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ORIGINAL ARTICLE

An evaluation of maintenance practices in Kenya: preliminary results

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Abstract Over time, the definition of maintenance has evolved from activities meant to keep equipment in an operable condition, to a set of activities required to keep the means of production in the desired operating conditions or to restore them to this condition. Further, all those systematic activities geared towards the actual execution and improvement of maintenance are referred to as maintenance practices. There is a general assumption that maintenance practices in the developing world are below standard, when compared to what happens in the developed world. However, this is not a fact that has been determined empirically, but rather a perception. This paper presents the results of an assessment of maintenance practices in Kenyan industries, using a maintenance practices evaluation tool. The analysis provides a critical overview of the current status of maintenance practices, and shows how these maintenance practices compare with the best practices globally. Research was carried out through a survey, using a questionnaire developed to establish the maintenance practices in a number of Kenyan companies. The survey clustered industries into different categories, namely, service, power generation, food manufacturing and processing, agro/chemical, metal processing, motor vehicle assemblers, transport, maintenance and construction industries. The responses from the survey were analyzed using three aspects of maintenance practices, namely, technical, managerial and human aspects. For each of these aspects, an evaluation index was developed and calculated. Subsequently, the general evaluation index was determined. This index showed that Kenyan companies are at the managed level of maintenance practices, where processes are partially planned, and performance depends on the operators' experience and competence. It is recommended that Kenyan companies should aim at improving the index to the highest level, namely the optimizing stage, by focusing more on improvements in the technical aspects of maintenance.

Keywords Maintenance practices · Maintenance actions · Evaluation criteria · Maintenance in Kenya

1 Introduction

The core function of maintenance should be to preserve components and equipment so that they can perform their desired functions. This calls for good policies and strategies in a company. Also, due to the rising demand on increased productivity, quality and availability, machines have become more complex and capital intensive (Labib 1998). Thus, there is need for improved maintenance techniques using sophisticated equipments to diagnose and even repair the machines. Also, the manpower must be well equipped to use the advanced monitoring and diagnostic equipment.

In view of the above, a good maintenance policy is a necessity in the work environment for increasing the availability of the equipment. Unfortunately, most individuals or companies perform maintenance after an emergency or breakdown, and mostly because it has to be done. In an effort to increase the profit and maximize availability

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of the equipment, maintenance is done only when the operators are not present e.g. over the weekends or on public holidays. This leads to unexpected breakdowns or poor performance because the operators do not have the actual performance history of the machine.

Maintenance practices have been defined in literature as the systematic activities that are geared towards the execution and improvement of maintenance. The two perspectives of maintenance practices are maintenance execution and maintenance improvement (Muchiri et al. 2015). A company must adopt good maintenance practices in order to achieve its goals of production.

Maintenance engineering is a new area of research in Kenya. Previously, maintenance was handled as a topic in the various engineering courses. In turn, this has led to local graduates being employed without a firm grounding in maintenance. This has had a significant contribution to how maintenance is handled. Unless there is failure, no effort is made to check the probabilities and effects of a failure occurring. This is an undesirable approach to maintenance.

2 Problem statement

The world has become a global market today. Thus, for the local companies to compete effectively with others from around the globe, their production costs must be kept low. One way of achieving cost reduction is through effective maintenance. There is, therefore, a need to establish how maintenance is practiced in Kenya. Also, an area of interest is how the country compares with other nations in terms of maintenance practices.

This paper aims at establishing the maintenance practices used in Kenya, and evaluating these practices with the aim of determining how the country compares with other economies.

2.1 Significance of the research

This research will provides an in depth analysis of the local maintenance practices and determine the level of these practices. Also, a comparison of these practices with the best practices globally will be done. This knowledge gap lacks in the research work done in the country in this field.

3 Evaluating maintenance practices

Over the years, the concepts of maintenance have undergone many major developments. Thus, several maintenance approaches, strategies, policies, methodologies and philosophies have been developed. These concepts are normally developed with a managerial perspective, and little is known about the execution perspective, i.e. what actually is done on the shop floor.

A lot of literature has being written in the field of maintenance (Pintelon et al. 2006; Zio and Compare 2013; Raouf 1993). Macchi and Fumagalli (2013) evaluated maintenance in terms of managerial, organizational and technological capabilities. They further developed the five levels of maintenance maturity. However, their main focus was on maintenance management. Areas not covered in their study included maintenance practices with regard to activities that happen on the shop floor. Tahboub (2011) investigated maintenance practices and the problems faced by Jordanian industries. The key finding of his research was that most industries had maintenance departments but did not allocate sufficient budgets to them. This research did not assess maintenance practices.

There is also a lot of literature on maintenance modeling and optimization, but for evaluation purposes there is a gap when it comes to the observable actions and practices in the manufacturing industries.

This research intends to establish the maintenance practices in Kenyan industries, and to evaluate them against a pre-defined criteria.

4 Methodology

This paper forms part of a larger research on optimization of maintenance practices in the developing world, and specifically in Kenya. The main objective of this paper is to assess the level of maintenance practices in the Kenyan manufacturing industries. For this purpose, a theoretical framework for assessment of maintenance was used. A survey was conducted in several companies as a sample of the population. The results of this survey are presented later in this paper.

4.1 The assessment framework

Muchiri et al. (2015) proposed a five-level framework for classifying maintenance practices, as presented on Table 1.

The framework suggests that an organization at level 1 has poor maintenance practices, and one at level 5 utilizes best maintenance practices. However, it is possible for an organization at this highest level to utilize all strong practices from the levels below. It is also possible that an organization at a lower level employs some of the practices associated with higher levels (Muchiri et al. 2015).

4.2 Data collection

A quantitative approach was used to achieve the objectives of the research. A survey questionnaire was developed to assist the researcher to collect the quantitative data

Table 1 The five-level framework for classifying maintenance practices (Muchiri et al. 2015)

Stage	Classification	Description
Level 1	Basic practices	Practices employed tend to be unplanned and unpredictable. Performance of tasks is very subjective to the person assigned
Level 2	Repeatable practices	Practices associated with repetitive maintenance practices. Partial planning of processes, and practices related to process monitoring is utilized
Level 3	Proactive practices	Practices associated with planning and implementation according to organizational objectives. Use of quantitative analysis to plan and define maintenance tasks
Level 4	Managed practices	Practices related to managing and controlling maintenance, by planning based on feedback data from various maintenance processes
Level 5	Optimum practices	Practices related to continuous improvement of maintenance and quality control, failure analysis, defect analysis, future improvements, Design Out Maintenance (DOM) practices also utilized. Testing of new maintenance methods and techniques may also feature

regarding the maintenance level, the operations of the maintenance department, the workforce in the department, the tools and equipment used etc. The questionnaire had 38 questions, sub-divided into five sections, namely: introduction, the technical evaluation, the managerial evaluation, the human related evaluation and finally comments of the interviewee. Direct interviews with the maintenance engineer or personnel was used to collect the opinions of the interviewee and their explanations on information which may not be clear from the data collected.

This approach has been used by a number of researchers in the field of maintenance engineering (Tahboub 2011; Mjema and Mweta 2003; Mjema 2002; Reiman and Oedewald 2006; Muchiri 2010; Pinjala et al. 2006).

The questions were formulated to bring clarity on elements of the maintenance practices. The analysis of the questions answered the following:

1. The maintenance activities performed in the industry under investigation.
2. The details of the maintenance programs pursued.
3. The extent of the application of maintenance concepts.
4. The level of improvement on the maintenance concepts.
5. The cost elements of maintenance and budgetary provisions.
6. The performance measurement system used.

The questions were made as simple and straight forward as possible. This was to try and ensure as many responses as possible. In order to avoid a bias in terms of rating performance, e.g. asking respondents to rate their companies, alternative answers were provided, from which the respondents could recognize their organizations. Each of the answers carries a weight which can later be used in the evaluation.

To illustrate this, question 7 from the questionnaire is sampled here below:

7. When do you perform machine/equipment/component replacement?

   - Upon failure.
   - In accordance with the original equipment manufacturer (OEM) specifications.
   - As a strategy.
   - On a case to case basis.
   - To improve the operational efficiency.

This question evaluates technical aspects of maintenance. If the weights for each answer are revealed, a significant bias can be expected. However, respondents can easily pick out the exact reason that drives a company to replace a component from the list.

The first answer suggest a very basic approach to maintenance, while the last one refers to a refined maintenance strategy, focussing on optimization.

4.3 Validation

Validation of the questionnaire and the data gathered was done at two levels. First, the questionnaires were sent out to four companies for pilot testing. Recipients were contacted before and after receipt of the questionnaire. The structure and questions were found to be adequate and comprehensible. The main feedback received was to include an open field to allow respondents to comment per question if they felt that the choices given were adequate.

The questionnaire was then modified and the main survey was carried out.

After data collection, a reliability analysis was performed on the data. This analysis is presented on Table 2.

The Cronbach's Alpha returned a value of 0.914 for the 26 items. This value is safely above 0.7, hence the results are acceptable.

Table 2 Reliability analysis

Reliability statistics		
Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of items
0.914	0.914	26

5 Results

5.1 Survey statistics

A total of 78 companies were approached to participate in the survey. 50 out of 78 companies responded to the survey. This represents a 64.1% response, which is is sufficient to provide a critical analysis of the maintenance practices being employed in the industries. The classification of industries generally followed the classes identified in the European industrial classification Code (NACE) (European Union 2010) and US Standard Industrial Classification (SIC) (US Securities and Exchange Commission 2011). The analysis of the responses is as shown in Table 3.

The sample size of 50 can be considered as being sufficient for purposes of further analysis (Muchiri et al. 2009). It can be observed that the food manufacturing industries had the highest number responses, in terms of number of questionnaires sent out. This is also representative of the total number of formal industries in the country. The service industry and motor vehicle assemblers had the lowest return rate.

A further analysis of the responses reveals that the number of companies with a multinational background is significantly close to that of local companies, as illustrated on Table 4. It would therefore be expected that there will be a strong influence of advanced maintenance practices on such companies in the country.

Further, Table 5 shows that half the number of companies surveyed have an employee population of between 100 and 500, hence making them medium-sized, in local terms. Large companies with over 1000 employees were 26%.

Table 3 Response per category of industry

Category of industry	Responses (%)
Service industry	50.0
Power generation plants	80.0
Food manufacturing industries	79.1
Metal processing industries	80.0
Agro/chemical industries	66.7
Motor vehicle assemblers	50.0
Transport industries	100
Maintenance industries	75.0
Construction industries	66.7
Total	64.1

Table 4 Origin of companies in Kenya

Origin of companies	Responses (%)
Local	42
Regional	24
Multinational	34

Table 5 Company size

Company size of respondents	Population (%)
Between 1–10	0
Between 11–50	10
Between 51–100	12
Between 101–500	48
Between 501–1000	4
Over 1000	26

Finally, Table 6 shows the proportions of maintenance personnel to the total employee population in the industrial sectors surveyed.

It is evident that apart from the Maintenance and the power generation sectors, most of the other sectors have $<20\%$ maintenance workers. This ratio is, however acceptable, since maintenance should serve the purpose of supporting the industry run, and it is not the core business of an organization. The Power generation sector sticks out in that most of the staff who work at these plants do maintenance related work, since engines do all the production work. On the other hand, the maintenance sector would be expected to have over 90% maintenance personnel. However, this is not the case, and it can be taken to point at inefficiencies in the structures of the organizations.

5.2 Determining the evaluation index

The results of the survey were analyzed based on the three aspects of maintenance practices, i.e. technical, managerial and human aspects (Muchiri et al. 2015). The evaluation index (EI) as per an individual aspect was then calculated using the Eq. (1) (Muchiri et al. 2015).

$$EI = \frac{\sum_{q=1}^{k} VN_{iq}}{k} \tag{1}$$

where q the index of the question, k total number of questions, VN_{iq} the weighted score in the question indexed.

The weighted score in Eq. (1) can be calculated as follows:

$$VN_{iq} = \frac{\text{question score} \times \text{level}}{5} \tag{2}$$

Table 6 Percentage of maintenance personnel to total personnel

	Category of industry	% Maintenance personnel to total personnel
1	Service	7
2	Power generation	41
3	Food manufacturing	7
4	Metal processing	14
5	Agro/chemical	5
6	Motor vehicle	14
7	Transport	21
8	Maintenance	76
9	Construction	12

The weighting of the score is based on the fact that there are 5 possible answers to each question. The answer given is then multiplied by the assigned level, then divided by the highest score. Thereafter, a combined general evaluation index (GEI) is determined, as an arithmetic average of the three aspects evaluation indexes.

The following rules are applied to the results from (1), with regard to determining the Level (L) for a given aspect:

$$\begin{aligned} &\textit{if} \quad 1 \le EI < 2 \quad \textit{then} \quad L = 1 \\ &\textit{if} \quad 2 \le EI < 3 \quad \textit{then} \quad L = 2 \\ &\textit{if} \quad 3 \le EI < 4 \quad \textit{then} \quad L = 3 \\ &\textit{if} \quad 4 \le EI < 5 \quad \textit{then} \quad L = 4 \\ &\textit{otherwise} \quad L = 5 \end{aligned} \tag{3}$$

Level 1 is the lowest attainable level (basic practices), and 5 is the highest attainable level (optimum practices). The L value from Eq. (3) has to be an integer. For instance, if a score level of 1.9 is arrived at, it means that the company is yet to get to the next level of Repeatable practices, so it still falls under basic practices.

5.3 Technical aspects

The technical aspects were covered by questions 7–20 of the questionnaire (see also: Appendix). The cumulative responses totaled 699. A summary of the responses is presented on Table 7.

5.3.1 The technical evaluation index (TEI)

The TEI was calculated using Eq. (1), and found to be 2.398.

Based on Eq. (3), the Level for technical aspects will be 2.

According to Table 1, the Technical aspects of maintenance practices are at the *Repeatable practices*.

Some deductions from the responses are as follows:

(i) Maintenance and repair activities generally follow the OEM maintenance specifications, with very little innovation or modification.

(ii) The re-ordering of spare parts is mainly done using the minimum stock levels based on experience, and there is very little automation in reordering processes.

(iii) Job cards are used, and repairs are monitored based on time.

(iv) There is a high dependency on highly specialized and experienced teams for any specialized maintenance and repair.

(v) There is a very low utilization of CMMS/ERP among respondents. Also, modern diagnostic equipment are not commonly used. Subsequently, failure records are poorly maintained, with a majority using a manual record keeping system.

(vi) A majority of the companies have safety rules and regulations, which are also reviewed regularly.

5.4 Managerial aspects

The above aspects were covered by questions 21–30 of the questionnaire. The cumulative responses totaled 437. A summary of the responses is presented on Table 8.

5.4.1 The managerial evaluation index (MEI)

The MEI was calculated using Eq. (1), and found to be 2.94. Based on Eq. (3), the Level for technical aspects will be 2

According to Table 1, the managerial aspects of maintenance practices are at the *managed level*.

Some deductions from the responses are as follows:

(i) Maintenance manuals a generally used, but some improvements have been made on them based on experience.

(ii) Training of maintenance personnel s normally planned and done continuously on and off the shop floor. Where diagnostic equipment is used, training is properly structured.

(iii) Technicians work with minimum supervision, and maintenance procedures are reviewed continuously.

Table 7 Responses on technical aspects

Question number	Number of responses per maintenance level					No. of responses
	L1	L2	L3	L4	L5	
7	9	16	5	13	7	50
8	8	18	8	9	7	50
9	9	15	3	16	7	50
10	8	15	12	5	10	50
11	5	19	3	20	3	50
12	13	3	15	5	14	50
13	9	10	12	7	12	50
14	2	6	9	16	17	50
15	4	10	12	7	17	50
16	3	4	7	18	18	50
17	16	9	9	7	9	50
18	9	15	15	1	9	49
19	5	2	25	8	10	50
20	0	2	14	11	23	50
Total	100	144	149	143	163	699

Table 8 Responses on managerial aspects

Question number	Number of responses per maintenance level					No. of responses
	L1	L2	L3	L4	L5	
21	3	3	25	11	7	49
22	2	8	2	16	21	49
23	0	14	5	15	14	48
24	12	1	5	18	13	49
25	10	9	8	10	12	49
27	10	8	10	2	19	49
28	1	7	6	19	15	48
29	5	5	1	6	32	49
30	5	5	5	16	16	47
Total	48	60	67	113	149	437

(iv) Companies have safety and environmental policies which are reviewed regularly.
(v) Most companies are certified both locally and internationally.

5.5 Human aspects

These aspects were covered by questions 33–35 of the questionnaire. The cumulative responses totaled 140. A summary of the responses is presented on Table 9.

5.5.1 The human evaluation index (HEI)

The MEI was calculated using Eq. (1), and found to be 2.564. Based on Eq. (3), the Level for technical aspects will be 2

According to Table 1, the managerial aspects of maintenance practices are at the *managed level*.

Some deductions from the responses are as follows:

(i) Companies had a well defined organization structure
(ii) Companies pay enough attention to detail when interviewing their technical personnel.
(iii) Most of the companies do have safety and environmental officers.

5.6 The general evaluation index (GEI)

The GEI can now be determined from the average of the TEI, MEI and HEI. This was found to be 2.634.

Again, this value is classified under L2. Processes are partially planned and performance analysis depends on the operator experience and competencies. Process management is weak due to deficiencies in the organizational or technical systems.

Table 9 Responses on human aspects

Question number	Number of responses per maintenance level					No. of responses
	L1	L2	L3	L4	L5	
33	1	4	27	10	5	47
34	2	11	15	10	9	47
35	7	2	16	0	21	46
Total	10	17	58	20	35	140

Table 10 Evaluation index per industrial category

Category of industry	TEI	MEI	HEI	GEI
Service industries	2.114	2.9	2.111	2.375
Power generation industries	2.586	3.9	2.9	3.129
Food processing industries	2.529	3.193	2.884	2.869
Metal processing industries	1.95	1.689	1.533	1.724
Agro/chemical industries	2.957	3.989	1.633	2.86
Motor vehicle assembly	2.614	2.367	3.1	2.695
Transport	2.896	3.178	2.9	2.991
Maintenance industries	2.229	2.619	2.478	2.442
Construction industries	1.636	2.106	2.178	1.973
Mean	2.398	2.9400	2.564	2.634
SD	0.6442	0.8549	0.7409	0.6692
Variance	0.4150	0.7308	0.5478	0.4478

5.7 Index analysis per category of industry

In order to gain a deeper understanding of the maintenance practices in different industrial sectors, an analysis is done per industrial category. Table 10 presents this analysis.

From the tabulated data in Table 10, the construction industries are the lowest rated in terms of technical aspects. Practically, the construction sector uses a lot manual labor with very little mechanization. The highest rated is the Agro/chemical industries. The explanation may also be that due to the nature of the products, then, the use of sophisticated machines is not an option. As regards managerial aspects, the Agro/chemical industries are the highest rated with the metal processing industries rated the lowest. Lastly, the motor vehicle sector becomes the best in terms of human

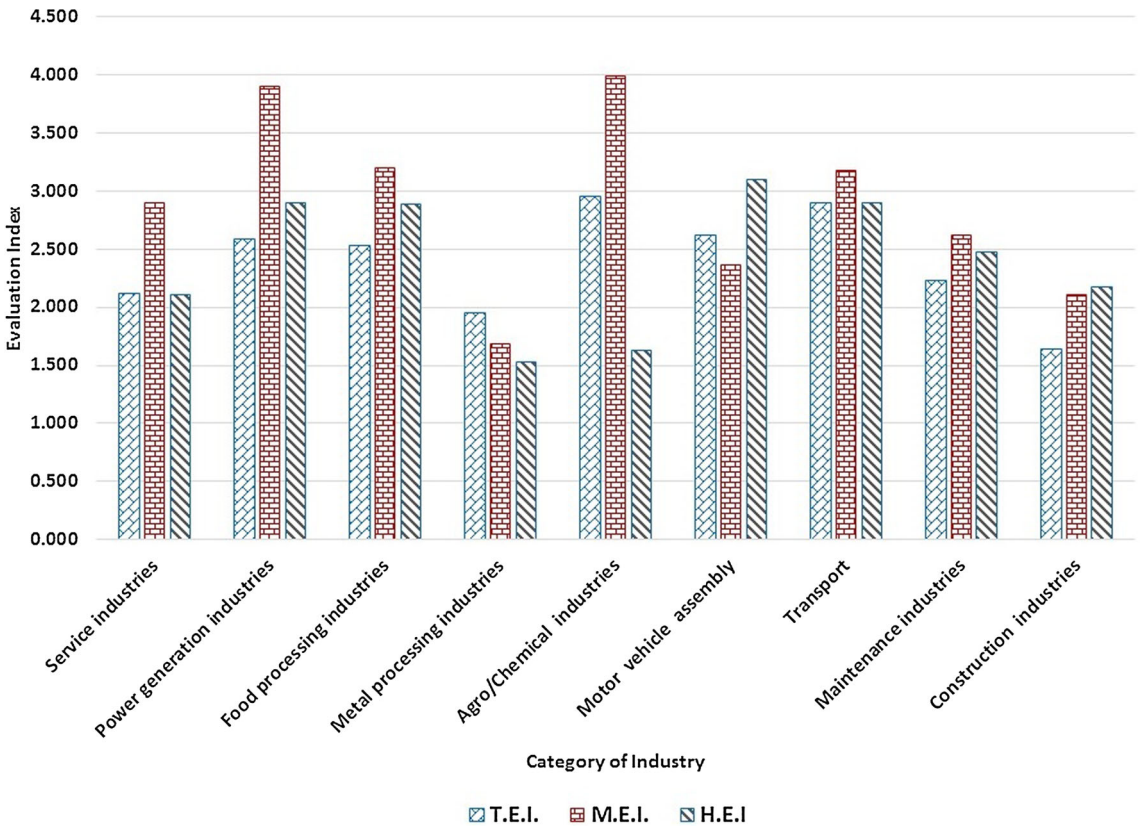

Fig. 1 Maintenance practice aspects of different categories

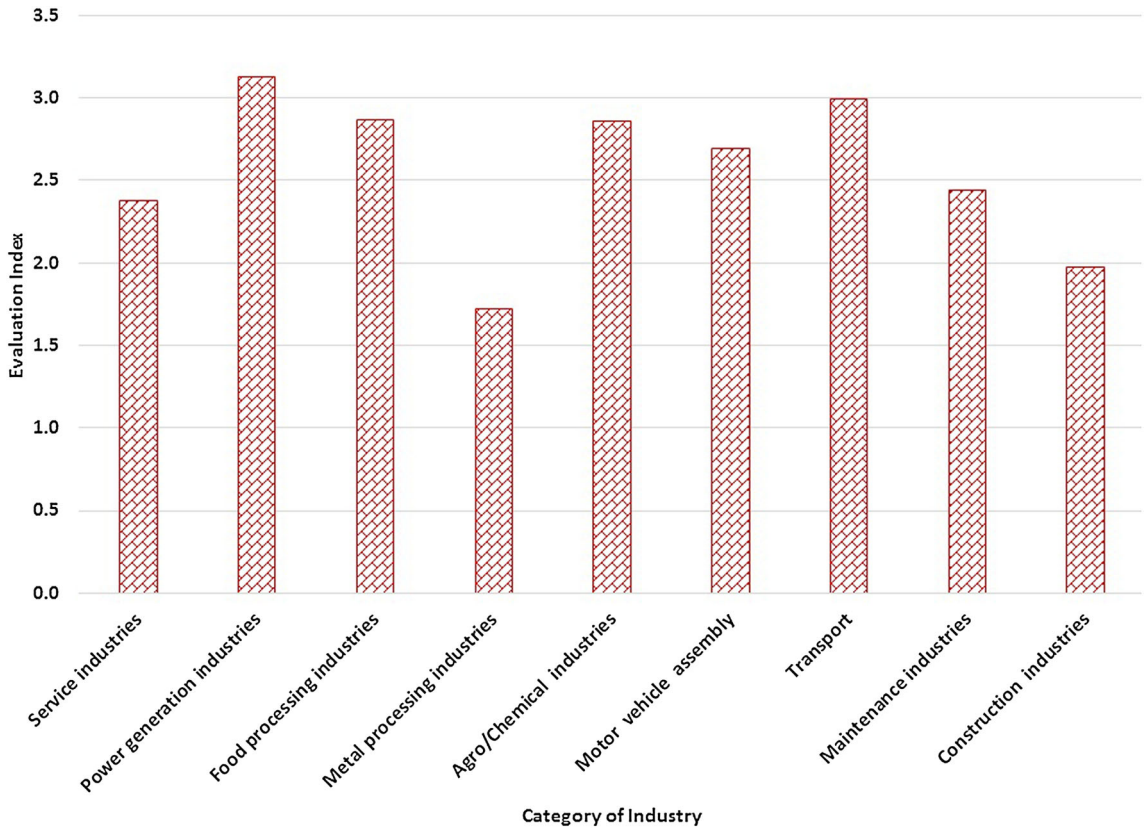

Fig. 2 The general evaluation index for different categories

aspects with the metal processing industries coming last in this category. This is also illustrated on Fig. 1.

Figure 2 shows the general evaluation indexes (GEI) for the different categories of companies. It can be seen that the power generation companies have the best general index. The Metal processing industries returned the poorest score, with a level 1

5.7.1 Factoring in uncertainties

Uncertainties in the measurement can be determined using the standard deviation and variance. The larger the deviation, the higher the uncertainty. The quality of the data will also be low if the variance is high. From Table 10, it can be seen that apart from the MEI, the variance is low. This can be attributed to the fact that MEI refers to skills that do not necessarily relate to engineering. Subsequently, it can be concluded that any bias in the answering of questions is insignificant.

6 Conclusions and recommendations

The research evaluated the maintenance practices applied in the Kenya by using the criteria referred to earlier. The GEI was found to be at level 2. The technical aspects (TEI) ranked the lowest, with the managerial aspects (MEI) ranking the best among the three aspects. Ultimately, companies must aim at achieving the highest standards that correspond to level 5.

This is indicative of a high application of managerial know-how, while technical aspects seem to lag behind.

Based on the survey results, the following are recommendations that can be made to improve maintenance practices in Kenya:

1. Automation of the maintenance process is very low, if not lacking at all. Subsequently, there is a need to introduce maintenance automation through the application of CMMS, automated diagnostics and also record keeping
2. Maintenance leans heavily on preventive maintenance, which originates from the OEM recommendations. Companies need to invest more in understanding and improving maintenance by considering introduction of maintenance practices related predictive and condition-based maintenance.

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Appendix: Survey questionnaire

Survey on Maintenance Practices in Kenyan Manufacturing Industries

Introduction

Thank you for accepting to spare some time and take part in this survey.
The purpose of this questionnaire is to aid in establishing the level and status of maintenance practices in Kenya. We define maintenance practices as "The systematic activities geared towards the actual execution and improvement of maintenance."
Ultimately, the survey results are to be used in comparing maintenance practices in Kenya with best practices, with the aim of improving such practices.

Kindly answer all questions on the questionnaire.
All information received will be treated in confidence.

The questionnaire is divided into five sections as follows:
Section A - Some basic information about your organization,
Section B - Technical Evaluation of your maintenance practices
Section C - Managerial Evaluation of your maintenance practices
Section D - Human-related Evaluation of your maintenance practices
Section E - Final comments on the survey.

If you wish to receive a summary of the survey result, kindly provide us with your name and email address.

Thank you.

Section A

Basic information about your organization

***1. Kindly provide us with the following details,**

Name:	
Company:	
Address 1:	
City/Town:	
Country:	
Email Address:	
Phone Number:	

2. Please select the industrial classification that best describes your organization's activities:

- Service industry: Power/water/fuel distribution
- Power generation: Thermal, Geothermal, Hydro, gas
- Food manufacturing and processing: Food products, beverages
- Steel manufacturing and processing:
- Agro processing industry
- Motor vehicle assembly
- Transport industry: Rail/Air/Road
- Maintenance industry: Maintenance and repair organization
- Construction industry

3. Please classify your company according to the following categories:

- Local
- Regional
- Multinational

4. How many employees work for the organization?

- Between 1 - 10
- Between 11- 50
- Between 51 - 100
- Between 100 - 500
- Between 501 - 1000
- Over 1000

***5. How many employees work in the maintenance department and maintenance related departments (such as spare part stores, machine/equipment operations)?**

6. How many departments does your organization have?

Section B

TECHNICAL ASPECTS OF MAINTENANCE

7. When do you perform machine/equipment component replacement?

- Upon failure
- In accordance with the original equipment manufacturer (OEM) specification
- As a strategy
- On a case to case basis
- To improve the operational efficiency.

8. When do you perform machine/equipment/component overhaul?

- Upon failure
- In accordance with the Original Equipment Manufacturer (OEM) specifications
- As a strategy
- On a case to case basis
- To improve the operational efficiency.

9. When are repair activities carried out?

- Upon equipment/component failure
- Planned, and in accordance with the OEM specification
- Unplanned but generated from routine maintenance
- Planned as a result of monitoring
- Planned and integrated with modification actions.

10. How is the reordering of spare parts done?

- Upon failure or done on demand
- Using the minimum stock levels based on experience
- Using predefined re-order triggers
- By defining and refining re-order triggers.
- By defining and refining re-order triggers using ERP system.

11. When is sampling, testing, oiling and topping up of fluids done?

- Unplanned or as a result of failure
- Planned, and according to OEM specifications
- Unplanned or generated from routine maintenance
- Planned as a result of monitoring
- Planned and integrated with modifications.

12. Are maintenance job cards used in your organization?

- Not used
- Generated on a case to case basis
- Generated for every job
- Electronic job cards are generated for each job
- Electronic job cards are generated for each job, and signed for confirmation after the job is completed

13. How are repair tasks monitored?

- Not timed or allocated time
- Only time based tasks are monitored
- Tasks have a defined time frame
- Reduction of time done on case to case basis
- Time allocated to tasks reviewed regularly.

14. Does the maintenance department work with specialized teams?

- Not used
- Used for specific job cards
- Teams constituted on case to case basis
- Teams constituted based on evaluation of each job
- Highly specialized teams are used.

15. Does the maintenance department evaluate its maintenance equipment?

- No evaluation is done
- Based on the OEM specifications
- Based on experience and training of personnel
- Based on case to case consideration
- Done regularly on all equipment.

16. How are specifications for new production equipment developed?

- No specifications are developed
- Using the technicians' experience
- Done in relation to maintenance tasks
- Done to improve the existing equipment
- An interactive process involving all related departments

17. Does the maintenance department incorporate the CMMS/ERP in performing its (daily) tasks?

- Not used
- Limited application only to some tasks
- Used to specify, facilitate and monitor jobs and task execution
- Used to diagnose and prescribe maintenance
- Used to optimize maintenance processes

18. How is inspection/diagnosis of failed equipment performed?

- Visually
- Using test equipment
- Using specialized diagnostic equipment
- Using CMMS to establish failure and its effects
- Using the trouble shooting module in the CMMS to predict failure causes and effects.

19. How are failure records maintained?

- No records are maintained
- Reported orally with minimal recording
- Proper manual record keeping
- Use of CMMS/ERP to maintain all records
- Maintained and reviewed to prescribe maintenance actions.

20. Are there any safety rules and regulations in the company?

- No safety rules and regulations
- Yes - Safety rules and regulations passed orally
- Yes - Written rules and regulations available
- Yes - Safety policies are available
- Yes - Safety policies are continuously reviewed for improvement

SECTION C

MANAGERIAL ASPECTS OF MAINTENANCE

21. Does the maintenance department make use of maintenance manuals?

- ○ No manual are provided
- ○ Manuals are used with no improvement
- ○ Manuals are improved based on experience
- ○ Manuals are Integrated with the CMMS modules
- ○ Manuals assist in measuring performance and integrating with CMMS.

22. How is personnel training performed?

- ○ Not done
- ○ Done informally on the shop floor
- ○ Done formally on the shop floor
- ○ Planned and done on and off the shop floor
- ○ Done continuous on and off the shop floor.

23. How are maintenance tasks supervised?

- ○ No supervision
- ○ Technicians work under Minimal supervision
- ○ Done on case to case basis
- ○ Well coordinated supervision
- ○ Maintenance procedures are reviewed continuously.

24. How are automatic diagnostic equipment used?

- ○ There are no diagnostics equipment available
- ○ Available but not used
- ○ Minimal use of such equipment
- ○ Used on some machines selectively
- ○ Used for all diagnostic and maintenance actions.

25. Are the personnel trained in using diagnostic equipment on the shop floor?

- ○ No training is done
- ○ Personnel learn on the job
- ○ Training done formally on shop floor
- ○ Proper training structures are used
- ○ Done continuously to learn new technological developments.

26. Has the organization developed any maintenance KPI's?

☐ Yes ☐ No

27. Are the KPI's monitored?

- No KPIs are monitored
- Only critical KPI'S are monitored
- Tools are available to measure KPI's
- KPI'S are applied selectively
- Monitoring done to optimize KPI's.

28. Does the company have any safety and environmental policies?

- There are no safety or environmental policy
- Only the statutory policies are enforced
- Policies are formulated over and above the statutory policies
- Policies are reviewed and improved regularly
- Policies are benchmarked with the best policies.

29. Is the organization certified by any local or international body?

- No certification is sought
- Only mandatory/statutory certification is sought
- Local certification for some of the processes is sought
- Local certification for all the processes is sought
- Both local and international certification for all processes is sought

30. How are cost items defined and identified?

- No definitions on cost items are available
- All items are costed based on their nominal cost
- There is a clear definition of cost items
- There are policies available on costing of maintenance items
- Cost items are defined, monitored and optimized on the ERP

31. What is the cost of maintenance as a percentage of the total cost of production?

32. What is the total cost of maintenance as a percentage of the organization's turnover?

Section D

HUMAN ASPECTS OF MAINTENANCE

33. Does the organization have a well-defined organizational structure?

- The structure is not clearly defined
- The structure is based on minimal degree specialization
- There is a well-defined structure upto the departmental level
- There are specialized sections within departments
- There are highly specialized teams to deal with specific matters

34. How are personnel interviews conducted?

- Very basic interviews are conducted
- Interviews are oral or written
- Interviews are oral AND written
- Interviews include practical examinations
- Interviews involve external firms, are oral, written and practical

35. Does the company have safety and environmental officers?

- No officers are appointed or employed for this task
- Safety and/or environmental officers are present but not trained
- Trained personnel are employed for this task
- An external body is engaged to assist with this task
- Personnel trained continuously to improve competence and performance

36. Indicate the number of employees that fall under the following categories of specialization

Engineers	
Technologists	
Technicians	
Craftsmen	
Artisans	
Other	

37. How many members of staff in the maintenance department have the following qualifications?

Degree	
Higher national diploma	
Diploma/Technician	
Craft	
Artisan/Trade test	

Section E

Conclusion

38. Kindly fill in any other information you may feel is important to this research

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