Engineering and Operations Management Education as the Anchor to Building, Operating, Managing, Maintaining and Sustaining Good Infrastructures, Facilities and Amenities in Nigerian Universities

Dr. Joseph Ogundu
President/CEO
Emerald Global Consulting Inc.
Farmington Hills, Michigan USA
mjogundu@emeraldglobalconsulting.com
https:/www.emeraldglobalconsulting.com

Abstract

The purpose of this study is to present an "Self-Help" alternative approach to developing, building, managing and maintaining of campus infrastructures, facilities and amenities in Nigerian Universities and integrating facilities management, operations and maintenance as part of the engineering education. Currently, Nigerian Universities follows the traditional method of infrastructures and facilities management. Most campuses around the country have delipidated dormitories, and campus roads are in terrible and debilitated conditions. Most campuses lack running water in the dormitories, libraries, offices and laboratories. Student have to walk down two to three stories to fetch water for their use. There is chronic and persistent shortage of electricity supply on campuses. In many universities across the country, students residing on campuses experience up to five days without electricity and had to rely on kerosine lamps for studying. In a country like Nigeria, this should be unacceptable in the 21st century because it hinders student learning and impedes campus growth and improvement. This approach centers on utilizing the services of students to lead operations, management and maintenance of infrastructures and facilities. The expected outcome is to maintain 24 hours electricity and water supply, environmentally safe dormitories and recreation areas, and clean classrooms, offices, and landscaping.

Keywords
Infrastructures, Facilities, Operations, Engineering, Education.

1. Introduction

Many studies have shown that infrastructure resources required for production of effective education processes are in short supply in Nigerian Universities (Subnair et al, 2012). This study is important, not because it is a study about a new area of study, but because if the suggestions from this study are implemented in university campuses across the country, the problems and issues of delipidated infrastructures, facilities and amenities would be greatly reduced to a minimum or totally eliminated. Electricity and water supply will be improved and the epileptic power outages will be a thing of the past and quality of life for the students, staff, and the surrounding environment will be improved. Also, executing this strategy, will help in solving most of the infrastructure and facilities problems facing higher institutions in the country. Though, this is not a scientific study, but a study based on observations and interactions with past and current students at University of Nigeria Nsuka, University of Lagos, University of Port Harcourt, University of Abuja, University of Science and Technology Port-Hacourt, Abia State University, Ahmadu Bello University Zaria, University of Calabar and University of Benin. To my surprise, these students provided similar narratives regarding the pitiful state of infrastructures, amenities, and facilities in their respective institutions (See Figures 1, 2 and 3). These pictures in the figures below attest to the severe decay in infrastructures, this is an indictment to a leadership that does not care for the welfare of the students and the university at large. Universities are responsibility for developing future leaders, both in the technical and non-technical areas. Universities helps to drive technological development and social changes as the infrastructure for performing various functions such as education, research, and community service and the universities role to foster social responsibility and develop human resources required

by society along with encouraging national competitiveness as expected and improve facilities and amenities (Kim et al., 2006; Hassanain, 2008; Akinyode, 2014).

My personal observations at some of these institutions confirmed to me that the students were not exaggerating and what I saw led me to believe that the state of decay of infrastructures, facilities and amenities in Nigeria universities is quite appalling and disgraceful to say the least. I am a Nigerian and a naturalized American citizen with all my higher education from four United States Universities, Wilberforce University, Wilberforce Ohio, The University of Tennessee, Knoxville Tennessee, Wayne State University, Detroit Michigan and Lawrence Technological University, Southfield Michigan. I spent four years in the dormitories at two of the universities, Wilberforce University, and The University of Tennessee. I was surprised to hear the horror stories about the constant and persistent power outages that keeps students without electricity for three to five days. The issue of no running water in the dormitories and delipidated campus roads, campus play grounds and student center, makes me wonder if these universities actually have engineering schools with students that can be deployed to help turnaround the situation. Also, I wonder if the vice chancellors and their staff at these institutions see the decay of the school's facilities and amenities and understand the importance of building and maintaining good infrastructures, facilities and amenities to support quality life on campuses taking into consideration that good and functional infrastructures and facilities are some of the major metrics that helps to improve student learning. It is difficult to learn when your environment is disorganized and facilities and amenities are deficient and without optimal performance.

2. Literature Review

There are limited peer review articles coming out of Nigeria Universities and other sources in the country dealing with the deplorable and terrible conditions of infrastructures, facilities and amenities in Nigerian universities across the country. All one need to do is to visit some of these campuses and see the magnitude of the problems. In an article titled "Infrastructure Decay in Universities", which was published in May of 2020, Ogbonaya M. Akomo pointed out that the rate at which infrastructural facilities are allowed to rot, decay and waste away in public universities in Nigeria is alarming. Mukhtar Bello pointed out in his 2007 article titled "The State of Nigerian Public Universities" that apart from poor funding, another serious problem facing Nigerian Universities is lack of good maintenance culture for the few available facilities. Abdullahi Isa and Wan Zahari Wan Yusoff in their article titled "State of Physical Facilities of Higher Education in Nigeria" indicated that comparing physical facilities in Nigerian Universities to the global best practices showed that physical facilities in Nigerian Universities are below average. He postulated that for Nigerian Univesities to produce students that will be able to compete favorably in international job markets, the institutions must pay more attention to the state of existing facilities. On Cecember 6, 2021, Damian Duruiheoma profiled the the deplorable condition of the Zik's estate at the University of Nsukka in his aticle titled "UNN: Inside the ramshackle Zik's Flats" (See Figure 4) below.

Nairaland Forum, an online publication pictorially chronicled many dilapidated building and laboratory facilities at several Nigerian Universities nationwide (See Figures 1, 2 and 3). The story is the same and the list goes on. My observations at University of Port-Harcourt, Rivers State University of Science and Technology, University of Calabar, University of Lagos tells the same story. Past and current students of these universities and others across the country tells the same story of deplorable infrastructures, decaying facilities and amenities without maintenance and a system with leaders that does not understand the magnitude of the problems facing them as was reported by Ogbonnaya M. Akomo in his aticle titled "Infrastructure Decay in Universities" and Hassanain, M. in his article titled "The Performance Evaluation of Sustainable Student Housing Facilities". This issue of facilities decay includes University Medical Centers and Campus Road (Figure 1) as well as University Engineering Workshop and Toilets in Hostel (Figure 2), Boarding Rooms and Chemistry Laboratories (Figures 2 and 3). The rest of the articles reviewed are included in the reference section.

2.1 Infrastructures, Facilities and Amenities Problems and Issues

There are many issues and problems facing Nigerian universities with regards to decaying and deplorable infrastructures, facilities and amenities needed to provide quality education and improved campus life. Though, financial constraints is one of the key issues, Abdullahi Isa and Wan Zahari Wan Yusoff (2015), but I believe that the inability of the administrators and leaders of the institution to pay attention to preventive and predictive maintenance and implement them with the students and faculty of engineering schools as some of the key stakeholders is the major issue. Reviews of the issues showed that the administrators are out of touch with reality, and may not understand that good and functional infrastructures are the key to delivering quality education to the students and providing a good and clean environment for improvement of campus life.

(A)

(B)

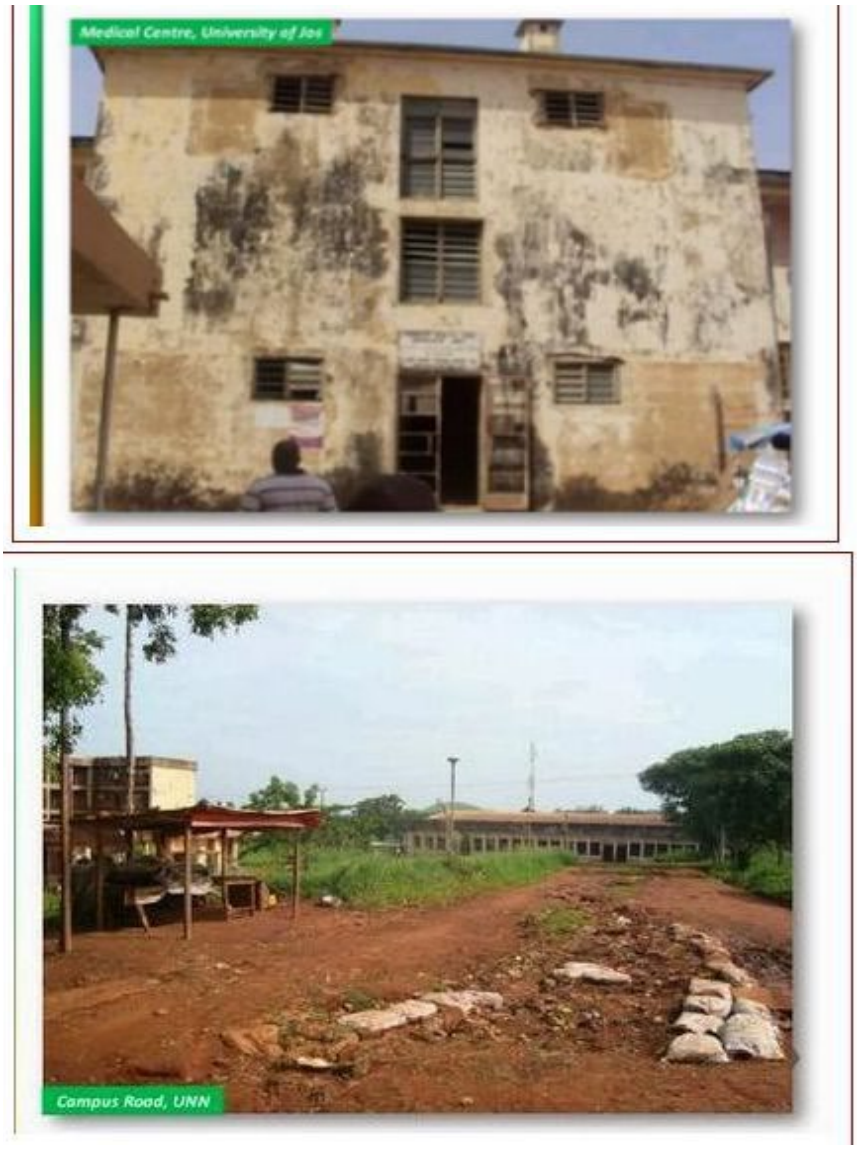

Figure 1. Delipidated Medical Center at University of Jos (A) and bad Campus Road at University of Nsukka (B)
Source: nairaland forum / nairaland / general / education / the deplorable state of infrastructure in nigerian universities (photos)

Figure 1 is the Medical Center Building the University of Jos (A) and a Campus Road at University of Nsukka (B). Which type of medical service will be offered in such a medical facility and how can students enjoy campus road in such delipidated state. Figure 2 below, is the Mechanical Engineering Workshop at Federal University of Technology Owerri (C), and a Toilet in the female Hostel at the university of Calabar (D). The workshop looks like a garbage dump. No one can collect meaningful engineering data from such a facility. This is an indictment of the leadership of both the engineering department and the administrators of the institution. The toilet is a health hazard and looks like an abandoned facility that have not been used and cleaned in years. It is impossible to phantom that female students actually use this toilet daily. This particular toilet facility compromises the health and quality of life of the female students in this Hostel.

(C)

(D)

Figure 2. Mechanical Engineering Automobile Workshop at FUTO and Delipidated Toilet in Female Hostel at University of Calabar

Source: nairaland forum / nairaland / general / education / the deplorable state of infrastructure in nigerian universities.

Figure 3 shows appalling and hazardous student rooms in the hostels at university of Benin (E) and at University of Calabar (F) respectively. Students cook in the same room where they sleep with kerosene stove cooker which in itself is dangerous and hazardous to health and if the stove explodes, or leaks toxic gas, it is a major safety hazard. Also, in the second room (F), students sleep on the floor and in a congested room. Learning in these types of environments would be definitely difficult and getting the needed rest that is required to rejuvenate the brain cells would be next to impossible. Unfortunately, it appears that the university administrators for the most part do not pay attention and find ways to solve these problems of the state of deplorable infrastructures, facilities and amenities on college campuses across Nigeria.

(E)

(F)

Figure 3. Delipidated student boarding rooms at University of Benin and University of Calabar
Source: nairaland forum / nairaland / general / education / the deplorable state of infrastructure in nigerian universities.

Figure 3 shows 3rd year Biology and Biotechnology laboratory (G) at the university of Benin and two different Chemistry laboratories (H) at a typical Nigerian university. How can students learn in a lab without the required laboratory equipment and tools? It is impossible to produce students that can compete favorably with their peers across the Globe. Also, the Chemistry Laboratory looks like an abandoned facility that has not been used for years. Overall, an outsider that visits these facilities would conclude that providing good and functional facilities to provide world class education and improve student learning is not the primary concern of the administrators of the universities, including the academic deans. Some or most of these issues and problems may be remedied through the involvement of engineering and operations management students.

(G)

(H)

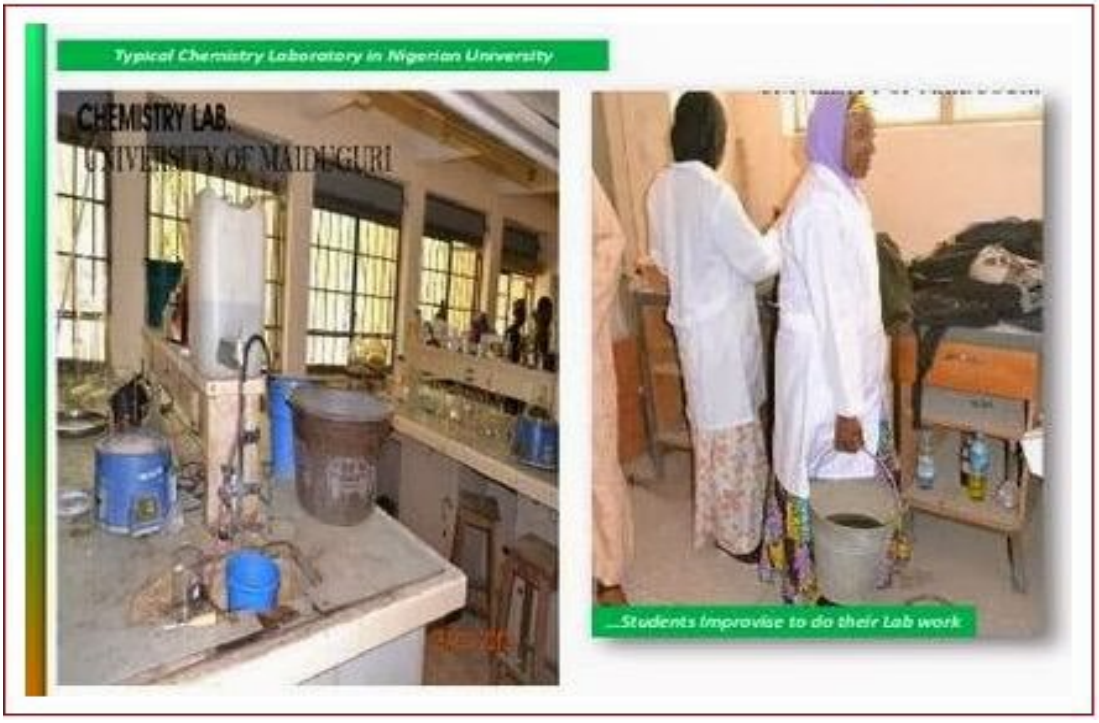

Figure 4. Unequipped and Delipidated Chemistry labs at Nigerian Universities
Source: nairaland forum / nairaland / general / education / the deplorable state of infrastructure in nigerian universities (photos)

Figure 4 shows the Zik's flats at the University of Nsukka that were neglected and finally abandoned due to lack of maintenance. This state-of-the-art estate facility has 20 story buildings, 12 bungalows that are used for student hostels with over 3000-bed capacity, a line of dozens of stores, car park areas and cafeteria with many restaurant facilities. The estate was donated to the institution by Dr. Nnamdi Azikiwe, and it has been abandoned for several years and currently the flats are unfit for human habitation (Damian Duruiheoma, 2021). The leadership of the institution over the years could not maintain the estate and were unable to think outside the box by leasing it to contractors that will run and maintain the facilities and share the profits after expenses with the institution.

Figure 5. UNN: Delipidated Zik's Flats at University of Nsukka
Source: the nationonline.net/unn-in-side-the–ramshackle-ziks-flats/

These facilities along with thousands of infrastructures, facilities and amenities in university campuses across the country have been abandoned by the university administrators due to lack of maintenance and operational capability and the inability of the administrators of these institutions to develop and execute effective strategies for building (Figure 5), operating, managing and maintaining infrastructures, and facilities for sustainable growth. The question is, why are engineering departments and their students not taking the lead for working on issues concerning infrastructures, facilities and amenities in their respective campuses as well as leading the development, building, operations, management and maintenance of these facilities? The answer may be connected to the following;

1. Leaders of Nigerian institutions of higher learning including Vice Chancellors, Provost, Engineering Deans and other staff that run these institutions do not think outside the box to identify what needs to be done and proffer workable solutions for improving their campus and surrounding communities.
2. The inability of the Universities to set up departments responsible for fund raising to generate the resources needed to fund infrastructure and facilities projects that were captured in the yearly physical budgets due to lack of funds from the federal and state governments.
3. Political considerations that lead to inefficiency, dependent behaviors, including over dependency on federal and state governments for infrastructure and facilities funds as well as funds needed for operation, management and maintenance.
4. Lack of flexibility on the part of Nigerian University Council (NUC), federal and state governments to make room for federal and state universities to raise the needed funds from the public, specifically from the alumni and wealthy individuals around the country.
5. Resistance from the leaders of the Universities such as the Vice Chancellor, Provost etc., from allowing engineering departments and their students to become major stakeholders and participate in researching, developing, building, operating, managing and maintaining campus infrastructures, facilities and amenities.

Universities need good infrastructures and facilities to remain competitive and keep up with future changes that are needed for qualitative and quantitative growth of the university education, including improved infrastructures, facilities, as well as thorough analysis of facilities and amenities operation and management to support campus life for the users (Reynolds and Caine, 2006; Kim et al., 2018). The state of infrastructures, facilities and amenities in Nigerian Universities and the surrounding communities are appalling, and in many cases, eye sores. Past and present students, as well as some professors that I spoke to agree with my observations, but informed me that there is nothing anyone can do about these issues because Nigerian system does not welcome changes that allows for improvement. I am of the opinion that a new approach is required to make Nigerian university campuses more appealing and functional to create conducive environment for learning and research. This approach if implemented, will integrate project management, infrastructure and facilities strategy, supply chain management, design and development, facilities

management, including operations and maintenance, quality assurance and control as part of engineering education for all engineering disciplines in particular as well as the universities at large.

The approach will combine experiential and theoretical teachings along with practical hands-on applications to build and apply the concept of continuous improvement for campus infrastructures and facilities. The development of infrastructure projects, such as roads and bridges, as well as building on campus power plants for generating electricity, distributing and transmitting throughout the campus and its surrounding communities would be accomplished. The production and distribution of running water for domestic application will be achieved. This type of engineering education will educate and train engineers that lives school with theoretical, practical and real-life applications experiences. It will involve the concept of self-help strategies that ignores and avoids dependency on federal and state government agencies that impedes growth and renders institutions inefficient and ineffective in delivering the required real-life applications that students need to be successful after graduation.

2.2 Contributing Departments

This is a qualitative study that is intended to present what universities in Nigeria need to do to improve infrastructures, facilities and amenities on campuses and their surrounding communities across the country. All areas of the engineering curriculum along with maintenance/sustainment, business and finance departments shall be part of departments that will formulate the strategic plan that includes infrastructures and facilities conceptualization, development, designing, building, operating, managing, maintaining, and sustaining the chosen infrastructure and facilities projects. The representatives shall include faculty members, and students from the departments as depicted in figure 6 below.

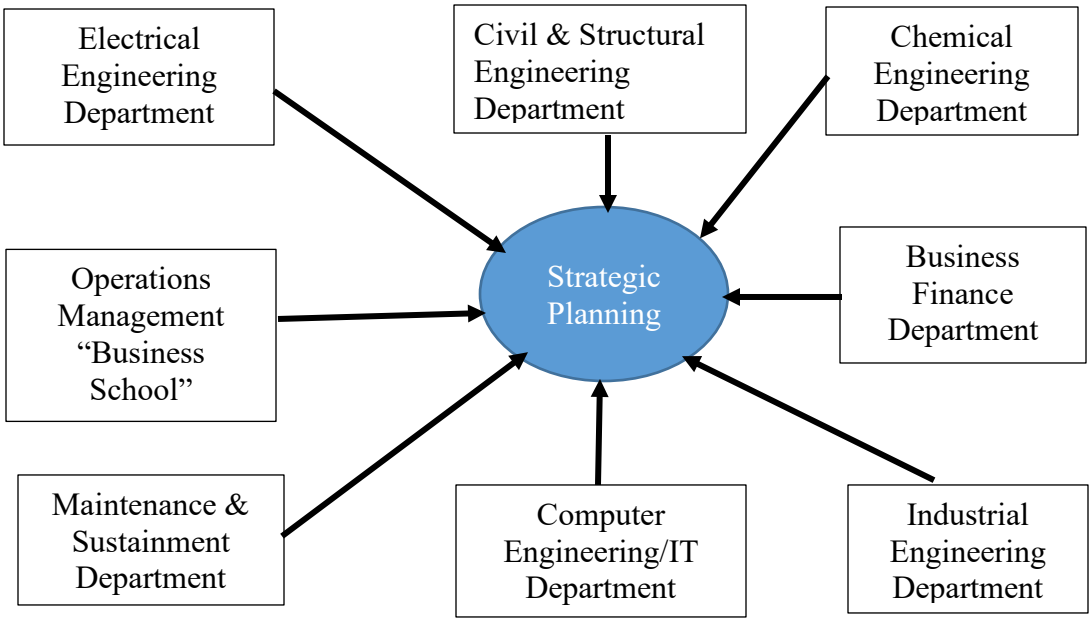

Figure 6. Strategic Planning Contributing Departments

The core to this approach will be to utilize the students as the strategic thinkers, developers, designers, builders, operators, managers and sustainers of the infrastructures, facilities and amenities. These students will be supported by the staff, consultants, and other employees from the surrounding communities. Selected student and staff members from these departments shall form the core of the infrastructure and facilities teams. The teams from the departments would be diverse and will be empowered to function as free thinkers and given the authority to function without intimation. Figure 5 above, depicts the different academic departments where members of the team will be chosen to actualize the intent of this study.

2.3 Integrating Facilities, Amenities and Infrastructure Management to Engineering and Operations Management Education

The areas shown in figure 7 below should be integrated into all engineering programs in Nigerian universities. These key areas are critical for the developing, building, managing, operating, maintaining and sustaining of the campus infrastructure, facilities and amenities. If any of these areas are not already part of the engineering and operations management education curriculum, they should be incorporated into the academic curriculums. The goal of including these areas as components of the infrastructure and facilities management and as part of academic curriculum for engineering and operations management education is to enrich the programs and provide the students with knowledge based experiential education anchored in integration of theory and practice.

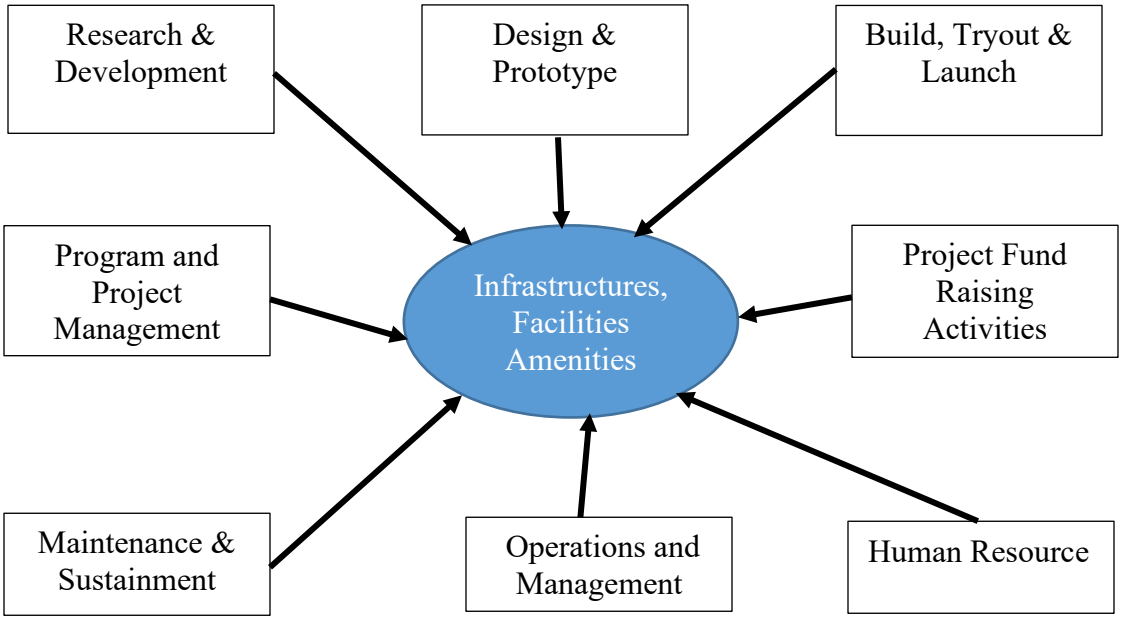

Figure 6. Strategic Planning Contributing Departments

It is clear that the quest to a sustainable national development and growth depends on the extent of transforming and revamping engineering education for global competition (Ajimotokan et al, 2010). Today, most Nigerian engineering and operations management education is based on theory and almost no practical and experiential or real-life applications. In general, attention should be directed at focusing on the improvement of engineering and operations management education with emphasis in integrating both theoretical and real-life applications in the academic curriculums where necessary. University education is supposed to provide students with the general ability to think critically, independently, and in the specialized competencies of their subject areas (Buktar Bello, 2007). In the case of engineering and operations management education, students need to gain some real life or practical experience while in school to complement their critical and independent thinking that they learned from theory. The integration of real life or hands on application of facilities, amenities, and infrastructure development, operation, management, maintenance, and continuous improvement will lead to utilizing engineering and operations management students in improving campus infrastructures ad amenities. Also, the students will gain the experience that they need to become good contributors to the organizations they decide to work for after graduation.

2.4 Reasons for Developing and executing good and functional Infrastructures, Facilities and Amenities in the Universities and its surrounding communities

It is important for university leaders and operators to understand why good and functional infrastructures, facilities and amenities are critical in achieving the goals and objectives of the institution. University administrators need to widen their horizon, develop and deploy their creative ability required to execute self-help legitimate initiatives and strategies required to maintain and improve campus facilities, infrastructures and amenities, as well as avoid administrative irresponsibility that leads to poor maintenance culture (Ogbonaya M. Akomo, 2020). Universities should provide high value campus facilities and amenities to attract quality prospective students, and industry experts like Mckinsey recommend that universities provide fewer ancillary services while keeping the broader well being of the students in mind and recognizing that students would care about all aspects of their college experience, including

the look, feel, and features of the campus (Dua, Andre, et al, 2020). Other reasons for providing good and functional infrastructures, facilities and amenities includes the following:

1. Good and functional facilities and amenities provide an environment for incubation of qualitative education.
2. Improves environmental and physical safety of the students, staff and visitors to the campus.
3. Produce college graduates that can compete favorable on the global stage.
4. Create campus environments that are conducive to learning and research.
5. Improve quality of life for students, staff and others that make use of the campus facilities and amenities.
6. Helps to encourage prospective students to select the school over others with bad and non-functional infrastructures, facilities and amenities.
7. Help in minimizing or eliminating infections associated with insects' infestation, delipidated and filthy facilities and environments
8. Help in minimizing or eliminating security problems

2.5 Infrastructure/Facilities Research and Development Strategies

Infrastructures and Facilities problems affect teaching and learning, students and staff health, day-to-day building operations, and the long-range fiscal health of the entire education system. Every university system in Nigeria, and all over the globe should have strategic plans to meet the challenges of effective infrastructure and facilities development, operations and maintenance as well as sustainment strategies because they are too big and too important to be addressed haphazardly. University campuses are large real estate objects viewed from the vintage points that campus infrastructures and facilities are developed, operated, managed and sustained within the frame work of a knowledge economy. The campuses are like areas contain different zones or departments (Figure 8) with different majors and disciplines that are established for the purpose of developing students that are needed for effective operation, management and maintenance of those things that we need to sustain life in a viable society, country or communities. These departments and those that are part of them are like a web of different zones interconnected and integrated as shown in in figure 7 below. The zones represent areas like classrooms, dormitories, offices, and the connecting lines represent paths and roads and other infrastructures that connect the zones or areas where real life activities take place within the university campus and the surrounding communities. Also, the zones contain individuals representing academic and nonacademic staff members, students from different academic disciplines, visitors as well as people in the surrounding communities.

Infrastructures, facilities and amenities strategies are to be developed to execute the following.

1. Developing, Designing, Building, Infrastructures, Facilities and Amenities anchored around engineering and operations management education.
2. Operations and management of the Facilities and Amenities using students, professors and some direct hires from the surrounding communities.
3. Maintaining the infrastructures, facilities and amenities using the students and direct hires from the surrounding communities.
4. Executing continuous improvement strategies for infrastructures, facilities and amenities within the university campuses and the surrounding communities

Figure 8. Infrastructure, Facilities and Amenities Zones showing individuals that perform activities

The individuals in each of the zones in figure 7 need good and functional infrastructures, facilities and amenities to carry out their day-to-day activities. If the infrastructures, facilities and amenities are inadequate or in bad conditions, the performance of the individuals and the systems within and outside the zones will not be optimal. Good and functional infrastructures, facilities and amenities to carry on with their daily lives and conduct their various activities without interruption and disruptions. In most cases, these infrastructures, facilities and amenities are provided and funded by the federal and state governments. In western countries such as United States of America, and Canada, universities have the opportunities of using both funds from the government as well as raising funds for developing and building infrastructures and facilities. Therefore, in these countries, campus infrastructures, facilities and amenities are usually world class and functional for supporting and sustaining campus life.

In African countries like Nigeria, the funding from the government to support the development and building of infrastructures, facilities and amenities are usually inadequate (Mukhtar Bello, 2007), and the opportunity to raise funds from the public through fund raising is almost is almost an impossible task. Students and others suffer the consequences of poor or non-existing infrastructures, facilities and amenities. Also, there are no strategies in place by the universities to utilize a self-help approach to develop, build, operate, manage and maintain infrastructures to support campus life and its surroundings. Due to the absence of self-help strategies and inadequate funding from the government, issues associated with campus electricity and water supply, campus road maintenance, recreation areas, class rooms, dormitories and even staff offices and quarters are highly deficient and students can stay for days without electricity in their dorms, class rooms, libraries and research labs. The academic and nonacademic staff suffer similar as the students with no electricity supply for the same number of days in their quarters and offices. Due to these issues, I propose that universities must develop and execute self-help strategies to take care of their infrastructure and facilities needs without relying on the government. Leaders of institutions that adopt this approach would see major improvements in the quality of life and improved morale of the students and staff of the university.

1. Strategies for Building, Campus Infrastructures, Facilities and Amenities

Formulating infrastructures and facilities development and building strategies must involve the functional engineering and non-engineering departments identified in Figure 5 on page 8 of this paper. Also, the areas identified in figure 6, page 9 of this paper must be taken into consideration. It is important to include operation, management, maintenance and sustainment when formulating the development and building strategies. These are very important to avoid formulating strategies that are difficult to execute. These strategies must take the key stakeholder, the students and staffs of the institution into consideration. The strategy must consider the following;

- Why the infrastructures, facilities and amenities are being considered?
- How would they be developed and built?
- What does the institution need to execute the projects?
- Who are the key players that will be responsible for executing the projects?

Once the above questions are answered, then, the strategic plan should take the following into consideration

- What will it take for the ongoing operations and management of the infrastructures and facilities?
- What will be the ongoing preventive maintenance protocols for continuously sustaining the infrastructure, facilities and amenities?
- Who are the key stake holdings that will anchor the ongoing management, operation, maintenance of the infrastructures, facilities and amenities?
- Ongoing training protocols for operations, management, maintenance and sustenance of the infrastructures and facilities.

The key to the self-help building and maintaining infrastructures is to involve the students from start to finish of the development and building phases of the projects. The students must participate in all aspect of the project and be trained to know and take pride in owning the project from concept to completion. Once the students are integrated into the projects and made to understand that they own it, then, the path to improvement may have started. Since the students and staffs are the key stakeholders, they must own the infrastructures, facilities and amenities projects. The goal of every campus infrastructure is to satisfy the students and staff that use them for their daily activities. A good and well-maintained facility is good for learning and boosting of morals for the stake holders (Isa and Wan Yusoff, 2015). Figure 8 shows the specific infrastructures, facilities and amenities that need to meet globally accepted standards either as new development or improvement of existing ones (figure 9).

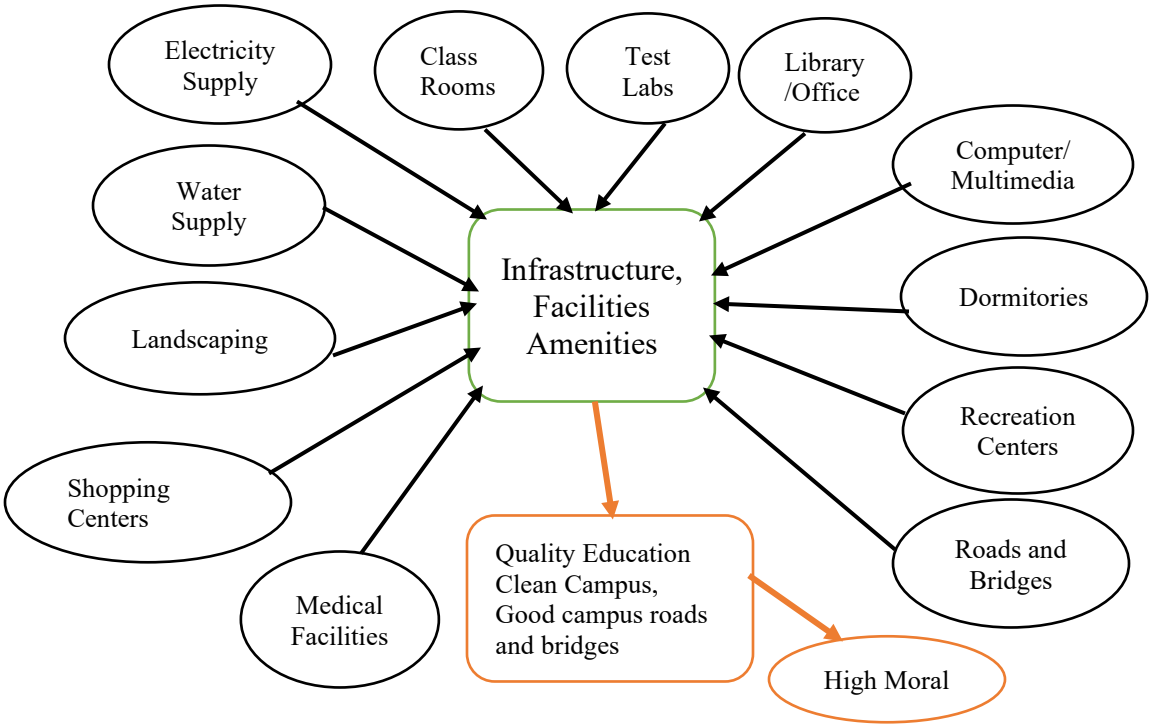

Figure 9. Components of Campus Infrastructures, Facilities and Amenities
Source: Bakare (2009).

Nigerian universities need to adopt globally accepted strategies for developing, executing and sustaining facilities and amenities for the befits of the students and the staff of the institution. These strategies are similar to what may be obtainable in corporate entities around the globe as shown in figure 9 below. Also, it is acceptable to improve the strategies from year to year to accommodate for local and specific institutional requirements. Ultimately, the goal is to develop and execute infrastructure and facility strategies that takes the interest of the students, staff and the entire institution into consideration. It is not acceptable for institutions to operate without plans and defined strategies for improving and sustaining campus infrastructures and facilities. Students and staff cannot be made to operate in a deplorable environment with poor and inadequate facilities that discourages learning. Nigerian universities must do better because what they have today is definitely not good enough if they want to compete globally (Figure 10).

Figure 10. Infrastructure, Facilities and Amenities Strategic Pie Chart
Source: Abraxas Energy Consulting

2.6 Operations and management of the Facilities and Amenities using students, professors and some direct hires from outside the campus

University infrastructures, facilities and amenities are developed to satisfy the student's and academic needs of the institution. For a university to improve facilities operating efficiency along with improving student satisfaction and reducing operating cost, the administrators must pay attention to the specific issues associated with infrastructure breakdown and maintenance, and work to continuously improve them. Operating and managing infrastructures, facilities and amenities requires the implementation of different processes, including internal and external human resource processes and non-human resources needed to achieve and sustain infrastructures, facilities and amenities on long term basis. It is clear to all that Nigeria has abysmal maintenance culture. It will require university administrators and leaders to start thinking strategically and out of the box, if they intend to develop and institutionalize maintenance culture. Engineering schools and colleges must develop curriculum that lays emphasis on infrastructure and facilities operation, management, maintenance and sustenance. Based on the abysmal and deplorable state of infrastructures and facilities across Nigerian universities, it is clear that those leading these institutions do not understand the magnitude of infrastructure and facility decays in their institutions or are not paying attention to the operations and management of these infrastructures and facilities in their institutions. The outcome in these universities, leads one to think that the university administrators have limited knowledge on operating and managing infrastructures and facilities. Therefore, they need to widen their horizon, and think out of the box to create initiatives and policies specifically tailored towards operations and management in this area. For universities to remain competitive, they need state of the art facilities and amenities and these facilities and amenities require good and effective operating and management capabilities to be sustained. Effective operation and management of facilities and amenities are required for growth in university education. Growth in university education require growth in facilities, infrastructures and amenities for supporting the campus for the students that are the main users of these facilities (Reynols and Cain, 2006; Kim et al., 2018).

Effective execution and application of world class facility management (FM) strategies to a university's infrastructures, facilities and amenities should be considered as a strong requirement for growing the institution and improving campus environment for the benefit of the students and staff of the institution (Shin and Kim 2012). University facilities and amenities, consist of facilities that require diverse functions, such as basic education facilities, research facilities, and support facilities. Therefore, to reduce university operating cost requires the optimal operation and management of these facilities and amenities (Kim & Kim, 2020). Many facilities, infrastructures and amenities at federal and state government universities in Nigerian are poorly operated and managed to the point that drastic actions are needed to save the deplorable conditions of facilities at these institutions. By apply the information shown in figure 11 and figure 12 below, Nigerian universities can get back on the right track of effective and efficient management of infrastructure, facilities and amenities for the benefit of improving campus life for all the stake holders.

Figure 11. Facility Management Hard and Soft Sides
Source: FTMaintenance CMMS

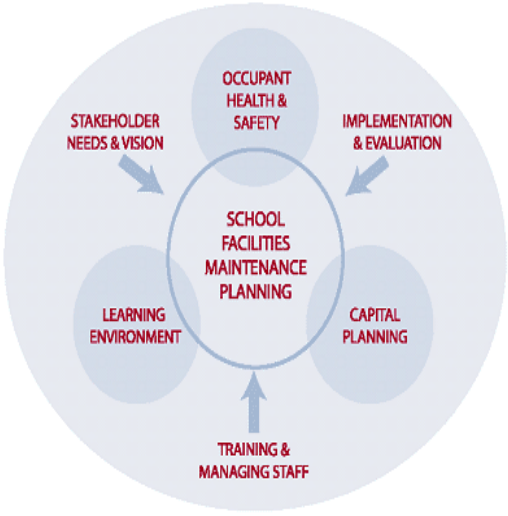

Figure 12. School Facilities Maintenance
Source: National Center for education Statistics
US Department of Education

2.7 Maintaining the infrastructures, facilities and amenities using the students and direct hires from the surrounding communities

Maintenance of infrastructures, facilities and amenities is probably the most critical part that most Nigerian Universities falls short on. I would say that the failure in this area by all tertiary institutions in Nigeria is the key contributor of the terrible and deplorable state of maintenance culture in the country. If the universities that are supposed to be the beacon of light and the citadel of learning in the country operate with deplorable infrastructures, facilities and amenities, how can the entire country do any better. It is the same products that comes out of these universities that goes out to lead most facets of the country's life. I am of the opinion that colleges of engineering and operations management in Nigerian universities should take the lead in correcting these anomalies. It is embarrassing to come into university campuses and experience the site of delipidated buildings, terrible roads, buildings with paint scales falling off of them, broken electrical circuits, broken water system, broken laboratory equipment, delipidated laboratories, broken water pipes, no running water to the hostels, dirty and dilapidated offices and libraries etc. These conditions should be unacceptable to the administrators, staff and students of any institution. Some of the issues identified here may be due to budget constraints, but most are attributed to outright negligence, incompetence, careless attitude, lack of direction and outright laziness on the part of administrators, staff and students. Everybody in any institution has one part or another to play in maintaining the environment and making sure that it is at least in clean and functional state of operation.

The students can be employed to work with outside hires to maintain infrastructures, facilities and amenities. In some cases, the students would do the direct work and other cases that can work as supervisors and managers to make sure that the job is done by hired staff from the surrounding communities. It does not make sense that power plants and electrical generators, if the school has any are not maintained properly in a higher institution with engineering students. Campus roads are bad, but the same school has civil and structural engineering students. Chemistry labs and other engineering labs do not function, but there are chemistry and chemical engineering students along with their lecturers and professors that are part of the engineering education curriculum. Engineering and operations management education in Nigeria need to incorporate maintenance as part of the curriculum in all engineering programs including actual hands-on experience in maintenance of campus infrastructures, facilities and amenities. Maintenance is very important in sustaining infrastructures and facilities for the long hull and it requires extensive planning to get it right. The component of infrastructures and facilities that Nigerian universities must consider are shown in figure 11 below. Good plans that include execution may lead to good maintenance protocols which makes it easier for institutions to maintain and improve its infrastructures, facilities and amenities. The practical side of maintenance is to perform or execute the actual maintenance activities. Execution of these activities is actually where the rubber meets the roads. The process for maintaining infrastructures and facilities start with the identification of the maintenance needs as shown in figure 13 below. This is followed with using the Plan-Do-Check-Act (PDCA) problem solving strategy to execute the maintenance activities (Figure 14).

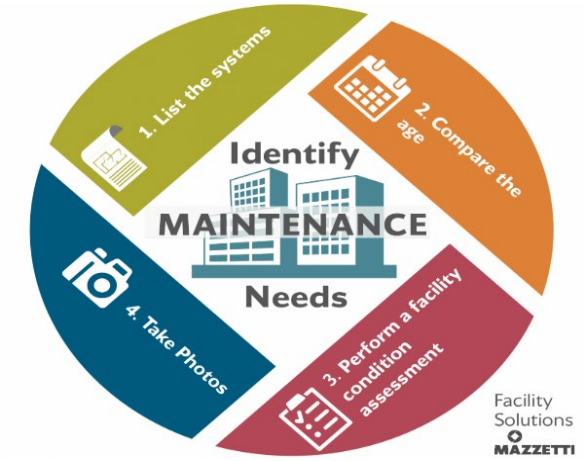

Figure 13. Identification of Maintenance Needs
Source: Mazzeti Facility Solutions

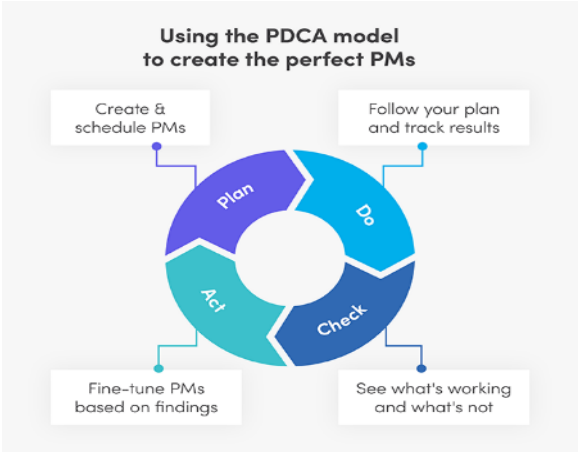

Figure 14. Executing Maintenance Program using PDCA
Source: Fixsoftware.com – Maintenance Planning

3. Methods

The data to support this research was obtained from studies by Subair et al (2012), Amadi and Ohaka (2018), and Baba and Abubakar (2015). The statistical result from Subair et al is presented in this report. The authors used sample size of 300 and 500 final year students from the faculties of Engineering and Sciences at University of Lagos, Obafemi Awolowo University, Lagos State University and Osun State University for a total sample size of 800 as shown in Table 1 below. The authors adopted the multistage cluster and simple random sampling techniques. 20 item questionnaires along with a checklist were used for data gathering. Descriptive Statistics was applied and a t-test statistics was used to test the hypothesis at 0.05 level significance.

Table 1. Distribution of Respondents by Institutions and Faculty

Institution	n	Ownership	Engineering	Sciences	Total Sample Size
1. University of Lagos		Federal	75	75	140
2. Obafemi Awolowo University		Federal	75	75	140
3. Lagos State University		State	125	125	250
…...4. Total Sample Size (n)					800……..

4. Results

The results from study by Subair et al are detailed below and shows that the conditions of infrastructures, facilities and amenities in Nigeria Universities are deplorable and terrible. The results shows that infrastructures, facilities and amenities are not available for use by the students due to decay or poor maintenance that rendered them inoperable. Based on the data shown in Table 2, most of the students agreed that there are inadequate facilities in the universities, and they while concurring that the lecturers were doing their best to provide quality education despite the deplorable conditions of the infrastructures, facilities and amenities. This is evident from the highest mean score of 3.46 identified with * in Tabel 2. Table 3 shows the mean ranking of available infrastructures, facilities and amenities at both federal and state universities in the study by Subair et al (2012). For federal institutions, the ranking by the students showed that the deplorable conditions of Libraries, Electricity/Water Supply, Buildings/Furniture have the highest mean scores and have the most impact on student's campus life. For state universities, Electricity/Water Supply, Laboratories/Workshops and Buildings/Furniture's have the highest mean scores and the most impact on student's campus life. Table 4 shows the mean scores of on the level of maintenance at these universities (Subair et al, (2012). The data showed that there is lack of maintenance culture in these universities.

Table 2. Availability of Quality Infrastructures, Facilities and Amenities in Nigerian Universities (n = 800)

Items	Description	Mean	Standard Deviation (SD)

1.	My university has enough classrooms and well-equipped laboratories	2.07	0.67
2.	I enjoy recent books, journals (print and electronic) in my school library	3.09	0.71
3.	I am though with seasoned lecturers with relevant teaching aids (Tools and equipment)	3.46*	0.72
4.	My university have adequate ICT Facilities	1.84	0.87
…...5.	University offers accommodation with reliable power and water supply	2.09	0.69……

Table 3. Ranking of Available Infrastructure, Facilities and Amenities in the Federal and State Universities

Items	Description	Federal Universities (N = 300)			State Universities (N = 500)		
		Mean	SD	Rank	Mean	SD	Rank…….
1.	Libraries	4.95*	0.94	1	2.51	0.25	2
2.	Electricity/Water Supply	3.53	0.76	2	4.98*	1.42	4
3.	Buildings/Furniture	3.33	0.32	3	2.76	1.33	3
4.	Laboratories/Workshops	1.70	1.34	4	3.42	0.63	1
…5.	Toilet Facilities	1.58	1.37	5	1.33	1.02	5……..

Table 4. Maintenance of University Infrastructures, Facilities and Amenities

Items	Descriptions	Mean	SD…….
1.	Teaching equipment are obsolete and need adequate maintenance	1.86	0.68
2.	Facilities are regularly monitored and maintained	2.70	0.79
3.	There is frequent Inspection of laboratory equipment	3.45	0.57
4.	Dilapidated structures are adequately repaired	2.45	0.81
……5.	Obsolete library materials are frequently replaced	2.55	0.74……..

5. Conclusion

Reviewing the standard deviations from tables 2 through 4 and comparing to the average standard deviation of 3 (3-sigma) considered to be good for rating infrastructures, amenities and infrastructures, I will conclude that in all ramifications that the state of infrastructure, facilities and amenities in Nigerian universities is worse than most people can phantom. For quality of infrastructures, facilities and amenities available, the average standard deviation is 0.732, which is 2.268 (75.6%) worse than the average. For student ranking of infrastructures, facilities and amenities at federal and state universities, the federal average standard deviation is .946, which is 2.054 (68.5%) worse than the average and for the state it is .930, which is 2.07 (69.0%) worse than the average. For the maintenance of university's infrastructures, facilities and amenities, the average standard deviation is .718, which is 2.282 (76.1%) worse than the average. Based on the data (tables 2, 3, and 4) above and physical observations, it is clear to any reasonable person that a new approach is required for managing, operating and mainlining facilities and amenities in Nigerian Universities. The leaders of higher institutions in Nigeria can lead the effort if they are interested in improving campus quality of life for students, faculty and others that use these facilities daily. Incorporating infrastructure and facilities management and operation as part of engineering education, will make it possible for the students to gain the real-life experience that may be missing today in their current engineering and operations management programs. It will help universities to utilize their student talents to operate, manage, maintain and sustain their new and existing facilities and amenities. The universities will become the main hubs for developing, and cascading maintenance culture throughout the entire country. The combination of theory and practice that leads to experiential teaching will be introduced into engineering and operations management education, and students would gain practical experience in infrastructure and facilities management which is transferable knowledge to the industrial sectors of the economy. The students will gain the practical experience that students from universities in United States of America and Europe gain from internships or industrial trainings at corporate entities where infrastructures and facilities management is a top priority for institutions. Infarct, this approach will be good for both graduate and undergraduate students since infrastructures and facilities decays in the universities and across the country is a major issue that hinders economic growth and needs to be addressed urgently.

It is clear to me and to anyone interested in the approach being advocated in this study, that there are cost implications associated in setting up this type of program. The cost implication includes cost of paying students employed in the

program, outside hires, training professors and lecturers as well as consultants that may be engaged in the program. Once the program is set up and running, it will pay for itself because preventive and predictive maintenance saves money and helps to increase the life of old facilities and prevent wasting resources to build new facilities that may not be needed. The university may no longer have the need to hire outside contractors for some certain projects because the students and staff can do the work at lower cost with better quality outcomes. For students from less economically viable homes and others, it could be a means of earning money on campus and using it to offset some expenses including tuition and fees. The students will obtain the practical experience they need to lead projects in the areas of Power generation, distribution and transmission, water purification and delivery to facilities, design and construction of campus roads and bridges, preventive and predictive maintenance of infrastructures and facilities, as well as construction and maintenance of new buildings, parks and recreation centers. Minting out new engineering graduates that do not have the proper tools to execute engineering projects may be responsible for Nigeria's dependency on foreign trained engineers for design and development of the country's infrastructure and facilities needs. With this approach, graduating engineers will acquire the critical and practical skills and experience they need to become productive and viable. The phenomenon of no real-life experience that makes graduating engineers disadvantaged when compared with their foreign counterparts will be eliminated. They will gain technological and infrastructural development, operations, management and maintenance experience and their understanding of what maintenance culture means will be greatly enhanced. The issue of unemployment would be reduced as they will become employable to the hiring companies. These engineers will gain the confidence to take over and lead maintenance of the infrastructures and facilities built by expatriate that left the country long after the projects were completed.

6. Recommendations

Facilities, infrastructure and amenities management, operations, maintenance and sustainment are very critical for maintaining a healthy environment and good quality of life on campus and its surroundings. Based on my findings, I would recommend the following:

- Executing continuous improvement strategies for infrastructures, facilities and amenities within the university campuses and the surrounding communities

- Anchor the campus infrastructures, facilities, and amenities development strategy around utilizing engineering students, lecturers and professors to research, develop, design, build, launch, operate, manage, maintain and sustain for the purpose of support quality of campus life and its surrounding communities.

- Develop strategies for encouraging engineering and operations management students to learn the skills needed to operate, manage, maintain and lead real life projects, and employees to deliver tangible results.

- Integrate these projects into the academic curriculum which will help in sustaining and improving infrastructures within and around the campus environment, its surroundings and the country at large.

- Work with college of management to integrate management education into engineering education and start the creation of a maintenance culture starting from the university campuses and cascade across the country.

- Integrate student led projects for developing, building operating, managing and maintaining electricity and water treatment and purification plants, solar energy, wind and gas-powered energy with emphasis for 24-hour uninterrupted electricity supply and water delivery directly to all campus facilities.

- Introduce fund raising department as part of the infrastructure, facilities and amenities development and sustainment program. The purpose is to raise funds from alumni and the general public including from businesses on a monthly, quarterly, and yearly basis for funding campus infrastructure and facilities projects.

References

Akinyode, B., Students' satisfaction and perception on rented apartments in Nigeria: experiment of Lautech students. Int. J. Bus. Soc. Res. 5, 58–70, 2014

Hassanain, M., On the performance evaluation of sustainable student housing facilities. J. Facil. Manag. 6, doi: 10.1108/14725960810885989, 212–225, 2008.

Kim, C., Jeong, Y., and Jeong, U., A study on the application of FMS for university campus facility demand management. J. Korean Inst. Archit. 22, 125–134, 2006

Kim, et al Development of key performance indicators for the improvement of university facility management services in Korea. J. Asian Archit. Build. Eng. 17, 313–320. doi:

10.3130/jaabe.17.313, 2018.
Reynolds, G., and Cain, D., Final Report on the Impact of Facilities on the Recruitment and Retention of Students. Alexandria: APPA Center for Facilities Research., 2006 https://www.thebustersgroup.co.uk/news/developing-a-facilities-management-strategy
Kim, M., Facility Management Item Analysis for Efficiency Improvement of University Facility Management. Master's Thesis, Kyung Hee University, Seoul., 2019.
Lee, H., and Cho, C., A study on the efficiency management of national university facilities and spaces. J. Korean Inst. Educ Facil. Assoc. 15, 21–32, 2008
Damian Duruiheoma, UNN: Inside the ramshackle Zik's Flats, The Nation, 2021. https://www.nationonline.net/unn-in-side-the-ramshackle-ziks-flats.
Muktar Bello, The State of Nigerian Public Universities, 2007. www.gamji.com/article 6000/News 7632.htm
Simeon Nwakandu, Infrastructure Development in Nigerian Universities, 2013. https://www.Thewillnigeria.com/news/infrastructure-development-in-nigeria-university
Blueprint Editorial IV, Decaying facilities in Nigerian Universities, 2019. https://www.blueprinting/decaying-facilities-in-nigeria-universities
A. Akintola, G. A. Aderounmu & O. K. Owolarafe, Problems of engineering education and training in developing countries: Nigeria as a case study, European Journal of Engineering Education, 27:4, 393-400, DOI: 10.1080/03043790210166693. 2002.
Ajimotokan A.H, Ajao K.R, Adebiyi K.A, Dainkeh A and Oloyede A.A, Engineering Education and Sustainable Development in Nigeria, Journal of Research Information in Civil Engineering Vol. 7 No 1 pp 93-98 2, 2010.
Abdullahi Isa and Wan Zahari Wan Yusoff, State of Physical Facilities of Higher education Institutions, International Journal of Scientific and Research Publications Vol. 5, Issue 4, 2015. www.ijsr.org,
Ogbonnaya M. Akoma, Infrastructure Decay in Universities https://www.sunnewsonline.com/infrastructure-decay-in-universities, 2020.
Parcel Pending, 8 Ways to improve college campuses. https://www.parcelpending.com/blog/8-ways-to-improve-college-campuses
Shin, E., and Kim, J., A comparative analysis of domestic and overseas university facility management for green campus. J. Korean Educ. Facil. Assoc. 9, 45–53. doi: 10.7859/kief.2012.19.1.045, 2012
Shin, E., Kim, Y., and Kim, J., Direction of FM service development for university facilities based on KS facility management standards. Korean Inst. Educ. Facil. 22, 37–45, 2015.
Min Soo Kim and Jun Ha Kim, Effective University Facility Management Plan Proposal Reflecting the needs of the main users, Department of Housing and Interior Design Kyung Lee University, Soul, South Korea, Frontiers in Psychology, 2020. https://www.frontiersin.org
Subnair, S. Tayo, Okotoni, Comfort A. and Adebakin, Azeez B., Perceived Quality of Infrastructure in Selected Nigerian Universities, Makerere oh Higher Education, ISSN: 1816-6822; 4(1) 111-124, 2021. DOI: htpps://dx.doi.org/10.4314/majohe.v4il.9.
Amadi, N. S. and Ohaka, A. O., Influence of Poor Infrastructure on Vocational Teacher Education in Rivers State Universities, International Journal of Innovative Social & Science Educational Research, ISSN: 2360-89786(1), 54-62, 2018.
Dayo Adesulu et al, How infrastructure decay in tertiary institutions affect students, 2019. https://www.vanguardngr.com.

Biography

Dr. Joseph Ogundu is the president of Emerald Global Consulting Inc., a Michigan based consulting firm. Dr. Ogundu has extensive experience in academia, leadership, project management, business process excellence, lean transformation, supply chain and change management. He is an operations excellence and lean six-sigma practitioner. Dr. Ogundu was Adjunct professor, Industrial and Systems Engineering at both Lawrence Technological University, Southfield Michigan and Oakland University, Rochester Michigan, and Adjunct Professor of Business Administration, Kettering University, Flint Michigan. He thought courses in undergraduate and graduate levels. Dr. Ogundu graduated with a Doctorate Degree in engineering and manufacturing systems, Masters Degree in business administration, Masters Degree in Manufacturing Engineering and Bachelor's Degree in Industrial Engineering. He was an executive director at Country Coach Inc, engineering manager at DaimlerChrysler AG, Operations leader at Chrysler Corporation, project manager at Ford Motors and Senior Product Engineer at General Motor s. He was a board member

of corporations and university organizations, including Lawrence Tech University College of Management Alumni Association, South University Novi, Campus, Vice President of Chapter Development IIE SE Michigan/Toledo Chapter and Director of Certifications of IEOM. Dr. Ogundu is the author of the book “The Relationship between Types of Waste and Operating Performance Measures.