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Harnessing Technology Management to Heighten Physical Assets Reliability

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

The requisite technology to sustain the prevalent maintenance strategies need to be deployed as a vital step towards enhancing competitive efficacy. Technological management as a strategic inclination should be applied as a measured and organized process of identifying novel technologies to replace or augment the existing technological apparatuses within the business, and more so, the strategic significance of the technology management need to be clearly specified. The prominence should be on technological management and innovation management within the field of physical assets reliability management. The objective of pursuing technology management under the auspices of reliability management is to capitalize on the heightened performance levels of the contemporary technological offerings to progress on the efficacy and swiftness of reliability enhancement activities. This study was undertaken to explore the facets of technology management that can be capitalized by maintenance practitioners on up surging the reliability of physical assets.

Keywords

Technology Management, Maintenance Strategy, Diagnostics, Prognostics

Introduction

Various industrial concerns are faced with unrestrained, international markets which compel organizations to be in possession of attributes for swift reaction and minimal costs structures (Garrido-Vega, et al., 2015:201). Considering the crucial role that technology possesses in organizational competitiveness, appropriate technological management in conjunction with good operational strategies, is important to curtail the prevailing challenges (Garrido-Vega, et al., 2015:201).It is now commonplace, that numerous organizations nowadays are technologically-dependent and they fail to effectively deliver dependable and top notch services if their technology bound operations are not functional, which may even culminate in total shutdown (Madu, 2000:938).

When an organization is faced with the daunting task of selecting and up-taking some technological management tools, challenges always spring up with regards to the right tools and the organizational readiness, and this is even compounded by the unavailability of sound toolkits that provide a fitting jigsaw that suits their situation (Kerr, et al., 2013:1050). The thrust is on developing industrially relevant strategic technology management toolkits (Kerr, et al., 2013:1050).

Technology management is concerned with the nominal realization, choice, acquirement, improvement, utilization and fortification of technologies necessary to uphold a flow of goods and services to the product-market (Kerr, et al., 2013:1051). The technological management framework is illustrated in the figure below.

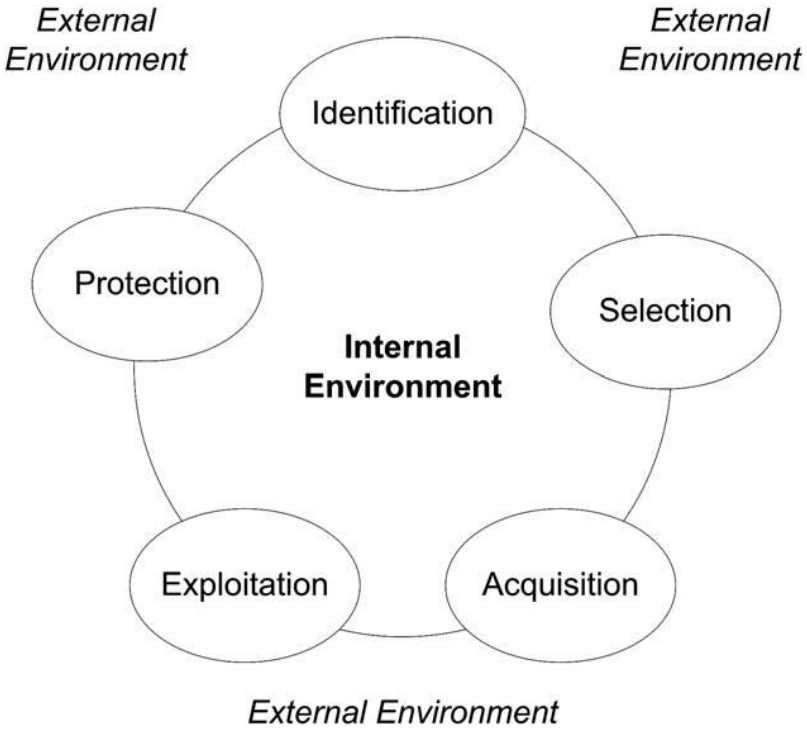

Figure 1: Technology management framework (Kerr, et al., 2013:1052).

Technological management cannot function effectively on its own, it needs to be complimented by other crucial business processes such as strategy, innovation and operations management, as these afford the essential association between the technological management practices and the broad business undertakings and this is depicted in the figure below (Kerr, et al., 2013:1052).

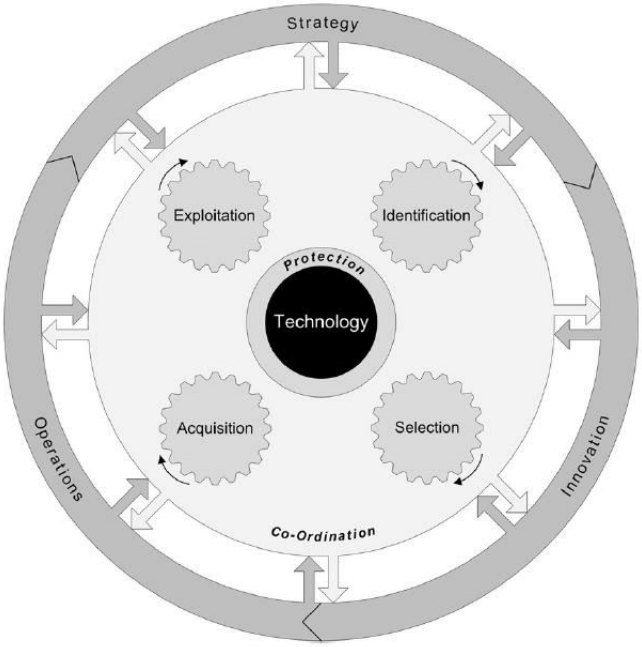

Figure 2: Strategic technology management framework (Kerr, et al., 2013:1053).

Any adopted technological management tool ought to be 'human-centric' — and that means that the tool should afford the occasion for people to interact with the technological outlay to provide solutions which embody their meaningful collaboration and generating a high quality product/service (Kerr, et al., 2013:1055). Technological management tools should have appreciation of the situational dynamics of real-life applications by taking into cognizance the cultural, sociological and psychological aspects of the human-centric settings (Kerr, et al., 2013:1055).

The broad inclination towards an upsurge in the application of technology in asset intensive enterprises is premised on the understanding that it will impact on physical assets reliability and effectiveness (Garrido-Vega, et al., 2015:202).

Interactive Technology and Strategic Reliability Management

Technology management should drive physical assets reliability within the maintenance function. It is useful as a multi-functional and multi-disciplinary thrust that is embedded in the strategic dispensation of a business, and cuts across functions such as innovation, maintenance and manufacturing (Kerr, et al., 2013:1051). The ever increasing complexity, significance and swiftness of technological advances proffer momentous challenges for technologically-oriented businesses and the obligation to center their competitive prowess on technology (Schuh and Kramer, 2016:437). As such, a well-defined and articulate technology management framework is vital for a business´ success with regards to ascertaining physical assets reliability and sustainable operation of assets (Schuh and Kramer, 2016:437). This signifies the imperative evaluation of the cause-and-effect relational disposition of technology management and asset reliability performance (Schuh and Kramer, 2016:437).
Nowadays technological aspects have become crucial drivers for asset reliability initiatives as such as information systems, diagnostic systems and repair systems have afforded maintenance practitioners to improve on repair effectiveness and efficiency.
Thus in maintenance management, technologies are vital resources and that have to be managed effectively for reliability amelioration and maintenance performance efficacy (Schuh and Kramer, 2016:438). For physical assets like mobile vehicles, novel technologies are appearing daily, with the engines revolving into more electronic or mechatronic biased assets (Monteiro Tavares and Szpytko, 2016:67). The evolution of mechatronics biased physical assets demand maintenance solutions and systems that are compatible with the new technology in the physical

assets, and the likes of E-maintenance support systems have become the trend nowadays (Monteiro Tavares and Szpytko, 2016:67). Computer-based maintenance systems for programmable logic controllers are commonplace in most manufacturing firms these days, and the skillsets are being inclined towards control and instrumentation, with even the capability of various maintenance activities being undertaken through the internet/ remote platforms (Monteiro Tavares and Szpytko, 2016:67). The evolution within the field of prognostics techniques facilitates the extrapolation of failures in physical assets ensuing in benefits to processing plants such as reduced outages, maximized operational reliability, minimized operational and maintenance expenditures, and enhanced maintenance and logistics planning (Kan, et al., 2015:1). Prognostic technology has been efficaciously applied for the monitoring of comparatively modest rotating equipment (Kan, et al., 2015:2).

Contemporary technological progresses have culminated in uncountable complex schemes, practices and goods, and these progressively more intricate systems have rendered considerable challenges for the maintenance practitioners (Venkatasubramanian, 2005:1253). The technologically advanced equipment now play a fundamental role in numerous process industries as they are used for process control and safety performance regulation, thereby demanding that advanced technological systems are mandated to monitor and rectify the physical assets health to prevent deleterious consequences to the organization (Venkatasubramanian, 2005:1253). Venkatasubramanian (2005:1255) gave an illustration of a typical prognosis and diagnostic system for a process plant that has advanced technological system applications.

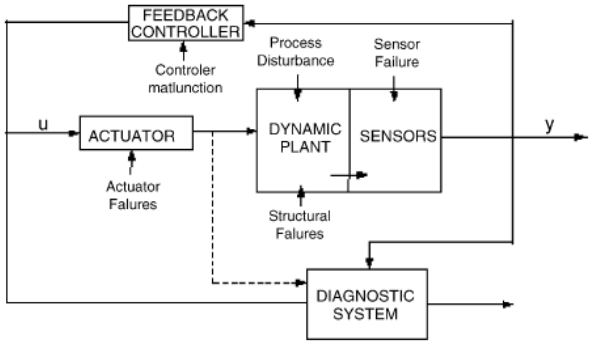

Figure 3: Diagnostic framework (Venkatasubramanian, 2005:1255).

Venkatasubramanian (2005:1255) further stipulated that an effective prognostic system should possess the following attributes: Speedy defect/fault exposure and diagnosis, high isolability to differentiate between diverse failures, system robustness to diverse noises and indecisions, considerable novelty identification, high reliability degree of classification error estimation, adaptability to external inputs or structural variations introduced by the likes of retrofitting , possession of fault exposition facility, high informational storage capability and multiplicity of fault/defect identification latitude (Venkatasubramanian, 2005:1255).
The diagnostic approaches are generally classified into different categories, and below is a diagrammatic depiction of the categories.

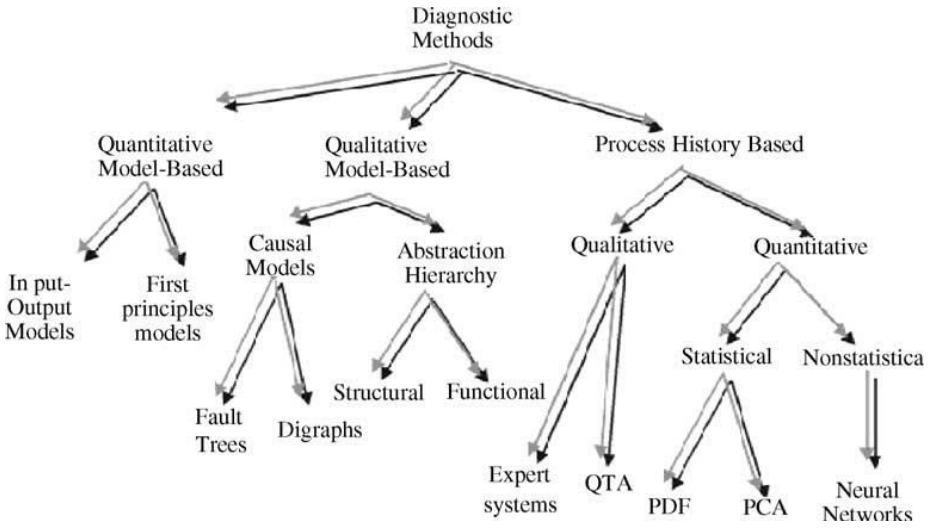

Figure 4: Categorization of prognostic/diagnostic approaches (Kandukuri et al., 2016: 699).

According to Kandukuri et al. (2016: 699), prognostic systems are categorized into four(4) tiers which engross:
Fault detection: The system has capability to detect a fault/defect; thereby differentiating amongst a healthy and a faulty system. This level allows for maintenance personnel to manually intervene if required, to expose the fault and rectify.
Fault diagnosis: The system possesses capability of explicitly recognizing the fault/defect that has arisen and the maintenance team may select an appropriate maintenance task for fault/defect rectification.
Fault quantification: This is when the system quantifies the fault/defect and determines its magnitude and this stage may call for immediate maintenance action
Fault prognosis: The system has capability of detecting and quantifying the fault/defect and it also displays its traits of forecasting the necessary course of action to the functional failure. Thus the Potential Failure interval (PF-interval) is extrapolated with satisfactory precision and a maintenance space is computed. The PF-interval is illustrated in the figure below and it is the basis upon which prognostic systems operate.

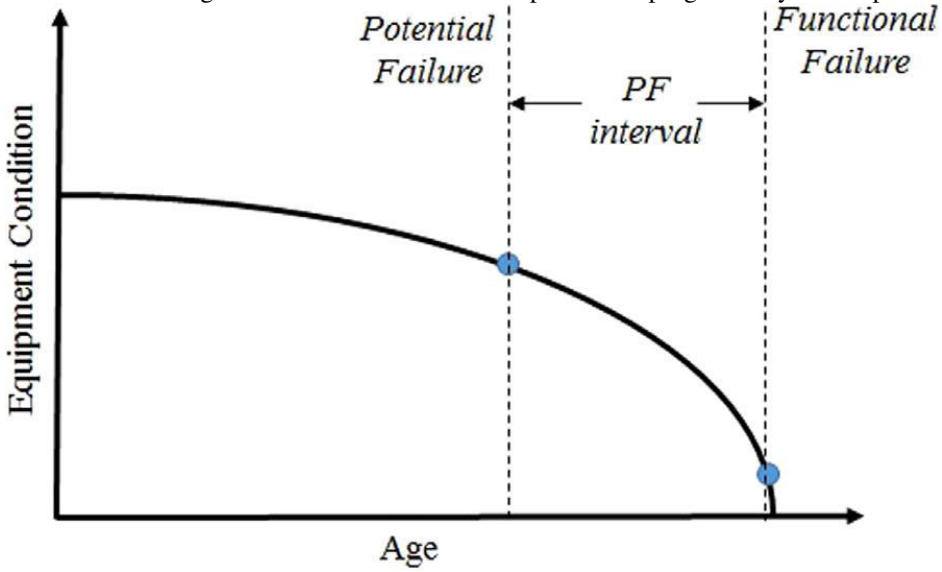

Figure 5: The PF - interval. (Kandukuri et al., 2016: 699)

In the above categorization, it is clearly exhibited that the diagnosis and the prognosis are noteworthy advances in terms of benefits to the maintenance process and physical assets reliability, as accurate diagnosis meaningfully diminishes the downtime by identifying faults/defects in embryonic stages and detecting the fault/defect location,

prognosis openly adds to maintenance planning to prevent functional failure occurrence(s) (Kandukuri et al., 2016: 699).

Strategic Significance of Technology Management

Technology management is habitually cross-functional and multi-functional structured and encompasses the organization's core-business processes that entail strategy, innovation, fresh products development and operational management (Schuh and Kramer, 2016:438). The management of technology is based on the conventional Engineering Management discipline and its effectiveness in maintenance strategic delivery and physical assets reliability enhancement need to be measured within the precepts of the maintenance strategy (Schuh and Kramer, 2016:439). The technology management framework is illustrated in the figure below, and its management should be treated within the context of maintenance management and as a crucial factor for assets reliability improvement.

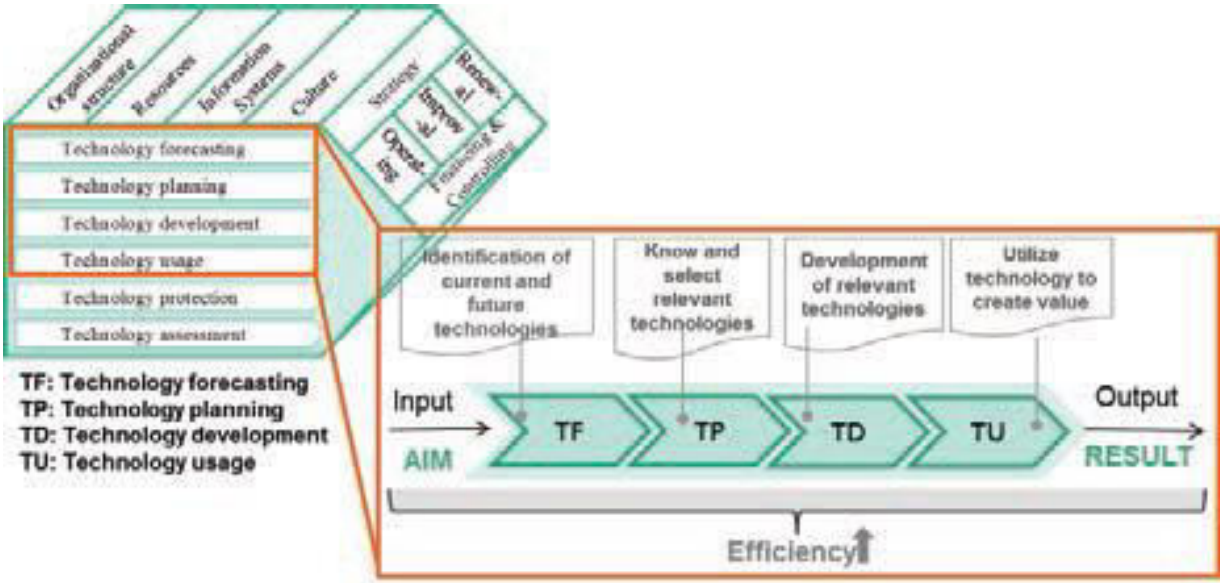

Figure 6: Technology management framework (Schuh and Kramer, 2016:440).

Pertinent to the mounting prominence and intricacy of technological breakthroughs and the bearing of technology to businesses in their quest for global competitiveness, a well-thought-out technology management route is indispensable for a business´ continued existence (Schuh and Kramer, 2016:441). Technological proficiency is regarded as the underpinning of strategy, as it proffers the standpoint on which technology ought to direct strategy (Ortega, et al., 2012:959).Technology management is regarded to be a dominant competitive element for nations at macro-level and for distinct businesses at micro-level (Sahoo, et al., 2011:13).

The comprehensive shift in end user predispositions, legislative regulations, safety and environmental trepidations have fetched rather discernible bearing on products or processes technologies (Sahoo, et al., 2011:10). Industrial firms' growth initiatives pivot on their level of competitiveness in the overall markets, and this level is predominantly heightened by the accessibility to novel technology and the proficiency to present groundbreaking goods/services (Krawczyk-Dembicka, (2017:19), Schuh and Kramer, (2016:437)). As a result of the predominant role that technology plays in business competitive advantage, appropriate technology management merged within an effective maintenance strategy, and therefore corporate strategy, is vital to redress prevalent business issues (Garrido-Vega, et al., 2015:201).

Technology Management in Manufacturing Organizations

A survey method was deployed to ascertain the application of technology management in manufacturing organizations within the South African context. The survey focused on manufacturing organizations within

Johannesburg which were randomly selected within their industrial areas. A total of one hundred and sixty eight (168) participants completed the survey questionnaires which were administered through emails in order to compile the research analysis. The participants comprised of maintenance managers and engineers, production managers and operators, maintenance artisans, and senior managers within the manufacturing businesses. The survey questions were structured as per the table(s) below and the responses were captured accordingly.

Table 1: Technology Management within manufacturing firms

	A: Extent to which your organization is performing on this factor.					Activity		B: Extent of influence that this factor exerts on growing the performance of your organization.				
	Very poor	Poor	Average	Good	Very Good			Not Influential	Slightly Influential	Neutral	Moderately Influential	Extremely Influential
Tally	42	68	37	21	0	Application of the most recent maintenance technology	Tally	15	22	55	49	27
N%	25.0%	40.5%	22.0%	12.5%	0%		N%	8.9%	13.1%	32.7%	29.2%	16.1%
Tally	47	82	30	7	2	Extent to which technology management is used to increase assets reliability	Tally	9	15	57	62	44
N%	28.0%	48.8%	17.8%	4.2%	1.20%		N%	5.4%	8.9%	33.9%	36.9%	26.2%
Tally	52	72	28	15	1	Extent to which Technology Management supports the Maintenance Strategy	Tally	14	21	28	40	65
N%	31.0%	42.9%	16.7%	8.9%	0.6%		N%	8.3%	12.5%	16.7%	23.8%	38.7%
Tally	55	74	19	15	5	Correlation between Technology Management and Business Strategy.	Tally	10	13	34	64	47
N%	32.7%	44.0%	11.3%	8.9%	3.0%		N%	6.0%	7.7%	20.2%	38.1%	28.0%
Tally	43	57	42	18	8	Capability of the organization to change according to contemporary technology	Tally	3	16	24	61	64
N%	25.6%	33.9%	25.0%	10.7%	4.8%		N%	1.8%	9.5%	14.3%	36.3%	38.1%

1. From the survey results, a total of 65.5% of respondents considered their application of the maintenance technology as poor, while 22% were undecided, and only 12% of the respondents considered the application of the latest maintenance technology by their organizations as good. 45.3% of the respondents considered the application of the latest maintenance technology as influential and only 22% of the participants considered the application of the latest maintenance technology as not influential to their maintenance performance. This signifies that the latest maintenance technology is regarded as essential for physical assets reliability improvement initiatives.

2. A total of 76.8% of respondents considered the use of technology management to increase assets reliability as poor, while 17.8% were undecided, and only 5.4% of the respondents considered the use of technology management to increase assets reliability by their organizations as good. 63.1% of the respondents considered the use of technology management to increase assets reliability as influential to their maintenance performance and only 14.3% of the participants considered the use of technology management to increase assets reliability as not influential to their maintenance performance. This signifies that the use of technology management to increase assets reliability is regarded as essential for physical assets reliability improvement for manufacturing firms.
3. A total of 73.9% of respondents considered the application of Technology Management to support the Maintenance Strategy as poor, while 16.7% were undecided, and only 9.5% of the respondents considered the application of Technology Management to support the Maintenance Strategy by their organizations as good. 62.5% of the respondents considered the application of Technology Management to support the Maintenance Strategy as influential to their maintenance performance and only 20.8% of the participants considered the application of Technology Management to support the Maintenance Strategy as not influential to their maintenance performance. Despite the poor application of Technology Management to support the Maintenance Strategy, it is regarded as a crucial aspect for maintenance performance increase and physical assets reliability improvement for manufacturing firms.
4. A total of 76.7% of respondents considered the Correlation between Technology Management and Business Strategy as poor, while 11.3% were undecided, and only 11.9% of the respondents considered the Correlation between Technology Management and Business Strategy by their organizations as good. 66.1% of the respondents considered the Correlation between Technology Management and Business Strategy as influential to their maintenance performance and only 13.7% of the participants considered the Correlation between Technology Management and Business Strategy as not influential to their maintenance performance. Although there was generally poor Correlation between Technology Management and Business Strategy, it is regarded as significant for maintenance performance increase and physical assets reliability improvement for manufacturing firms.
5. A total of 59.5% of respondents considered the Capability of the organization to change according to contemporary technology as poor, while 25% were undecided, and only 15.5% of the respondents considered the Capability of the organization to change according to contemporary technology by their organizations as good. 74.4% of the respondents considered the Capability of the organization to change according to contemporary technology as influential to their maintenance performance and only 11.3% of the participants considered the Capability of the organization to change according to contemporary technology as not influential to their maintenance performance. This signifies that the Capability of the organization to change according to contemporary technology is regarded as vital for physical assets reliability improvement for manufacturing firms and the general maintenance performance heightening.

Conclusion

Technology Management has a pivotal role in gratifying the promise of physical assets reliability in a socially responsible and sustainable manner. The survey that was carried out confirmed the significance of technology management as a maintenance improvement and physical asset reliability improvement factor. Despite technology management's low application by manufacturing firms in South Africa, it is highly influential in the maintenance and physical assets reliability improvement endeavours of organizations, and its strategic management is imperative. The application of technology management translates into competitiveness of the business in its markets, but only if technology management is appropriately strategically handled.

In some instances, legislative regulations impose technological requirements upon businesses especially with regards to the preservation of ecological systems, and in such instances technology management is enforced upon the businesses. Technology management requires the framework of engineering management to be imposed upon it, as it forms part of the engineering management discipline.

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Biographies

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.