Review Article

Implementation of Total Productive Maintenance in a Local Pharmaceutical Manufacturing Company in the Philippines

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Abstract

This paper determines the implementation of total productive maintenance (TPM) at a pharmaceutical manufacturing company in the Philippines. It also assesses the significance of TPM practices from the viewpoint of employees involved in production. A total of 44 employees participated in the survey. The data gathered were analyzed using Microsoft Excel 2019 Data analysis. The extent of TPM implementation was ranked by the value of the weighted mean, the practices that had the higher weighted average, implemented to a great extent. The significance of TPM practices was tested with the aid of a *t*-test statistical tool at a hypothesized mean of 2.5. The findings revealed that the manufacturing company implemented TPM practices to a high extent to maintain integrity and improve production quality by reducing downtime through preventive maintenance, technology assessment and usage, and employee involvement in maintaining their equipment. The results also indicated the significance of TPM practices in improving a company's production quality. The results of the study provide guidance and references to improve maintenance procedures and improve productivity.

Keywords: Housekeeping, preventive maintenance, technology effective usage, total productive maintenance

Introduction

The Filipino pharmaceutical is considered one of the key industries in the country as it has shown significant growth over the years. The Philippines is the 11th-most attractive pharmaceutical market in the Asia-Pacific region and the 3rd largest pharmaceutical market in ASEAN, after Indonesia and Thailand. Of the world's top 20 pharmaceutical companies, over 14 have manufacturing facilities in the Philippines.

Several challenges are being faced by the Philippine pharmaceutical industry such as a slow registration process, imposed taxes on pharmaceuticals, and price ceilings. However, the issue on quality of pharmaceuticals has become a very important subject. The prevalence of drug recalls in the global market due to contamination was traced back to a failure in supply and manufacturing. Due to recent incidents, pharmaceutical companies have been deeply concerned with their competence to produce quality drugs within acceptable specifications while keeping the cost within reasonable limits.

Total productive maintenance (TPM) is a concept that can be implemented to keep proper vigilance in producing products that are not defective, reducing recalls and wastage, eliminating equipment failure and downtime, and maximizing manpower efficiency. As the goal of TPM is to improve productivity without sacrificing the standard of the product, enormous companies are trying to adopt it. The pharmaceutical industry in the Philippines is one of the most promising earning sectors so there is a great extent to improve production rate and product quality when TPM is applied. This paper tries to find out the implementation of TPM at a pharmaceutical manufacturing company in the Philippines.

Literature Review

Philippine's health spending or Current Health Expenditure reached PhP 895.88 billion in 2020, 12.6% higher compared with PhP 795.64 billion in 2019.[1] The demand for healthcare in the country is driven by aging populations and a greater incidence of lifestyle-related diseases.

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In the ASEAN region, the Philippines is considered the third-largest pharmaceutical market, following Indonesia and Thailand, and as forecasted by IMS Health, it will grow by 4.5% over the next 5 years.[2] This growth is represented by the value output or production of the industry considering both research-based pharmaceutical and generic companies. Due to affordability, there is an acceleration in the country's generics market which was also influenced by the introduction of a Universal Health Coverage scheme which ensures equitable access to quality health care.[3] The market share of generic medicines is increasing also because public and private hospitals are mandated to supply generic drugs for Filipinos.[4]

As reported by Global Data (2016), the Philippine local pharmaceutical market is seen as a key industry player for the economic growth of the country.[5] The high demand for high-quality generics created opportunities for local and foreign investors to enter generic drug manufacturing in the country. Currently, 14 out of the world's top 20 pharmaceutical companies own a manufacturing plant in the Philippines. According to Globe Newswire (2021), the pharmacy chains are anticipated to increase their penetration in the semi-urban to rural regions of the country by acquiring independent pharmacies and regional chains.[6] The effect would be an increase in their expedited store count.

Recently, the Philippine's first pharmaceutical economic zone was approved to set to rise in Malolos, Bulacan. The 259,069 m^2 business park will house pharmaceutical and biotechnology companies. The new land will be added to the existing 38-hectare Bulacan Industrial City established in 1991, also dubbed as the "Pharma City of the North." Currently, the city houses numerous pharmaceutical firms such as Pascual Laboratories and Cargill Philippines.[7] The pharmaceutical sector in the country contributes largely to the economy through value-added products and creating jobs.

Total productive maintenance

The manufacturing industry is being characterized as highly dynamic and rapidly changing affecting developments in a company's performance by looking into cost-cutting, and improving productivity levels and quality to satisfy the consumers.[8] Companies excel in their respective industries by providing a wide range of products with state-of-the-art features manufactured in high quality, lower cost, and faster Research and Development.[9] TPM program can increase employee morale and job satisfaction by improving productivity and quality of products or services. TPM is an approach that promotes the effectiveness of materials, removes breakdowns, and optimizes operator maintenance activities. According to Besterfield *et al*., TPM helps maintain the current plant and equipment at the highest production level through the collaboration of all utilized areas in the organization.[10]

Ahuja and Khamba summarized eight pillars for the success of TPM implementation, as shown in Figure 1. By implementing these pillars, the goals are 0 breakdowns, 0 defects, 0 accidents, and 0 waste.[11]

TPM optimizes the reliability of machines and overall plant assets.[12] During implementation, TPM involves the members from operator level to management so it is considered as a responsibility of all employees in the organization. Daily objective includes 0 defects and 0 breakdowns during operation.[13] The concept of TPM was implemented in the semiconductor industry and Chan *et al.* (2005)[14] reported 83% improvement in equipment productivity. Failure of TPM implementation was observed by Rodrigues and Hatakeyama and concluded that the shallow involvement of workers contributed to it.[15] In a cellular manufacturing system, TPM was implemented by Chand *et al*. (2000)[16] and discussed that sustained TPM is essential to maintain acceptable overall equipment effectiveness.

Preventive maintenance

A system can be maintained through actions such as repairing, replacing, inspecting, adjusting, and detecting faults to avoid interruptions during operations.[17,18] If the maintenance is effective, the life of a system can be extended and the occurrence of failure can be reduced.[19] Preventive maintenance (PM) is a policy that is planned and performed after a specified period or if a system has been used with the goal of reducing failure.[20] As reported by Mechefske and Wang, almost all of their systems were maintained and a significant amount of useful time was remained when PM was implemented.[21]

There are two perspectives of PM known as managerial and operational.[22] Decision-making that facilitates data analysis refers to the managerial perspective of PM. Information about the determination of PM's objectives, methods for maintenance actions, and problem-solving with regard to PM are the inputs of managerial perspective. On the other hand, the operational perspective pertains to the execution of maintenance action so that the system can perform its intended functions.[23] Managerial and operational perspectives of PM are important for the guaranteed effectiveness of the system.

Effective technology usage

The degree of automation and precision of equipment used in production has moderately improved with the development of technology and technological cost has become more remarkable.[24] The TPM element "technology usage" refers to the evaluation of the market for new production technologies and the assessment of their financial benefit. The

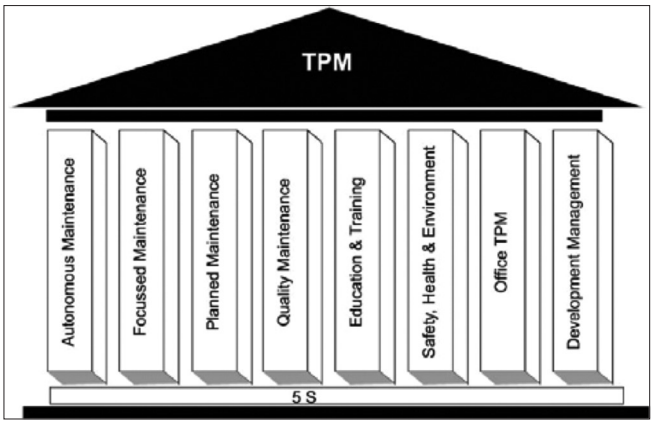

Figure 1: Eight pillars of total productive maintenance

Table 1: Preventive maintenance practices

Preventive Maintenance Checklist at Vonwelt Inc.	WM	*t*	Rank
Have formal program for maintaining machines and equipment	3.32	6.639*	2.5
Maintenance plans and checklists are posted closely to machines and maintenance jobs are documented	3.32	7.667*	2.5
Emphasizes good maintenance as a strategy for increasing quality and planning for compliance	3.39	8.140*	1
All potential bottleneck machines are identified and supplied with additional spare parts	3.27	7.383*	4.5
Continuously optimize maintenance program based on a dedicated failure analysis	3.27	8.218*	4.5
Maintenance department focuses on assisting machine operators perform their own preventive maintenance	3.23	6.008*	6
Machine operators are actively involved into the decision-making process when management decide to buy new machines	3.20	7.398*	7.5
Machines are mainly maintained internally and avoid external maintenance service as far as possible	3.20	6.662*	7.5
Total	3.28	10.825	2

t-value at a degree of freedom (43) and the level of significance 0.05 equal 1.681 (significant: *$P \leq 0.05$). Mean scale: 1-not at all to 4-to a very great extent. WM: Weighted mean

Table 2: Effective technology usage practices

Technology Usage Checklist at Vonwelt Inc.	WM	*t*	Rank
Plant is situated at the leading edge of new technology in our industry	3.18	6.543*	3
Constantly screening the market for new production technology and assess new technology concerning its technical and financial benefit	3.20	8.448*	1.5
Rely on vendors for all of our equipment	2.82	2.590*	5
Part of our equipment is protected by the firm's patents	2.91	4.237*	4
Proprietary process technology and equipment helps us gain a competitive advantage	3.20	7.001*	1.5
Total	3.06	7.638	3

t-value at a degree of freedom (43) and the level of significance 0.05 equal 1.681 (significant: *$P \leq 0.05$). Mean scale: 1-not at all to 4-to a very great extent. WM: Weighted mean

Table 3: Housekeeping practices

Housekeeping Checklist at Vonwelt Inc.	WM	*t*	Rank
Employees strive to keep our plant neat and clean	3.43	9.890*	1
Plant procedures emphasize putting all tools and fixtures in their place	3.30	8.353*	2
Have a housekeeping checklist to continuously monitor the condition and cleanness of our machines and equipment	3.27	8.218*	3
Total	3.33	10.275	1

t-value at a degree of freedom (43) and the level of significance 0.05 equal 1.681 (significant: *$P \leq 0.05$). Mean scale: 1-not at all to 4-to a very great extent. WM: Weighted mean

implementation of technology contributes to easier and less time-consuming improvement initiatives.[25]

Housekeeping

The first step in getting regulatory approvals is good housekeeping.[26] Major manufacturing companies have obligated their workers to maintain the cleanliness of the plant and come up with tools such as housekeeping checklists. TPM participants must learn to continuously keep equipment to its original state to restore them. Equipment that are vulnerable to forces of friction must be subjected to proper cleaning and lubrication to avoid equipment failure.

According to Gupta and Garg, the implementation of TPM must include the process of housekeeping to achieve a peaceful environment within the workplace. Arranging the working environment properly leads to a reduction if defective products, lead time, unsatisfied customers, demoralized workers, and poor returns.[27]

Methods

The study employed descriptive study. A descriptive study is one in which information is collected in a completely natural and unchanged natural environment. It identified the extent of implementation of TPM practices. The participants of the study were the forty-two employees involved in the implementation of Vonwelt Inc. TPM practices, namely the Administrative, QC/QA, Production, Logistics, and Engineering departments.

The main instrument used in this paper is a questionnaire adopted from the Operational Excellence (OPEX) Model. The same question items used in the OPEX project were used to collect data from the Vonwelt Inc. The questionnaire consists of two parts: The first part covers the sociodemographic data of the respondents, such as their age, gender, civil status, educational attainment, job status, length of service, salary, and employee position in the company. The second part assessed the extent of implementation of TPM practices from employees viewpoint. It consists of 16 practices representing three dimensions of TPM namely, PM, technology usage, and housekeeping. Respondents were asked to rate each practice of the 16 practices in terms of the level of implementation of TPM using a Likert scale ranging from 1-not at all (least) to 4-to a very great extent. The significance of the variables (practices) used was tested with the aid of *t*-test statistical tool at a critical value of 2.50.

The variables (practices) were also ranked with the aid of the weighted responses of the respondents. The questionnaire survey was analyzed using MS Excel Data Analysis. Data collected from the questionnaire were entered into MS-Excel data sheet and all analyses were performed.

The principal statistical tool utilized was the nonparametric statistical testing using descriptive statistics and one sample *t*-test. The extent of implementation was tested with the aid of a *t*-test statistical tool at a critical value of 2.50. Interpretation of the results was done at a 5% level of significance; where the value of $P \leq 0.05$ was considered as being significant.

Results and Discussion

In manufacturing companies like Vonwelt Inc., most of the production processes rely on machines, thus machines breakdowns cause production disturbance.

Currently, Vonwelt Inc., use the TPM for planned maintenance to eliminate disturbance. As seen in Table 1, in terms of PM, the Vonwellt Inc. puts more emphasis on good maintenance as a strategy for increasing quality, and planning for compliance got the highest rank (weighted mean [WM] = 3.39). Consequently, a formal program for maintaining machines and equipment, and maintenance plans and checklists are posted closely to machines and maintenance jobs are documented have been prioritized by the company (WM = 3.32). Further, all potential bottleneck machines are identified and supplied with additional spare parts and the company continuously optimizes the maintenance program based on a dedicated failure analysis (3.27). However, the maintenance department of Vonwelt Inc. gives less importance to assisting machine operators to perform their PM (WM = 3.23). Machines are mainly maintained internally and avoid external maintenance service as far as possible and machines are mainly maintained internally and avoid external maintenance service as far as possible got the lowest rank (WM = 3.20). The overall implementation level of TPM practices on PM has a composite mean of 3.28 with an adjectival rating of agree. It can be justified by the study cited by Alkhalidi and Abdallah, that the backbone of a manufacturing site is its production lines, which are dependent on machines.[28] Thus, the company must focus on keeping the machines running at full capacity during production time. Machine failure, lower production capacity, and low product quality as the results of poor production maintenance. Respondents also agree on the significance of PM practices to maintain the integrity and improve the production quality of the pharmaceutical company. The result is supported by the calculated absolute value of T is greater than the spreadsheet value of T which is equal to 1.681 when the degree of freedom is 43 (n − 1) and the level of significance is 0.05.

The second dimension of TPM is the technology assessment and usage. Table 2 shows that in terms of the implementation of technology assessment and usage practices the Vonwelt Inc. got a composite mean of 2.96 with an adjectival rating of Agree. The Vonwelt Inc. give the highest importance on proprietary process technology and equipment to gain a competitive advantage and constantly screening the market for new production technology and assess new technology concerning its technical and financial benefit (WM = 3.20). In addition, the plant is situated at the leading edge of new technology in the pharmaceutical industry ranked 3 (WM = 3.18). At ranked 4, part of equipment is protected by the firm's patents (WM = 2.91) and ranked 5 (WM = 2.82) Vonwelt Inc rely on vendors for all of equipment. Vonwelt Inc. uses new technologies and state-of-the-art machines and focuses on the proprietary technologies to sustain advantage. Friedli *et al*.,[29] explained that most of the pharmaceutical manufacturing companies increasingly rely on vendors for all the machines used in the production instead of developing their solutions. Consequently, the respondents expressed their agreement on the significance of effective technology usage to maintain integrity and quality of production, since, the calculated absolute value of T is greater than the spreadsheet value of T which is equal to 1.681 when the degree of freedom 43 (n − 1) and level of significance 0.05.

The company is serious about the implementation of TPM practices in terms of housekeeping with the composite mean of 3.25 with an adjectival rating of Agree as seen in Table 3. The employees put the greatest emphasize in striving to remain their plant neat and clean (WM = 3.36). In addition, their staff are putting all tools and fixtures in their place (WM = 3.30). Housekeeping checklist to continuously monitor the condition and cleanness of machines and equipment (WM = 3.27) is also practiced by the company. Chowdury *et al*., states that full PM start with a scientific process of housekeeping to understand a serene environment within the workplace involving the workers with a commitment to sincerely implement and practice housekeeping.[30] Problems cannot be clearly seen when the workplace is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. If this could be seldom obsessed seriously, then it finally ends up with delays, defects, dissatisfied customers, declining profits, and demoralized employees. The employees level of agreement on the significance of housekeeping practices in reducing the downtime of production. The result is supported by the calculated absolute value of T is greater than the spreadsheet value of T which is equal to 1.681 when the degree of freedom is 43 (n − 1) and the level of significance is 0.05.

Conclusion

This paper determines the extent of the implementation of TPM practices in the Vonwelt Inc. pharmaceutical manufacturing company from employees' viewpoint. Forty-four employees were given 16 TPM practices, adopted from OPEX to assess the extent of implementation and they are to choose between not at all and to a very high extent. The extent of implementation of TPM dimensions such as PM, technology assessment, and usage and housekeeping reveal rating to a great extent. The employees prioritize housekeeping, by striving to keep the plant neat and clean, putting all tools and fixtures in their place, and maintaining a checklist to continuously monitor the condition and cleanness of the machines and equipment. The employees also emphasize good maintenance as a strategy for increasing quality and planning for compliance. However, the

company must improve effective technology usage practices to maintain integrity and improve production quality. The significance of TPM practices used was tested with the aid of a *t*-test statistical tool at a critical value of 2.50. The findings indicate the significant role of all 16 TPM practices in improving the quality of production of pharmaceutical products, where the calculated absolute value of T is greater than the spreadsheet value of T which is equal to 1.681 when the degree of freedom 43 (n − 1) and level of significance 0.05.

The results of this paper will assist the pharmaceutical company, specifically, Vonwelt Inc. to maintain integrity and to improve the quality of production through TPM, dimension of OPEX. The study will enable the production manager which practices of TPM should require more attention on achieving OPEX. The practices described in this paper would hopefully be applied to provide guidance and references for maintaining the integrity and production quality of pharmaceutical products. The findings of this research are expected to (contribute) to achieve OPEX through various strategies and practices. The results of the study provide useful recommendations for production managers or policymakers for improving production strategies and practices in the future.

Recommendation

This research can be extended by:

(a) Developing criteria for assessing performance levels of TPM practices to make an overall assessment and rating
(b) Adding the three dimensions of OPEX, namely, total quality management, just in time, and human resource management.

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Conflicts of interest

There are no conflicts of interest.

References

1. Philippine Statistics Authority. Health Spending Grew by 10.9 Percent in 2019. Philippine National Health Accounts; 2020. Available from: https://psa.gov.ph/pnha-press-release/node/163258. [Last accessed on 2022 Nov 11].
2. Bajpai P. Philippines Pharma: All Set for Continuous Growth. Biospectrum Asia; 2019. Available from: https://www.biospectrumasia.com/analysis/29/12941/philippines-pharma-all-set-for-continuous-growth-.html. [Last accessed on 2022 Nov 11].
3. Dayrit MM, Lagrada LP, Picazo OF, Pons MC, Villaverde MC. The Philippines health system review. Health Syst Transit 2018;8:2.
4. Reyes CM, Tabuga AD. A Profile of the Philippine Pharmaceutical Industry. PCC Issues Paper, 02; 2020. Available from: https://www.phcc.gov.ph/wp-content/uploads/2020/06/PCC-Issues-Paper-2020-02-A-Profile-of-the-Philippine-Pharmaceutical-Industry.pdf. [Last retrieved on 2022 Dec 02].
5. Country Focus: Healthcare, Regulatory and Reimbursement Landscape – Philippines. Global Data; 2016. Available from: https://store.globaldata.com/report/countryfocus-healthcare-regulatory-and-reimbursement-landscape-philippines/. [Last retrieved on 2023 Jan 04].
6. Philippines Pharmacy Retail Industry Outlook to 2025. Ken Research; 2021. Available from: https://www.globenewswire.com. [Last retrieved on 2022 Oct 15].
7. Rivas R. Philippines' First Pharma Ecozone to Rise in Bulacan; 2021. Available from: https://www.rappler.com/business/philippines-first-pharmaceutical-economic-zone-rise-bulacan/. [Last retrieved on 2022 Dec 03].
8. Raouf A. Improving capital productivity through maintenance. Int J Oper Prod Manage 1994;14:44-52.
9. Cooke FL. Implementing TPM in plant maintenance: Some organizational barriers. Int J Qual Reliab Manage 2000;17:1003-16.
10. Besterfield DH, Besterfield-Michna C, Besterfield GH, Besterfield-Sacre M. Total Quality Management. 2nd ed. Englewood Cliffs, NJ: Prentice-Hall International; 1999.
11. Ahuja IP, Khamba JS. Total productive maintenance: Literature review and directions. Int J Qual Reliab Manage 2008;25:709-56.
12. Robinson CJ, Ginder AP. Implementing TPM: The North American Experience. Portland, OR: Productivity Press; 1995.
13. Eti MC, Ogaji SO, Probert SD. Reducing the cost of preventive maintenance (PM) through adopting a proactive reliability-focused culture. Appl Energy 2006;83:1235-48.
14. Chan FS, Lau HW, Chan HK, Kong S. Implementation of total productive maintenance: A case study. International Journal of Production Economics 2005.
15. Rodrigues M, Hatakeyama K. Analysis of the fall of TPM in companies. J Mater Process Technol 2006;179:276-9.
16. Chand G, Shirvani B. Implementation of TPM in cellular manufacture. Journal of Materials processing Technology; 2000.
17. Duffuaa SO, Raouf A, Campbell J. Planning and Control of Maintenance Systems: Modelling and Analysis. New York: John Wiley & Sons, Inc.; 1999.
18. Ismail AR, Ismail R, Zulkifli R, Makhtar NK, Deros BM. A study on implementation of preventive maintenance program at Malaysia palm oil mill. Eur J Sci Res 2009;29:126-35.
19. Wikstan J, Jonannson M. Maintenance and Reliability with Focus on Aircraft Maintenance and Spares Provisioning. Bachelor's Thesis, Lulea University of Technology; 2006.
20. Kimura Y. Maintenance tribology: Its significance and activity in Japan. Wear 1997;207:63-6.
21. Mechefske CK, Wang Z. Using fuzzy linguistics to select optimum maintenance and condition monitoring strategies. Mech Syst Signal Process 2001;15:1129-40.
22. Simões JM, Gomes CF, Yasin MM. A literature review of maintenance performance measurement: A conceptual framework and directions for future research. J Qual Maint Eng 2011;17:116-37.
23. Bjorklund S, Pribytkova M, Karaulova T. Development the Maintenance Plan: Maintenance Activities on Operational Level: Industrial Engineering. International DAAAM Baltic Conference, Tallinn, Estonia; 2010.
24. Tian Xiang Z, Jeng Feng C. Implementing total productive maintenance in a manufacturing small or medium-sized enterprise. J Ind Eng Manage 2021;14:152-75.
25. Bamber CJ, Sharp JM, Hides MT. Factors affecting successful implementation of total productive maintenance: A UK manufacturing case study. J Qual Maint Eng 1999;5:162-81.
26. Friedli T, Basu P, Bellm D, Werani J. Leading Pharmaceutical Operational Excellence Outstanding Practices and Cases. Heidelberg: Springer; 2013. p. 411-8.
27. Gupta AK, Garg RK. OEE improvement by TPM implementation: A case study. Int J IT Eng Appl Sci Res (IJIEASR) 2012;1:115-24.
28. Alkhalidi B, Abdallah A. Lean bundles and performance outcomes in the pharmaceutical industry: Benchmarking a Jordanian Company and Operational excellence international project. Modern Appl Sci 2018;12:97. [doi: 10.5539/mas.v12n8p90].
29. Friedli T, Macuvele J, Netland T.H. The role of management in lean implementation: evidence from the pharmaceutical industry. International Journal of Operations and Production Management 2023.
30. Chowdury ML, Rahman C, Hoque MA, Uddin S. Assessment of total productive maintenance implementation through downtime and mean downtime analysis (case study: A semi-automated manufacturing company of Bangladesh). IOSR Journal of Engineering 2014;04:38-47.