Comparative Aspects between TPM and World Class Maintenance – Literature Review

Peter Muganyi
Department of Engineering Management
University of Johannesburg
Johannesburg, South Africa
peter777.muganyi@gmail.com

Charles Mbohwa
Faculty of Engineering and the Built Environment
University of Johannesburg
Johannesburg, South Africa
cmbohwa@uj.ac.za

Abstract

Apart from Reliability Centred Maintenance (RCM), Total Productive Maintenance (TPM) and World Class Maintenance (WCS) are the other two most popular inclusive maintenance strategies and they are broadly applied in the industrial settings. Some companies are currently applying TPM whilst others have opted for WCS or other variants of maintenance strategies. The underlying factors for selecting one of these two strategies need to be unveiled and the points of departure and similarities in these two strategies need to be exposed. A literature review approach was undertaken to analyse the basic tenets of the two strategies and ascertain their compatibility or immiscibility.

Keywords
TPM, WCS, Maintenance Strategy, WCM

1. Introduction

Global rivalry demands quality as a precursor to market survival, and equipment maintenance to assure quality ascendancy is being pursued by countless enterprises. Total Productive Maintenance (TPM) and World Class Maintenance System (WCS) populate the innumerable strategic arsenal that businesses employ to outsmart rivals and gain unassailable momentum in the marketplace. Unified approaches are being trialed in organizations, like coupling TPM with Lean Manufacturing (LM)/TQM and establishing viable correlations (Ahmad, et al., 2012). Quality and maintenance of production structures are interrelated disciplines of any business, and the recent bygone era has unveiled 2 models - TPM and Total TQM sideways with others to attain world class manufacturing (Singh, et al., 2013). World class manufacturing (WCM) incorporates the world class maintenance system (WCS). Maintenance is budding up as the nexus to present day manufacturing organizations and it is more so to enterprises that are embracing maintenance as a revenue spawning industrial constituent (Jain, et al., 2015). TPM is effectual in the arena of maintenance and it is efficacious in uplifting reliability and equipment safety with evenhanded outlays, and it is therefore imperative for corporations to hand-pick the fitting maintenance strategy (Jain, et al., 2015). Consumers value three characteristics in a product, and these are quality, cost and delivery lead period; and the development of maintenance strategies to ensure that consumer expectations are met in this regard have become crucial (Bakri et al., 2012).

2. Literature Review of TPM and WCS

The prerogative of TPM is to enhance machinery efficacy by deploying equipment management during the early lifespan stages and maintenance deterrence, allotment of mundane undertakings of maintenance to their operatives, intensification of the commitment of workforce involvement in maintenance activities, and warranting that once failures and faults are eradicated, the operational velocity of machinery will upswing, tumbling operating costs and up swinging throughput (Chlebus, et al., 2015). Chlebus, et al., 2015, adjusted the standard ''TPM Model'', compacting it to 3 core columns as depicted in figure 1 below. (TPM) is a maintenance strategic thrust harnesed to heighten an enterprise's throughput and quality superiority by diminishing wastage and simultaneously plummeting expenditures (Poduval et al., 2013). The focal thrust of TPM is roping in machine attendants to get involved in menial maintenance chores and leave the intricate chores to qualified artisans all this being done to advance equipment uptime and impacting positively on business revenue (Poduval et al., 2015). Zero slanted conceptions that embrace zero acceptance for wastage, faults, break-downs and occupational incidents are being prioritized in many industrial settings. Apart from TPM's capability to realize uplifted worker self-esteem and occupational fulfillment, it is regarded as an inventive slant to maintenance that elevates equipment efficacy and eradicates functional failures (Singh, et al., 2013, Jain, et al., 2015). Variants of TPM outlines have been proposed in literature and an interesting one is the compacted version as depicted in table 1 below.

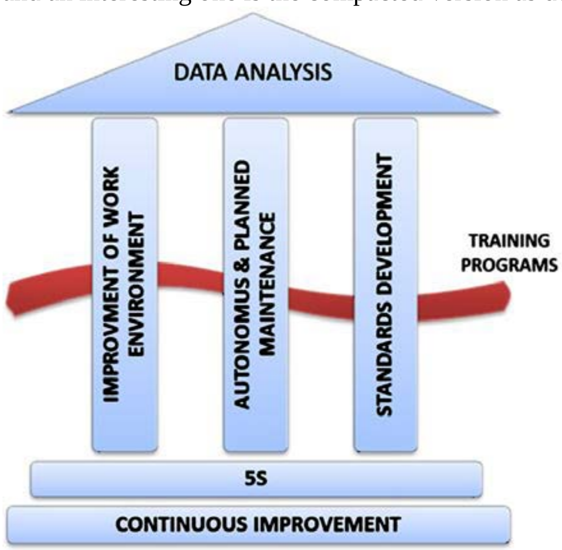

Figure 1. Compacted TPM arrangement (Shen, 2015).

Implementing TPM entails pursuing the 8 key dimensions, but some alternate operationalization techniques prefer going for the 12 steps of TPM application and drive onward gradually (Shen, 2015). The 9^{th} dimension of TPM is maintenance circumvention, where the knowledge focus is in attaining determined performance criterions for new machinery acquisitions and their specified operational and care parametric assertions (Méndez, J. D. M. and Rodriguez, R.S., 2017). Figure 2 below depicts the TPM framework with its 8 dimensions.

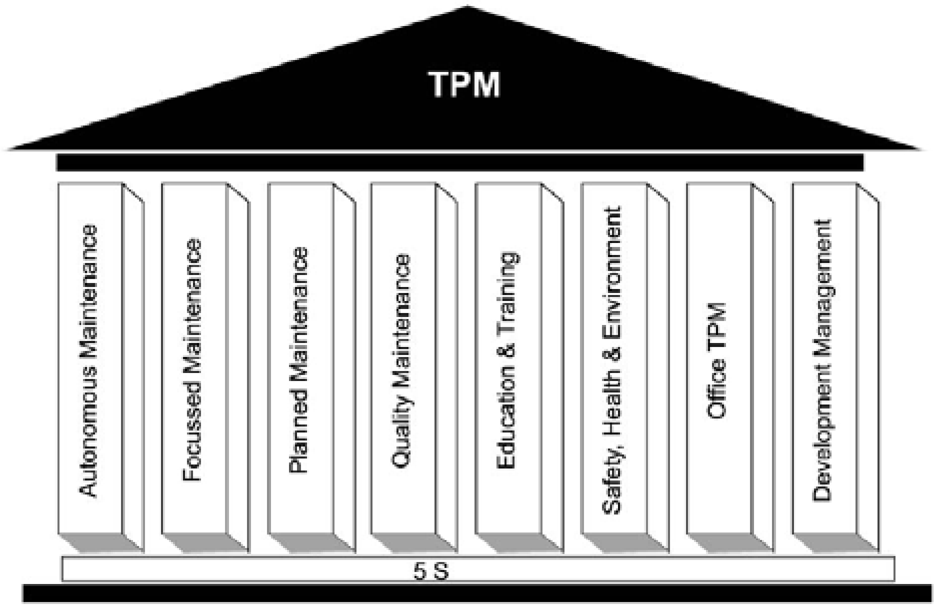

Figure 2. Dimensions of TPM (Singh, et al., 2013)

TPM sanctions the pertinent running of equipment, which in this day and age is a requisite state that businesses must comply with to ascertain competitiveness in supplying grander quality goods expressly (Borkowski, et al., 2014). Contemporary production systems call for mutually effective and proficient maintenance setups, and TPM is at the disposal to effect that (Attri, et al., 2014). WCS by definition is the unsurpassed maintenance system in a specific industrial segment globally and, this must be coupled with superlative quality, near to the ground production expenses, dependable distribution performance and superior customer service; the chief aim is to capitalize on performance to realize momentous advantage over opponents (Sadeghi and Manesh, 2012). WCS is an approach centered on a continuous improvement and its footing is in TPM and it also targets zero wastage, flaws, downtimes and inventory. WCM (which incorporates WCS) has a total of 10 technical pillars and these are depicted in figure 3 below.

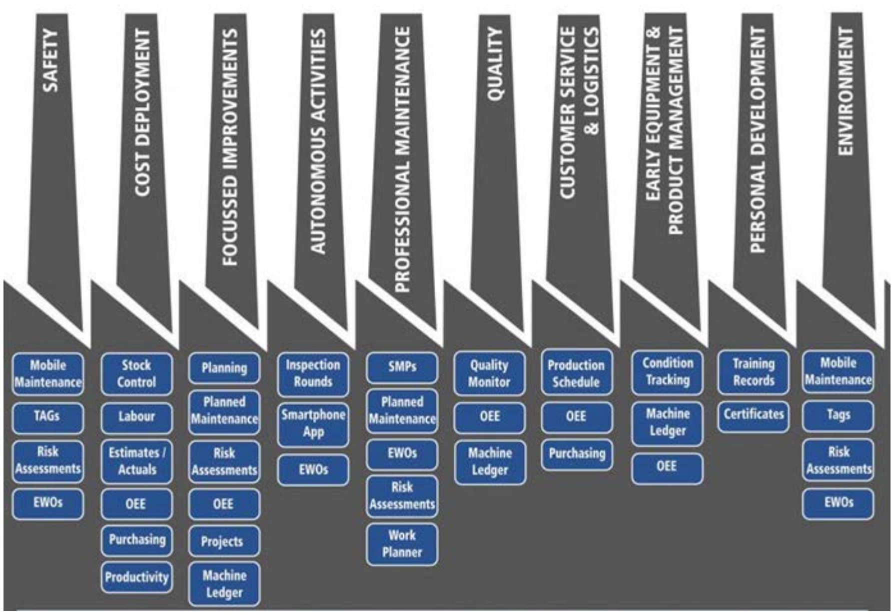

Figure 3. Technical pillars of WCM (Source: http://www.idhammarsystems.com/2017/05/fundamentals-wcm-i/)

WCM aims to attain:

- **Amplified Pellucidity**
  Continuous perfection through heightened discernibility of maintenance and production assignments, and root cause analysis.
- **Improved Throughput**
  Manufacturing yields negligible wastage, culminating in superlative quality and reduced expenditure
- **Value-added Communication**
  WCM endorses connectivity across all functions, and between top leadership and workers.

Benefits derived from WCM are:

- **Safety**
  Avoidance of occupational incidents, entrenching safe conduct and culture in the firm
- **Cost Deployment**
  Lessening of the impression of faults from a wastage and loss viewpoint
- **Focused Improvement**
  Application of appropriate kaizen tools or approaches to increase productivity and quality
- **Autonomous Maintenenace**
  Machine attendants involvement in maintenance
- **Professional Maintenance**
  Nil downtimes and maintenance costs minimization
- **Quality**
  Nil defects, Nil wastage
- **Customer Services and Logistics**
  100% client gratification and eradicating stock
- **Early Equipment and Product Management**
  Unveiling fresh machinery or goods to support competitiveness and diminish project expenditures and period
- **Personal Development**
  Teach, develop and support personnel to make WCM everybody's obligation
- **Environment**
  Regulate and diminish all environmental effects from the firm's activities

The individual technical pillar has to have a precise list of main measures to ascertain an operation-critical equipment or "model" area, and then the kaizen process is accomplished by pursuing a 7-steps methodology that is utilized to pinpoint root causes and preclude reoccurrence, thus moving the business from a *reactive* to *preventive* and ultimately *proactive* tactic.

3. Research Methodology

The chief concentration on the literature review was to pursue a structured approach in search of papers pertaining to TPM and WCS. A variety of publications were went through and this covered papers from 2005 up to 2017. The chief databases used were EBSCO, Scopus, Taylor and Francis, Elsevier and Emerald, interrelated publications were also tracked by reviewing the list of references in the papers selected and a total of 17 sources were finally selected from a total of 28 initially selected papers.

The assessment manner started by reviewing the TPM and WCS publications' abstracts and then followed by the detailed full text evaluation to ascertain relevance to the field of study. Thus the systematic evaluation of the literature focusing on tenets of TPM and WCS was conducted. Science Citation Index databases were deployed as the prime exploration databases as they are broadly utilized in the academia. Peer-reviewed academic paper publications were of principal emphasis in this research.

Search words used in the literature search were "Total Productive Maintenance", "TPM", "World Class Maintenance", "WCM" and "WCS" with selection confined to only English publications. Book reviews, prefaces, journal abstracts and editorial notes were excluded from the research.

The elementary literature review phases were thus deployed in this research and the phases are listed below:

1. Evaluation of peer-reviewed publications in Science Citation Index databases

2. Brief surveys, book chapters, abstracts and editorial notes were excluded.
3. The publications were designated and arranged, focusing on TPM and WCS
4. Methodical assessment of every chosen article was performed and the data was stratified to construct alignment from various insights.
5. Modern-day research was typically dedicated on as this reflects contemporary trends in the study field.

Table 1 Research List Cataloguing

Publication Database	Number of Articles selected
Procedia - Social and Behavioral Sciences	3
International Journal of Production Research	3
International Journal of Advanced Manufacturing Technology	2
Quality and Reliability Engineering International	2
Archives of Civil and Mechanical Engineering	1
International Journal of Quality & Reliability Management	2
Procedia CIRP	1
Journal of Applied Research and Technology	1
Procedia Engineering	2

4. Comparative Aspects between TPM and WCS

Table 2. Comparison of TPM and WCS

Element	**TPM**	**WCS**
Implementation duration	2.5 – 5 years (*Shen, 2015)*	2 – 5 years (authors' experience)
Goals – 0-breakdowns, 0-defects, 0-accidents and 0-wastage	√	√
Consequences sought from the riddance of breakdowns and defects - the productivity rates increase, costs reduction, inventory minimization and labor output escalations	√	√
Seeking commitment from intra and inter-functional sectors to track maximum efficacy of manufacturing machinery	√	√
Entails operators and maintenance artisans collectively working to diminish wastage, improve reliability and uplift the produced goods quality	√	√
The **productive maintenance** executed by workers through minor cluster actions and can be regarded	√	√

as machinery maintenance done on an enterprise-wide basis.		
Compatibility with Lean and other Improvement techniques	√	√
Identification of **clear, unambiguous, deliverable and finite objectives and targets**. Workers should be conscious of what the enterprise desires to realize.	√	√

In essence, WCS in an enhanced TPM system as it is founded on the TPM fundamentals. All the TPM elements are enmeshed in WCS as elements like quality maintenance, autonomous maintenance, maintenance prevention and planned maintenance are all included in the Professional Maintenance and Autonomous Maintenance technical pillars of WCM. The paramount practices in maintenance are engrained as components of WCS as an answer to surpass the limitations of TPM, as WCS is constructed centered on the principal notions of TPM, but fused the paramount practices within each constituent of WCS - one of the downsides of TPM is that a suitable application ideal is not obtainable (Mishra, et al., 2015). WCS has diverse sub undertakings such as spare parts controlling, inventory control, worker participation, lubrication management, of which a comprehensive list of essentials and their accompanying practices has been drafted in the outline for application of WCS (Mishra, et al., 2015). These practices are derived from the basis of prevailing TPM understanding and the execution of preeminent maintenance practices in numerous establishments as described in the literature (Mishra, et al., 2015).

5. Conclusion

Application of WCS is an interminable practice and devoting in WCS application is a highly worthy investment with well paying returns, although it often denotes a selection of an enduring exertion that entails a boundless covenant of commitment, management devotion, monetary investment, endurance, and resolve (Mishra, et al. 2015). WCS is an advanced version of TPM, and without understanding the TPM fundamentals one cannot implement WCS effectively. The only difference between TPM and WCS is that WCS is TPM that is gunning for best practices and modeled for implementability. Therefore, it is time to move from TPM and start embracing WCM and WCS as they are contemporary strategies that exude more benefits than TPM. Further research need to be taken on exploring the deficiencies and limitations of WCS and thereby recommending further improvement actions to make it more robust and adaptable to a diversity of firms.

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Biography

Peter Muganyi is a doctoral candidate in Engineering Management at the University of Johannesburg, South Africa and he is an Engineering Manager at Gyproc. His research interest covers the areas of Lean Six Sigma effectiveness, Strategic Maintenance Systems deployment and Business Process Modelling.

Professor Charles Mbohwa is the Vice-Dean Postgraduate Studies, Research and Innovation at the University of Johannesburg's (UJ) Faculty of Engineering and the Built Environment (FEBE). As an established researcher and professor in the field of sustainability engineering and energy, his specializations include sustainable engineering, energy systems, life cycle assessment and bio-energy/fuel feasibility and sustainability with general research interests in renewable energies and sustainability issues.