices since the path predicted in H2 was not supported. This path was removed and re-analyzed the data. The fit indices yielded were shown in Table 3. These fit indices satisfy the model fit criteria mentioned above. The final model is shown in Figure 2 with path coefficients. Standardized regression coefficient of 0.454 ($p < 0.001$) reveals that TPM significantly positively related to AC. This supports H1. Standardized regression coefficient of 0.668 ($p < 0.001$) reveals that AC significantly positively related to ER. This supports H3. The coefficient of determination of 0.272 suggests that this mediation relationship accounts for 27% of the variation of ER. Overall, the results support the mediation relationship predicted in H4.

Table 3. Fit indices.

	χ2/df	CFI	TLI	RMSEA
TPM -> AC -> ER	2.337	0.992	0.975	0.063

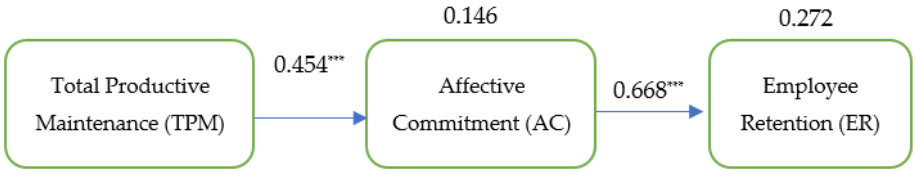


Figure 2. Proposed model with path coefficients. Note: Unstandardized coefficients are reported. *** $p < 0.001$ (two-tailed).

5. Discussion, Implications and Conclusions

This research study investigated the TPM practices implemented by apparel production firms, and the effect of these practices on affective commitment (AC), and employee retention (ER) of operators in labor-intensive apparel production. Affective commitment and ER are behavioral outcomes expected from employees in labor-intensive sectors in general worldwide. By investigating the AC and ER, and the effect of TPM practices on these the study intended to advance the understanding of implementations of advanced manufacturing systems and behavioral outcomes in labor-intensive sectors. We have collected data from 411 operators who have knowledge and direct involvement with TPM practices in the production flow in apparel manufacturing firms in Sri Lanka. The findings revealed that TPM practices are significantly positively related to AC; AC mediates the relationship between TPM and ER. Our findings have important implications for the extant literature and practice on the TPM implementations, and employees' AC and ER. As these outcomes are desired by employers in the TPM context, the findings presented in this paper would be of interest to both academics and practitioners.

Retention of employees is at the heart of business success. Employee retention not only decreases employee turnover but also reduces costs associated with hiring, orienting, and training of new employees. Organizations can optimize the contributions of existing

employees with appropriate retention strategies. Therefore, the findings of this study are connected to several practical recommendations. First, workplace strategies such as delegation, job autonomy, and job involvement create a work environment with adaptive, accommodative, and collaborative features that lead to committed workforce with higher levels of intention to stay with the organization. Second, success and sustainability of TPM implementation itself depend on firms' ability to retain operators and keep their commitment at higher levels. Third, total productive maintenance creates an adaptive, accommodative, and collaborative work environment, enabling firms to survive and excel in competitive markets. Total productive maintenance demands higher levels of delegative and consultative employee participation within the day-to-day practice of the job itself, which provides employees with opportunities to take part in job-related decision-making and provide suggestions for improvement that may have broader and long-term effects on the way work is performed in the organization.

We studied associations between TPM practices and two employee behavioral outcomes, i.e., AC and ER, which are considered as interdependent in yielding better work performance from employees. The findings showed that TPM increases their AC commitment, and, in turn, increases their intention to remain with the organization. In other words, TPM and the participative employee behaviors it propagates lead to favorable outcomes that are important for organizations. Hence, employees' AC and ER can be identified as important considerations in TPM implementations. Our study provides valuable understanding for academics and practitioners because of the study's pragmatic significance that employee participation practices lead to positive behavioral outcomes. Practitioners can benefit from the study to take better and more effective decisions to uplift operators' well-being and for the sustainability of firms. Voluntary quits by employees imply a potential retention issue and addressing voluntary turnover is challenging. Hence, one of the main challenges for an organization is retaining employees for long-term sustainability. Employee retention helps in making more accurate predictions in human resource planning and reduces costs associated with hiring new employees and reduces training costs. The findings showed that TPM implementations enhance employees' AC, which, in turn, enhances employees' retention intentions. Overall, the findings of our study on the influence of TPM on the two behavioral outcomes of employees are timely and add value to labor-intensive sectors, such as apparel production.

6. Limitations and Recommendations for Further Research

This study was limited to investigating the effect of TPM practices on affective commitment and employee retention in apparel production. Future studies could explore these relationships in other industrial and service sectors. Furthermore, more research using different research methodologies such as longitudinal could provide more information to complement survey research. Furthermore, future research could extend data collection by including managers, team leaders, and human resource managers who are actively involved in the TPM implementations.

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