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WORK ORDER BUILDING INFORMATICS PLATFORM FOR PLANNING RESIDENTIAL BUILDING PROJECTS AND MAINTENANCE WORK

Amusan, Lekan, Kehinde Ayo-Yussuf, Ayodeji Ogunde, Tunji-Olayeni P., Adedeji Afolabi, James Owolabi

Covenant University, Department of Building Technology,
College of Science and Technology.

ABSTRACT

Building and facility maintenance is one of the important aspect of life cycle of a building or facility, and this has been done overtime with manual approach which tends to create an effectiveness gap between the time of ordering for work and the execution time, therefore the need for an automation system. Therefore adopting an automated system that could help in proper management of the maintenance process is highly essential. The study aims to fill the knowledge gap through developing a platform through which facilities and building users can request for maintenance work to be done, this would eliminates delay in work execution and request processing and aids maintenance planning scheduling and execution. The platform is compact and well guided with a view to facilitating and eliminating facility and building maintenance vices. Also the knowledge gap was filled based on data obtained through questionnaire survey that was conducted between 2017 and 2018 in Nigeria involving 60 residential accommodations with maintainable facility components, while the task of developing the web platform was achieved with tools like PhP and MySQL. Descriptive statistics, categorical regression and factor analysis, mean item scores, simple percentages were used to analyze the data. The following parameters were investigated and analyzed; factors influencing the effectiveness of the proposed maintenance platform, critical success factor in deployment of the interphase, importance of web based maintenance work order portal system, critical components for an effective payment platform and creating a sustainable web-based platform. The study identified important factors, which are critical to the realization of the sustainable platform as, include high human-machine compatibility, good internet and intranet facility, high ergonomic component design, effective return time in request execution, eliminating delay in work execution among others. The above factors formed part of the contribution of the study to the body of knowledge in the field of ICT applications in building and facility maintenance operations. The study concludes by bringing to the fore parameters like access to regular power supply and computer

literacy, technical intelligence or know-how among others as factors that influences the usefulness of the Web-based maintenance work order platform interface.

Key words: Information, Work order, Platform, Planning, Residential Building.

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1. INTRODUCTION

Construction is considered to be the most basic and critical all through the lifecycle of the development of community. The deterioration of buildings in the construction sector has caused a tremendous damage, thus it is important to ensure proper maintenance to prevent deterioration. The deterioration and making good of the environment all depends on human factor that determines the level of the human efforts. Past and current maintenance practices in private and public environment shows that proper maintenance involves a technology base system which will regulate its actions. According to English dictionary maintenance is an action performed to keep some machine or system functioning or in service. Maintenance brings about improved operation of buildings ensuring a high safety standards. Maintenance should be encouraged more rather than less, so it is necessary to improve the value and amenity of the building to be maintained. Most buildings are usually neglected in which defects occur and may result in extensive and avoidable damage to the building fabric or envelope (Adam, Carton and Sammon 2007). Successful maintenance administration has tremendous human motivating factor on running cost of particular building. Another recognized issue of support organization is nonattendance of completed outlines, to realize, control and measure the upkeep execution of the workplaces (Chanter and Swallow, 2007, Adriaanse and Voordijk 2005). According to English dictionary, maintenance can be defined as actions performed to keep machines, systems functioning or in continuous operation. Maintenance is the process of preserving a condition or situation or the state of being preserved. Olameji (1996) describes maintenance as the combination of any actions out to retain an item in or to restore it to an acceptable condition. There are different types of maintenance methods that are human factor related they includes: Strategic maintenance, Unexpected maintenance and Routine maintenance. Strategic maintenance is a deliberate work carried out by a skilled professionals, to confirm the present condition of an equipment whether it's effective and will avoid any breakdown of the system. Strategic maintenance can be sub-divided into various categories namely; Strategic corrective maintenance, Strategic preventive maintenance and Condition-based maintenance. In addition, planned corrective maintenance is the most straight forward in term of application among other methods. It is a type of building upkeep methodology, where a component in a building is utilized until the point that it breaks down. It covers all exercises, including substitution or repair of a component that has neglected to a time when it cannot play out its required capacity. On the other hand, planned preventive maintenance is usually carried out by personnel for the purpose of sustaining equipment and facilities in suitable working conditions by providing for system monitor, usually for finding and rectification of failures just before damage or after damage. Finally, conditioned -based maintenance is a concept that could be described as adjustment in condition or performance of an item that requires maintenance. According to Kelly and Anyakoha (1991) defines conditioned-base as the maintenance carried out because of major deterioration in a building. This is usually determined by a monitored parameter of

the unit performance. Conditioned-based maintenance could be summarily described as maintaining buildings a need arises.

2. CAUSES OF MAINTENANCE

According to Arayela and Adams (2001), maintenance work is generated by factors such as; weathering-low initial expenditure, corrosion-structural and thermal, interior outline the utilization of substandard materials for workmanship, poor supervision by clients, danger of wear and tear, age of the building (Babatunde 2012). The rapid deterioration of buildings and their components was attributed to many different factors by Amusan, Dosunmu and Opeyemi (2017) such as; inappropriate use by the inhabitants, consideration given to support of the building parts and poor understanding of the different systems of decay or deterioration.

2.1. Process and Procedures for Maintenance

According to Ransom (1985) effective building maintenance requires accurate analysis of defects and implementation of proper correction method, based on practical information otherwise there can be generation of construction waste materials while carrying out the maintenance operation. However, with careful planning, wastage could be eliminated. Nonetheless, Smith (2003) stated that planning the progress for usage of the best maintenance practices is essential. Timetables, individual assignments, documentations must be produced before changes start to happen.

2.2. The Need for Importance of Web-Based Maintenance Work Ordering System

The quick utilization of e-ordering framework will require a help of ICT abilities among laborers in the development business. Application of ICT in maintenance operation can affect the effectiveness of maintenance operations. It has been established that ICT based applications has increased the speed of maintenance effectiveness and quality of work among other things (Acar, Kocak, Sey and Arditi 2005).

3. RESEARCH METHODOLOGY

Startified sampling method was used in this study. Also the knowledge gap was filled based on data obtained through questionnaire survey that was conducted between 2017 and 2018 in Nigeria involving 260 residential accommodations with maintainable facility components, while the task of developing the web platform was achieved with tools like PhP and MySQL. Descriptive statistics, categorical regression and factor analysis, mean item scores, simple percentages were used to analyze the data. The following parameters were investigated and analyzed; factors influencing the effectiveness of the proposed maintenance platform, critical success factor in deployment of the interphase, importance of web based maintenance work order portal system, critical components for an effective payment platform and creating a sustainable web-based platform. Population sample 260 residential accommodation was used while sample size of 150 was picked from the population. The study respondents for this research includes facility managers and home owners of residential accommodation pulation frame. Therefore in line with sample size, 200 questionnaire designed in Likert scale of scale 1-5 was administered on building maintenance opertaot and professionals. Questionnaire survey was used for the main research design for maintenance practitioners and users in residential accommodation. Some other approaches such as the descriptive and explanatory approach were used for literature review and in collating information about the study and to analyze the data, collection and presentation.

3.1. Analysis and Presentation of Results

Table 1 Factors Influencing Effective Maintenance

S/N	Factors	Mean Score	RAI	Rank
1	Proper understanding of maintenance practice.	3.93	0.79	1st
2	Prefential treatment based on how much they can pay to the maintenance department.	3.60	0.72	4th
3	Poor understanding of how to fix defect in building.	3.45	0.70	5th
4	The quality of maintenance of resident users.	3.85	0.77	2nd
5	Maintenance quality depends on the amount of rentage paid by the occupants.	3.03	0.61	9th
6	Shortage of personnel to attend to complains	3.69	0.74	3rd
7	Insufficient capital to sustain maintenance	3.25	0.65	6th
8	No record of maintenance request.	3.05	0.61	9th
9	Lack of regular maintenance check	3.08	0.62	8th
10	Lack of skilled personnel	2.88	0.61	9th
11	Late delivery of maintenance reports to personnel	3.23	0.65	6th

Source: 2018 Survey

Table 1 shows the factors influencing effective maintenance. This table identifies the views of respondents on the factors influencing effective maintenance. From the Table 1, the proper understanding of maintenance practice is highly required with the largest RAI value of (0.79) was ranked first. The quality of maintenance of the resident users is also required was ranked second in the RAI marking with a value of (0.77), shortage of personnel to attend to complains, ranked third in the RAI value of (0.74), prefential treatment based on how much they can pay to the maintenance department in the RAI with a value of (0.72) ranked fourth. Similarly, poor understanding of how to fix defects in the building in the RAI with a value of (0.70) was ranked fifth. However, insufficient capital to sustain maintenance and late delivery of maintenance reports to personnel with RAI value of (0.65) were ranked sith respectively. This was followed by the lack of regular maintenance check with RAI value of (0.62). The maintenance quality depends on the amount of rentage paid by the occupants and no record of maintenance request and lack of skilled personnel, which are the lowest ranked with RAI value of (0.61) respectively. This ranking shows that there is an effective maintenance system in place.

Table 2 Analysis of the Maintenance Policy and Schedule of Maintenance Practice

S/N	Feedback	Mean	RAI	Rank
1	Maintenance policy and schedule of maintenance practice that is being carried out by the management and occupiers	3.83	0.81	1st
2	Maintenance in the halls should be scheduled weekly	4.00	0.80	2nd
3	There is an effective maintenance policy in my hall of residence.	3.10	0.62	8th
4	Maintenance department always meet up to scheduled appointments.	3.18	0.64	5th
5	There is an effective response to repair of defects in my residence.	3.20	0.64	5th
6	Infrastructure develop defects as soon as it is maintained.	3.30	0.70	3rd
7	Maintenance in my hall is satisfactory.	3.33	0.67	4th
8	There is usage of standard materials	3.20	0.64	5th
9	There are skilled personnel attending to complains	3.08	0.62	8th
10	There is quick response to maintenance issues.	2.95	0.59	10th

Source: 2018 Survey

Table 2 shows the importance of using web-based ordering system for maintenance. This table shows the various correspondents views on the increased maintenance works order by students with RAI value of (0.76). This is followed by the easy documentation of maintenance

report with RAI value (0.73). Third which is the reduction in cost of maintenance has RAI value of (0.72), faster request for maintenance work and reduced corruption and increased level of transparency process with has a RAI value of (0.71) respectively. Also, easy access to maintenance page with RAI value of (0.70) was ranked third, the reduction in the use of paper has RAI value (0.68). This followed by the increased level of accountability with RAI value of (0.67) and the increased innovation and creativity with RAI value of (0.66).

Table 3 Important Tools to Web-Based System in Maintenance Works

S/N	Platforms	Mean	RAI	Rank
1	Microsoft Word	3.90	0.78	1ST
2	Microsoft Project	3.50	0.70	2ND
3	Microsoft Excel	3.40	0.68	4TH
4				
5	Email response	3.43	0.69	3RD

Source: 2018 Survey

From Table 3 shows the various important tools used in web-based maintenance system. The perception and views of the correspondents on the various important tools for a web-based maintenance work. From the table it can be seen that Microsoft word ha the following strengths: Availability and Self-adapting documentation platform, it has the largest RAI value of (0.78). Then also Microsoft project with the second largest RAI value of (0.70) has the following advantages relating to its strength, this includes: Maintenance presentations, and Preparing maintenance report sheets respectively while the weaknesses are found to be its high technical nature and high cost. This closely followed by email response with a RAI value of (0.69) with its various strength Fourth which is Microsoft excel with a RAI value of (0.68). This table convincingly describes the perception of the respondents on the importance of web-based tools (Acar, Kocak, Sey and Arditi 2005).

Table 4 Importance of Using Web-Based Ordering System For Maintenance

S/N	Importance	Mean	RAI	Rank
1	Increased maintenance works order by students	3.80	0.76	1ST
2	Reduction in cost of maintenance	3.58	0.72	3RD
3	Faster request for maintenance work	3.53	0.71	4TH
4	Easy access to maintenance page	3.50	0.70	7TH
5	Reduced corruption	3.33	0.71	4TH
6	Reduction in the use of paper	3.40	0.68	8TH
7	Increased level of accountability	3.43	0.67	9TH
8	Increased level of transparency process	3.53	0.71	4TH
9	Easy documentation of maintenance report	3.65	0.73	2ND
10	Increased Innovation and creativity	3.28	0.66	10TH

Source: 2018 Survey

Table 4 shows the importance of using web-based ordering system for maintenance. This table shows the various correspondents views on the increased maintenance works order by students with RAI value of (0.76). This is followed by the easy documentation of maintenance report with RAI value (0.73). Third, this is the reduction in cost of maintenance with RAI value of (0.72). This is followed by the faster request for maintenance work and reduced corruption and increased level of transparency process with RAI value of (0.71) respectively. This is followed by the easy access to maintenance page with RAI value of (0.70). The reduction in the use of paper with RAI value (0.68). This followed by the increased level of accountability with RAI value of (0.67). The increased innovation and creativity with RAI value of (0.66).

Table 5 Test on Homogeneity of Variances for Differences in Importance of Using Web-Based Ordering System For Maintenance

Levene Statistics	df1	df2	Sig.
9.767	3	835	0.000

Source: 2018 Survey Analysis

Implication of the results in the Table 5 above, is that there is no significant difference in the opinion among the Engineer, Architect, Maintenance supervisors and the Facilities users about the factors in Importance of Using Web-Based Ordering System for Maintenance.

Table 6 ANOVA Test on Differences in Factors Influencing Adoption of E-maintenance and Effective Maintenance Operation

Levene Statistics	Sum of Squares	df	Mean Square	F	Sig.	Remark
Between groups	.680	3	.387	1.432	.339	NS
Within groups	168.367	837	.186			
Total	169.407	850				

Source: 2018 Survey

Implication of the results in the table above is that there is no significant difference in the opinion among the Engineer, Architect, Maintenance supervisors and the Facilities users about the factors influencing adoption of E-maintenance platform and Effective maintenance operation. There tend to be agreement in the rating of the factors as earlier presented in Table 1.

4. WORK ORDER-BASED PLANNING INFORMATICS PLATFORM FOR BUILDING

The following were created and incorporated in to the developed work order system interface system. While the screen shots of the pages containing the incorporated features still under development is presented. Request/Ordering: i. The customer would be able to place request for material supply. ii. Database Creation: Provide platforms for access into already created database of departments in an organization, offices and units. iii.Material Ordering System: The incorporated facility for requisition facility incorporated into the device would enable online requisition of materials within an organization. iv.Ease of Access to Material v.: Provide platform for material requisition from available material lists and outlets. vi.Point of Registration for locations where items are to be repaired: Provide facility for data capture of customer and Supplier. vii.Notification System for type of optimum replacement method to adopt.

5. DEVELOPMENT OF A COMPACT WEB-BASED WORK ORDERING SYSTEM FOR BUILDING MAINTENANCE

i.Mobile Material Ordering System: The incorporated facility for requisition facility incorporated into the device would enable online requisition of materials within an organization.

ii.Ease of Access to Material Requisition: Provide platform for material requisition from available material lists and outlets.

iii.Point of Registration for locations where items are to be repaired: Provide facility for data capture of customer and Supplier.

iv.Notification System for type of optimum replacement method to adopt.

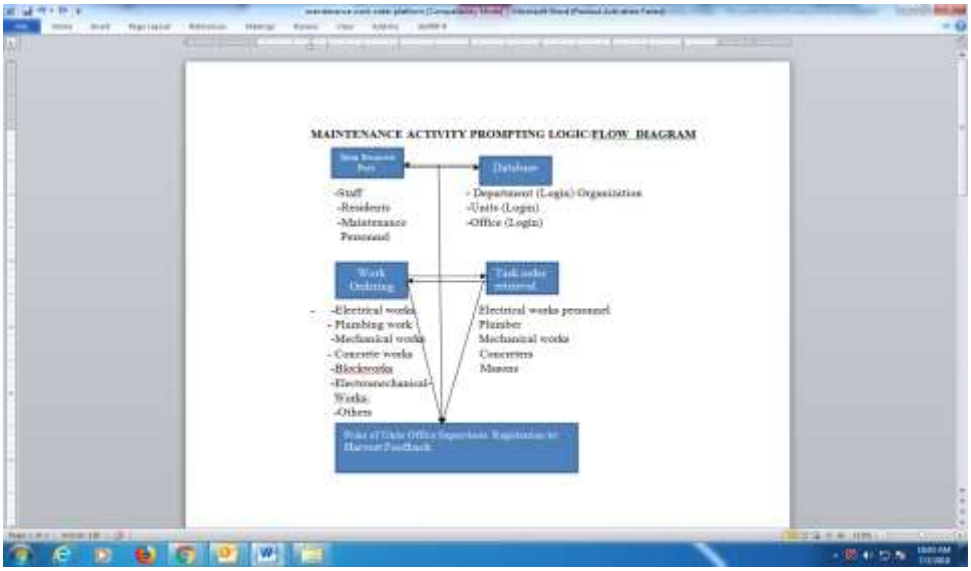

Figure 1 Screen Shot of Logic Flow Diagram for Maintenance activity Prompting Component of the Prompting Unit

Figure 2 Screen Shot of the Request Page

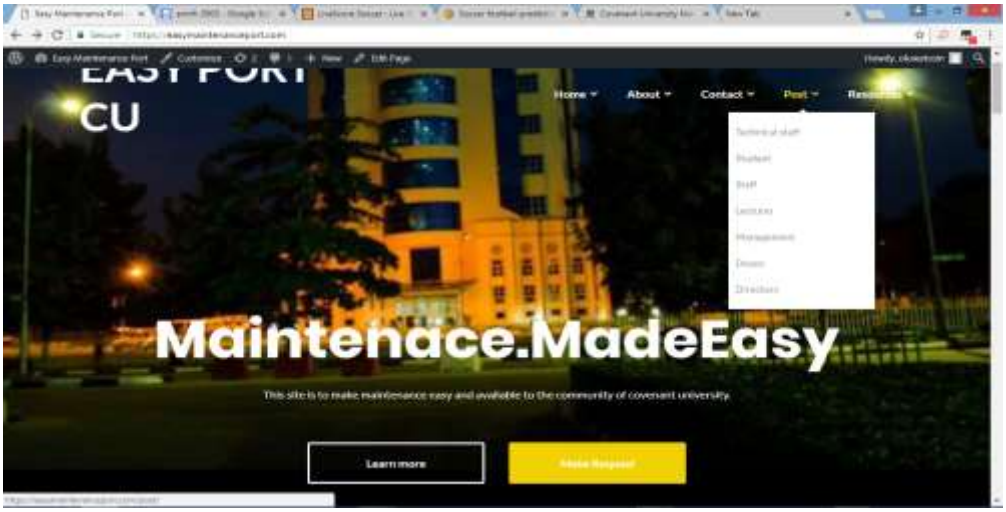

Figure 3 Screen Shot of the Application Resources Pane

This is the maintenance home page which covers the various information that is required for the site to be well utilized. These are included on the top right corner above the home pages which include home, about, contact, post, and resources. These various menus have sub menus attached to them individually.

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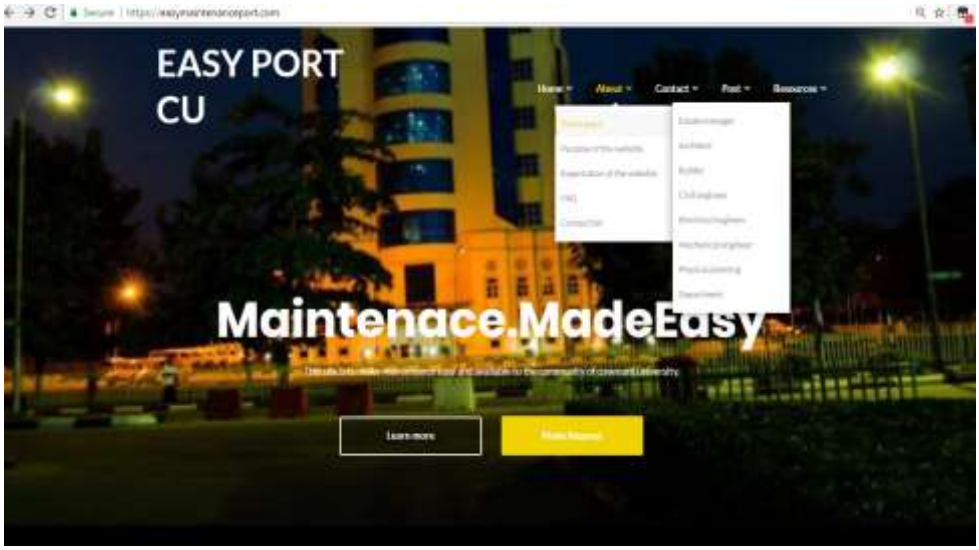

Figure 4 Screen Shot of Access Point for Connecting Information about Navigating the Site

This is the maintenance home page which covers the various information that is required for the site to be well utilized. These are included on the top right corner above the home pages which include home, about, contact, post, and resources. These various menus have sub menus attached to them individually.

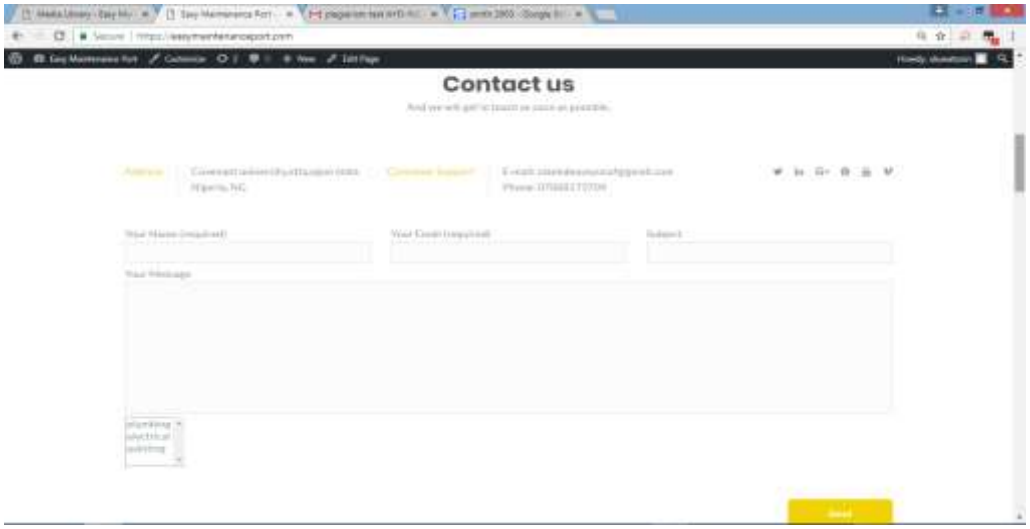

Figure 5 Contact Menu

This is the maintenance home page, which covers the various information that is required for the site to be well utilized. These are included on the top right corner above the home

pages, which include home, about, contact, post, and resources. These various menus have sub menus attached to them individually.

Table 7 Usability Test for the Compact Web-Based Work Ordering System for Building Maintenance Completion Rates [Usability scale of 1-10].

S/N	Parameters	System User I	SystemUser II	SystemUser III	SystemUser IV	SystemUser II	SystemUser III	SystemUser IV	SystemUser II	SystemUser III	SystemUser IV	Average Rating
i.	Requests on Plumbing works	8	7	6	7	7	7	8	8	8	9	7.5
ii.	Request on Concrete and Structural works	7	6	9	7	6	7	8	8	9	7	7.4
iii.	Electrical and Mechanical related request	6	7	7	9	6	5	9	8	8	8	7.3
iv.	Building Internal related civil works problems	6	5	8	8	7	5	9	9	9	9	7.6
v.	External works and environmental challenges	5	8	9	7	8	7	8	7	9	9	8.6

Usability test was carried out on the work order system for Building maintenance work. Average rating of the users is presented in Table 7. Usability of the system was rated averagely 7 out of 10 for the following work parameters; Requests on Plumbing works. Request on Concrete and Structural works, Electrical and Mechanical related request and External works and environmental challenges. The system was also rated as being averagely useful in carrying out operations in Building Internal related civil works. On account of this, the work content of building related problems need to be appraised and streamline areas that need to be augmented for the system to be able to be used to achieved near 100 percent Building Internal related civil works problems.

Table 8 Task Time Completion Rate[scale 0-1] 0= Task Failure; 1 = Task Success.

S/N	Parameters	System User I	System User II	System User III	System User IV	System User IV	
i.	Requests on Plumbing works	1	1	1	1	1	5
ii.	Request on Concrete and Structural works	1	1	1	1	1	5
iii.	Electrical and Mechanical related request	1	1	1	1	1	5
iv.	Building Internal related civil works problems	1	0	1	1	1	4
v.	External works and environmental challenges	0	1	0	1	1	3
	Total	4	4	4	5	5	22

Source:2018 Survey

Task completion rate was presented here on scale 0 to 1. One (1) represents the success rate while 0 represents failure rate. The system users rated the following items of work when

used on the developed system as successful on the following operations: plumbing works, concrete and structural works, Electrical and Mechanical engineering related request while one of the users was unable to record success in External works, and Building internal works. It took a while beyond 3 minutes to fill the required information and complete the task. The completion rate was measured in second considering time lag between the placing the fist order and the time the order was sent.

Table 9 Job Ordering Satisfaction Level

S/N	Parameters	System User I	System User II	System User III	System User IV
i.	**Requests on Plumbing works**	VE	VE	VE	VE
ii.	**Request on Concrete and Structural works**	VE	VE	VE	VE
iii.	**Electrical and Mechanical related request**	VE	VE	VE	VE
iv	**External works and environmental challenges**	VE	VE	VE	VE
v.	**Building Internal related civil works problems**	VE	VE	VE	VE

Source:2018 Survey Legend: VE= Very Easy.

The system was tested for job ordering satisfaction level using the following parameters Requests on Plumbing works, Request on Concrete and Structural works, Electrical and Mechanical related request, External works and environmental challenges and Building Internal related civil works problems. All the parameters measured are described as very easy to manipulate and carried out.

Table 10 System Usability

S/N	Parameters	S.U I	S.U II	S.U III	S.U IV	S.U V	S.U VI	S.UVII	S.U VIII	S.U IX	S.U X	Total
i.	**Login and log out protocol is cumbersome**	3	3	3	3	3	3	2	2	3	2	54%
ii.	**I would prefer frequent use of the system**	5	5	5	5	5	4	4	5	4	5	94%
iii.	**I need to learn many things to be able to use the system**	3	3	3	3	3	3	3	3	3	3	60%
iv.	**Professional should learn how to use the system on time to increase output**	5	5	5	4	4	5	5	5	4	4	92%
v.	**It speed up time lag between job order and response to job order**	5	4	5	4	4	5	5	5	5	4	47%
vi.	**The functions are well integrated**	5	4	5	4	5	5	5	5	5	4	94%
	Total	52%	48%	50%	54%	58%	50%	48%	50%	58%	44%	51.2%

Source:2018 Survey Legend: S.U = Service Unit

In Table 10 above, survey on test of system usability for the system developed was presented. The survey involved a Questionnaire designed in Likert scale 1-5. The scale is described as follow: 5- Strongly agree, 4-agree, 3-Strongly disagree, 2-Agree, 1-Neutral. The parameter that has to do with integration of features was described as good with 94% of the system users agreed to the system usability. In addition, 94% prefer frequent use of the system while 92% recommended that professional should learn how to use the system on time to increase output and productivity. In addition, 60% indicated that they do not need to learn many things to be able to use the system in other words it is easy to use. Finally 54% indicated that the system is cumbersome in term of accessibility of Log in and Log out procedure, the reason may be due to failure to remember login detail quickly which may lead to system denying such individual access to the platform

6. CONCLUSIONS

The study has presented a platform that could facilitate easy ordering and requesting for maintenance task that need to be carried out. The features that could facilitate easy application of the system has been presented as well. The system was validated with relevant parameters and opinion of earlier users of the pilot system was censored with their recommendation. Some are in support while some did not.

So also, the study has assessed the factors that influences maintenance and present the following factors: The Proper understanding of maintenance practice, lack on skilled personnel, and shortage of personnel to attend to complains among others. Also, the study identified important factors that are critical to the realization of the sustainable platform as include high human-machine compatibility, good internet and intranet facility, high ergonomic component design, effective return time in request execution, eliminating delay in work execution among others. The above factors formed part of the contribution of the study to the body of knowledge in the field of ICT applications in building and facility maintenance operations

REFERENCES

[1] Acar, E., Kocak, I., Sey, Y. & Arditi, D. (2005). Use of information and communication technologies by small and medium-sized enterprises (SMEs) in building construction. *Construction Management and Economics*, 23, 713-722

[2] Adam, F., Carton, F. & Sammon, D. (2007). Project management: a case study of a successful ERP implementation. *International Journal of Managing Projects in Businesses*, 1, 106-124

[3] Adriaanse, A. & Voordijk, H. (2005). Inter-organizational communication and ICT in construction projects: A review using meta-triangulation. *Construction innovation*, 5(3), 159-177.

[4] Amusan Lekan, Dosunmu Dolapo and Opeyemi Joshua (2017). International Journal of Mechanical Engineering and Technology (IJMET) Volume 8, Issue 10, October 2017, pp. 918–927.

[5] Anyakoha, M. W. (1991). *Basic librarianship: Modern technologies in information work*. Owerri: Totan publisher, 106-108.

[6] Babatunde, S. O. (2012). Quantitative Assessment of Construction Materials Wastage in the Nigerian Construction Sites. *Journal of Emerging Trends in Economics and Management Sciences (JETEMS)*, 3(3), 238-241

[7] Lekan M Amusan, Charles Ayo (2017) Multi-Parameter Optimization Of Cost Entropy For Reinforced Concrete Office Building Projects Using Ant Colony Optimization. Journal of Engineering And Applied Sciences.12(9). 2260-2275.

[8] Olameji (2009). *Material management handbook*. Aldershot, England

[9] Chanter and Swallow, 2007). *Materials management*. 4th edition, American Management Association, New York.