PUBLIC INSTITUTIONS' READINESS FOR THE ADOPTION OF COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM IN NIGERIA

Osuji E. C.[1], Nkeleme E I[2],. Achighu O [3] Diogu E. O[4]

[1]Ahmadu Bello University Zaria.

[2, 3 & 4] Federal University of Technology Owerri Imo State

Abstract

The advent of real time maintenance control and monitoring approaches such the Computerized Maintenance Management System (CMMS) is a trend promising to tackle the numerous challenges encountered in the maintenance of facilities of public institutions. The research aimed at assessing the readiness of public institution to adopt computerized maintenance management system (CMMS) in the maintenance of public facility in Nigeria, with a view to improving the maintenance activities of public facilities. The research adopted the Quantitative research methods, which made use of questionnaires as a data collection tool. The questionnaires were administered randomly in seven public institutions in Zaria to 33 facility management staffs in those institutions. The result was analyzed using statistical tools such as Percentage, Mean Score (MS), Standard Error Mean and Standard Deviation. The VERDICT model was used to classify the readiness of public institutions to adopt Computerized Maintenance Management System (CMMS). The result was based on the average mean of each of the determinants of the public organization's readiness. The technology readiness MS of 3.29 which is indicates that it is partially ready, People readiness has MS of 3.28 which indicates that it is partially ready; Process readiness has MS of 3.15 which indicates that it is partially ready, and the management readiness has MS of 2.87 which also indicates that it is partially ready. Therefore, the research concludes that the public institutions are partially ready for the adoption of computerized maintenance management systems (CMMS); however, there is need to put certain considerations as identified in the research especially at management level. The research recommends that there is a need for management of public institutions to identify the far-reaching possibility of CMMS in maintenance, to encourage management readiness, and hence full adoption of CMMS in public institutions.

Keywords: CMMS, Maintenance, FM, Public Institutions, Information Technology (IT)

Introduction

Facilities management (FM) denotes one of the fastest emergent sectors in real estate and construction industries. Organizations need to grasp that they must educate clients in managing their facilities and properties in other to benefit more. Nevertheless, tracking and managing facilities effectively are extremely difficult owed to the various facilities. Real time control and monitoring for maintenance management may be basic and helpful to control and manage efficiently the maintenance work in the building facilities (Yu, Lee & Lin, 2011). The advancement in science and technology, necessitate that the facility manager should adopt modern methods of facilities management. The liability of management of facilities requires collective efforts. Management processes, which encompass planning, decision making, organizing, coordinating, controlling and leading, are applied in facilities management. Broadened goals and objectives as a significance of changes in socio-economic progress have necessitated the involvement of quite a lot of minds in the facilities management process. It necessitates professional idea from a broad range of stakeholders (Asiabaka, 2009). Collaborative efforts bring into facilities management fresh ideas and perceptions and these have demanded the utilization of information technology to capture the variety of information by high-powered technologies.

Public facilities are facilities provided, owned, or being controlled by government either at the federal, state or local government level. principally, they can be categorized into two namely movable facilities which are facilities like earth moving equipment, vehicles, computers, etc., that can change position from time to time and non-movable facilities like buildings, electricity lines, pipe lines for water, etc., that cannot change their location. However, importance is focused on both movable and none-moveable public facilities. All these facilities, regardless of their group require efficient consistent maintenance for suitable functioning of the assets acquired. The performance of public facilities hinge on the extent of effectual maintenance. Unfortunately, however, maintenance is one of the topmost troubles facing the public organizations with a substantial effect of having their premises littered with broken down facilities that are allowed to wear away under different kind of weather and in due course are sold as scraps (Iwarere & Lawal, 2011).

Although information technology (IT) have brought significant benefits to organizational systems, facility maintenance management including planning, monitoring, and control are still acknowledged as an area of severely relying on expertise of experienced engineers. The crucial purpose may be the reality that decision-makings with facility maintenance management are conservative in nature, in that machines and facilities are typically highly cost resources, hence even their slight malfunction can cause vast financial loss to organizations. However, the notion of e-maintenance has been progressively recognized as a prevailing approach of computerized maintenance management through the last decades (Muller, Marquez & Iung 2008). Use of IT to support decision-making in maintenance management includes planning activities, selecting policies, scheduling, documentation of history, and forecasting facility reliability and maintainability (Faiz & Edirisinghe, 2009, Yam, Tse, Li & Tu, 2001).

The concept of maintenance has suffered countless transformations over time. In the ancient times, Tsang, (1995), described maintenance as unavoidable, the act of replacing a component in a process machine after it broke. Currently, maintenance is a multifaceted management procedure that associates several organizational processes like production, quality, environment, risk analysis and safety (Stamboliska, Rusiński & Moczko, 2015). Muchiri, Pintelon, Gelders and Martin (2011) likewise consider that equipment maintenance and dependability are relevant factors that have a solid impact on organization's ability to make available quality and well-timed services to customers. Considering that maintenance is an imperative function of organizations, maintenance management needs a multidisciplinary method with a business perspective (Muchiri et al, 2011).

Maintenance management is defined as a lay down of activities to institute the maintenance objectives, strategies, and responsibilities and accomplish them by means such as maintenance planning, maintenance supervision and control, enhancement of procedures in the organization including economical aspects (EN 13306 European Standard: Maintenance Terminology, 2007). Throughout the industrial evolution, one of the utmost important resources that make known to be determinant to develop the maintenance function is information. Information can be said as a gathering of data, which is transmitted, to a receptor that utilized it decisions making (Laudon & Laudon, 2000). Information appears in organizations as a strategic resource, critical for a better operability and coordination between all players. Information systems came up with computer science and include many activities from the information technologies to organizational activities, such as the use of techniques to describe user requirements and respective solutions (Laudon & Laudon, 2000). Information systems to keep up maintenance function are described as Computerized Maintenance Management Systems (CMMS).

According to O'Brien, (2016) Computerized Maintenance Management System (CMMS) is also acknowledged in various terms and names, like Integrated Information Management System (IIMS), Enterprise Asset Management (EAM), Computerized Maintenance Management Information System (CMMIS), etc. nevertheless, they denote a system in which the basic functionality is to keep up a computer database of information about an organization's maintenance operations.

Nowadays computerized maintenance management system, (CMMS) has become very popular amid building maintenance management teams in daily activities (Ramachandra, Srinivas, and Shruthi, 2012). Designed to store information and absolute data for each activity, system or equipment such as maintenance of buildings planned or unplanned; work orders; schedule of activities; maintenance record, parts suppliers; purchase orders and fiscal flows. In addition, the documented data will be adopted in the monitoring and control of maintenance work; budget planning and fiscal reporting and maintenance of all information stored in the CMMS it easier to refer back when needed (Azahar & Mydin, 2014).

The organization ought to comprehend the role of a CMMS in order to describe which information the system must record and provide to sustain maintenance strategy. The operation of a CMMS will tolerate a speedy and effective communication and will transport countless benefits such as better planning and scheduling, effortless access to historical data and report generation allowing cost saving connected with spare parts and maintenance activities, etc.(Wienker, Henderson, & Volkerts, 2016). The exploit of a CMMS in the organization will also facilitate the implementation of Total Productive Maintenance (TPM) (Ying, 2008 & Yee, 2007) which will go a long way in ensuring maintenance of public facility in Nigeria and a reduction in the maintenance cost in the end. Therefore, this research will seek to assess the readiness for the adoption of computerized maintenance management system (CMMS) in the maintenance of public facility in Nigeria.

Literature Review

Concept of Computerized Maintenance Management System (CMMS)

Computerized maintenance management system (CMMS) as described as popular among structure maintenance management teams in daily activities, designed to preserve information and complete data for each activity, system or equipment such as maintenance of structures planned or unplanned; work orders; schedule of activities; maintenance history, parts suppliers; purchase orders and financial flows. In addition, the documented data will be adopted in the monitoring and control of maintenance work; budget planning and financial reporting and maintenance of all information stored in the CMMS it easier to refer back when desired (Azahar & Mydin, 2014).

According to Zhang, Li and Huo (2006) CMMS have allotted a set of functions and applications, including:

1. Assets Management: that comprises of recording all assets (or equipment) and a historic record of repairs and equipment parts list;
2. Work Orders Management: that allows setting and releasing of work orders to the maintenance technicians.
3. Preventive Maintenance Management: that supports the planning, scheduling and control of activities;
4. Inventory control: giving access to spare parts availability.
5. Report Management: CMMS processes large amounts of data and produces performance indicators

Isabel, Patricia, Sandrina, Vera, Catarina, Joao,Anabela, Jose and Manuel (2016) described the computerized maintenance management system as an important tool for companies to support the maintenance management activities. The current system is adapted to the activities performed by the maintenance department; however, there is several improvement opportunities, such as:

1. analysis of failures to reduce its occurrences, and to plan maintenance activities and condition monitoring;
2. Access to the information in real-time at different places to facilitate technicians actions;
3. Support scheduling function attending both maintenance technician availability and production plan;
4. Support performance assessment and improvement initiatives

Processes Involved in CMMS

Maintenance management can be described as managing the maintenance activities. Computerized Maintenance management can be considered as the direction and organization of resources in order to control the readiness and performance of facilities to specified level using a computerized system. Maintenance activities are a key cost factor in most facilities, affecting both profit on capital and production throughout. Maintenance management is the art and science of executing the maintenance activities in an efficient way. The objective of the computerized maintenance management system is to stream line the huge maintenance information system to improve the output of an industrial plant. A worthy maintenance management system makes equipment and facilities available (Muchiri, *et al;* 2011).

Managing maintenance comprises several activities such as: planning of preventive maintenance actions; scheduling of activities considering available resources and strategic production; management of spare parts; analysis of data to lessen the occurrence of failures and to enhance performance of the maintenance function. To support this function, companies adopt information systems designated by computerized maintenance management systems (CMMS) to provide apt and precise information. Several CMMS are offered in market. However, its main drawback is that they do not perfectly match the particularities of each company**.**

The fundamental steps of computerized maintenance management program are shown in Figure 1

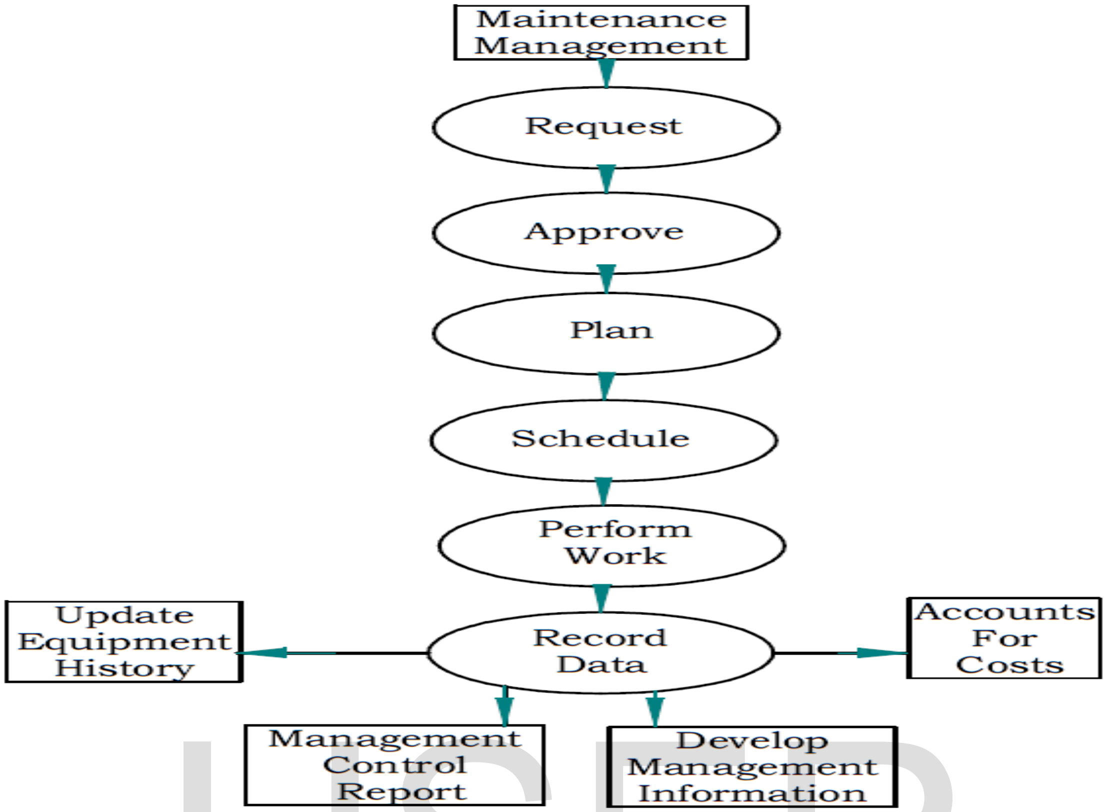

Figure 1: Processes Involved in CMMS
Source: Isabel *et al.* (2016).

A. Request

Request to perform maintenance work may be transmitted in different ways i.e. verbal, telephone call, written request.

B. Approve

Simple jobs may be handles by the maintenance supervisor. When large expenditure is involved, several levels of management approvals may be required.

C. Plan

The planner will prepare a work order. On major projects, the planner may follow critical path method, detailing all the steps, procedures and instructions for carryout the plan.

D. Schedule

Schedule involves three factors

a) Priority: Priority codes based on established criteria or on the importance of the equipment and the kind of work to be performed may be used.

b) Job Assignment: May be on a first come basis or may reflect skill requirements and time estimates as part of a manpower-scheduling plan.

E. Perform Work

This step involves craft man working from little or no instructions or from detailed procedure.

F. Record Data

The data recording may vary from simply listing the actual hours to keeping comprehensive records of material charges, equipment identification, work assigned and performed and other pertinent data.

G. Accounts for Costs

It is imperative to know where and what the money is being spent for.

H. Develop Management Information

It involves providing facts on current work, including coast, accumulated data, equipment identification, productivity, and budgets and scheduling.

I. Update Equipment History

History records may vary from little or no data online upgrading of all equipment, showing use, downtime and maintenance labor and material costs on every piece of equipment.

J. Management Control Reports

As Management Information is developed, control reports, covering expenditures, performance, backlog, equipment data etc., can be generated regularly to summarize the results of the maintenance function. Some key problems pertaining to maintenance management are

- **i.** Labor requirements.
- **ii.** Employee production.
- **iii.** Facility's productivity.
- **iv.** Planning for material and tools availability.
- **v.** Lack of history records.
- **vi.** Incomplete material control records.
- **vii.** Lack of preventive maintenance that causes high unscheduled downtime (Isabel *et al;* 2016).

Readiness Assessment Models

So many readiness assessment models have been developed in recent times. Ruikar, Anumba and Carrillo (2006), states that each tool gauges how prepared a society or economy is to profit from Information Technology (IT) and e-commerce. Vaezi and Bimar (2009) detected that the series of tools use widely varying definitions for e-readiness and diverse methods of measurement. Aziz and Salleh (2011) correspondingly asserts that there is no precise definition for the concept of readiness. Some tools evaluate the readiness of countries and economies to implement internet technologies on a global platform, whereas others further focused on evaluating the readiness of definite sectors to adopt the technologies.

Some of those tools includes the one developed by Harvard University Center for International Development (CID 2001) called 'Networked Readiness Index' which gauges a country's capacity to make use of its Information and Communication Technology (ICT) resources. Readiness is defined as the degree to which a community is equipped to partake in the networked world and it's latent to be part of the networked world in the future (Kirkman, Rosen, Gibson & Mcpherson, 2002). Similarly, the Asia Pacific Economic Cooperation's (APEC) e-readiness assessment concentrated on government policies for e-commerce, whereas Mosaic global diffusion of the internet project's readiness assessment tool aimed at gauging and analyzing the worldwide progress of the internet. (Ruikar et al; 2006), (Vaezi & Bimar, 2009).

On the other hand, as these tools were centered on measuring the readiness of countries, governments and policies for embracing internet technologies, there are others that focused on assessing the readiness to adopt different engineering concepts and approaches. For example, SCALES (Supply Chain Assessment and Lean Evaluation System) was developed specifically for the manufacturing industry in order to assess companies' (especially SMEs) readiness for adopting Lean manufacturing techniques. Furthermore, there are several other tools that were developed for Concurrent Engineering (CE) such as RACE (Readiness Assessment for Concurrent Engineering) which was developed in the West Virginia University (United States) in the early 90s. It was conceptualized in terms of two major components: Process and technology, It is widely used in the software engineering, automotive and electronic industries. According to Khalfan and Anumba (2000), RACE can be improved to be used in the construction and other industries. Alike to this one is the SPICE (Standard Process Improvement for Concurrent Engineering), which was developed in the University of Salford, United Kingdom in a form of a questionnaire. It was intended to weigh the key construction processes within construction organizations (SPICE Questionnaire, 1998). In addition, the BEACON (Benchmarking and Readiness Assessment Model for Concurrent Engineering) was fashioned to evaluate the construction companies' readiness level in executing concurrent engineering with the goal of refining the project delivery process. Others comprise the competence Maturity Model CMM developed for software development and evaluation, and the IQ Net readiness scorecard (Khalfan & Anumba, 2000) and (Ruikar et al; 2006).

Alternative readiness assessment tool that is of specific relevance to this research is the VERDICT (Verify End-User e-Readiness using Diagnostic Tool) developed to assess the overall readiness of final users involves in the public facility for using e-commerce technologies (Aziz & Salleh, 2011). The VERDICT model is a mixture of two e-readiness assessment models-the BEACON model and the IQ Net readiness scorecard. BEACON, as cited earlier, assesses the readiness of construction companies to advance its practices for executing concurrent engineering. It comprises of four elements- process, people, project and technology. IQ Net readiness scorecard is web based application developed by CISCO based on a book called Net ready. Aminali, Albadvi, and Naude, (2009) Evaluates the readiness of IT service providers in such a way that the companies are presented with statements which fall into four classes as leadership, governance, technology and organizational competencies, for which, upon completion, they will be shown their e-readiness assessment result.

Similar methodology was adopted in developing the VERDICT model. In it, companies' e-readiness results are obtainable to them after answering some statements that fall under four categories- management, process, people and technology. Ruikar et al. (2006) the developers of

VERDICT debated that to successfully execute any technology, there is necessary to have the people with suitable skills, understanding of, and confidence in the technology, then processes that enable and support the successful adoption of the technology, then the technology tools and infrastructure necessary to aid the business functions and another key element to consider is the management buy-in and belief. Therefore the next is the management that believes in the technology and takes strategic measures to drive its adoption, implementation and usage in order to derive business benefits from the technology, (Ruikar et al, 2006, Vaezi & Bimar 2009). All the four elements have to work complementarily for any organization to achieve e-readiness. The model is different from the BEACON and the IQ Net readiness scorecard in that it directly addresses the construction sector end-users in evaluating their e-readiness for using e-commerce technologies such as web based collaboration while the former two are concerned with the readiness of technology companies such as software companies or vendors.

The developers claim that VERDICT can be used to assess the e-readiness of construction companies, departments within a company, or even working groups within a department. The assessment is achieved by discovery an average score for each of the four categories from the judgment of the respondents on the statements of the questionnaire

i. An average score greater than or equal to zero and less than 2.5 shows a red colour which shows that critical attention is desirable to achieve e-readiness.

ii. An average score greater than or equal to 2.5 and less than 3.5 is amber colour which means that certain aspects need attention to attain e-readiness

iii. An average score greater than 3.5 shows a green colour which specifies that the organization is adequately ready and matured enough for e-commerce tools.

The choice of these boundaries was based on simple average scores computed for each of the four elements in the questionnaire (Ruikar et al; 2006).

Research Methods

This study used descriptive approach. This descriptive type of research used questionnaires. The purpose of adopting this method is to describe the nature of the situation as it exists at the time of the study and to assess the readiness for the adoption of computerized maintenance management system (CMMS) in the maintenance of public facility in Nigeria.

Rajasekar *et al. (*2013) describe the methods adopted in the research as similar to the research design and can be seen as the diverse approaches to be used in solving the research problem, sources and information related to the problem and, time frame and the cost budget. Essentially, the research design creates the basis of the whole research work. The design will help perform the chosen task easily and in a systematic way. Once the research design is completed the actual work can be initiated. The first step in the actual work is to learn the facts pertaining to the problem. Particularly, theoretical methods, numerical techniques, experimental techniques and other relevant data and tools necessary for the present study have to be collected and learnt.

Since the population of the study is small, the sample size considered for the study consists of the seven (7) public institutions. The research focused on management staffs of the planning and development department, this is because they are responsible for maintenance decisions and activities in the institutions. The numbers of respondent considered in each institution were four (4) management staffs. Therefore giving a total of 4x7=28 respondents

To take care of non-return questionnaire / not useful a 10% of 28 is added to give thirty tree (33) questionnaire.

There are two types of sampling technique used in scientific research which is probability and non-probability sampling. This research adopted the simple random probability sampling technique because it can represent the entire population and the respondents have equal opportunity of been selected at random. It also help to avoid biasness.

The study used a well-structured questionnaire to collect its data. These questionnaires was distributed to maintenance department and personnel: that is the Nigerian institute of transport technology (NITT), Nigerian college of aviation all in Zaria (NCAT) Nigerian Institute of Leather and Science Technology (NILEST), National Research Institute for Chemical Technology (NARICT), Federal college of education Zaria (FCE), Ahmadu Bello University Zaria and Nuhu Bamali polytechnic Zaria. The questions will be close ended so as to streamline the responses to the concept of the research, while the question used in the research will coined out of similar literatures on the subject area.

Data Analysis Technique

When the entire survey questionnaires have been collected, the research used statistics tools to analyse all the data.

Mean Score $= \frac{\sum fx}{\sum f}$

Where,

$\sum fx$ = is the total weight given to each attributes by the respondents.

$\sum f$ = is the total number or respondents in the sample.

For simplicity, Statistical Package for Social Sciences (SPSS) computer package was used in conducting

The responses obtained, were used to draw inferences; using the mean scores of each group of firms, based on the VERDICT model developed by Ruikar *et al*; (2006). According to Ruikar *et al;* (2006)

1. An average score greater than or equal to zero and less than 2.5 shows a red colour which indicates that urgent attention is needed for to achieve e-readiness.
2. An average score greater than or equal to 2.5 and less than 3.5 is amber colour which means that certain aspects need attention to achieve e-readiness
3. An average score greater than 3.5 shows a green colour which indicates that the organisation is adequately ready and matured enough for e-commerce tools.

The choice of these boundaries was based on simple average scores computed for each of the four elements in the questionnaire.

Result and Discussions

The demographic data collected indicated that, 33 questionnaires were distributed within seven (7) public institutions in Zaria. Table 1 represents the number of questionnaires distributed to the institution. Thirty tree (33) questionnaires were distributed and 30 were properly completed and returned representing a percentage response of 91%. According to Moser and Kalton (1971), the result of a survey could be considered significant if the response rate not lower than 30-40%. Therefore, the response rate is considered adequate.

Table 1: Demographic Data of the Respondent

Questionnaire Distributed	Frequency (No.)	Percentage (%)
Returned	30	91
Not Returned	3	9
Total	33	100

Source: Field Survey (2018)

Years of experience of the respondent

The classifications of the years of experience within the respondents are represented in Figure 2 of which indicate that 37% of the respondents are 6 to 10 years. The other categories of year's classification are given as follows; 27% and above 20years, 20% are 16 to 20 years, 10% are 11 to 15years and 7% is 0 to 5years and above which is the lowest. Based on the data analyzed the respondents have a good knowledge and experience on facilities management processes.

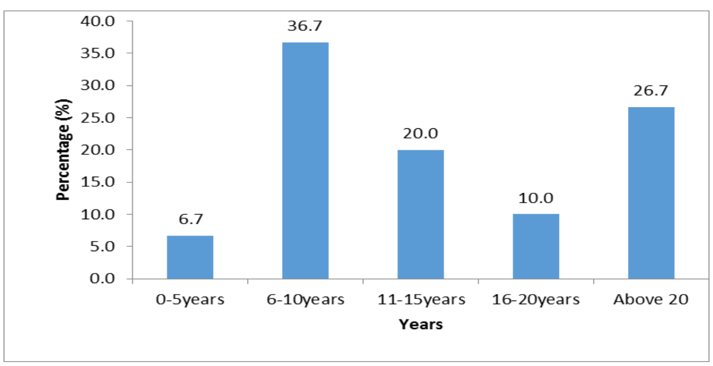

Figure 2: years of experience

Source: Field Survey (2018)

Professional Career of the Respondent

Figure 3 shows the career of professionals in the institution of which indicate that, 30% of the respondents were structural engineers which has the highest frequency and 27% were electrical engineers, 13% were quantity surveyors, 10% were builders, 7% were mechanical engineers, 3% were Estate Surveyors, 3% were technologist and 3% ICT respectively. Based on the result of the professional career of the respondent within the group it can be concluded that the respondents represent a good spread of structural engineer who have in depth knowledge on many areas of facilities management profession in the construction processes. The data provided by the respondents could be relied upon for the purpose of the analysis.

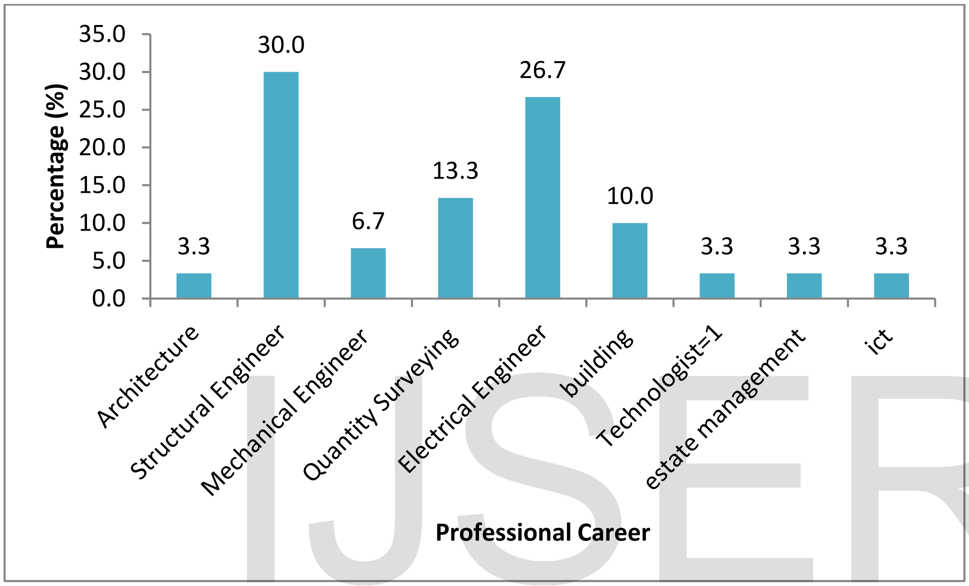

Figure 3 Career of the Professionals

Source: Field Survey (2018)

Readiness to adopt Computerize Maintenance Management System

From Table 2 shows the respondent views on the Readiness to adopt Computerize Maintenance Management System. The use of CMMS tools will facilitate and improve faster and more cost effective business processes is ranked first with the mean score of 3.93 and it is significant. The use/need of CMMS tools to facilitate and improve faster and more cost effective business processes is seen as the most significant Readiness measures to adopt Computerize Maintenance Management System. According to Crain (2016) this is necessary because it will Encourage, among the maintenance team (and even your organization), the use of up-to date concepts, both maintenance concepts and management concepts, Obtain knowledge/information on maintenance, systematize it and make it available for anyone, anywhere – and no longer needing to rely on people's heads, Introduce improvements in the Organization, starting immediately with the Implementation process, Automatically produce reports and KPIs for Management and ultimately Increase productivity. Effective business processes have people with the ability to implement change and move quickly to adopt and use CMMS tools ranked second with a mean score of 3.80, which is significant. The use of CMMS tools will improve integration of design and construction

ISSN 2229-5518

processes ranked third with a mean score of 3.77, which is also significant. The staff fully understand the importance of training required for using CMMS tools is ranked fourth with a mean score of 3.70, which is significant. Qualified IT staff that can manage CMMS operations with other professionals ranked fifth with a mean score of 3.67 and it's significant. Staff recognized the importance and benefits of adopting and using CMMS tools in practice of building design and management of facility ranked sixth with a mean score of 3.60 and which is significant. Having the necessary computer literacy, functional expertise and skills to use CMMS tools ranked seventh with a mean score of 3.53, which is significant. Design professionals have adequate knowledge on the use of CMMS tools and adequate infrastructure (computer systems and software) to support CMMS adoption in the company ranked eighth with a mean score of 3.50 each, which is also significant.

However according to Wienker *et al* (2016) despite the importance of the CMMS as a key tool in maintenance management, the degree of success achieved in successfully implementing such systems, even in large, well–resourced organizations, is surprisingly poor. According to internet research, the number of successful CMMS implementations is only around 25 – 40 % and the number of users that use a CMMS or eAM at its full capability is only 6-15%. Six (6) key reasons for poor implementation success are: 1. Attempting to implement a new maintenance management strategy & the associated processes and tools such as a CMMS to an organization that is not "ready". 2. Believing that the CMMS is the "strategy" rather than one of the "tools" to facilitate effective implementation of the Maintenance Management Process. 3. Inadequate IT infrastructure. The failure to ensure that IT related issues are resolved. (E.g., poor network capacity and speed demotivate people quickly). 4. The failure to sell the benefits of the CMMS to senior management & hence sustain their support over the often-long duration of the implementation. 5. The failure to understand the need for a well-designed "change management" process. 6. Inadequate resources to carry out the implementation.

Table 2: Readiness to adopt Computerize Maintenance Management System

S/N	Readiness	Management Readiness						
		N	Minimum	Maximum	Mean	Std.Err	Std. Deviation	Positions
1	Management is keenly interested in working with CMMS technologies	30	1	5	3.20	.206	1.126	1st
2	Recognized the importance and benefits of adopting and using CMMS tools in our practice of building design and facility management	30	1	5	3.20	.242	1.324	2nd
3	Ready to align business processes to achieve CMMS implementation in practice	30	1	5	3.13	.248	1.358	3rd
4	A policy for training and capacity building to keep our staff up to date with CMMS tools	30	1	5	2.97	.277	1.520	4th
5	Management is aware of CMMS technology and its benefits to the public facility	30	1	5	2.80	.269	1.472	5th
6	Aware of the successes recorded by using CMMS tools in public facility	30	1	4	2.73	.185	1.015	6th

ISSN 2229-5518

7	Change management strategies that will ensure successful migration to CMMS based practices	30	1	5	2.70	.215	1.179	7th
8	Developed business strategies that will drive successful CMMS adoption in organization	30	1	4	2.67	.200	1.093	8th
9	Provided adequate financial resources to facilitate CMMS implementation in practices	30	1	5	2.40	.243	1.329	9th
Average mean					**2.87**			
Process Readiness								
10	Use of CMMS tools will facilitate and improve faster and more cost effective business processes	30	1	5	3.93	.214	1.172	1st
11	Use of CMMS tools will improve integration of design and construction processes	30	1	5	3.77	.223	1.223	2nd
12	Business process supports and encourage interdisciplinary/inter organizational collaboration	30	1	5	3.47	.184	1.008	3rd
13	Existing business processes are flexible enough to accommodate CMMS technologies	30	1	5	3.37	.232	1.273	4th
14	Identified the bottlenecks and inefficiencies in current business process	30	1	5	3.07	.209	1.143	5th
15	Made changes to current business (where necessary) to facilitate the adoption of CMMS technologies	30	1	5	2.60	.212	1.163	6th
16	Designed new web based information sharing system that supports collaboration of design team members from all disciplines	30	1	5	2.53	.234	1.279	7th
17	Some CMMS tools to exchange design information internally (within the organization) and externally with other professionals in the design and construction	30	1	5	2.47	.234	1.279	8th
Average mean					**3.15**			
People Readiness								
18	People with the ability to implement change and move quickly to adopt and use CMMS tools	30	2	5	3.80	.169	.925	1st
19	Staff fully understand the importance of training required for using CMMS tools	30	1	5	3.70	.199	1.088	2nd
20	Qualified IT staff that can manage CMMS operations with other professionals	30	1	5	3.67	.205	1.124	3rd

21	Recognized the importance and benefits of adopting and using CMMS tools in our practice of building design and management of facility	30	1	5	3.60	.218	1.192	4th
22	Staffs have the necessary computer literacy, functional expertise and skills to use CMMS tools	30	1	5	3.53	.252	1.383	5th
23	Design professionals have adequate knowledge on the use of CMMS tools	30	1	5	3.50	.229	1.253	6th
24	Encourage all staff to learn and use CMMS tools in all applicable practices	30	1	5	3.20	.232	1.270	7th
25	Committed to addressing any issues/inhibitions that staff may have about using CMMS tools	30	1	5	3.10	.211	1.155	8th
26	Current organizational structure provides an environment that is well suited for CMMS adoption and use	30	1	5	3.03	.242	1.326	9th
27	CMMS managers/users have adequate knowledge of the business processes with CMMS tools	30	1	5	2.97	.227	1.245	10th
28	Devised training procedures that will enable staff to effectively use CMMS tools	30	1	5	2.93	.253	1.388	11th
29	Identified and clearly defined roles and responsibilities of staff who use (or will use) CMMS tools	30	1	4	2.90	.205	1.125	12th
30	Provided design department with the necessary manpower to handle CMMS applications and tools	30	1	5	2.70	.263	1.442	13th
Average mean					**3.28**			
Technology Readiness								
31	Adequate infrastructure (computer systems and software) to support CMMS adoption in our company	30	1	5	3.50	.253	1.383	1st
32	Familiar with the use specialist software applications related to expertise	30	1	5	3.33	.268	1.470	2nd
33	Well defined IT policy in our organization	30	1	5	3.20	.242	1.324	3rd
34	Effective intranet and extranet facilities to facilitate information sharing and interoperability in working with CMMS tools	30	1	5	3.13	.266	1.456	4th
	Average mean						**3.29**	

Source: Field Survey (2018)

It can be depicted from the results that considering the levels of measurement developed by Ruikar *et al*; (2006), all the public institution in Zaria can be said to be partially ready. This is based on their analytical frame (management, technology, process and people) for the adoption of

ISSN 2229-5518

computerize maintenance management system, considering their mean score between <3.5 and >2.5 in all the four elements of readiness assessed.

ssessment for CKM	Average mean score	Readiness	Colour
Management Readiness	2.87	Partially ready	Amber
Process readiness	3.15	Partially ready	Amber
People Readiness	3.28	Partially ready	Amber
Technology Readiness	3.29	Partially ready	Amber

Source: Field Survey (2018)

Table 3: Readiness Classification

Source: Field Survey (2018)

Figure 4: Colour Presentation of CMMS readiness

The technology readiness however has the highest average mean score of 3.29 which is significant and this implies that the public institutions are partially ready technologically for the adoption of computerize maintenance management system. People readiness is the second highest with an average mean score of 3.28 which is significant and it implies that people are partially ready for the adoption of computerize maintenance management system within the public institutions. Process readiness rated thirdly with an average mean score of 3.15, which is also significant, and this as well implies that the public institutions are partially ready process wise for the adoption of computerize maintenance management system. Lastly the management readiness rated the lowest with an average mean score of 2.87 but yet still implies that the management of the public institutions are also partially ready for the adoption of computerize maintenance management system. Abubakar, Ibrahim, Kado, and Bala, (2014), identified that management is key in determining the readiness to adopt any technology in the system, considering their role as the highest decision making body in the organization. Management directly or indirectly controls the other elements such as people, process and technology. Therefore, it is important to note that that the adoption of CMMS in public institutions is largely dependent on the management readiness.

The overview and adoption of any new technology such as CMMS frequently necessitates that the key elements that aids the adoption by the related stakeholders be recognized and addressed for the successful take up of the innovations and subsequent benefits to be derived. Fox and Hietanen (2006) put that some of these obstacles are detailed to CMMS, whereas others are universal to the diffusion of innovation. Eastman, Teichol, Sacks and Liston (2011) posited that the elements to CMMS adoption fall into two categories: process and technology related to readiness and implementation. Autodesk (2004) on the other hand view the elements to CMMS adoption in three aspects as transactional process, people, and management. On critical observation, it can be grasped that all these aspects of can conveniently and adequately fall into the categorization by Eastman et al. (2011) and are considered very important.

Some of them include lack of highly skilled cross trained staff with both facility management and IT skills could hinder the realization of CMMS benefits, (Fox & Hietanen, 2006). A survey conducted in UK reported the primary barriers to the adoption of CMMS by the UK facility management companies as the unfamiliarity of companies with the use of CMMS, reluctance to train staff or initiate new work flows, lack of opportunities to implement, and lack of proof for tangible benefits of CMMS. The same survey also discovered that deficiency of training, cost of training and huge costs of software are the barriers to CMMS adoption by other respondents. Ayarici et al. (2009).

Conclusion and Recommendations

Based on the average mean of each of the determinants of the public organization's readiness. The technology readiness MS of 3.29 which indicates partially ready, People readiness has MS of 3.28 which indicates partially ready; Process readiness has MS of 3.15 which is also indicates partially ready, while management readiness has MS of 2.87 which is indicates partially ready. This therefore imply that the public institutions are partially ready for the adoption of computerized maintenance management systems (CMMS), however there is need to put certain considerations as identified in the research especially at management level. The research recommends that as much as process, people and technological readiness is important, there is also the need for management of public institutions to identify the far-reaching possibility of CMMS in maintenance, to encourage management readiness, and hence full adoption of CMMS in public institutions.

References

Abubakar, M., Ibrahim, Y. M., Kado, D. and Bala, K. (2014). Contractors Perception of the Factors Affecting Building Information Modelling (BIM) Adoption in the Nigerian Construction. Proceedings of 2014 International Conference on Computing in Civil and Building Engineering 167-178.

Aminali, P., Albadvi, A. and Nauden, P. (2009). Application of VERDICT for Electronic readiness Assessment within Iran's automotive industry. European journal of operational research.

Asiabaka, P. (2009). The Need for Effective Facility Management in Schools in Nigeria. New York Science Journal.

Azahar N. F, and Mydin A. O. (2014). Potential of Computerized Maintenance Management System in Facilities Management. School of Housing, Building and Planning, Universiti Sains Malasia. EDP Sciences, SHS web conference 11, 01010.

Aziz, N. M. and Salleh, H. (2011): A readiness model for IT investment in the construction Industry. African Journal of Business Management 5 (7), 2524-2530, 4 April.

Crain, M (2016). The Role of CMMS. A white paper on the selection and implementation of computerized maintenance management systems. Industrial Technologies Northern Digital, Inc.

Eastman, C., Teichelz, P.M., Sacks, R., Liston, K. (2011). A Guide to Building information modelling for owners. Article January 2011.

EN 13306. European Standard: Maintenance Terminology 2007. Trilingual version EN13306:2007-12

Faiz, R. B. and Edirisinghe, E. A. (2009). "Decision Making for Predictive Maintenance in Asset Information Management", Interdisciplinary Journal of Information, Knowledge and Mgt., 4, 23-36.

Isabel, L. Patrícia S., Sandrina V., Vera S., Catarina T., João L., Anabela A., José A,. Oliveiraa, Manuel F., (2016) –82Requirements specification of a computerized maintenance management system. Sixth international conference on challengeable, Anglie, Reconfigurable and Virtual Production 52, 268-273

Iwarere, H. T. and Lawal, K. O. (2011). Performance Measures of Maintenance of Public Facilities in Nigeria. Research Journal of Business Management, 5: 16-25

Khalfan, M. M. and Anumba, C. J. (2000). Readiness Assessment for Concurrent Engineering in Construction, Bizarre Fruit 2000 Conference, University of Salford, 9-10 March 2000, 42-54.

Kirkman,L.,Rosen, B., Gibson, B. Mcpherson, (2002). Five challenges to virtual Team success: Lesson from sabre inc Ausgust 2002

Laudon, K. C and Laudon, J. P. (2000). Management information systems. vol. 6. Prentice Hall Upper Saddle River, NJ.

Moser, C. A., and Kalton, (1971). Survey methods in social investigation. Second edition A-Z index publications.

Muchiri, P., Pintelon, L., Gelders, L. and Martin, H. (2011). Development of maintenance function performance measurement framework and indicator international journal of Economics 2011, 131, 1295-302.

Muller A, Marquez A. C and Iung B, (2014). “On the concept of e-maintenance: Review and current research”, Reliability Engineering and System Safety, 93. 1165-1187.

O'Brien, J. (2016). Comprehensive CMMS Implementation Guide. A complete resource for all the information you need to research, source, set-up and excel at CMMS.

Ramachandra, C. G., Srinivas, T. R. and Shruthi, T. S. (2012). A Study on Development and Implementation of a Computerized Maintenance Management Information System for a Process Industry International Journal of Engineering and Innovative Technology (IJEIT) 2(5).

Rajasekar, S., Philominathan, P. and Chinnathambi,V. (2013). Research Methodology, School of Physics, Bharathidasan University, Tiruchirapalli – 620 024, Tamilnadu, India.

Ruikar, K. Anumba, C. J. and Carrillo P.M. (2006). VERDICT--An e-readiness assessment application for construction companies. Automation in Construction, 15(1): 98-110.

Stamboliska, Z., Rusiński, E., and Moczko, P. (2015). Proactive Condition Monitoring of Low-Speed Machines, Cham: Springer International Publishing; 9–34.

Tsang, A.H.C. (1995). Condition-based maintenance: tools and decision making. J Qual Maint Eng; 1:3–17.

Vaezi, K. Seyed, Sattary, H. and Bimar, I. (2009). Comparison of E-readiness assessment models. Scientific research and essays. A scientific research and essays 2009: 4(5).

Wienker, M., Henderson, K. and Volkerts, J. (2016). The Computerized Maintenance Management System An essential Tool for World Class Maintenance. “SYMPHOS 2015”, 3rd International Symposium on Innovation and Technology in the Phosphate Industry. Procedia Engineering 138, 413 – 420.

Yam, R. C. M., Tse, P. W., Li, L. and Tu, P., (2001) “Intelligent Predictive Decision Support System for Condition-Based Maintenance”, the international journal of advanced manufacturing 17, 5,383-391, 6-2001.

Yee, V. (2007). Advancing CMMS to Support Performance Based Asset Management .Proc Water Environ Fed 2007; 894–902.

Ying, Z. U. (2008). CMMS integrated system and its application based on TPM and RCM synergic relationship. Chinese journal institute of manufacturing engineering 6-2008.

Yu, C. S., Lee, Y.C. and Lin, C.Y. (2011). Enhancing maintenance management using building information modelling in facilities management. Department of Civil Engineering, National Taipei University of Technology, Taipei, Taiwan

Zhang, Z., Li, Z., and Huo, Z. (2006). CMMS and its application in power system. Int J Power Energy System; 26:75