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# EXPLORING FACTORS THAT INFLUENCES THE ADOPTION OF ICT-BASED BUILDING AND CONSTRUCTION INFORMATICS PLATFORMS

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## ABSTRACT

*Construction industry has witnessed introduction of automation processes in executing construction operations. Introduction of green building concept, building automation, intelligent buildings and all informatics platform. In this study stratified sampling method was used in data collection. The knowledge gap was bridged with the aid of data collated through questionnaires distributed to 950 respondents. Population sample 100 residential accommodation was used while sample size of 95 was picked from the population. The study respondents for this research includes facility managers and professionals that have been informed in the use of informatics platform in solving built environment related problems. Existing informatics platforms were explored, level of awareness of the available informatics platform was also explored and later the factors that influences effective adoption of informatics platform in solving problems in building and construction works was presented in this study.*

**Key Words:** Informatics, Model, Adoption.

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## 1. INTRODUCTION

### 1.2. Understanding the Concept of Building and Construction Informatics

Building Informatics and Construction Informatics is one of the emerging areas of Construction automation, management and technology. All over the world, automation is gradually replacing manual work in administrative and technological function on construction sites, firms,

maintenance organizations, private establishment and facility management outfits. The trend has occurred as a result of multidisciplinary nature of construction industry. In recent time, with the advent of knowledge multiplication and wide scale application of computer and intelligent systems which is part of the components of Information communication technology (ICT) [1], [2],

Building informatics and Construction Informatics, is an aspect of application of ICT to building construction design, process, procurement, planning, construction, resources (time, cost, human resources and material resources) management, facility occupancy management and post-occupancy management. Some aspects that have been covered in application of Building and Construction informatics includes, Knowledge augmentation, Virtual reality, BIM, Intelligent systems, Neural networking, Expert systems among others.

However, ICT has found application in building construction in recent times. Some of the application that has been introduced and gradually gaining ground in term of their application in building construction design process and management includes the following: Design software, Planning software, Cost formation and planning software and various ICT platform. Overtime, there have been challenges, prospect, advantages and disadvantages of the informatics platforms, in the context of this study therefore, application platforms were explored and the factors that influences the adoption of informatics platforms were explored based on the opinion of professionals that have worked or came in contact with them overtime. The areas of informatics application was explored and selected theories that is relevant and supports the adoption of Informatics platform was presented in the study.

## **1.2. Theories of Adoption of Information Communication and Technology (ICT) in Construction.**

Application of ICT in building and construction works is often through innovation diffusion mechanism. Also, there are theories that underlines the innovation approaches in building and construction fields. In this study, some selected relevant theories were explored, such as Roger Everret theory of Innovation diffusion and Technology communication theory, and Claude Elwood Shannon and Warren Weaver theory of communication. There are other researches new models of communication from other scientific perspectives like psychology and sociology. In science, a model is a structure that represents a reality depicted by theory. Diffusion is the theory that tends to explain the reason for, why? how? when? which? and nature of spread of a technology. In the context of this study, it explains why, people adopt a technology, pattern of adoption and nature of diffusion pattern, when it would be adopted and the impact of the diffusion on the social system. In [1], diffusion of innovation theory was presented, the concept of adoption of innovative idea was expressed in context [3], [4], [5].

The theory presented succinctly four parameters that are german to the adoption of any informative system. The parameters include identification of channel of communication, time and social systems. The study presented certain assumption that impacts the adoption or rejection of an innovation. Some of the assumptions include certainty of information source, sourcing of information from interpersonal relationship, information are collected from respondents, opinion of respondents is objective and subjective in nature depending on research context[6],[7],[11].

[2] Presented communication theory. The study focussed explicitly oh the mechanism to design, code and transmit technological innovation and the mechanism and medium to transmit information to the audience. Probability theory was used as well in the study in information communication as developed by Nobert Weiner.

### **1.3. Areas of ICT informatics Platform in Building Informatics a Departure from Old Methods.**

There are many explored unexplored areas in Information communication technology in construction industry, The construction field involves preliminary study, feasibility study, design, planning, construction stage, costing of the construction components, management and coordination of activities, maintenance and post-occupancy stage of construction. However, certain ICT packages have found application in some of the above listed areas. One of the identified Building informatics application includes some of the following applications: Autodesk, Revit, Naviswork, Autodesk BIM 360, Sketch Up, Telkia BIM Sight, Procore, Dassault, system BIM, Trimble connect, ACCOSIM Building Designer, Hevacomp, BIM object, BIMX, ArchiCAD, Vector works Architect, E-difficulus, Medas Gen, Alphian Architecture, BuilderTrend, BricsCAD, Lean Kit and Touch plan among others [8], [9] and [10].

### **1.4. Review of Some Selected Existing ICT Application in Construction and Building Informatics.**

The importance of informatics platform in construction field cannot be overemphasized, and there are a number of Informatics platform that are often used for specific application in construction works such as costing of construction elements, project management and [8], maintenance. Some of the identified informatics platform for solving cost related challenges by construction professionals includes; Ms Excel, Alcon soft, Build soft Pro., WinQS, Civil, Autodesk Quantity Take off among others. They have regularized spread sheet as a common feature and they are used in solving the taking off of quantity and scheduling of prices challenges. Also, challenges in Project management are solved with the aid of the following applications: Zoho project, Liquid planner, Wrike, Team work projects, Celoxis, Microsoft project, Team Gantt and Clarizen among others. They are used in planning and coordination of construction activities on sites and off sites. The scope of application also includes human resources and materials sourcing, planning and procurement. Finally, there are specialized applications for maintenance and facility management problem solving. They are basically designed for solving design, procurement and project coordination in building post occupancy stage, facility management and maintenance management. They include: CBRE Service, Insight, 360-facility, I-Lab core facility management and Hippo CMMS among others [9], [10].

## **2. RESEARCH METHODOLOGY**

In this study stratified sampling method was used in data collation. Knowledge gap was bridged with the aid of data collated through questionnaires distributed to 50 respondents. 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 professionals that have been informed in the use of informatics platform in solving built environment related problems. Existing informatics platforms were explored, level of awareness of the available informatics platform was also explored and later the factors that influence effective adoption of informatics platform in solving problems in building and construction works [8], [9], [10].

## 2.1. Analysis of Results and Presentation

**Table 1** Existing Informatics Platform for solving Cost, Design, and Maintenance Challenges

S/N	Informatics Platforms	Professional				
		Architect	Quantity Surveyor	Builder	Civil Engineer	Facility Manager
		Relative Agreement Index[RAI]	Relative Agreement Index[RAI]	Relative Agreement Index[RAI]	Relative Agreement Index[RAI]	Relative Agreement Index[RAI]
1	Auto Desk BIM	0.82	0.92	0.75	0.76	0.75
2	Sketch Up	0.70	0.80	0.72	0.23	0.35
3	BIM 360	0.50	0.85	0.76	0.73	0.11
4	Win QS	0.85	0.75	0.70	0.00	0.10
5	Ms Project/Excel	0.80	0.35	0.76	0.67	0.21
6	Team Gantt	0.45	0.42	0.65	0.00	0.32
7	CBRE Service Insight	0.42	0.50	0.72	0.00	0.76
8	360 <sup>0</sup> Facility	0.35	0.65	0.80	0.00	0.80
9	Hippo CMMS	0.33	0.68	0.72	0.00	0.70
10	Builder Soft Pro.	0.80	0.78	0.73	0.45	0.73
11	Cu Easy Maintenance	Features Presented in Section II (Figs.1-4 ).				

Detail of existing informatics platform was presented in Table 1. The professionals' perspectives of the survey was presented in Table 1 using relative agreement index values. Different informatics platforms were explored, while professionals like Builders Architect, Quantity surveyor, Civil engineer and Facility manager among others. Architects and Quantity surveyors indicated highest recognition of the application of platforms such as Auto Desk BIM, WinQS, MS Project, Soft Pro and Builder soft informatics platform with RAI values of 0.82, 0.85, 0.80 and 0.80 respectively. Similarly quantity surveyor indicates the existence and application of Autodesk, BIM, Sketch up, BIM 360, WinQS and Builder soft Pro platforms. The opinion of Quantity surveyors sampled indicated that Autodesk, Sketch Up, BIM 360, WinQS are in use in solving problems and most popular among them with RAI values of 0.92, 0.80, 0.85 and 0.75 respectively. Among Builders, AutodeskBIM, Sketch up, BIM 360, MS Project and Excel platforms with RAI values of 0.75, 0.72, 0.76 and 0.70 are in much deployment by Builders. It was indicated as well that some facility management informatics platforms are also being used and common among sampled builders. The facility platforms includes CBRE Service Insight (RAI 0.72), 360<sup>0</sup> Facility (RAI 0.80), Hippo CMMS (RAI 0.72), and Builder soft (RAI 0.73). However, the core service of a professional could be attributed to the trend observed in the data spread, especially their areas of professionals core practice demand. For instance, Autodesk and Sketch up was common to all the software's demand of all the professional cadres sampled. Architect, Civil engineer and Quantity surveyors has highest subscription for Autodesk, BIM and the like while Facility managers subscribed for Autodesk BIM,3600 facility and Builder Soft Pro. Platforms, with RAAI values

of 0.85, 0.82 and 0.80 respectively according to ranking order. Similarly, the Quantity surveyors supported the existence and application of Autodesk, Sketch up, BIM 360, and Win QS to be in use in quantity surveyors' operations in solving problems and was popular among them with RAAI values of 0.92, 0.85, 0.80 and 0.75 respectively in the order of ranking.

Similarly among Builders and Civil Engineers, Autodesk BIM, Sketch up, BIM360, Ms. Project/Excel are in deployment in construction operations. Some platforms also find application in facility management, they include: CBRE Service, Service-Insight (RAAI 0.72) and 360 Facility with (RAAI of 0.80), Hippo CMS (RAAI 0.75) and Builder Pro. (RAAI 0.85). However, the core service of a professional could be attributed to the trend observed in the data presented in Table1 based on their core competence. For instance, Auto Desk and Sketch up was common to all the Software demand of the professional cadre sampled. Architect, Quantity surveyors, and Civil engineer has indicated highest subscription for Auto Desk, BIM and the like while Facility managers highly subscribed to Autodesk, BIM, CBRE Facility, Service Light and Builder Soft Pro.[5], [7].

**Table 2** Level of Awareness of Adoption of Building Informatics Platforms in Construction and Maintenance Works

S/ N	Application Users	Design [RAI]	Costin g[RAI ]	Plannin g [RAI]	Maintenanc e [RAI]	Average RAI
1	Architects	0.82	0.50	0.75	0.55	0.67
2	Builders	0.75	0.76	0.90	0.72	0.78
3	Civil Engineer	0.65	0.92	0.75	0.50	0.71
4	Cost Experts	0.55	0.89	0.68	0.68	0.70
5	Project Managers	0.70	0.77	0.80	0.67	0.74
	Mean Average RAAI	0.69	0.77	0.78	0.62	0.72

RAAI---- Relative Average Agreement Index, RAI—Relative Agreement Index.

In Table 2 level of awareness of building informatics platform among built environment related professionals was presented. Among the professionals, awareness about planning information platform was the highest with mean relative average agreement index (RAAI) of 0.78. This indicates that planning task is common among the chores of the professionals. Costing platform was ranked second high with RAAI of 0.77, while design platform was third highest with RAAI value of 0.69. Awareness and deployment of maintenance related platform was the least as recommended by the professionals with RAAI value of 0.62. The highest adopter of the platform according to the survey are Builders, there are project managers and Civil engineers among others. From the analysis, the high subscription to planning informatics platform reflected the veracity of application of planning platforms, the reason lies in the fact that planning is involved in executing various components of construction works., invariably all aspects of construction works involves planning.

**Table 3** Factors that Influences the Adoption of ICT Based Informatics Platforms for Construction Works.

S/N	Adoption Parameters	Mean	Rank
A	Organizational Related Factors		
1	Availability of trained expert to engage the platforms	0.82	1 <sup>st</sup>
2	Organizational Cybernetics challenges	0.78	2 <sup>nd</sup>
3	Preference of an organization for a particular platform type.	0.76	3 <sup>rd</sup>
4	Readiness of an organization to embrace ICT informatics platform	0.66	4 <sup>th</sup>
B	Professional Related Factors	Mean	Rank
1	ICT Compliance professional curriculum	0.92	1 <sup>st</sup>
2	Incorporation of ICT content in professional certification	0.69	2 <sup>nd</sup>
3	Professional reception to ICT application on construction work	0.43	3 <sup>rd</sup>
4	Technology transfers	0.37	4 <sup>th</sup>
C	Construction Industry/Stakeholders' Related Factors	Mean	Rank
1	Knowledge of adaptability of an application to challenges	0.95	1 <sup>st</sup>
2	Complex nature of construction tasks	0.90	2 <sup>nd</sup>
3	Reception of construction firms to informatics applications	0.70	3 <sup>rd</sup>
4	Expensive nature of informatics platform	0.68	4 <sup>th</sup>
D	Internet of Things Related Factors	Mean	Rank
1	Limited storage space	0.86	1 <sup>st</sup>
2	Interoperability of ICT functions	0.82	2 <sup>nd</sup>
3	Advent of Cloud storage facility	0.76	3 <sup>rd</sup>
4	Computer application literacy	0.76	4 <sup>th</sup>
5	Cybersecurity/cyber insecurity.	0.72	5 <sup>th</sup>

Factors influencing the adoption of informatics platform was presented in Table 3. There are number of factors that influences the adoption of informatics platform, the factors are divided into four (4) parts: Organizational Related Factors, Professional Related Factors, Construction Industry/Stakeholders' Related Factors, Internet of Things Related Factors. In organizational factor, availability of trained expert to engaged the platforms was ranked first RAAI value of 0.82, with as a priority, Cybernetics challenges was second with RAAI value of 0.78., others are ranked in the following order: Preference of an organization for a particular platform type with RAAI 0.76 and Readiness of an organization to embrace ICT informatics platform with RAAI value of 0.66 was ranked fourth.

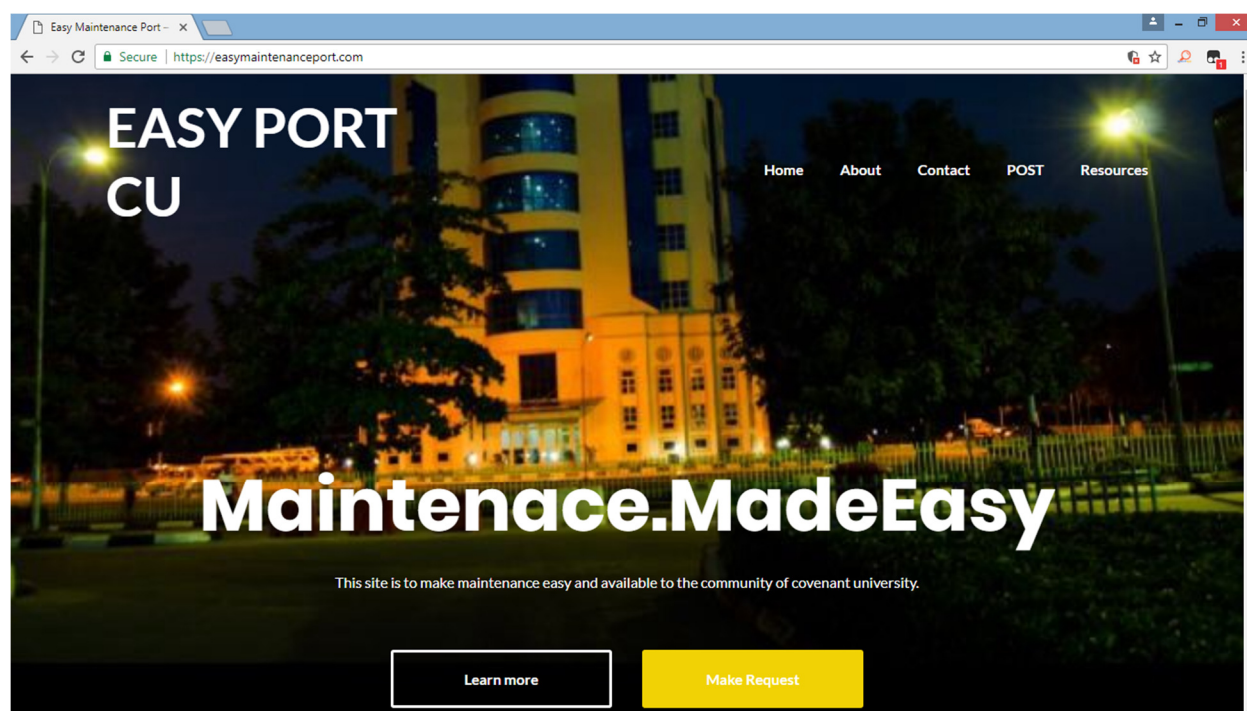
Also, professionally related factors is another important factors in consideration, under this group of factor, ICT Compliance professional curriculum was ranked first with RAAI value of 0.92, Incorporation of ICT content in professional certification with RAAI value of 0.69 was ranked second, Professional reception to ICT application on construction work was ranked third with RAAI of 0.43 while Technology transfers with RAAI 0.37 was ranked fourth. For effective understanding of ICT, integrating ICT study as cardinal point in the curriculum of professionals in the built environment followed by professional certification, to be part of their training and development in their institute, this would ensure thorough understanding of ICT

component of construction works. Also, the extent to which professionals are receptive to the application of the platforms is vital to ICT application in the construction industry.

Similarly, construction industry/stakeholders' related factors is also relevant as one of the factors that determines the application of informatics platform in building. Adaptability of users to innovation was ranked first with RAAI value of 0.95, complex nature of construction operations and construction tasks with RAAI value of 0.90 was ranked second, Expensive nature of ICT platform was ranked fourth with RAAI value of 0.70. Adaptability issues top the rank, the only thing that is constant is change, the man-machine compatibility plays a major role in adaptation of users to ICT platform, users should take time to study component of the ICT application for better understanding and application. In the same vein, the computer system should be made available at an affordable prices for easy circulation.

Finally, Internet of things related issues was also considered as one of the factors that influences adoption of ICT informatics platform in building and construction fields. Limited storage space, Interoperability of ICT functions, Advent of Cloud storage facility, Computer application literacy and Cybersecurity/cyber insecurity. The items were scored with the following RAAI values in this order; 0.86, 0.82, 0.76 and 0.72. Storage space is of utmost importance and some of the applications needs big storage database, also Interoperability of ICT functions. However panacea to this is availability of cloud storage facility. Cloud storage is a new dimension in the data storage science in the construction industry, the complex data of construction activity would enable large data to be stored in the cloud and utilized as occasion demands.

### 2.2.1. Screen Shot of a Typical Maintenance Informatics Ergonomic Portal



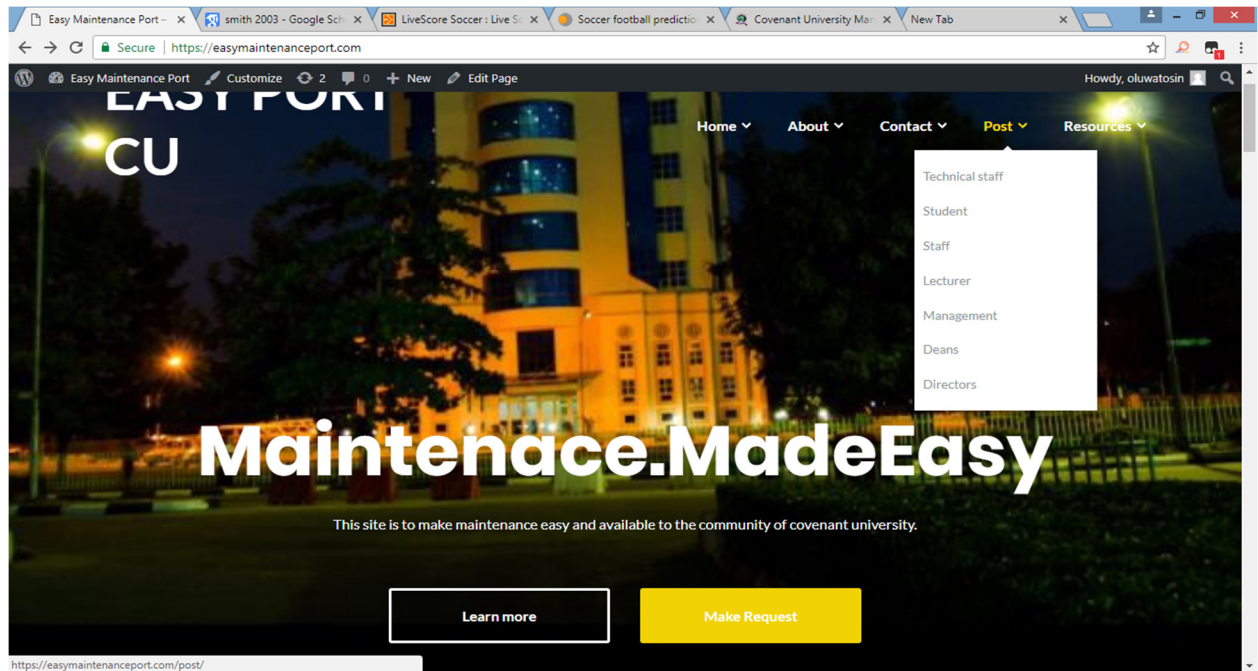
Amusan and Ayo-Yussuf et al (2018).

**Figure 1:** Request Access Portal Page

Maintenance made easy portal page was presented in Fig.1. The page contains the access page that contains all navigational details for the portal. Icons that leads to the detail about

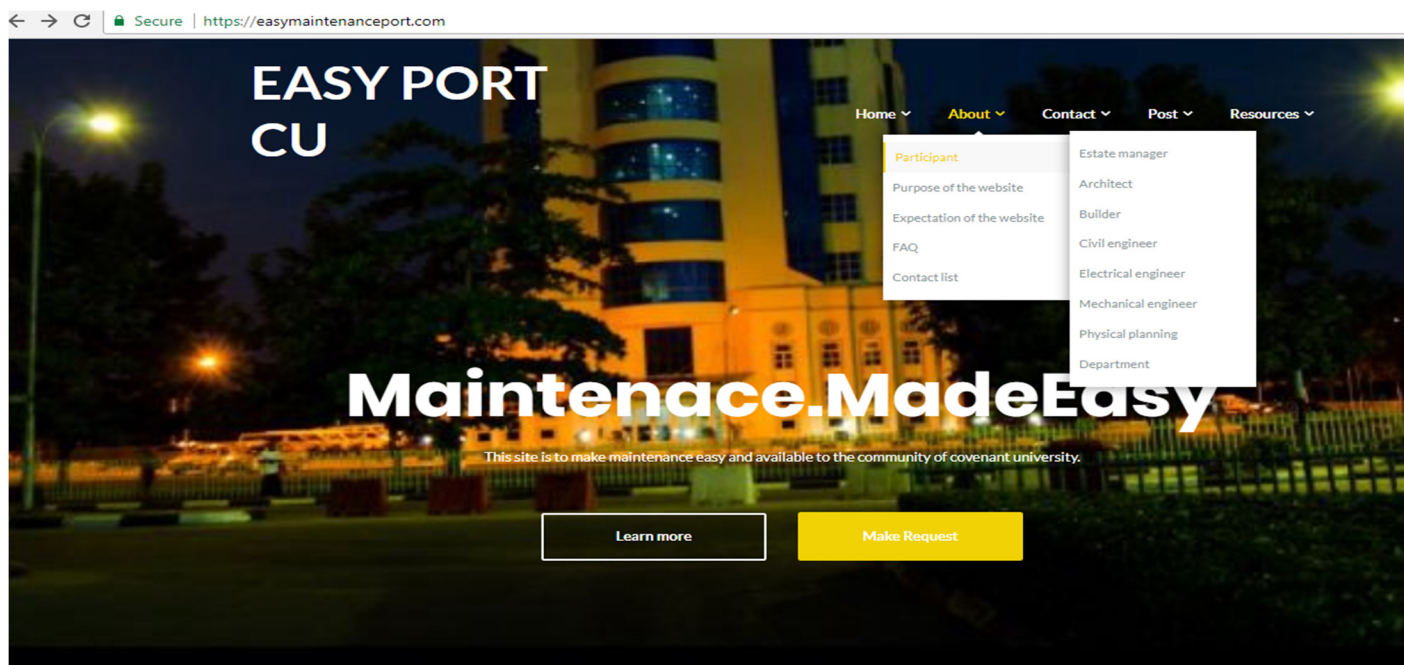


home page, resources available on the portal page, information access pane to learn about the page and icon points to make request for maintenance operations.



**Figure.2** Ergonomic arrangement of Posting Points and Resources Pane

The interface presented in Fig.2, it contains the 'Make request Icon', available services points, how to contact the resource officers in the charge of various services. The Icons are well arranged in a way that facilitates easy navigation across the portal.



Amusan et al (2018)

**Figure.3:** 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

### 3. DISCUSSION

In this study, exploratory approach to factors that influences the adoption of ICT-based building and construction informatics platforms was presented in this study. The study presented issues on theories of adoption of innovation and its diffusion drawing strength from Roger Everret(162) and Roger Everret(2003), level of awareness of informatics platform deployment, existing informatics platforms and factors influencing the adoption of informatics platform in construction operations. Also areas of application of ICT platforms in building and construction was presented. It was discovered that there has been prevalence of platforms in planning, design, costing and maintenance. However, there are few applications in the aspect of construction, facility management, maintenance and building costing. Also, level of awareness of ICT platform deployment was carried out, the general survey indicated that the awareness of application of ICT informatics platform has not been fully explored. There should be increased level of awareness in the application of ICT in solving a wide range of problems in construction. There is promise of an enhanced productivity and profit that could be achieved in the application of the informatics platform in construction operations when deployed appropriately.

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