



MEETING THE CHALLENGE OF ENGINEERING ASSET MAINTENANCE IN NIGERIA THROUGH ASSET MAINTENANCE ENGINEERING EDUCATION

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Abstract

In Nigeria today, many public engineering assets and infrastructures have become dilapidated, unattended to and oftentimes moribund. Engineering education and training in maintenance are important in ensuring that public and private assets and infrastructures are useful over their entire lifespan. Many engineering trainees lack training in asset and infrastructure maintenance. An empirical study was carried out on engineering students via an online survey to investigate the status of engineering asset management and maintenance (EAMM) in Nigeria and the level of training received by the Nigerian engineering student. Respondents were polled from different parts of the country. The results showed that 29% of the respondents did not have any maintenance training, only 56.1% of the respondents claimed to have courses taught on EAMM and only 61.8% of those who have received EAMM training agreed to have acquired valuable knowledge on asset maintenance. 64.2% are aware of assets and infrastructures needing maintenance in various locations in the country and almost all respondents (97.6%) were favourably disposed to having training on engineering assets and infrastructure maintenance. It is concluded that government, through various education regulators should make engineering asset and infrastructure maintenance training mandatory for the Nigerian engineering students at all levels by putting in place a maintenance policy, establishing maintenance organisation and mandate higher institutions to carry out training on the subjects.

Keywords: Asset and infrastructure, engineering education, maintenance policy, engineering curriculum, engineering training

Introduction

Engineering education and training are the basis of knowledge sharing that brings up systems, facilities, devices and infrastructures on which the modern human societies thrive. This knowledge has produced various solutions to diverse human and societal problems in areas such as civil, mechanical, agricultural, bio-medical, chemical, computer and software, aeronautics, electrical and electronic engineering, to mention just a few. When structures and facility provided by engineers are commissioned, their efficiency and utilization impact are almost perfect. In the course of usage over the years, these systems and infrastructures deteriorate and often need attention in forms of maintenance and repair. Examples of such assets in Nigeria is presented in Figure 1.

Engineering maintenance ensures that systems and infrastructures in public and private establishments are useful over their entire lifespan and give value for resources invested in them. In Nigeria today, many public engineering assets (systems and infrastructures) easily become dilapidated, unattended to, nonfunctional and oftentimes moribund. These assets are usually put in place by the government as contracts executed by both local and foreign companies and handed over to the clients. Upon handing over, few of the assets and structures oftentimes get minimal maintenance attention after commissioning while a larger percentage do not receive any care whatsoever until they break down and stop functioning. The art of maintenance needs to be inculcated into the people producing and utilizing the assets, infrastructure and physical engineering property as a matter of necessity and must be based on a budget (Mahto, & Khumar, 2011). This is important because maintenance absorbs a significant percentage of operating costs of systems and infrastructures (Tan, & Kramer, 1997; Tomlingson, 2005).



Figure 1: Examples of assets needing maintenance in Nigeria

It is very important to make every engineer at all levels aware of the importance of asset management. Technician training must be primarily skill-oriented (Hodkiewicz & Pascual, 2006); however, this must expand to incorporate an awareness of the systems in which the technicians operate and their connections to essential business processes. Every engineer requires knowledge of equipment failures: the what, when, and why (Blanton, 2022). This is especially true in maintenance, where assessments are constantly made by engineers working on equipment/tools that can have a significant impact on process availability, product quality, and thus system life cycle.

The professional practice of engineering practices provides technical excellence in sector-specific infrastructure systems that are built in harmony with their dynamic operating context. A comprehensive and more thorough educational foundation is now not supporting the requisite professional competencies as it should. Effective advanced asset management education for engineers and other professionals is thought to have a significant role in generating strategic asset management leaders capable of implementing these advanced processes (Thorpe & Aghili, 2021). The likelihood of major dreadful engineering asset failures and challenges can be decreased by the knowledge and application and knowledge of asset management tools.

In Nigeria, it is noteworthy that engineering asset management (EAM) is currently being done at a minimal level by government parastatals, institutional and private individual companies but there has not been developed a formal “body of knowledge” in carrying out EAM. The trend in the 21st century demands that Nigeria as country takes maintenance serious at this point in time. More complexity in equipment design is expected this century and they will be more computerized and reliable in addition to being much more complex (Dhillon, 2002). As such, advancement in computerization will significantly increase the importance of software (Blanton, 2002) and software maintenance such as described by (Idowu, et al., 2021).

2 The Role of Engineering Asset Maintenance Organisations

Maintenance has been described as the science-art-philosophy to be assigned in manufacturing, power production, or service facilities to ensure a smooth running of systems, and infrastructures (Mobley, 2008). It is also defined as the effort required to undertake for maintaining the equipment or system performance similar to new ones (Deyin 2021). According to Misra (2008), an important aim of maintenance of systems is to prolong the state of functioning of equipment or a system by not allowing it to deteriorate in condition.

In many developed countries, government take charge and put in place efforts at EAM by training necessary personnel and establishing institutions to carry out the work. Examples of such efforts from different countries include:

- i) The Society of Maintenance and Reliability Professionals (SMRP, based in the USA).
- ii) The Institute of Asset Management (IAM, based in the UK). (Woodhouse 2006).
- iii) The American Society for Quality (ASQ).
- iv) Society for Maintenance and Reliability Professionals, U.S.A.
- v) American Institute of Plant Engineers, U.S.A.
- vi) Society for Machinery Failure Prevention Technology, U.S.A.
- vii) Maintenance Engineering Society of Australia, Australia.
- viii) Maintenance/Engineering Division, Canadian Institute of Mining, Metallurgy and Petroleum Canada
- ix) The Institution of Plant Engineers, U.K.
- x) Japan Institute of Plant Maintenance, Japan.

- xi) The Institute of Marine Engineers, U.K.
- xii) Society of Logistic Engineers, U.S.A.
- xiii) International Maintenance Institute, U.S.A.
- xiv) Society of Automotive Engineers, Inc., U.S.A.

To take the issue on asset and infrastructure maintenance seriously require that Nigeria as a country imitate the procedures employed in the developed countries which include establishing such organisations as listed above. Maintenance process should take a formalized procedure developed over the years through systematic verification and elimination process. An example is exemplified by Smit, (2014) as shown in Figure 2. With such a procedure, engineering systems can be analysed and maintenance needs and probable causes or combination of causes can be identified when pertinent questions such as what?, who?, how?, where?, how much? (Blanton, 2002) concerning assets and infrastructure maintenance and management are asked.

To begin the process of a new orientation in EAM and management, it is necessary to train engineers in the art of engineering maintenance. This study was set out to find out how much of this training is carried out in engineering training in Nigeria and proffer ways in which the Nigeria public assets should be maintained by personnel. It also examines the current engineering training and determines what is lacking and way to ameliorate same.

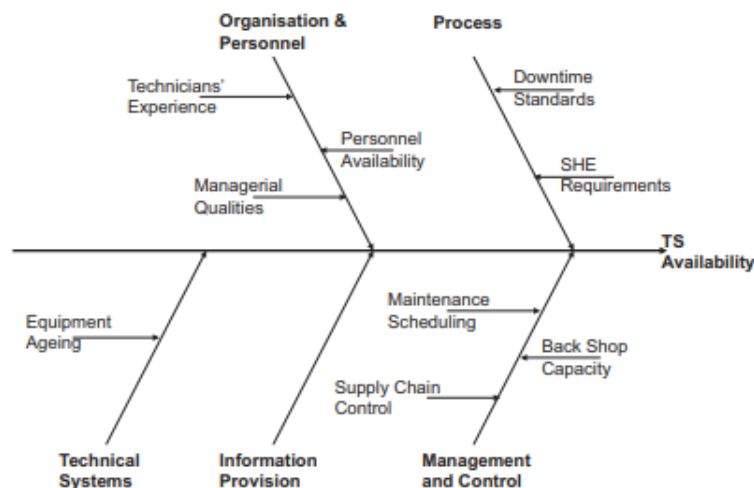


Figure 1: Possible cause and effect diagram in maintenance

3 Methodology

The methodology employed involves gathering data from several engineering students throughout the country to obtain the level of training in engineering asset maintenance. The data was subsequently analysed for the information showing how connected the respondents were to engineering maintenance in their studies and engineering asset and infrastructure maintenance (EAIM) on the other hand.

Research Design

The research was designed with an empirical study approach using electronic medium of data collection. The data collected was examined to determine the status of EAM in Nigeria and the level of training received by the Nigerian engineering trainee. The study also was directed at all level of engineering training. After the initial development of the questionnaire, it was subjected to pilot test by inviting eleven (11) members of staff in the School of Engineering, Federal Polytechnic, Ilaro, who were outside the targeted population in the study to complete the form. The results of the test were analysed and subsequent modifications made to the survey form before final distribution.

Research Sample and Selection Criteria

The survey was targeted at engineering students in various higher institutions across the country. The category of students included National Diploma (ND), Higher National Diploma (HND), Bachelor of Science/Technology/Engineering (BSc/BTech/Eng), Master of Science/Technology/Engineering (MSc/MTech/MEng) and Doctor of Philosophy (PhD) students in various engineering discipline.



Data and Instrument for Data Collection

The data involved in the research were primary data from the randomly selected engineering students of all levels in institutions of higher learning in Nigeria. An online survey was developed using *Google Form* to interact with student respondents across the country obtaining the data of interest. The data were obtained using randomized sampling and analysed using descriptive statistics.

Survey Questions

The interactive questionnaire employs eleven questions to reveal the involvement or otherwise of the respondents with engineering assets and infrastructure maintenance in their training. With the questions developed, the key performance indices (KPI) given in Table 1 were employed in assessing the respondents:

Table 1: Research KPI

S/N	Performance Index	Expected Response					
1.	Course of engineering study	List of course of study.					
2.	Programme of study	ND	HND	BSc/B Eng/B Tech	MSc/ MEng/ MTech	PhD	
3.	Level of study	100	200	300	400	500	Above 500
4.	Knowledge of EAIM	Yes		No.		Not sure.	
5.	Availability of course taught on EAIM	Yes.		No.		Not sure.	
6.	Awareness of assets and infrastructures needing maintenance	Yes.			No.		
7.	Disposition to students receiving training in EAIM	Favourably disposed.			Not favourably disposed.		
8.	Acquisition of valuable knowledge on EAIM	Yes.		No.		Not sure.	

4 Results and Discussion

A total of 123 responses was obtained from the survey out of which 84.6% was male and 15.4% female respondents. The field of study accessed included only 9 departments. All programmes (ND to PhD) and levels of study (100 to above 500) were covered in the responses. It is noteworthy that most respondents were beginners in engineering education as 48.4%, 32.5% and 13 % were ND, HND and BSc/BEng/BTech students respectively. However, a good number of respondents were also postgraduate students in the universities (6.5%). The various proportion for the programme of study and level of study of the respondents are presented in Table 2. As observed from the table, responses from the postgraduate students were the least. Though most responses came from 200 level and below responders, a very good response was obtained from other undergraduates.

The need to involve students at all levels in engineering maintenance principles is exemplified by the responses to the question “Do you offer any course on maintenance and repair in your course of study?” as presented on Table 2. A proportion of 29% of total respondents answered “no”. This indicated that more was needed to be done in the curricula of engineering studies to help engineering trainees at all levels in the acquisition of maintenance knowledge. Further, despite the fact that some respondents claim to have the knowledge of engineering asset management and maintenance (EAMM), it is still alien to many of the respondents. As can be seen in Table 2, only 56.1% of the respondents claimed to have courses taught in the course of their education. Also, as shown in item (8) on the table, only 61.8 % of respondents who have received the training agreed to have acquired valuable knowledge on EAIM.

Table 2: Summary of Results

	Performance Index	Response					
1.	Course of engineering study	<ul style="list-style-type: none"> • Electrical electronic engineering • Mechanical engineering • Civil engineering • Computer engineering • Mining engineering • Agric and bio-environmental engineering • Mechatronics • Information and communication engineering 					
2.	Programme of study	ND	HND	BSc/B Eng/B Tech	MSc/MEng /MTech	PhD	
		48 %	32.5 %	13 %	5.7%	0.8%	
3.	Level of study	100	200	300	400	500	Above 500
		10.6%	38.2%	5.7 %	18.7 %	15.4 %	11.4%
4.	Knowledge of EAIM	Yes (65.1%)		No (20.3)		Not sure (14.6%)	
5.	Availability of course taught on EAIM	Yes. (56.1%)		No (34.1%)		Not sure (9.8%)	
6.	Awareness of assets and infrastructures needing maintenance	Yes. (64.2%)			No. (35.8%)		
7.	Disposition to students receiving training in EAIM	Favourable. (97.6%)			Not favourable. (2.4%)		
8.	Acquisition of valuable knowledge on EAIM	Yes. (61.8%)		No. (23.5%)		Not sure. (14.7%)	

A very good proportion of the respondents (64.2%) are aware of assets and infrastructures needing maintenance in various locations in the country and almost all (97.6%) were favourably disposed to having training on EAIM.

5 Recommendations

We suggest that all engineering institutions should work hand in hand with the professional bodies such Council for the Regulation of Engineering (COREN), Nigerian Society of Engineers (NSE), etc. to produce a workable training on EAMM for the Nigerian engineering students at all levels. Government should take charge of the responsibilities of maintenance of public assets and infrastructure. More attention can be paid to deteriorating assets if a maintenance department and organisations for maintenance are established. Such organisations that will take up the challenge of training engineers and carrying out some other supervisory roles in the whole process of asset and infrastructure maintenance should be established as a matter of urgency

Government, through various education regulators (NUC, NBTE, etc.) should make EAM mandatory for the Nigerian engineering students at all levels. The first step in establishing courses on EAM will be creating course curricula in EAM for the various engineering courses in the country. The curricula should be made practical-oriented and impactful to all level of engineering training. Further, there should be the training of the trainers in EAM to acquire requisite knowledge in EAMM. The trainers in turn would then be adequately equipped and ready to impart EAM knowledge. By this, the trainers will be encouraged to assist students in developing competency level needed in the maintenance and management of various engineering assets and infrastructure.

6 Conclusions

The current Nigerian education engineering education curricula are lacking in asset and infrastructure maintenance. Only few engineering trainees have courses taught in asset and infrastructure maintenance and are not enough to



carry out meaningful asset and infrastructure maintenance across the country. Many engineering trainees don't have any idea whatsoever about EAIM. In view of the many dilapidating assets and infrastructure scattered across Nigeria, EAIM should be given a top priority in education. Government and other stakeholders should take a holistic view of this subject. Engineers, technologists and technicians need to be adequately trained to take up the challenge of EAIM. To achieve this requires developing engineering curricula on EAIM in all aspects of engineering and for all levels of engineering education.

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