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Efficient Maintenance and 5s Implementation in Industrial Power Generation's Infrastructure in Nigeria

Akinwole O.O.[1] , Oladimeji Tolulope Tunji [2*]
[1,2] Department of Electrical-Electronic-Engineering, School of Engineering, The Federal Polytechnic, Ado-Ekiti, Nigeria.
*Corresponding author: Oladimeji Tolulope Tunji, E-mail: tolulopett@yahoo.com
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ABSTRACT
Efficiency in Power generation in the third world countries which Nigeria is among can never be waived aside by any responsible government. Local productions are expected to be stepped up in order to boost national economy and also put recession at bay. This cannot be optimally achieved without adequate attention to enough power which itself is obtainable through concerted effort of all players. 5S forms the basic foundation for Total Productive Maintenance and hence lean manufacturing; they are methodologies made possible by teams and industrial stakeholders. The paper illuminates various ways 5S methodology can be incorporated into the industry in order to reduce losses that tend to affect efficiency. It systematically discusses 5S pillars, seiri, seiton, seiso, seiketsu and shitsuke, viz- a-viz power generation infrastructures. It suggests various maintenance activities that can optimise maintenance cost and gender efficiency thus dovetailing into high productivity and profits.
Keywords: *Power, Generation, Maintenance, Infrastructure, Efficiency*

INTRODUCTION
According to Merriam-Webster's 11th collegiate dictionary, the word infrastructure, a noun, was first used in 1927; it was defined as follows: (1) the underlying foundation or basic framework (as of a system or organization). (2) The permanent installations required for military purposes. (3) The system of public works of a country, state or region also: the resources (as personnel, buildings, or equipment) required for an activity. Going by these, one can refer to all equipment needed for generation of power supply are infrastructures. And in order to enhance efficiency, there must be concerted efforts by all and sundries to embrace any activity or operations that will reduce downtimes. Historically, the perennial power problem in Nigeria has undoubtedly encouraged proliferation of generators' systems in the polity. Though there have been concerted efforts by various governments since 1999 to solve the problems by increasing the amount of power generated and fed to the power grid, there is still pockets of darkness and its concomitant economic impasse.

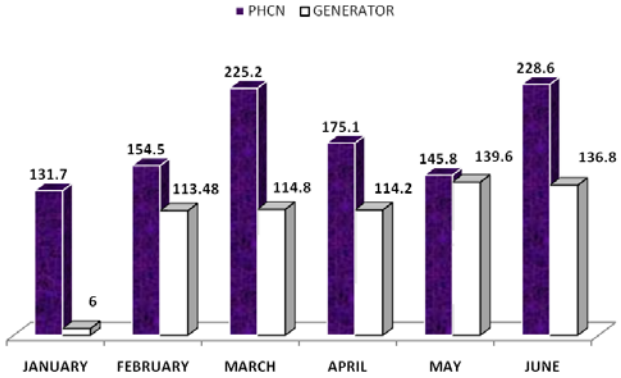

Figure 1:A Nigerian Factory Monthly Electricity Consumption in MWH for first half of 2010

Source: [9]

Figure 1 shows power consumption in an industrial outfit in 2010. As a result of power outages from the local supply authority, diesel powered generators are engaged, the result is an exorbitant resources being expended on diesel fuel. The foregoing calls for efficient maintenance of local power generating infrastructures; any lull in maintenance will undoubtedly brings about losses in production times and everything will boils down to low production efficiency. A sustenance of low efficiency will result to low profits, itself will herald laying off of workers, a thing that will further impoverish the recessed economy.

Nevertheless, implementation of 5S methodology in the power house and good maintenance acumen will ensure power availability with affordable costs. 5S is the foundation of Total Productive Maintenance (TPM) . According to Peugeot-Citroen TPM service, TPM is defined as a system for continuously improving production equipment through the practical daily involvement of all players. After the process of initiation, to lunch it, six pillars are positioned. Maintenance may be defined as actions necessary for retaining or restoring a piece of equipment, machine, or system to the specified operable condition to achieve its maximum useful life [1]. Also, maintenance can be look as "all actions which have the objective of retaining or restoring an item in or to a state in which it can perform its required function". The actions include the combination of all technical and corresponding administrative, managerial, and supervisory actions. The primary objective of maintenance is to ensure that physical assets continue to fulfil their intended functions throughout the lifetime of the assets. [2]

Before a generating set is acquired, one should be certain of the number of phases needed to power loads, that is, single or three phase, there should be proper analysis on the projected demands thus forestalling overloading of the unit in case of an under estimation of loads in one hand and prevention of over sizing of the facilities that always attracts high costs and continuous high running cost. An important step in sizing a generator is to identify every type and size of load it will carry. It should be noted that when non linear loads are present, it may be necessary to oversize the alternator [3].

The minimum generator set capacity should not be in anyway exceeded as running a set with a high load can lead to engine damage and reduction in reliability. Some manufacturers of generator sets do frown at running them less than 30% of the

rated load [3]. Thus, a set is normally encouraged to be run at between 30 -70% for the foregoing reasons. The importance of this topic has necessitated the development of various programs for sizing generator sets while others make do with assistance of manufacturers' sales representatives' expertise. 5S Methodology is explained in relation to maintenance using its pillars while various generators maintenance actions included thus gendering efficient maintenance of power infrastructure in the country.

Industrial Power House

A typical industrial power house in Nigeria is connected to the power grid through a 33/11 KV. It comprises power generators as the main infrastructure, in some places there are generators that are synchronised together to produce higher power needed to drive industrial loads. Three units of synchronized 2MVA, 11kV generators will deliver 6MVA 11kVA to be distributed into the switch rooms. In the rooms are distribution transformers that change voltage levels from 11kV to 415V. Other equipment are various isolators, tap-changers circuit breakers which are normally position in the yard at the milieu of the power house. The control room has batteries, control panel which itself is made up of metering units and mimic panels. Switch-rooms houses different types of breakers rated according to the circuit to be protected. In Table 1, a typical transformer parameters in relation to their loads are illustrated,

Table 1: A Typical Transformers Parameters

Trans-formers	Switch Room	KVA Rating	Primary (V)	Secondary (V)	Secondary (A)
1	A	1500	11000	415	2000
2	A	1600	11000	415	2123
3	A	1500	11000	415	2000
4	B	1600	11000	415	2123
5	C	1600	11000	415	2123

Source: [9]

5s

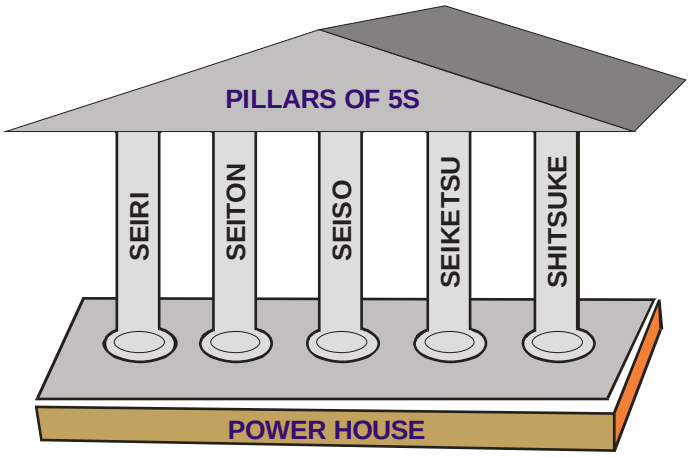

Figure 2:Pillars of 5S

5S is defined as systematic process of house keepingto achieve a serene environment in the workplace involving the employees with a commitment to sincerely implement and practice housekeeping [4]. Also, Lista white paper considered it as workplace organizational housekeeping methodology to foster continuous improvement and gender lean manufacturing [5]. It is a foundation programme for the implementation of Total Productive Maintenance TPM. [4]

5S is coined from Japanese words that starts with letter "S" that is, Seiri, Seiton, Seiso, Seiketsu and Shitsuke. English translation are Organization, Tidiness, Cleaning, Standardization and Discipline respectively. They form the pillars of 5S. The pillars are further explained as follows.

Seiri

Seiri or Sort out is a way of organizing items in the switch rooms and generators' hall. Items are classified according to their usefulness, frequency of usage and importance. Proper organization is carried out by throwing away unserviceable units and replaced parts that clog the environment. For example, old and flat batteries, faulty engine starters and off cuts from burnt armoured cables, burnt switches are thrown away; any part that can be salvaged can be realised while others thrown out. Things that are used daily are positioned strategically and orderly while others that are rarely used are positioned in a determined store. By doing these, there will be neat environment void of old and un-useful things that tend to reduce space for power house operations, Deploying Seiri will also allow safety since bad and unserviceable items that may cause trip-over of personnel would have been removed.

Seiton

Seiton or Systematize refers to the process of tiding up the work areas. Every item has its place and only one place. When Seiton is deployed in power generation infrastructure, there willbe reduction in time needed to search items, efficiency will be enhanced since time losses must have been reduced thus increasing time needed to do reasonable activities. In practice, floor areas are marked out with a standard colours border lines indicating the positions of items. It can be a fire extinguisher, waste bin, tools box. Other items can be movable ancillary equipment like air compressors, welding machines and safety gears. In the event of fire, personnel in power house know where to get fire extinguishers depending on the type of fire. If any of these is removed to be used elsewhere, it has to be returned to the marked area allocated to it.

Seiso

Seiso or sweep is referring to an act of cleaning in order to shine the work-zones. Rags, torn papers, oil, grease, dirts are swept away and are not allow in the work-areas of the power generation and switch rooms. The environment, pillars, walls, waste-bins, fire extinguishers, tool boxes are painted with bright colour accordingto the standard colours determined by stakeholders in that particular industry or internationally by safety operatives , for example, $C0_2$, Powder , Water fire extinguishers are appropriately distinguished with colours like black, green and red respectively. In an advance environment where 5S is practised, White or light grey colours are adopted for walls; in this case, any dirt or grease can be spotted; in all workers themselves cultivates the habits of neatness with concomitant feelings of excellence and perfections thus gendering efficiencies in all their works.

Seiketsu

Seiketsu refers to Standardization, Power house 5S teams are formed, 5S pilot per zone are designated, 5S stakeholders are determined with its steering committee coupled with dashboard comprising various developmental indicators. In essence, various standards are formulated and circulated. It could be colour standards for power plant water pipelines, Fire Hydrant for water

sprinklers systems, Gas pipelines, Diesels fuel pipelines. It is very common in the power house to see pipelines on the wall, manholes and channels; it is the responsibility of 5S team to determine which colour goes for each product pipeline. For example, based on my experience, we use red for fire hydrant pipes, that is, water from industrial reservoir dedicated to quenching fire outbreak; the pipeline also supplies sprinklers systems deployed in the power house; diesel fuel pipelines are painted black, compressor air pipeline is painted green. Apart from this, colour standard could be determined for file shelves, tables and chairs. A 5S practising power environment uses grey for all equipment manuals and records shelves, grey colour on the iron parts of all tables and maroon colour deployed on wooden parts and doors. Each closed shelve has a manifest pasted on it; showing what are the content of the shelves and where the item could be found.

Figure 3:**A 3MVA 11kV** Generator's Prime Mover:Metallic Barriers are Painted Yellow [10]

Shitsuke

Shitsuke means discipline, that is, self discipline. Workers poised to be disciplined and in order to do that, posters are created, work-zones teams are certificated as they progress in their 5S compliance, this allows completions among different teams of work-zones. With discipline, every worker knows what to do each morning at resumption, for example, cleaning and mopping its work areas with detergents, ensure that his overall and safety boot is neat. 5S has now become a norm. Where 5S is practised, tenet of lean manufacturing thrives, you don't employ cleaners to clean the work zones, workers themselves do it. Each time he completes a repair works on any item, he does the cleaning of the environment where he has work by himself and return all tools to the appropriate mark out place.

Generators and Power Infrastructure Maintenance

Maintenance enhances generating set reliability [3]. It is certain that generators become more likely to fail after a number of years in operation. This is as a result of components ageing. Experience has also shown that high ambient temperatures, high vibration levels, humidity, dirt or heavy loads can reduce components lifetimes thus hastens failures. The OEM maintenance manuals are required to be referred to for such items as torque values, voltage settings and other settings [6]. The result is the reduction of maintenance and component replacement intervals.

An organisation employing qualified technicians will undoubtedly have peace of mind when it comes to power supply. A deployment of various preventive maintenance operations is sine-qua-non to improved power availability for production purposes. It will also optimise maintenance cost and minimise repair costs. The following are various preventive maintenance schemes recommended for diesel powered generators.

General Inspection

A generator operator is expected to check the set when it is not running.

Check the fuel system for leakages, cracks and abrasions of tubing. If any abnormal situation is discovered, make amendment immediately. When the set is not running, ensure that the body of the set is clean and devoid of oils or dirt as this will enable all abnormalities on the unit to be discovered easily.

Check the exhaust system for leakages during operations. Check the battery terminals for clean and tight connections.

Lubrication System Maintenance

Check the engine oil level when it is shut down. By using dipstick, ensure that the oil level is as close as possible to the full mark. You are to add the same brand of oil in case it is lower than the full mark. Follow the manufacturer's directives on intervals for changing oil and filters. Some manufacturers, as normal policy advocates changing of lubricating oil and oil filters every 250 hours or 24 months whichever comes first [7]. With the advent of oil analysis, the oil would be changed depending on the test results. This practice is environmental friendly and prevents waste of financial resources [7].

Cooling System Maintenance

Using a prepared checklist, you can also check the coolant solution that is recommended by the manufacturer. Maintenance service man can also use soft brush to clean the exteriors of the radiator – the latter should be done without damaging the fins. Also, a low pressure compressed air can be used in the opposite direction of the normal air flow to clear the radiator.

Fuel System Maintenance

Fuel system comprising tanks, fuel filters, hoses, piping, gauges and safety mechanisms should be properly checked. The diesel fuel should also be checked for condensations and water in fuel.

Air Intake System Maintenance

All the components for the air intake should be checked. That is, air filter elements, piping and connections and crank case breather. Air cleaners' elements can be cleaned and reused if not damaged.

Battery System Maintenance

Batteries for starting generators must have their terminals and connections cleaned always. Use always battery hydrometer to check the specific gravity of the electrolyte in each battery cell. You should charge the battery if the reading is below 1.215. A fully charged battery has itsvalue to be 1.260 while a battery in good condition when fully charged will read 12.6 to 12.8VDC on its terminals [8].

Generator System Checklist

In order to implement the aforementioned maintenance systems effectively, the use of checklists will be priceless. The checklist will divide the activities into daily, weekly, monthly and annual basis. Manufacturer's suggestions on maintenance of their products can be employed in this case. Proper implementation of the maintenance schemes will extend the lifetime of the generator and enhance its reliability.

Conclusion and Recommendation

It has been shown how 5S can be implemented in the power generation section of an industrial section of Nigerian economy. Efficient maintenance acumen has been highlighted for reduced power supply downtimes which also increases productivity and boost the national economy. An adherence to the information will always ensure efficient system. It has been explained that 5S methodology will bring about clean industrial environment, boost workers morale in striving for excellence, eliminate time to be wasted in searching materials urgently needed for productive activities and boost safety of personnel

Also, cognizance should be given to proper terminations of conductors on electrical panels' busbars; if the quality of terminations of conductors during installation is bad, safety hazards do ensue with its concomitant costs thus making the standby power system becoming unreliable. Other recommendations of note are:

- To implement 5S well, 5 steps should be created according the pillars and each team should have on their indicators where they are. This will allow healthy competition among various work zones.
- Each team must be rewarded with certificates going by their level in 5S practice.
- There should be industrial wide publicity and awareness using leaflets, vests and caps.
- Lubricating oil can be changed after proper oil analysis but not necessarily depending on running hours [7].
- Introduction of Total Productive Maintenance methodology would ensure generator availability and efficiency [6].
- There should be proper reference to the generator's manufacturers' manuals in order to ascertain various periodical maintenance to be carried out.

REFERENCES

1. BUSINESS DICTIONARY. ACCESSED ONLINE, 2015 FROM WWW. BUSINESSDICTIONARY.COM/MAINTENANCE
2. BE OKAH. THE SCIENCE OF INDUSTRIAL MACHINERY AND SYSTEM MAINTENANCE. W. GIRARDET PRESS (WA) COMPANY IBADAN, NIGERIA, 1996.
3. J. IVERSON. TECHNICAL REFERENCE MANUAL: HOW TO SIZE GENERATING SET. POWE TOPIC:#7007. ACCESSED ONLINE FROM WWW.CUMMINSPOWER.COM. 2003.
4. [J. VENKATESH. AN INTRODUCTION TO TOTAL PRODUCTIVE MAINTENANCE. RETRIEVED ONLINE FROM WWW.PLANT-MAINTENANCE.COM/ARTICLES/TPM_INTO.PDF. 2017
5. LISTA WHITE PAPER. IMPLEMENTING 5S WORKPLACE ORGANIZATION METHODOLOGY PROGRAMS IN MANUFACTURING FACILITIES. RETRIEVED FROM WWW.LISTAINT,COM. 2017
6. OO AKINWOLE. IMPROVING ELECTRICAL ENERGY EFFICIENCY IN NIGERIAN INDUSTRIES.IJCST VOL 3 ISSUE 3, (170-176), 2015.
7. FDL P OWER SOLUTION: GENERATOR MAINTENANCE MANUAL. RETRIEVED FROM WWW.FDLPOWER.CO.UK.2012
8. FLIGHT SYSTEM: RV GENERATOR TROUBLESHOOTING MANUAL. FLIGHT SYSTEMS. RETRIEVED FROM WWW. FLIGHTSSYSTEMS.COM. *2015.*
9. OO AKINWOLE INVESTIGATION OF ELECTRICAL ENERGY USE EFFICIENCY IN PEUGEOT AUTOMOBILE NIGERIA LIMITED MENG THESIS. FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA NIGERIA.WWW.DSPACE.FUTMINNA.EDU.NG.2012
10. OO AKINWOLE. ET AL. ELEMENTS OF GENERATOR'S SELECTION, SIZING AND MAINTENANCE IN NIGERIAN INDUSTRIES. IJARI VOL 5. ISSUE 2. 2017, (276-278).

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