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Declaration

The researcher declares that, the work presented in this thesis to the best of his knowledge is original and his own work. Also, neither the thesis in its entirety nor any portion of it has been submitted for application for another academic degree or qualification in another University or Institution. Other sources of data or information used in the study have been well acknowledged and referenced.

Abbreviations

ABCD-Australian Building Codes Board

ACS-Automatic Climbing System

ADePT-Analytical Design Planning Technique

BSI-British Standard Institution

CABE-Commission for Architecture and the Built Environment

CBPP-Construction Best Practice Programme

CBM-Condition-Based Maintenance

CDM-Construction Design and Management Regulations

CEA-Cause Effect Analysis

CEM-College of Estate Management

CIOB-Chartered Institute of Building

CM-Condition Monitoring

CMMS-Computerised Maintenance Management Systems

Co2-Carbon

CPA-Critical Path Analysis

CPF-Construction Project Features

CPM-Critical Path Model

DESA-Department of Economic and Social Affairs

dB- Decibel

DEFRA-Department for Environment, Food and Rural Affairs

DOE-World Commission on Environment and Development

EBSCO-Economic Business Source Complete

EMAS-Eco-Management and Audit Scheme

EMS-Environmental Management System

EPA-Energy Performance Assessment

EPBD-Energy Performance of Buildings

EU-European Union

EWSC-Early Warning System Chart

FEMA-Federation of Environmental Agency

FM-Facilities Management

FMEA-Failures Modes and Effects Analysis

FPM-Facilities Performance Management

FTM-Fault Tree Methods

HEIs-Higher Education Institutions

HHSRS-Housing Health and Safety Rating System

HOQ-House of Quality

HSO-Health and Safety Offences

HVAC-Heating, Ventilating and Air-Conditioning

ICT-Information Communication Technology

IDEFO-Integration Definition for Functional Modelling

IEQ-Indoor Environmental Quality

ISDR-International Strategy for Disaster Reduction

ISO-International Standard Organisation

IT-Information Technology

JIT-Just –in-time

KPI-Key Performance Indicator

LCA-Life Cycle Analysis

LCC-Life Cycle Costing

LCCM-Life Cycle Cost Management

LCCP-Life Cycle Cost Planning

MDP-Markov Decision Process

NCCARF-National Climate Change Adaptation Research Facility

OEE-Overall Equipment Effectiveness

OLS-Ordinary Least Square

PAHO-Pan-American Health Organisation

PE-Public Engagement

PERT-Programme Evaluation and Review Technique

PPID-Project Production Information Documents

PPMM-Planned Preventive Maintenance Method

PPM-Planned Preventive Maintenance

PM-Preventive Maintenance

PMT-Project Management Tools

QFO-Quality Function Development

RCM-Reliability – Centred Maintenance

RIBA-Royal Institution of British Architect

RICS-Royal Institution of Chartered Surveying

RMHS-Rocky Mountain High School

SBS-Sick Building Syndrome

SCS-Stock Condition Survey

SMS-Short Messages

TPM-Total Productive Maintenance

UAE-United Arab Emirate

UN-United Nations

UNDESA-United Nations Department of Economic and Social Affairs

UK-United Kingdom

USA-United States of America

USCB-United States Census Bureau

USGBC-United States Green Building Council

UNISDR-United Nations International Strategy for Disaster Reduction

VM-Value Methodology

WBTC-Works Bureau

WBS-Works Breakdown Structure

WHO-World Health Organisation

A Theoretical Framework to Support Facilities Maintenance Management of Higher Education Institutions (HEIs) Facilities in Nigeria

Abstract

The processes required in maintaining Higher Education Institutions (HEIs) buildings, and to retain their services and facilities to an acceptable standard in Nigeria is being undermined by insufficient maintenance budget and lack of strategic planning.

The aim of the study is to develop a new theoretical strategic framework to support Facilities maintenance management of Higher Education Institutions facilities in Nigeria. The key objectives of the study include: investigating the current theoretical approaches to facilities maintenance management, evaluating works and services departments' constraints in relation to procurement strategies, maintenance methods, maintenance budgets, post occupancy evaluations, project quality control, sustainable programme, and the influence of culture on project execution. Others objectives include: developing a strategic framework to support facilities maintenance management, and validating its effectiveness and the efficiency. The scope of the study is focussed on the general maintenance of all building elements; services provided in the selected twelve HEIs in south west of Nigeria.

The study adopted a mixed method research strategy by conducting series of semi-structured interviews with the directors of works and services of the selected HEIs, and a questionnaire survey of the 36 Technical Officers from the selected HEIs in Nigeria. The qualitative and quantitative data collected were analysed by using thematic analyses and multiple regressions respectively.

The findings of the thematic analyses of the interviews reveal that, there was a general shortage of financial resources that allow keeping of backlogs of maintenance and repairs of HEIs buildings across both the federal and state HEIs. The work identified that, the following factors have caused majority of the backlogs of maintenance: low level of overall maintenance budget, delays in releasing cash (maintenance funds), lack of the adoption and

use of planned prevent maintenance method, a shortage of in-house technical staff, and the absence of maintenance programmes and maintenance schedules.

In addition, the findings of the questionnaire survey identified the largest and the strongest among the variables used (Predictor-Maintenance Budget), it determines the effectiveness and efficiency of the framework to about 58%, and determines at which level, that the smallest and less stronger variables can join together with the largest and strongest variable to make the framework effective in the facilities maintenance management of HEIs facilities in Nigeria. The findings further reveal that: majority of the HEIs works and services departments do not have full complements of technical staff, so they outsource most of their maintenance projects; most HEIs works and services departments do not have maintenance budgets; where the budgets are in place, they do not adopt appropriate techniques for data collection. In most HEIs sampled, the major defects are often caused by long delays in releasing maintenance cash.

Other challenges include: use of inappropriate maintenance methods; lack of establishment of a project control unit within the works and services department; inability to prepare and use maintenance control toolkit; over reliance on complaints from the facilities users instead of carrying out post occupancy evaluations; and lack of adequate programmes to maintain the built environments under their management.

A framework was subsequently developed to address the challenges and shortcomings discovered through interviews and the questionnaire survey. The key element of the framework is based on the extensive literature review and is the further validated through a series of interviews with senior technical officers from eight out of the twelve HEIs sampled. The interviewees agreed that the framework is valid, adaptable, and will make facilities maintenance management of HEIs facilities in Nigeria cost effective, efficient in running, and ensures the achievement of project quality control and project deliveries in a timely fashion.

Key words: Backlog, budget, environment, sustainable, procurement, maintenance and quality.

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