BUILDING MAINTENANCE DEFICIT: EVIDENCE FROM PUBLIC POLYTECHNICS IN SOUTH-EAST, NIGERIA

Abstract

Higher education institutions in Nigeria significantly rely on the adequacy of existing physical facilities as a success factor for indoor space audit, academic rating, certification and carrying capacity. However, there has been a growing concern over the deferred maintenance backlogs in tertiary education institutions in Nigeria due to the stylized notion of maintenance as a cost item rather than investment.This backward-looking perception has contributed to unwholesome maintenance practices leading to inadequate maintenance plan, insufficient maintenance budget, paucity of technical staff, poor integration of information technology, lack of stakeholders' participation and insecurity. The study examined the challenges of building maintenance in public polytechnics in South-East, Nigeria and attempted to proffer solutions to them.The investigation embarked on physical inspection of the facilities of some polytechnics in South-East, Nigeria. While from a population of 11 polytechnics, samples of 6 were randomly selected and studied covering directors of budget and planning, directors of works and services, heads of maintenance unit of the selected public institutions. Analytical techniques employed was exploratory factor analysis mechanism. The findings of this work show that all the factor groups contribute significantly to building maintenance with average loading of staffing (0.847), data and information management (0.780), maintenance policy (0.807)and technical related issues (0.849).The study therefore recommends a win-win integration of all the factor groups to achieve effective performance of polytechnic buildings in South-East, Nigeria.

Key words: Building, Maintenance, Deficit, Polytechnics, Nigeria.

1.0 INTRODUCTION

Higher education institution buildings play significant roles in actualizing the core mandate of academic institutions in Nigeria. Their primary purpose is to provide occupants with conducive, safe, comfortable, healthy and secured indoor environment to carry out activities such as work, study and other events of socio-economic nature (Osuagwu, Okolie, Nkeleme, Okoye and Onwuka (2021). Buildings, in their operational life, undergo certain stages that reduce their functional, financial, economic and aesthetic values. Public buildings in Nigeria seem to be under pressure of over-use without clear maintenance culture. Rather than establish a maintenance policy to arrest the rapid decay in public buildings, the Nigerian government has continued to increase its expenditure on constructing new infrastructures, such as roads, schools,

hospitals, civic centres and markets with less concern on the sustainability of existing infrastructures. Ibrahim, Ameji and Taiga (2023) citing the Central Bank of Nigeria (2021) corroborate the increase in government expenditure on infrastructure from 8 billion to 2,522 billion in 2021 notwithstanding the hourly need for a paradigm shift from availability of infrastructure to reliability of infrastructure.

The obvious neglect on maintenance of public buildings can be blamed on lack of commitment of governments to Sustainable Development Goals, SDGs (2015). Supporting this, Ayman, Motawa and Ogunlana (2015) conclude that building maintenance has consistently been treated as the 'poor relation' of the construction and building industry in Nigeria. A position that can be connected to government's perception of maintenance as a cost item rather than investment. This negative perception has contributed to substandard and dilapidated pedagogy, learning and research environment while campus surroundings are littered and overgrown with weeds. Considering the poor state of the buildings, Faremi, Olupolola and Farem (2020) question the quality of buildings in Nigeria, given the numerous counts of undesired and unpleasant manifestations that follow shortly after completion and most times during the operational stage. However, integrity question on factor inputs in any economy tend to negatively affect ease of doing business and will be counter- productive to life cycle costs. The construction of half-lived and substandard buildings has contributed to negative consequences ranging from rapid deterioration of building elements, premature failures of key building components, and sometimes building collapse as regularly experienced in public institutions (Farem et al., 2020). However, Ogunor, Mbanusi and Okoye (2018) attribute inadequate maintenance of educational buildings to environmental and social issues; students' behaviour and workers' productivity.

Despite previous studies on maintenance practice in Nigeria, problems of maintenance have remained and persisted, particularly in public buildings. The study, therefore, focuses on common maintenance challenges in public higher education institutions and therefrom simulates a maintenance framework to facilitate building efficiency and enhance productivity in public institutions.

1.2 Statement of the Problem

The main objective of polytechnic and technical education in Nigeria is to produce medium and high-level manpower with soft and technical skills to drive the nation's economy, particularly in

the areas of engineering, science and technology, and business and management. Regrettably, evidence from the Nigerian factor market seem to indicate that this vision is still yet to be attained in the 21st century due to a prevailing skill-gap. The reason for this gap may not be unconnected to dilapidated, deplorable and insanitary condition of the academic environment, including physical facilities. Many of the pedagogic facilities appear to be neglected and ill-maintained, resulting in deferred maintenance backlogs and various maintenance problems such as poor sanitation, cracked floors and walls, broken windows and doors, leaking roofs, peeling paints, dampness, growth of fungi or plants, foundation and truss element failures as well as plumbing, electrical and mechanical faults. Ayokunle, Aigbavboa, Aghimien and Adesominus (2024) describe the maintenance backlogs in higher education buildings as daunting due to numerous problems. Also, focusing on staff residential houses, students' hostels, offices and classrooms, Ugwu, Okafor and Nwoji (2018) find that about 80% of the buildings within the university require immediate maintenance.

1.3 Objectives of the Study

The objectives of the study are to:

i. determine the challenges in maintenance of building facilities in public polytechnics in South-East, Nigeria.
ii. develop a maintenance framework that will increase building efficiency in pubic polytechnics in South-East, Nigeria.

2.0 LITERATURE REVIEW

2.1 Concept of Maintenance

Building maintenance practice is yet evolving and gaining deeper understanding and insight as facility management profession attains more global recognition. Consequently, its perception will continue to change in line with the emerging universal business economy. However, Mydin (2015) describes maintenance as how a system of maintenance endeavor might be prearranged to deal with a problem of building maintenance. Maintenance is a method to keep the building functional and it can mean any interventions made on the property and its component or element with the purpose of preserving or recovering its functional capacity (ABNT, 2013). Pampana,

Jeon, Yoon, Weeildner and Hastak (2022) agree that maintenance is a combination of all the technical and administrative actions taken during the service life of a building to retain its parts and functions. Also, maintenance is defined as a combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function (BS-EN-13306,2010). Similarly, Leandro and Eli del (2023) define maintenance as the integration of all possible technical and administrative actions, including planning, supervising, monitoring and controlling towards retaining an item, a system, a machine to restore their original functional state in which they can perform the intended functions.

However, previous studies including (Muyingo, 2009; Hsu- Hua, 2009; Chen, 2019; Hernandez &Trupkin, 2021) have questioned the definition of maintenance: " … to retain it in or restore it to, a state in which it can perform the intended function", inferring that the definition perceives maintenance as a cost centre rather than a profit centre: core business driver. Maintenance is an aspect of investment with expectations of rewards in form of returns such as low operational costs, reduced defectives and increased reliability. Osuagwu, Okolie, Nkeleme and Onwuka (2021) posit maintenance as an investment involving rehabilitation, repair, refurbishment, renovation, renewal, extension and demolition as well as many unrelated design decisions such as unsuitable materials, incorrect assessment of loads, inadequate appreciation of conditions of use and wrong assessment of exposures such as rainfall, prevalent wind direction, microclimate atmospheric pollution and building height aspects.

Pampana et al. (2021) divided maintenance into two broad types: Planned Preventive Maintenance, PPM and Unplanned Maintenance. PPM comprises planned maintenance and preventive maintenance. Planned maintenance is prepared ahead of time and performed at predetermined time. It is a forethought action and includes daily works, periodic upkeep and major repairs (Osuagwu et al., 2021). On the other hand, UPM consist of corrective and reactive maintenance and caters for all maintenance activities that are not planned. In most cases, it is done under emergency and impromptu situations to swiftly address or correct existing failures, defects and faults in a building. The problem with this type of maintenance is that it is susceptible to incidence of over spending, use of substandard materials, use of unskilled labour and poor project delivery.

The European standard on maintenance (EN 13306) simply defines a maintenance strategy as a management method used to achieve the maintenance objectives. The dynamic business environment and rapid advancement in technology coupled with the current economic problems in Nigeria has necessitated a move away from the traditional maintenance approach to meta strategies to gain the win-win and most effective method to achieve ecologically sustainable buildings, service reliability, occupancy cost reduction and consistence. To achieve this milestone, Bokrantz, Skoogh, Berlin, Wuest and Stahre (2020) stress the need for an array of related investment in intangible assets such as human resource development in the built environment, financial management, data science, investment analysis as well as building economics.

2.2 Challenges of Building Maintenance in Public Polytechnics in South-East, Nigeria

Most public and private buildings in Nigeria are faced with maintenance problems such as deteriorations and ultimate defects of various degrees (Olanrewaju & Anifowose, 2015). Ram and Khet (2020) identify these challenges: plumbing and water closet, bathroom and sanitary, electrical problems, poor maintenance management and practices, peeling of paints, dampness, surface cracking, growth of fungi or small plants and decay or breaking of floor/tiles as the most significant building maintenance problems. Also, Olanrewaju and Anifowose (2015) agree that maintenance culture requires the correct diagnosis of defects, current remedial measures, sound technical knowledge of material usage, management resources as well as the formulation of integrated plan and policies to sustain utility.

The study identified and discussed the following building maintenance challenges in public polytechnics in South-East, Nigeria:

2.2.1 Poor Staffing

The Directorates of works and services in the various polytechnics assessed seem to be poorly staffed both in number, quality and mix. Majority of the staff have engineering background: civil, mechanical and electrical with few complements of technical and administrative staff. The lopsided arrangement is linked to the notion of building maintenance as an aspect of maintenance of building systems (Ahmad, 2013) without considering its strategic dimension of planning, management, staffing, competency, technology and technical capabilities (Nurofini, Noor, Izni, Fodzi& Nik, 2021). Also, Kadhim and Altaie (2023) include lack of work experience, inadequate

training, non-use of skilled maintenance personnel, shortage of maintenance staff and unavailability of skilled appointed maintenance personnel inspection and cleaning as human factors affecting building maintenance.

2.2.2 Poor Data and Information Management

There is no building information modeling system or computer aided system to track maintenance data, maintenance activities, maintenance frequency for each building, maintenance expenses, service providers and warranty periods in the maintenance department in the study area. The absence of maintenance manual to provide relevant information on the use and maintenance of facilities tends to hinder maintenance activities as tertiary institution buildings become more specialised. The objective of maintenance manual is to provide all building users with a common system of maintenance information recording and retrieval for the proper guidance of maintenance operatives (Ofori, Duodu & Bonney, 2015). Abdullateef, Seong and Lee (2017) attribute the major causes of poor communication to the absence of a shared language between superiors and workers. Workplace stress, attitude among stakeholders, poor communication skills, noise and misinterpreting of instructions.

2.2.3 Lack of Maintenance Policy

Lack of maintenance policy is a major problem in the maintenance management of tertiary education buildings. Many of the higher education institutions do not consider sustainability as a key policy objective in the management of their assets. Policy issues such as adequate maintenance budget, position of maintenance department, hiring of staff and quality assurance affect work delivery. Sustainability is one of the most significant societal challenges, and it needs to be taken into account in all sectors and level of organisation (Oladejo & Uzor, 2024). Adam and Lateef (2018) include resource allocation, performance requirements, executions, administrative activities and place of maintenance department in the organisation as policy issues that occur in maintenance. Olayinka (2017) posits that neglect or delay in maintenance causes user dissatisfaction and additional stress on the resources to provide a solution to the lack of functionality of the buildings they occupy.

2.2.4 Poor Handling of Technical Related issues

The stylised maintenance departments in the sampled public polytechnics most times do not carry out periodic building condition survey to determine the structural, functional and aesthetic

condition of the buildings. The effect of this is that they lack information on the existing buildings while relying on the occupants (staff and students) for information, which is only available when there is breakdown in the factors that affect occupants' comfort such as aesthetics, lighting, acoustics, air quality and temperature. Peduto, Necodemo, Maccabiani and Ferlisi (2017) using Building Assessment Rating System in their physical survey find that defects ranging from cracks, settlement, dampness, growth of vegetation, stains on wall and peeling of paint are common problems. Ayarkwa, Opoku, Afari and Li (2022) affirm that technical related issues such as energy efficiency, quality of construction and using less harmful materials in the building process have gained more attention in the sustainable building process.

2.2.5 Problems Related to Outsourcing

Outsourcing of major maintenance projects have been identified as regular and conventional practice in the sampled public institutions. This is because many of the maintenance departments do not have adequate skilled labour force to handle big projects despite the fact that it is ideal to outsource works that can easily be measured and monitored, leaving the projects that are strategic to the growth of the core business enterprise to the in-house maintenance team. Unfortunately, many of the maintenance works, particularly extensive renovation, remodeling and rehabilitation works in the public institutions studied were outsourced and 68% of the projects experience time overruns (Lawrence, Eziyi, Francis & Amechi 2023) due to deficiency in planning, feedback process, construction methods. ground condition, interferences, cashflow and economic challenges, scheduling strategies, design and documentation issues, underestimation of project cost, substandard materials and weak institutional regulation.

3.0 METHODOLOGY

3.1 Research Design and Study Area

This study used primary data obtained from field survey and through direct observation. Cross-sectional survey design was adopted.

3.2 Data Collection

The research data was collected directly by the researcher and his research assistants. However, direct observation method forms the approach.

3.3 Sampling Technique

Sampling methods employed in the research investigation was random sampling scheme. The random sampling procedure was statistically proven to be devoid of bias, representative and the best method of sampling since it gives every element of the population an equal chance of being included in the study.

3.4 Techniques of Data Analysis

Analytical techniques employed in validating the research aim includes descriptive statistics (mean score index), Relative Importance Index, Kendall's test of Concordance, and Exploratory Factor Analysis (EFA) by Principal Component Methods (PCM). The factor analysis is a Reduction Statistics (RS) which is usually employed in cases where the researcher has intention of identifying critical factors affecting a phenomenon at a given time. Also, in comparison to other studies, PCA stands out for its ability to handle intricate associations and provide a nuanced understanding of complex relationships within diverse contexts. Advanced computations and high degree of accuracy of PCA estimation makes it outstanding for research studies of this or similar aim. Particularly, this study aims to provide valuable insights into the challenges of building maintenance in public polytechnics in South-East, Nigeria.

3.4.1 Mean Score Index

In order to rank the severity of challenges of building maintenance in public polytechnics in South-East, Nigeria, mean score index will be used. The Mean Score Index (MSI) is mathematically represented as:

$$MSI = \frac{\sum FX_i}{N} \qquad \text{…..…….. (3.1)}$$

Where;F = Frequency of respondents to each, Xi = The score given to each factor by the respondents, and N = The total number of respondents concerning each factor

3.4.2 Relative Importance Index (RII)

This tool was used to descriptively ascertain the key challenges to building maintenance in public polytechnics in South-East, Nigeria. The RII was computed using the formula: can be computed using the formula below:

$$RII = \frac{\sum_{i=1}^{4} W_i X_i}{4 \sum X_i} \qquad \text{……..... (3.2)}$$

Where; W_i = the weighting given to each variable by the respondents, ranging from 1- 4, X_i = the percentage of respondents scoring, i = the order number of respondents

3.4.3 Kendall tau Rank Correlation Coefficient

The Kendall's tau (τ) coefficient was used to test the level of similarity in opinions of the respondents across the different polytechnics in the South-East region. The Kendall tau(τ) coefficient is defined as:

$$\tau = \frac{(Number\ of\ concordant\ pairs)-(Number\ of\ discordant\ pairs)}{\frac{1}{2}n(n-1)} \qquad \ldots\ldots.(3.3)$$

The coefficient is usually between -1 and $+1$; that is, $-1 \leq \tau \leq 1$. Based on the guidelines for interpretation, the agreement or disagreement is said to be perfect if the Kendall's tau coefficient is 1 or -1 respectively. Additionally, if X and Y are independent; then, we would expect the coefficient to be approximately zero.

4.0 RESULTS AND DISCUSSION

The analysis presented proportion of the participants in the study. The result as shown below in table 1 indicates that out of a total of 60 copies of the questionnaire distributed across the directors of budget and planning, directors of works and services, and heads of maintenance unit of the selected public institutions, a total of 47(78.3%) were returned for statistical analysis. The 53 number returned comprises 8/10 from Federal Polytechnic, Oko, Anambra state; 9/10 from Abia state Plytechnic, Aba; 9/10 from Institute of Management and Technology (IMT), Enugu; 6/10 from AkanuIbiam Polytechnic, Uwana, Ebonyi state; 7/10 from Imo State Polytechnic, Umuagwo; and Federal Polytechnic, Nekede, Imo state.

Kendall's test of concordance was performed on the respondents' opinion result to support or refute application of common pooled/composite analysis. See table 1 below.

Table 1: Result of Kendall's Test of Concordance

Location	%age	Kendall's W stat.	Chi-Sq.	p-value
Federal Polytechnic, Oko, Anambra state	80.0%	0.803	159.08	P<0.0001
Abia state Polytechnic, Aba	90.0%			
Institute of Management and Technology (IMT), Enugu	90.0%			
AkanuIbiam Polytechnic, Uwana,	60.0%			

Ebonyi state	
Imo State Polytechnic, Umuagwo	70.0%
Federal Polytechnic, Nekede	80.0%

Source: Author's computation using SPSS 27.0

The Kendall's test of concordance was performed to obtain an overall level of agreement in the responses. The choice of this technique stems from the fact that the researcher's interest in on the pooled outcome of the investigation. However, the result shows that the respondents' opinions from the various Polytechnics were highly correlated [Kendall's W-stat. = 0.803, $p<0.0001$]. Hence, aggregated analysis was fully supported.

4.1 Diagnostic Tests

Before conducting a factor analysis, there are some tests which needs to be performed to ensure that the analysis did not give birth to misleading result. Some of these tests are test of sample adequacy, test of correlations, and scree plot of the eigenvalue (latent root) against the component numbers. All these tests are aimed at ensuring accurate and reliable results. This paper captured test of sample adequacy and test of correlations.

Table 2: *KMO & Bartlett's Test*

KMO test stat.		.888
Bartlett's Test	Approx. Chi-Square [p-value]	286.212 [0.0002]

Source: Author's SPSS 27.0 computation (2024)

The Kaiser-Meyer-Olkin (KMO) and Bartlett's tests are essential diagnostic test for factor analysis. This is because, they capture the sample adequacy and correlations of the variables respectively. The KMO test result [KMO = 0.888] is meritorious, confirming sufficiency of the sample size; and therefore, presenting that it is plausible to conduct factor analysis on the variables. However, the Bartlett's test [Chi-Sq. = 286.212, $p=0.0002<0.05$] proved that the correlation matrix is not an identity matrix. In other words, the null statement that the variables are unrelated was not upheld, hence, correlation coefficients of the variables are non-zeros. Having performed these two essential tests, the researcher proceeded with the factor analysis proper, so as to collapse and simplify the large list of challenges of building maintenance in Public Polytechnics in South-East, Nigeria to critical, significant and achievable structure. See table 3 below showing the summary of results of the factor analysis.

Table 3: Summary of Exploratory factor analysis and Cronbach's alpha of the challenges of building maintenance in Public Polytechnics in South-East, Nigeria

Challenges	*Poor Staffing*	*Poor data & Info. Mgt*	*Maintenance Policy*	*Technical related issues*
Poor staffing				
Number of staff	0.851			
Adequate mix of staff	0.763			
Quality of staff	0.892			
Work experience	0.517			
Competency	0.882			
Technical capability	0.547			
Administrative staff	0.556			
Poor Data and Information Management				
Shared language		0.504		
Reduced workplace stress		0.498		
Stakeholders' attitude		0.536		
Strong communication skills		0.799		
Data management tools		0.814		
Clear instructions		0.468		
Maintenance manuals		0.771		
Drawings and models		0.753		
Logbooks		0.740		
Report and charts		0.802		
Maintenance Policy				
Resource allocation			0.813	
Performance targets			0.795	
Performance indicator			0.453	
Execution			0.839	
Administrative style			0.564	
Place of maintenance department			0.717	
Sustainability			0.872	
Technical Related Issues				
Energy efficiency				0.908
Quality of construction				0.501
Green materials				0.885
Physical inspections				0.478
Identifications of defects/failures				0.520
Assessments of defects/failure				0.745
Design decisions				0.483
Cronbach Alpha	***0.783***	***0.744***	***0.698***	***0.813***

Source: Author's field result from SPSS 27.0

Table 3 shows factor loadings of the challenges of building maintenance in higher education institutions in South-East, Nigeria. To choose salient variables for each factor, a threshold loading value of 0.60 was used. As shown in the table, a total of 18 factors were loaded high,

with component scores greater than 0.60, indicating that they arethe major challenges to building maintenance in higher education institutions in South-East, Nigeria. Reliability of each factor group was determined using the Cronbach's Alpha method at a benchmark of 0.50. Based on the Cronbach's alpha estimate, all the factor groups contribute significantly to building maintenance. The entire 31 outlisted factors were grouped into 4 namely: staffing, data and information management, maintenance policy, and technical related issues. From the staffing factors, Number of staff (0.851), Adequate mix of staff (0.763), Quality of staff (0.892) and Competency (0.882) were extracted. From the data and information management, strong communication skills (0.799), data management tools (0.814), maintenance manuals (0.771), drawings and models (0.753), logbooks (0.740), and report and charts (0.802) were extracted.

In maintenance policy, the factors extracted were: resource allocation (0.813), performance targets (0.795), execution (0.839), place of maintenance department (0.717), and sustainability (0.872); while in technical related issues, energy efficiency (0.908), green materials (0.885), and assessment of defects/failure (0.745) were sieved out as essential factors. The Cronbach's alpha estimates were all greater than 0.60, indicating high level of reliability of these results.

Table 4: Remedial Measures of the challenges of building maintenance in Public Polytechnics in South-East, Nigeria

Remedial Measures	***Code***	***Scores***	***Rank***
Planning	PLN	56.7%	6th
Feedback process	FEDP	89.4%	2nd
Construction methods	CONMT	86.9%	3rd
Ground condition	GRCD	50.8%	8th
Design ad documentation	DSND	47.2%	9th
Interferences	INTF	79.9%	4th
Scheduling strategy	SCST	55.1%	7th
Substandard materials	SUSM	72.0%	5th
Strong institutional regulations	STIRG	91.4%	1st
Mean = 3.02; t-stat. = 7.165, p=0.013<0.05			

Source: Field survey result (2024)

The study identified the 4 top-most remedial measures of building maintenance challenges in public polytechnics in south-east, Nigeria, to include:strong institutional regulations (STIRG: 91.4%, 1st), feedback process (FEDP: 89.4%, 2nd), construction methods (CONMT: 86.9%, 3rd), and interferences (INTF: 79.9%, 4th). Following closely after 4th factor was substandard materials (SUSM) with fractional ranking estimate of 72.0%. These factors [***t-stat. = 7.165, p=0.013<0.05***]

were statistically proven to have the capacity to proffer sustainable solution to the building maintenance deficit in public polytechnics in South-East, Nigeria.

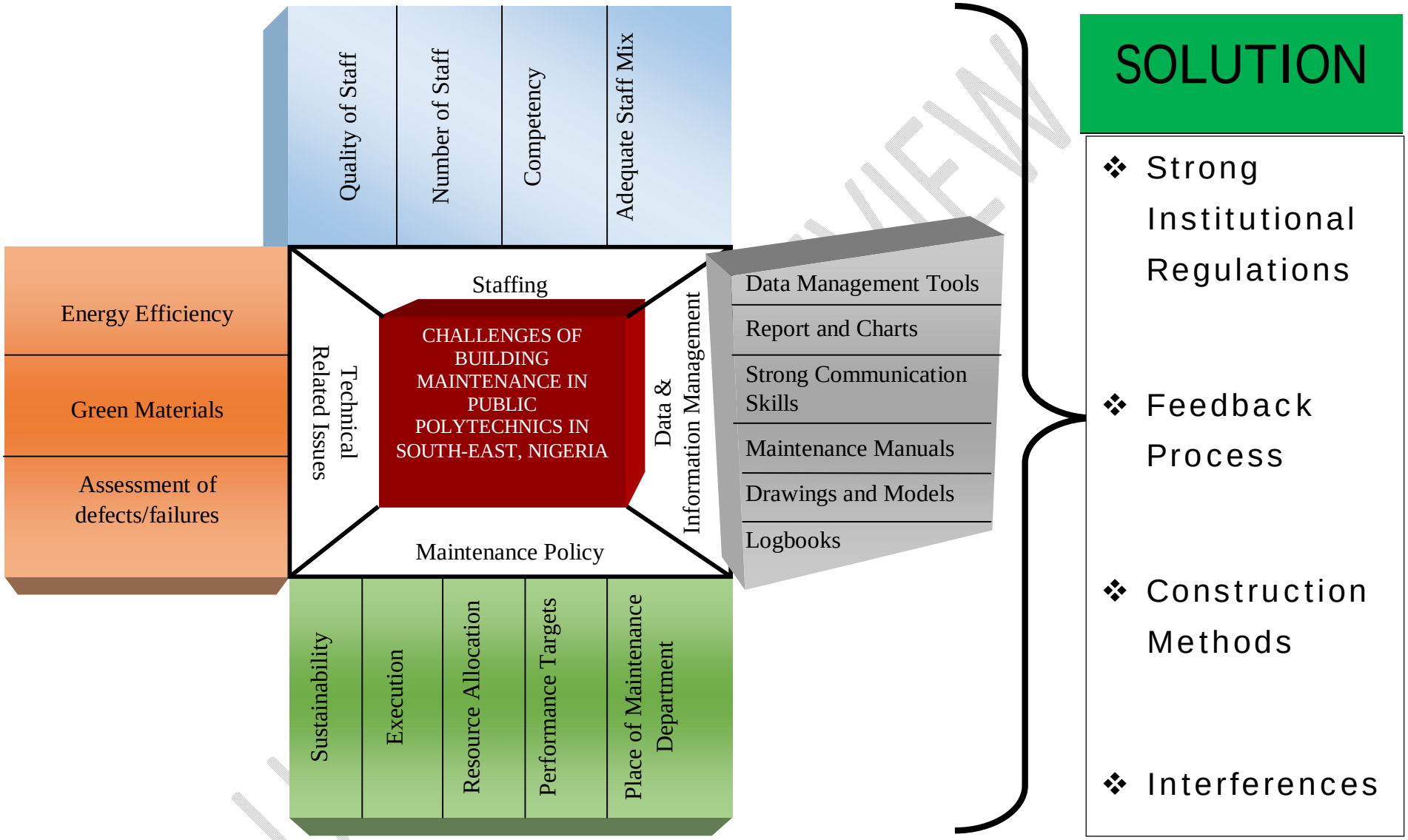

Fig.1 : Diagrammatic representation of key Obstacles to effective application of Facility Management (FM) in public polytechnics in South-East, Nigeria.

5.0 CONCLUSION AND RECOMMENDATIONS

The study concludes that staffing comprising staff mix, number of staff, quality of staff and competence; data and information management made up of reports and charts, communication skills, drawings and models,data management tools and log books; maintenance policy consisting of sustainability, execution, resource allocation, performance targets and place of maintenance department; and finally technical issues comprising energy efficiency, green materials and defect/failure assessment contribute significantly to building maintenance.

Based on the findings of this work, the study, therefore. recommends as follows:

i. Governments should enact a strong institutional regulation to prioritize maintenance of polytechnics buildings in South-East, Nigeria.

ii. Maintenancedepartments should adopt adequate staffing, effective information and data management tools, sound maintenance policy and efficient handling of all technical related issues such as consumption of energy and water, green construction in the maintenance managements of their buildings.

iii. Public institutions should establish a well-placed and funded maintenance department in their various institutions with clear cut objectives to cater for the maintenance of pedagogic buildings.

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Report 86 Building and Real Estate Economics School of Architecture and Built Environment Royal Institute of Technology Kungliga TekniskaHögskolan Printed by Tryckoch Media, Universitetsservice US-AB, Stockholm.

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