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Total productive maintenance and companies performance: a case study of fast moving consumer goods companies

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TPM implementation by FMCG firms in Ado/Ota industrial hub of Ogun State, Nigeria was investigated, and its influence on the firm's performance was analyzed. Primary data were collected through the administration of an online questionnaire. A total number of 98 respondents participated in this research. The analysis was conducted through descriptive analysis and structural equation model (SEM) using a smart partial least square (PLS) software. It was observed that TPM implementation had a positive influence on firms' performance. In the descriptive analysis, it was noted that most of the firms explored in this study have implemented TPM. It implies that above ninety percent of companies in the industrial hub are practicing TPM. The data used employed in this research are limited to those obtained from FMCG firms in Ado/Ota in Ogun State, Nigeria. However, this study's findings can represent other firms in other locations where TPM is practiced. This research will be helpful for FMCG firms in Nigeria, especially those in Ogun State. TPM was measured using the following indicators: 5S, Autonomous Maintenance, Kobetsu Kaizen, Planned Maintenance, Quality, Education and Training, Office TPM, and Health, Safety and Environment. Eight indicators measure The company's performance: Product Quality, Cost, Inventory, Lead Time, Processing Cycle Time, Customer Complaints, Equipment Efficiency and Overall Productivity. The research review shows that the TPM implementation significantly affects firms' sustainable performance. In addition, the result shows that local firms in the survey area are yet to key into implementing TPM practices fully.

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1. INTRODUCTION

Fast Moving Consumable Goods (FMCG) are products that generate a quick turnover at a low cost, with a short lifespan and are purchased regularly [1]. FMCGs are believed to be the engine for economic growth, economic development, increased employment, capital savings, and poverty reduction [2]. FMCG products include processed food, beverages, hygiene, home care and personal care products.

Nigeria's Fast Moving Consumer Goods sector is one of the country's largest, and its impact on the economy cannot be underestimated. FMCG companies might be small, medium, or large, but they contribute significantly to the development of the Nigerian economy. Household care, personal care, food and drinks comprise the FMCG industry's three segments. Nigeria's food business has thrived over the years, thanks to the country's enormous population, which drives sales growth for numerous food industries. Fast-moving consumable goods are products that have a high turnover rate at a cheap cost, resulting in increased employment and capital savings [2]. FMCG is defined by Majumbar [3] as a non-essential or essential commodity that is regularly acquired interchangeably at the convenience of different consumers and sold in a short time at a low price.

The FMCG sector in Nigeria contributes to the country's income generation and profitability of businesses; a report by KPMG International [4] revealed that the FMCG subsector, which includes food, beverage and tobacco, constitutes about 5% of Nigeria's Gross Domestic Product (GDP). The Nigerian Stock Exchange's (NSE) report of 2019 shows that FMCG constitutes about 17% of the total equity value. It signifies the importance of the FMCG sector to the economy of Nigeria. They can be small, medium, or large, but they all contribute significantly to the development of the Nigerian economy, regardless of their size [5]. Due to the ongoing increase in raw and packaging materials prices, FMCG companies are under competitive market pressure to sustain their products' selling prices, and profitability is directly endangered unless they apply cost cutting initiatives [6].

The FMCG industry's production process necessitates the continuous functioning of the production equipment. A failure in a manufacturing line results in a decrease in output rate and product quality issues. Ineffective maintenance methods on plant equipment, according to Sharma et al. [7], are one of the contributing factors to unwanted outcomes in manufacturing processes. Several manufacturing firms are now prioritizing equipment maintenance as a key component of achieving optimal output to solve this. Maintenance practices are critical in ensuring that the plant is operational, safe to work in, produces high-quality products, and cost-effective, as maintenance costs account for a large part of the operational budget of companies in the industrial sector [8]. Maintenance costs are a bigger component of many manufacturing industries' operational budgets. In contrast, 30 percent of the total workforce of a manufacturing plant will belong to the maintenance and operation department [9]. In addition, several production process tools are available to improve the production line and the company's overall performance.

TPM is a lean tool and maintenance program offering a completely new equipment maintenance approach. This maintenance program aims to optimize the machines and processes [10]. TPM is defined by Nakajima [11] as a method of maintenance that maximizes equipment efficiency, prevents breakdowns, and encourages autonomous maintenance by operators by incorporating the entire workforce into day-to-day activities. According to Zahid, and Kang [12], TPM focuses on productive maintenance, understanding the importance of reliability, maintenance and cost-efficiency in plant design. It emphasizes active and preventative maintenance to maximize equipment's operational efficiency. TPM's unique eight-pillars and 5S foundation methodology provide the path for excellent planning, organizing, monitoring, and controlling processes [13].

TPM is a method of equipment maintenance that aims for optimal output with no breakdowns, minor stops, defects, or accidents [14]. Improving the efficiency and efficacy of maintenance involves incorporating operators into daily maintenance to achieve autonomous maintenance [15]. TPM also contributes to the organization's capability by facilitating cross-functional learning and enhancing individuals' problem-solving abilities [16]. There are many different ways to analyze a manufacturing facility's productivity, but the most common method is to evaluate cost, quality, delivery, and flexibility as the main characteristics of manufacturing performance [17]. Depending on the size, nature, personnel, effort, management, and implementation method, TPM could be adopted in any organization. Some businesses may implement only a few specific pillars depending on the implementation requirements. TPM is implemented in five phases; awareness, organization, planning, implementation, and assessment [18], [19].

TPM has a strong beneficial influence on improving maintenance management procedures and their economic impact, as well as a significant impact on quality and delivery. However, many FCMG firms in Nigeria have failed to implement TPM. Most organizations' inability to adopt TPM has been linked to obstacles encountered in

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implementing TPM, which include a lack of management support and knowledge, insufficient training, and failure to provide enough time for development [20]. Zahid and Kang [12] reiterated that a greater level of participation from everyone in the production facility is required for successful TPM adoption.

Statistics from various sources, including maintenance records, production employees, and daily production data, were used to calculate total equipment effectiveness over six months. The authors discovered that successful implementation of the autonomous maintenance pillar and focused improvement increased production output, as measured by overall equipment effectiveness. Wakjira and Singh [21] did another study in a malt-producing plant. The impact of TPM implementation on the boiler plant and manufacturing process bottleneck was investigated. The malt plant's overall equipment effectiveness was calculated, and it was discovered that implementing TPM had favourable effects, as an enhanced OEE signifies increased availability, performance, and decreased defect rates. Sabry and Awni [6] explored the important factors related to successful TPM implementation in fast moving consumer goods enterprises in Egypt. The authors concluded that the important critical elements for TPM implementation are dependent on the maturity level of the organization's TPM implementation. Eti et al. [22] investigated how Nigerian manufacturing industries might use total productive maintenance as a strategy and a culture to improve their performance. The study suggests that self-auditing and benchmarking are ideal requirements for TPM implementation in Nigerian manufacturing businesses.

The impact of production process improvement technologies like six sigma and total quality management on FMCG performance has been studied. However, few studies look at the effect of TPM on the performance of FMCG companies. Especially in the context of Nigerian FMCG companies. Furthermore, there are few studies on the partial least square approach of structural equation modelling (PLS-SEM) in quality management. Studies linked to the PLS-SEM evaluating the relationship between TPM and FMCG firms' performance are particularly interesting. Therefore, this study aims to:

1) Assess the level of awareness of total productive maintenance practices in Nigerian FMCG companies.
2) Assess the level of adoption of total productive maintenance pillars in Nigerian FMCG companies.
3) Use PLS-SEM to determine the relationship between TPM practices and the business performance of FCMG companies in Nigeria.

PLS-SEM was used in this study because it has some advantages, including the ability to manage small sample sizes, estimate complex models, and balance prediction [23], [24]. In small sample analysis, the PLS-SEM performs better than the covariance-based structural equation modelling (CB-SEM) based on the covariance matrix. There are no strict constraints for selecting a sample size, as long as the residual distribution follows the same pattern [25]. In addition, PLS supports both formative and reflective interactions, whereas CBSEM only provides reflective indicators [26]. PLS is a method for evaluating the theoretical structure and development model that employs a component-based estimate strategy [27]. Akanmu et al. [28] conducted a preliminary analysis of quality management elements, environmental regulation and policy (ERP), and organizational performance in Malaysian food and beverage companies using partial least squares structural equation modelling. The developed structural equation model combines enterprise resource planning with effective features such as quality assurance and nonstop process improvement.

Arromba et al. [29] investigated the difficulties encountered in implementing the TPM program in production systems. A literature study, a panel of experts, and a survey of manufacturing industry professionals were employed as research methodologies. The method used was PLS-SEM to evaluate the survey data collected. According to the authors, there was a relationship between challenges encountered during the development phase of a TPM program and problems encountered during Implementation. To determine the inter-relationship between total quality management and total productive maintenance variables. Singh and Ahuja [30] apply a confirmatory factor analysis (CFA) approach in the analysis of moment structures utilizing SEM. The TQM-TPM model matches the obtained data better. It means TQM and TPM have a synergistic relationship that can aid manufacturing firms in achieving high levels of customer satisfaction, reliability, productivity, market share, profitability, and even product quality, cost, and maintenance activities. Habidin et al. [31] also used

structural equation modelling to examine the connection between TPM, kaizen events, and innovation performance in the Malaysian automobile sector. According to the findings, the relationship between total productive maintenance and innovation performance is unaffected by kaizen events. However, the effect of total productive maintenance on innovation performance increases with the mediating of kaizen events for the Malaysian automotive industry. Empirical test results reveal that implementing total productive maintenance and kaizen events has increased the Malaysian automobile industry's innovation performance.

In addition, few studies have successfully exploited the potential of PLS-SEM to analyze and generate relevant results in areas related to operation management [32]. As a result, compared to other disciplines that have discussed the PLS SMART application, a complete exposition of PLS-SEM in operation management is required with this research focus on TPM. The fundamental operational functions of the quality management system in operation management are total quality management and total productive maintenance. TPM can be viewed as a tool for achieving TQM's purpose. Hence, PLS-SEM was utilized to study the relationship between TPM and company performance.

2. RESEARCH METHODS

A cross-sectional survey was implemented to test the research hypothesis. Smart PLS-3 was used to implement this study's partial least square structural equation modelling technique. The study utilized convenience sampling techniques. The population sample comprises those that work in FMCG industries in the industrial hub of Ado/ Odo/ Ota local government, Ogun State, Nigeria, ranging from owner/top management staff to junior staff. The data utilized were collected for three months through online questionnaire distribution. A total of 98 copies of questionnaires were returned with a response rate of 100%.

It implies that the entire questionnaires returned were found usable. The first section of the questionnaire included questions about demographics, while the second section focused on the awareness of TPM Pillars in Nigeria FMCG companies. The third part addresses the company's adoption and implementation of these TPM practices/pillars, and the last part focuses on TPM and company performance measures. Table 1 shows the scale items that address the awareness of TPM pillars in the industry under consideration and the key performance indicators of the companies in the industry. Items were rated on a 5-point Likert-scale, with 1 representing "Very Low" and 5 representing "Very High". Eight items based on the TPM pillars were used to assess TPM awareness among FMCG companies. The extent to which TPM contributes to FMCG companies' performance was measured with 8 items. After a comprehensive literature review, the following hypotheses were developed. The multivariate statistic technique, namely, PLS-SEM, was then used to test the hypotheses proposed empirically:

The null hypothesis, H0: TPM does not influence the performance of the company that practices it.

The alternate hypothesis, H1: TPM has a positive and significant influence on the performance of the company that practices it.

Table 1. Scales items

No	Level of awareness of TPM pillars in Nigeria FMCG companies
B1	5S
B2	Autonomous Maintenance
B3	Kobetsu Kaizen
B4	Planned Maintenance
B5	Quality
B6	Education and Training
B7	Office TPM
B8	Health, Safety and Environment
	Company's key performance indicators (CKPI)
D1	Product Quality
D2	Cost
D3	Inventory
D4	Lead Time
D5	Processing Cycle Time
D6	Customer Complaints
D7	Equipment Efficiency

3. RESULTS AND DISCUSSION

3.1. The demography of the sample

Table 2 represents the sample demographics. It is seen from the Table 2 that most of the 98 respondents are male (93.3%), with an age group of 40-49 years (48%) dominating the respondent list. 85.7% of the foreign companies indicate that

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more of the foreign companies participated in the survey compared to others with the highest company size respondent (98%). The five years and above have the highest number of respondents (99%) of the company's years of operation. The respondents with the highest year of experience are those above 10years (77.6%), and those with the highest level of education are Bsc/HND (75.5%), while senior staff are the highest respondents with (62.2%).

Table 2. Demographic description of the respondents

Description	Statistics
Gender	
Male	92 (93.9%)
Female	6 (6.1%)
Age Group	
<30Years	9 (9.2%)
30-39Years	24(24.5%)
40-49Years	47 (48%)
50Years&Above	18 (18.4%)
Company Ownership	
Local	3 (3.1%)
Foreign	84 (85.7%)
Joint Venture	11 (11.2%)
Company Size	
Small (10-49)	2 (2%)
Medium (50-199)	Nil
Large (200-249)	96 (98%)
Years of Experience	
<1Year	Nil
1-5Years	9 (9.2%)
6-10Years	13 (13.3%)
Above 10Years	76 (77.6%)
Company Year of Operation	
<1Years	1 (1.0%)
1-5Years	Nil
5Years & Above	97 (99%)
Education qualification	
Primary	Nil
SSCE/GCE	Nil
OND/N.C.E/City Guide	8 (8.2%)
BSc/HND	74 (75.5%)
MSc	16 (16.3%)
PhD	Nil
Job Position	
Owner/Director	1 (1.0%)
Top Management Staff	5 (5.1%)
Manager	24 (24.5%)
Senior Staff	61 (62.2%)
Junior Staff	7 (7.1%)

3.2. TPM implementation

The descriptive statistic shows that the mean, standard deviation and number of respondent's data analyzed are 98. The standard deviation values suggest a high degree of concurrence of the data obtained. In contrast, the mean of the gathered data displayed in Table 3 reveals a high degree of correlation among respondents on numerous matters. The descriptive statistic shows that the mean, standard deviation and number of respondent's data analyzed are 98. The standard deviation values suggest a high degree of concurrence of the data obtained. In contrast, the mean of the gathered data displayed in Table 3 reveals a high degree of correlation among respondents on numerous matters.

From the result analysis shown in Fig. 1, it can be observed that except for local companies, all other companies (foreign, joint venture and public quoted companies) have keyed to the implementation and practices of TPM pillars in their respective organizations.

Table 3. Item descriptive statistic of the survey data

Items	N	Mean	Std. deviation
5S	98	4.041	0.794
Autonomous Maintenance	98	3.745	0.983
Kobetsu Kaizen	98	2.582	1.186
Planned Maintenance	98	3.908	0.822
Quality	98	3.888	0.868
Education and Training	98	3.857	0.821
Office TPM	98	3.694	0.885
Health, Safety and Environment	98	4.061	0.831
Product Quality	98	3.959	0.768
Cost	98	3.622	0.802
Inventory	98	3.663	0.769
Lead Time	98	3.602	0.866
Processing Cycle Time	98	3.592	0.831
Customer Complaints	98	3.143	1.262
Equipment Efficiency	98	3.888	0.781
Overall Productivity	98	3.939	0.767

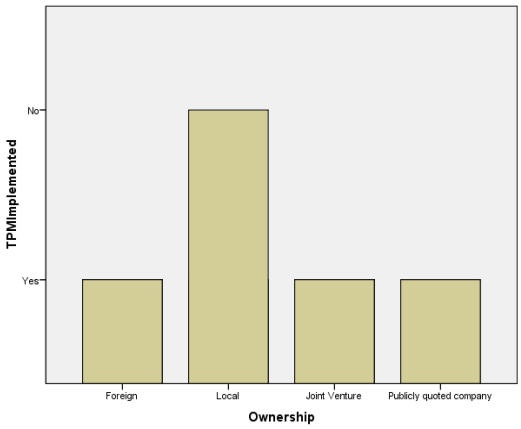

Fig.1. A plot of TPM implementation by various categories of manufacturing firms

3.3. Reliability and validity

The reliability of the variables/items (i.e. the TPM pillars and CKPI in Table 1) was verified using Cronbach's Alpha and Composite Reliability. The values of Cronbach's Alpha and Composite Reliability were higher than the recommended value of 0.700, which agrees with Latif et al. [33]. Who stated that values of Alpha and CRs closer to or higher than the recommended value of 0.700 are acceptable. The authors also indicate that an AVE higher or close to 0.500 confirms the convergent validity. It shows a high level of internal consistency and reliability among all the variables, which implies that there is general agreement between the several items that make up the measured Cronbach's Alpha and Composite scores of the survey. The correlation between the items measures the agreement. Also, the average variance extract (AVE) was higher than 0.700, respectively, which affirms the convergent validity (Table 4).

The cross-loading of all the items is as shown in Table 5. B1 – B8 are items measuring the level of awareness of TPM, which is their parental construct, and D1 – D7 are items that measure company performance, which is also their parental construct. Each of these respective items is to load better in their parental construct compared to the other parental construct (i.e. B1 – B8 are expected to load better in their parental construct (level of awareness of TPM) compared to companies' performance construct). In Table 4, it was observed that all the factor loadings are more significant than their cross-loadings, indicating a sign of discriminant validity. The items were further subjected to other discriminant validity tests, such as the Fornell-Larcker and Heterotrait-Monotrait methods. Their results are shown in Table 6 to buttress further the discriminant validity established through the cross-loading of the items. The items were subjected to these tests to discriminate between different constructs In the case of the Fornell-Larcker test, it can be seen that the AVE square root for each item is higher than its correlation with the other item respecttively. It can be concluded that discriminant validity exists between the level of awareness of TPM and TPM's contribution to the company's performance. Also, using the Heterotrait-Monotrait method, the discriminant validity can only be established when the value ratio is less than the acceptable threshold of 0.85 [34]. In this case, the value ratio of 0.844 is less than the acceptable threshold. Hence, the discriminant validity of this analysis is well established.

3.4. TPM and company performance variance

The Smart PLS result analyzes the hypothesis that postulated a positive and significant relationship between all dimensions of TPM (5S, Autonomous Maintenance, Kobetus Kaizen, Planned Maintenance, Quality Maintenance, Education and Training, Office TPM, Health Safety and environment) and the company performance. The analysis determines the variances of the company's performance explained by the TPM dimensions, shown in Fig. 2. The result indicates that the coefficient of determination, R^2, is 0.677. It implies that 67.7% variation in companies' performance is predictable from the TPM dimensions. As indicated in the Smart PLS result, the path coefficient of the TPM level of awareness tools is represented as B1 to B8 sequentially, as shown in Fig. 2, which means that the dimension tools have a strong effect on TPM, except for Kobetsu Kaizen (B3) which contributed 0.416

Table 4. Item reliability and validity

	Cronbach's alpha	Composite reliability	Average variance extract
Level of Awareness of TPM	0.938	0.952	0.720
TPM and CKPI	0.937	0.948	0.701

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Table 5. Item cross-loading (discriminant validity)

	Level of awareness of TPM	Company's performance
B1	0.939	0.786
B2	0.841	0.629
B3	0.416	0.326
B4	0.914	0.821
B5	0.880	0.686
B6	0.884	0.722
B7	0.852	0.678
B8	0.939	0.799
D1	0.805	0.895
D2	0.650	0.871
D3	0.647	0.857
D4	0.634	0.835
D5	0.532	0.784
D6	0.355	0.548
D7	0.856	0.927
D8	0.840	0.916

Table 6. Discriminant validity using fornell-larcker and heterotrait-monotrait method

Fornell-larcker method		
	Level of Awareness of TPM	TPM Performance
Level of Awareness of TPM	0.848	
TPM Performance	0.823	0.837
Heterotrait-monotrait method		
	Level of Awareness of TPM	TPM Performance
Level of Awareness of TPM		
TPM Performance	0.844	

Meanwhile, the effect of TPM level of awareness on company performance had a path coefficient value of 0.823. The Smart PLS result also indicates that of all the eight dimensions of a company's performance, equipment efficiency (D7) had the highest path coefficient value of 0.927, which means that equipment efficiency had the strongest effect on the company's performance (Fig. 3). A two-tail t-test was conducted with a significance level of 5 % To check whether the model's path coefficients are significant. The findings indicate that the hypothesized path relationship among the variables was statistically significant as the null hypothesis was rejected. Therefore, the proposed alternate hypothesis (i.e. TPM has a positive and significant influence on the performance of the company that practices it) was supported

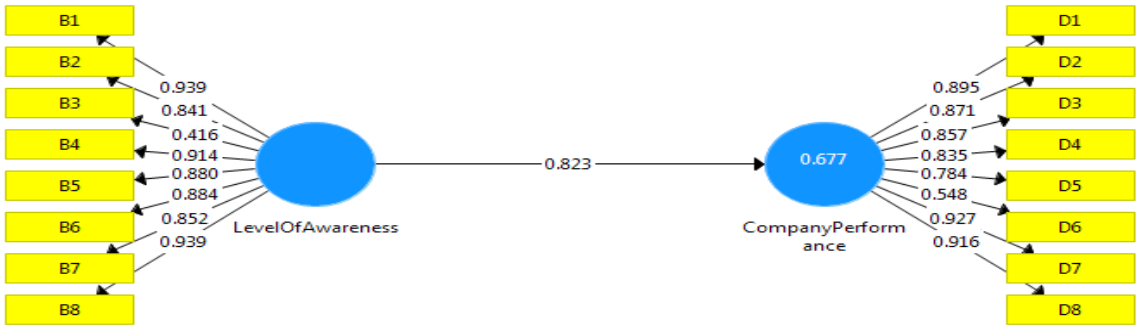

Fig. 2. Relationship between TPM and company performances established by PLS-SEM analysis

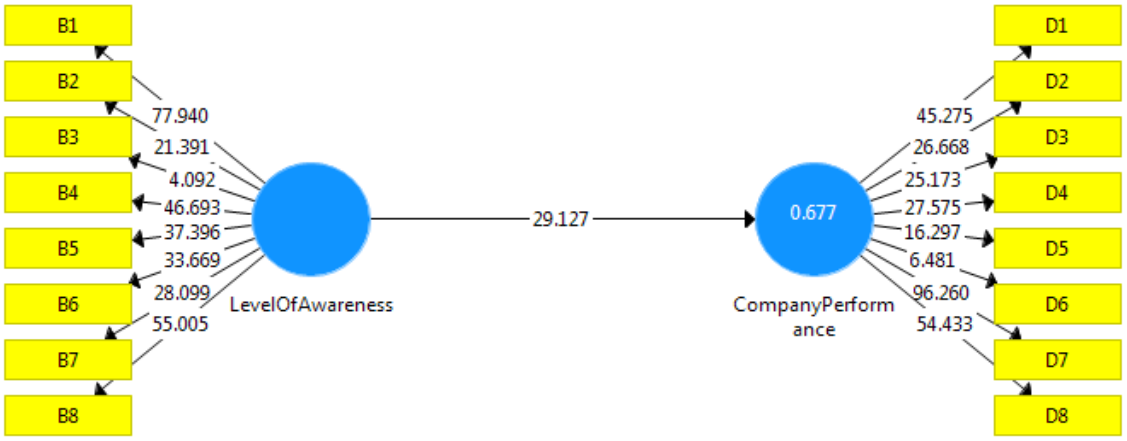

Fig. 3. Structural path significance in bootstrapping

4. CONCLUSION

The study focused on the TPM awareness and implementation in some manufacturing firms within the industrial hub of Ado/Odo Ota in Ogun State. The study postulated the role of TPM as a sustainable tool for firms' and organizations' performance. The results show a significant effect of TPM awareness and implementation on a firm's sustainable performance. The PLS-SEM analysis results indicated that all of the pillars of TPM positively influence the quality performance of firms' operations. The implementation of 5s and health, safety and environment programs are the most predominant TPM pillars that contribute more to the positive changes in the firms' performance, except for Kobetus Kaizen, which has the least effect. Therefore, manufacturing firms need to further improve on the development and the management of tools to support the effective implementation of TPM pillars for better performance.

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